Waimakariri District Council
215 High Street
Private Bag 1005
Rangiora 7440, New Zealand
Phone 0800 965 468

DISTRICT PLAN REVIEW

Proposed Waimakariri District Plan - Submission

Clause 6 of Schedule 1, Resource Management Act 1991

Submitter details

*(Our preferred methods of corresponding with you are by **email** and **phone**).*

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Postal Address: PO Box 2551, Christchurch Post Code: 8140

Physical address: 130 Gressons Road - Waikuku Post Code:
(if different from above)

Please select one of the two options below:

☒ I **could not** gain an advantage in trade competition through this submission *(go to Submission details, you do not need to complete the rest of this section)*

☐ I **could** gain an advantage in trade competition through this submission *(please complete the rest of this section before continuing to Submission details)*

Please select one of the two options below:

☐ I **am** directly affected by an effect of the subject matter of the submission that:

A) Adversely affects the environment; and

B) Does not relate to trade competition or the effect of trade competition.

☐ I **am not** directly affected by an effect of the subject matter of the submission that:

A) Adversely affects the environment; and

B) Does not relate to trade competition or the effect of trade competition.

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Submission details

The specific provisions of the proposal that my submission relates to are as follows: *(please give details)*

The Rural Zoning proposed for our property at Woodend – Waikuku and statements of Plan Objectives and Policies for the Woodend – Waikuku area. Please refer to the attached reports for full details.

My submission is that: *(state in summary the Proposed Plan chapter subject and provision of your submission. Clearly indicate whether you support or oppose the specific provisions or wish to have amendments made, giving reasons) (please include additional pages as necessary)*

The zoning of the subject property should be changed to a combination of General Residential Zone and Medium Density Residential Zone to enable the development and subdivision of the property for residential purposes and as a coordinated and integrated part of the Woodend – Ravenswood residential community.

I/we have included **17 additional pages and 10 Annexures.**

I/we seek the following decision from the Waimakariri District Council: *(give precise details, use additional pages if required)*

1) Zoning – Amend the zoning of the property from Rural Lifestyle Zone to General and Medium Density Residential Zone (or identified as a New Development Area – Ravenswood-Woodend)
2) Outline Development Plan – adopt and include in the District Plan the ODP attached as part of the submission (Refer Appendix 4) together with any amendments identified as desirable during the submission process.
3) The submission support the approach and preparation and use of ODPs and specifically SUB-P6, and RESZ-P12.

Submission at the Hearing

☒ I/we wish to speak in support of my/our submission

☐ I/we do not wish to speak in support of my/our submission

☒ If others make a similar further submission, I/we will consider presenting a joint case with them at the hearing

Signature

Of submitters or person authorised to sign on behalf of submitter(s)

Signature: Date 24 November 2021

(If you are making your submission electronically, a signature is not required)

Important Information

1. The Council must receive this submission before the closing date and time for submissions.
2. Please note that submissions are public. Your name and submission will be included in papers that are available to the media and public. Your submission will only be used for the purpose of the District Plan review process.
3. Only those submitters who indicate they wish to speak at the hearing will be emailed a copy of the planning officers report (please ensure you include an email address on this submission form).

If you are a person who could gain an advantage in trade competition through the submission, your right to make a submission may be limited by clause 6(4) of Part 1 of Schedule 1 of the Resource Management Act 1991.

Please note that your submission (or part of your submission) may be struck out if the authority is satisfied that at least 1 of the following applies to the submission (or part of the submission):

- It is frivolous or vexatious
- It discloses no reasonable or relevant case
- It would be an abuse of the hearing process to allow the submission (or the part) to be taken further
- It contains offensive language
- It is supported only by material that purports to be independent expert evidence, but has been prepared by a person who is not independent or who does not have sufficient specialised knowledge or skill to give expert advice on the matter.

Send your submission to: Proposed District Plan Submission
Waimakariri District Council
Private Bag 1005, Rangiora 7440

Email to: developmentplanning@wmk.govt.nz

Phone: 0800 965 468 (0800WMKGOV)

You can also deliver this submission form to one our service centres:

Rangiora Service Centre: 215 High Street, Rangiora

Kaiapoi Service Centre: Ruataniwha Kaiapoi Civic Centre, 176 Williams Street, Kaiapoi

Oxford Service Centre: 34 Main Street, Oxford

Submissions close 5pm, Friday 26 November 2021

Please refer to the Council website waimakariri.govt.nz for further updates

SUBMISSION ON

PROPOSED DISTRICT PLAN

WAIMAKARIRI DISTRICT COUNCIL

To:	District Plan Submissions Waimakariri District Council Private Bag 1005 Rangiora 7440	
Submission by:	B and A Stokes 130 Gressons Road Waikuku	
Contact details:	Email: B and A Stokes McCracken & Associates	bjalstokes@gmail.com office@rgmc.co.nz
Hearing of Submission:	The submitters do wish to be heard in support of their submission	

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1. THE SUBMISSION

1.1 The Land

The land involved in the submission to rezone is approximately 144ha. The land occupies an area located between the north boundary of the Ravenswood development and in particular the Ravenswood commercial area and stormwater ponds and Gressons Road, Waikuku.

The land to be rezoned is characteristic of much of the land around Woodend-Ravenswood and is occupied and used for dairying and grazing.

The Site

1.2 The Surrounding Environemtn

Gressons Road and an area of Waikuku village adjoin the north side of the site. The adjoining area of Waikuku village is zoned Residential 4B in the Operative District Plan and proposed for Large Lot Residential - zoning in the District Plan Review. The north section of the submission land generally fronting Gressons Road was identified for a proposed Rural-Residential Zone in the WDC Rural Residential strategy. To quote:

> *"Overall the Gressons Road area offers a number of strengths that support further rural residential development (No 4 – Gressons Road)."*

The south boundary adjoins the existing Ravenswood village and urban zoning. This zoning and layout provides opportunities for road and services access into the submitters land.

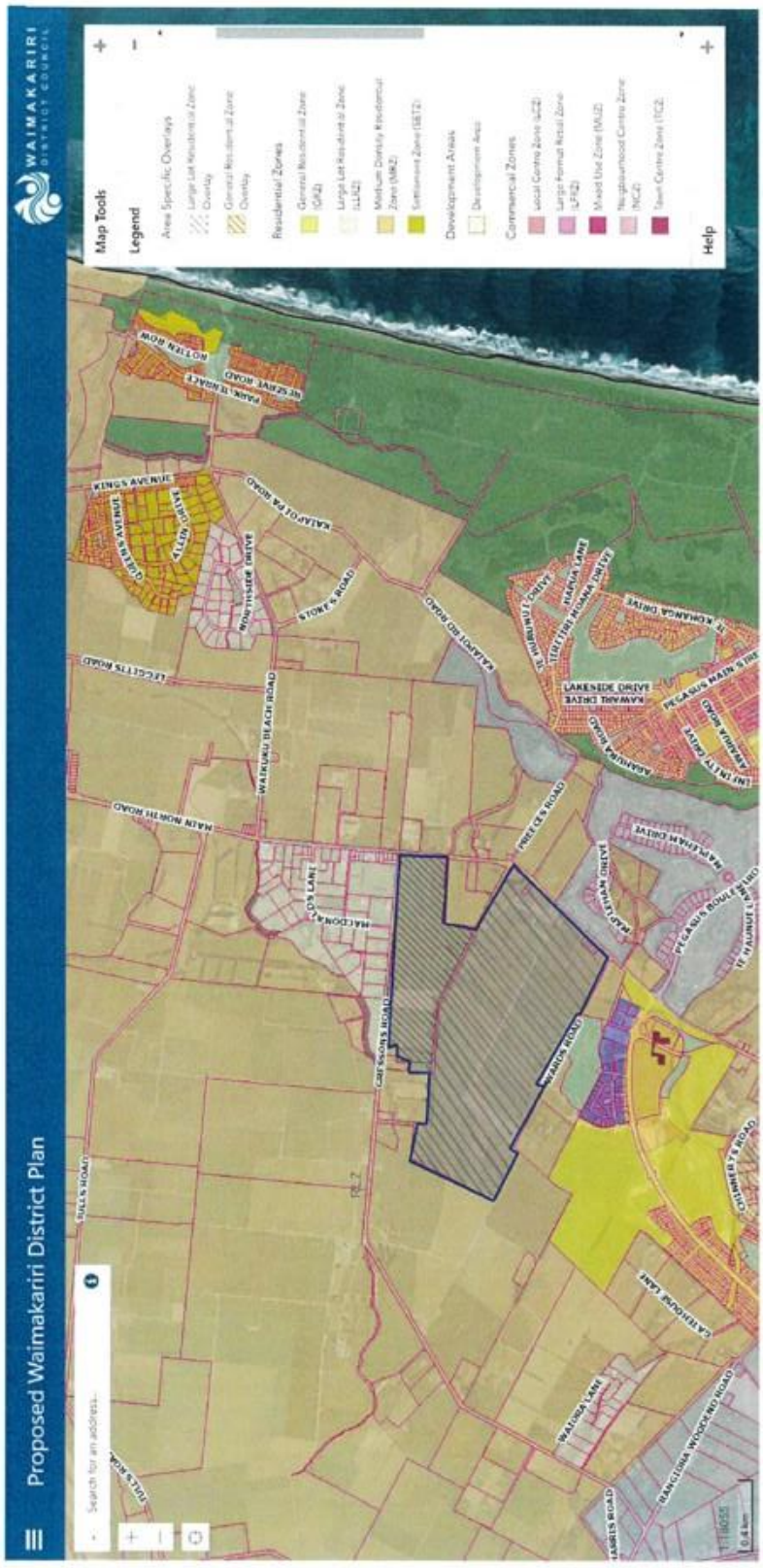
2. THE PROPOSAL

2.1 Outline

The proposal is to either seek a Residential Zone combining both General and Medium Density zoning or to identify the land as a future New Development Area. The land is estimated to yield between 1200 and 1500 lots and growth scenarios have been assessed in Annexure 10.

An Outline Development Plan (ODP) has been prepared for inclusion in the District Plan whether the land is rezoned or set aside as a Future Development Area and subject to the assessment that provision would require (Annexure 3). The ODP provides for:

- The critical road connections,
- Interlinking internal road linkages,
- Major stormwater conveyance,
- The need for major external road connection and upgrading, and
- The initial protection of major cultural assets.



Site for rezoning

2.2 Servicing

Servicing of the development will be by reticulated services. The outline of the infrastructure requirements are set out in Annexure 8. In summary,

- all sites will be services by gravity sewer. Sewerage will likely be pumped to Woodend,
- Water supply pumped from Pegasus,
- Stormwater will be addressed onsite,
- Power/telecommunication – will be provided to all sites and cables will be placed underground,
- Roading – the ODP will be serviced with road connections from the existing urban area at Ravenswood and to Gressons Road. Major intersection upgrade will be required at the intersection of Gressons Road and SHN01, and
- Earthworks – the general goal is maintain the natural landform and to minimise earthworks generally retaining the same topography across the site.

3. CONSULTATION

3.1 The applicants have undertaken consultation with WDC in relation to the proposal. In addition the applicant submitted and consulted extensively on:

- The Rural-Residential Development Strategy (2010),
- Submission on the 2010 Plan,
- Correspondence to the Planning Advisory Group 2013,
- Submissions on the Draft Rural-Residential Development Strategy, March 2019 including detailed assessments on geotechnical, Ground Contamination and servicing requirements.

3.2 The applicants have also developed a Rural-Residential complex at Waikuku Beach.

3.3 The submitters respect and understand that this 'area' is of significant importance and value to Iwi. Mahaanui Kurataiao Ltd will be forwarded a copy of the submission and if able, contracted to advise comment or give direction on the proposal.

4. POLICY ASSESSMENT

4.1 Location

The land sought to be rezoned is outside of the Urban Limits for Woodend which is defined at the northern boundary of Ravenswood. From a general perspective the land is concluded to be a part of the Woodend – Ravenswood – Waikuku community. The current operative District Plan has been in place since 2005. There have been changes and an overall review of growth, projections and opportunities is set out in Annexure 10.

In recognising the land is located outside of the Urban Limits significant regard has been had to several policy matters as well as the preliminary detail and assessment of the lands suitability for urban-residential development.

5. POLICY MATTERS

5.1 Rural-Residential Strategy (2019)

As part of the above strategy the Council developed a series of locations as preferred options for rural-residential development. A significant part of the submission land is located in the Gressons Road preferred locality for rural-residential zoning which signalled a likely change in urban use and zoning (Refer Annexure 1).

5.2 Waimakariri 2048 – District Development Strategy

The District Development Strategy identified two matters that support growth in the subject locality. These were:

(i) **Woodend - Pegasus Town Centre**
The centre is identified as a major commercial growth node with the ambition of providing for a single continuous area of land that could become a KAC. The submission land would provide support to that outcome and place the KAC at the centre of a major residential community (Refer Annexure 2)

(ii) **Woodend - Pegasus Residential Growth**
The strategy set out a number of matters. These included:

- Future growth directions proposed to the north of Woodend (being the submitters land),
- Identification of opportunities for the intensification of activities, and
- To take into account areas of unacceptable natural hazards and important cultural values,

The later consideration is of paramount importance in this area of the district and both the Rural Residential Strategy and the District Development Strategy recognises this situation (Refer Annexures 1 and 2).

5.3 Proposed District Plan (WDC) Policy

The proposed District Plan provides two major overarching objectives and policies in terms of new urban growth these are:

- SD – 02 Urban Development
- UFD – P2 Identification of New Residential Development Area

These provisions are addressed as follows:

SD-02 Urban development
Urban development and infrastructure that:

1. *is consolidated and integrated with the urban environment;*
2. *that recognises existing character, amenity values, and is attractive and functional to residents, businesses and visitors;*
3. *utilises the District Council's reticulated wastewater system, and potable water supply and stormwater infrastructure where available;*
4. *provides a range of housing opportunities, focusing new residential activity within existing towns, and identified development areas in Rangiora and Kaiapoi, in order to achieve the housing bottom lines in UFD-O1;*
5. *supports a hierarchy of urban centres, with the District's main centres in Rangiora, Kaiapoi, Oxford and Woodend being:*
   a. *the primary centres for community facilities;*
   b. *the primary focus for retail, office and other commercial activity; and*
   c. *the focus around which residential development and intensification can occur.*
6. *provides opportunities for business activities to establish and prosper within a network of business and industrial areas zoned appropriate to their type and scale of activity and which support district self-sufficiency;*
7. *provides people with access to a network of spaces within urban environments for open space and recreation;*
8. *supports the transition of the Special Purpose Zone (Kāinga Nohoanga) to a unique mixture of urban and rural activities reflecting the aspirations of Te Ngāi Tūāhuriri Rūnanga;*
9. *provides limited opportunities for Large Lot Residential development in identified areas, subject to adequate infrastructure; and*
10. *recognise and support Ngāi Tūāhuriri cultural values through the protection of sites and areas of significance to Māori identified in SASM-SCHED1.*

The assessment is that the proposed rezoning:

- Is consolidated and integrated with the urban environment,
- It will recognise the character and amenity values and in particular the cultural (Iwi) values,
- Utilised District Council reticulated systems,

- Supports a hierarchy of centres,
- Provides opportunities for and the strengthening of businesses, and
- Will be able to access open space networks

At the more detailed level UFD-P2 is relevant – Identification of new Residential Development-Areas. The policy sets up the following:

UFD-P2

Identification/location of new Residential Development Areas.
In relation to the identification/location of residential development areas:

1. *residential development in the new Residential Development Areas at Kaiapoi, North East Rangiora, South East Rangiora and West Rangiora is located to implement the urban form identified in the Future Development Strategy;*
2. *for new Residential Development Areas, other than those identified by (1) above, avoid residential development unless located so that they:*

a. *occur in a form that concentrates, or are attached to, an existing urban environment and promotes a coordinated pattern of development;*
b. *occur in a manner that makes use of existing and planned transport and three waters infrastructure, or where such infrastructure is not available, upgrades, funds and builds infrastructure as required;*
c. *have good accessibility for all people between housing, jobs, community services, natural spaces, and open spaces, including by way of public or active transport;*
d. *concentrate higher density residential housing in locations focusing on activity nodes such as key activity centres, schools, public transport routes and open space;*
e. *take into account the need to provide for intensification of residential development while maintaining appropriate levels of amenity values on surrounding sites and streetscapes;*
f. *are informed through the development of an ODP;*
g. *supports reductions in greenhouse gas emissions; and*
h. *are resilient to natural hazards and the likely current and future effects of climate change as identified in SD-O6.*

The assessment is that the proposal represents new residential development that;

(a) Occurs in a form that concentrates or is attached to an existing urban environment and promote a co-ordinated and integrated pattern of development,

(b) Makes use of the existing transport infrastructure as well three waters infrastructure,
(c) Good access for all people to jobs, community services, open space and public transport,
(d) Will concentrate higher density residential activity around the KAC at Ravenswood,
(e) Is informed by way of an ODP,
(f) Is supportive of greenhouse reductions and resilient natural hazards, and
(g) Will recognise and respect Iwi cultural values and when necessary protect sites of significance to Iwi.

The CRPs provides direction on matters relevant to the growth of settlements in the region. In particular Chapter 5, Land Use and Infrastructure and Chapter 6, Recovery and Rebuilding of Greater Christchurch are applicable.

