Desktop Natural Hazards Risk Assessment Report

Version B

Pegasus Mākete, 1250 Main North Road, Woodend

Prepared for Dexin Investments Ltd

503498

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Quality Control Certificate

Eliot Sinclair & Partners Limited

eliotsinclair.co.nz

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Status	Description	Author	Release Date
A	First issue of document	P. Ngenang	20 December 2023
B	Second issue of document	P. Ngenang	04 March 2024

Executive Summary

Eliot Sinclair & Partners Ltd was engaged by Dexin Investments Ltd to undertake a calibrated desktop assessment to support rezoning of the land at Pegasus Mākete - 1250 Main North Road, Woodend ('the site') and to provide preliminary geotechnical foundation recommendations.

Eliot Sinclair's assessment considered the risk associated with natural hazards in relation to the RMA:1991. For this site, the most relevant natural hazards are earthquake shaking, earthquake-induced land deformation (settlement and lateral stretch), the possible presence of undocumented fill (associated with historic soil disturbance) presenting a settlement risk, tsunami, and flood inundation.

- **Methodology**

a) Our desktop assessment comprises of a review of available online geotechnical data and records that are relevant to the site and the wider area.

b) Eliot Sinclair has previously carried out significant investigation and reporting across the Pegasus area, hence, Eliot Sinclair is familiar with the local geotechnical conditions.

- **Key Findings**

a) The underlying ground model across the site is inferred to comprise of silt/sands with intermediate gravel layers within the upper 10m. It is likely the intermediate gravels taper out towards the south. Groundwater is expected to range between 1-2m below ground level.

b) Analysis of the inferred underlying ground model across the site indicates TC2 land performance where there is a dense and thick gravel body within the upper 10m soil profile. The presence of any dense sand or gravel at least 3-4m thick is likely to suppress any deeper liquefiable soils and is not likely to contribute much to liquefaction-induced damage to shallow foundations. Therefore, TC2 land performance is expected across the northeast part of the site and TC3 across the southwest part of the site. We note, to fully assess the representative land performance across the site and to better map the transition between the two Technical Categories, additional geotechnical investigation and assessment is required.

c) We have concluded that the risk and consequence of potential natural hazards is either acceptable or tolerable.

- **Recommendations**

a) Providing normal good practice investigation, design and development controls are implemented we have found no significant risks from natural hazards that would prevent the rezoning of the site.

b) Any new foundations shall be subject to detailed investigation and design. We assess that it is likely that the proposed building structures can be supported on either shallow or deep foundations.

Contents

1. Introduction

Eliot Sinclair & Partners Ltd was engaged by Dexin Investments Ltd to undertake a calibrated desktop assessment to support rezoning of the land at Pegasus Mākete - 1250 Main North Road, Woodend ('the site') and to provide preliminary geotechnical foundation recommendations.

In our preparation of the present report, we have relied exclusively on existing geotechnical investigations and our knowledge of the area.

Our calibrated desktop assessment will comment on the risk of natural hazards relevant to the site, as they relate to the proposed rezoning of the site.

2. Scope of Work

The scope of work for this assessment comprised:

- Review available data from the New Zealand Geotechnical Database[1] (NZGD), Canterbury Maps[2], Waimakariri District Council Natural Hazards Viewer[3] and the Institute of Geological & Nuclear Sciences' (GNS) Active Faults Database[4].
- Review over existing reporting and investigations relevant to the site.
- Undertake a calibrated desktop assessment (Level B) in accordance with MfE's '*planning and engineering guidance for potentially liquefaction-prone land*'.

Prepare a Desktop Natural Hazards Assessment Report to comment on the hazards relevant to the site, to summarise the general geotechnical conditions inferred across the site and to advise on preliminary geotechnical foundation recommendations.

3. Site Description

3.1. General

The site comprises a total area of approximately 3.05 hectares located on the corner of Main North Road and Pegasus Boulevard. The site is currently '*Rural*' in the operative Waimakariri District Council Plan with the proposed rezoning of the site as '*Special Purpose Zone*' to accommodate the '*Pegasus Resort*'.

The '*Special Purpose Zone*' will provide for a visitor destination to complement the Pegasus Resort activities, a range of agricultural tourism activities and some medium density residential development.

Refer to Appendix A for the proposed site plan.

The existing rural land comprise of a 170m^2 single storey dwelling constructed in the 1900s with an adjoining detached single garage and farm/garden sheds.

[1] New Zealand Geotechnical Database (NZGD) - https://www.nzgd.org.nz/

[2] Canterbury Maps - https://mapviewer.canterburymaps.govt.nz

[3] https://waimakariri.maps.arcgis.com/apps/MapSeries/index.html?appid=16d97d92a45f4b3081ffa3930b534553#

[4] GNS Active Faults Database - http://maps.gns.cri.nz/website/af/viewer.htm

The landform is typically flat with the *'Taranaki Stream (tributary of Rakahuri/Ashley River)'* intersecting the site with a southwest to northeast orientation. We understand the stream is spring-fed. Based on existing LiDAR records, the invert of the stream typically ranges from around 1m to 2m below surrounding ground level.

Refer to Figure 1 for the site layout plan.

Refer to Appendix B for site photographs sourced from Harcourts, retrieved in December 2023.

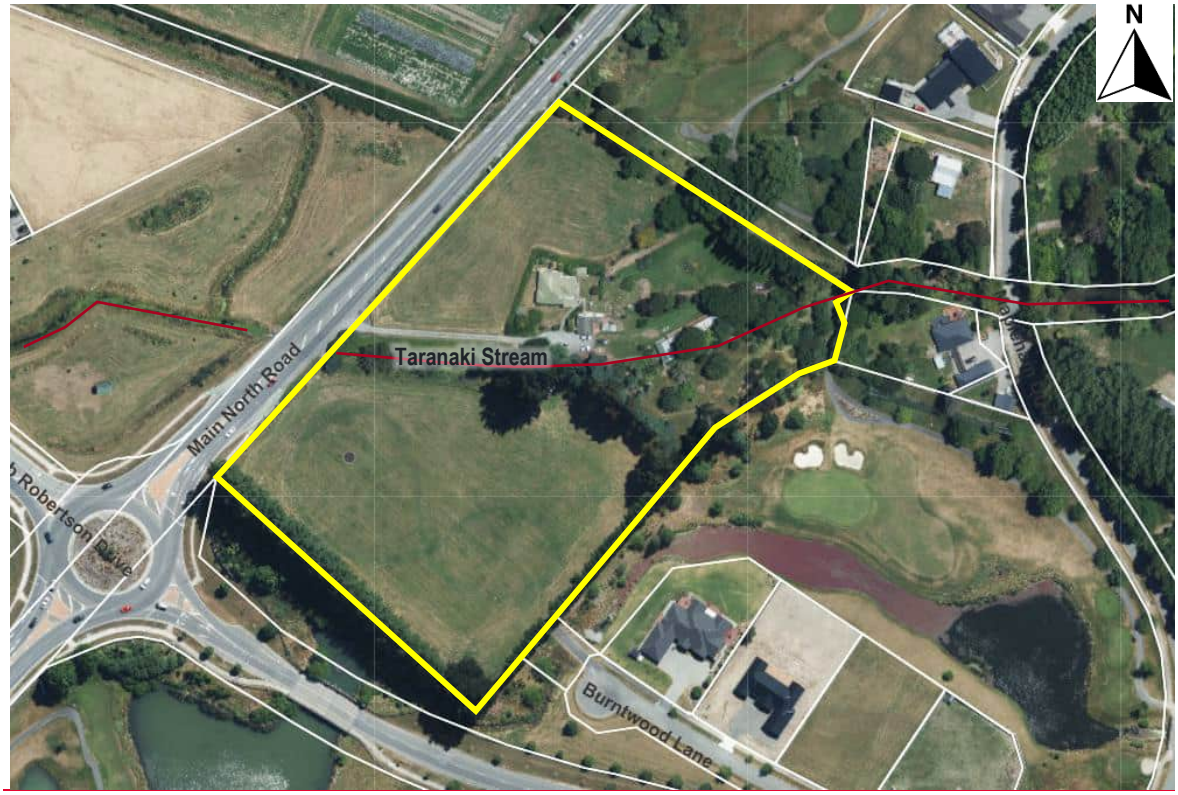


Figure 1. Aerial imagery sourced from Eliot Sinclair GIS. Approximate site boundary outlined in yellow.

4. Desktop Review

4.1. Engineering Geology

The published geology[5] for the site indicates it is underlain by *'Modern River floodplain/low-level degradation terrace. Unweathered, variably sorted gravel/sand/silt/clay. Surfaces <2-degree slope.' OIS1 (Holocene) river deposits.*

The GNS Active Fault Database[4] indicates there are no known active faults near the site.

4.2. Land Classification

The site is currently mapped as MBIE residential technical category *'N/A – Rural & Unmapped'*. Technical category *'not applicable'* means that the site has not been given a Technical Category.

[5]https://data.gns.cri.nz/geology/

The Technical Category (TC) system is intended for residential land only; however, it does provide a useful index of the relative vulnerability to liquefaction and earthquake induced land deformation for non-residential land.

The site is located within the *'Eastern Canterbury Liquefaction Susceptibility'* zone *as 'Liquefaction damage'* is possible.

4.3. Historical Aerial Review

We have reviewed available historical aerial imagery sourced from Canterbury Maps and Google Earth dating back from the 1940s through to 2023. Our review has identified areas of soil disturbance across the north-eastern part of the site as a result of removing former building structures (detached sheds and outbuildings), trees and vegetation and the establishment of a market garden.

The existing stream has been clearly defined, dating back to the 1940s.

We note, there is a possibility uncontrolled fill may be encountered below existing ground level across the site.

4.4. Tsunami Hazard Mapping

Tsunami hazard mapping is provided by ECan[6]. The site is located outside (inland) of the three mapped Tsunami Evacuation Zones.

4.5. Flood Hazard Mapping

Eliot Sinclair has undertaken an Infrastructure Servicing Report[7] which comments on the risk of flooding across the site following a 200-year Average Recurrence Interval (ARI) and a 50-year ARI storm event.

The report states the following:

- 200-year ARI

  The site is subject to a low to medium flood hazard along the north of the site. The proposed buildings are located outside of the flood hazard area. Taranaki Stream is shown as a high hazard flood zone; however, this is due to stream depth. Refer to Figure 2.

- 50-year ARI
  - The Waimakariri District Natural Hazards Interactive Viewer does not provide a 50-year ARI flood model. However, it is reasonable to assume that the less extreme storm event will result in shallower depths.
  - The 50-year flood hazard maps will need to be requested from WDC or Environment Canterbury (ECan). It is recommended that building platforms be kept out of any flood zones where possible.

- Finished Floor Level Requirement
  - It is recommended that consultation directly with WDC is required to obtain the minimum floor level requirements for the site.

In conclusion, the proposed buildings shown in Appendix A are typically located outside of the 200 year ARI flood hazard model. Therefore, assuming normal good practice design and ensuring development controls are implemented, the risk of flooding following a 200-year ARI storm across the site is deemed acceptable for development.

[6] https://www.ecan.govt.nz/your-region/your-environment/natural-hazards/tsunamis/tsunami-evacuation-zones-and-warnings/
[7] Infrastructure Servicing Report at Pegasus Mākete, prepared for Dexlin Investments Limited, reference 503498.

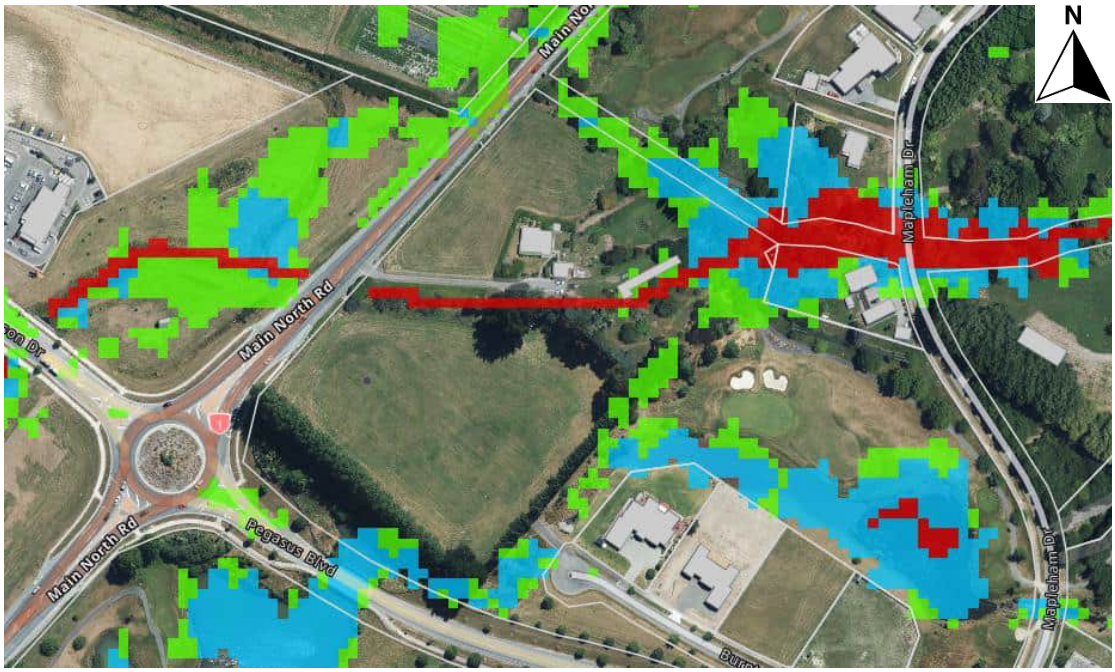


Figure 2. 200-year Flood Hazard Map sourced from Waimakariri District Natural Hazards Interactive Viewer retrieved in December 2023.

4.6. ECan Boreholes

Nearby ECan boreholes with well logs were reviewed from Canterbury Maps in December 2023. The well logs are summarised in Table 1 below and the bore locations are given in Figure 3. ECan borehole records are attached in Appendix C.

Table 1. Summary of ECan borehole well logs

Borehole ID	Depth of investigation (m)	Depth to upper gravel body (m)	Thickness of upper gravel layer (m)	Initial Water Level depth below Measuring Point (m)
M35/10715 Water level observation bore	6.7	- (Sand/Sandy SILT to Target depth)	- (Sand/Sandy SILT to Target depth)	2.8
M35/10716 Water level observation bore	9.7	- (Sand/Sandy SILT to Target depth)	- (Sand/Sandy SILT to Target depth)	4.6
M35/10720 Water level observation bore	8.0	6.5	1.5	2.7

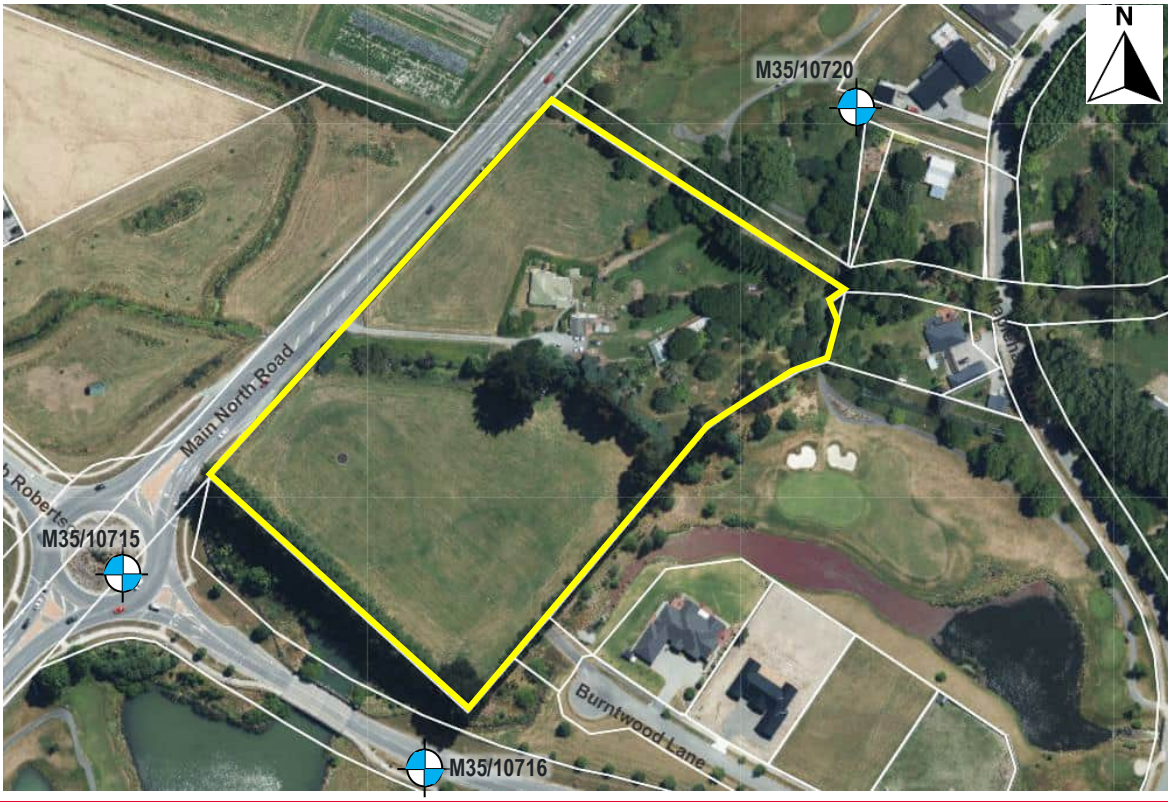


Figure 3. Aerial site plan with ECan well bores with borehole logs shown. Site is outlined in yellow.

4.7. NZGD – Nearby Site Investigation Records

At time of this report, there are existing geotechnical investigation records (i.e. Boreholes, Cone Penetrometer Test and test pits) shown on the NZGD (retrieved in December 2023).

Based on the wider area deep investigations, we infer the underlying ground model across the northeast part of the site is likely to be underlain by silty sand/sandy silt within the upper 3m to 6m soil profile underlain by dense sandy gravels and sands to at least 10m bgl.

However, at the southern part of the site, the underlying silty sand/sandy silt layers extends to at least 10m bgl.

Refer to Appendix D for the deep investigation ID and location plan.

4.8. Groundwater

Eliot Sinclair's review of existing geotechnical investigations across the surrounding area indicates groundwater is estimated to range around 1m to 2m bgl.

We note, the is site located within the *'Coastal Confined Gravel Aquifer System'* sourced from Canterbury Maps.

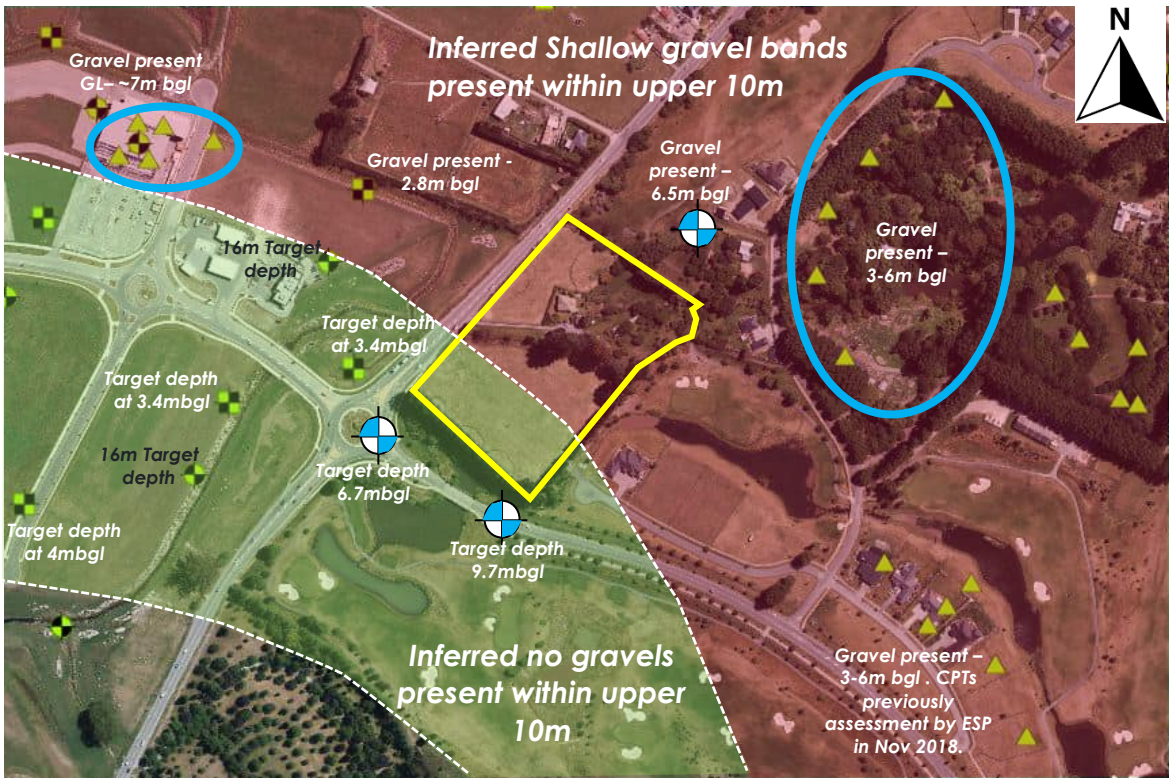


Figure 4. Deep test location plan sourced from the NZGD and ECan well bores with borehole logs. Test locations are approximate. CPTs outlined in blue were analysed.

5. Liquefaction Hazard

5.1. Assessment Method

The calculation of liquefaction triggering was undertaken using the method outlined in Boulanger & Idriss (2014)[8], and the estimation of post-liquefaction induced settlements using the method outlined by Zhang et al (2002)[9]. The liquefaction analysis was calculated using CLiq[10] software.

The CPTs surrounding the site were analysed for the Serviceability Limit State (SLS), Intermediate Limit State (ILS) and the Ultimate Limit State (ULS) levels of earthquake shaking in accordance with the New Zealand Geotechnical Society (NZGS) Module 1.

Based on the area wide investigations, we have assumed the 'earthquake' groundwater depth to be 2m bgl.

The CPTs analysed (refer to Figure 4) were sourced from 67 Mapleham Drive, approximately 100m northeast of the site and 10 Bob Robertson Drive, approximately 300m west of the site. Refer to Figure 4.

Refer to Appendix E our Liquefaction Analysis Report detailed results.

[8] Boulanger, R. W., and Idriss, I. M. (2014). *CPT and SPT based liquefaction triggering procedures*. Report No. UCD/CGM-14/01, Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California, Davis, CA, 134 pp.

[9] Zhang, G., Robertson, P.K. & Brachman, R. (2002). *Estimating liquefaction-induced ground settlements from CPT for level ground*. Canadian Geotechnical Journal, 39(5): 1168-1180.

[10] CLiq (version 2.3.1.14). GeoLogismiki Geotechnical Software

5.2. Vertical settlement due to liquefaction (index value)

The liquefaction-induced '*index*' settlement values (S_{V1D}) were calculated using the method by Zhang et al (2002)[12] for a range of parameters that are estimated from the four basic CPT parameters (depth, cone tip resistance, skin friction and pore water pressure) and represent 'free-field' settlements. Therefore, the settlements shown in Table 2 are not an exact figure, but only index values for interpretation of relative susceptibility to damaging effect of liquefaction.

Summary plots of the vertical settlement results are included in Appendix E.

5.3. Liquefaction Severity Number (LSN)

The liquefaction severity number (LSN) is a parameter developed to predict the more damaging effects of shallow liquefaction on residential land and shallow foundations. Calculation of the LSN is limited to the upper 10m of soil.

The CPT's where gravels were encountered at depth, calculated LSN values for SLS and ULS range between 0-20 indicating little to minor expression of liquefaction.

5.4. Lateral Stretch

Lateral stretch is possible close to the existing stream within the site. This risk can be mitigated through site specific investigation, design, and development controls.

5.5. Technical Category

The Technical Category (TC) system is intended for residential land only; however, it does provide a useful index of the relative vulnerability to liquefaction and earthquake induced land deformation for non-residential land.

Our desktop assessment of the earthquake-induced land performance finds the northeast part of the site is expected to have TC2 equivalent earthquake performance defined as '*minor to moderate land damage from liquefaction is possible in future large earthquakes*'. This area is expected to have a shallow dense gravel body within the upper 10m soil profile. The presence of any dense sand or gravel at least 3-4m thick is likely to suppress any deeper liquefiable soils and is not likely to contribute much to liquefaction-induced damage to shallow foundations.

At the southeast part of the site, the underlying inferred silt/sands are likely to extend at least 10m bgl and is inferred to have a TC3 equivalent land performance defined as '*moderate to significant land damage from liquefaction is possible in future large earthquakes*'.

Refer to Figure 5 for the area extent of the inferred land performance areas.

We note, to fully assess the representative land performance across the site and to better map the transition between the two Technical Categories, additional geotechnical investigation and assessment is required.

5.6. Standard of Investigation

In terms of Table 3.1 of MfE's guidance, Eliot Sinclair's desktop assessment of the site and surrounding areas can be considered to satisfy the requirements of Level B *i.e Calibrated desktop assessment.*

Location	CPT ID	Depth of CPT test (m bgl)	Predrill (m bgl)	Liquefaction-induced 'index' settlements, S_{V1D} (mm)			MBIE Equivalent land classification at test location
				SLS (M7.5, 0.13g)	SLSa (M6.0, 0.19g)	ULS (M7.5, 0.35g)	
67 Mapleham Drive	CPT_37505	12.2	-	5	13	70	**TC2**
67 Mapleham Drive	CPT_37930*	5.2	-	1	4	29	**TC2***
67 Mapleham Drive	CPT_37929*	2.8	-	-	-	-	**-**
67 Mapleham Drive	CPT_37927*	9.2	-	10	18	43	**TC2***
67 Mapleham Drive	CPT_37926*	6.2	-	7	15	31	**TC2***
10 Bob Robertson Drive	CPT_201450*	7.0	GL - 2.4	0	1	11	**TC1***
10 Bob Robertson Drive	CPT_126066*	7.7	0.8 – 3.6	6	12	15	**TC1***
10 Bob Robertson Drive	CPT_126063	15	0.7 – 3.2	19	34	73	**TC2**
10 Bob Robertson Drive	CPT_126065*	6.3	GL – 3.7	1	4	11	**TC1***
10 Bob Robertson Drive	CPT_126062	15	0.7 – 3.1	50	78	97	**TC3**
10 Bob Robertson Drive	CPT_126060*	7.7	GL – 3.1	3	8	22	**TC1**

Table 2. Overall Vertical Settlements Summary Table – Limited to the upper 10m soil profile

Notes:

*Shallow refusal of CPT indicating dense ground at the terminated depth, but analysis is for less than 10m penetration. Where penetration was ≤3m, data was not analysed.

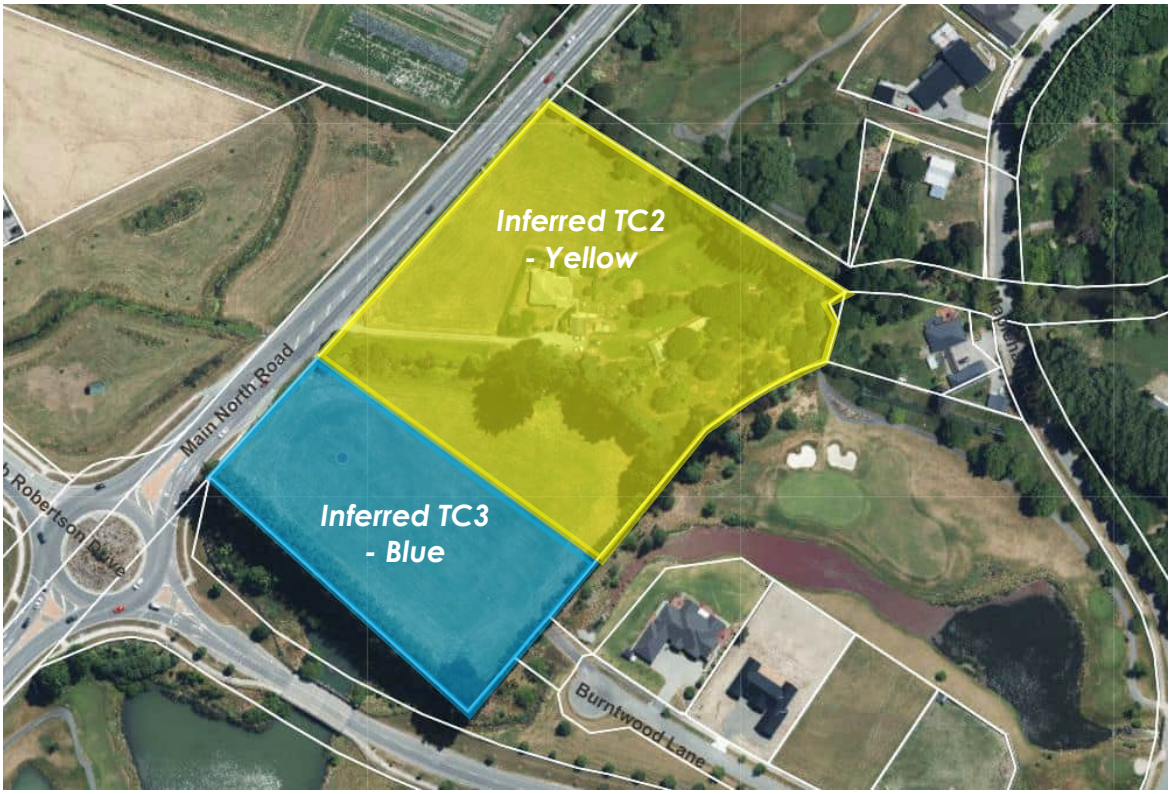


Figure 5. Inferred land performance in accordance with Eliot Sinclair's wider area desktop review and MBIE guidance.

6. Site Specific Assessment of Risk from Natural Hazards

Council can refuse plan change consent if there is a significant risk of material damage or injury from one, or a combination of, natural hazards. Decision-makers are guided by the matters set out in RMA Section 106 which requires an assessment of:

- The existing likelihood and consequence of natural hazards, and
- The likelihood that subdivision of the site could increase the likelihood or consequence of the natural hazard.

Refer to Appendix F for GNS risk assessment method.

The RMA defines natural hazards as:

Any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment[11].

[11] https://www.mfe.govt.nz/publications/rma/resource-legislation-amendments-2017-fact-sheet-series

Our desktop risk assessment of natural hazards for the proposed development assuming normal good practice investigation, design and development controls are implemented is listed below;

- Earthquake Fault Rupture and shaking hazard (Tolerable).
    - The nearest mapped active fault is located kilometres away to the northwest.
- Tsunami (Tolerable)
    - The site is outside of the three mapped Tsunami Evacuation Zones.
- Erosion & Sedimentation (Acceptable)
    - No erosion or sedimentation was observed following review of available site photographs and aerial imagery.
- Subsidence (Tolerable)

  The risk of subsidence from liquefaction across the site is considered to be moderate and is inferred to be equivalent to TC2 for future ground performance within the northeast part of the site and TC3 across the southwest part of the site. To fully assess the representative land performance across the site, additional geotechnical investigation and assessment is required.
    - The risk of subsidence from undocumented fill following normal good practice investigation, design, and construction management practices the site can be engineered for suitability.
- Flooding (Acceptable)
    - The proposed buildings are located outside of the 200-year ARI flood hazard model hence the risk of flooding following a 200-year ARI storm is acceptable.

6.1. Conclusions

We have considered the risk associated with natural hazards in relation to the RMA:1991 and concluded that the risk and consequence of potential natural hazards is either acceptable or tolerable. For this site, the most relevant natural hazards are earthquake shaking, earthquake-induced land deformation (settlement and lateral stretch), the possible presence of undocumented fill (associated with historic soil disturbance) presenting a settlement risk, and flood inundation.

Providing normal good practice investigation, design and development controls are implemented we have found no significant risks from natural hazards that would prevent the rezoning of the site.

7. Preliminary Geotechnical Foundation Recommendations

Eliot Sinclair's recommendations below are strictly preliminary, and any new foundations shall be subject to detailed investigation and design.

7.1. Shallow foundations

The risk of differential settlement to a tolerable level could be mitigated via shallow ground improvement in conjunction with a stiffened raft, grid ground beams or mat-type foundations.

Whilst there is some risk of differential settlement occurring in a SLS and an ULS event, the resilient shallow foundations above are easily able to be re-levelled using a ground injection method if there is ground deformation and foundation movement.

7.2. Deep foundations

Eliot Sinclair's assessment of the underlying deeper soils is prone to liquefaction-induced settlements and lateral displacement. Dense gravel layers are inferred to be underlain across the northeast part of the site.

If there is a requirement to reduce the risk of differential settlement further, any new foundations shall be supported on deep ground improvement (i.e. stone columns) or deep piles (i.e. screw or driven).

Site specific deep investigations will be required to confirm depth and feasibility of any proposed ground improvement methods.

8. Disclaimer

This report has been prepared by Eliot Sinclair & Partners Limited ("Eliot Sinclair") only for the intended purpose as a Desktop Natural Hazards Risk Assessment.

The report is based on:

- Information shown on the NZGD, Canterbury Maps, Waimakariri District Council Natural Hazards Viewer and GNS's Active Faults Database.
- Review over existing reporting and investigations relevant to the site.
- Eliot Sinclair's calibrated desktop assessment (Level B) in accordance with MfE's '*planning and engineering guidance for potentially liquefaction-prone land*'.

Where data supplied by Dexin Investments Ltd or other external sources, including previous site investigation reports, have been relied upon, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Eliot Sinclair for incomplete or inaccurate data supplied by other parties.

Whilst every care has been taken during our desktop assessment and interpretation of the subsurface conditions to ensure that the conclusions drawn, and the opinions and recommendations expressed are correct at the time of reporting, Eliot Sinclair has not performed an assessment of all possible conditions or circumstances that may exist at the site. Variations in conditions may occur between investigatory locations and there may be conditions such as subsoil strata and features that were not detected by the scope of the investigation that was carried out or have been covered over or obscured over time. Additionally, on-going seismicity in the general area may lead to deterioration or additional ground settlement that could not have been anticipated at the time of writing this report. Eliot Sinclair does not provide any warranty, either express or implied, that all conditions will conform exactly to the assessments contained in this report.

The exposure of conditions that vary from those described in this report, or occurrence of additional strong seismicity, or any future update of MBIE's guidelines may require a review of our assessment. Eliot Sinclair should be contacted to confirm the validity of this report should any of these occur.

This report has been prepared for the benefit of Dexin Investments Ltd for the purposes as stated above. This report is specifically prepared for the proposed rezoning of the site. No liability is accepted by Eliot Sinclair or any of their employees with respect to the use of this report, in whole or in part, for any other purpose or by any other party.

Appendix A. Proposed Site Plan

Proposed Site Plan

- With Flood Risk

Appendix B. Site Photographs

Appendix C. ECan Well Borehole Records

Bore or Well No	M35/10720
Well Name	BTWN GLADSTONE & PREECES ROADS
Owner	PEGASUS TOWN LIMITED

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Well Number	M35/10720	File Number	CO6C/22855
Owner	PEGASUS TOWN LIMITED	Well Status	Active (exist, present)
Street/Road	BTWN GLADSTONE & PREECES ROADS	NZTM Grid Reference	BW24:73889-04939
Locality	Woodend	NZTM X and Y	1573889 - 5204939
Location Description		Location Accuracy	2 - 15m
CWMS Zone	Waimakariri	Use	Water Level Observation,
Groundwater Allocation Zone	Ashley	Water Level Monitoring	--
Depth	8.00m	Water Level Count	0
Diameter	32mm	Initial Water Level	2.70m below MP
Measuring Point Description	ToC	Highest Water Level	
Measuring Point Elevation	8.12m above MSL (Lyttelton 1937)	Lowest Water Level	
Elevation Accuracy	< 0.5 m	First reading	
Ground Level	0.10m below MP	Last reading	
Strata Layers	4	Calc Min 80%	2.49m below MP (Estimated)
Aquifer Name		Aquifer Tests	0
Aquifer Type		Yield Drawdown Tests	0
Drill Date	18 May 2005	Max Tested Yield	
Driller	McMillan Drilling Ltd	Drawdown at Max Tested Yield	
Drilling Method	Driven Pipe	Specific Capacity	
Casing Material	PVC	Last Updated	29 Jun 2023
Pump Type		Last Field Check	
Water Use Data	No		

Screens

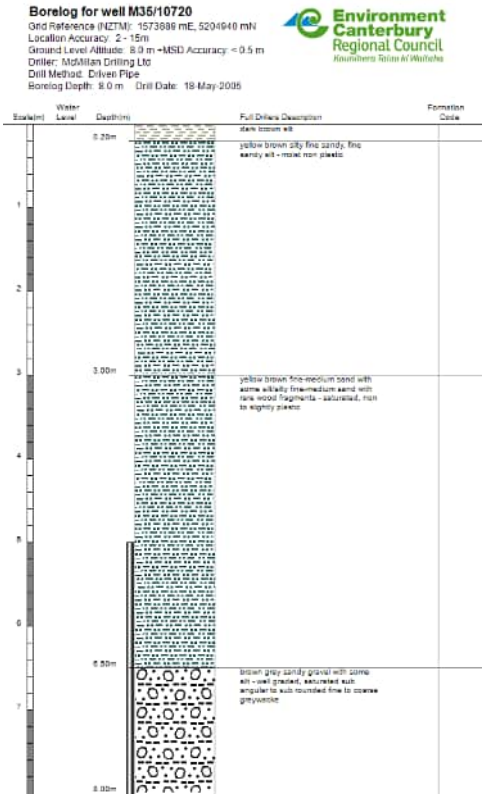
SCREEN NO.	SCREEN TYPE	TOP (M)	BOTTOM (M)	SLOT SIZE (MM)	SLOT LENGTH (MM)	DIAMETER (MM)	LEADER LENGTH (MM)
1	Slotted PVC	5	8				

No step tests for this well

Comments

COMMENT DATE	COMMENT
01 May 2006	Gridref changed from: M35:8402-6678
01 May 2006	Also called PT-019 on BCR
10 Jan 2023	Reference Level updated using LiDAR imagery in Dec 2022. The existing RL was 9.23 and the QAR RL was 4. The method of calculating the original RL was: Interpolated DTM. If GL from MP is updated in future please assess if RL also needs to be updated.

Bore Log


Borelog for well M35/10720
Grid Reference (NZTM): 1573686 mE, 5204940 mN
Location Accuracy: 2 - 15m
Ground Level Altitude: 8.0 m +MSD Accuracy: < 0.5 m
Driller: McMillan Drilling Ltd
Drill Method: Driven Pipe
Borelog Depth: 8.0 m Drill Date: 18-May-2006
Environment Canterbury
Regional Council
Water Level
Depth(m)
Full Drillers Description
Formation Code
0.20m
yellow brown silty fine sandy, fine sandy silt - moist non plastic
3.00m
yellow brown fine-medium sand with some silt/silty fine-medium sand with rare wood fragments - saturated, non to slightly plastic
6.50m
brown grey sandy gravel with some silt - well graded, saturated sub angular to sub rounded fine to coarse greywacke
8.00m

Bore or Well No	M35/10715
Well Name	BTWN GLADSTONE & PREECES ROADS
Owner	PEGASUS TOWN LIMITED

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Well Number	M35/10715	File Number	CO6C/22855
Owner	PEGASUS TOWN LIMITED	Well Status	Active (exist, present)
Street/Road	BTWN GLADSTONE & PREECES ROADS	NZTM Grid Reference	BW24:73591-04745
Locality	Woodend	NZTM X and Y	1573591 - 5204745
Location Description		Location Accuracy	2 - 15m
CWMS Zone	Waimakariri	Use	Water Level Observation,
Groundwater Allocation Zone	Ashley	Water Level Monitoring	--
Depth	6.70m	Water Level Count	0
Diameter	32mm	Initial Water Level	2.80m below MP
Measuring Point Description	ToC	Highest Water Level	
Measuring Point Elevation	9.51m above MSL (Lyttelton 1937)	Lowest Water Level	
Elevation Accuracy	< 0.5 m	First reading	
Ground Level	0.10m below MP	Last reading	
Strata Layers	11	Calc Min 80%	2.37m below MP (Estimated)
Aquifer Name		Aquifer Tests	0
Aquifer Type		Yield Drawdown Tests	0
Drill Date	12 Apr 2005	Max Tested Yield	
Driller	McMillan Drilling Ltd	Drawdown at Max Tested Yield	
Drilling Method	Driven Pipe	Specific Capacity	
Casing Material	PVC	Last Updated	29 Jun 2023
Pump Type		Last Field Check	
Water Use Data	No		

Screens

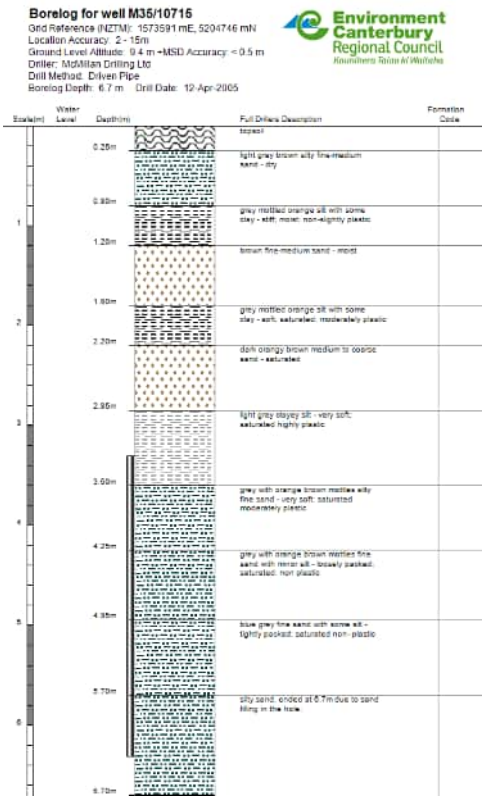
SCREEN NO.	SCREEN TYPE	TOP (M)	BOTTOM (M)	SLOT SIZE (MM)	SLOT LENGTH (MM)	DIAMETER (MM)	LEADER LENGTH (MM)
1	Slotted PVC	3.3	6.3				

No step tests for this well

Comments

COMMENT DATE	COMMENT
01 May 2006	Gridref changed from: M35:8361-6637
01 May 2006	Also called PT-014 on BCR
10 Jan 2023	Reference Level updated using LiDAR imagery in Dec 2022. The existing RL was 10.57 and the QAR RL was 4. The method of calculating the original RL was: Interpolated DTM. If GL from MP is updated in future please assess if RL also needs to be updated.

Bore Log


Borelog for well M35/10715
Grid Reference (NZTM): 1573591 mE, 5204746 mN
Location Accuracy: 2 - 15m
Ground Level Altitude: 9.4 m +MSD Accuracy: < 0.5 m
Driller: McMillan Drilling Ltd
Drill Method: Driven Pipe
Borelog Depth: 6.7 m Drill Date: 12-Apr-2005
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha
Scale(m)
Water Level
Depth(m)
Full Drillers Description
Formation Code
0.35m
topsoil
light grey brown silty fine-medium sand - dry
0.80m
grey mottled orange silt with some clay - stiff, moist, non-slightly plastic
1.20m
brown fine-medium sand - moist
1.80m
grey mottled orange silt with some clay - soft, saturated, moderately plastic
2.20m
dark orangy brown medium to coarse sand - saturated
2.95m
light grey clayey silt - very soft, saturated highly plastic
3.60m
grey with orange brown mottles silty fine sand - very soft, saturated moderately plastic
4.25m
grey with orange brown mottles fine sand with minor silt - loosely packed, saturated, non plastic
4.95m
blue grey fine sand with some silt - tightly packed, saturated non - plastic
5.70m
silty sand, ended at 6.7m due to sand filling in the hole
6.70m

Bore or Well No	M35/10716
Well Name	BTWN GLADSTONE & PREECES ROADS
Owner	PEGASUS TOWN LIMITED

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Well Number	M35/10716	File Number	CO6C/22855
Owner	PEGASUS TOWN LIMITED	Well Status	Active (exist, present)
Street/Road	BTWN GLADSTONE & PREECES ROADS	NZTM Grid Reference	BW24:73712-04671
Locality	Woodend	NZTM X and Y	1573712 - 5204671
Location Description		Location Accuracy	2 - 15m
CWMS Zone	Waimakariri	Use	Water Level Observation,
Groundwater Allocation Zone	Ashley	Water Level Monitoring	--
Depth	9.70m	Water Level Count	0
Diameter	32mm	Initial Water Level	4.55m below MP
Measuring Point Description	ToC	Highest Water Level	
Measuring Point Elevation	9.57m above MSL (Lyttelton 1937)	Lowest Water Level	
Elevation Accuracy	< 0.5 m	First reading	
Ground Level	0.10m below MP	Last reading	
Strata Layers	10	Calc Min 80%	2.39m below MP (Estimated)
Aquifer Name		Aquifer Tests	0
Aquifer Type		Yield Drawdown Tests	0
Drill Date	13 Apr 2005	Max Tested Yield	
Driller	McMillan Drilling Ltd	Drawdown at Max Tested Yield	
Drilling Method	Driven Pipe	Specific Capacity	
Casing Material	PVC	Last Updated	29 Jun 2023
Pump Type		Last Field Check	
Water Use Data	No		

Screens

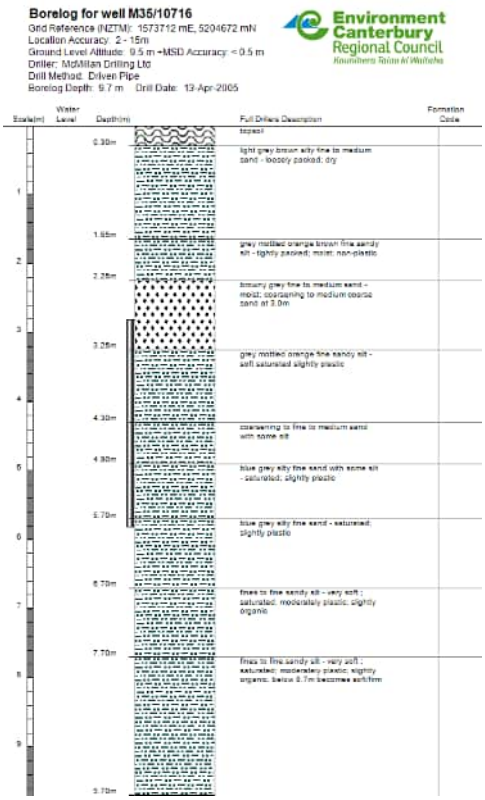
SCREEN NO.	SCREEN TYPE	TOP (M)	BOTTOM (M)	SLOT SIZE (MM)	SLOT LENGTH (MM)	DIAMETER (MM)	LEADER LENGTH (MM)
1	Slotted PVC	2.8	5.8				

No step tests for this well

Comments

COMMENT DATE	COMMENT
01 May 2006	Gridref changed from: M35:8371-6630
01 May 2006	Also called PT-015 on BCR
10 Jan 2023	Reference Level updated using LiDAR imagery in Dec 2022. The existing RL was 10.38 and the QAR RL was 4. The method of calculating the original RL was: Interpolated DTM. If GL from MP is updated in future please assess if RL also needs to be updated.

Bore Log


Borelog for well M35/10716
Grid Reference (NZTM): 1573712 mE, 5204672 mN
Location Accuracy: 2 - 15m
Ground Level Altitude: 9.5 m +MSD Accuracy: < 0.5 m
Driller: McMillan Drilling Ltd
Drill Method: Driven Pipe
Borelog Depth: 9.7 m Drill Date: 19-Apr-2005
Environment Canterbury Regional Council
Water Level
Depth(m)
Full Drillers Description
Formation Code
topsoil
light grey brown silty fine to medium sand - loosely packed; dry
grey mottled orange brown fine sandy silt - tightly packed; moist; non-plastic
binuary grey fine to medium sand - moist; coarsening to medium coarse sand at 3.0m
grey mottled orange fine sandy silt - soft saturated slightly plastic
coarsening to fine to medium sand with some silt
blue grey silty fine sand with some silt - saturated; slightly plastic
blue grey silty fine sand - saturated; slightly plastic
fines to fine sandy silt - very soft ; saturated; moderately plastic; slightly organic
fines to fine sandy silt - very soft ; saturated; moderately plastic; slightly organic; below 9.7m becomes soft/firm

Appendix D. NZGD Area Wide Deep Investigation Records and Site Plans


TP_147435
TP_147434
TP_147429

NZGD ID: TP_147434

TONKIN & TAYLOR LTD

EXCAVATION LOG

EXCAVATION No: TP9-04
Hole Location: See Attached Plan

SHEET 1 OF 1

PROJECT: Ravenswood Subdivision		LOCATION: Ravenswood, Woodend		JOB No: 53214.100	
CO-ORDINATES:	831272.75 mN 395708.94 mE	EXPOSURE TYPE:	Test Pit	EXCAV. STARTED:	12/2/14
		EQUIPMENT:	Tracked Excavator 8 tonne	EXCAV FINISHED:	12/2/14
R.L.	9.30 m	OPERATOR:	Shearings	LOGGED BY:	JXXM
DATUM	Mount Pleasant (2000)	DIMENSIONS:	1.75m x 3.7m x 3.4m	CHECKED BY:	RRG

EXCAVATION TESTS					ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
				9.30 / 0.0		ML	TOPSOIL: Sandy SILT, with minor rootlets; brownish grey. Firm, dry; sand, fine; rootlets, fine.	D	F		Topsoil	
				9.0 / 0.5		SM	Silty, very fine SAND, with trace rootlets; yellowish grey. Dry; rootlets, fine. 0.45m: becomes trace iron staining, moist.	M			Springston Formation	
			Bag 1	8.5 / 1.0		ML	SILT, with some sand and trace rootlets; brownish grey, with trace iron staining. Firm, moist, non-plastic; sand, fine; rootlets, fine. 0.8m: grades to minor sand, low plasticity. 0.9m: grades to sandy, non-plastic.		F			
				8.0 / 1.5		SP	Fine to medium SAND, with some silt; brownish grey, trace iron staining. Moist.					
			Bag 2	7.5 / 2.0			1.8m: becomes wet. 1.9m: Slight Water Seepage.	W				
				7.0 / 2.5			2.4m: Significant Water Inflow.					
			Bag 3	6.5 / 3.0		ML	SILT, with minor clay; bluish grey. Very soft, wet, moderate plasticity, non-dilatant. 2.75m: becomes saturated.	Sat	VS			
				6.0 / 3.5			**END OF TEST PIT AT 3.4m.** **Could not advance further due to significant collapse.** **Collapse worsened due to water inflow below 2.4m.**					
				5.5 / 4.0								
				5.0 / 4.5								
				4.5								

T+T DATATEMPLATE.GDT rtg

Log Scale 1:25

EXCAVATION 53214TP.GPJ 25-Mar-2014

NZGD ID: TP_147434

NZGD ID: TP_147435

TONKIN & TAYLOR LTD

EXCAVATION LOG

EXCAVATION No: TP9-05
Hole Location: See Attached Plan

SHEET 1 OF 1

PROJECT: Ravenswood Subdivision		LOCATION: Ravenswood, Woodend		JOB No: 53214.100	
CO-ORDINATES:	831429.77 mN 395717.78 mE	EXPOSURE TYPE:	Test Pit	EXCAV. STARTED:	13/2/14
		EQUIPMENT:	Tracked Excavator 8 tonne	EXCAV FINISHED:	13/2/14
R.L.	9.30 m	OPERATOR:	Shearings	LOGGED BY:	JXXM
DATUM	Mount Pleasant (2000)	DIMENSIONS:	1.75m x 3.9m x 3.8m	CHECKED BY:	RRG

EXCAVATION TESTS				ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
				9.0	0.5		ML	TOPSOIL: Sandy SILT, with trace rootlets; brownish grey. Stiff, dry; rootlets, fine; sand, fine.	D	St		Topsoil	
							ML	Sandy SILT, with trace rootlets; brownish grey with trace iron staining. Stiff, dry, non-plastic; rootlets, fine; sand, fine.				Springston Formation	
							SM	Grades to silty, very fine SAND; brownish grey with trace iron staining. Dry.					
				8.5	1.0			0.65m: becomes moist.	M				
			Bag 1				ML	Grades to SILT, with some sand; brownish grey with minor iron staining. Firm, moist, non-plastic; sand, fine.		F			
							SM	Grades to silty, very fine SAND; brownish grey with minor iron staining. Moist, non-plastic. Minor sandy silt layers/lenses.					
			Bag 2	8.0	1.5								
				7.5	2.0			2.2m: becomes trace iron staining.					
				7.0	2.5								
							GW	Sandy, fine to coarse GRAVEL, with trace silt; reddish brown, dominant iron staining. Loose, moist; sand, fine to coarse; gravel, sub-angular to sub-rounded.		L			
				6.5	3.0								
				6.0	3.5			3.7m: becomes grey, iron staining absent. Wet.	W				
				5.5	4.0			**END OF TEST PIT AT 3.8m.** **Could not advance further, as excavator at maximum reach.** **No groundwater encountered.**					
				5.0	4.5								
				4.5									

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

EXCAVATION 53214TP.GPJ 25-Mar-2014

NZGD ID: TP_147435

NZGD ID: TP_147429

TONKIN & TAYLOR LTD

EXCAVATION LOG

EXCAVATION No: TP8-01
Hole Location: See Attached Plan

SHEET 1 OF 1

PROJECT: Ravenswood Subdivision		LOCATION: Ravenswood, Woodend		JOB No: 53214.100	
CO-ORDINATES:	831242.95 mN 395599.78 mE	EXPOSURE TYPE:	Test Pit	EXCAV. STARTED:	12/2/14
		EQUIPMENT:	Tracked Excavator 8 tonne	EXCAV FINISHED:	12/2/14
R.L.	9.70 m	OPERATOR:	Shearings	LOGGED BY:	JXXM
DATUM	Mount Pleasant (2000)	DIMENSIONS:	1.75m x 3.7m x 3.88m	CHECKED BY:	RRG

EXCAVATION TESTS				ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
				9.5 / 0.0			TOPSOIL: Sandy SILT, with trace rootlets; brownish grey . Stiff; sand, fine; rootlets, fine.	D	St		Topsoil	
						SM	Silty, very fine SAND, with trace rootlets; yellowish grey. Dry; rootlets, fine.				Springston Formation	
				0.5		SP	0.45m: grades to some silt. Becomes brownish grey, trace iron staining, loose, moist.	M	L			
				9.0		SM	0.6m: grades to silty.					
						ML	Grades to sandy SILT, with trace rootlets; brownish grey with trace iron staining. Firm, moist, non-plastic; sand, fine; rootlets, fine.		F St			
			Bag 1	1.0 / 8.5		SM	0.8m: grades to minor sand. Stiff, low plasticity.	W				
							Silty, fine SAND, with trace rootlets; brownish grey, trace iron staining. Moist; rootlets, fine.					
				1.5 / 8.0		SP	1.4m: becomes wet. Grades to some silt. Minor iron staining. Rootlets absent.					
				2.0		ML	SILT; grey with orange mottles and trace iron staining. Soft, wet, low to moderate plasticity, very slow. Slight Water Seepage.		S			
			Bag 2	7.5 / 2.5								
				7.0 / 3.0								
				6.5								
				3.5			3.3m: grades to minor clay. Becomes bluish grey, iron staining and orange mottles absent. Very soft, moderate plasticity, non-dilatant.		VS			
				6.0								
				4.0 / 5.5			**END OF TEST PIT AT 3.8.** **Could not advance further, as excavator at maximum reach.**					
				4.5 / 5.0								

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

EXCAVATION 53214TP.GPJ 25-Mar-2014

NZGD ID: TP_147429


BH_147392
BH_126061
BH_147393
88598
BH_147390
BH_147388
BH_147389
60m

NZGD ID: BH_147392

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH9-02
Hole Location: See Attached Plan
SHEET 1 OF 4

PROJECT: Ravenswood Subdivision | LOCATION: Ravenswood, Woodend | JOB No: 53214.100

CO-ORDINATES: 831502.81 mN, 395484.38 mE
R.L.: 9.40 m
DATUM: Mount Pleasant (2000)

DRILL TYPE: AMS-17C
DRILL METHOD: SONIC
DRILL FLUID: Drill pro

HOLE STARTED: 27/1/14
HOLE FINISHED: 27/1/14
DRILLED BY: Prodrill Ltd
LOGGED BY: JXXM CHECKED: RRG

GEOLOGICAL									ENGINEERING DESCRIPTION								
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
Topsoil								9.40			M	S				TOPSOIL: SILT, with trace sand and rootlets; brownish dark grey. Soft, moist; sand, fine.
Springston Formation								9.0 / 0.5		ML	D	F				SILT, with some sand; brownish grey, with trace iron staining. Firm, dry; sand, fine.
			47	SONIC						SM	M	L				Silty, fine SAND; brownish grey, with trace iron staining. Loose, moist. 0.5
								8.5 / 1.0		SP						0.55m: Grades to some silt. 0.65m: Grades to minor silt. NO RECOVERY: 0.8-1.5m. 1.0
			100	SPT		1/1/2/ 0/0/0 N=2		8.0 / 1.5		SM						1.5m: Grades to silty, trace wood fragments. 1.5 1.65m: Becomes grey, iron staining absent.
								7.5 / 2.0		ML	W	S				SILT, with trace organics, some sand; grey. Soft, wet, low plasticity, quick; sand, fine; organics, fibrous. 2.0 2.2m: Grades to sandy. Non-plastic.
			100	SONIC				7.0 / 2.5		SM		L				Silty, fine SAND, trace organics; grey. Loose, wet; organics, fibrous. Interbedded SILT layers within sand. 2.5
						5/6/7/ 6/7/7 N=27		6.5 / 3.0		GW		MD				Fine to coarse GRAVEL, with some sand and trace silt; grey. Medium dense, wet; sand, fine to coarse; gravel, sub-angular to sub-rounded. 3.0 NO RECOVERY: 3.3-3.45m. 3.45m: Grades to trace cobbles. 3.5
			67	SPT				6.0 / 3.5								
			91	SONIC				5.5 / 4.0								4.1m: Grades to minor sand. 4.0
								5.0 / 4.5								NO RECOVERY: 4.5-4.6m. 4.5 4.6m: Becomes loose. NO RECOVERY: 4.7-5.0m.
			22	SPT		3/2/2/ 1/2/2 N=7		4.5 / 5				L				

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG 53214-A.GPJ 25-Mar-2014

NZGD ID: BH_147392

NZGD ID: BH_147392

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH9-02
Hole Location: See Attached Plan
SHEET 2 OF 4

PROJECT: Ravenswood Subdivision | LOCATION: Ravenswood, Woodend | JOB No: 53214.100

CO-ORDINATES: 831502.81 mN, 395484.38 mE
R.L.: 9.40 m
DATUM: Mount Pleasant (2000)

DRILL TYPE: AMS-17C
DRILL METHOD: SONIC
DRILL FLUID: Drill pro

HOLE STARTED: 27/1/14
HOLE FINISHED: 27/1/14
DRILLED BY: Prodrill Ltd
LOGGED BY: JXXM CHECKED: RRG

GEOLOGICAL									ENGINEERING DESCRIPTION								
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
Springston Formation			100	SONIC				4.0 / 5.5		GW	W	L				Fine to coarse GRAVEL, with minor sand and trace silt and cobbles; grey. Loose, wet; sand, fine to coarse; gravel, sub-angular to sub-rounded. NO RECOVERY: 5.0-5.05m. 5.25m: Grades to minor wood fragments. Saturated. 5.35m: Grades to wood fragmnets absent.
								3.5 / 6.0			Sat					5.5
																5.9m: Grades to some sand. Wet.
											W					6.0
			67	SPT		1/1/2/ 1/1/0 N=4		3.0 / 6.5		SP						Fine SAND, with some silt and trace wood fragments; grey. Loose, wet. NO RECOVERY: 6.4-6.55m.
																6.5
																6.8m: Grades to silty.
										SM						
			100	SONIC				2.5 / 7.0		ML		VS				SILT, with some sand and trace organics; grey. Very soft, wet, low plasticity, quick; sand, fine; organics, fibrous. 7.0
								2.0 / 7.5		SM		L				Silty, fine SAND; grey. Loose, wet. 7.5
																WOOD; brown. Wet.
			100	SPT		3/1/0/ 1/3/5 N=9		1.5 / 8.0		ML		VS				SILT, with some sand; grey. Very soft, wet, low plasticity, quick; sand, fine.
																WOOD; brown. Wet. 8.0
			100	SONIC				1.0 / 8.5		ML		F				SILT, with some sand; grey. Firm, wet, non-plastic, quick; sand, fine. 8.5
												S				8.55m: Grades to sand absent. Soft, moderate plasticity, non-dilatant.
								0.5 / 9.0								9.0
																9.1m: Grades to trace fibrous organics.
			67	SPT		0/0/0/ 0/0/1 N=1		0.0 / 9.5								NO RECOVERY: 9.4-9.55m. 9.5
																9.55m: Becomes low to moderate plasticity. Very slow.
			91	SONIC				-0.5 / 10								

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG 53214-A.GPJ 25-Mar-2014

NZGD ID: BH_147392

NZGD ID: BH_147392

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH9-02
Hole Location: See Attached Plan
SHEET 3 OF 4

PROJECT: Ravenswood Subdivision | LOCATION: Ravenswood, Woodend | JOB No: 53214.100

CO-ORDINATES: 831502.81 mN, 395484.38 mE
R.L.: 9.40 m
DATUM: Mount Pleasant (2000)

DRILL TYPE: AMS-17C
DRILL METHOD: SONIC
DRILL FLUID: Drill pro

HOLE STARTED: 27/1/14
HOLE FINISHED: 27/1/14
DRILLED BY: Prodrill Ltd
LOGGED BY: JXXM CHECKED: RRG

GEOLOGICAL									ENGINEERING DESCRIPTION								
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
Springston Formation			91	SONIC				-1.0 / 10.5		ML	W	S				SILT, with trace organics; grey. Soft, wet, low to moderate plasticity, very slow; organics, fibrous.
												VS				10.35m: Becomes very soft. Grades to minor organics. 10.5
			100	SPT		0/0/0/ 0/0/0 N=0		-1.5 / 11.0								NO RECOVERY: 10.6-10.7m. 11.0
								-2.0 / 11.5		SM		L				11.0m: Grades to sandy. Non-plastic. Quick. Silty, fine SAND, with trace organics; grey. Loose, wet; organics, fibrous.
			100	SONIC						ML		S				Grades to sandy SILT, with trace organics; grey. Soft, wet, non-plastic, quick; sand, fine; organics, fibrous. 11.5
								-2.5 / 12.0								11.7m: Grades to some sand. Low plasticity, slow. 12.0m: Grades to sandy, minor gravel. Non-plastic, quick; gravel, fine to medium, sub-rounded. 12.0
			100	SPT		3/6/9/ 9/9/9 N=36		-3.0 / 12.5		SP		D				Fine to coarse, predominantly fine SAND, with some gravel and silt; grey. Dense, wet; gravel, fine to coarse, sub-rounded. 12.2m: Grades to gravel absent. Sand, fine. 12.5
			100	SONIC				-3.5 / 13.0		SM						13.0
								-4.0 / 13.5								13.05m: Grades to silty, with minor interbedded silt lenses in sand, trace fibrous organics. 13.45m: 100mm SILT lens. 13.5
			100	SPT		4/5/7/ 7/8/10 N=32		-4.5 / 14.0		SP	Sat					13.7m: Grades to interbedded silt lenses absent. Organics absent. Trace shell fragments. Some silt. Saturated. 14.0
			100	SONIC				-5.0 / 14.5		SM						14.5 14.6m: Grades to silty.
								-5.5 / 15								

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG 53214-A.GPJ 25-Mar-2014

NZGD ID: BH_147392

NZGD ID: BH_147392

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH9-02
Hole Location: See Attached Plan
SHEET 4 OF 4

PROJECT: Ravenswood Subdivision | LOCATION: Ravenswood, Woodend | JOB No: 53214.100

CO-ORDINATES: 831502.81 mN, 395484.38 mE
R.L.: 9.40 m
DATUM: Mount Pleasant (2000)

DRILL TYPE: AMS-17C
DRILL METHOD: SONIC
DRILL FLUID: Drill pro

HOLE STARTED: 27/1/14
HOLE FINISHED: 27/1/14
DRILLED BY: Prodrill Ltd
LOGGED BY: JXXM CHECKED: RRG

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
Springston Formation			100	SONIC							SM	Sat	D				Silty, fine SAND, with trace shell fragments; grey. Dense, saturated.
						2/4/5/ 5/8/7 N=25			-6.0 15.5			W	MD				15.05m: Becomes medium dense, wet. 15.5
			100	SPT													
									-6.5 16.0								**END OF BOREHOLE AT 15.65m. Target Depth Reached.** Piezo Installed: 3m Screen 3m Blank 16.0
									-7.0 16.5								16.5
									-7.5 17.0								17.0
									-8.0 17.5								17.5
									-8.5 18.0								18.0
									-9.0 18.5								18.5
									-9.5 19.0								19.0
									-10.0 19.5								19.5
									-10.5 20								

SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG 53214-A.GPJ 25-Mar-2014

NZGD ID: BH_147392

NZGD ID: BH_147393

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH9-03
Hole Location: See Attached Plan
SHEET 1 OF 4

PROJECT: Ravenswood Subdivision | LOCATION: Ravenswood, Woodend | JOB No: 53214.100

CO-ORDINATES: 831366.53 mN, 395688.4 mE
R.L.: 9.50 m
DATUM: Mount Pleasant (2000)

DRILL TYPE: AMS-17C
DRILL METHOD: SONIC
DRILL FLUID: Drill pro

HOLE STARTED: 27/1/14
HOLE FINISHED: 27/1/14
DRILLED BY: Prodrill Ltd
LOGGED BY: JXXM CHECKED: RRG

GEOLOGICAL														ENGINEERING DESCRIPTION
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
Topsoil								9.5 / 0.0			M	S				TOPSOIL: SILT, with minor sand and rootlets; brownish grey. Soft, moist; sand, fine.
Springston Formation											D	F				SILT, with some sand; brownish grey. Firm, dry; sand, fine. Trace iron staining.
										ML						0.4m: Grades to sandy. Trace fibrous organics. 0.5
			67	SONIC				9.0 / 0.5		SP		L				Fine SAND, with some silt; brownish grey with some iron staining. Loose, dry.
								8.5 / 1.0								0.95m: Sand becomes fine to coarse. 1.0 NO RECOVERY: 1.0-1.5m.
			78	SPT		0/0/0/ 0/0/0 N=0		8.0 / 1.5		ML	W	VS				SILT, with some sand; grey. Very soft, wet, low plasticity, quick; sand, fine. 1.5
			100	SONIC				7.5 / 2.0								1.8m: Grades to trace sand, trace fibrous organics. Low to moderate plasticity, slow. NO RECOVERY: 1.85-1.95m. 2.0
								7.0 / 2.5		SM		L				2.25m: Grades to sandy, organics absent. Non-plastic, quick. 2.5 Grades to silty, fine SAND; grey. Loose, wet.
			78	SPT		0/1/2/ 1/3/2 N=8		6.5 / 3.0		ML		S				Grades to sandy SILT; grey. Soft, wet, non-plastic, quick; sand, fine. 3.0
										SM		L				Grades to silty, fine SAND; grey. Loose, wet. NO RECOVERY: 3.35-3.45m.
			91	SONIC				6.0 / 3.5								Below 3.45m: Intermittent sandy SILT/silty SAND layers. Non-plastic, quick; sand, fine. 3.5 4.0
								5.5 / 4.0								NO RECOVERY: 4.5-4.6m. 4.5
			67	SPT		0/0/1/ 1/1/2 N=5		4.5		SM						Below 4.75m: Intermittent sandy SILT layers absent. NO RECOVERY: 4.9-5.0m.
								5								

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG 53214-A.GPJ 25-Mar-2014

NZGD ID: BH_147393

NZGD ID: BH_147393

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH9-03
Hole Location: See Attached Plan
SHEET 2 OF 4

PROJECT: Ravenswood Subdivision | LOCATION: Ravenswood, Woodend | JOB No: 53214.100

CO-ORDINATES: 831366.53 mN, 395688.4 mE | DRILL TYPE: AMS-17C | HOLE STARTED: 27/1/14

DRILL METHOD: SONIC | HOLE FINISHED: 27/1/14

R.L.: 9.50 m | DRILLED BY: Prodrill Ltd

DATUM: Mount Pleasant (2000) | DRILL FLUID: Drill pro | LOGGED BY: JXXM | CHECKED: RRG

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
Springston Formation			100	SONIC				4.5	5.0		SM	W	L				Silty, fine SAND, with trace organics; grey. Loose, wet; organics, fibrous. NO RECOVERY: 5.0-5.05m.
								4.0	5.5		SP						5.65m: Grades to some silt; sand, fine to medium.
											SM						5.85m: Grades to silty; sand, fine.
			100	SPT		2/2/2/ 2/2/1 N=7		3.5	6.0								
								3.0	6.5								Below 6.55m: Intermittent sandy SILT/silty SAND layers. Non-plastic, quick; sand, fine.
			100	SONIC				2.5	7.0		SM						Below 7.1m: Intermittent sandy SILT layers.
								2.0	7.5		ML		VS				SILT, wtih some sand and trace organics; grey. Very soft, wet, low plasticity, quick; sand, fine; organics, fibrous.
			100	SPT		0/0/0/ 0/1/1 N=2		1.5	8.0				F				8.05m: Grades to sand absent. Firm, moderate plasticity, non-dilatant.
			100	SONIC				1.0	8.5				St				8.45m: Becomes stiff.
													F				8.65m: Grades to minor fine sand. Firm, low plasticity, slow.
								0.5	9.0								8.85m: Grades to sand absent. Low to moderate plasticity, very slow.
			100	SPT		0/0/0/ 0/2/2 N=4											
								9.5					S				9.55m: Becomes soft.
			91	SONIC					10								

SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG 53214-A.GPJ 25-Mar-2014

NZGD ID: BH_147393

NZGD ID: BH_147393

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH9-03
Hole Location: See Attached Plan
SHEET 3 OF 4

PROJECT: Ravenswood Subdivision		LOCATION: Ravenswood, Woodend	JOB No: 53214.100
CO-ORDINATES:	831366.53 mN 395688.4 mE	DRILL TYPE: AMS-17C	HOLE STARTED: 27/1/14 HOLE FINISHED: 27/1/14
R.L.:	9.50 m	DRILL METHOD: SONIC	DRILLED BY: Prodrill Ltd
DATUM:	Mount Pleasant (2000)	DRILL FLUID: Drill pro	LOGGED BY: JXXM CHECKED: RRG

GEOLOGICAL																ENGINEERING DESCRIPTION
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
Springston Formation			91	SONIC				0.0 -0.5		ML	W	S				SILT, with trace organics; grey. Soft, wet, low to moderate plasticity, very slow; organics, fibrous.
								-1.0 10.5								10.5
																NO RECOVERY: 10.6-10.7m.
			78	SPT		0/0/0/ 0/0/1 N=1						VS				10.7m: Grades to sandy. Very soft, non-plastic, quick.
								-1.5 11.0								11.0
																NO RECOVERY: 11.05-11.15m.
			100	SONIC						SM		MD				Grades to silty, fine SAND; grey. Medium dense, wet. Intermittent thin silt lenses.
								-2.0 11.5								11.5
										SP						11.65m: Grades to some silt. Intermittent silt lenses absent.
								-2.5 12.0								12.0
			56	SPT		1/3/7/ 8/9/7 N=31						D				12.35m: Grades to minor gravel. Becomes dense; gravel, fine to coarse, sub-rounded; sand, fine to coarse, predominantly fine.
								-3.0 12.5								12.5
																NO RECOVERY: 12.45-12.65m.
										SM						12.65m: Grades to gravel absent. Sand becomes fine.
																12.75m: Grades to silty, trace shell fragments.
			100	SONIC				-3.5 13.0								13.0
										ML		S				Grades to sandy SILT, with intermittent thin sand lenses; grey. Soft, wet, non-plastic, quick; sand, fine. Trace shell fragments.
								-4.0 13.5				VS				13.45m: Grades to minor sand. Becomes very soft, low plasticity, slow. Intermittent sand lenses absent. 13.5
			100	SPT		0/0/0/ 0/1/0 N=1										
								-4.5 14.0		SM		MD				14.0 Silty, fine SAND; grey. Medium dense, wet. Intermittent silt lenses.
								14.5								14.55m: Grades to minor silt, intermittent silt lenses absent. Trace shell fragments. Sand, fine to coarse, predominantly fine to medium. 14.5
			95	SONIC						SP						
										ML		S				Sandy SILT; grey. Soft, wet, non-plastic, quick; sand, fine.
								15		SP		MD				14.8m: Grades to sand absent. Low plasticity, slow.