5.4 National Policy Statement on Urban Development

The national Policy Statement on Urban Development came into effect on 20 August 2020 providing direction to decision matters under the RMA1991 on Urban Development Capacity. In particular the objective seeks;

- Urban environments that provide for the social, economic and cultural well-being and for their safety now and in the future,
- Planning decisions that improve housing affordability by supporting competitive land and development markets,
- Regional policy statements and district plans enabling more people to live in areas of urban environments near centres or areas with employment opportunities, areas well serviced by public transport or a high demand for housing in the area,
- Urban environments develop and change over time in response to diverse and changing need of people, communities and future generations,
- Local authority decisions on urban development are integrated with infrastructure planning and strategic over the medium term and long term.

The main tool to achieve these objectives is a Future Development Strategy (FDS) which has the purpose of achieving well-functioning environments in existing and future urban areas and to provide at least sufficient development capacity over the next 30 years to meet expected demand.

The provision of additional land for housing through rezoning at Ravenswood-Woodend achieves these policies. In summary:

Policy 1 – Planning decisions

The requested rezoning with accompanying ODP provides the District Council with a mechanism to make a planning decisions that provide for a variety of homes. The preliminary economic analysis concluded that demand for housing in WDC has been strong and that there is a need for additional land.

Consolidated Urban Form

The proposed developments are centrl to the preferred urban growth form at North Woodend and will consolidate urban activity in an area around the proposed KAC at Ravenswood.

Proximity to Urban Infrastructure

The proposed development can be serviced with good access to schools, community facilities, recreation and will support these facilities throughout the district (ie Kaiapoi, Rangiora and Woodend Pegasus).

Reduced Reliance on Vehicle Travel

Public Transport services are already servicing the locality and this development will consolidate that mode of travel.

Policy 2

The policy recognises that local authorities provide sufficient development capacity to meet expected demand. This area was identified to achieve that outcome in the 2048 Development Strategy.

Policy 8

Although this policy could appear to be confined to Plan Changes, it does require local authorities to be responsive to changes that add significantly to development capacity and contribute to well-functioning urban environments. The subject land:

- Can deliver in the short, medium and long term,
- It will bring capacity for between 1200-1500 new dwellings at a range of densities, and
- It would enable the provision of housing within affordable housing price brackets.

5.5 Regional Policy Statement and Plans (CRPS)

- Canterbury Regional Policy Statement
- Iwi Management Plan

The CRPS provides direction on matters related to the growth of settlements in the region. In particular Chapter 5, Land use and Infrastructure and Chapter 6 Recovery and Rebuilding of Greater Christchurch area relevant.

Chapter 5 – Land Use and Infrastructure

Objective 5.2.1 – Location, design and function of development (Entire Region)

Objective 5.2.2 – Integration of land-use and regionally significant infrastructure (Wider Region)

Objective 5.2.3 – Transport network (Wider Region)

Policy 5.3.1 – Regional Growth (Wider Region)

Policy 5.3.2 – Development conditions (Wider Region)

Policy 5.3.5 – Servicing development for potable water, and sewage and stormwater disposal (Wider Region)

Policy 5.3.7 – Strategic land transport network and arterial roads (Entire Region)

Policy 5.3.8 – Land use and transport integration (Wider Region)

Policy 5.3.9 – Regionally significant infrastructure (Wider Region)

Assessment

The proposal represents integrated and consolidated development at a Regional level including access to roading, housing choice and minimising any adverse effect on infrastructure. There is a high level of land use and transport integration, all services exist and all stormwater discharge consents obtained. Overall the proposed rezoning is considerated to give effect to Chapter 5 and in particular Objective 5.2.1 and 5.3.7.

Chapter 6 – Recovery and Rebuilding of Greater Christchurch

A key requirement of Chapter 6 was to respond to the anticipated demand for residential activities.

Objective 6.2.1 – Recovery frameworks

Objective 6.2.2 – Urban form and settlement pattern

Objective 6.2.3 – Sustainability

Objective 6.2.4 – Integration of transport infrastructure and land use

Objective 6.3.2 – Development form and urban design

Objective 6.3.3 – Development in accordance with OD Plans

Assessment
The principle purpose is to provide sufficient land for urban purposes including a coordinated land use and infrastructure framework for the recovery of Greater Christchurch. The definition of "Urban" within the RPS does not assist, referring to urban activities in a much broader context. As such the use of the land for the purpose proposed support the urban form identified on Map A and is integrated both within the wider urban area and with the principle urban infrastructure.

In terms of Policy 6.3.4 – Transport effectiveness, the proposed zoning is located alongside principle urban areas optimising the use of that infrastructure. The development reflects an integrated transport outcome in terms of the road network. The reason for the policy recognises that efficient and effective movement of goods and people is important for future wellbeing and energy efficiency. The proposed development will operate as part of the urban area and strategic routes thereby delivering economic wellbeing and energy efficiency.

Policy 6.3.5, Integration of land use and infrastructure seeks to ensure development and infrastructure are integrated and that new development does not occur until provision for appropriate infrastructure is in place. The policy also refers to providing for new development that does not affect the efficient operation, use and development of existing infrastructure or transport corridors but rather supports that infrastructure in an energy efficient manner. The policy further refers to:

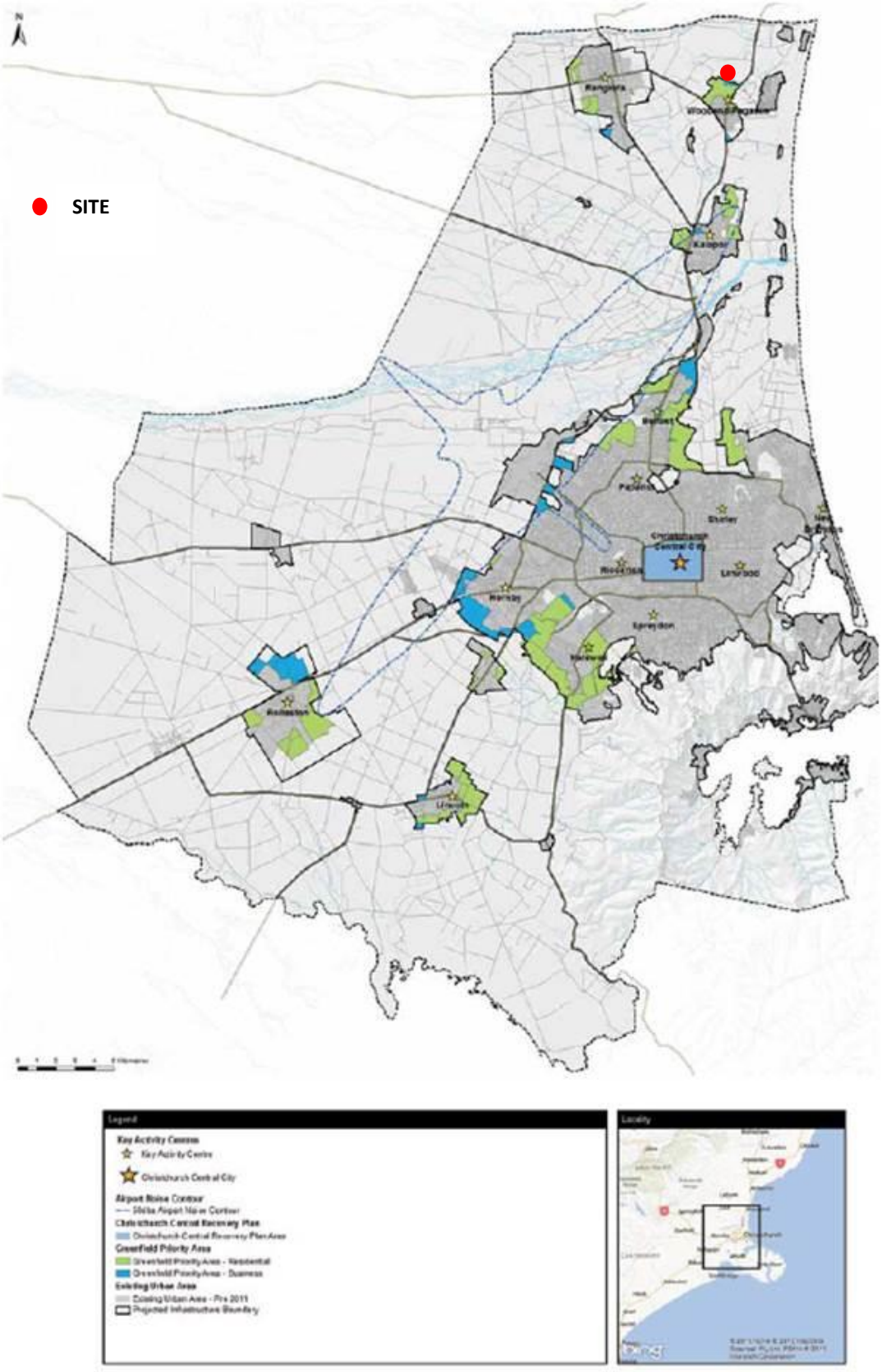
> *Strategic infrastructure represents an important regional and sometimes national asset that should not be compromised by urban growth and intensification. Strategic infrastructure such as Christchurch international Airport, the Lyttelton Port of Christchurch, the State Highway and strategic road networks and rail corridors is required to support Greater Christchurch's recovery through transporting such things as building materials, equipment and personnel. The locational requirements and existing investment in strategic infrastructure means that it is extremely inefficient for them to relocate, and effects of land use on their operation can significantly reduce efficiency and attractiveness as transport options. The operation of strategic infrastructure can affect the liveability of residential developments in their vicinity, despite the application of practicable mitigation measures to address effects, which in turn exerts pressure on the infrastructure to further mitigate their effects. It is better to instead select development options where such reverse sensitivity constraints do not exist.*

The rezoning by way of location and type of actvity is highly supportive of the above outcomes and would make good use of the strategic infrastructure most particularly the road network, service infrastructure and support businesses.

Chapter 16- Energy

Objective 16.2.1 – Efficient use of energy

Assessment:
The development outcome will be a highly efficient and suitable outcome. It will make efficient use of the road network and is predicated on energy efficient development,


SITE
Legend
Key Activity Centres
Christchurch Central City
Airport Noise Contour
Christchurch Central Recovery Plan
Greenfield Priority Area
Existing Urban Area
Locality

given the proximity to the established urban areas, the type of activity involved and access to the principle road network and public transport.

5.6 Greater Christchurch Recovery Strategy

The Recovery Strategy for Greater Christchurch prepared by CERA under the Canterbury Earthquake Recovery Act became operative on 1 June 2012. It is a statutory document to be read with, and form part of, other relevant legislation within the greater Christchurch area. The City Plan must not be interpreted or applied in a way that is inconsistent with the Recovery Strategy. Sections 3-8 of the Strategy have statutory effect.

The development proposed is consistent with the above strategy outcomes.

5.7 The Mahaanui Iwi Management Plan (IMP)

Sets out Ngai Tahu objectives, issues and policies for natural resources and environmental management within the area covered by the zoning request Under Section 74(2A) of the RMA a Territorial authority must take into account any such plan to the extent it has a bearing on the resource management issues in the district.

The proposed rezoning will require extensive consultation and critical assessment with local Iwi and this is proposed.

5.8 Resource Management Act

The following matters listed in Section 7 of the Act are relevant to this application (being the full site) and must be had particular regard to:

- S7(b) *The efficient use and development of natural and physical resources;*
- S7(c) *The maintenance and enhancement of amenity values; and*
- S7(f) *The maintenance and enhancement of the quality of the environment.*

6.0 ENVIRONMENTAL ASSESSMENT (OVERVIEW)

The Environmental Assessment has considered a number of matters.

6.1 Outside of Urban Limits

The position of the land and its relationship to the Urban Limits has been addressed by reference to the major policy documents. The conclusion is that the land:

- Has been identified for future rural-residential use in part,
- The land adjoins the main residential and commercial nodes at Ravenswood and Woodend, and

- The 2048 Waimakariri Development Strategy summarised the position in respect of the area as the preferred or proposed residential growth direction.

6.2 Housing Choice

The creation of additional Residential Zones or zone able to be comprehensively developed enables:

- A range of densities,
- Housing choice,
- The ability to create significant reserves and enhance the elements of natural character on the site,
- Walkable access to shopping, schools and community facilities, and
- The ability to plan for and design for all modes of transport

6.3 Character and Amenity

The land currently contains a network of waterways which will significantly enhance the amenity of the area. Three boundaries of the subject land already integrate with urban or rural residential areas and major urban transport routes. These considerations provide for an integrated to and consistent with the potential for consolidated, sustainable and efficient urban form.

6.4 Water Quality

As set out in the infrastructure reports the development can be fully reticulated. Stormwater generated within the site will be treated via swales. Treatment and discharge of stormwater is addressed in Annexure 8.

6.5 Reverse Sensitivity

The neighbouring activities on the adjoining properties are residential, rural residential, commercial, stormwater mitigation farming activities and a major State Highway. The site is very large and the potential exists to mitigate any reverse sensitivity effects on the more sensitive adjoining properties, the road network or matter of critical cultural value and significance.

6.7 Natural Features

There are three major stormwater and flood links through the land area. These are all capable of being enhanced and forming part of both a sustainable stormwater solution and major pedestrian and open space linkages.

6.8 Transportation

The ODP provides the opportunity for roading and pedestrian/cycle access throughout the development by way of a network of collector roads. These linkages provide principally for north-south linkages between Gressons Road and the Ravenswood development. This will have the advantage of linking into some of the established Ravenswood road network without having to gain direct access from the State Highway recognising that a significant upgrading of the Gresssons Road/State Highway intersection.

The wider traffic environment in this area of the district has changed significantly over the last 20 years with the expansion of Woodend (south), Pegasus and Ravenswood and the linkages to Rangiora.

Stantec Ltd have prepared a preliminary transport assessment (Refer Annexure 10)

6.9 Natural Hazards

Two geotechnical investigations have been prepared for the site. These are by Elliot Sinclair (2020) and Engeo (2021). (Refer Annexures 4 and 6).

6.10 Cultural Impacts

The area is of major cultural significance and a full assessment of the matters of importance to and the need for protection of major cultural assets or by and for the local Iwi will be a primary consideration.

7.0 SUMMARY

The subject land can make a valuable contribution to urban growth in the district:

- It is an area already identified for Large Lot Residential,
- It is identified as the direction for future growth at Ravenswood-Woodend,
- It will consolidate development around the KAC at Ravenswood,
- There are no natural hazards that preclude the use of the land,
- The natural asset of the land can be protected and enhanced, and
- It accords with proposed WDC district plan direction for new urban growth at Woodend-Pegasus.

In addition the outcome the submission is effective and provides for:

- Residential development at an appropriate scale that can provide a range of section and housing opportunities,
- Development in accordance with an ODP, and

- Interaction of development with existing infrastructure

Based on the assessment above, the overall conclusion is that the submission outcome is a more appropriate method for achieving the objectives and policies of the District Plan than the existing plan provisions. It is also concluded that the environmental, social and economic benefits of the submission outcome outweigh any of the costs. On this basis, the proposed rezoning is considered to be an appropriate, efficient and effective means of achieving the purpose of the Resource Management Act.

APPENDIX 1

RURAL RESIDENTIAL STRATEGY DOCUMENTS

4. Gressons Road

The Gressons Road Residential 4B area comprises approximately 53 hectares and 56 lots. It is located 3km north of Woodend and Pegasus, and 3km west of Waikuku Beach. The area is bounded by State Highway 1 / Main North Road to the east, Gressons Road to the south, and the Waikuku Stream to the north and west.

The area does not contain any community facilities or amenities, however, it is in close proximity to Woodend and Pegasus and their associated community facilities and social infrastructure.

The area is not currently connected to a reticulated wastewater network so wastewater disposal occurs via individual septic tanks. Similarly, the area is not currently connected to a reticulated water supply, which means water is sourced via individual bores. However, given the area's relatively close proximity to Woodend, Pegasus and Waikuku, connecting to these reticulated networks is possible with sufficient growth. The location is within a rated drainage area.

Strengths

Overall, the Gressons Road area offers a number of strengths that support further rural residential development:

- Close proximity to Woodend and Pegasus which have abundant community facilities and social infrastructure in place
- Close proximity to State Highway 1 providing good transport connections
- Medium soil drainage to the south and east, high soil drainage to the north
- Council Localised Flood Hazard Modelling shows only some small areas of low flood hazard surrounding the existing Residential 4B area. Areas to the south and east of the existing Residential 4B area are clear from medium to high flood hazard under Environment Canterbury's Ashley River Breakout Flood Modelling.
- Outside of identified active fault lines
- Within a rated drainage area
- No high voltage transmission lines infrastructure nearby
- No nearby mapped notable plants, vegetation and habitat sites or heritage sites.

Constraints

The Gressons Road area also faces some environmental and other constraints:

- Silent File Area SF017 Pekapeka to the south
- Within a Liquefaction Susceptibility Area
- Potential for coastal hazard issues including groundwater level rise associated with sea level rise
- Largely surrounded by versatile soils, except for a small portion to the northeast
- Low soil drainage to the west
- Council Localised Flood Hazard Modelling and Environment Canterbury's Ashley River Breakout Flood Modelling shows some medium to high flood hazard to the north and northwest of the existing Residential 4B area.