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG 53214-A.GPJ 25-Mar-2014

NZGD ID: BH_147393

NZGD ID: BH_147393

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH9-03
Hole Location: See Attached Plan
SHEET 4 OF 4

PROJECT: Ravenswood Subdivision | LOCATION: Ravenswood, Woodend | JOB No: 53214.100

CO-ORDINATES: 831366.53 mN, 395688.4 mE
R.L.: 9.50 m
DATUM: Mount Pleasant (2000)

DRILL TYPE: AMS-17C
DRILL METHOD: SONIC
DRILL FLUID: Drill pro

HOLE STARTED: 27/1/14
HOLE FINISHED: 27/1/14
DRILLED BY: Prodrill Ltd
LOGGED BY: JXXM CHECKED: RRG

GEOLOGICAL									ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
Springston Formation			100	SPT		3/4/5/ 5/9/10 N=29		-5.0 / -5.5		SP / SM	W	MD				Fine to medium SAND, with minor silt; grey. Medium dense, wet. 15.0m: 80mm SILT lens. 15.08m: Grades to some shell fragments. NO RECOVERY: 15.15-15.2m. 15.2m: Grades to silty. Trace shell fragments and fibrous organics; sand becomes fine.
								-6.0 15.5								15.5
								-6.5 16.0								**END OF BOREHOLE AT 15.65m. Target Depth Reached.** Piezo Installed: 3m Screen 3m Blank 16.0
								-7.0 16.5								16.5
								-7.5 17.0								17.0
								-8.0 17.5								17.5
								-8.5 18.0								18.0
								-9.0 18.5								18.5
								-9.5 19.0								19.0
								19.5								19.5
								20								

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG 53214-A.GPJ 25-Mar-2014

NZGD ID: BH_147393

NZGD ID: BH_126061

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BOREHOLE RECORD

HOLE NO. **BH1**

PROJECT NO. **505601**

PROJECT **Ravenswood New World**
Bob Robertson Drive

METHOD **Borehole**

MACHINE & NO. **Sonic**

FLUSHING MEDIUM **Water**

CO-ORDINATES (NZTM)
E 1573378
N 5205010

ORIENTATION **VERTICAL**

SHEET **1** of **2**

DATE from **28/03/2019** to **28/03/2019**

GROUND-LEVEL **+11.00** m RL

Drilling Progress	Casing depth/size	Water level (m) shift start/ end	Water Recovery %	Total core Recovery %	Solid core Recovery %	R.Q.D.	Fracture Index	Tests	Samples Type Ref Depth	Reduced Level	Depth (m)	Legend	STRATA DESCRIPTION
											0.00		SUBORDINATE FRACTION, MAJOR FRACTION, MINOR FRACTION, COLOUR, STRUCTURE, STRENGTH, MOISTURE CONDITION GRADING, BEDDING, PLASTICITY, ETC.... *(NZ GEOTECHNICAL SOCIETY - FIELD DESCRIPTION OF SOIL AND ROCK)*
				100						+10.80	0.20		SILT with minor sand and trace rootlets; brown. Moist, non-plastic; sand, fine to medium. [TOPSOIL]
													Fine to coarse GRAVEL with some sand; brown. Moist, subangular to subrounded; sand, fine to coarse. [FILL]
										+9.70	1.30		
										+9.55	1.45		Sandy GRAVEL; brown. Moist, subangular to subrounded; sand, fine to coarse.
				100				(18, 21, 34, 26) N = 60/110 mm					Fine to coarse GRAVEL with some sand; brown. Moist, subangular to subrounded; sand, fine to coarse. [FILL] 1.70m Becomes wet.
										+8.70	2.30		
										+8.50	2.50		SILT with minor sand; light brown. *Stiff*, wet, low plasticity; sand, fine to medium.
										+8.20	2.80		Silty fine to coarse SAND; brown mottled orange. Wet.
										+8.00	3.00		Fine to coarse SAND with some silt; brown. Wet.
				100				(1, 1, 1, 0, 1, 1) N = 3					SILT with minor sand; grey. Wet, low plasticity; sand, fine to coarse. 3.40m Becomes saturated. 3.50m Becomes with some sand, grey mottled orange and brown.
										+7.00	4.00		Fine to coarse SAND with minor silt; dark grey. Saturated.
										+6.60	4.40		Fine to coarse GRAVEL with some sand; grey. Saturated, subangular to subrounded; sand, fine to coarse.
				90				(7, 9, 8, 9, 9, 9) N = 35					
				85				(8, 9, 8, 7, 5, 5) N = 25		+4.80	6.20		Fine to coarse SAND with minor gravel; grey. Saturated; gravel, fine to coarse, subangular to subrounded.
										+4.40	6.60		
										+4.30	6.70		Sandy fine to coarse GRAVEL; grey. Saturated, subangular to subrounded; sand, fine to coarse.
													Fine to coarse SAND with minor gravel; grey. Saturated; gravel, fine to coarse, subangular to subrounded.
										+3.40	7.60		
				100				(7, 11, 6, 5, 5, 5) N = 21		+3.30	7.70		Sandy fine to coarse GRAVEL; grey. Saturated, subangular to subrounded; sand, fine to coarse.
													Fine to coarse SAND with trace silt; grey. Saturated.
										+2.40	8.60		8.50m Becomes with some silt.
				100				(1, 1, 1, 0, 0, 3) N = 4					SILT with minor sand and trace roots; dark grey. Saturated, low plasticity; sand, fine to medium. 8.70m Becomes with no roots. 9.50m - 9.55m Becomes with some organics; fibrous to woody. 9.70m - 9.80m Becomes with some sand.

- Small Disturbed Sample
- Large Disturbed Sample
- SPT Liner Sample
- Thin Wall Undisturbed Sample
- U100 Undisturbed Sample
- Pocket Penetrometer Test
- Piston Sample
- Water Level
- Impression Packer Test
- Standard Penetration Test
- Permeability Test
- Piezometer / Standpipe Tip
- Packer Test
- In-situ Vane Shear Test

LOGGED **S. MORRIS**

DATE **09/04/2019**

CHECKED **K. FOOTE**

DATE **10/04/2019**

REMARKS

Groundwater not recorded at time of drilling.

Co-ordinates and elevation data from handheld GPS, accurate to +/-5m.

Elevation based on CCC Drainage Datum.

Auto-SPT Hammer with 93.0% efficiency.

Aurecon, 93 Cambridge Terrace, . Tel: 0800 AURECON Fax:

NZGD ID: BH_126061

NZGD ID: BH_126061

aurecon
www.aurecongroup.com

BOREHOLE RECORD

HOLE NO. **BH1**

PROJECT NO. **505601**

PROJECT **Ravenswood New World**
Bob Robertson Drive

METHOD **Borehole**

MACHINE & NO. **Sonic**

FLUSHING MEDIUM **Water**

CO-ORDINATES (NZTM)
E 1573378
N 5205010

ORIENTATION **VERTICAL**

SHEET **2** of **2**

DATE from **28/03/2019** to **28/03/2019**

GROUND-LEVEL **+11.00** m RL

Drilling Progress	Casing depth/size	Water level (m) shift start/ end	Water Recovery %	Total core Recovery %	Solid core Recovery %	R.Q.D.	Fracture Index	Tests	Samples Type Ref Depth	Reduced Level	Depth (m) 10.00	Legend	STRATA DESCRIPTION
				100						+0.80	10.20		
										+0.60	10.40		Peaty SILT; black with grey inclusions. Saturated, non-plastic; fibrous with woody inclusions, no odour.
				100				(2, 1, 2, 3, 2, 2) N = 9					SILT with minor sand; grey. Saturated, low plasticity; sand, fine. 11.20m - 11.30m Becomes with some sand. 11.60m Becomes with trace sand. 12.10m Becomes with no sand, trace clay. 12.80m Becomes with trace sand, no clay. 13.00m Becomes with minor sand.
				100				(1, 0, 0, 4, 3, 0) N = 7					
				100				(0, 0, 0, 0, 0, 0) N = 0		-3.00	14.00		Fine to coarse SAND with minor silt; grey. Saturated. 14.00m - 14.20m Becomes with trace gravel, fine. 14.30m Becomes with some silt. 14.70m Becomes with minor silt. 15.10m Becomes with trace silt.
				100				(7, 7, 8, 5, 2, 2) N = 17					
									16.72	-5.72	16.72		16.60m Becomes with minor silt.
								(7, 10, 11, 11, 13, 17) N = 52					End of Borehole at 16.72m, on 28/03/2019 *Termination Reason:* Target depth reached.

- Small Disturbed Sample
- Large Disturbed Sample
- SPT Liner Sample
- Thin Wall Undisturbed Sample
- U100 Undisturbed Sample
- Pocket Penetrometer Test
- Piston Sample
- Water Level
- Impression Packer Test
- Standard Penetration Test
- Permeability Test
- Piezometer / Standpipe Tip
- Packer Test
- In-situ Vane Shear Test

LOGGED **S. MORRIS**

DATE **09/04/2019**

CHECKED **K. FOOTE**

DATE **10/04/2019**

REMARKS

Groundwater not recorded at time of drilling.

Co-ordinates and elevation data from handheld GPS, accurate to +/-5m.

Elevation based on CCC Drainage Datum.

Auto-SPT Hammer with 93.0% efficiency.

Aurecon, 93 Cambridge Terrace, . Tel: 0800 AURECON Fax:

NZGD ID: BH_126061

NZGD ID: BH_147388

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH8-01
Hole Location: See Attached Plan
SHEET 1 OF 4

PROJECT: Ravenswood Subdivision | LOCATION: Ravenswood, Woodend | JOB No: 53214.100

CO-ORDINATES: 831190.93 mN 395343.73 mE
R.L.: 10.30 m
DATUM: Mount Pleasant (2000)

DRILL TYPE: Mobile drill
DRILL METHOD: SONIC
DRILL FLUID: Drill pro

HOLE STARTED: 24/1/14
HOLE FINISHED: 24/1/14
DRILLED BY: Prodrill Ltd
LOGGED BY: JIMB CHECKED: RRG

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
Topsoil												D					Topsoil
Springston Formation			100	SONIC				10.0	0.5		SM	M	L				Silty, fine SAND; light brown. Moist.
											SP						0.6m: Grades to some silt.
								9.5	1.0								0.8m: Grades to minor silt.
								9.0	1.5		ML	M	F				Sandy SILT; light brown with orangey brown mottles. Moist, low plasticity.
			0	SPT		No SPT Barrel sunk											NO RECOVERY: 1.5-1.95m.
			100	SONIC				8.5	2.0		SM	W	VL				Silty SAND; brown. Loose, wet.
											SP						2.2m: Grades to minor silt. Becomes brown with orangey brown mottles; sand becomes fine to medium.
								8.0	2.5								2.7m: Grades to some silt.
								7.5	3.0		ML		VS				Sandy SILT; greyish brown with orange mottles. Very soft, wet, low plasticity, quick; sand, fine.
			100	SPT		0/0/0/ 0/1/0 N=1											
								7.0	3.5				S				3.4m: Grades to trace sand. Becomes soft.
			91	SONIC				6.5	4.0								3.8m: Grades to trace organics. Becomes slow.
								6.0	4.5								NO RECOVERY: 4.5-4.6m.
			100	SPT		0/1/0/ 1/0/1 N=2		5.5	5								4.6m to 4.7m: Minor wood pieces. 4.7m: Grades to trace rootlets.

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG RAVENSWOOD 8-01,8-02,8-03&9.01.GPJ 25-Mar-2014

NZGD ID: BH_147388

NZGD ID: BH_147388

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH8-01
Hole Location: See Attached Plan
SHEET 2 OF 4

PROJECT: Ravenswood Subdivision | LOCATION: Ravenswood, Woodend | JOB No: 53214.100

CO-ORDINATES: 831190.93 mN, 395343.73 mE | DRILL TYPE: Mobile drill | HOLE STARTED: 24/1/14

DRILL METHOD: SONIC | HOLE FINISHED: 24/1/14

R.L.: 10.30 m | DRILLED BY: Prodrill Ltd

DATUM: Mount Pleasant (2000) | DRILL FLUID: Drill pro | LOGGED BY: JIMB | CHECKED: RRG

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION (WEATHERING)	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
Springston Formation			100	SONIC				5.0	5.5		ML	W	S				SILT, with trace sand, rootlets and organics; greyish brown with orange mottles. Soft, wet, low plasticity, slow; sand, fine.
											SM		L				Silty SAND; grey. Wet. 5.4m to 5.5m: Wood pieces 5.5
								4.5	6.0		ML		S				SILT, with trace sand; grey. Soft, wet, low plasticity, slow; sand, fine. 6.0
			67	SPT		2/1/0/ 1/1/1 N=3		4.0	6.5								6.1m: Grades to some sand. Becomes quick. NO RECOVERY: 6.4-6.55m. 6.5
			76	SONIC				3.5	7.0		SM SP		VL				Silty SAND; grey. Wet. 6.75m: Grades to minor silt. 7.0
								3.0	7.5								NO RECOVERY: 7.35-7.6m. 7.5
			77	SONIC		No SPT Barrel sunk		2.5	8.0		SM						7.7m: Grades to silty. Becomes very soft. 8.0m: Becomes soft. 8.0
								2.0	8.5		ML		S				SILT, with trace sand; grey. Soft, wet, low plasticity, slow; sand, fine. 8.5m: Becomes non-dilatant. 8.5
								1.5	9.0								NO RECOVERY: 8.75-9.1m. 9.0
			67	SPT		0/1/1/ 1/1/2 N=5		1.0	9.5		SM SP		L				Silty, fine SAND; grey. Loose, wet. NO RECOVERY: 9.4-9.55m 9.4m: Grades to trace silt. Sand becomes fine to coarse. 9.5
			91	SONIC				0.5	10								9.85m: Grades to some silt. Sand becomes fine.

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG RAVENSWOOD 8-01,8-02,8-03&9.01.GPJ 25-Mar-2014

NZGD ID: BH_147388

NZGD ID: BH_147388

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH8-01
Hole Location: See Attached Plan
SHEET 3 OF 4

PROJECT: Ravenswood Subdivision | LOCATION: Ravenswood, Woodend | JOB No: 53214.100

CO-ORDINATES: 831190.93 mN 395343.73 mE
R.L.: 10.30 m
DATUM: Mount Pleasant (2000)

DRILL TYPE: Mobile drill
DRILL METHOD: SONIC
DRILL FLUID: Drill pro

HOLE STARTED: 24/1/14
HOLE FINISHED: 24/1/14
DRILLED BY: Prodrill Ltd
LOGGED BY: JIMB CHECKED: RRG

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
Springston Formation			91	SONIC				0.0	10.5		SM	W	L				Silty, fine SAND; grey. Loose, wet.
			100	SPT		1/1/2/ 2/2/3 N-9		-0.5	11.0								10.5 to 10.6m: Trace organics. NO RECOVERY: 10.6-10.7m.
			100	SONIC				-1.0	11.5								
								-1.5	12.0								12.1m: Grades to trace gravel. Gravel is medium.
			100	SPT		4/8/8/ 10/12/12 N=42		-2.0	12.5		SW		D				Fine to coarse GRAVEL, with some sand; grey. Dense, wet; gravel, sub-angular to sub-rounded; sand, fine to coarse.
			100	SONIC				-2.5	13.0								13.0m: Grades to some sand.
								-3.0	13.5		ML		F				SILT, with trace sand; grey. Firm, wet, low plasticity, slow; sand, fine. 13.3m: Grades to trace black organics. 13.5 to 13.6m: Fine to coarse SAND lens. 13.6m: Grades to sandy.
			100	SPT		1/2/1/ 2/1/1 N=5		-3.5	14.0		SM		L				Silty, fine SAND; grey. Loose, wet.
			100	SONIC				-4.0	14.5		SP						14.3m: Grades to some silt. Sand becomes fine to coarse.
								-4.5	15								

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG RAVENSWOOD 8-01,8-02,8-03&9.01.GPJ 25-Mar-2014

NZGD ID: BH_147388

NZGD ID: BH_147388

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH8-01
Hole Location: See Attached Plan

PROJECT: Ravenswood Subdivision		LOCATION: Ravenswood, Woodend	JOB No: 53214.100
CO-ORDINATES:	831190.93 mN 395343.73 mE	DRILL TYPE: Mobile drill	HOLE STARTED: 24/1/14
		DRILL METHOD: SONIC	HOLE FINISHED: 24/1/14
R.L.:	10.30 m		DRILLED BY: Prodrill Ltd
DATUM:	Mount Pleasant (2000)	DRILL FLUID: Drill pro	LOGGED BY: JIMB CHECKED: RRG

GEOLOGICAL	ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
Springston Formation			100	SONIC							SP	W	L				Fine to coarse SAND, with trace silt and brown organics; grey. Loose, wet.
									-5.0								15.2m: Grades to some silt.
			100	SPT		1/1/1/ 1/1/1 N=4			15.5		SM						15.4m: Grades to silty. Sand becomes fine. 15.5
									-5.5								**END OF BOREHOLE AT 15.65m.** **Target Depth Reached.**
									16.0								Piezo Installed: 3m Screen 3m Blank 16.0
									-6.0								
									16.5								16.5
									-6.5								
									17.0								17.0
									-7.0								
									17.5								17.5
									-7.5								
									18.0								18.0
									-8.0								
									18.5								18.5
									-8.5								
									19.0								19.0
									-9.0								
									19.5								19.5
									-9.5								
									20								

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG RAVENSWOOD 8-01,8-02,8-03&9.01.GPJ 25-Mar-2014

NZGD ID: BH_147388

NZGD ID: BH_147389

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH8-02
Hole Location: See Attached Plan
SHEET 1 OF 4

PROJECT: Ravenswood Subdivision		LOCATION: Ravenswood, Woodend	JOB No: 53214.100
CO-ORDINATES:	831179.19 mN 395569.23 mE	DRILL TYPE: Mobile drill	HOLE STARTED: 24/1/14 HOLE FINISHED: 24/1/14
R.L.:	10.10 m	DRILL METHOD: SONIC	DRILLED BY: Prodrill Ltd
DATUM:	Mount Pleasant (2000)	DRILL FLUID: Drill pro	LOGGED BY: JIMB CHECKED: RRG

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION	WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
Topsoil								10.0	0		ML	M		S				Topsoil: SILT, with trace sand and rootlets; brown. Soft, moist, low placticity; sand, fine.
Springston Formation			87	SONIC				9.5	0.5		SM							Silty, fine SAND; light brown with orange mottles. Moist. 0.5
								9.0	1.0		ML							1.0 Sandy SILT; greyish brown with orange mottles. Soft, moist, low plasticity, quick. NO RECOVERY: 1.3-1.5m.
			87	SONIC		No SPT Barrel sunk		8.5	1.5		SM	W		VL				1.5 Silty, fine SAND; brownish grey with orangey mottles. Very loose, wet. NO RECOVERY: 1.5-1.7m. 2.0
								8.0	2.0		ML			S				SILT, with some sand; brownish grey with orangey mottles. Soft, wet, low plasticity, quick; sand, fine. 2.5
								7.5	2.5									2.5m: Grades to trace sand.
														F				2.7m: Becomes firm.
																		NO RECOVERY: 2.8 - 3.0m.
														VS				2.9m: Grades to sandy. Becomes very soft.
			100	SPT		0/1/0/ 1/1/2 N=4		7.0	3.0					S				3.0 3.0m: Grades to trace sand. Becomes soft.
								6.5	3.5					F				3.5 3.5m: Becomes firm and slow.
			100	SONIC				6.0	4.0									3.8m: Grades to trace organics. 4.0
														S				4.3m: Becomes soft.
			100	SPT		0/0/0/ 1/1/0 N=2		5.5	4.5									4.5
									5		SM			VL				Silty, fine SAND; light brown. Very loose, wet.

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG RAVENSWOOD 8-01,8-02,8-03&9.01.GPJ 25-Mar-2014

NZGD ID: BH_147389

NZGD ID: BH_147389

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH8-02
Hole Location: See Attached Plan
SHEET 2 OF 4

PROJECT: Ravenswood Subdivision | LOCATION: Ravenswood, Woodend | JOB No: 53214.100

CO-ORDINATES: 831179.19 mN 395569.23 mE
R.L.: 10.10 m
DATUM: Mount Pleasant (2000)

DRILL TYPE: Mobile drill
DRILL METHOD: SONIC
DRILL FLUID: Drill pro

HOLE STARTED: 24/1/14
HOLE FINISHED: 24/1/14
DRILLED BY: Prodrill Ltd
LOGGED BY: JIMB CHECKED: RRG

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
Springston Formation			100	SONIC				5.0	5.5		SM	W	VL				Silty, fine SAND; light brown. Very loose, wet.
								4.5			ML		S				Sandy SILT; grey. Soft, wet, low plasticity, quick; sand, fine.
			100	SPT		0/0/1/ 1/3/5 N=10		4.0	6.0								
									6.5		SM		MD				Silty, fine SAND; grey. Medium dense, wet.
								3.5			SP						6.5m: Grades to trace silt.
			86	SONIC				3.0	7.0								6.9m: Grades to some silt.
											SM						7.2m: Grades to silty.
									7.5		SP						7.4m: Grades to minor silt. NO RECOVERY: 7.45 - 7.6m.
			78	SPT		2/3/4/ 3/3/4 N=14		2.5									7.6m: Grades to some silt.
									8.0								NO RECOVERY: 7.95-8.05m.
			100	SONIC				2.0			ML		S				SILT, with some sand and trace organics; grey with black organics. Soft, wet, low plasticity, slow; sand, fine.
								1.5	8.5								
									9.0								
			100	SPT		0/0/0/ 2/1/2 N=5		1.0									
									9.5				F				9.5m: Becomes firm.
			78	SONIC				0.5									
									10								

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG RAVENSWOOD 8-01,8-02,8-03&9.01.GPJ 25-Mar-2014

NZGD ID: BH_147389

NZGD ID: BH_147389

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH8-02
Hole Location: See Attached Plan
SHEET 3 OF 4

PROJECT: Ravenswood Subdivision | LOCATION: Ravenswood, Woodend | JOB No: 53214.100

CO-ORDINATES: 831179.19 mN 395569.23 mE
R.L.: 10.10 m
DATUM: Mount Pleasant (2000)

DRILL TYPE: Mobile drill
DRILL METHOD: SONIC
DRILL FLUID: Drill pro

HOLE STARTED: 24/1/14
HOLE FINISHED: 24/1/14
DRILLED BY: Prodrill Ltd
LOGGED BY: JIMB CHECKED: RRG

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
Springston Formation			78	SONIC				0.0			ML	W	S				SILT, with some sand and trace organics; grey with black organics. Soft, wet, low plasticity, slow; sand, fine.
								10.5	-0.5								SILT, with some sand and trace organics; grey with black organics. Firm, wet, low plasticity, slow; sand, fine.
																	NO RECOVERY: 10.45-10.7m. 10.5
			100	SPT		0/1/0/ 1/2/0 N=3		11.0	-1.0				F				11.0m: Becomes firm. 11.0
			100	SONIC				11.5	-1.5								11.5
								12.0	-2.0		SM		VL				12.0 Silty, fine SAND; grey. Very loose, wet.
			100	SPT		0/0/1/ 1/1/0 N=3		12.5	-2.5								12.5
			86	SONIC				13.0	-3.0		SP						13.0 13.0m: Grades to trace black and brown organics. 13.1m: Grades to minor silt.
											SM						13.3m: Grades to silty.
								13.5	-3.5		GW		MD				13.5 Fine to coarse GRAVEL, with minor sand and trace silt; grey. Medium dense, wet; sand, fine to coarse. NO RECOVERY: 13.55-13.7m.
			67	SPT		3/3/3/ 4/3/4 N=14					SM						Silty, fine SAND; grey. Medium dense, wet.
								14.0	-4.0								NO RECOVERY: 14.0-14.15m. 14.0
			100	SONIC				14.5	-4.5								14.5m: Grades to trace shells. 14.5
								15									

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG RAVENSWOOD 8-01,8-02,8-03&9.01.GPJ 25-Mar-2014

NZGD ID: BH_147389

NZGD ID: BH_147389

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH8-02
Hole Location: See Attached Plan
SHEET 4 OF 4

PROJECT: Ravenswood Subdivision | LOCATION: Ravenswood, Woodend | JOB No: 53214.100

CO-ORDINATES: 831179.19 mN, 395569.23 mE | DRILL TYPE: Mobile drill | HOLE STARTED: 24/1/14

DRILL METHOD: SONIC | HOLE FINISHED: 24/1/14

R.L.: 10.10 m | DRILLED BY: Prodrill Ltd

DATUM: Mount Pleasant (2000) | DRILL FLUID: Drill pro | LOGGED BY: JIMB | CHECKED: RRG

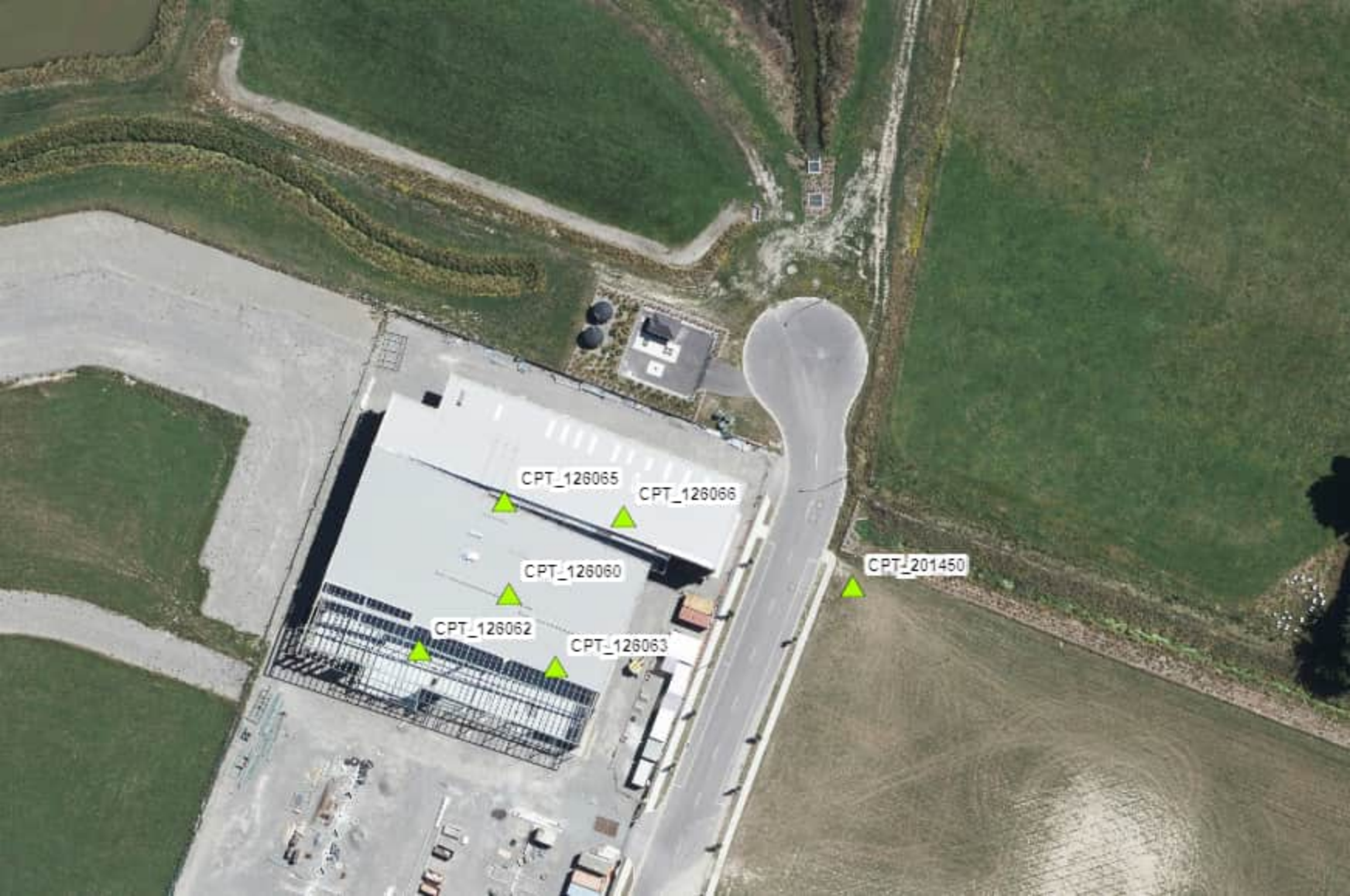
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
Springston Formation			100	SONIC				-5.0		SW	W	MD				Fine to coarse SAND, with minor silt; grey. Medium dense, wet.
			100	SPT		5/8/8/ 8/11/11 N=38		15.5 -5.5		SM		D				15.2m: Grades to silty with trace shells. Becomes dense. 15.5
								16.0 -6.0								**END OF BOREHOLE AT 15.65m. Target Depth Reached.** Piezo Installed: 3m Screen 3m Blank 16.0
								16.5 -6.5								16.5
								17.0 -7.0								17.0
								17.5 -7.5								17.5
								18.0 -8.0								18.0
								18.5 -8.5								18.5
								19.0 -9.0								19.0
								19.5 -9.5								19.5
								20								

T+T DATATEMPLATE.GDT trg

Log Scale 1:25

BORELOG RAVENSWOOD 8-01,8-02,8-03&9.01.GPJ 25-Mar-2014

NZGD ID: BH_147389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CPT_126066
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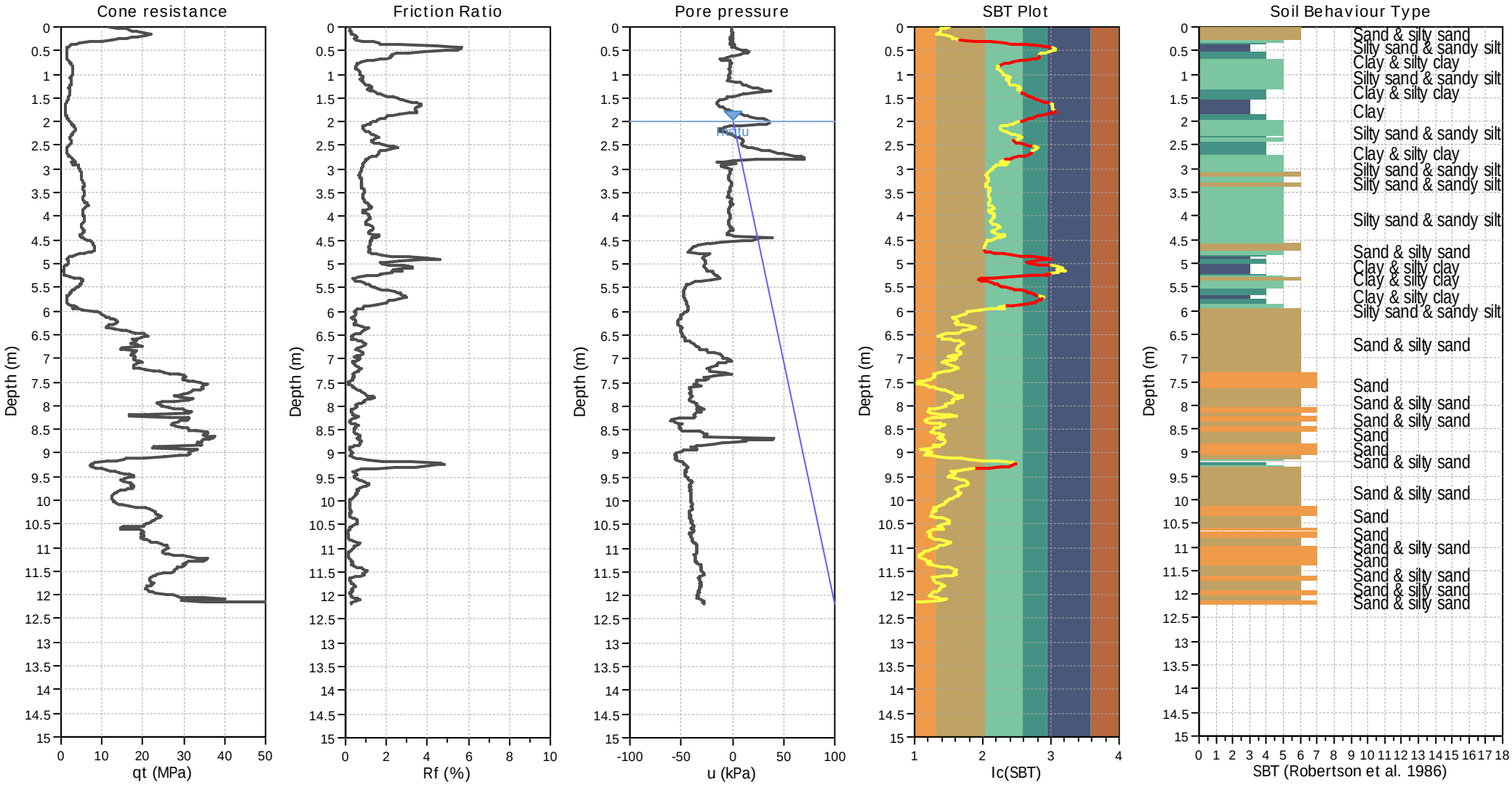
CPT_126063
CPT_201450