Growth Direction

Taking into account these various constraints and opportunities, further rural residential growth will be enabled to the south of the existing Residential 4B settlement, as shown in Figure 10.

This area is relatively free from localised flood hazard and avoids the potential community severance associated with State Highway 1. It also allows a greater level of integration with the existing settlement via Gressons Road. The key underlying landowner is in support of rural residential development at this site.

It is acknowledged the growth direction is within a Silent File Area indicating the presence of significant wāhi tapu or wāhi taonga somewhere in the area. Therefore, consultation with Ngāi Tūāhuriri is particularly important in order to identify effects of the activity and to avoid, remedy or mitigate those effects. It is also acknowledged that the growth direction does impact land with versatile soils.

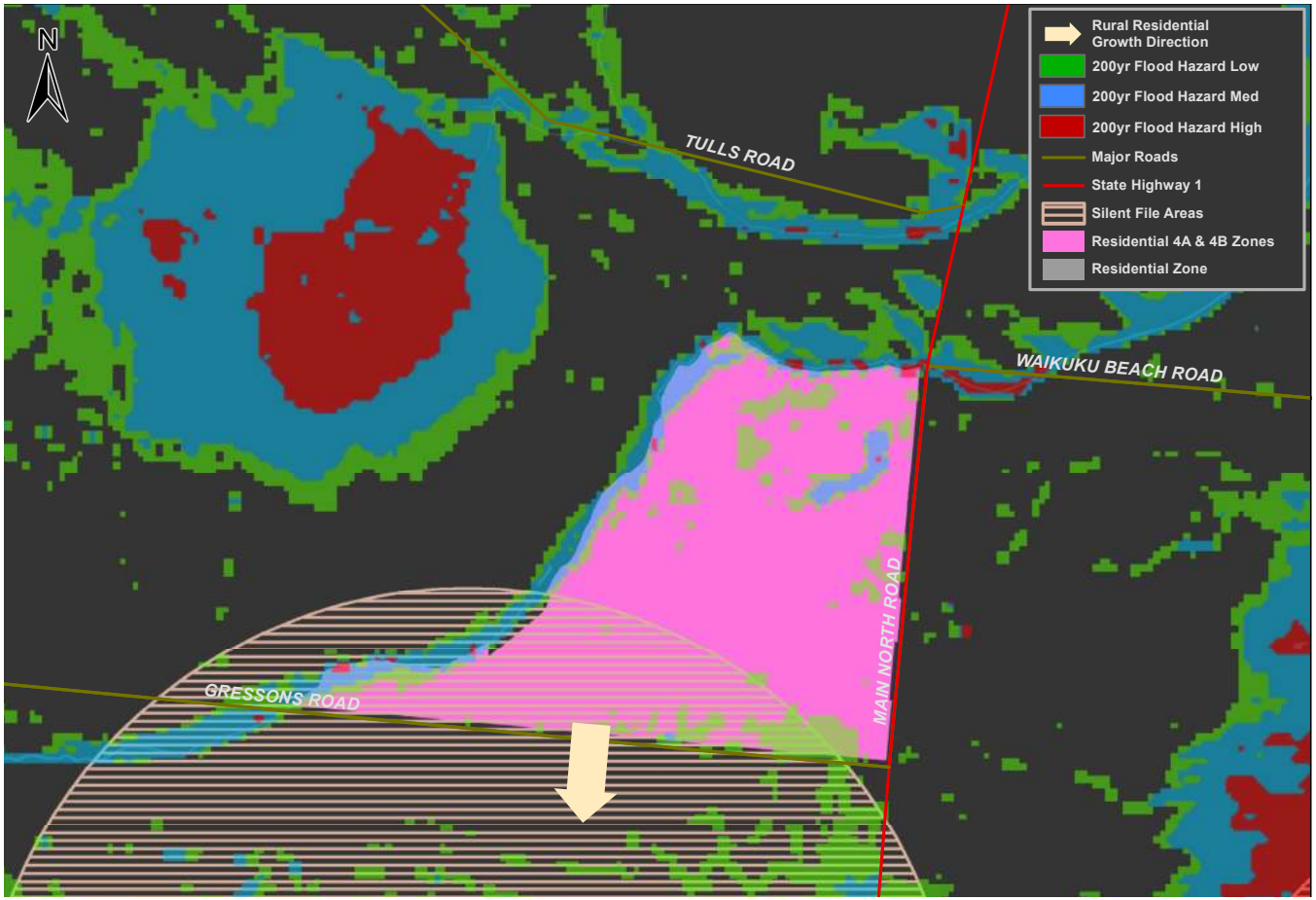


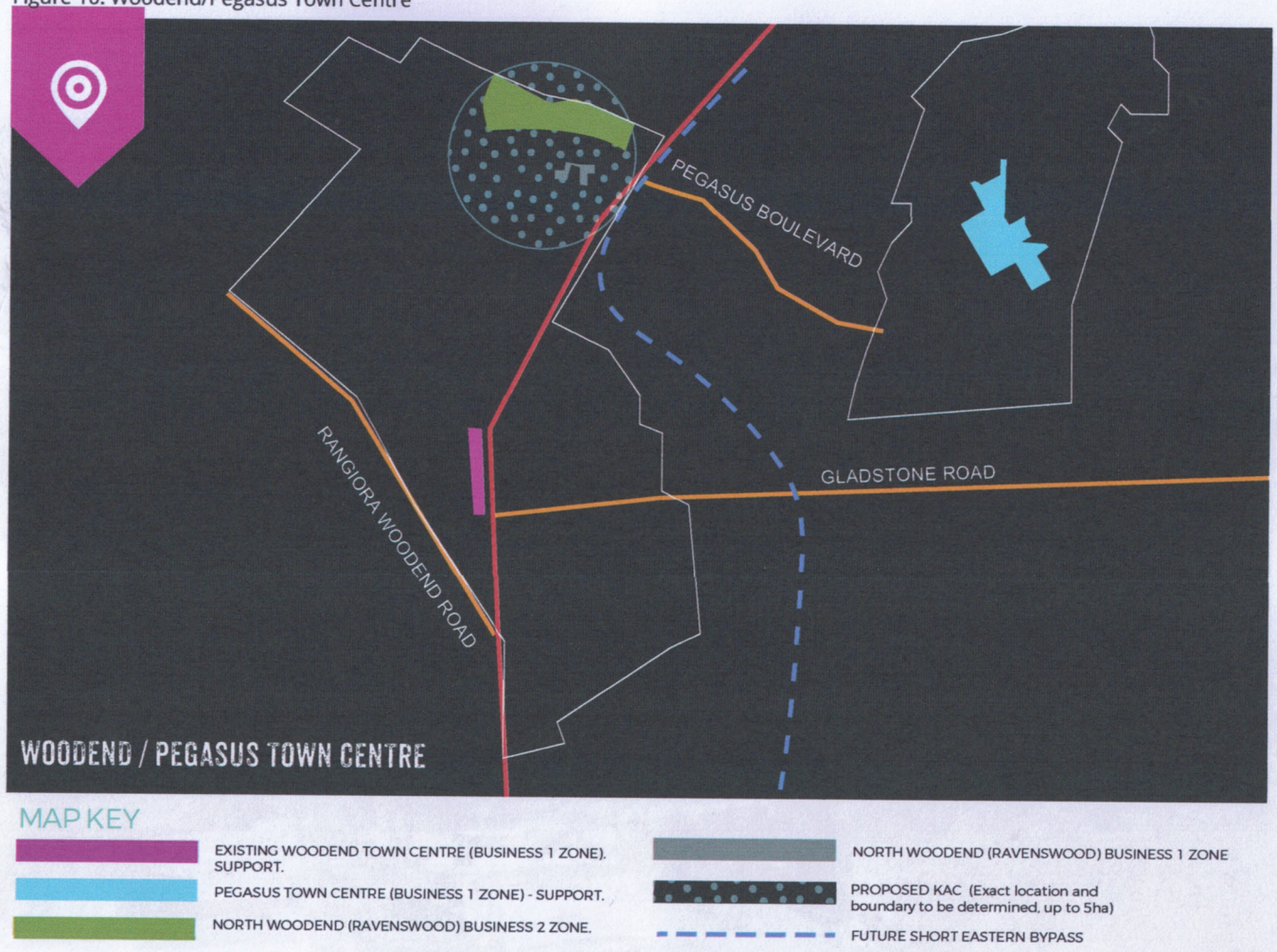
Figure 10: Gressons Road rural residential growth direction

Figure 11: Gressons Road area aerial map 2017

APPENDIX 2

WAIMAKARIRI GROWTH STRATEGY (2048)

Figure 10. Woodend/Pegasus Town Centre



The exact spatial locations of the Rangiora and Kaiapoi KACs are well defined, being largely the Business 1 Zoned areas. However, this is not the case in Woodend/Pegasus. With projected population growth in the Woodend/Pegasus area catchment, it has been identified that more than 14,000m² of additional retail floor space could be sustainable in a KAC by 2043, which translates into the provision of up to 5 hectares of KAC land. It is not considered practicable to expand the small existing Woodend town centre, which is surrounded by primarily residential activities, to provide for a single, contiguous area of land that could become a KAC. The planned commercial location at North Woodend (Ravenswood) benefits from its central location in Woodend/Pegasus, its proximity to State Highway 1 as a significant link from Picton (Wellington) to Christchurch, its consented and anticipated commercial activity and its land availability to accommodate a centre of the size required. Based on this analysis and community feedback received the KAC will be located at North Woodend subject to further work being undertaken through the District Plan Review and with the developers to identify the exact location and ensure good town centre outcomes are achieved.

Further discussions will be required with NZTA to identify and confirm issues and options for the future Woodend Bypass alignment and the current State Highway 1 designated land through Woodend. As the timing and nature of development of the Woodend Bypass and development of the KAC at North Woodend clarifies, the Council will develop an approach to confirm the future form and function of the existing town centre, noting the opportunities available in the current State Highway 1 corridor. At the same time, the existing centres at Woodend and Pegasus will continue to be supported.

WHERE ARE WE GOING (2048)?

- North Woodend development (Ravenswood) will 'join' Woodend and Pegasus to create a single town with three distinct sub-areas
- 12,116 – estimated population (2048)
- 4,846 – estimated households
- 2,786 – new households in Woodend
- 93 – estimated annual building consents for new houses (from 2017-2048)
- At least 20 hectares of additional feasible residential greenfield land by 2048 (this includes capacity in remaining stages of existing residential developments and new greenfield areas) inside and outside of the Infrastructure Boundary
- Future residential growth directions proposed to the north of Woodend
- Intensification opportunities to be identified
- New growth directions take into account the areas of unacceptable natural hazard risk and areas of significant environmental and cultural values
- Commercial (retail and office) land supply sufficient to meet 2048 requirements
- Key Activity Centre (KAC) proposed to be located in new commercial area in North Woodend
- 8% of retail activity in the District occurs in Woodend/Pegasus
- Woodend Pegasus Area Strategy implementation to be monitored
- New growth areas to connect into existing sewer and water networks
- Stormwater Levels of Service designed to meet increased performance requirements
- The needs for community facilities such as libraries, meeting spaces, pools, parks and sports fields of a growing Woodend/Pegasus population are met
- Completion of the Woodend Bypass
- Completion of a number of the Council's local roading projects including walking and cycling
- Strategic corridors protected
- Public transport services between Woodend/Pegasus and other key District and City destinations meet demand
- Develop an approach to confirm the future form and function of the existing town centre, noting the opportunities available in the current State Highway 1 corridor
- Existing strategic infrastructure is considered

Figure 13

MAP KEY

- CURRENT BUSINESS ZONED AREA
- CURRENT RESIDENTIAL AREA INCLUDING ZONED & YET TO BE DEVELOPED
- PROPOSED RESIDENTIAL GROWTH DIRECTION
- FUTURE SHORT EASTERN BY PASS
- INFRASTRUCTURE SUPPORTED BOUNDARY (indicative location only)

APPENDIX 3

RMM – PRELIMINARY URBAN DESIGN ASSESSMENT AND OUTLINE DEVELOPMENT PLAN

RMM

ROUGH MILNE MITCHELL
LANDSCAPE ARCHITECTS

rmmla.co.nz

ODP Report

Proposed
Outline Development Plan

Ravenswood 24 November 2021
Waikuku Land

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Date: 24 November 2021
Status: For District Plan Review

Prepared for: Brian and Anne Stokes

Prepared by:

…….
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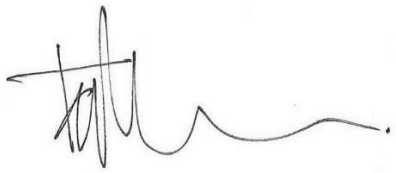
Reviewed by:



…….
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Director and NZILA Fellow

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Appendix - Graphic Attachment (GA)

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1.0 Introduction

1.1 Purpose and Scope

The owners (the submitter) of a block of land located to the north of Ravenswood and south of Waikuku village wish to have residential subdivision of this land considered for a plan change. The property has road frontages to Gressons Road to the north, Wards Road to the south and State Highway 1 to the east. It is described as Lots 1 and 2 DP428676, Lots 2 and 3 DP62186, Lot 2 DP303387, Lots 1 and 2 DP46765, Part Lot 4 DP923, Lots 5 and 6 DP923, Lot 1 DP43146, Lot 1 DP470921 and Part RS 3093, 3129, 3141-3144, 3169, 3170, comprising approximately 143.5 hectares.

Rough Milne Mitchell Landscape Architects (RMM) has been engaged by the submitter to prepare an Outline Development Plan (ODP) for the site along with the supporting site analysis and urban design information contained in this report.

This report examines the landscape character of the context and location, the spatial character of the site and proposes an ODP which integrates the above elements and can be treated as the start of discussion for how the land may be developed in the future.

The report is accompanied by a Graphic Attachment (GA), which includes context plans, a site analysis, site photographs and the ODP.

2.0 Executive Summary

2.1 Executive Summary

The land comprises open, flat farmland and sits between the existing Ravenswood development to the south, the Waikuku village to the north, Pegasus golf course and township to the east with more open farmland to the west.

Identified in the WDC 2048 Growth Strategy for residential expansion, the site is a logical extension of those existing developments.

It is a large piece of land (143.5 ha) so potentially lot development numbers are large depending on the density, demand, urban design and infrastructure that is provided for the site.

In contemplating developing the site, it is important to capitalise on Ravenswood and its Key Activity Centre (KAC) but respect the special character of the context and the important cultural sites as well as the general character of the location.

The ODP provides a framework of strong linkages, roading, pedestrian/cycle and recreation reserves and waterways. These reflect internal linkages and connection as well as connections to valuable assets outside the site.

The density of development needs much discussion and resolution, but what is shown on the ODP is a pattern of greater density closer to the KAC, with other dense pockets around community assets and some form of open space adjacent to rural boundaries.

3.0 Landscape Contexts

3.1 Existing Landscape Character and Amenity

The recent report prepared by Boffa Miskell "Waimakariri District – Rural Character Assessment" (dated 6 June 2018) is helpful in assessing the existing landscape character and amenity of the receiving environment embedding the proposed site. The report identifies a dozen "character areas" that make up the rural areas of the Waimakariri District and provides a commentary on the potential for rural residential development and intensification of the rural land, while considering the provisions of the CRPS and the WDP (refer to Sheet 3 of the Graphic Attachment).

The report identifies the rural context of the site and much of the surrounds as "Coastal Plains" (refer to Sheet 4 of the Graphic Attachment). This character area encompasses approximately 15km of coast between the mouth of the Waimakariri River and the Ashley River/Rakahuri Lagoon, the coastal margin seaward of urban and residential areas of Kaiapoi, Woodend, Pegasus and Waikuku, and the lower plains of the Ashley River. The site is also located near the "Lower Plains" area which includes most of the urban development within the Waimakariri District, including the townships of Rangiora, Kaiapoi Woodend and Pegasus, as well as semi-urban development clusters at Mandeville Ohoka, Fernside, Tuahiwi and Swannanoa. The report describes the character of the "Coastal Plains" under the following headings: (1) Landform, (2) Land Cover, (3) Land Use, (4) Built Form Character and Patterns, Boundary/ edges. The following is a brief landscape character description, under the above headings, relevant to the site and its immediate surrounding areas.

3.2 Landform

The subject site is located within the low-lying hinterland area of the coastal character area which comprises flat floodplains of gravel, sand silt and clay, with the character of the area having been influenced by the sea and braided rivers. It is approximately 2km from the Ashley River/Rakahuri to the north, which marks the northern extent of the "Coastal Plains "character area and District boundary, and 2.5km from the east coast. The lower reaches of the Waimakariri River are approximately 9km away.

The topography of the area is mostly flat rising to 20msl inland towards Rangiora, with many of the low-lying areas prone to surface flooding. A few streams and creeks flow through the area. Coastal features include river mouths, open beaches, dunes, ponds, wetlands, and remnant lagoons. The low-lying plains of the adjoining "Lower plains"" area is also relatively flat with much of the area having been drained during the early years of European settlement to create farmland.

3.3 Landcover

The open productive rural areas of locality largely comprise pasture grass cover with vegetation patterns of exotic hedgerows, sporadic groups of established trees and a few individual trees. The finer grain vegetation patterns of the rural residential lots to the north of Gressons Road include shelterbelts enclosing small, grassed paddocks, small copses of trees and individual trees, and domestic scale indigenous and exotic vegetation gardens. Ravenswood to the south has finer grain

newly established street trees and garden vegetation. Some riparian panting can be found on the margins of waterways although the above areas are largely absent of indigenous vegetation.

To the east land cover is increasingly complex, diverse, and natural with river mouths, estuaries, and sand dunes. Pine plantations dominate the fore dunes as well as further inland tracts. Shelterbelts, pasture, willows, gorse and broom are also present. A District Plan Significant Natural Area is located north of Ashely River.

3.4 Land Use

The area has been highly modified with the larger urban and residential areas of Rangiora, Kaiapoi, Woodend and Pegasus and the small coastal settlements of Waikuku Beach, Woodend Beach and Pines Beach along the coastline being more lightly developed.

The open rural land surrounding the site includes a mix of medium to small blocks of pastoral farmland, some for rural lifestyle development. These rural areas and the subject site are zoned Rural in the Operative Waimakariri District Plan (Operative District Plan) and are subject to a minimum 4ha allotment area (Refer Graphic Attachment, Sheet 5).

The Proposed Waimakariri District Plan (Proposed District Plan) seeks to rezone some of the rural land including the subject site to Rural Lifestyle with the same minimum allotment size and identifies areas subject to a Proposed District Plan Overlay that encourages higher density residential development,matching the Large Lot Residential Zone of the Waikuku village (refer Graphic Attachment, Sheet 6). It also seeks that those other areas of rural land be developed at a higher density.

To the north of the site across Gressons Road are rural residential lots zoned Residential 4b in the Operative District Plan and Large Lot Residential in the Proposed District Plan anticipating one residential unit per 5,000m2 of net site area.

The Ravenswood development to the south of the subject site comprises a subdivision that is being developed in accordance with the North Woodend Outline Development Plan and acts as an extension to the Woodend township with business, residential, open space and stormwater areas (Refer Graphic Attachment, Sheets 5 and 6).

The land and waterways are of profound importance to Te Runganga O Ngai Tuahuriri. Historically, settlement by tangata whenua was along the coastal plains and eastern edge of the “Lower Plains” character area. There are silent file and archaeological areas of significance on the site and within the general locality.

3.5 Built Form, Character and Edge Patterns

On the eastern boundary of the subject site State Highway 1 (SH1) borders the golf course of Pegasus to the south. The area is relatively manicured, and several houses sit in a spacious setting overlooking the course. Further to the north along this eastern boundary there is a range of rural living, all with a very typical rural character for the location. This comprises open vistas, shelter and amenity planting and rural residences at a variety of distances, between each other and from the road.

To the north of the subject site is Gressons Road which adjoins the large lot residential area of Waikuku to the east. Here houses sit typically in a one-hectare lot with a prevalence of amenity and shelter planting providing a pleasant and spacious outlook. To the west along Gressons Road is a typical set of rural activities with accompanying character. This north-western boundary does have a long shelter belt to the north of the road which generally confines the outlook in this western area.
Along the western boundary the site does not connect with an existing road but is bounded by open rural land, mainly used for dairying. This area has a number of residences some of which are used for farm support. Generally, the landscape is relatively open aside from a block of well-established shelter planting in the northwest corner.

On these three boundaries the land use and landscape character are relatively open with well spaced residential lots, appealing views to the wider landscape and amenity and farm planting. On these boundaries it is the open space and variety of planting that principally forms the character rather than any built form.

On the southern side of the site is the recently constructed Ravenswood development. Along this boundary runs Wards Rd which is currently formed as a gravel road and connects right through to Gressons Rd, although this is only formed as a farm track in its northern half. The landscape here is a change from the rural pattern on the other boundaries. At this boundary in the centre of the proposed site is a large complex of stormwater ponds. To the south of this again is the Key Activity Centre (KAC) of Ravenswood. This comprises a variety of large and small commercial sites, including a supermarket, petrol station, fast food and child care centre and a variety of small businesses. The residential aspect of that development will fill into the south of this. While there is open space on this boundary with the stormwater basins, there is also the very noticeable difference in character of a typical residential and KAC development. On either side of Ravenswood along this southern boundary there is open rural space with an existing residence at each end.

4.0 The Site

4.1 Site

The proposed site is legally described as Lots 1 and 2 DP428676, Lots 2 and 3 DP62186, Lot 2 DP303387, Lots 1 and 2 DP46765, Part Lot 4 DP923, Lots 5 and 6 DP923, Lot 1 DP43146, Lot 1 DP470921 and Part RS 3093, 3129, 3141-3144, 3169, 3170, comprising approximately 143.5 hectares. It is bounded by State Highway 1 to the east, Gressons Road to the north, existing farmland to the west and Wards Road and the Ravenswood development and two residential owners to the south (refer to the Sheet 7 in the Graphic Attachment).

The site is currently owned by one entity (the submitter) and is used for the purpose of dairy farming. It is split into four zones, with three running east/west across the site and one at the western end. There are two long laneways which run east/west and connect through the farm to the dairy shed at the eastern end. The three southern zones are split into rotationally grazed areas and the northern zone has larger paddocks. All are pivot irrigated. There is a large dairy shed and curtilage area along the centre of the eastern boundary, near to SH1. At the north end of this are two residences for servicing the farm.

4.2 Landform

This site is generally flat although it consistently slopes down towards the coast. There is a natural watercourse outside the northwest corner of the site, the Waikuku Stream, which has an WDC esplanade reserve around it. The site has an access over the stream and hence possible connection to it. There is also a channelised drain running through the centre of the site from west to east.
The soils for this site are mainly Flaxton deep silt to the west and Wakanui deep silt and Temuka deep silt over clay to the east which typically are poorly or imperfectly drained.

4.3 Landcover

The site generally is covered in pasture grass. This varies in cover where there have been heavily grazed sections of the rotational grazing practice.

There are a number of exotic species shelter belts running north/south and east/west through the site, particularly in the north-western part. Along the eastern edge, there is a greater variety of existing planting. Low shelter belts enclose the service areas of the farm. There is a tall well-established copse of trees associated with the farm houses. To the north of this, where there is a site of Ngai Tahu significance, this is sheltered on three sides by pine shelter. The other remaining trees on the site are generally single farm tree species rather than valuable single specimens.

There do not appear to be any areas of particular ecological significance, such as remnant habitats. The exception to this is the opportunities provided by the Waikuku Stream to the northwest of the site. Ecological assessments have not been carried out to date.

4.4 Land Use

As described the site is currently used for dairy farming. However, the location and this site does have a long and varied history of habitation. The site is west of the Kaiapoi Pa site which was the centre of Ngai Tahu life. It was the largest fortified pa in the South Island, but also a valued trading location. There is a silent file site at the eastern edge of the site and no doubt other places valued by Ngai Tahu in this location. The area has an interesting history of European habitation. One of the earliest was John Raven who arrived from England in 1853.

The site has a paper road running from SH1 into the centre of the site from the east, but there is no known or recognised access into the site for public use.

There are no other on site or neighbouring land uses that may cause reverse sensitivity issues.

4.5 Views to the Site

Along the south eastern boundary, looking from SH1 there are intermittent views into the site as shelter belts and existing residences partially screen the extent of open space within the site (refer to the Graphic Attachment, Sheet 10). At the north east corner on SH1 the boundary is more open and there are views into the site and to the wider landscape (refer to the Graphic Attachment, Sheet 9).

Along the northern boundary with Gressons Road the views into the site are predominantly open into the site with wider views to the west and south possible. Views to the north are confined by the existing shelter belt on the north side of the road.

To the west, the views into the site are open from the existing rural land (refer to the Graphic Attachment, Sheet 9).

To the south, driving along Wards Rd, the views into the site generally open with two lengths of utilitarian shelter on the northern side (refer to the Graphic Attachment, Sheet 11).

.

5.0 Appropriateness of the Site at a Broad Scale

5.1 Appropriateness

The Waimakariri 2048 District Development Strategy (WDDS) identified that additional feasible greenfield residential and intensification opportunities are needed in the District's main towns. Approximately 15,000 new houses are likely required to meet population growth by 2048. As well as recommending new rural residential areas, the strategy focusses on enabling larger lot intensification within existing rural residential areas where there is sufficient community support and servicing available. The Strategy clearly signals proposed residential growth extending north of Ravenswood. In addition, the Proposed District Plan earmarks the northern part of the subject site for higher density development through the provision of the Large Lot Residential Zone Overlay (refer to Graphic Attachment, Sheet 6).

At a broad scale the site appears to be a logical site for increased residential density. It sits between the low residential density Woodend settlement and Ravenswood ODP areas to the south and the rural residential Operative District Plan Residential 4B and District Plan Residential Large Lot zones (min. 5000m2 lot) to the North building on existing services, corridors, and infrastructure. In addition, the Pegasus township exists to the southeast and the site is away from the more sensitive natural landscape coastal features. Gressons Road and State Highway 1 will contain the growth.

6.0 Outline Development Plan

6.1 ODP (refer to the Graphic Attachment, Sheet 7).

Relevant general development issues include:

- Concentrating development to provide efficient urban form and minimum resource use in the future;
- Building on existing centres to optimise urban design outcomes;
- Respecting the character and history of the place;
- Working with the character of the landscape;
- Creating choice and healthy environments for Waimakariri citizens in the future.

This proposal principally responds to the factors influencing the site from its landscape context and the 2048 Growth Strategy for the district. These can be summarised as follows:

- Anticipating a residential density for the site overall, possibly denser close to the KAC and less dense on the periphery particularly on the east and northern boundaries;
- Working off existing connection opportunities at south and through to Gressons Road with a number of smaller intersections;
- Using existing and proposed waterways as focal points;
- Having a clear urban hierarchy based on connecting the development's main assets in a legible and efficient manner.

6.2 Density

The land is approximately 143.5 hectares in size. At the WDC's aspirational 12 lots per hectare for residential land, this would be 1722 lots. However, there are other factors to consider for this site, varying density due to site factors and good design practice, the degree of public space to be considered, market factors governing demand and lot profile, and environmental and servicing requirements. At this stage the proposal shows areas that may suit higher density, based around the KAC and the proposed public assets for the site being waterways and a recreation reserve. It also shows public space along SH1 and an open space buffer along the remaining section of SH1 and the length of Gressons Rd. There is a lot of consultation with affected parties anticipated to advance this aspect of the proposal.

6.3 Connective Network

There are three existing road connection opportunities from the south through the existing layout of Ravenswood. Two of these are on either side of the existing stormwater basins. These would allow logical access points with the eastern proposed road splitting. This would form three main routes running north south and connecting to Gressons Rd. Future road connections would be allowed to

connect to the existing rural land to the west which has been identified for further development in the 2048 Growth Strategy and also back to Ravenswood to the southwest.

An extensive pedestrian and cycle network is shown on the ODP, connecting the main assets of the proposal together. This would run along the esplanade reserves, connect back to the KAC and proposed recreation reserve and then spread wider to connect outside the site towards Waikuku village, the Waikuku Stream and then to possible future developed land to the west.

6.4 Reserves Green Space and Waterways

The ODP shows a reserve framework through the site. There is an existing stormwater system on the southern boundary of the site on Ravenswood land. There may be opportunities to connect with this for stormwater on the southern side of the site. This may then connect to a larger anticipated stormwater detention and treatment system on the eastern boundary of the site adjacent to SH1. This would sit at the southern end of the Ngai Tahu silent file area although the extent and treatment of this area still needs extensive consultation with mana whenua. There is also a central waterway reserve shown. This is shown as 40 metres wide, and this is proposed as the general width, although the area at SH1 is shown as 240 metres wide.

There is also a central large reserve shown on the ODP. This is shown as over 5.0 hectares, allowing for senior playing fields (and/or other combinations) as well as supporting and passive recreation opportunities. In terms of walking distances, these range from 300 to 800 metres to the boundary of the site. A smaller reserve is shown in the western part of the site. This would complement the reserves already constructed or consented in Ravenswood to the south. Liaison with WDC to confirm levels of service and pedestrian shed requirements will refine this aspect of the proposal.

6.5 Boundary Treatments

Eastern Boundary – As described there is a large, proposed stormwater detention and treatment reserve along this boundary. The intention for this would be that it retains the open space that is valuable in this landscape, allowing views into and through the reserve and connecting to the longer views of the mountains to the west. At the north end of this boundary the intention is to create an open space buffer that allows the feeling of open space and the longer views. The extent of this and the mechanism for achieving this still need discussion and development. `

Northern Boundary – The intention for this boundary treatment is similar to that for the north eastern area. The retention of open space here is desirable although the character of the large lot residential area of Waikuku village would not require the same degree of open space as may be anticipated along SH1. This again requires further discussion and development.

Western Boundary – This area is listed in the 2048 Growth Strategy for future development. Just what the character and density of development that is anticipated here is yet to be confirmed. This would be the guiding factor in determining the boundary treatments along the western face of the development.

Southern Boundary – The applicant has met with the Ravenswood developers and in principle agreed to work together. This would be around residential density, future commercial opportunities and the

combination and layout of infrastructure. These discussions will be formative in the treatment of this site boundary. Obviously, this would involve liaison with WDC to achieve outcomes for the benefit of the district. There are also two residential neighbours along this boundary where access and treatment issues are relevant. At this early stage no consultation with neighbours has been conducted.

7.0 Conclusion

7.1 Conclusion

At a broad scale, the proposed site represents a logical extension of the Ravenswood area, particularly with its proximity to the KAC. This also fits with an extension towards the Waikuku village and the proximity to Pegasus and Woodend.

Overall, the physical aspects of the landscape suits residential development. The cultural aspects, especially the silent file area need very respectful treatment. This would also create a higher quality more appropriate living environment. Apart from this aspect, there are no other landscape factors that would unduly limit residential development.

The draft ODP shows opportunities and facilities that at this early stage of the proposal capitalise on the site and location and represent best practice urban design and site planning.

Ravenswood Waikuku Land, Waimakariri

25 November 2021

Document Information

Project

Ravenswood Waikuku Land

Address

1323 Main North Road, Waikuku

Client

Brian & Anne Stokes

Document

Graphic Attachment to Landscape Assessment Report

Status

Plan Change Application

Prepared By

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Project Number: 21346

Author: Matt Lester, Jess Mills

Peer Reviewed: Tony Milne

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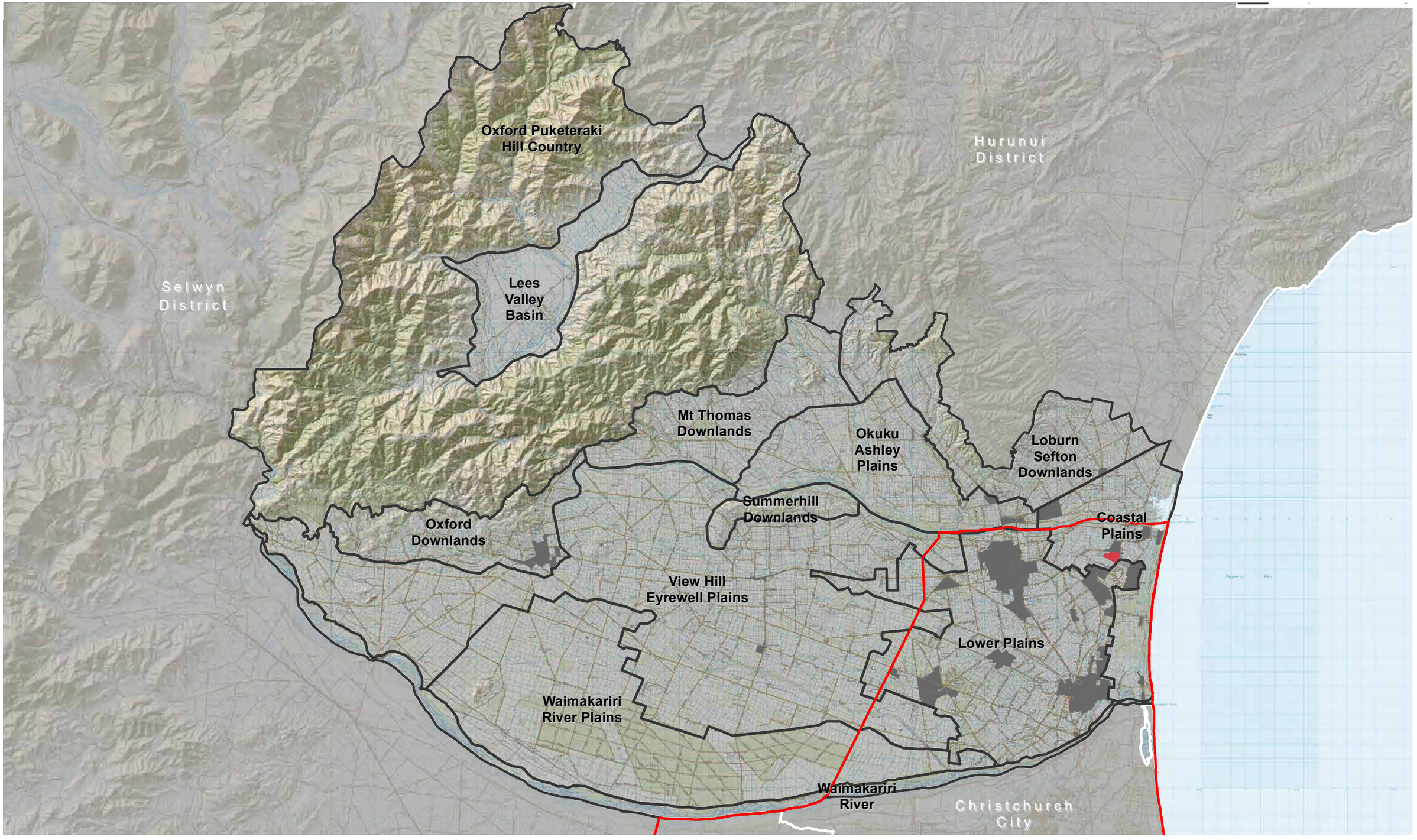
Rural Character Areas