CPT_37926
CPT_37927
CPT_37929
CPT_37930
CPT_37505
CPT_37919
CPT_37920
CPT_37923
CPT_37922

Appendix E. CLiq Analysis

CPT basic interpretation plots



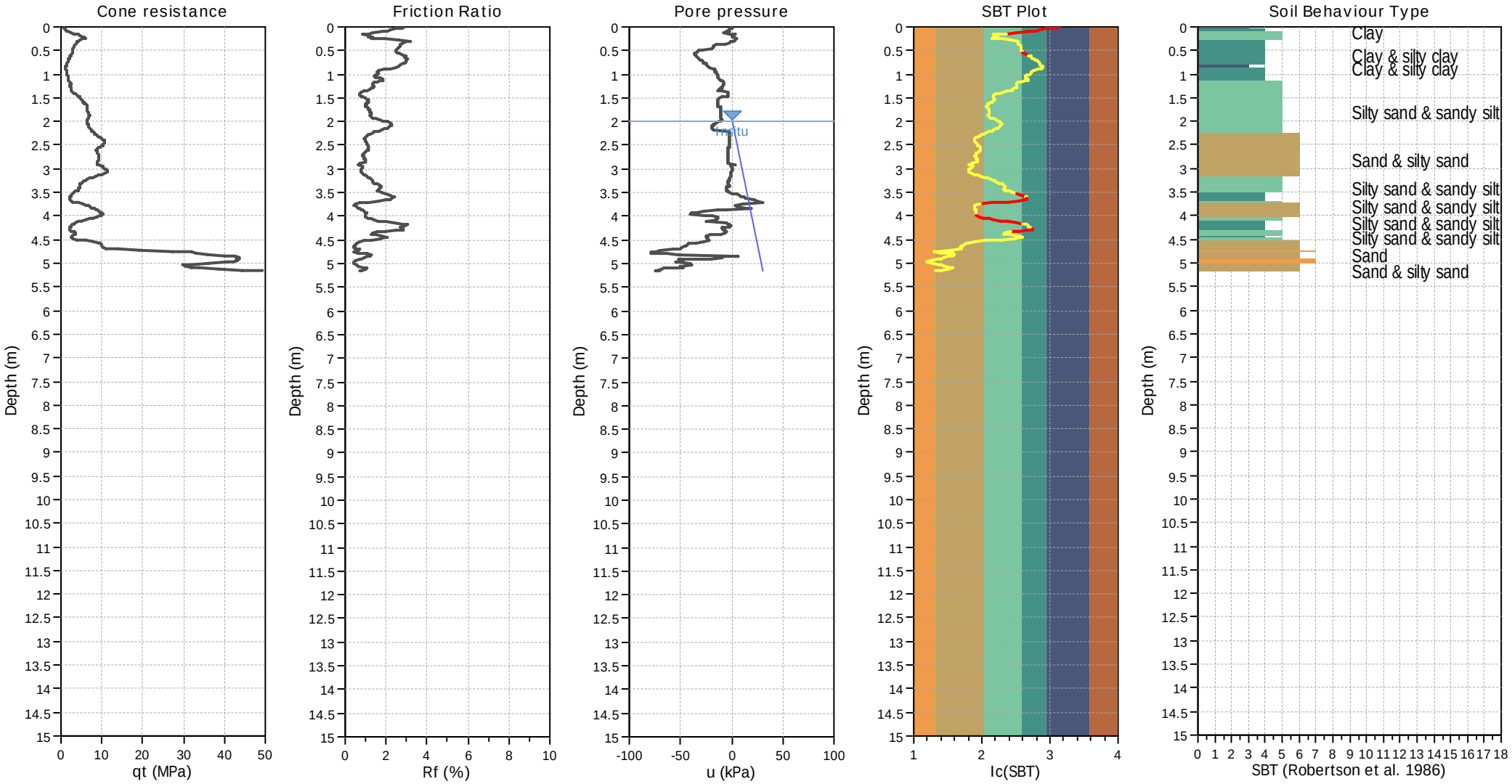
Input parameters and analysis data

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:	Yes
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:	Sand & Clay
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

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



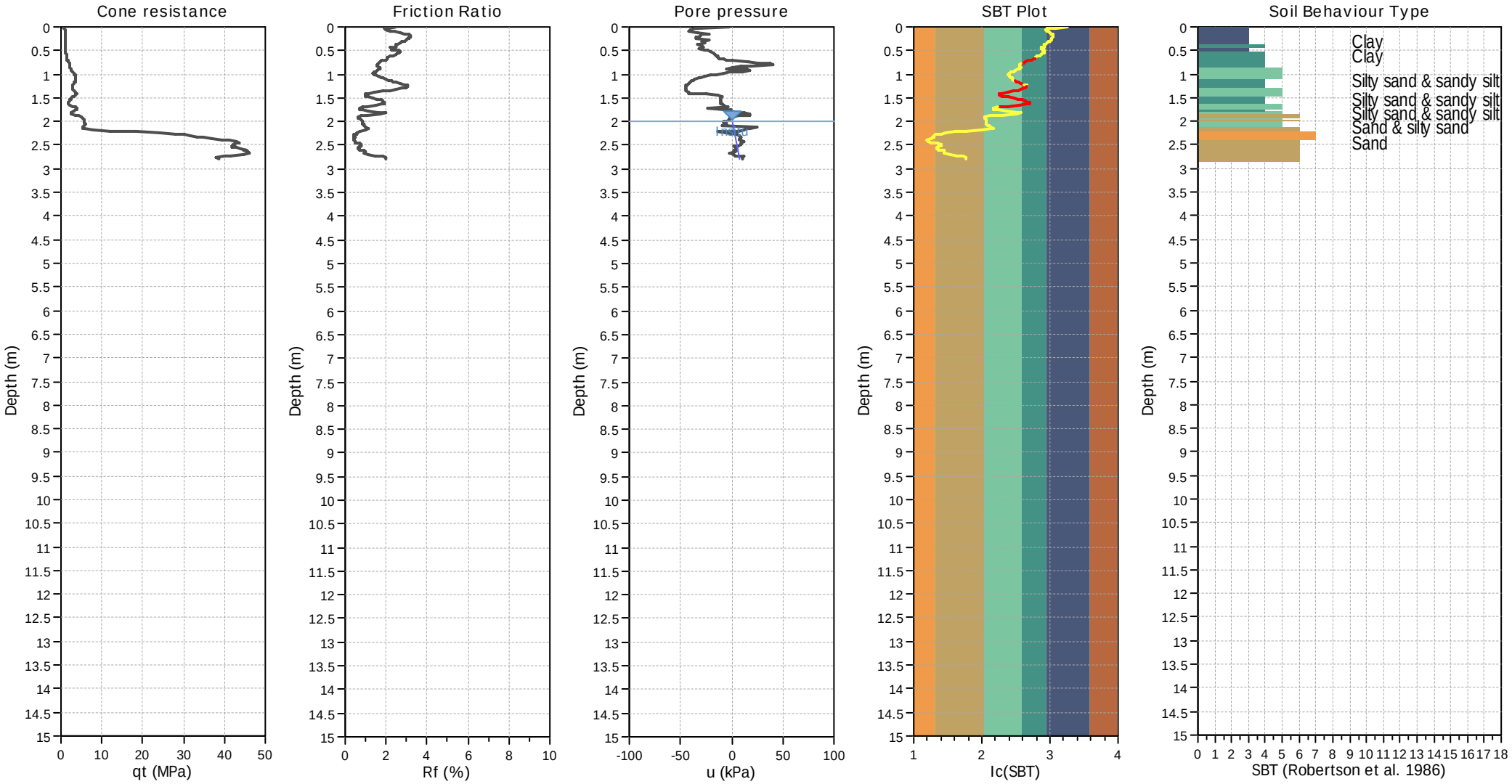
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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:	Sand & Clay
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

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



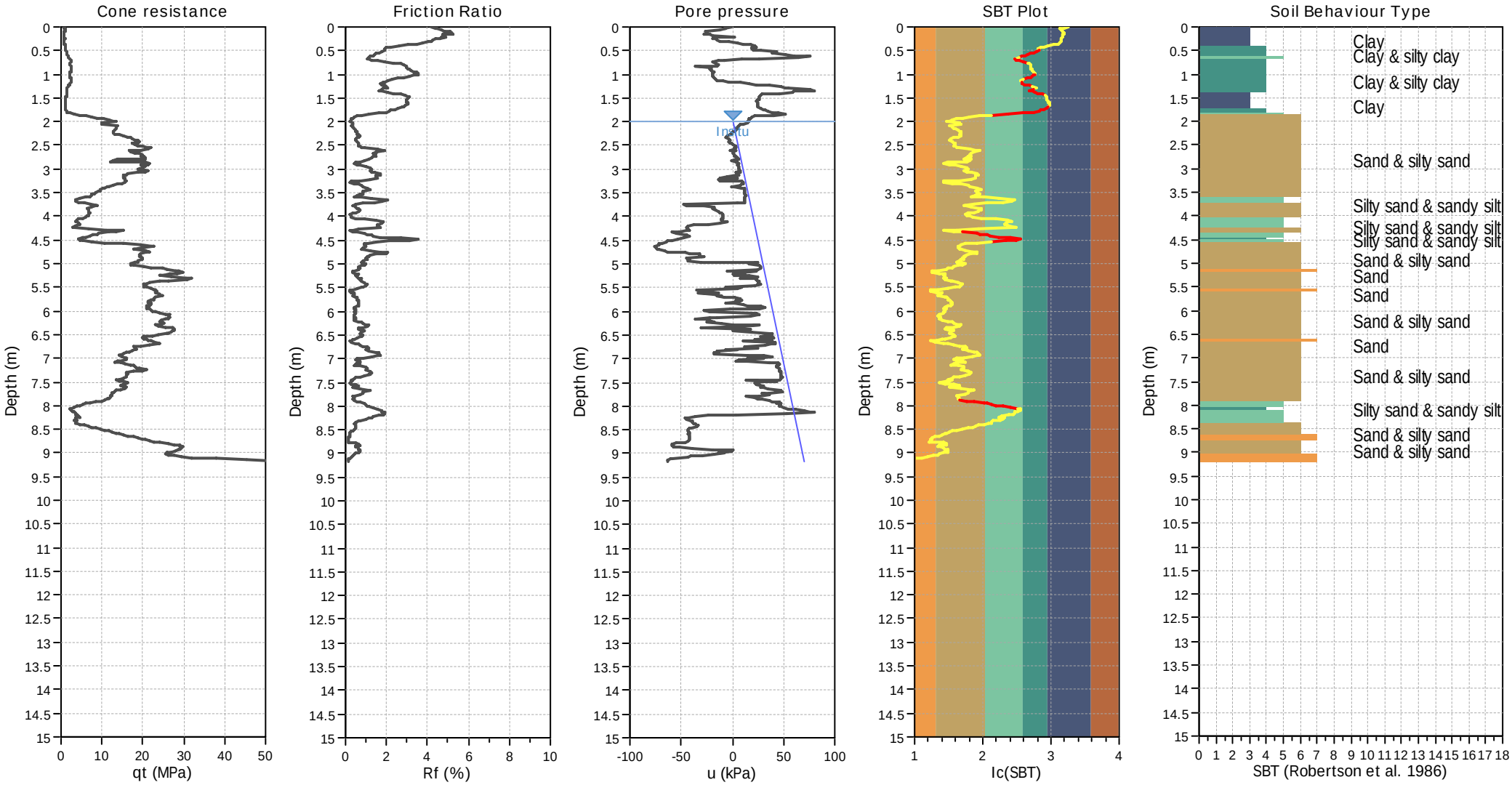
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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:	Sand & Clay
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

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



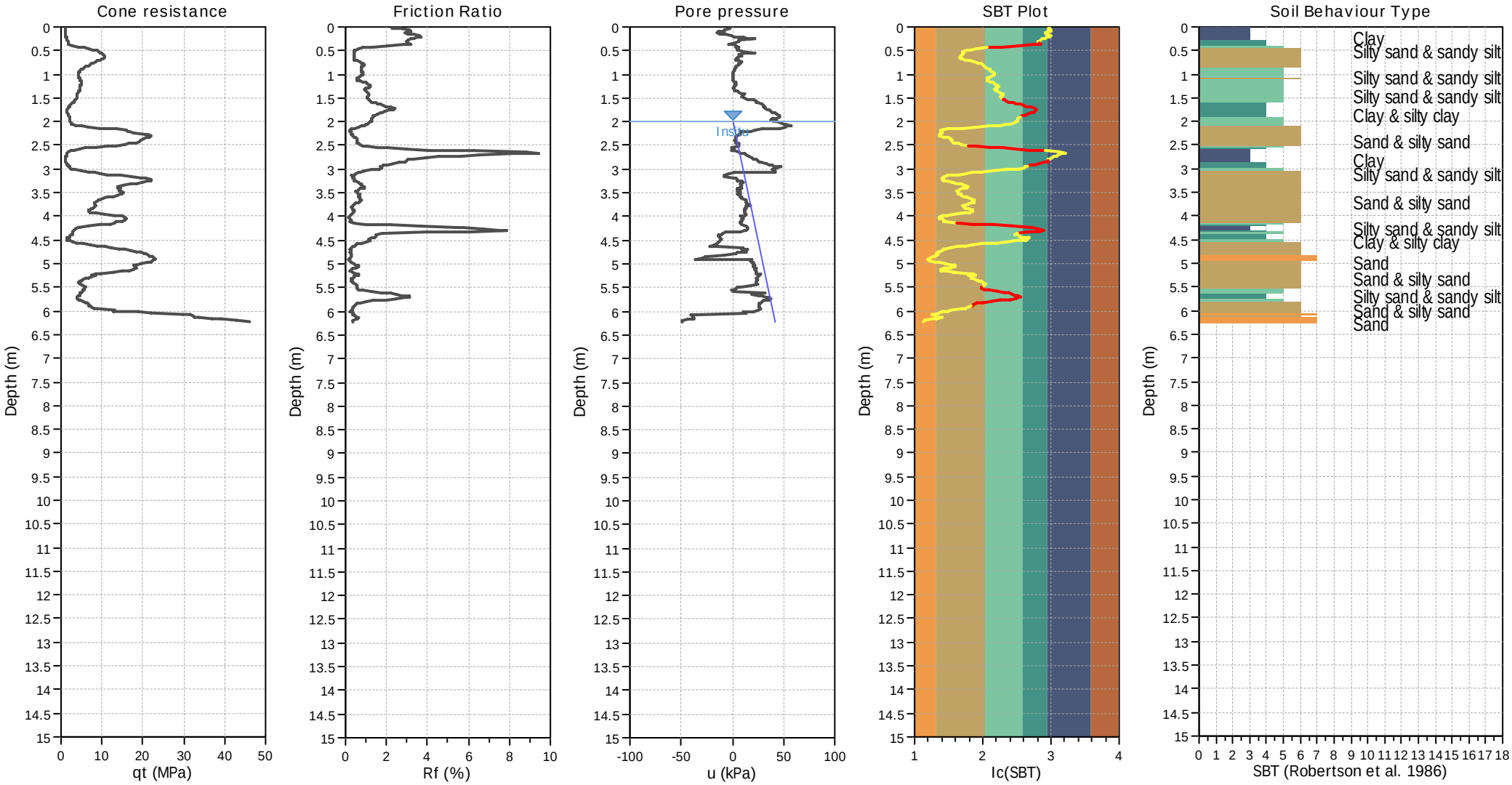
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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:	Sand & Clay
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

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



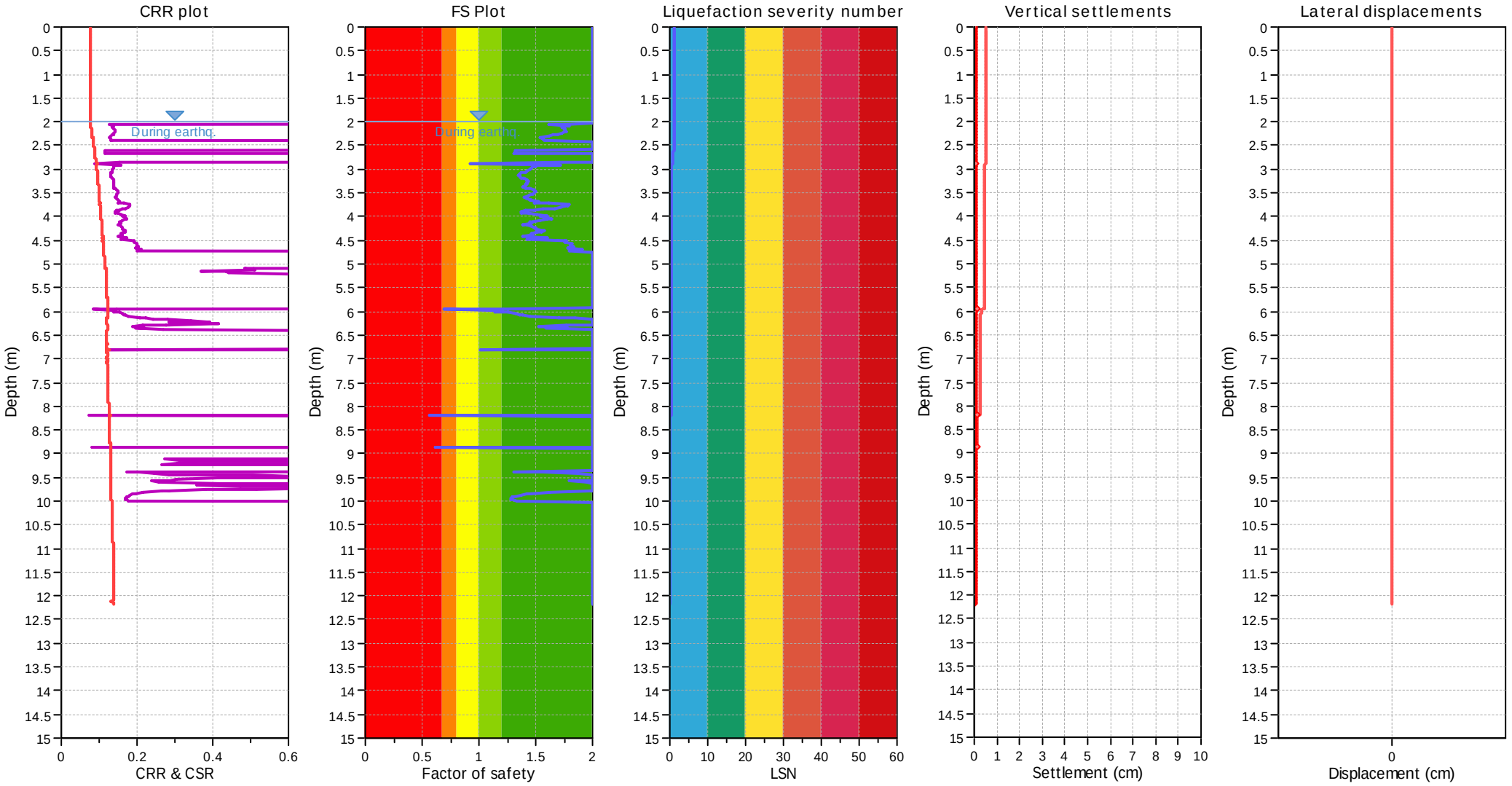
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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:	Sand & Clay
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



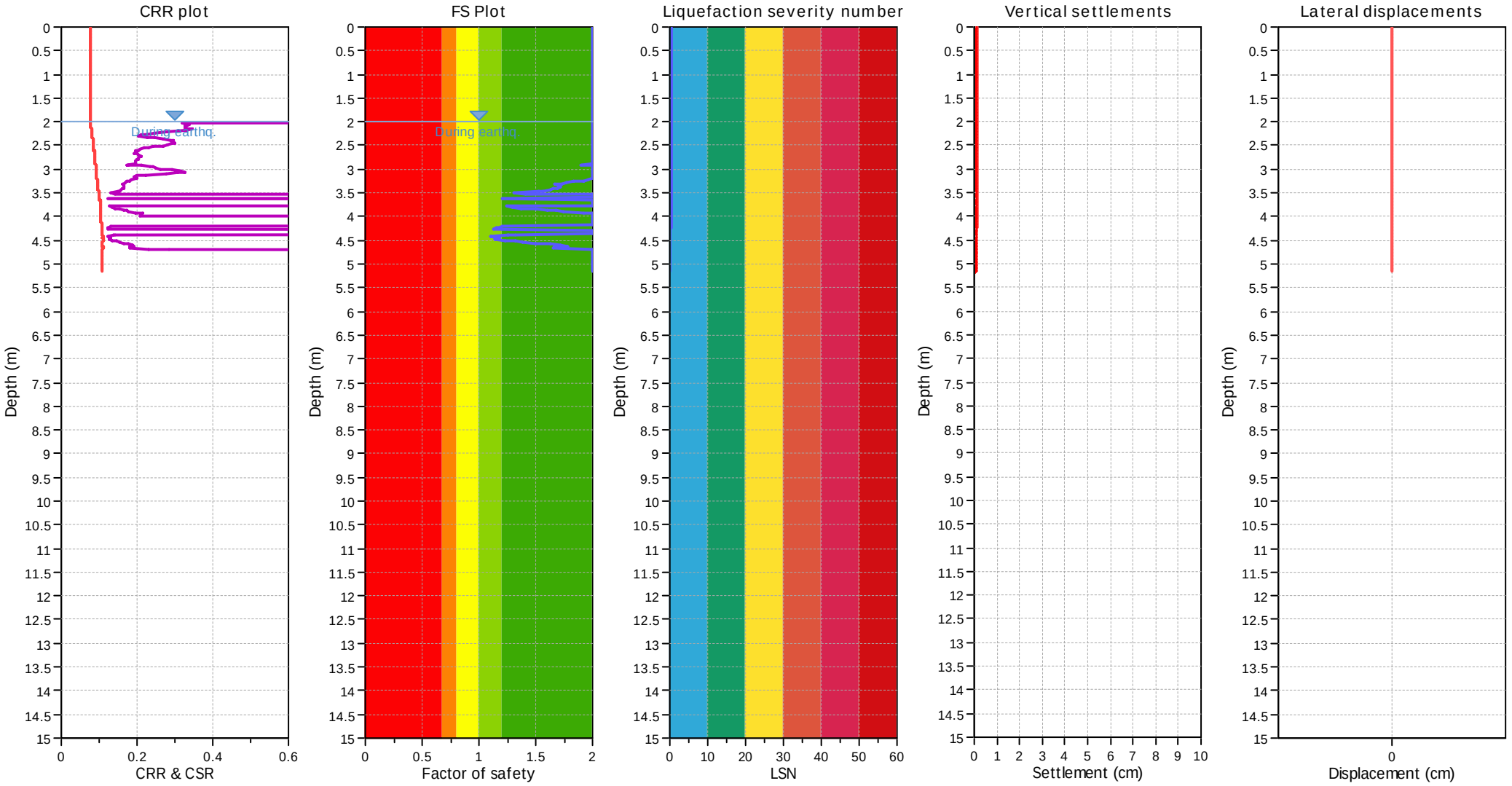
Input parameters and analysis data

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:	Yes
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:	Sand & Clay
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

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

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:	Yes
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:	Sand & Clay
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
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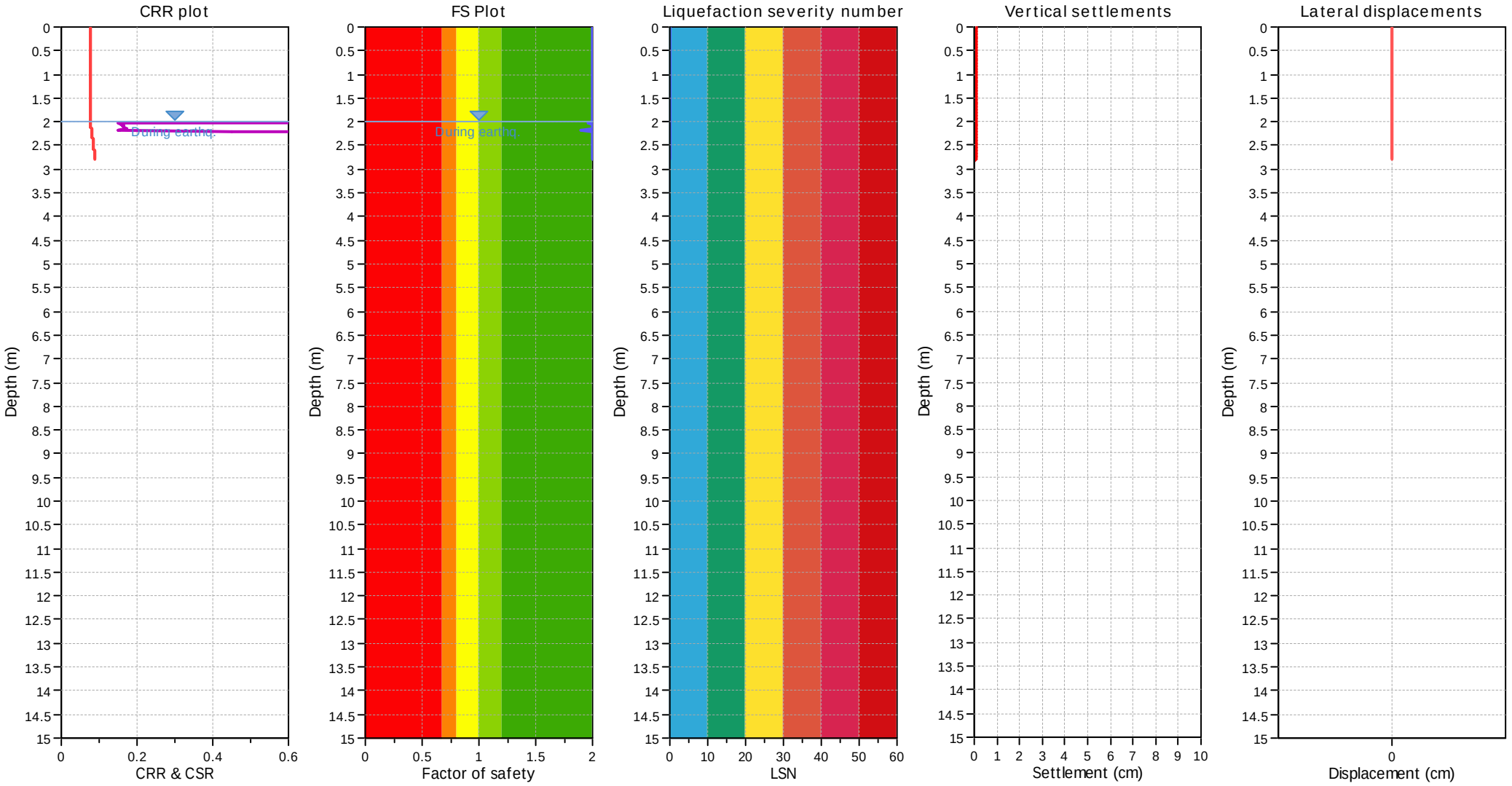
Liquefaction analysis overall plots



Input parameters and analysis data

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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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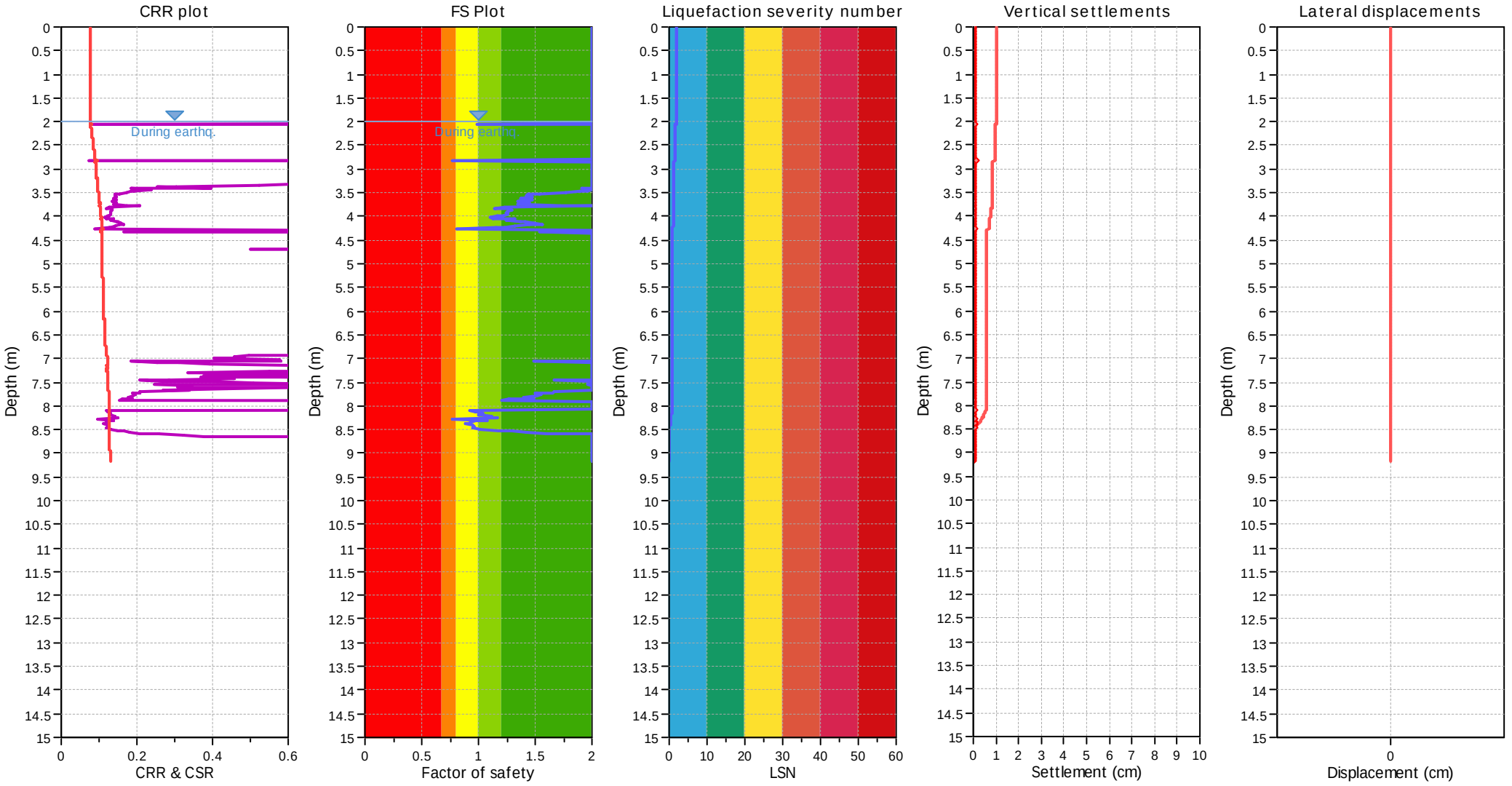
Liquefaction analysis overall plots



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:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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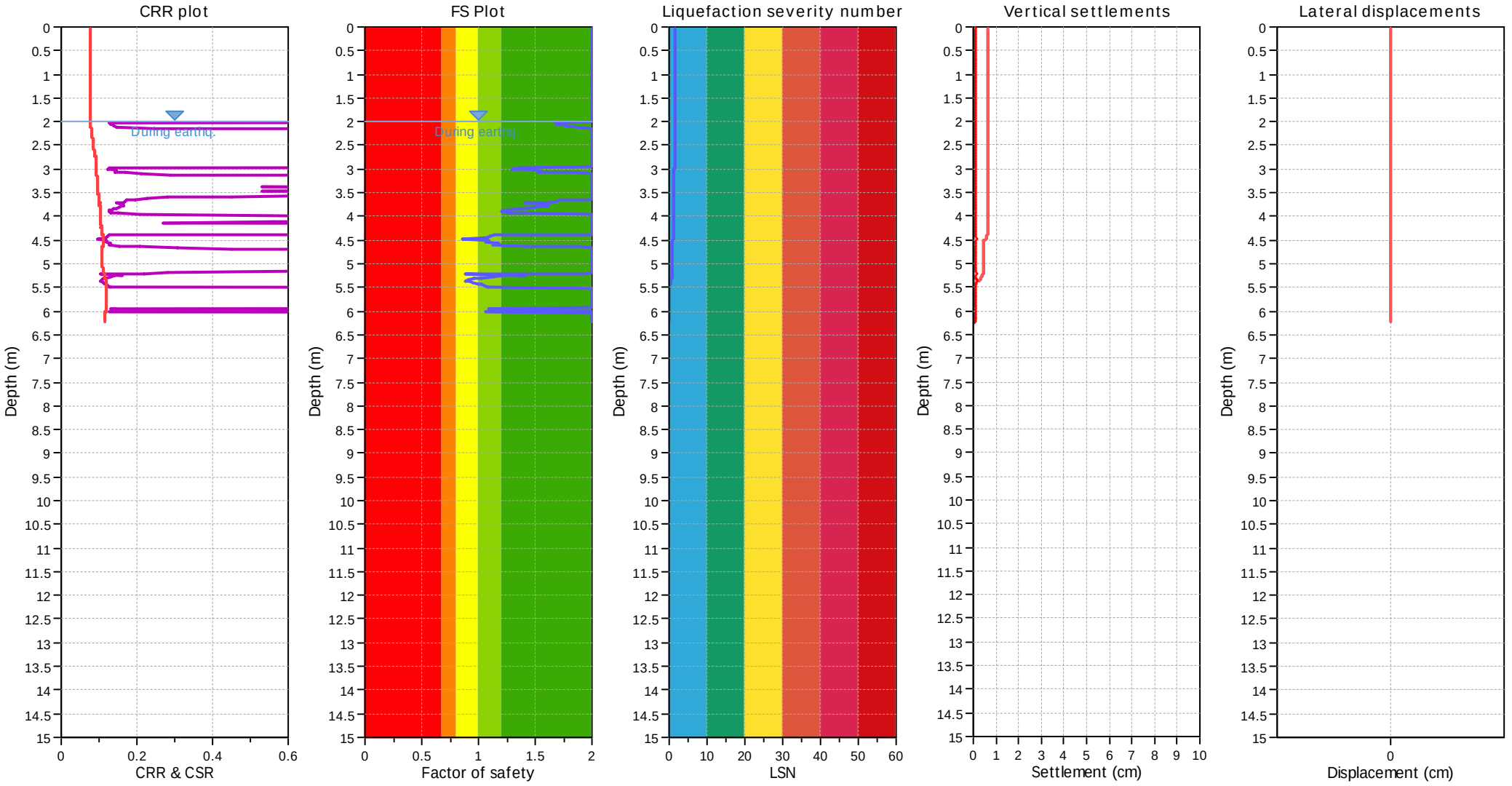
Liquefaction analysis overall plots



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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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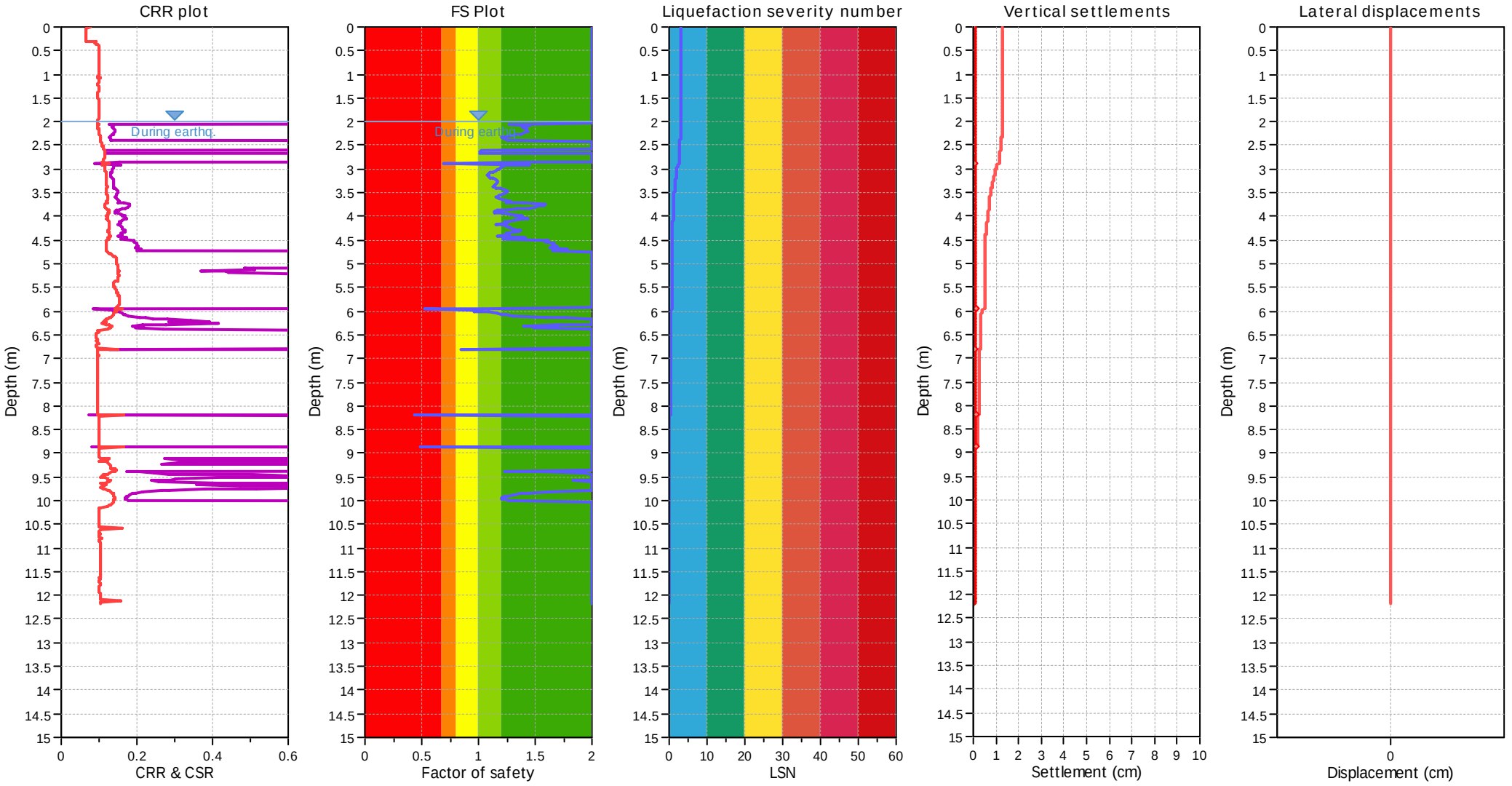
Liquefaction analysis overall plots