Scale 1:250,000 @ A3

Source: Boffa Miskell - Waimakariri District Rural Character Study

Legend

The Site	Non Rural Zones
Greater Christchurch Boundary	Landscape Character Boundary



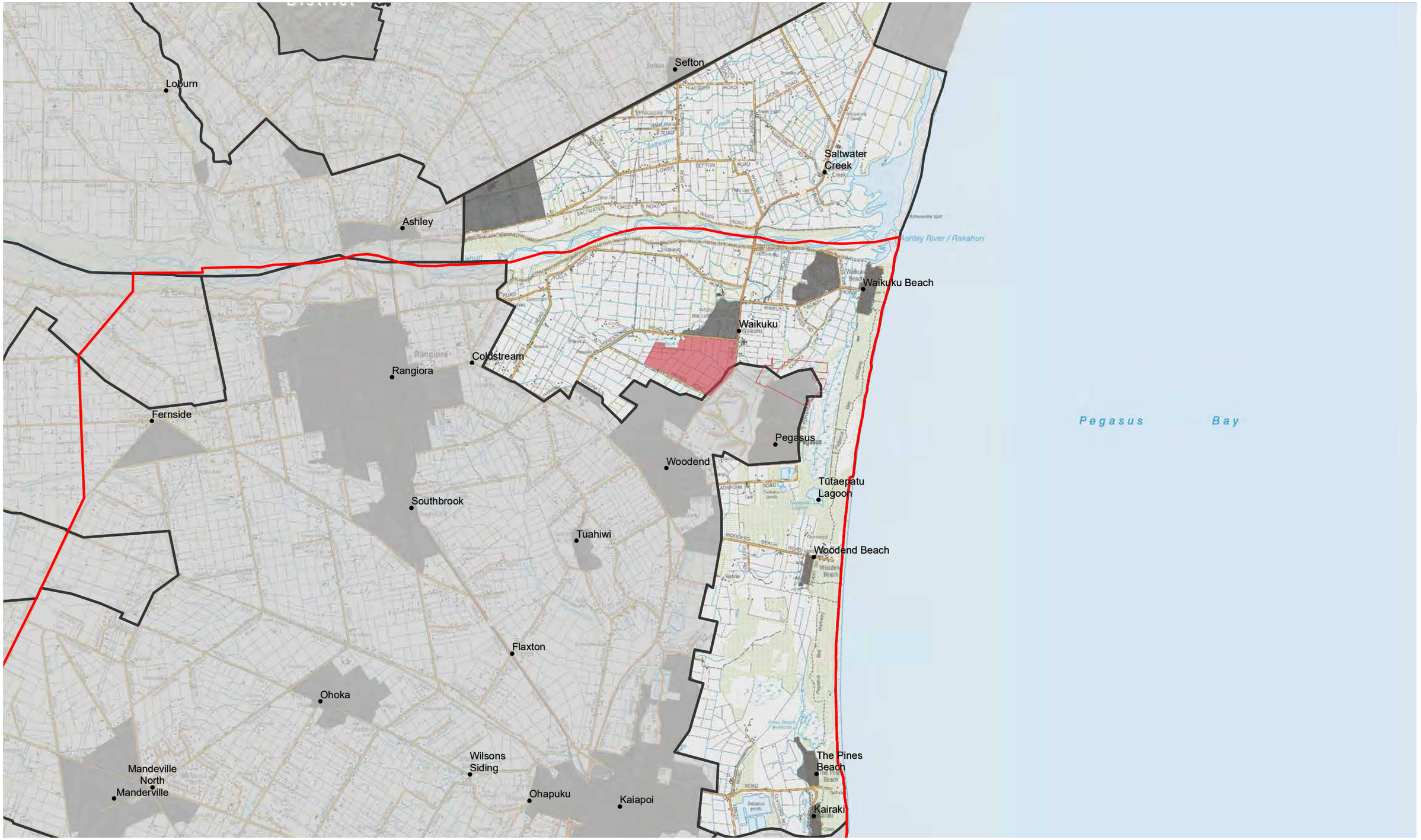
Coastal Plains Character Areas

Scale 1:75,000 @ A3

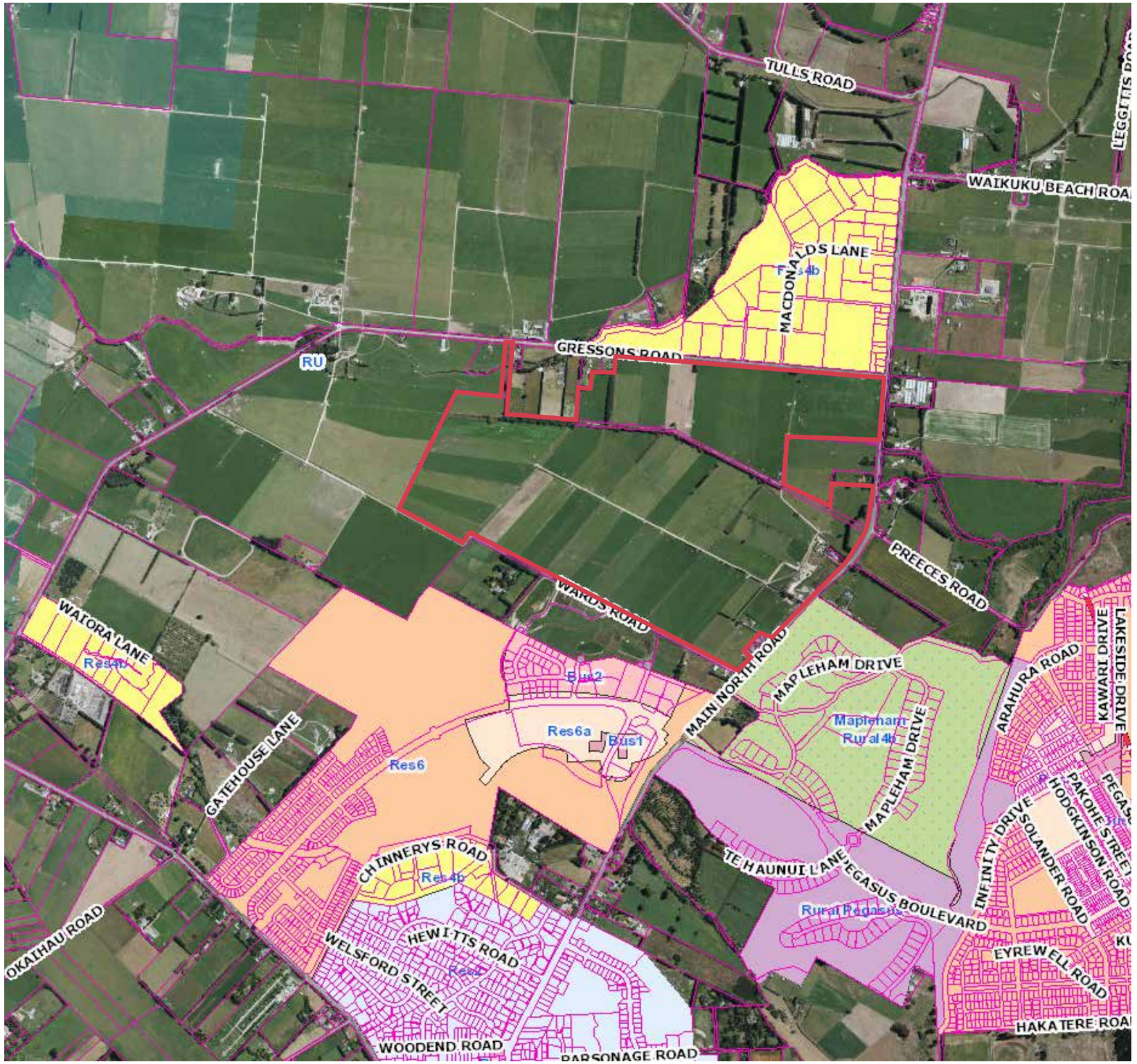
Source: Boffa Miskell - Waimakariri District Rural Character Study

Legend

The Site	Non Rural Zones
Greater Christchurch Boundary	Landscape Character Boundary



Waimakariri Zoning Plan (Operative District Plan)



Legend

- RU Zone
- Business 1 Zone
- Business 2 Zone
- Residential 6a Zone
- Residential 6 Zone
- Residential 2 Zone
- Residential 4b Zone
- Rural Pegasus
- Mapleham Rural4b Zone
- The Site

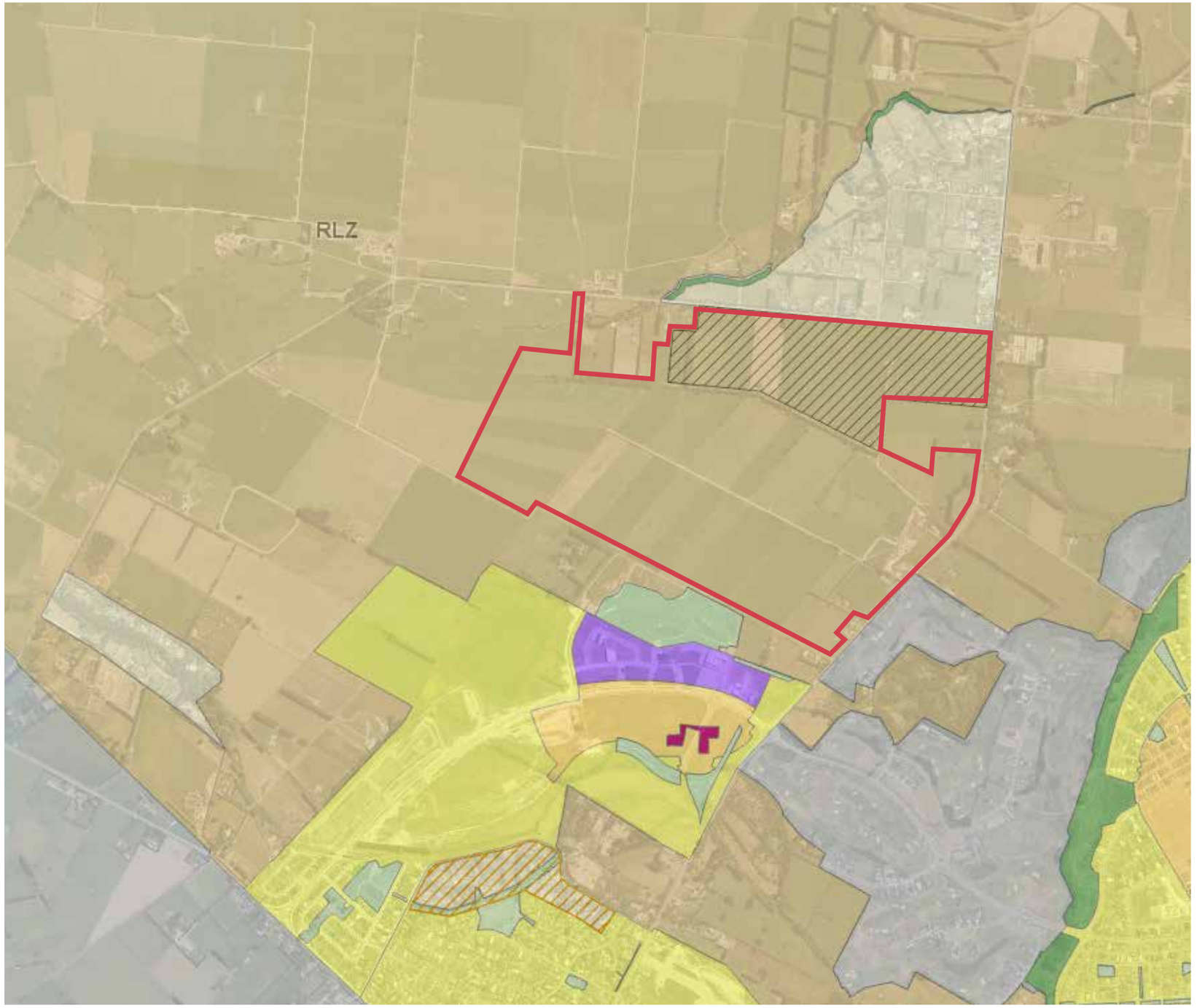
Not to Scale

Data Source: Waimakariri.isoplan.co.nz

Waimakariri Zoning Plan (Proposed District Plan)

Legend

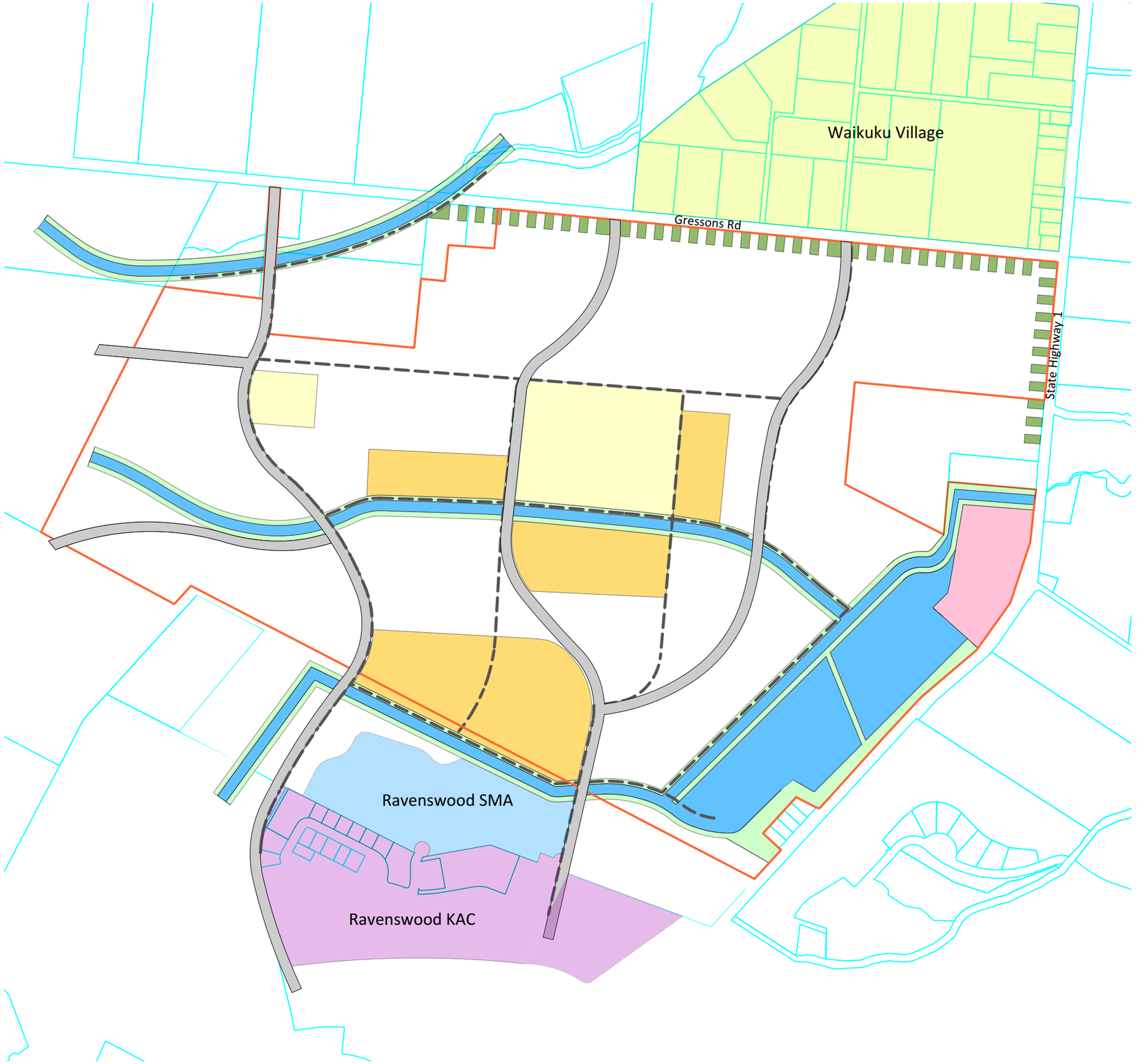
- Large Lot Residential Zone (LLRZ)
- Rural Lifestyle Zone (RLZ)
- Open Space Zone (OSZ)
- General Industrial Zone (GIZ)
- Medium Density Residential Zone (MRZ)
- Town Centre Zone (TCZ)
- SPZ (PR)
- Natural Open Space Zone (NOSZ)
- Large Lot Residential Zone Overlay
- Large Lot Residential Zone Overlay
- General Residential Zone Overlay
- The Site



Not to Scale

Data Source: Waimakariri.isoplan.co.nz

Outline Development Plan



Legend

- Proposed Plan Change Area
- Proposed Cylceway
- Proposed Major Road
- Proposed Reserve Link
- Proposed Stormwater & Flood Link
- Proposed Ngāi Tahu Reserve
- Proposed Recreation Reserve
- Proposed High Density Residential
- Proposed Open Space Buffer
- Existing Land Parcels

Scale 1:8,000 @ A3

Site Analysis and Site Photograph Location Plan

Not to Scale

Site Photographs

Site Photograph 1: Looking into the Site from the northeastern corner from Gressons Road.

Site Photograph 2: Looking south towards the western boundary from Gressons Road.

Site Photographs

Site Photograph 3: Looking into west boundary of the Site from SH1.

Site Photograph 4: Looking over Pegasus Golf Course and houses from SH1.

Site Photographs

Site Photograph 5: Looking into the Site from south on Wards Road.

Site Photographs

Site Photograph 6: Looking over rural land to east of the Site from SH1.

Site Photograph 7: Looking into large lot residential area from Gressons Road.

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APPENDIX 4

ELLIOT SINCLAIR – GEOTECHNICAL ASSESSMENT (2020)

Geotechnical Report

81 Gressons Road and 1375 Main North Road, Waikuku

Prepared for Northside Country

350494

eliot sinclair

Geotechnical Report

81 Gressons Road and 1375 Main North Road, Waikuku

Prepared for Northside Country

350494

Quality Control Certificate

Eliot Sinclair & Partners Limited

eliotsinclair.co.nz

Action	Name	Signature	Date
Prepared by:	Jeffrey Fleming Geotechnical Engineering Technician NZDE Civil MEngNZ		27 November 2020
Directed and approved for release by:	John Aramowicz Director, Civil/Geotechnical Engineer BE(Hons), CMEngNZ, CPEng, IntPE(NZ		27 November 2020
Status:	Final		
Release date:	27 November 2020		
Reference no:	350494		
Distributed to:	Northside Country		

Limitations

This report has been prepared for Northside Country according to their instructions and for the particular objectives described in this report. The information contained in this report should not be used by anyone else or for any other purposes.

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Appendix A. Aerial Photo

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Appendix C. Topographical Survey

Appendix D. CPTu Test Location Plan

Appendix E. CPTu Test Results

1. Introduction

Eliot Sinclair have been engaged by Northside Country to undertake a geotechnical investigation and report at 81 Gressons Road and 1375 Main North Road to inform a proposed zone change from rural to rural-residential land use. The site is legally described as Lot 2 DP 428676, Lots 2-3 DP 62186, Lot 2 DP 303387, Lot 1 DP 470921 and Pt RS 3101.

Eliot Sinclair have previously completed a Geotechnical Report for the Proposed Subdivision dated 29 October 2012. We have carried out a further site visit on 10 November 2020 and reviewed the geotechnical data available for the site, and have updated our assessment of the liquefaction hazard at the site.

2. Scope of Work

The scope of work for this geotechnical assessment of the proposed zone change was;

- Review published geology,
- Review Environment Canterbury's database for nearby bore log data,
- Review of GNS Science's strong motion data for 4 September 2010 and 22 February 2011 earthquakes,
- Review the New Zealand Geotechnical Database,
- Reanalyse the 11 X cone penetration tests carried out in 2012 using the results of on-site groundwater monitoring records,
- Summarise the results of the geotechnical analysis, in this report and to provide geotechnical recommendations for the proposed rezoning.

3. Disclaimer

Comments made in this geotechnical report are based on a detailed site inspection undertaken in July 2012, a further site inspection on 10 November 2020, published geological and bore log information, CPTu testing, and assessment of the risk of liquefaction due to seismic shaking.

Whilst every care was taken during our investigation and interpretation of subsurface conditions, there may well be subsoil strata and features that were not detected. Additionally, on-going seismicity in the general area may lead to deterioration or additional ground settlement that could not have been anticipated at time of writing of this report.

The exposure of such conditions, or occurrence of additional strong seismicity, may require a review of our recommendations.

This report has been prepared for the benefit of Northside Country, and the Waimakariri District Council. No liability is accepted by this company or any employee of this company with respect to the use of this report by any other party.

4. Rezoning Proposal

The site is legally described as Lot 2 DP 428676, Lot 2 DP 62186, Lot 2 DP 303387, Lot 3 DP 62186, Lot 1 DP 470921and Pt RS 3101 (paper road, 0.7852 ha) and totals approximately 34.2 hectares.

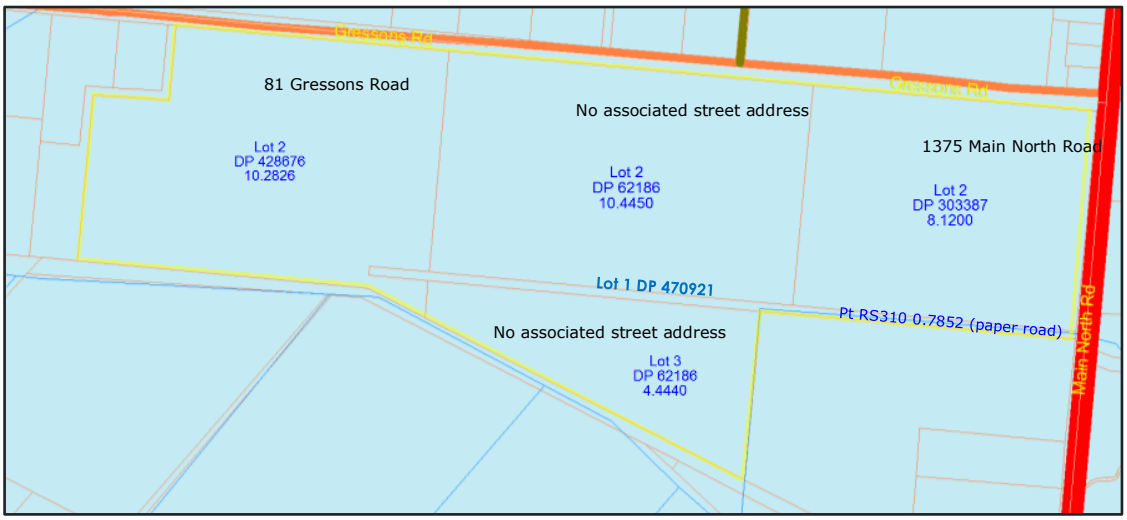


Figure 1: Site location plan (Source LINZ database)

It is proposed to rezone the site situated on the corner of Gressons Road and Main North Road, Waikuku, from rural to rural-residential land use.

Refer to Appendix A and Appendix B.

5. Site Description

5.1. Engineering Geology

GNS's geological map[1] notes the site being underlain by '*Grey river alluvium comprising gravel, sand and silt in active floodplains*'.

'The vast expanse of the Canterbury Plains comprises coalesced floodplains. Large parts of the plains are abandoned braided river floodplains, last occupied during the LGM (last glacial maximum'.

[1] Forsyth, P.J., Barrell, D.J.A., Jongens, R. (compliers) 2008 Geology of the Christchurch area. Scale 1:250 000. Institute of Geological & Nuclear Sciences geological map 16. 1 sheet + 67p. Lower Hutt, New Zealand. GNS Science.

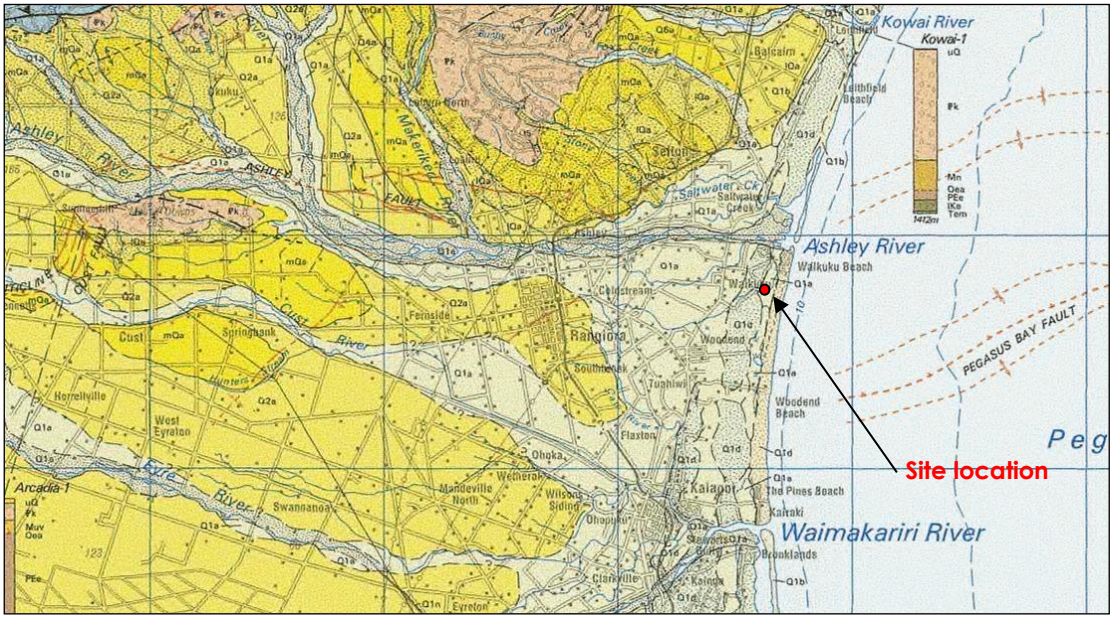


Figure 2: Geological Map of Christchurch.

5.2. Existing bore hole data

Bore log records from the Environment Canterbury (ECan) GIS system were reviewed to determine typical subsoil geology of the general area.

Well M35/6353, located on the western boundary of Pt Lot DP 57114 encountered '*sandy* silt' to 4m, '*grey pug with some vegetation*' to 12.5m, '*sand*' to 15m overlying '*sandy* gravel' to at least 16m depth where the well terminated.

Well M35/7340, located approximately 25m north of the site along Gressons Road, encountered '*clay*' to 3m, multiple layers of '*pug*' and '*gravel*' to 14.3m, '*pug and sea shells*' to 20m overlying gravels to at least 23m depth where the well terminated.

Well M35/7197, located approximately 355m west of Lot 1 DP 62186 encountered '*claybound*' and '*sandy* gravels' to 5m, '*sandy pug with* gravels' to 21m, '*black clay*' to 25m overlying '*gravel*' to at least 41m depth below ground level.

Well M35/6176, located approximately 22m from the southern boundary along Main North Road (SH1), encountered '*clay*' to 3m, '*sand & some small gravels*' to 14m, '*peat*' to 20m, overlying '*gravels*' to at least 23m depth below ground level where the well was terminated.

5.3. Topography

The site is located on the corner of Gressons Road and Main North Road. The site topography is flat.

Photograph 1: The southeast corner of the site looking west, showing the flat topography across the site. (November 2020)

5.4. Drainage

An open drain is located along the west and south boundaries of the site, and is piped in places.

Photograph 2: The large drain situated on the neighbouring property, south of the site. (July 2012)

5.5. Vegetation

The site is vegetated in grass, with shelterbelts located in the western part of the site.

Photograph 3: The west end of the site looking northeast. (November 2020)

5.6. Buildings

There are no buildings within the area of the proposed subdivision.

A residential dwelling is located at the adjacent property at the northwest corner of the site.

5.7. 2010/2011 Canterbury Earthquakes

The M7.1 Darfield earthquake on 04 September 2010 occurred on a previously unknown (Greendale) fault, producing peak horizontal ground accelerations of 0.21g and 0.41g at Ashley School and Kaiapoi North School respectively. Whilst the earthquake resulted in liquefaction within the soft alluvial soils predominantly across eastern Christchurch and some areas of Kaiapoi, we understand that there was no liquefaction identified areas on or around the site.

The subsequent M6.3 aftershock on 22 February 2011, located near Lyttleton/Heathcote, produced peak horizontal ground accelerations of 0.09g at Ashley School and 0.23g at Kaiapoi North School.

Table 1 Comparison of peak horizontal ground accelerations close to site.

PGA (horizontal)	SLS (1/25, M7.5)	ULS (1/500, M7.5)	04 Sept 2010[2] (M7.1)	22 Feb 2011[3] (M6.3)
Current design pga	0.13g	0.35g		
Ashley School			0.21g	0.09g
Kaiapoi North School			0.41g	0.23g

5.8. Technical Land Category

This site has not been classified by CERA, as it is deemed rural /NA.

The site is located within the area of "liquefaction susceptibility" shown on the Waimakariri District Council's *'Natural Hazards Liquefaction Susceptibility Map'*, dated 19 May 2016.

6. Site Investigation

6.1. CPTu Testing

Eleven cone penetration tests with measurement of pore water pressure (CPTu) were undertaken across the site in 2012. Refer to Appendix E.

These test results generally indicate the presence of interbedded sand, sandy silts, and silty clays throughout the profile.

CPTu testing met practical refusal at 2.6 to 20m depth across the site, most likely on a dense sand or sandy gravel. Shallow refusal at CPTu's 1, 3, 4, 7, 8, 10 and 11 is likely to have occurred within an upper layer of gravelly sand. Refer to Appendix E.

It appears that there is a layer of sandy gravel located around 2-4m below ground level across the site, roughly in a southwest-northeast orientation. It is likely that this is an historic paleochannel, with overbank deposits to the northwest and southeast.

6.2. Groundwater

Pore water pressure measurements at the time of the CPTu testing indicated inferred groundwater at around 3 to 4m below ground level.

Subsequent to this, Eliot Sinclair installed 7 standpipes across the site in July 2013 and then monitored ground water levels monthly between July 2013 to September 2017. Our monitoring records indicate the highest ground water level occurs in winter and spring when the ground water level rises to between 1m to 2m below ground level across the site.

[2] Darfield (Canterbury) earthquake strong motion data, GNS Science, 04 September 2010.

[3] Christchurch earthquake strong motion data, GNS Science, 22 February 2011.

Potentially, the highest groundwater monitoring data is not accurate and there may have been water (or rainfall) infiltration into the standpipes giving a false result. It was noted that during some monitoring periods, especially after rainfall some wells indicated a groundwater near the surface while other suggested it was 1 m bgl. It is considered that the 15th and 85th percentile groundwater records should be used for groundwater depth measurements. The average annual groundwater depth across the full site is 1.10 m bgl.

6.3. Site investigation density

The Ministry for Business, Innovation and Employment released their 'Planning and engineering guidance for potentially liquefaction-prone land' in September 2017.

The new guidelines set out typical requirements for geotechnical investigations, assessment and reporting primarily for Plan Change and Subdivision Consent applications.

Our assessment for the site was based on a Level C detailed area-wide assessment. The guidelines suggest that between 0.1 to 4 deep ground test/investigation locations be undertaken per Ha for adequate ground characterisation for liquefaction assessments to inform planning and consenting processes. Our CPTu testing special density across the site the site is equivalent to 0.3 tests per Ha. The testing undertaken across the site included:

- Cone penetrometer testing with pore water pressure measurement at eleven (11) locations across the site, down to 2.5 to 20m depth.

We consider the results of the deep site investigation, along with supporting information from geological maps, records shown on the New Zealand Geotechnical Database, and Environment Canterbury well logs, provide sufficient evidence of the underlying ground conditions and the risk of natural hazards at this site to inform this report which is advises on the geotechnical suitability of the site for rural-residential land use.

7. Liquefaction Assessment

7.1. Methodology

Following the most recent version of MBIE's guidelines and Supplement Issue 7, the calculation of liquefaction triggering was undertaken using the method by Boulanger and Idriss (2014)[4] and the estimation of post-liquefaction induced settlements using the method by Zhang et al (2002)[5].

The peak ground accelerations used for liquefaction assessment were $PGA_{6.0}$ = 0.19g and $PGA_{7.5}$ = 0.13g for the serviceability limit state (SLS) event, and $PGA_{7.5}$ = 0.35g for an ultimate limit state (ULS) event.

For the purpose of this assessment, the depth to groundwater for liquefaction assessment was conservatively assumed to be 1m below existing ground level.

[4] Boulanger, R. W. and Idriss, I. M. (2014). CPT and SPT based liquefaction triggering procedures (Report No. UCD/CGM-14/01), University of California, Davis, CA, 134 p.

[5] 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.

7.2. Liquefaction-Induced '*Index*' Settlement

Liquefaction-induced 'index' settlements were calculated using CLiq[6] software, with the results summarised in table 2. The vertical 'index' settlements were calculated using the method by Zhang et al (2002) using the four basic CPT parameters (depth, cone tip resistance, skin friction and pore water pressure). Reported settlements are 'index' values that indicate relative susceptibility to liquefaction and free-field ground surface settlement.

The analysis indicates that in an SLS earthquake event the silty sands and sands typically located between around 3 to 6m bgl would liquefy, but the near-surface clay and silty clay-like soils would generally not liquefy. In a ULS earthquake the clay silts and sands between 1m to 10m bgl are expected to liquefy at various depths.

Where CPTu testing met practical refusal at shallow depth, estimation of liquefaction risk and settlements will not have taken the presence of deeper soil layers into account.

Please refer to the CPT data, Liquefaction Analysis and the Summary of Liquefaction Hazard in Appendix E.