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:	Yes
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:	Sand & Clay
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

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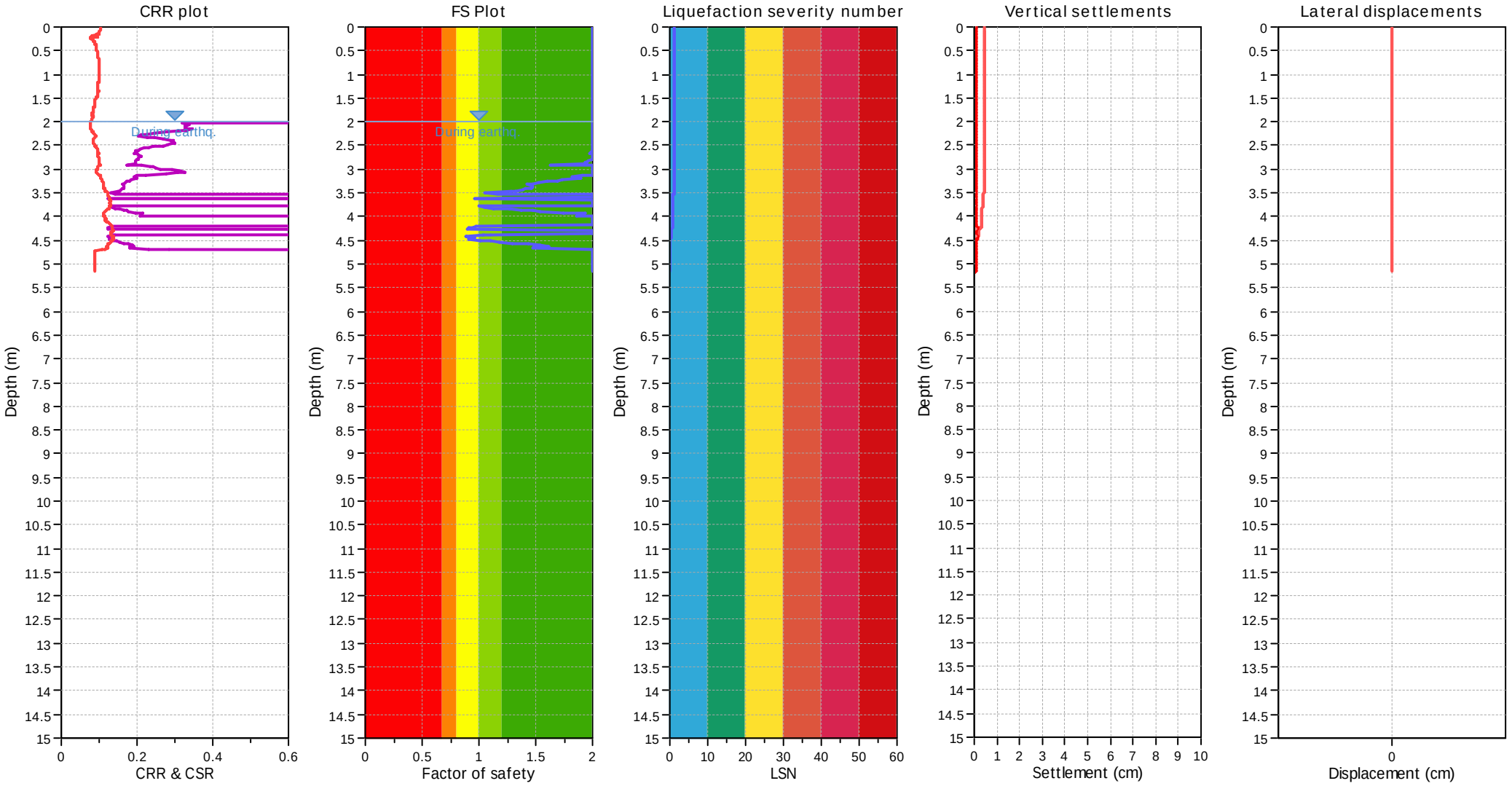
Liquefaction analysis overall plots



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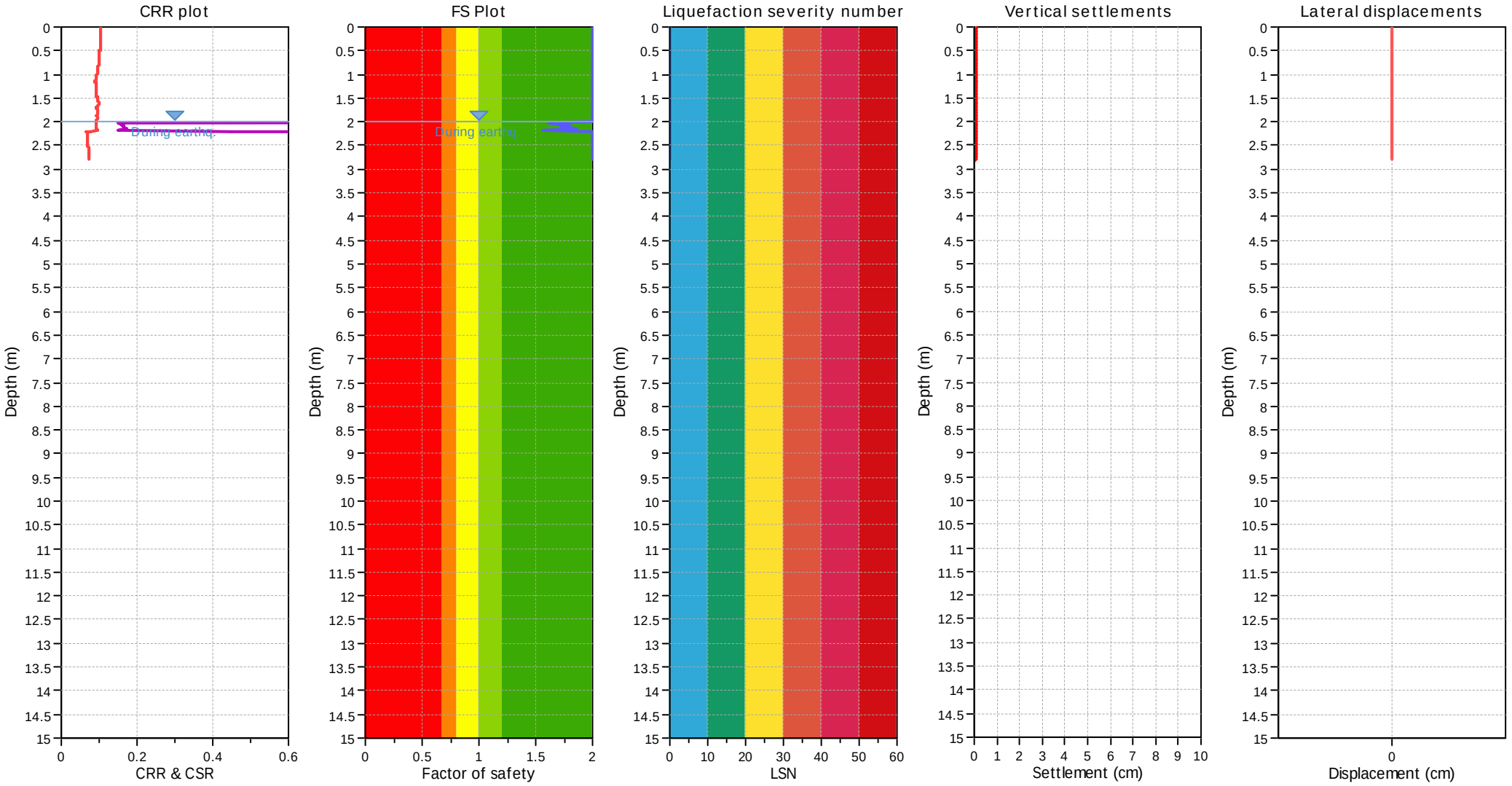
Liquefaction analysis overall plots



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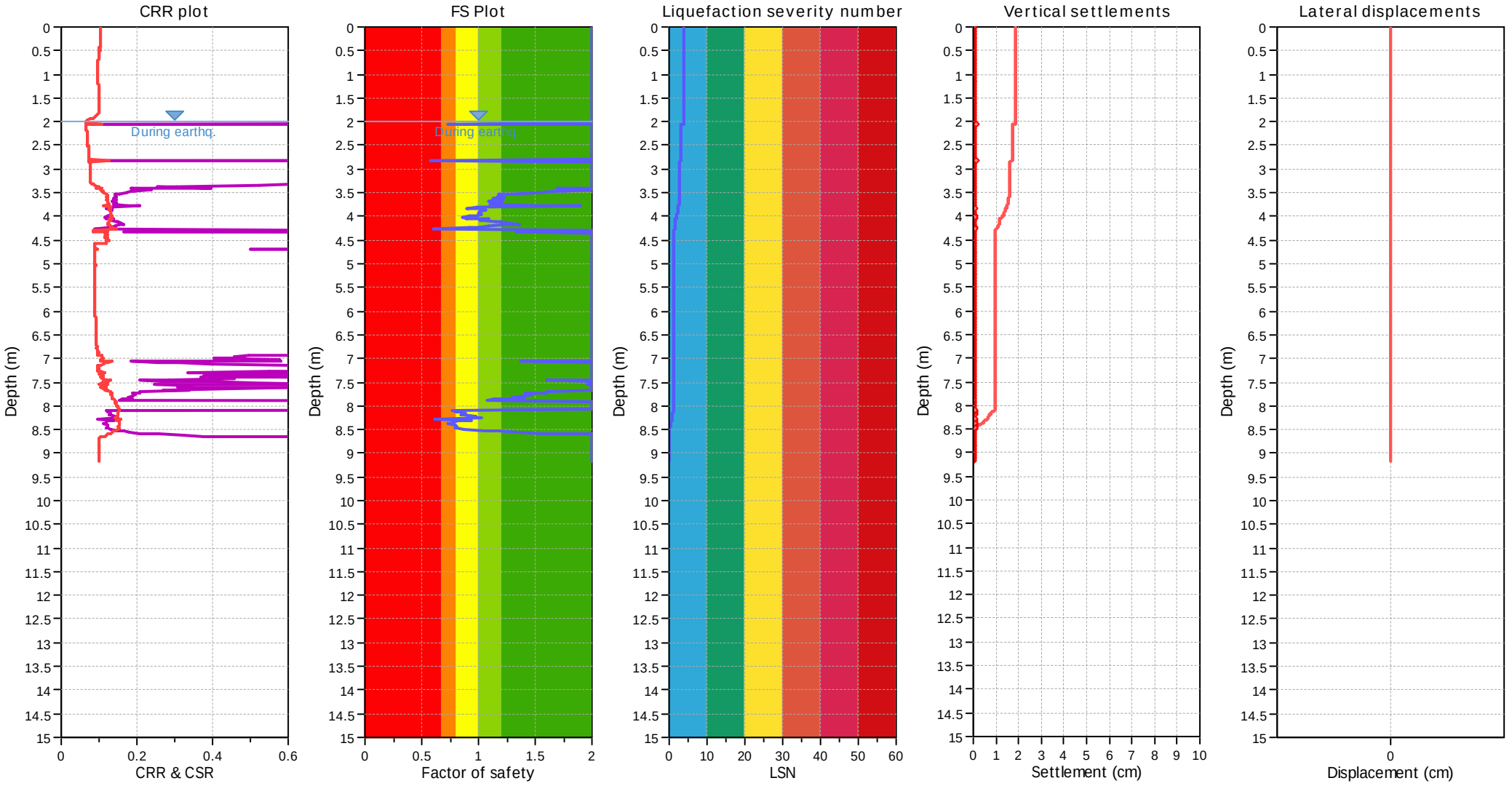
Liquefaction analysis overall plots



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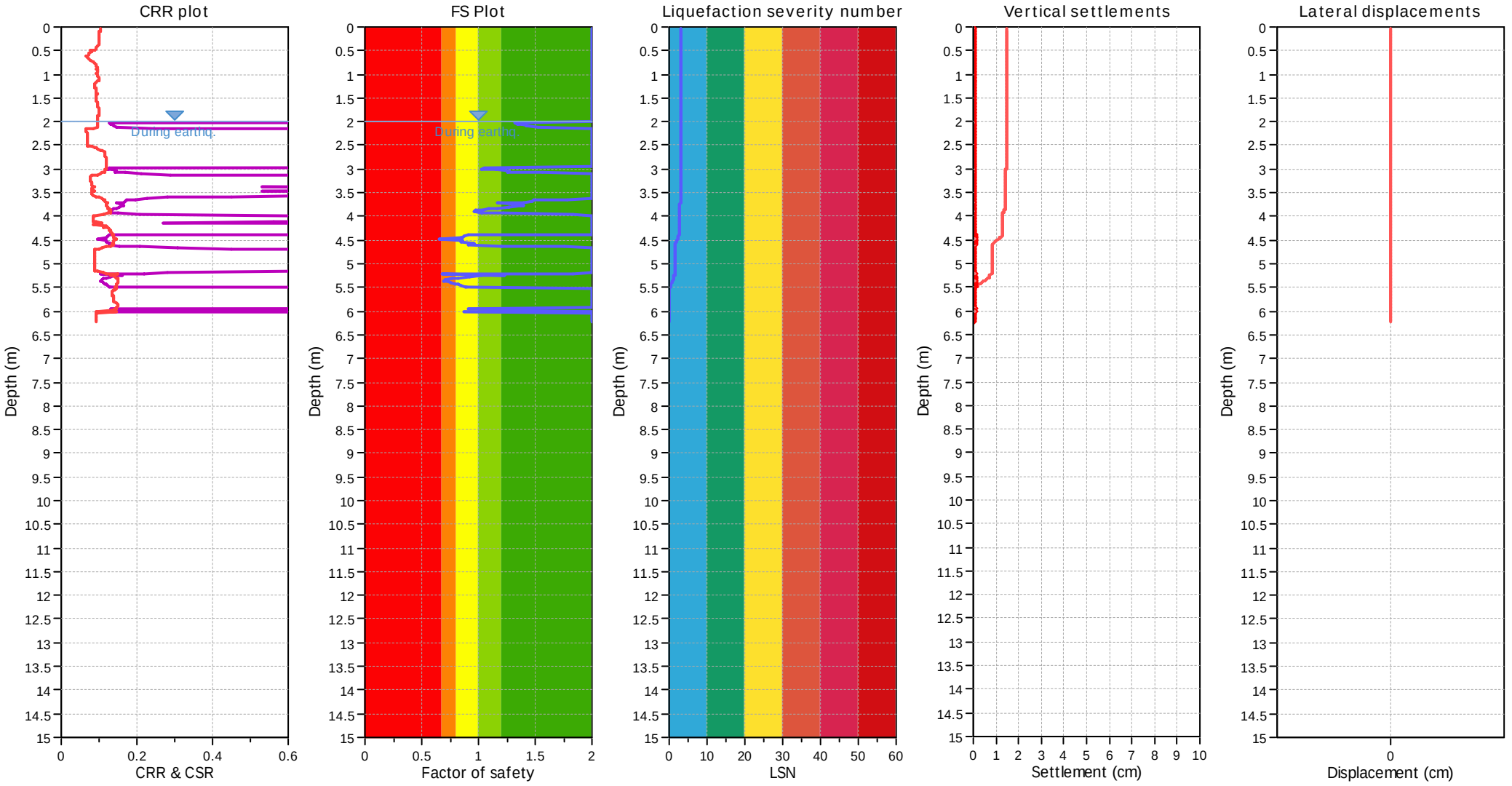
Liquefaction analysis overall plots



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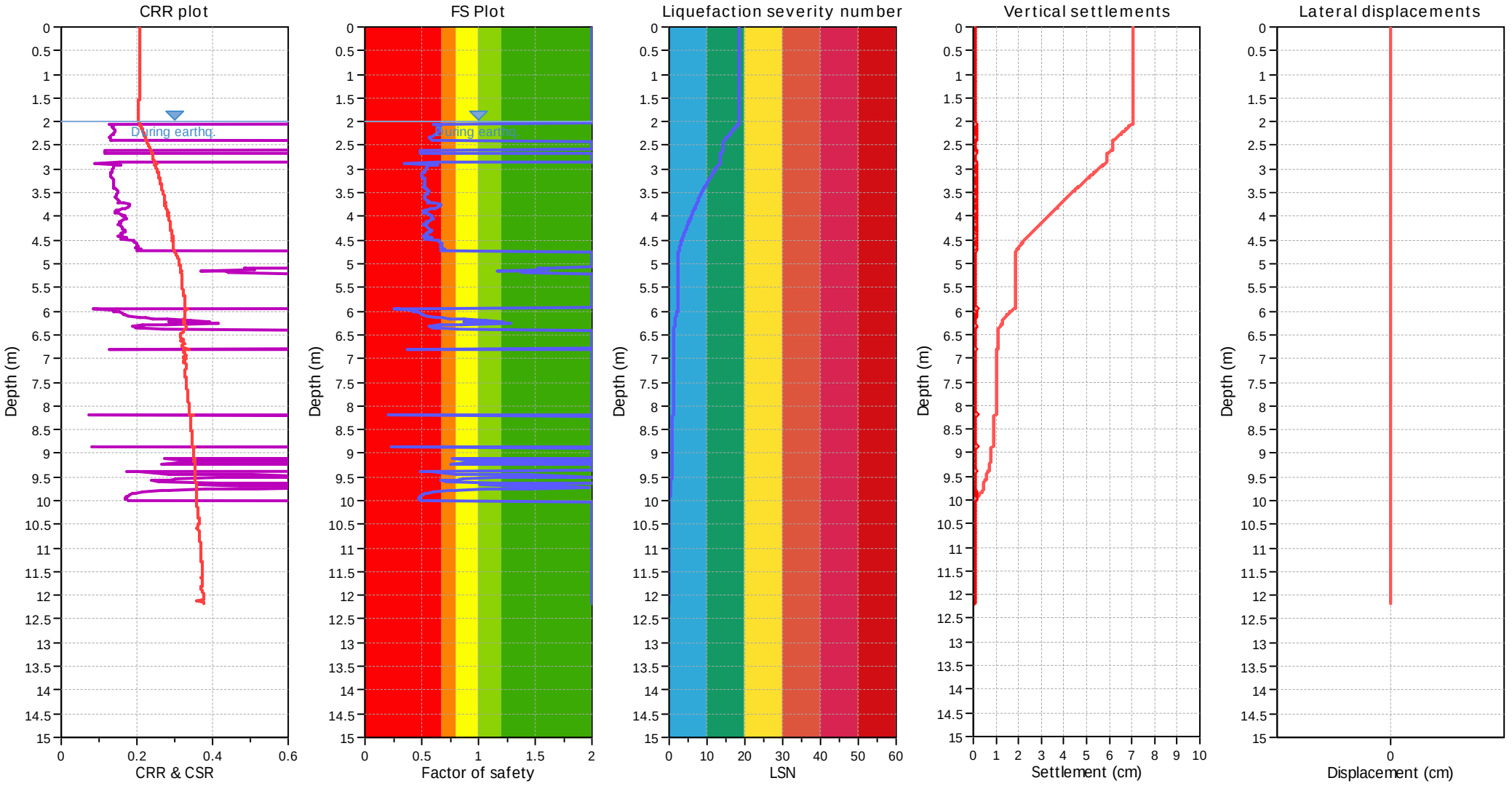
Liquefaction analysis overall plots



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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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:	Sand & Clay
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

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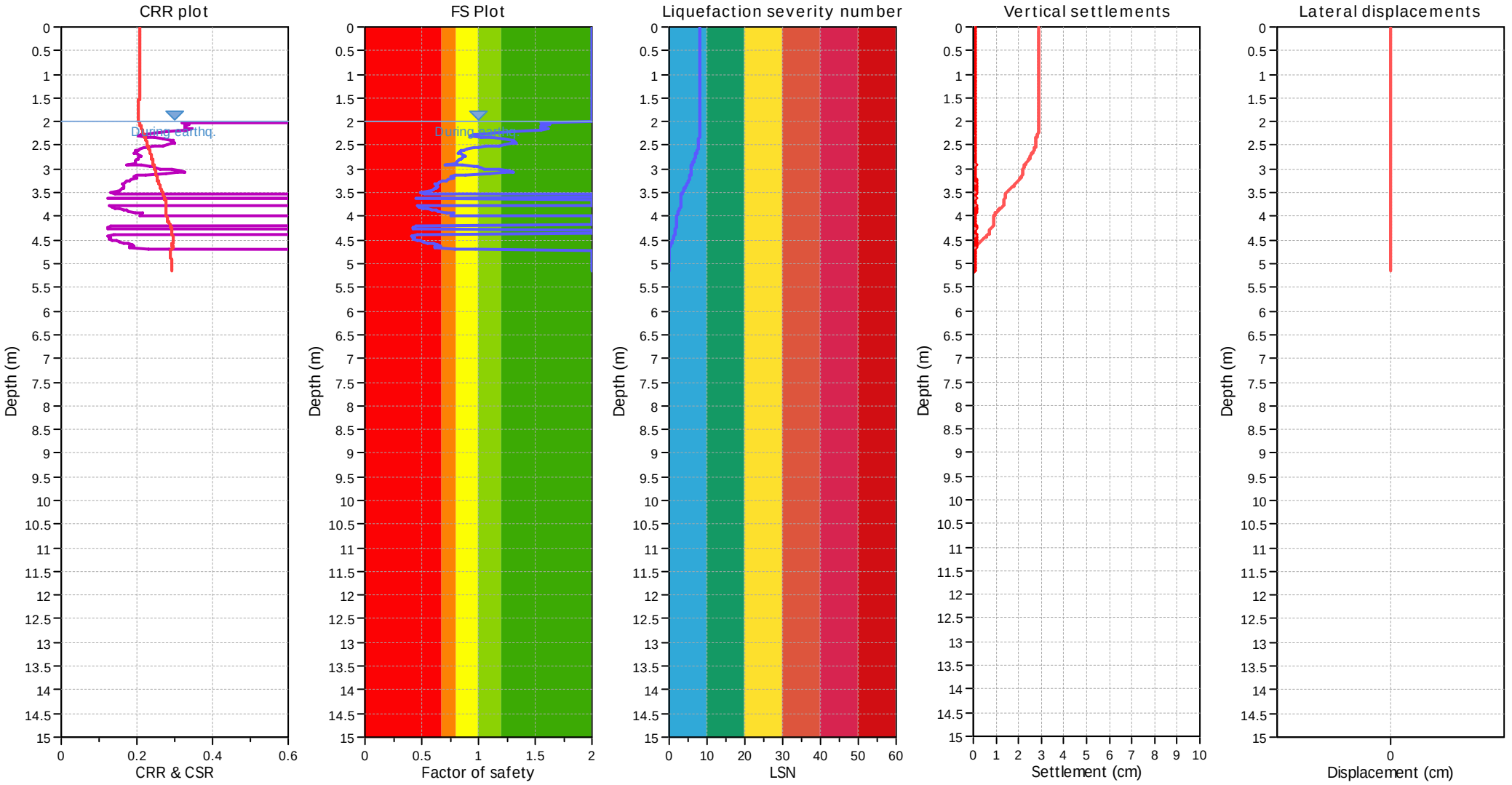
Liquefaction analysis overall plots



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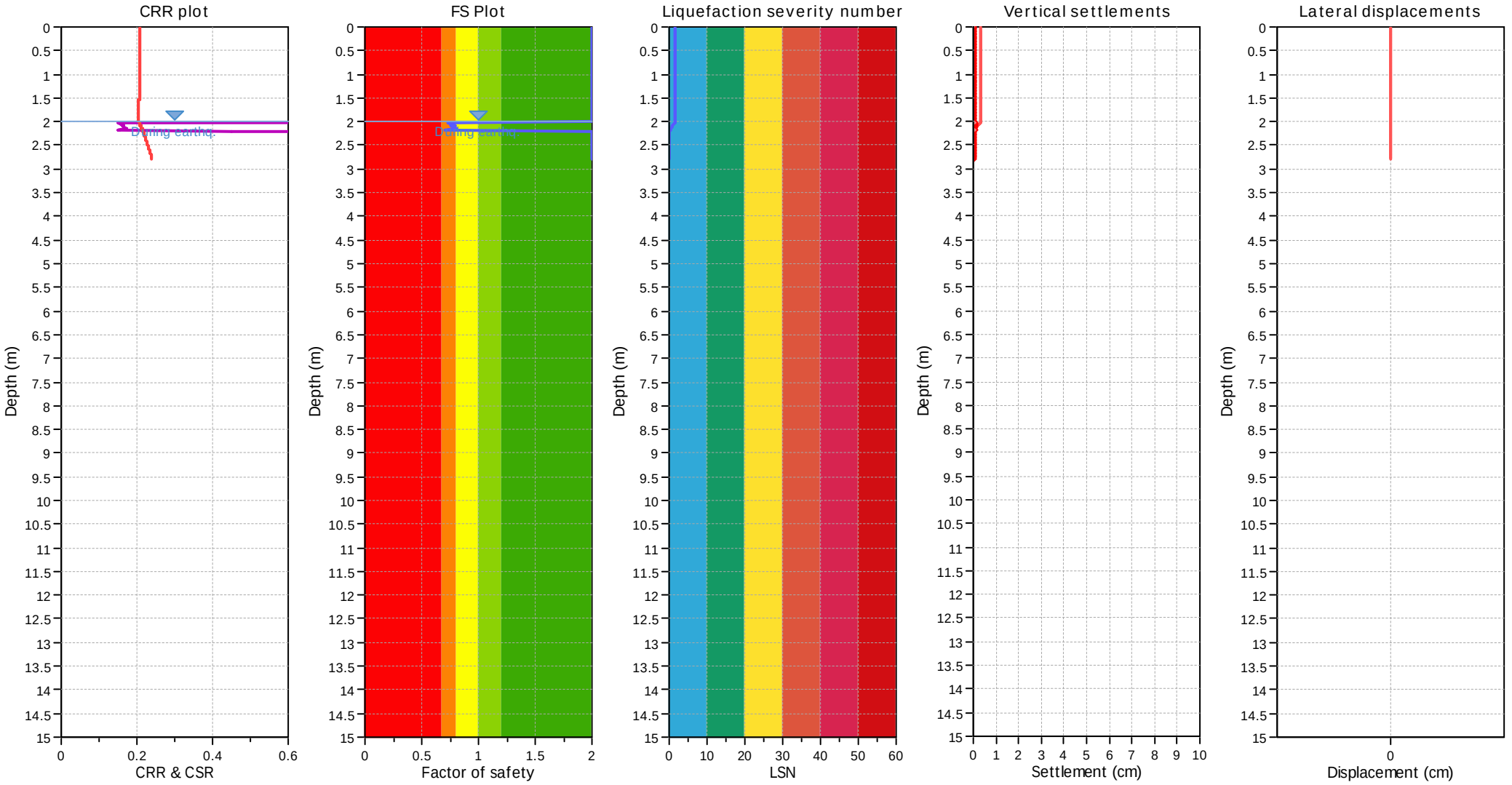
Liquefaction analysis overall plots



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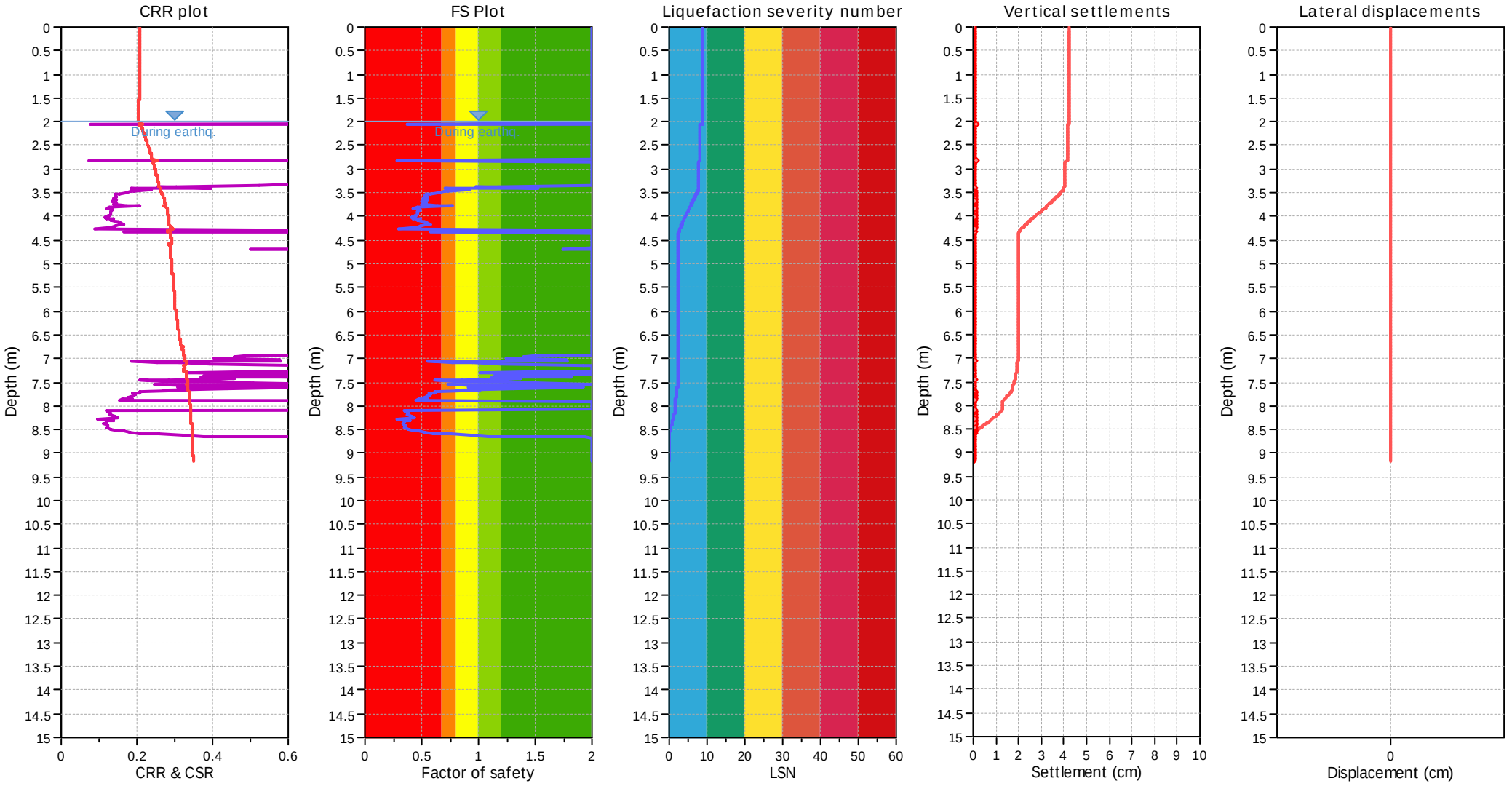
Liquefaction analysis overall plots



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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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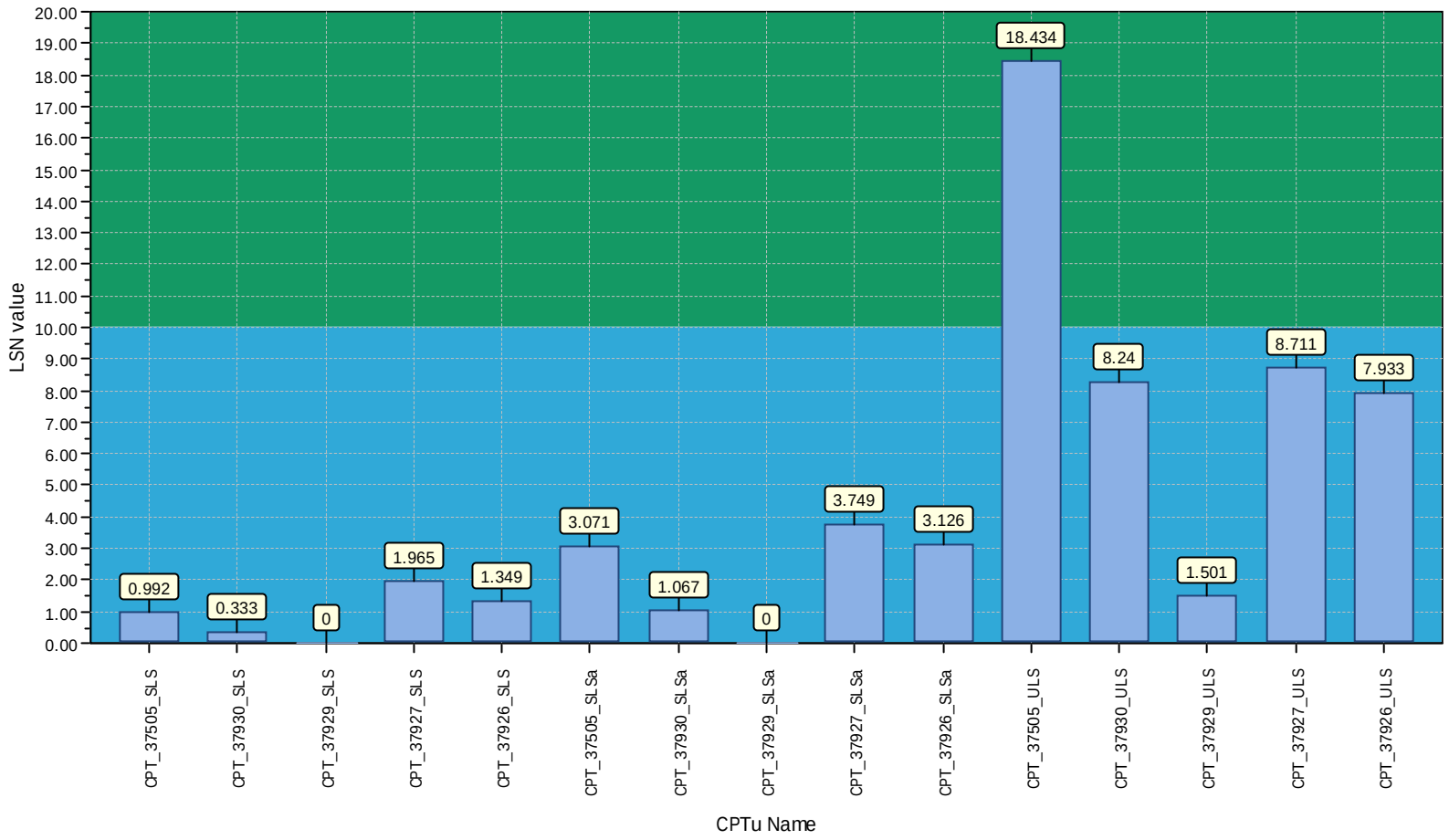
Eliot Sinclair
20 Troup Drive, Tower Junction
8011
eliotsinclair.co.nz

Project title : CLiq Analysis

Location : Nearby CPTs (NZGD) - 67 Mapleham Drive, Pegasus - West of Site

Overall Liquefaction Severity Number report



LSN color scheme

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Basic statistics

Total CPT number: 15

93% little liquefaction

7% minor liquefaction

0% moderate liquefaction

0% moderate to major liquefaction

0% major liquefaction

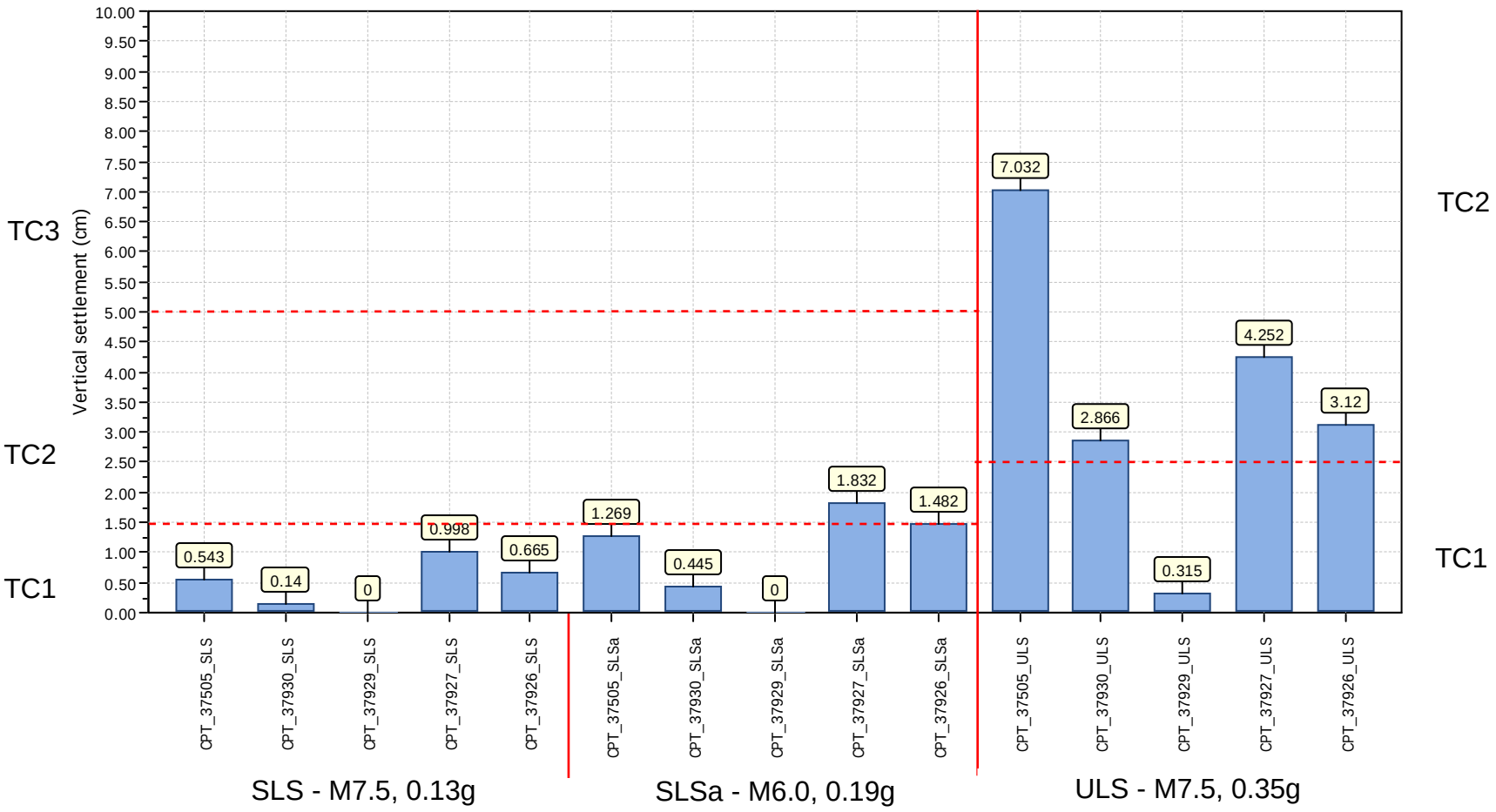
0% severe liquefaction

Eliot Sinclair
20 Troup Drive, Tower Junction
8011
eliotsinclair.co.nz

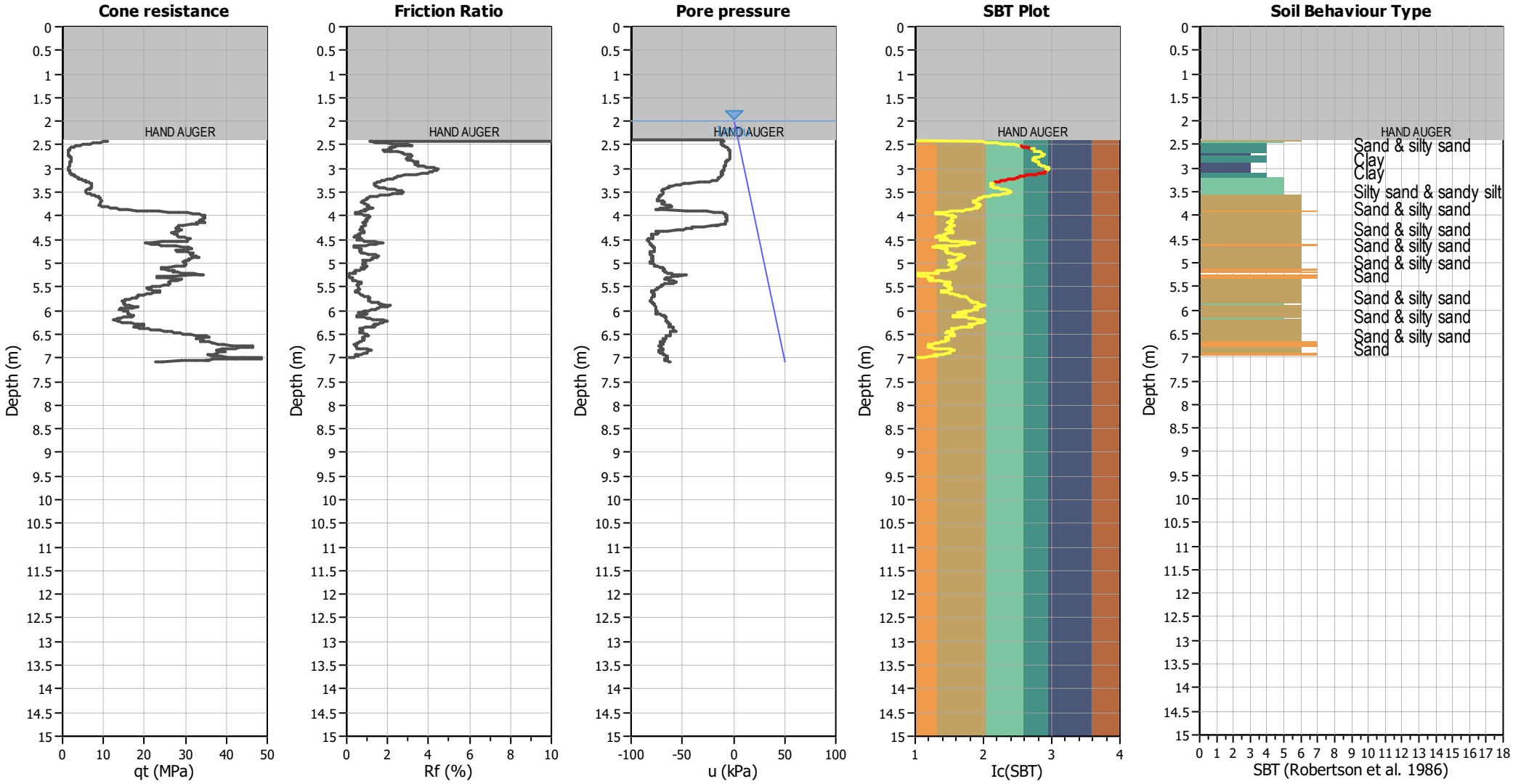
Project title : CLiq Analysis

Location : Nearby CPTs (NZGD) - 67 Mapleham Drive, Pegasus - West of Site

Overall vertical settlements report



CPT basic interpretation plots



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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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:	Sand & Clay
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

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
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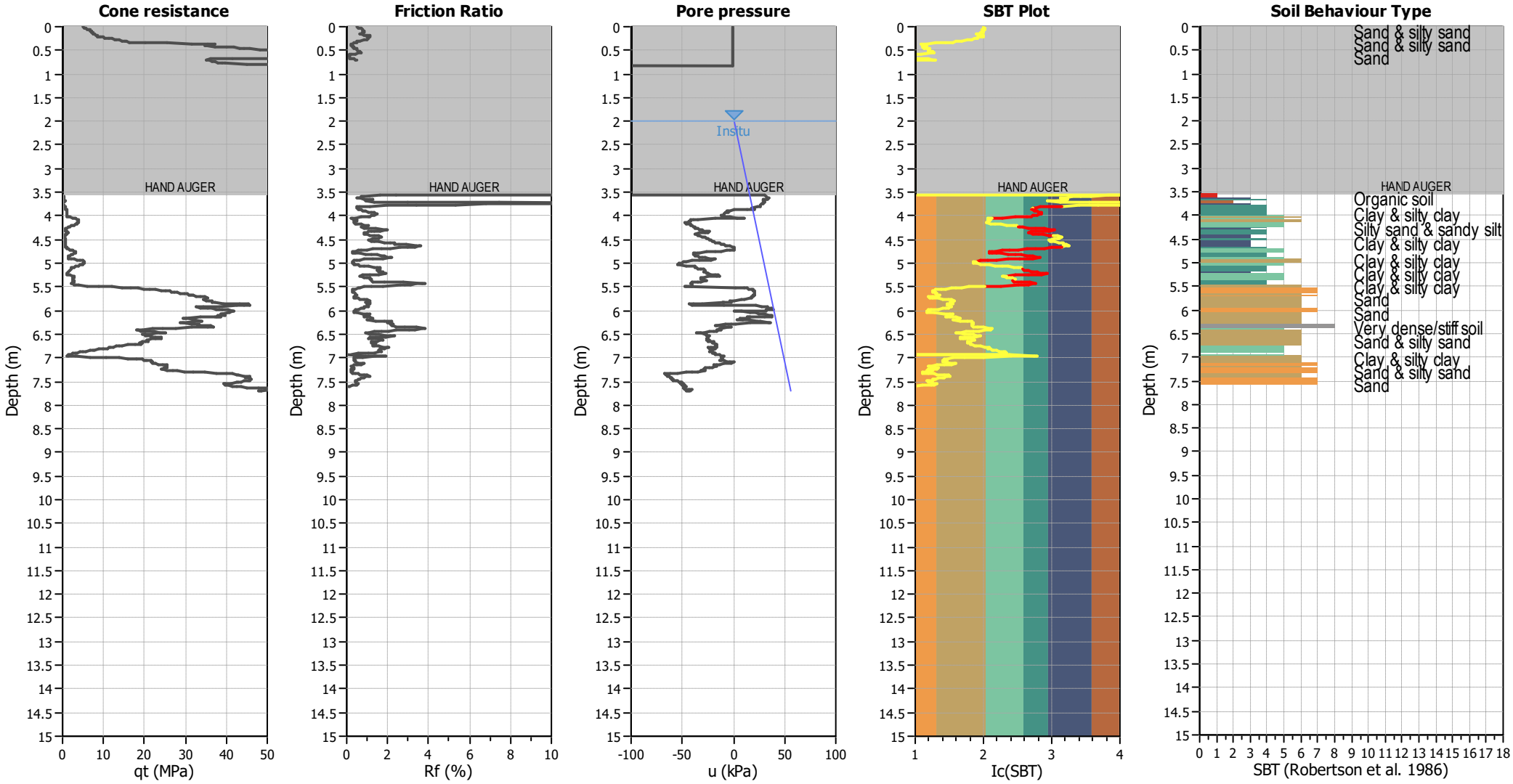
CPT basic interpretation plots



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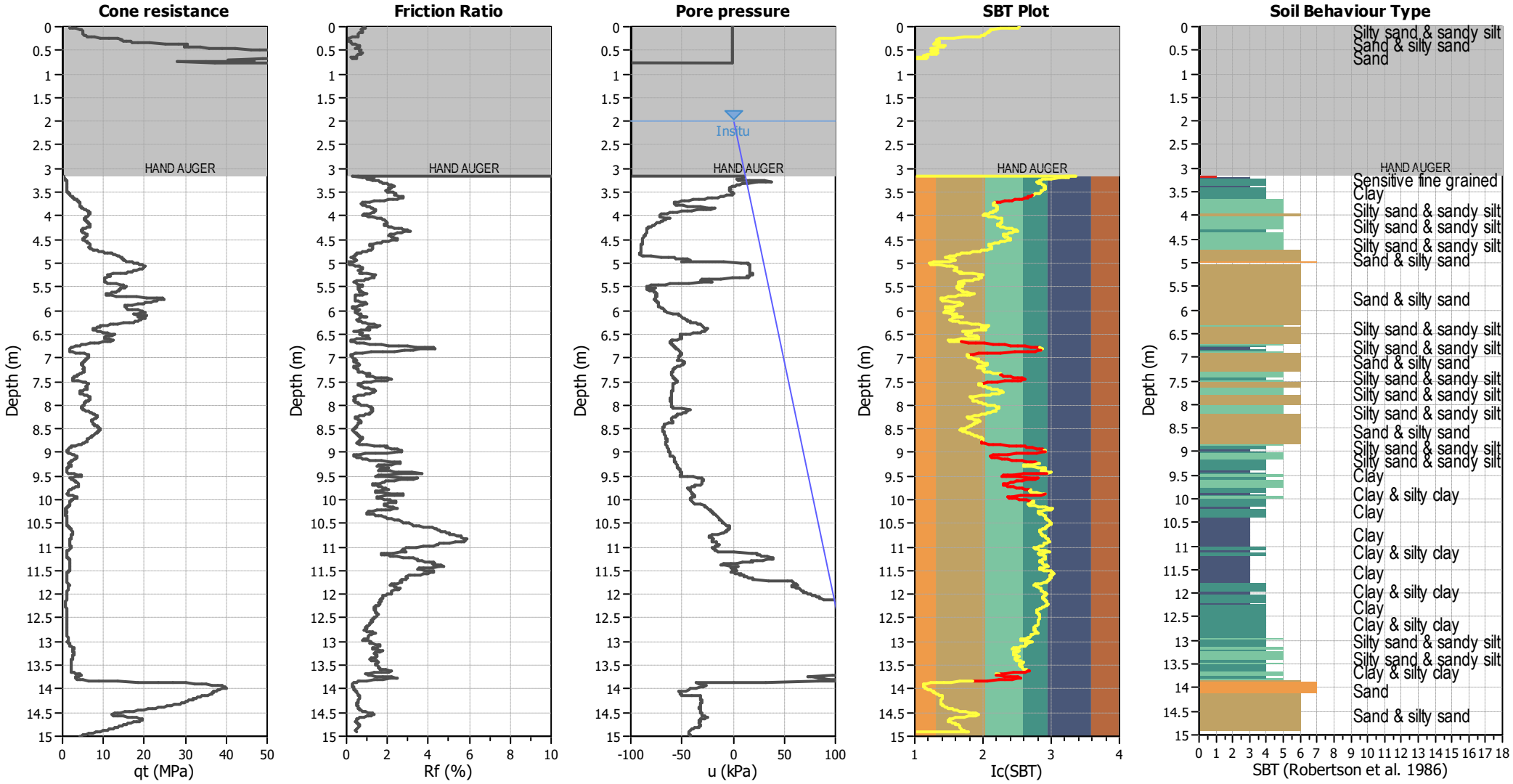
9. Very stiff fine grained

CPT basic interpretation plots



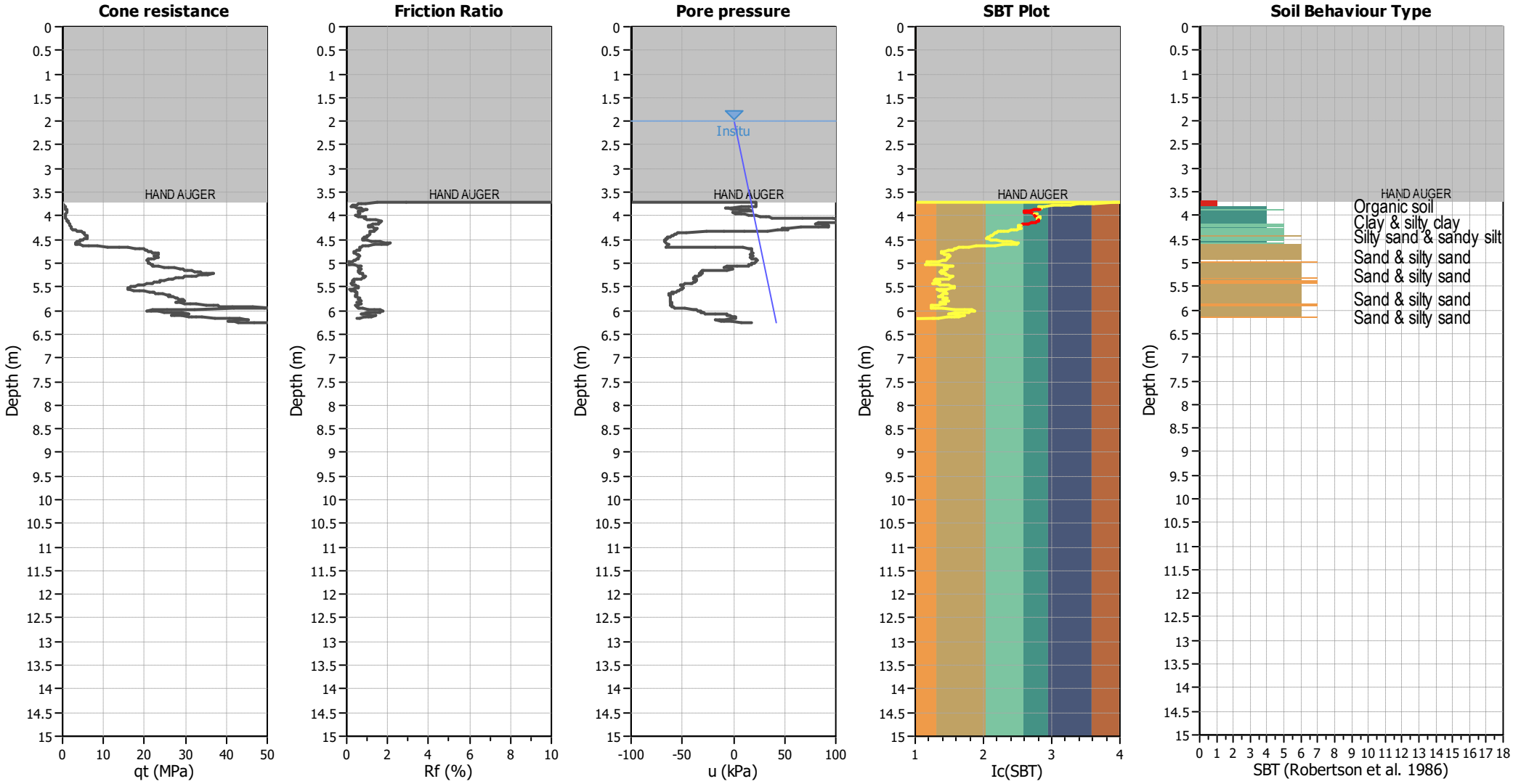
Input parameters and analysis data

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:	Yes
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:	Sand & Clay
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

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



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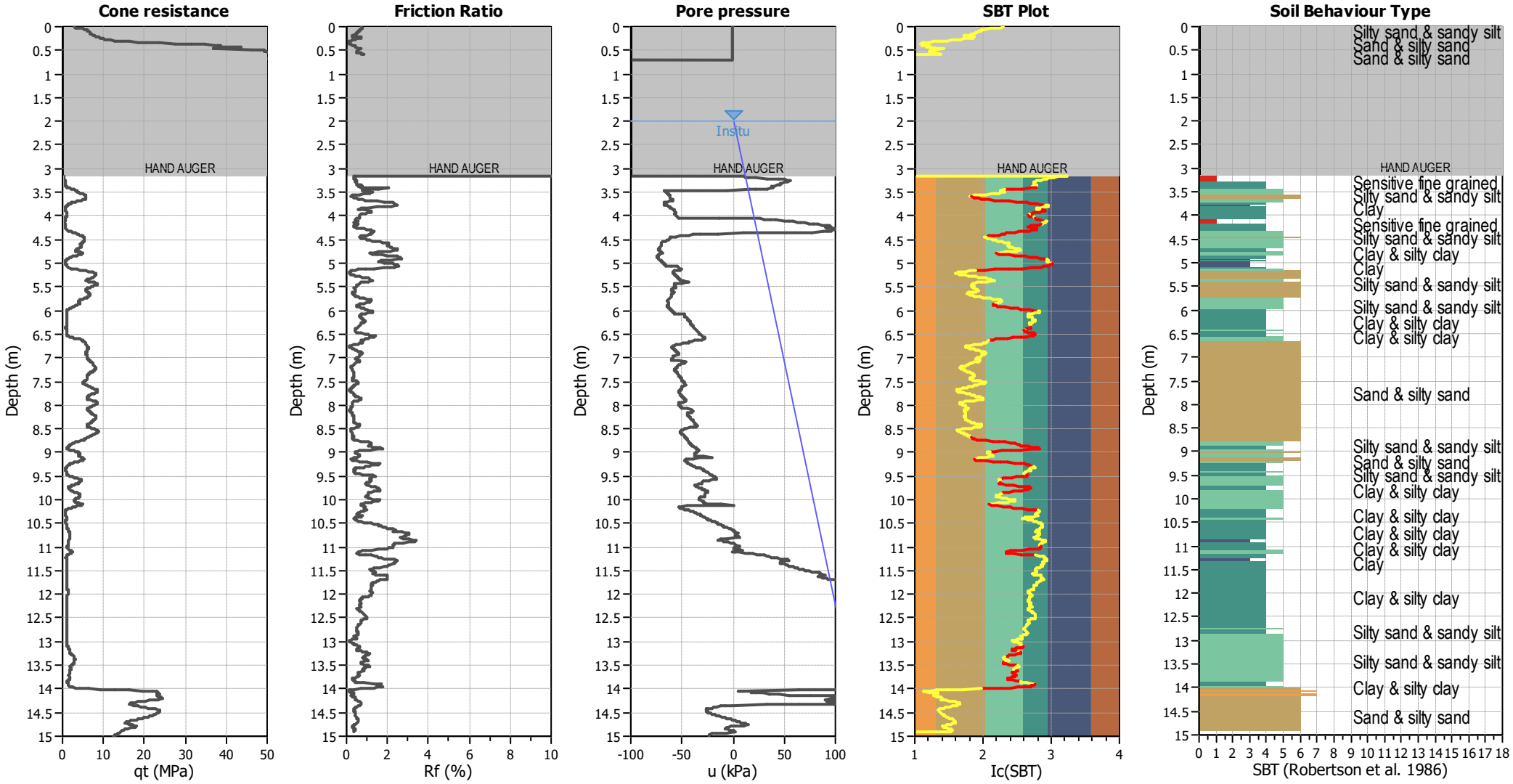

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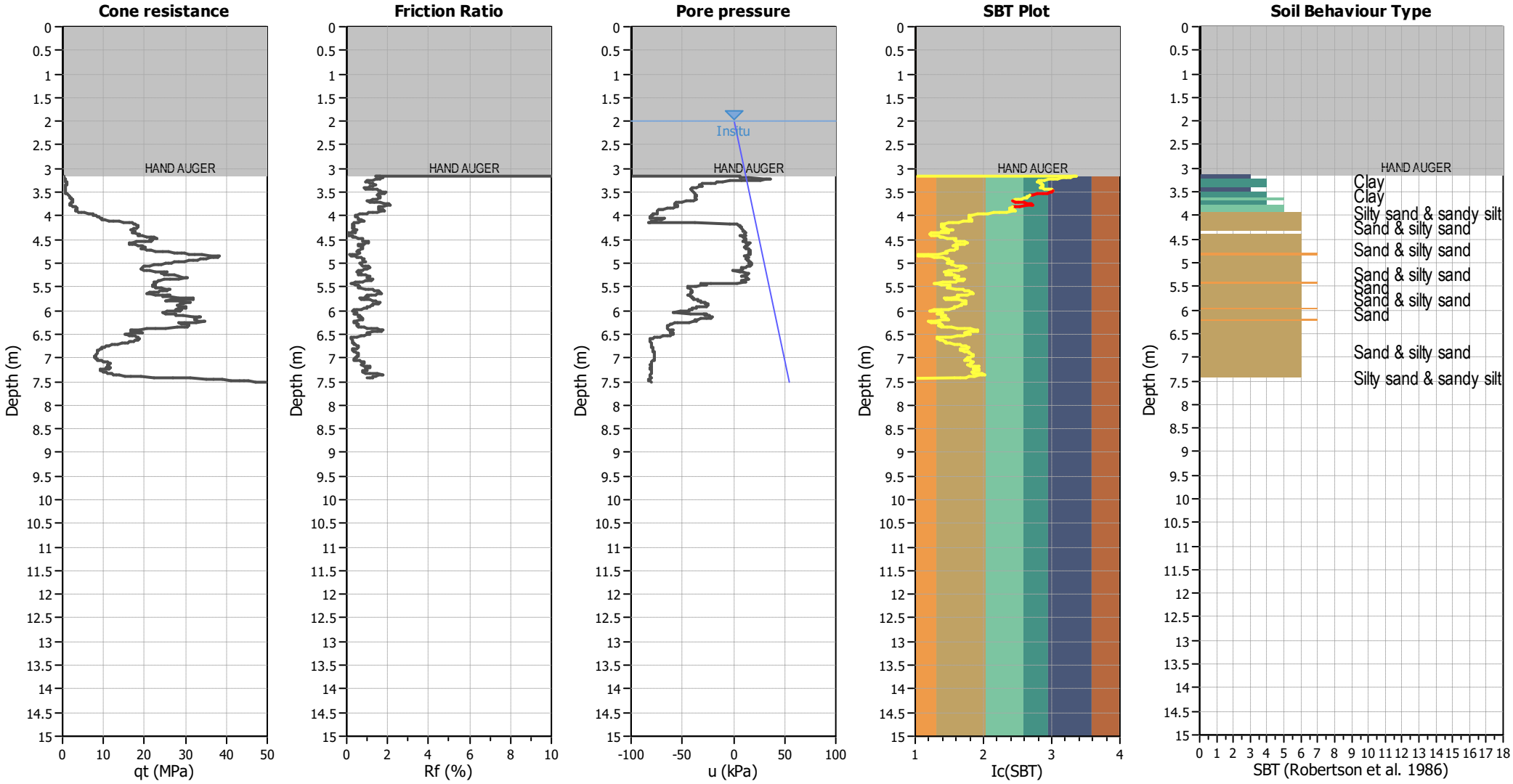

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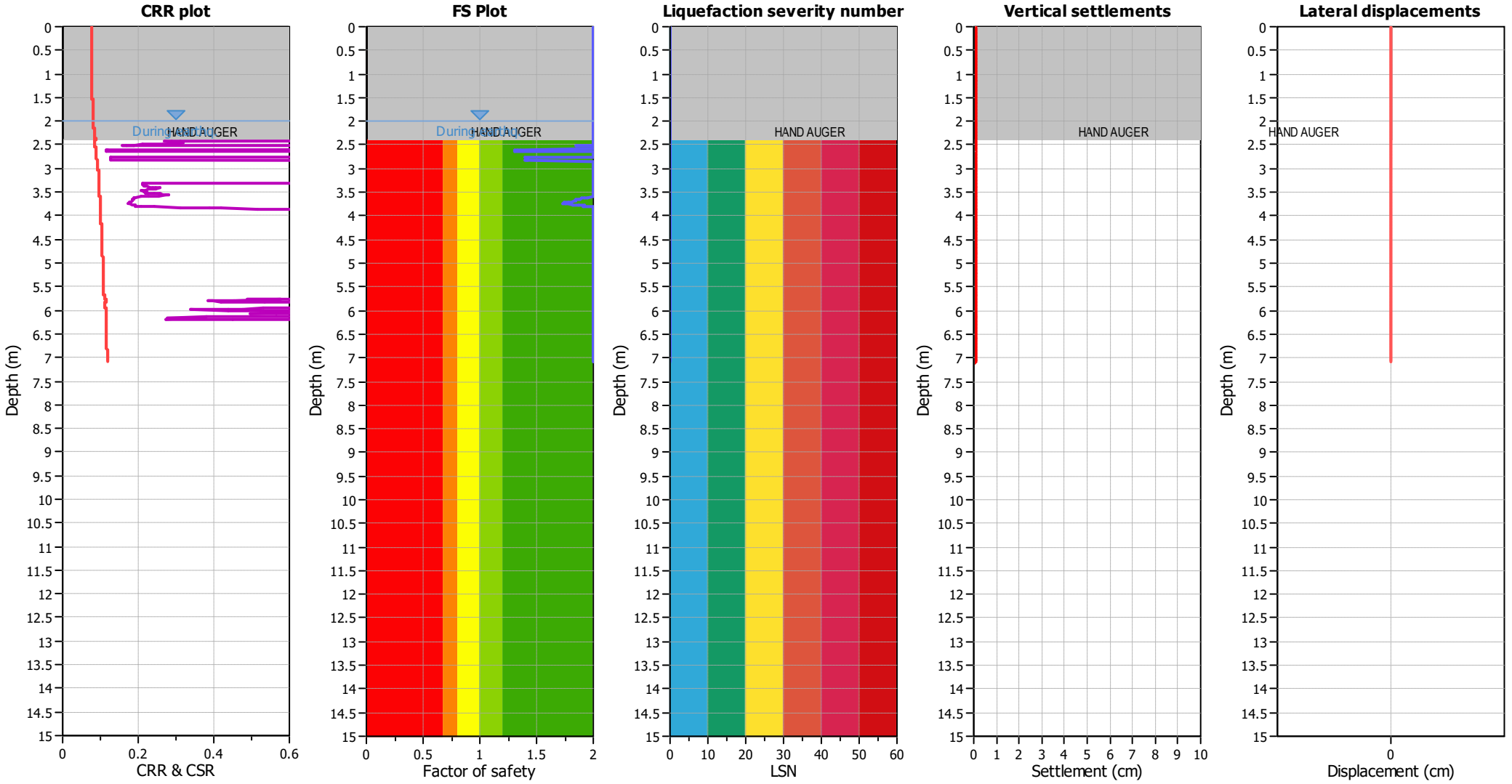
Liquefaction analysis overall plots



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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:	Yes
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Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
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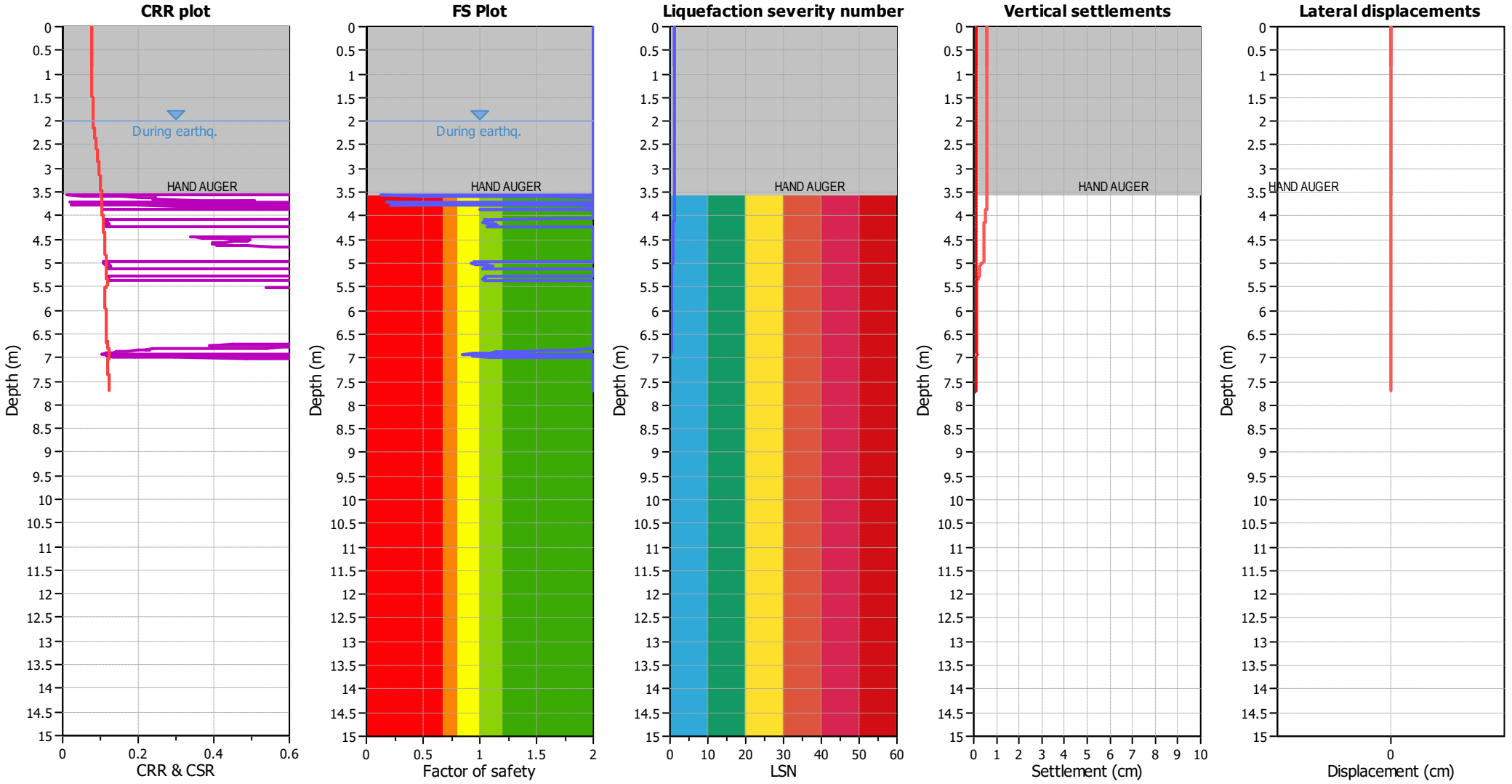
Liquefaction analysis overall plots



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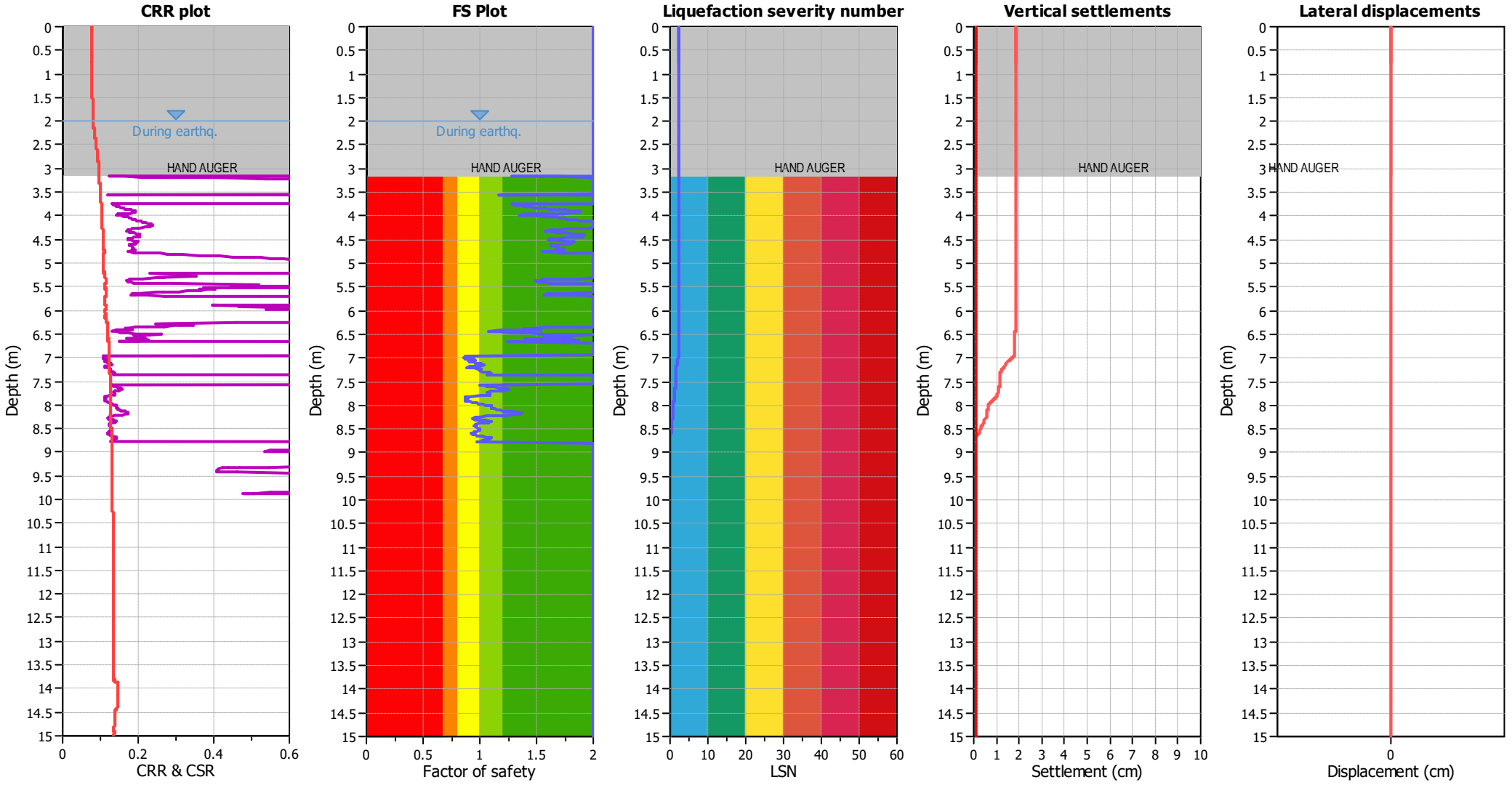