Test No.	Depth of CPTu test	Results of liquefaction analysis (mm)						
		SLS1 (M6.0, 0.19g)		SLS2 (M7.5, 0.13g)		ULS (M7.5, 0.35g)		Assessed Technical land Category
		Index	LSN	Index	LSN	Index	LSN	
CPTu01	3.9m*	3	1	2	1	7	4	TC1
CPTu02	14.7m	66	22	43	10	101	38	TC2
CPTu03	12.7m	55	12	42	8	76	20	TC2
CPTu04	2.4m*	3	2	1	1	10	7	TC1
CPTu05	20.0m	39	12	28	7	58	23	TC2
CPTu06	18.0m	56	17	41	10	63	21	TC2
CPTu07	4.3m*	10	6	4	2	19	11	TC1
CPTu08	3.2m	1	1	0	1	2	2	TC1
CPTu09	18.1m	79	18	67	12	94	24	TC2
CPTu10	4.0m*	5	3	3	1	13	8	TC1
CPTu11	2.6m*	6	5	1	1	26	18	TC1

Table 2 - Liquefaction-induced '*index*' settlement (mm) – Limited to the upper 10m of soils.

[6] CLiq (version 2.2.0.37). (2006). Computer software. Serres, Greece: GeoLogismiki.

*CPT testing terminated prematurely and did not reach 10m bgl, therefore these values may not completely reflect the geotechnical conditions that exist deeper down.

7.3. Liquefaction Severity Number (LSN)

The liquefaction severity number (LSN) is a parameter developed to reflect the more damaging effects of shallow liquefaction on residential land and shallow foundations[7]. Calculation of the LSN is limited to 10m bgl. The estimated LSN values are summarised in Table 3.

Table 3: Maximum LSN

Event	Typical Maximum LSN Assessed for CPT 1-11	Predominant performance
SLS	10 - 20	'Minor expression of liquefaction'
ULS	20 -30	'Moderate expression of liquefaction'

7.3.1. Serviceability limit state, SLS

LSN values of between 0 to 20 were calculated, which suggest only minor expression of liquefaction would occur in an SLS event. This is consistent with either TC1 or TC2 land.

7.3.2. Ultimate limit state, ULS

LSN values around 20-30 were calculated for an ULS earthquake. This is consistent with TC2 land.

7.3.3. Actual Damage

We did not observe any visual evidence of liquefaction or lateral spreading across the site in our July 2012 site inspection, although we note that our inspection occurred around 20 months after the September 2010 earthquake, and it is likely that any visual evidence of ground damage across the paddocks, if present, may have been obscured by grass.

There was no obvious ejection of groundwater or sediment across the site in aerial photography taken soon after the September 2010 M7.1 earthquake.

The road surface of Gressons Rd and SH1 were in relatively good condition for their age at our site visit in 2012, and we did not observe any unusual settlement, slumping or heaving of the road surface that may have indicated the occurrence of shallow liquefaction.

7.4. Lateral spreading

The Waikuku Stream is located around 150m north of the site. The topography of the site is flat, and there are no steep slopes or banks across the site or surrounding area. Therefore, lateral spreading in an SLS event is not likely to affect the future subdivision.

While there is an open drain along the south boundary of the site, the risk of lateral stretch to nearby building platform can be addressed by adopting TC2- type foundation systems that are designed with sufficient tensile capacity to avoid rupture if lateral spread ever occurred.

[7] Tonkin & Taylor's (T&T) report '*Liquefaction Vulnerability Study*', February 2013, T&T Ref: 52020.0200/v1.0

8. Natural Hazards

8.1. Falling debris

The site is flat, and not close to any steep slopes, and is therefore not at risk of falling debris due to rock fall/roll.

8.2. Landsliding

The site is flat, and not close to any steep slopes, and therefore is not at risk of land damage due to landsliding.

8.3. Tsunami

The site is **not** located within a Canterbury Tsunami Evacuation Zone[8] *"No zone: Tsunami flooding is not expected, even in a very large tsunami"*.

8.4. Earthquake rupture

We have searched GNS's Active Faults database[9] to determine the presence of any known active faults in the general locality. The Loburn Fault is located approximately 4.5km northwest of the site. Based on available data the site is likely to be located outside the minimum 20m fault avoidance zone recommended by the Ministry for the Environment[10].

While the site is not affected by active faulting, it is important to acknowledge that New Zealand is a seismically active country.

These risks are considered by various New Zealand standards, the New Zealand Building Code, various Ministry guidelines, and the Council's design standards. Providing design and construction work is undertaken in accordance with the appropriate standards and guidelines then the risk to life and property can be kept to an acceptable low level.

[8] https://ecan.maps.arcgis.com/apps/Minimalist/index.html?appid=591062afb6b542abb247cc8d15a64855

[9] https://data.gns.cri.nz/af/

[10] Planning for Development of Land on or Close to Active Faults: A Guideline to Assist Resource Management Planners in New Zealand (Published July 2003).

8.5. Inundation from the Ashley River

There are no topographical features that concentrate stormwater onto the site.

The *'Waimakariri District flood planning hazard management strategy Ashley River floodplain*[11]*'* indicates that the site is not at risk at from the Ashley River Floodplain for a 0.5% AEP (200 year return period) event.

The Waimakariri District Natural Hazards Interactive viewer shows the site is generally at very low risk of flooding for the 1 in 200 year return period. Parts of the southeast corners of the site are at low to medium risk.

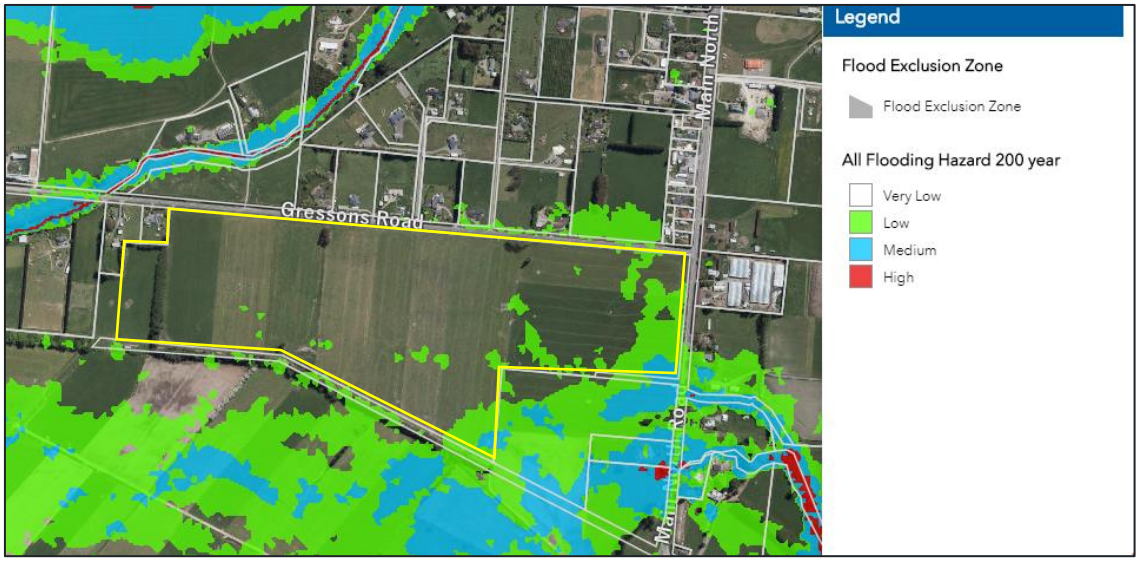


Figure 3 Waimakariri District Natural Hazards Interactive Viewer, retrieved Nov 2020.

8.6. Erosion

The site is flat, and there are no large watercourses or rivers close to the site. There is a small watercourse along the southern boundary, however this does not carry large flows of stormwater. Therefore, the site is not likely to be subject to erosion. Further, the site is almost entirely located outside of the area of risk of inundation from the Ashley River Floodplain, and therefore erosion is not likely.

8.7. Stormwater from developed site

There is no piped stormwater system along Gressons Rd or SH1.

Concentrations of roof and surface stormwater will almost certainly require onsite treatment and attenuation before discharge either to ground or an existing waterway.

We note that subdivision and future residential construction on the lots will tend to increase the rate of stormwater runoff from the site and therefore the stormwater design will need to take into account the risk of inundation to adjacent and downstream property, and provide attenuation before discharge to surface waterways.

11 Waimakariri District, flood hazard Management Strategy, Ashley River Floodplain Investigation, Report No. R08/23, June 2008, Environment Canterbury.

8.8. Subsidence (Liquefaction)

Geotechnical testing and analysis indicates the site is at low risk of damage to shallow building foundations in a serviceability limit state event (7.5, 0.13g), and a moderate risk of damage to building foundations in a ultimate limit state event (M7.5, 0.35g). Refer to Section 7: Liquefaction Assessment.

Based on the calculated index settlements and LSN values, with ground water at 1m bgl, we conclude the site should be considered equivalent to TC2.

9. Requirements for Residential Foundations

Based on our site assessment and review of geotechnical information for the site, future residential buildings located over undisturbed natural ground are likely to require TC2 foundations. Site-specific geotechnical investigation, assessment and foundation design will be required as part of the normal building consent requirements once the nature and location of the proposed buildings has been established.

10. Conclusions

Eliot Sinclair has completed a geotechnical desktop investigation, liquefaction analysis and review of relevant geotechnical, topographic data and Council records that relate to the site and wider area.

While further assessment and consideration will need to be given to inundation and the need for site specific foundation requirements for buildings. This will be part of the standard geotechnical requirements, including Section 106 of the RMA, for future subdivision consents. There are no significant geotechnical constraints that would prevent the re-zoning of the land.

In summary, in accordance with the recommendations set out in this report, we consider the site is geotechnically suitable for residential development.

Appendix A. Aerial Photo

Photo 1: Aerial Photo of site and surrounding land (source: Google Earth, Image January 2019

Appendix B. Proposed Scheme Plan

DRAFT

GRESSONS ROAD Collector Road - see WDC Planning Map 135 - Road Hierarchy

MAIN NORTH ROAD (STATE HIGHWAY) (Limited Access Road)

LEGAL ROAD

UNFORMED LEGAL ROAD

PREECES ROAD

Lot 1 DP 428676

61 Pedestrian Accessway 1422m²

1 5027m² 2 4437m² 3 5038m² 4 4662m² 5 5058m²

6 5001m² 7 2970m² 8 3102m² 9 4026m² 10 3227m² 11 3036m² 12 5001m²

13 4669m² 14 4650m² 15 4886m² 26 7987m²

63 Road to vest in Waimakariri District Council 112m²

43 5513m² 44 3192m² 45 2739m² 46 3340m² 47 2672m² 48 3273m² 49 3006m² 50 3230m²

51 5087m² 52 3424m² 53 4556m² 54 3268m² 55 4712m² 56 3192m² 57 5087m²

16 4986m² 17 4805m² 18 5054m²

42 4317m² C 133m² B 133m² 39 3148m²

60 Road to vest in Waimakariri District Council 2.7271ha

59 Stormwater Detention Basin 1.4926ha

41 5881m² 40 5558m² 38 6494m² 37 6732m² 36 6503m² 35 6881m² 34 8018m² 33 7075m² 32 6862m² 31 7293m²

23 3287m² 22 5561m² 21 4756m² 20 6207m² 19 7248m²

Stormwater Easement

Stormwater (Open Drain)

A 1679m²

24 4541m² Easement 4.0 metres wide

Pt R S 3101

Land subject to Claim by Adverse Possession defined on LT 470921 - 935m²

Possible Future Road

30 9982m² 29 6857m² 28 4166m² 27 7070m² 25 7691m²

62 Stormwater Detention Basin 8061m²

Pt R S 3101

Pt R S 3101

Pt R S 3101

Lot 2 DP 428676

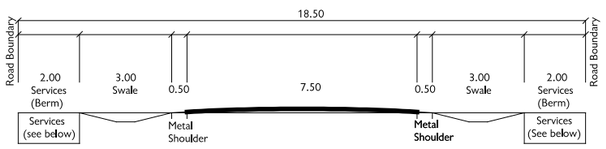
Lot 2 DP 62186

Lot 2 DP 303387

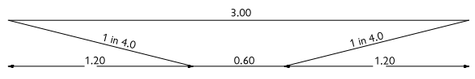
NOTES

All roads are 18.50 metres wide.

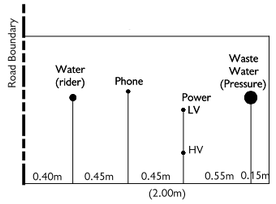
Piped Stormwater Easements are 2 metres wide unless shown otherwise



TYPICAL ROAD CROSS SECTION
Scale 1:100



TYPICAL SWALE CROSS SECTION
Scale 1:20



SERVICES LOCATION
Scale 1:5

no.	amendment	initial	date
A	Lot 61 added - pedestrian access, swale moved across, note re bnd in LT 470921	rksg	25.6.14
B	Road widened to 18.5m and revised Road Cross Section added	rksg	24.7.14
C	Stormwater amended - two ponds . Lot 26 cnr SH 1 and Gressons. Lot 58 removed	rksg	18.8.14
D	Possible Future Road added to Lot 27	rksg	

designed Bob Greening
manager Bruce Sinclair
drawn Bob Greening
checked

surveyed Roger Claessens
surv.date Feb 2014

origin of levels UA 87
Main North Road (SH1) RL 6.271
LINZ Dec 2013
datum Lyttelton 1937 post Dec 2013

Projection NZGD 2000
Circuit Mount Pleasant 2000

Scale: 1:2000 (A1) 1:4000(A3)
Date: 20/3/2014

Drawing Set 350494 C4
PLOT 350494 C4 140312.PDF

Sheet 1 of 1
rev D

Eliot Sinclair
surveyors | engineers | planners

20 Troup Drive, PO Box 9339, Tower Junction, Christchurch 8149, Phone: 03 379-4014, Fax: 03 365-2449, info@eliotsinclair.co.nz
www.eliotsinclair.co.nz

Proposed Subdivision of 81 Gressons Road and 1375 Main North Road (SH1), Waikuku (Lot 1 LT 470921, Lots 1 and 2 DP 428676, Lots 2 and 3 DP 62186 and Lot 2 DP 303387 for Northside Country

[plotted: Wednesday, September 10, 2014 11:26:22] [computer operator: rksg] [Project: G:\Jobs\35\350494\12d\SURVEY\RCON\Proposed Subdivision Gressons Road Waikuku\Proposed Subdivision Gressons Road Waikuku]

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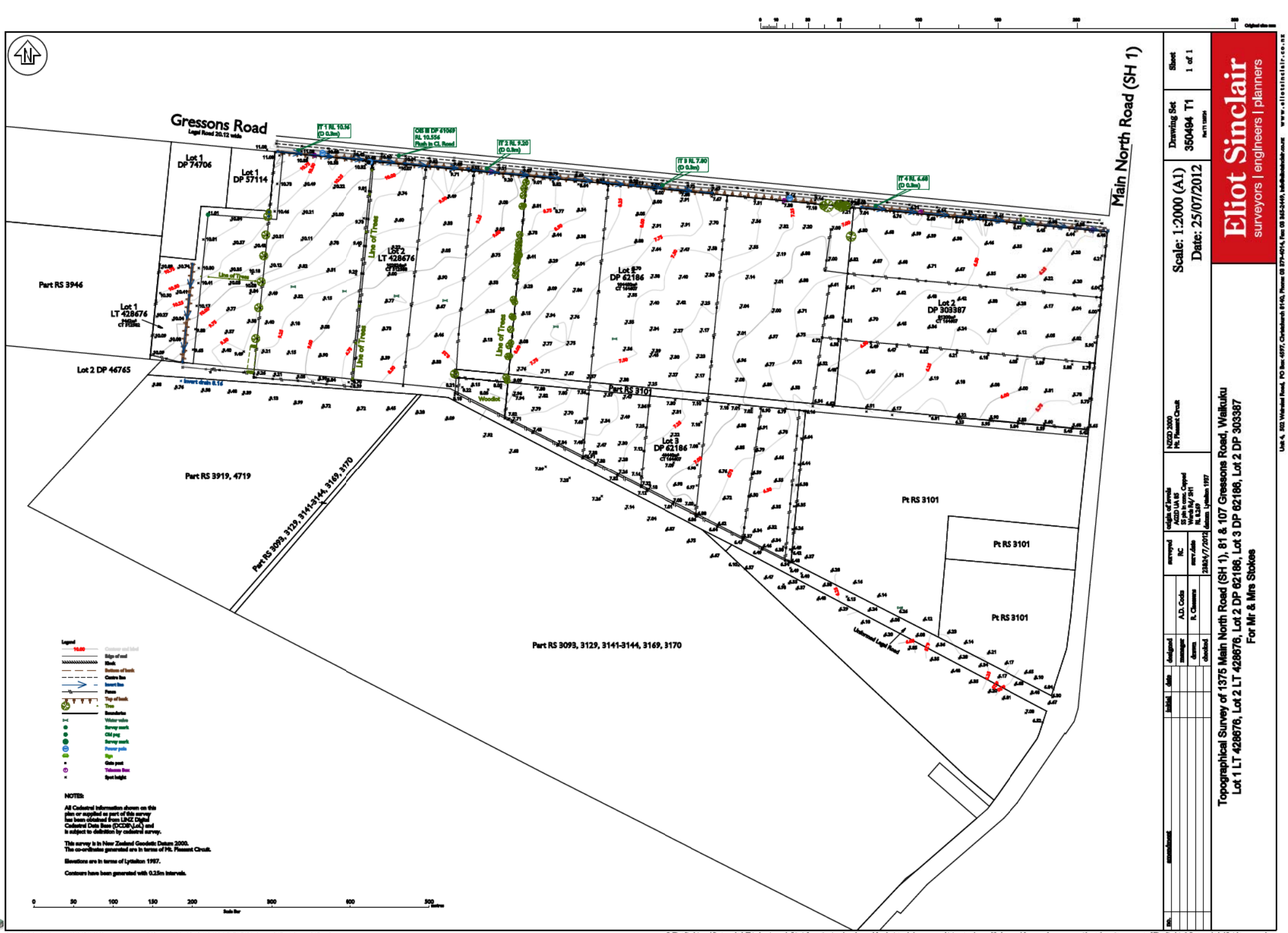
Appendix C. Topographical Survey