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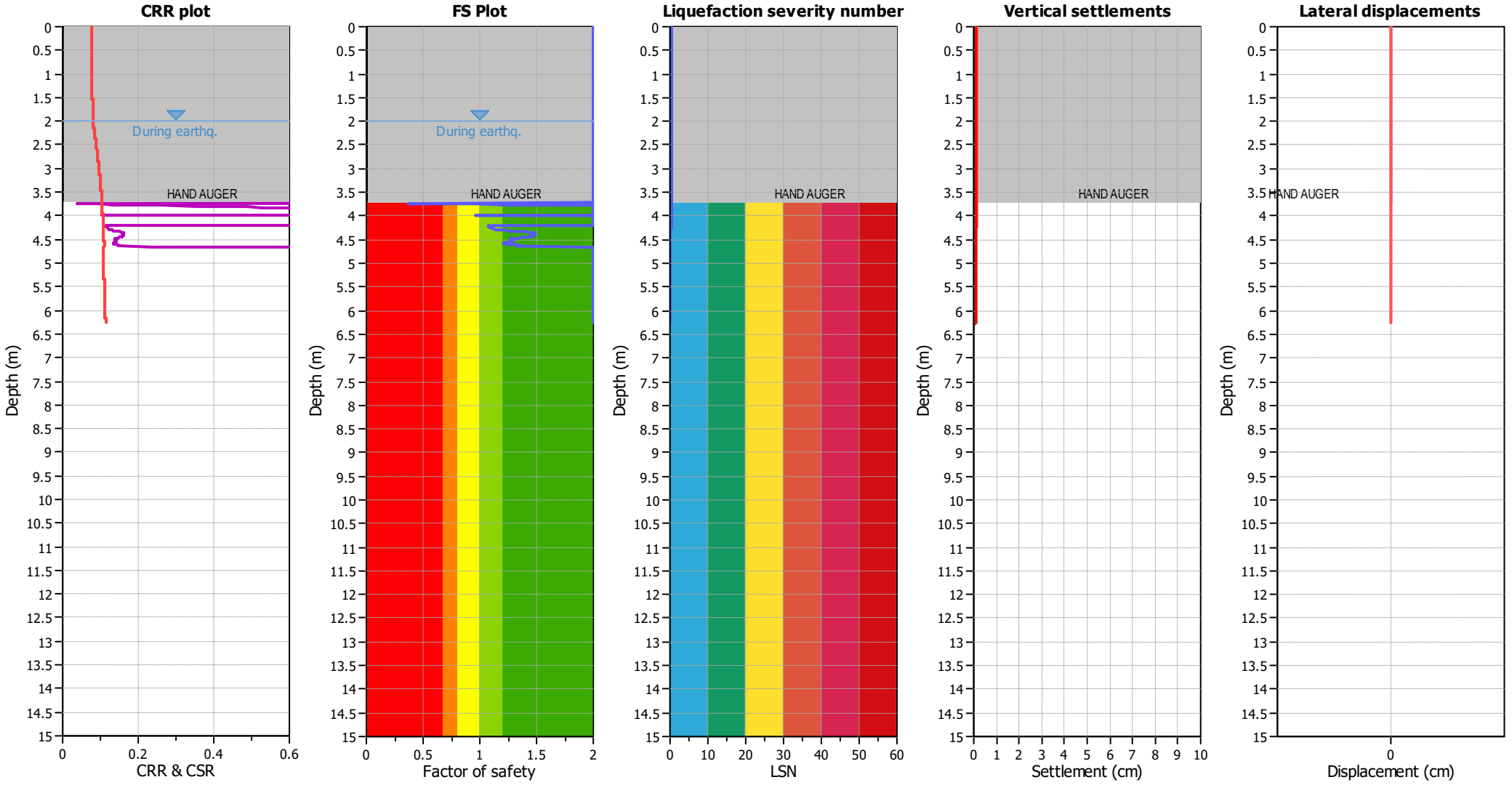

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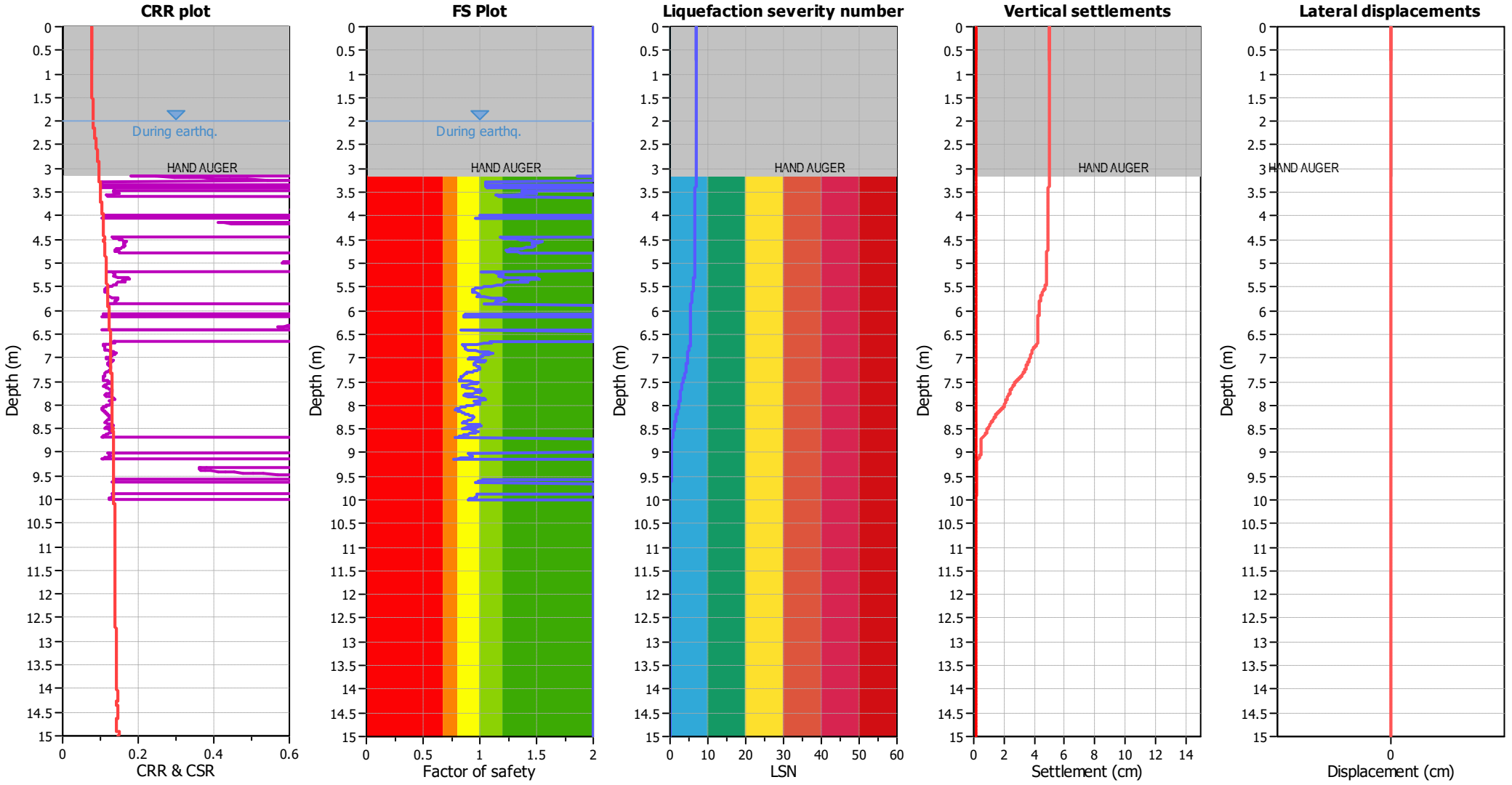

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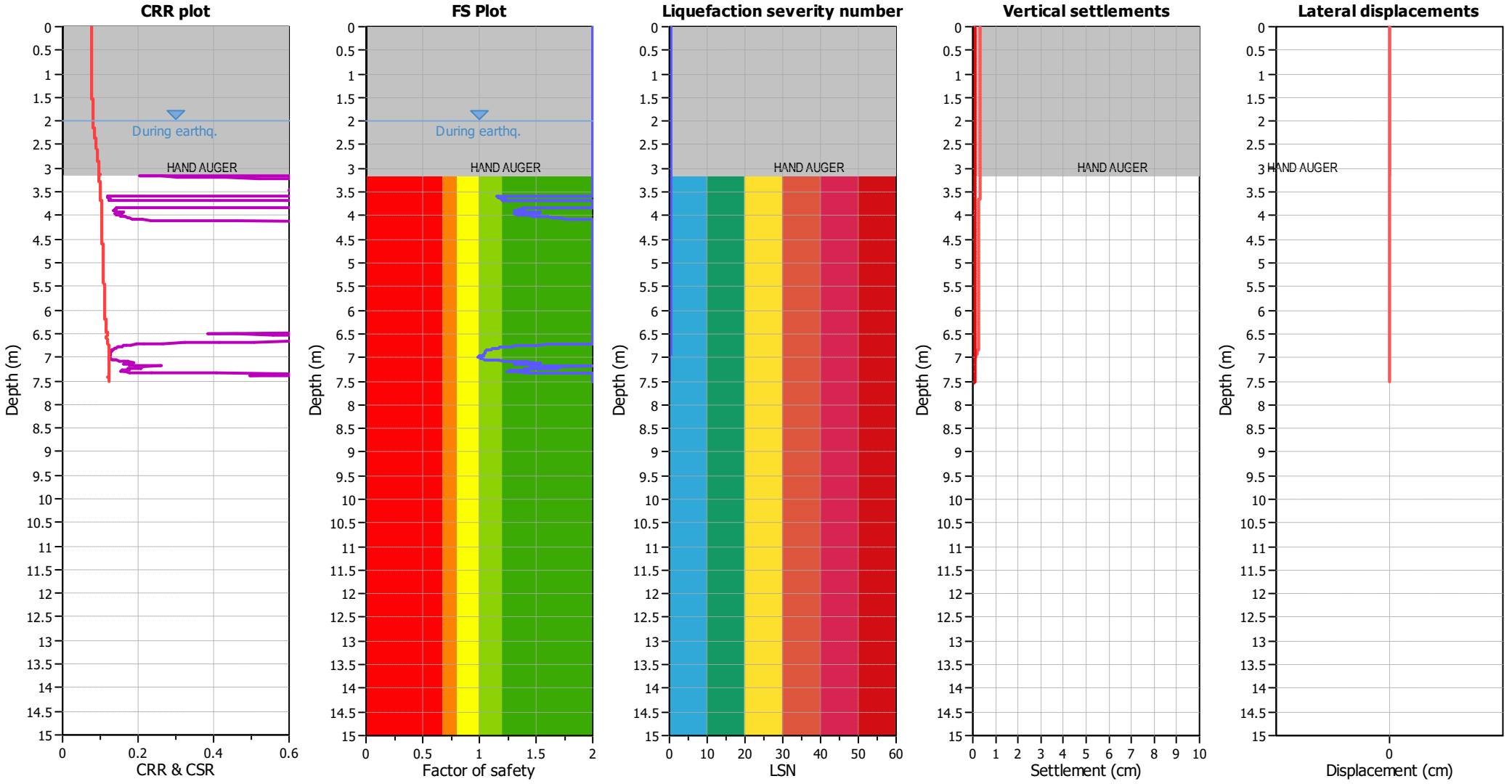

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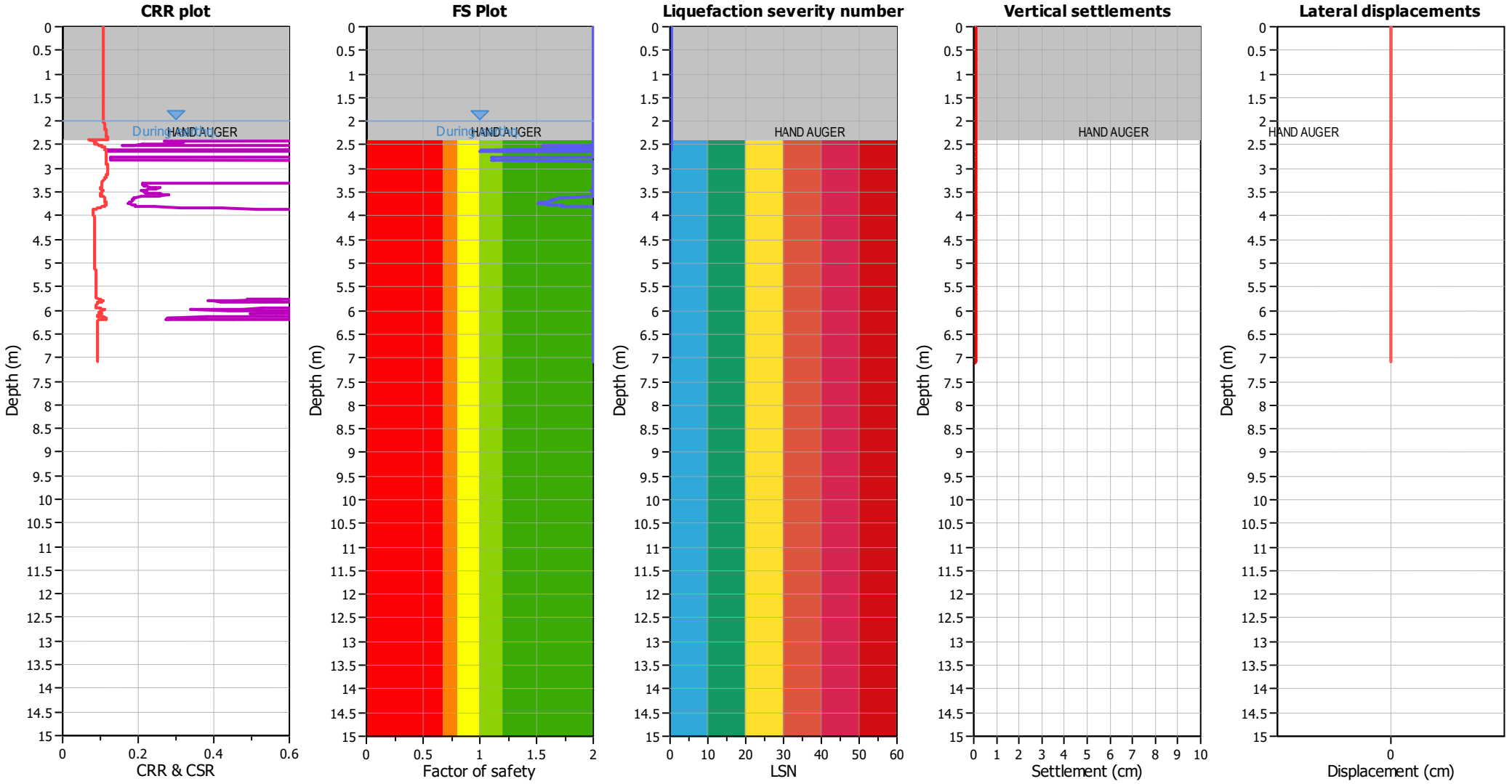

Input parameters and analysis data

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:	Yes
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:	Sand & Clay
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

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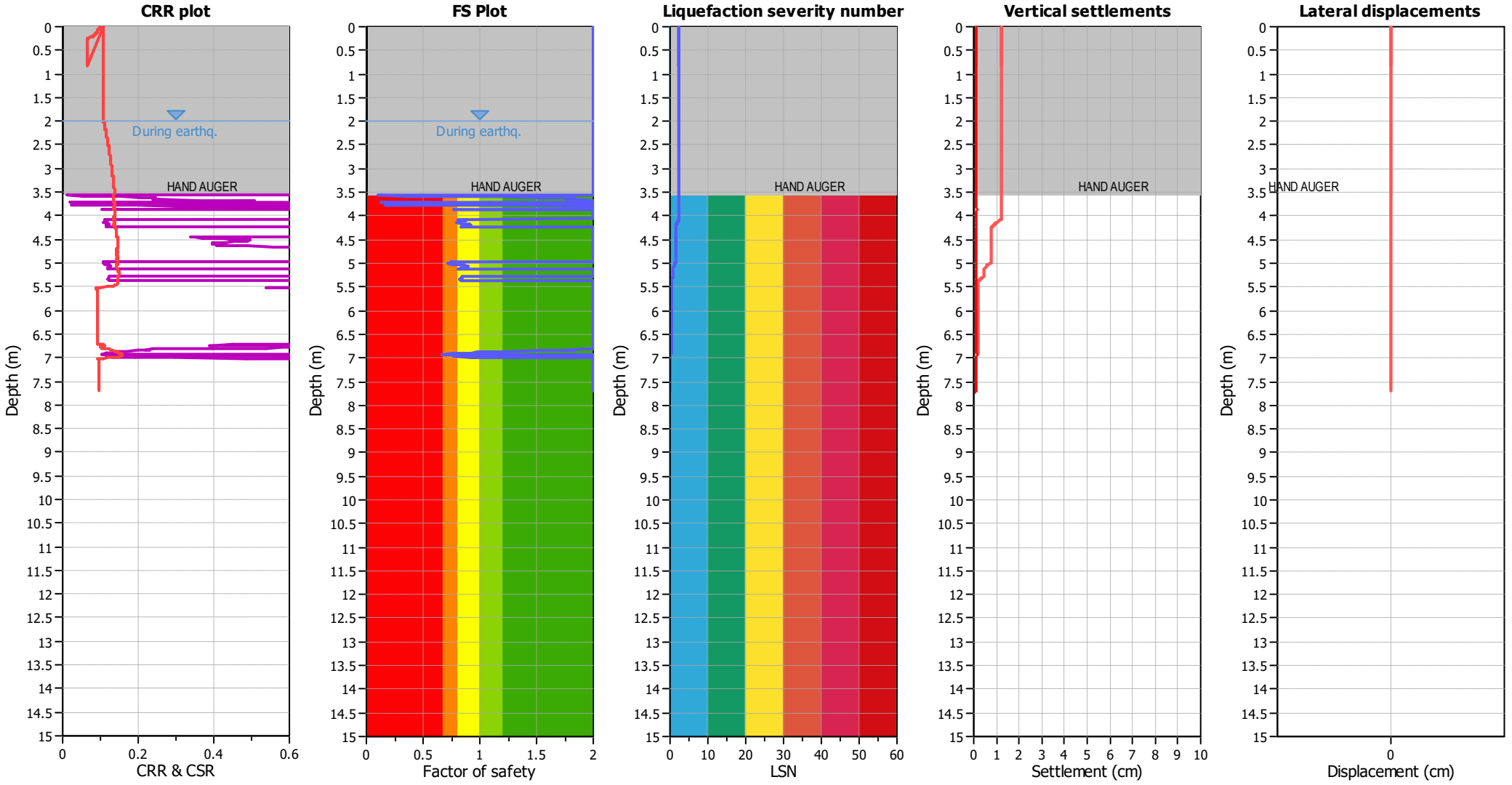
Liquefaction analysis overall plots



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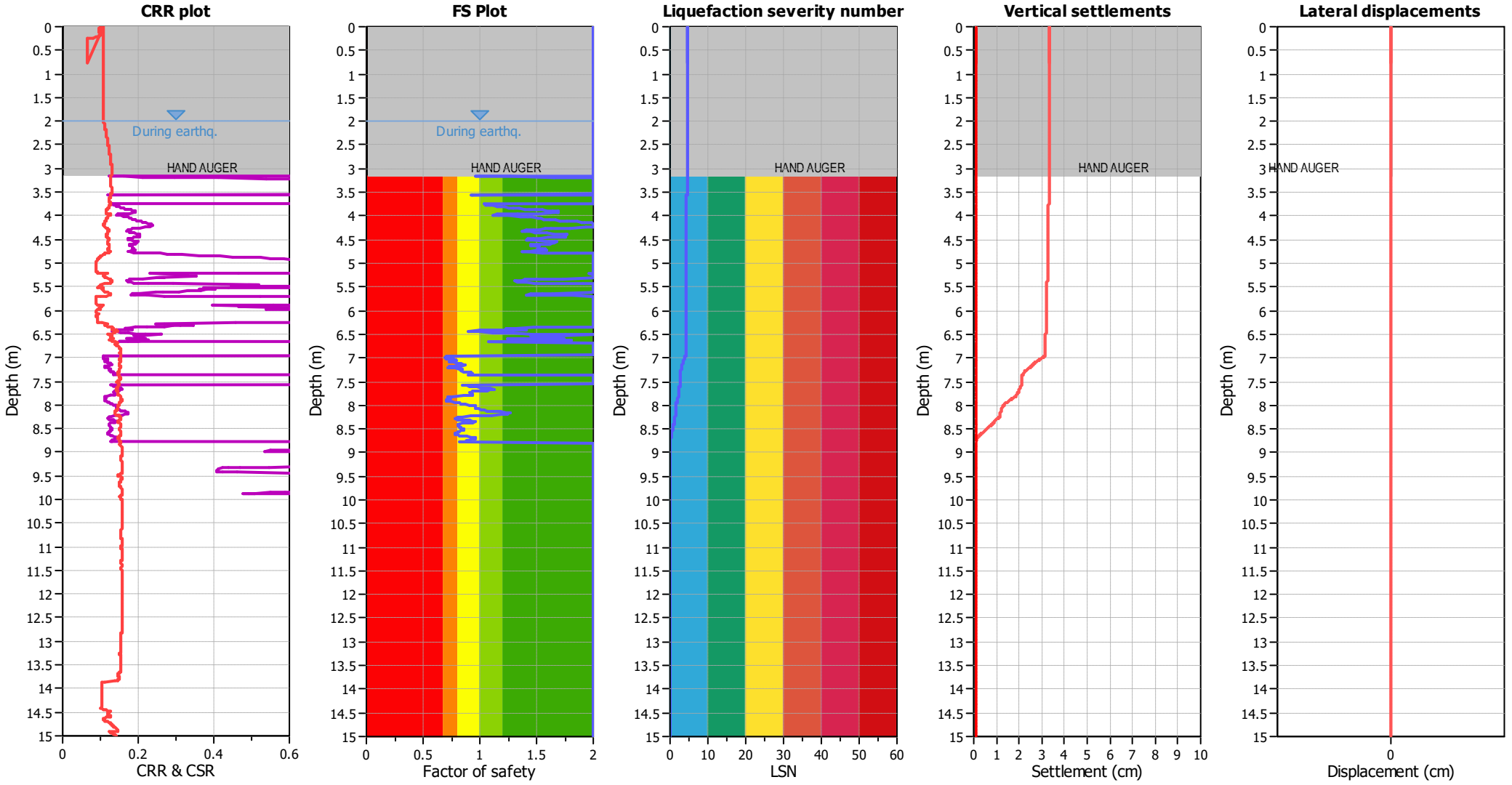

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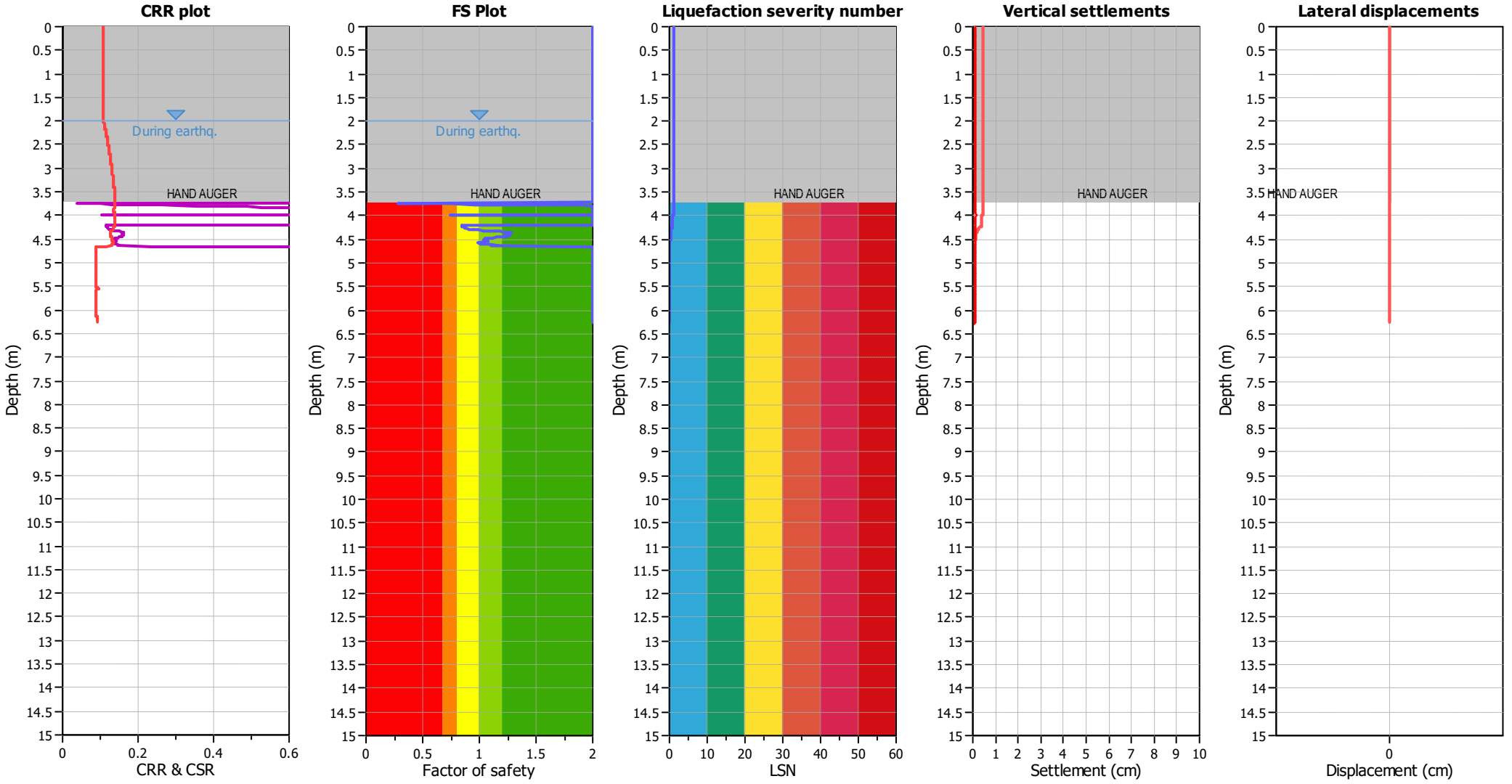

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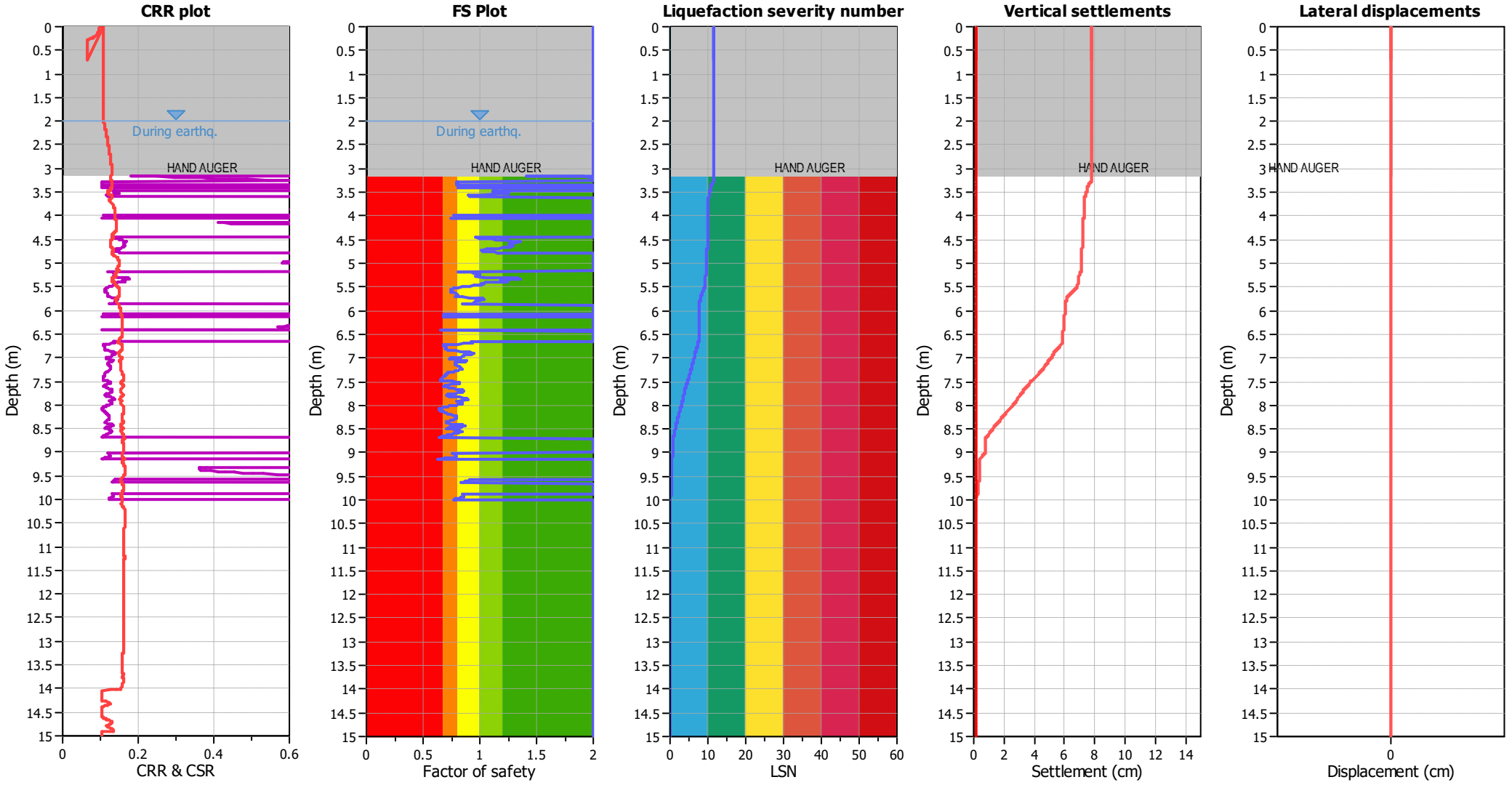

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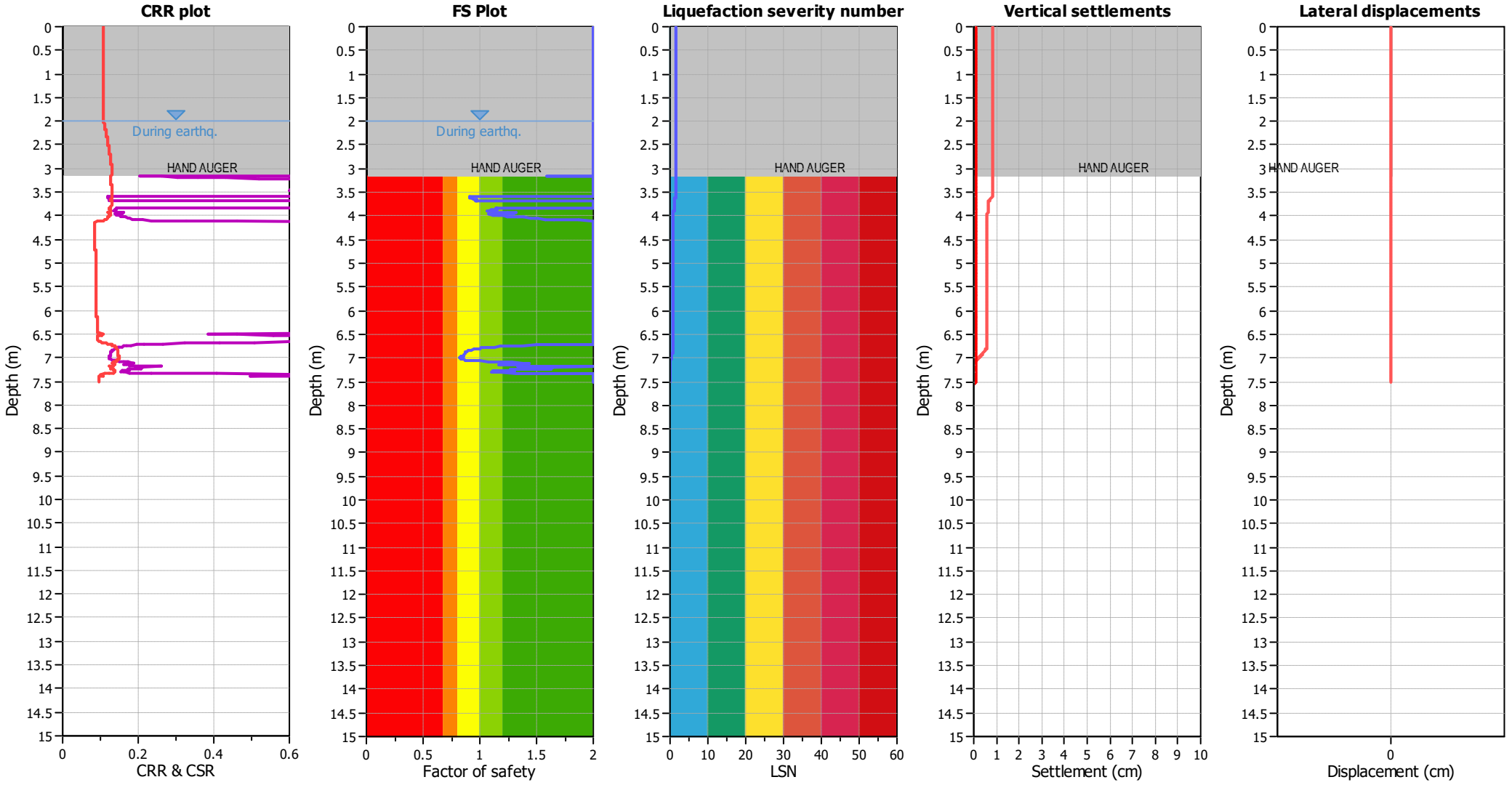

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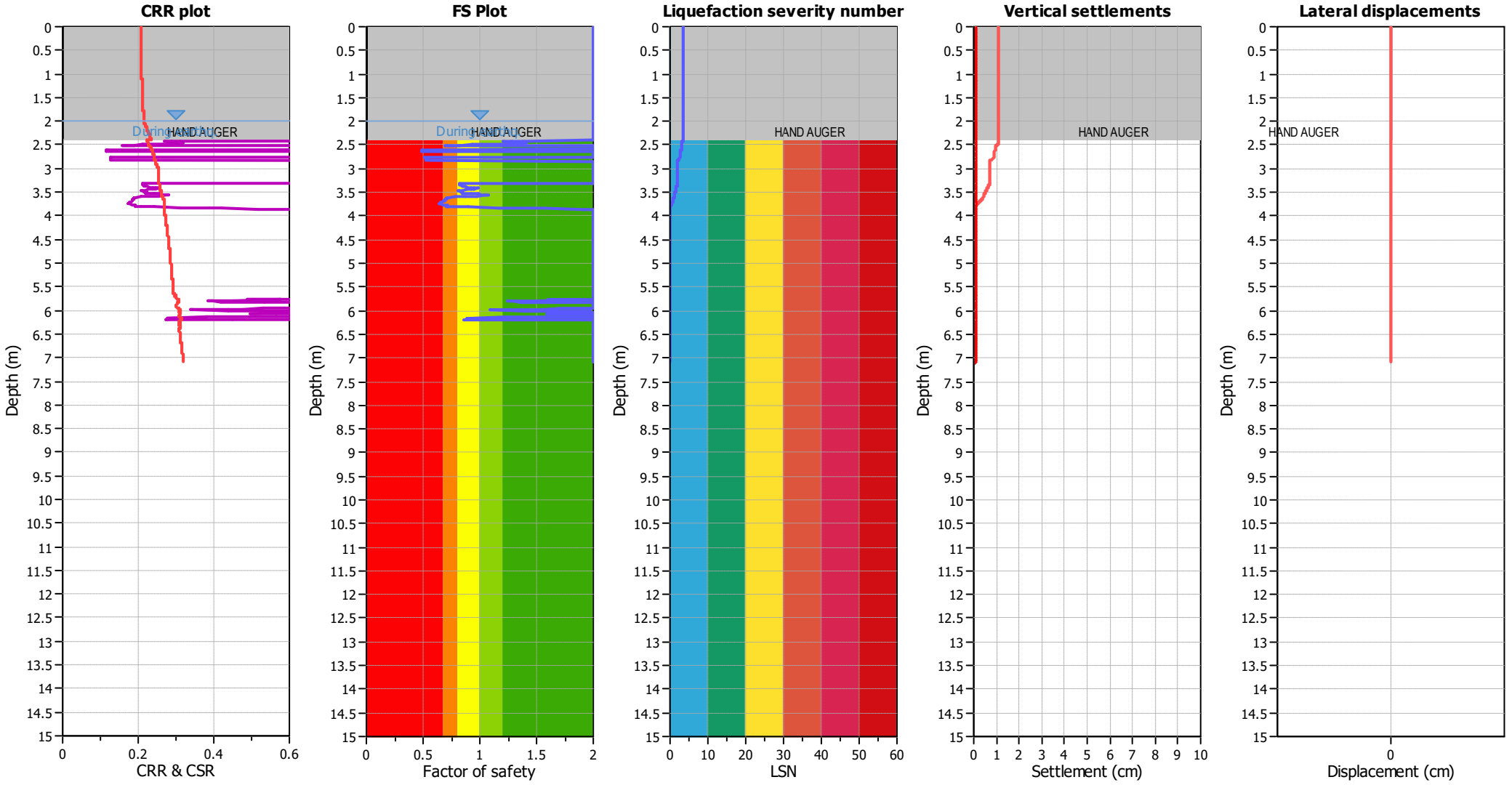

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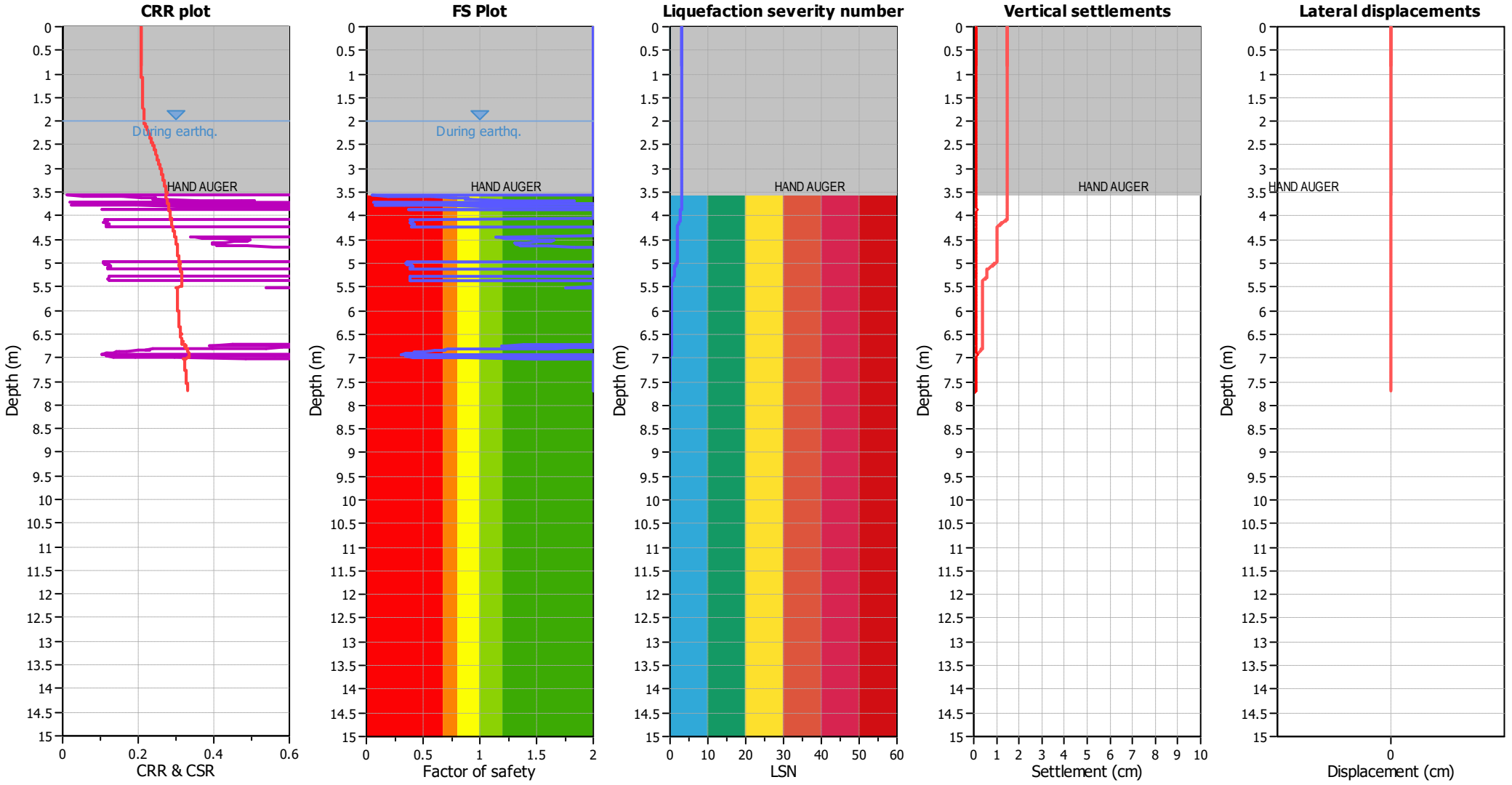

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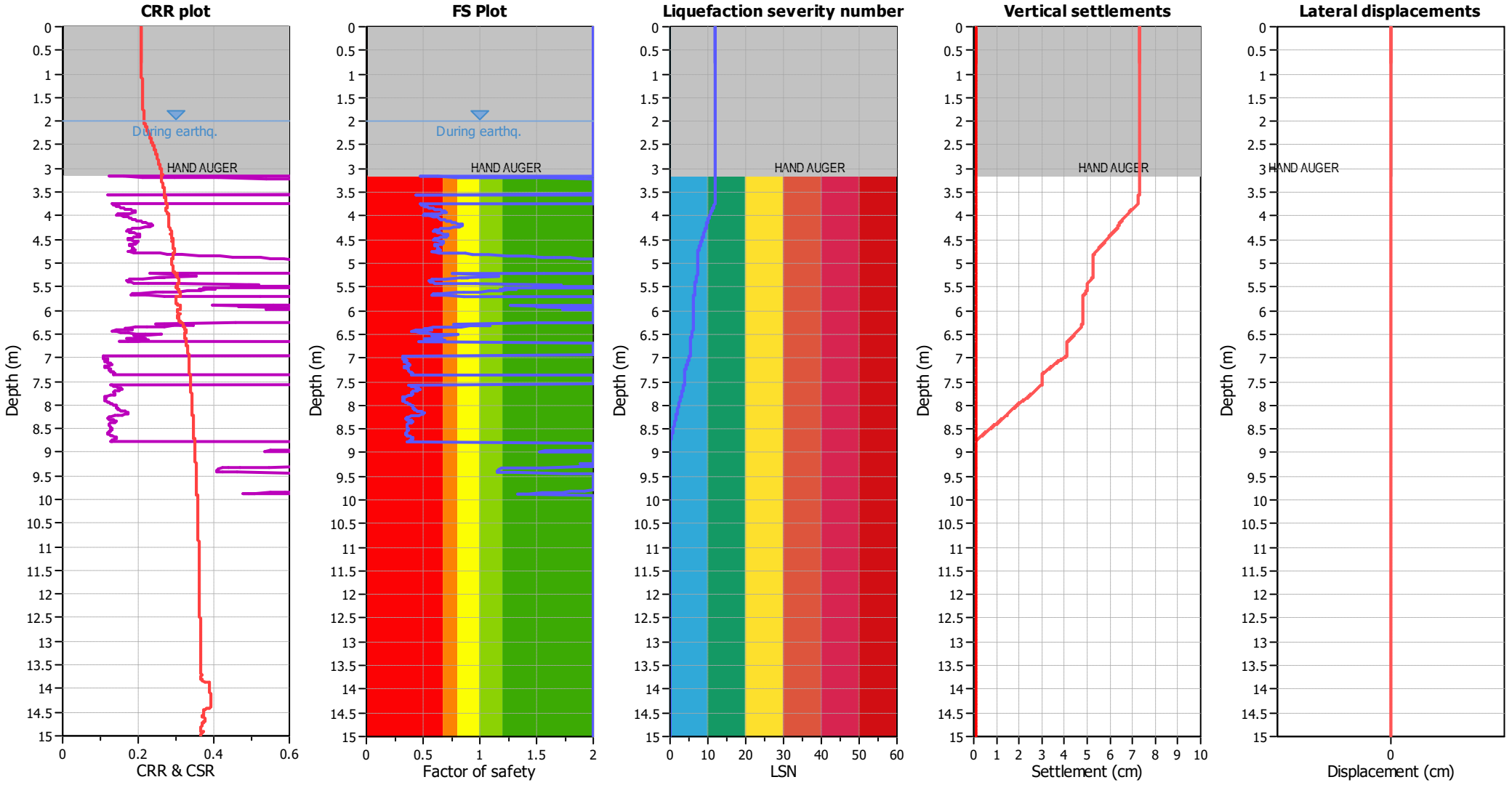
Liquefaction analysis overall plots



Input parameters and analysis data

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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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:	Sand & Clay
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

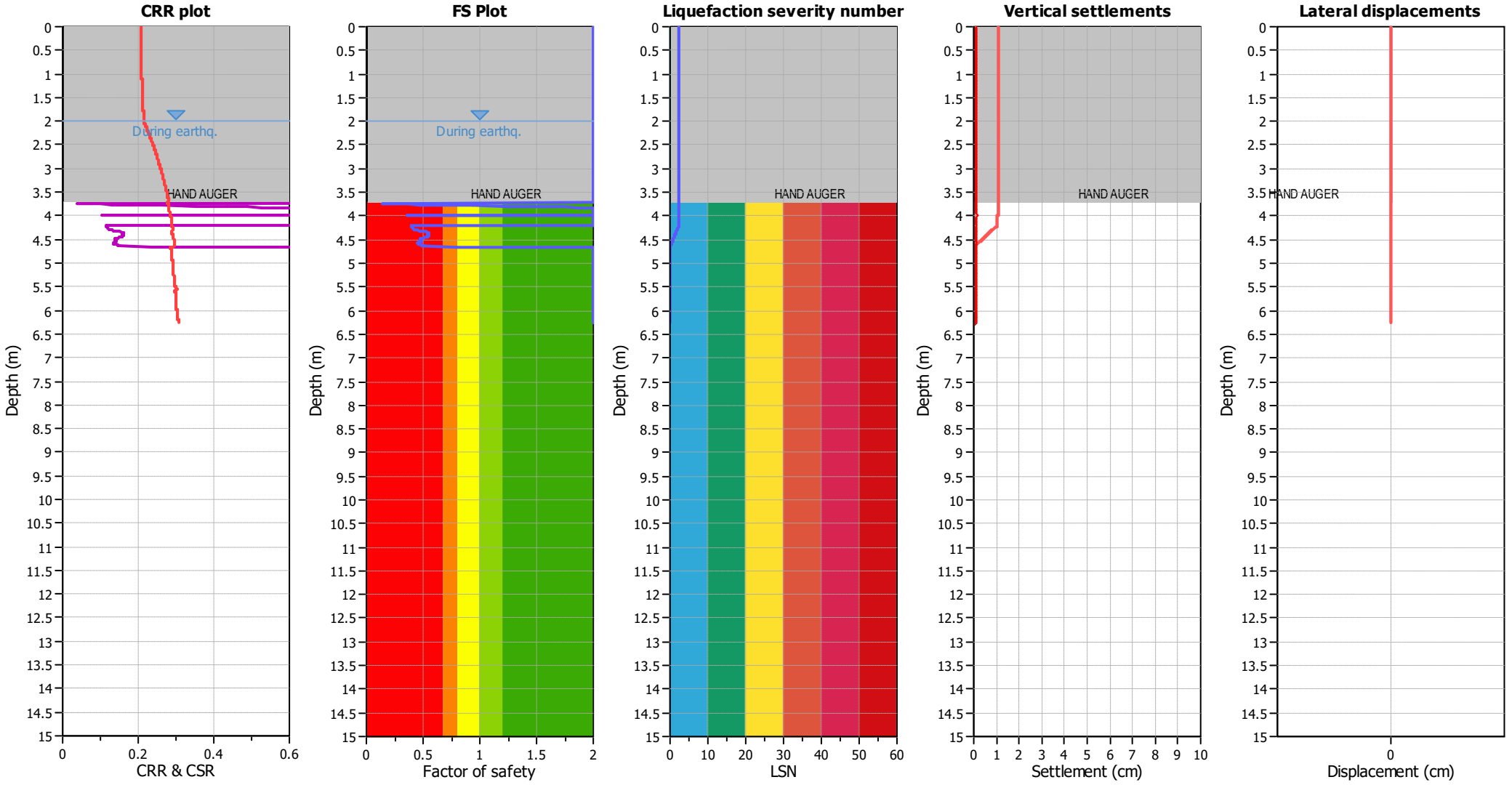
F.S. color scheme

- 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

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

Liquefaction analysis overall plots



Input parameters and analysis data

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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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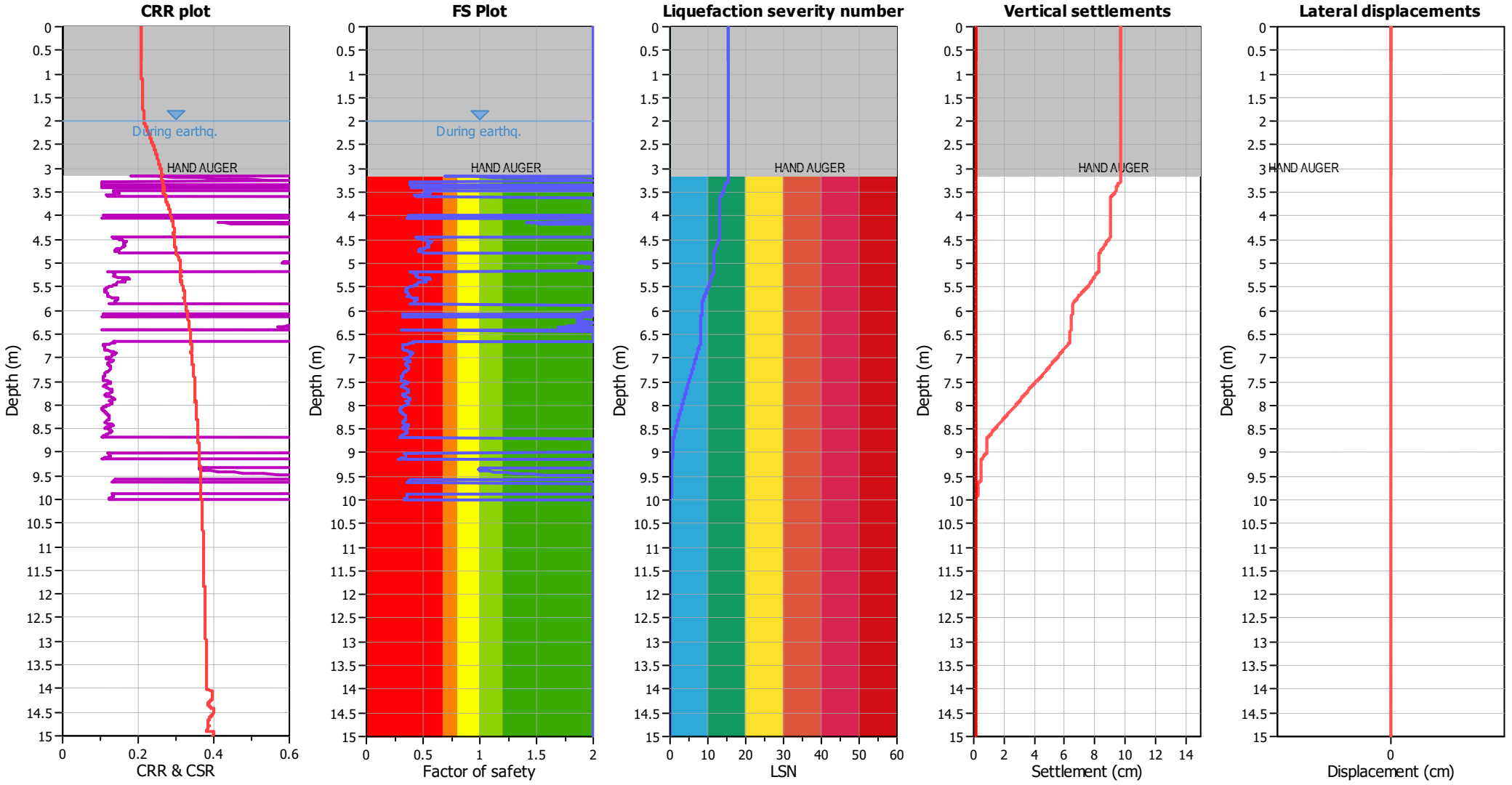
Liquefaction analysis overall plots



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:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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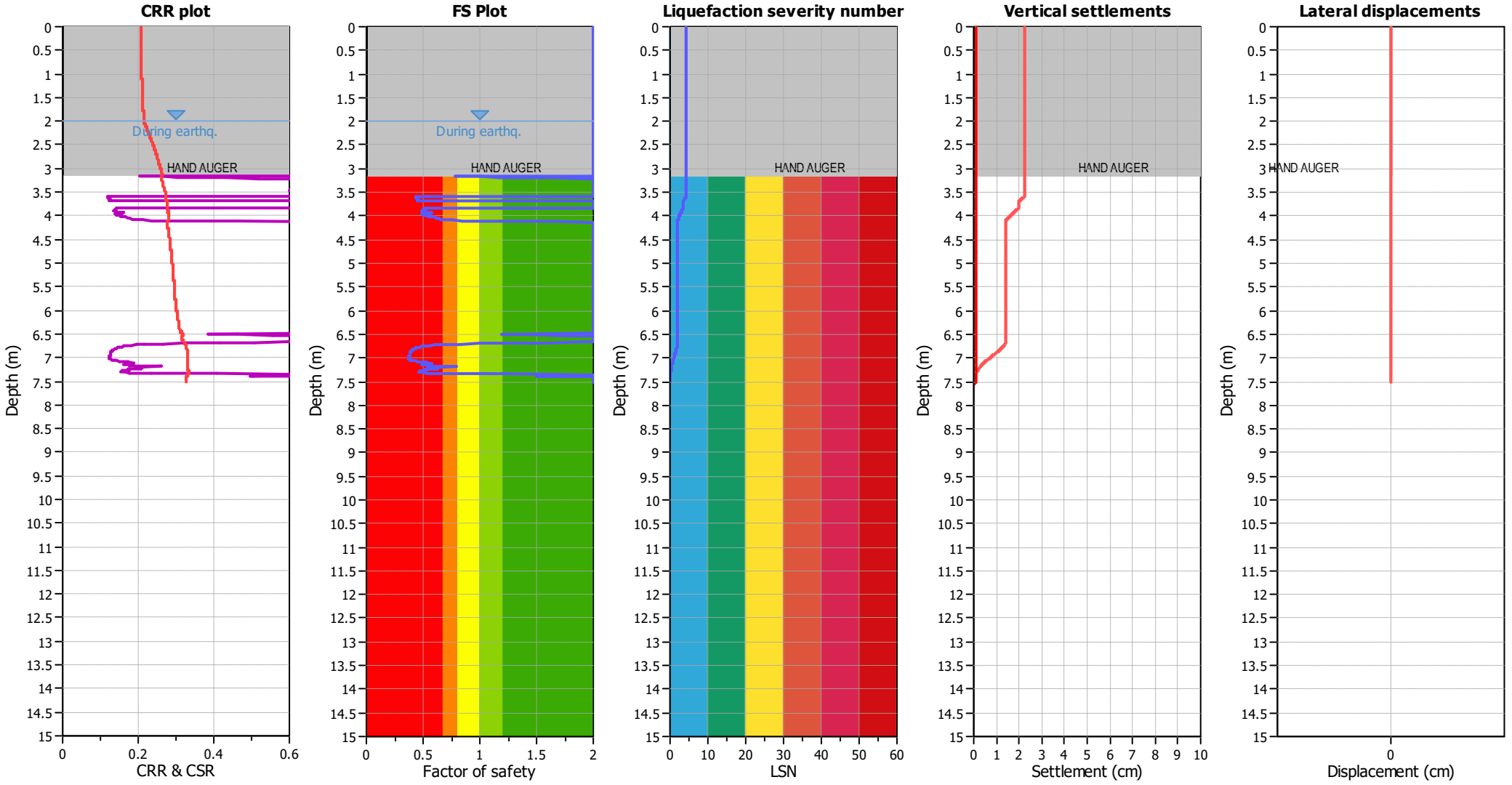
Liquefaction analysis overall plots



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:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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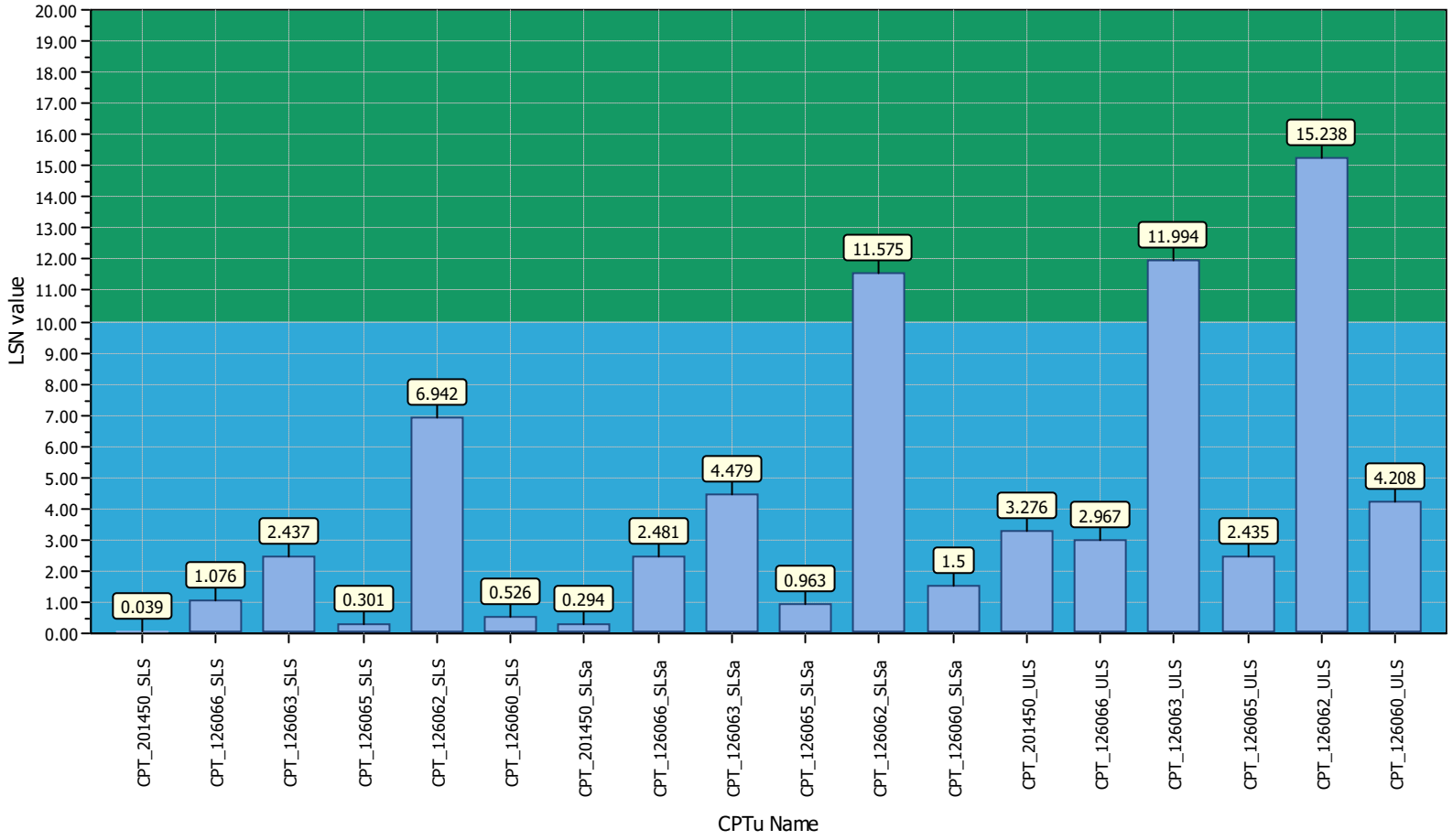
Project title : CLiq Analysis

Location : 10 Bob Robertson Drive, Pegasus

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

83% little liquefaction

17% minor liquefaction

0% moderate liquefaction

0% moderate to major liquefaction

0% major liquefaction

0% severe liquefaction

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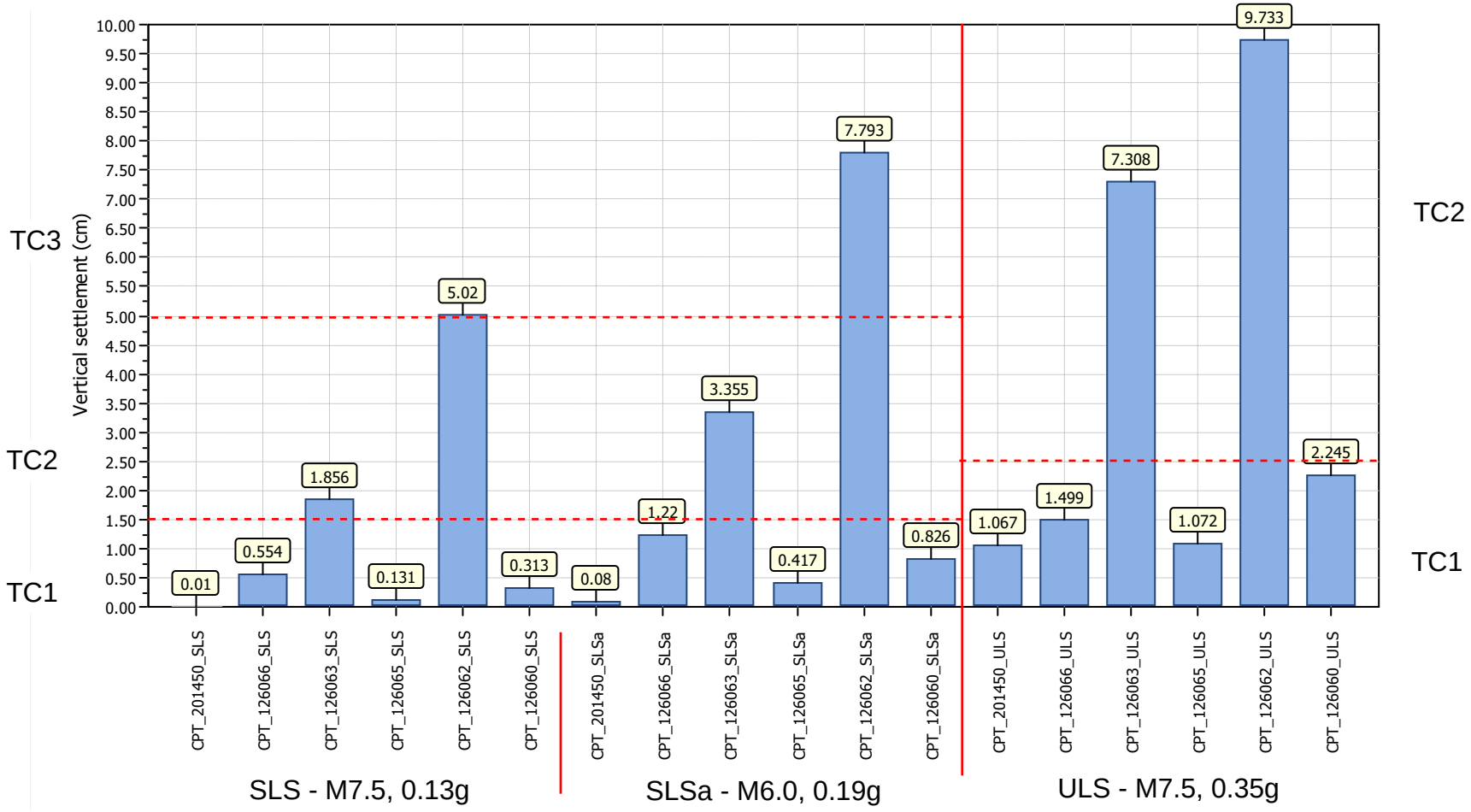
eliotsinclair.co.nz

Project title : CLiq Analysis

Location : 10 Bob Robertson Drive, Pegasus

Overall vertical settlements report



Appendix F. GNS Risk Assessment Method

Risk Assessment Method

Principles

The natural hazards risk assessment is based on GNS's risk-based land use planning toolbox[12]. We have adapted the toolbox for the scale of the proposed residential subdivision and for the purposes of the RMA s106 reporting requirements. We have also considered Section 71 of the Building Act (2004), which includes a consent 'test' of whether land is likely to be subject to damage from a natural hazard.

The approach taken for this risk assessment considers whether land is likely to be subject to material damage from a natural hazard, where "likely" has been determined to be a 1 in 100-year return period event, rather than an extreme event with a low probability of occurrence. There are inevitable inconsistencies in the definitions used by different agencies and in this instance, we note that GNS refers to a 1 in 100-year return period event as a "possible" event.

The GNS toolbox report notes that many land use planning objectives, policies, rules, and decisions are based around a likelihood assessment of a natural hazard, such as the 1 in 100-year return period event. Where information exists that enables us to consider other relevant levels of likelihood, we have included additional commentary e.g., for different design earthquake scenarios.

Risk Calculation

In accordance with GNS's approach the risk is calculated as the product of the consequence and the likelihood, with the two inputs drawn from the Consequence Table (GNS Figure 3.4) and the Likelihood Scale (GNS Figure 3.5), as presented below.

Table 3. GNS Consequence Table

	Built					
Severity of Impact	**Social / Cultural**	**Buildings**	**Critical Buildings**	**Lifelines**	**Economic**	**Health & Safety**
Catastrophic (V)	≥25% of buildings of social/cultural significance within hazard zone have functionality compromised	≥50% of affected buildings within hazard zone have functionality compromised	≥25% of critical facilities within hazards zone have functionality compromised	Out of service for >1 month (affecting ≥20% of the town/city population) OR suburbs out of service for >6 months (affecting <20% of the town/city population)	>10% of regional GDP	>101 dead and/or >1001 injured
Major (IV)	11-24% of buildings of social/cultural significance within hazard zone have functionality compromised	21-49% of buildings within hazard have functionality compromised	11-24% of buildings within hazard zone have functionality compromised	Out of service for 1 week – 1 month (affecting ≥20% of the town/city population) OR suburbs out of service for 6 weeks to 6 months (affecting <20% of the town/city population)	1-9.99% of regional GDP	11 – 100 dead and/or 101-1001 injured

[12] https://www.gns.cri.nz/Home/RBP/Risk-based-planning/A-toolbox

Severity of Impact	Built				Economic	Health & Safety
	Social / Cultural	Buildings	Critical Buildings	Lifelines		
Moderate (III)	6-10% of buildings of social/cultural significance within hazard zone have functionality compromised	11-20% of buildings within hazard zone have functionality compromised	6-10% of buildings within hazard zone have functionality compromised	Out of service for 1 day to 1 week (affecting ≥20% of the town/city population people) OR suburbs out of service for 1week to 6 weeks (affecting <20% of the town/city population)	0.1-0.99% of regional GDP	2 – 10 dead and/or 11 – 100 injured
Minor (II)	1-5% of buildings of social/cultural significance within hazard zone have functionality compromised	2-10% of buildings within hazard zone have functionality compromised	1-5% of buildings within hazard zone have functionality compromised	Out of service for 2 hours to 1 day (affecting ≥20% of the town/city population) OR suburbs out of service for 1 day to 1 week (affecting <20% of the town/city population)	0.01-0.09% of regional GDP	<=1 dead and/or 1 – 10 injured
Insignificant (I)	No buildings of social/cultural significance within hazard zone have functionality compromised	<1% of affected buildings within hazard zone have functionality compromised	No damage within hazard zone, fully functional	Out of service for up to 2 hours (affecting ≥20% of the town/city population) OR suburbs out of service for up to 1 day (affecting <20% of the town/city population)	0.01% of regional GDP	No dead No injured

We have applied judgement and interpretation in the application of GNS's table to the scale and nature of the proposed subdivision.

For this assessment there are no social/cultural buildings to consider and the economic impacts are deemed not applicable. We use the '*Buildings*' column as the basis to assess effects on the integrity of buildings (i.e., their amenity and life-safety function), and the '*Lifelines*' column as the basis to assess the effects on utilities servicing the building/s.

Table 4. GNS Likelihood Scale

Level	Descriptor	Description	Indicative Frequency
5	Likely	The event has occurred several times in your lifetime	Up to once every 50 years
4	Possible	The event might occur in your lifetime	Once every 51 – 100 years
3	Unlikely	The event does occur somewhere from time to time	Once every 101 – 1000 years
2	Rare	Possible but not expected to occur except in exceptional circumstances	Once every 1001 – 2,500 years
1	Very rare	Possible but not expected to occur except in exceptional circumstances	2,501 years plus

To take a risk-based approach, the consequences and likelihood need to be quantified to provide a level of risk. To achieve this, a matrix is used that incorporates the relevant risk level, expressed as the consequences multiplied by likelihood (GNS Figure 3.8). The risk then ranges from 1 (extremely low) to 25 (extremely high).

Table 5. Color-coding the matrix based on level of risk

	Consequences				
Likelihood	**1**	**2**	**3**	**4**	**5**
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

GNS then suggests the consent status (treatment) of the activity can be presented as follows (GNS Figure 3.9):

Table 6. Level of risk and associated consent status

Level of risk	Consent
Acceptable	Permitted
Acceptable	Controlled
Tolerable	Restricted Discretionary
Tolerable	Discretionary
Intolerable	Non-complying, prohibited

GNS recommends that when assessing consequences, the final level of impact is assessed on the 'first past the post' principle, in that the consequence with the highest severity of impact applies.