Sheet 1 of 1

Drawing Set 350494 T1

Scale: 1:2000 (A1)
Date: 25/07/2012

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www.eliotsinclair.co.nz

Unit 4, 502 Wairakei Road, PO Box 4577, Christchurch 8140, Phone 03 379-4014, Fax 03 342-2449, info@eliotsinclair.co.nz

NZGD 2000
Mt. Pleasant Circuit

origin of levels
PM 60 on NE kerb of Legge/Wairakei Rds SW
RL 8.369
datum: Lyttelton 1937

surveyed RC
A.D. Cocks
R. Claassens
checked

rev	date	amendment
	23/24/7/2012	

Topographical Survey of 1375 Main North Road (SH 1), 81 & 107 Gressons Road, Waikuku
Lot 1 LT 428676, Lot 2 LT 428676, Lot 2 DP 62186, Lot 3 DP 62186, Lot 2 DP 303387
For Mr & Mrs Stokes

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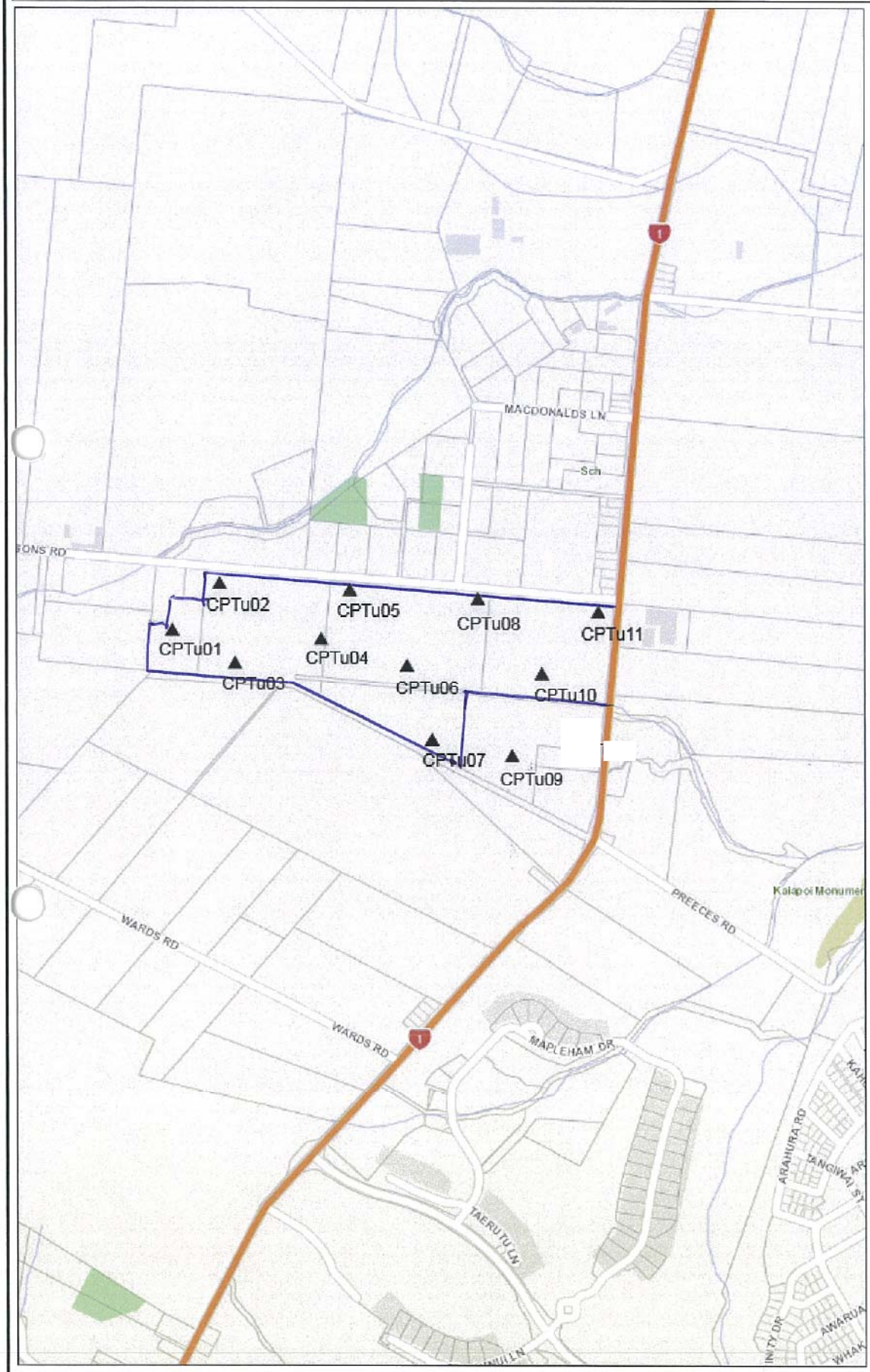
Appendix D. CPTu Test Location Plan

CPTu Location Map

Date Printed: 22 June 2012



Legend

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

THIS MAP IS NOT TO BE USED FOR NAVIGATION

SCALE 1: 14,189

0.4 0 0.4 Miles

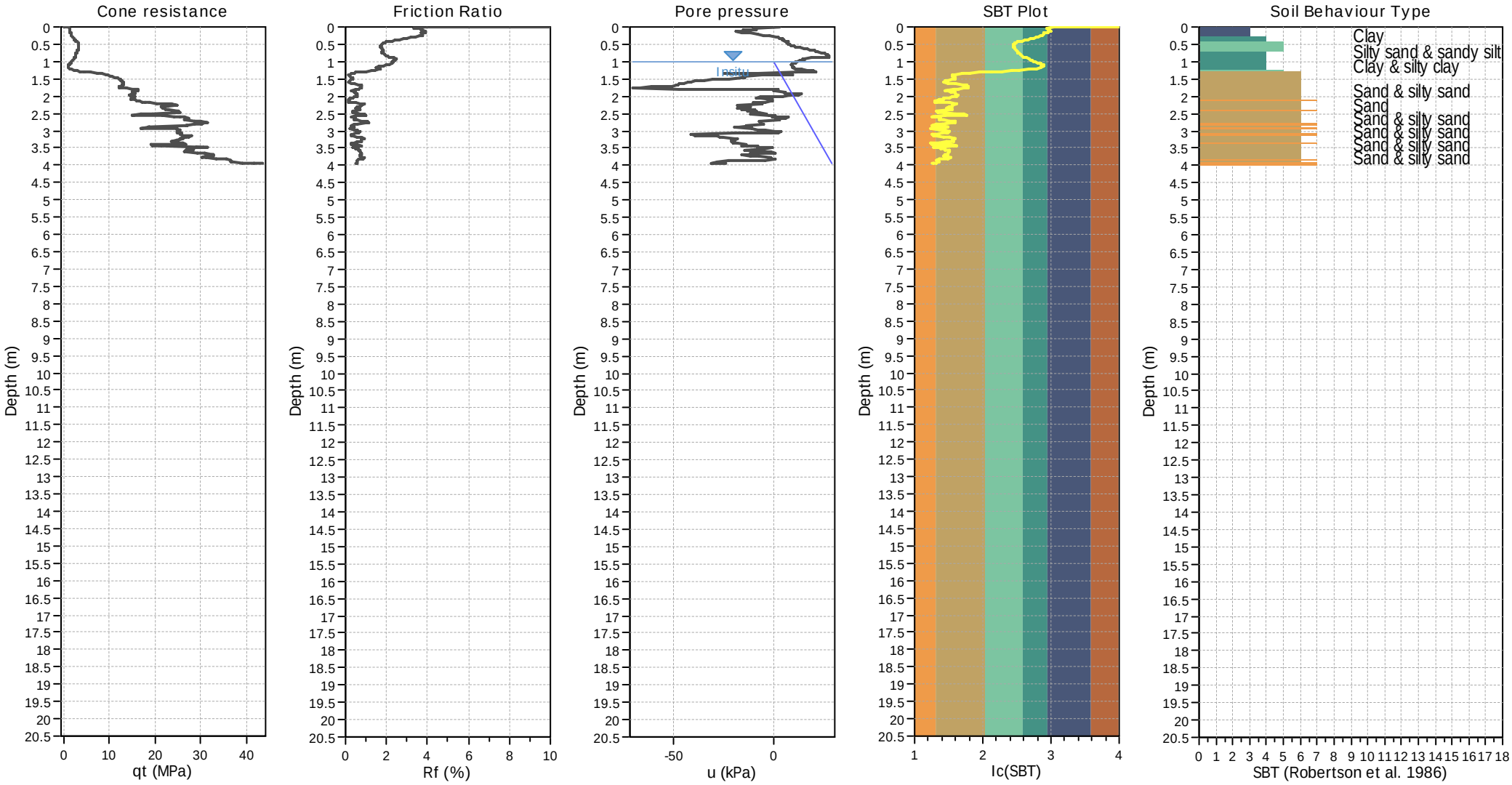
Projection: NZGD_2000_New_Zealand_Transverse_Mercator

New Zealand Government

Appendix E. CPTu Test Results

CPT basic Interpretation Plots

CPT basic interpretation plots



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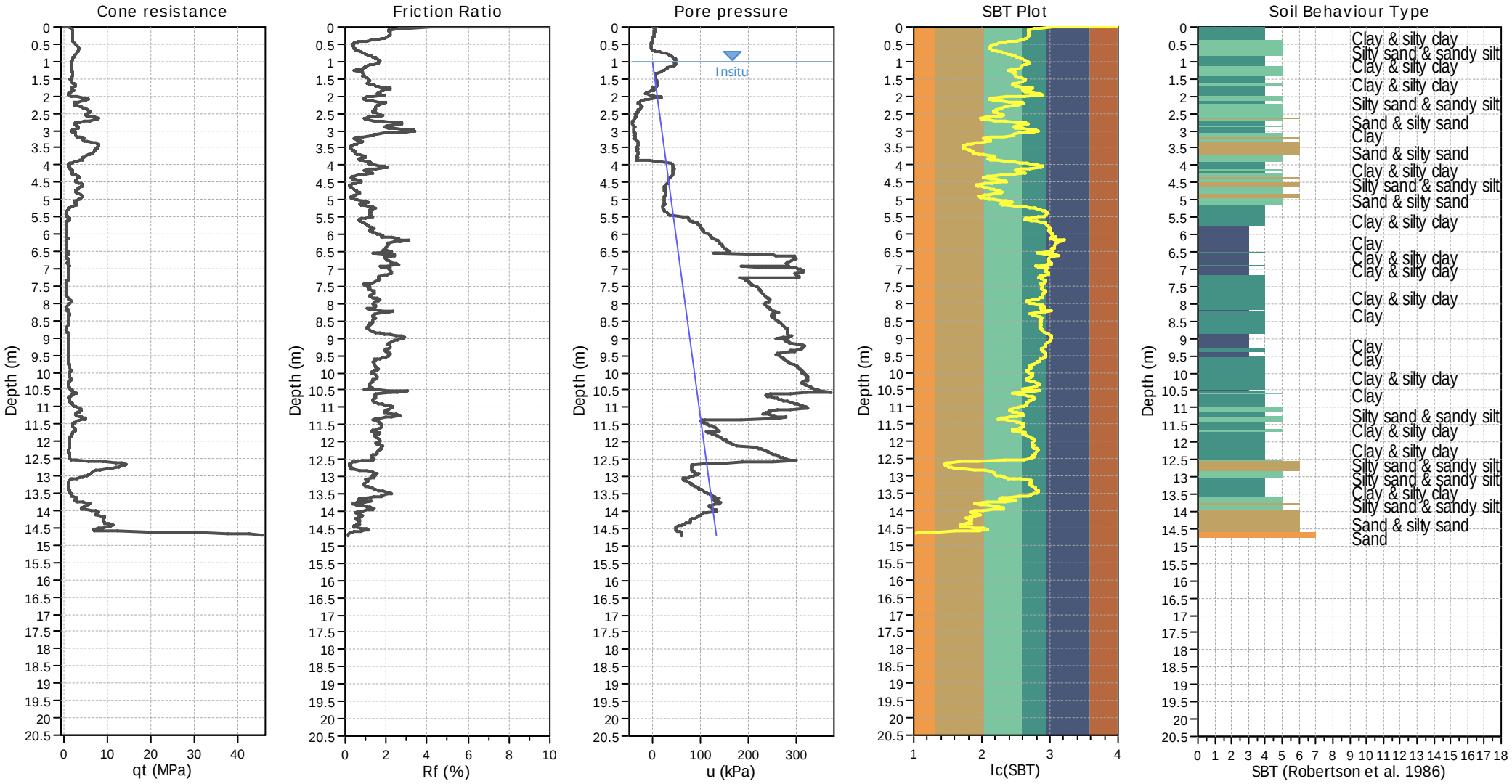
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
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Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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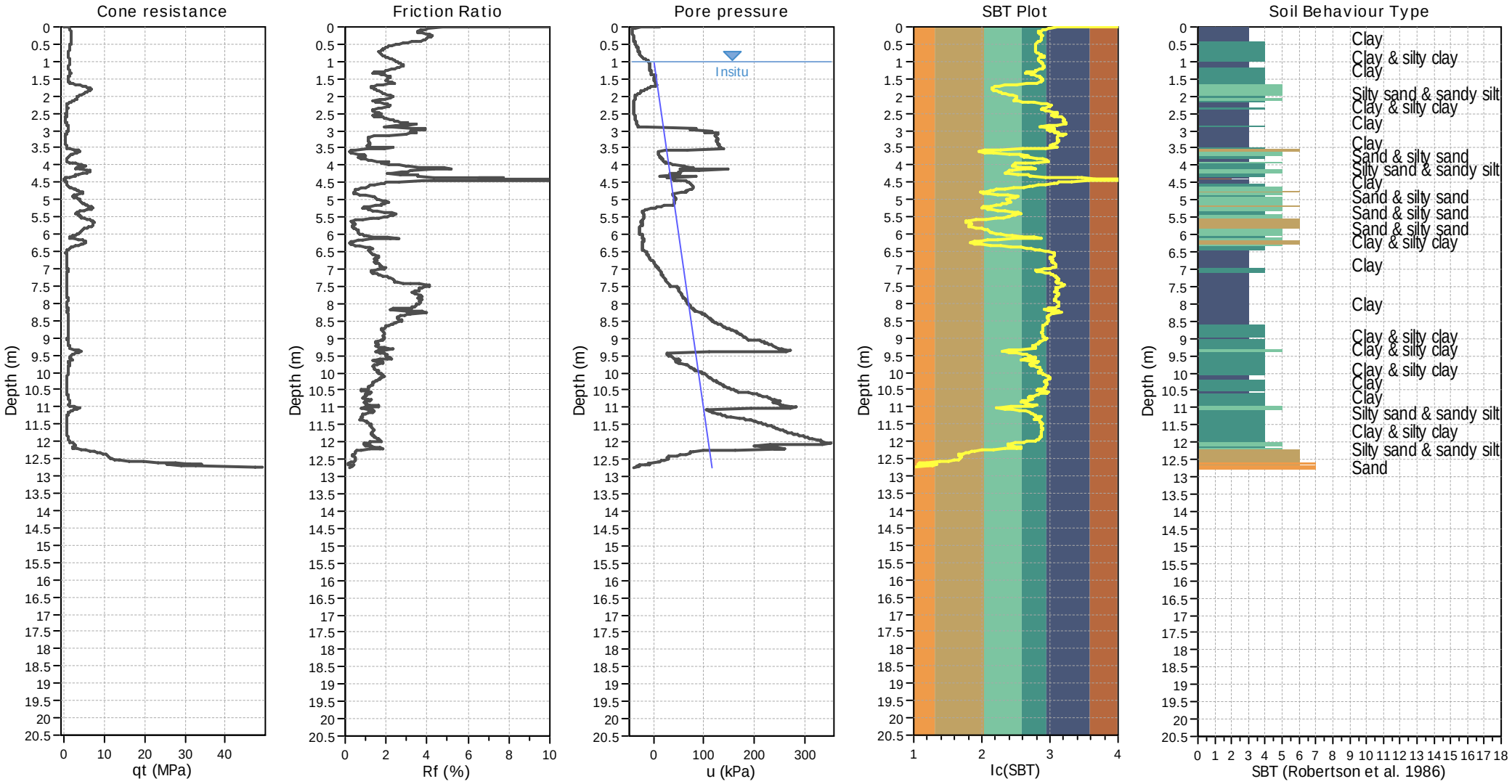
8. Very stiff sand to
9. Very stiff fine grained

CPT basic interpretation plots



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7. Gravely sand to sand
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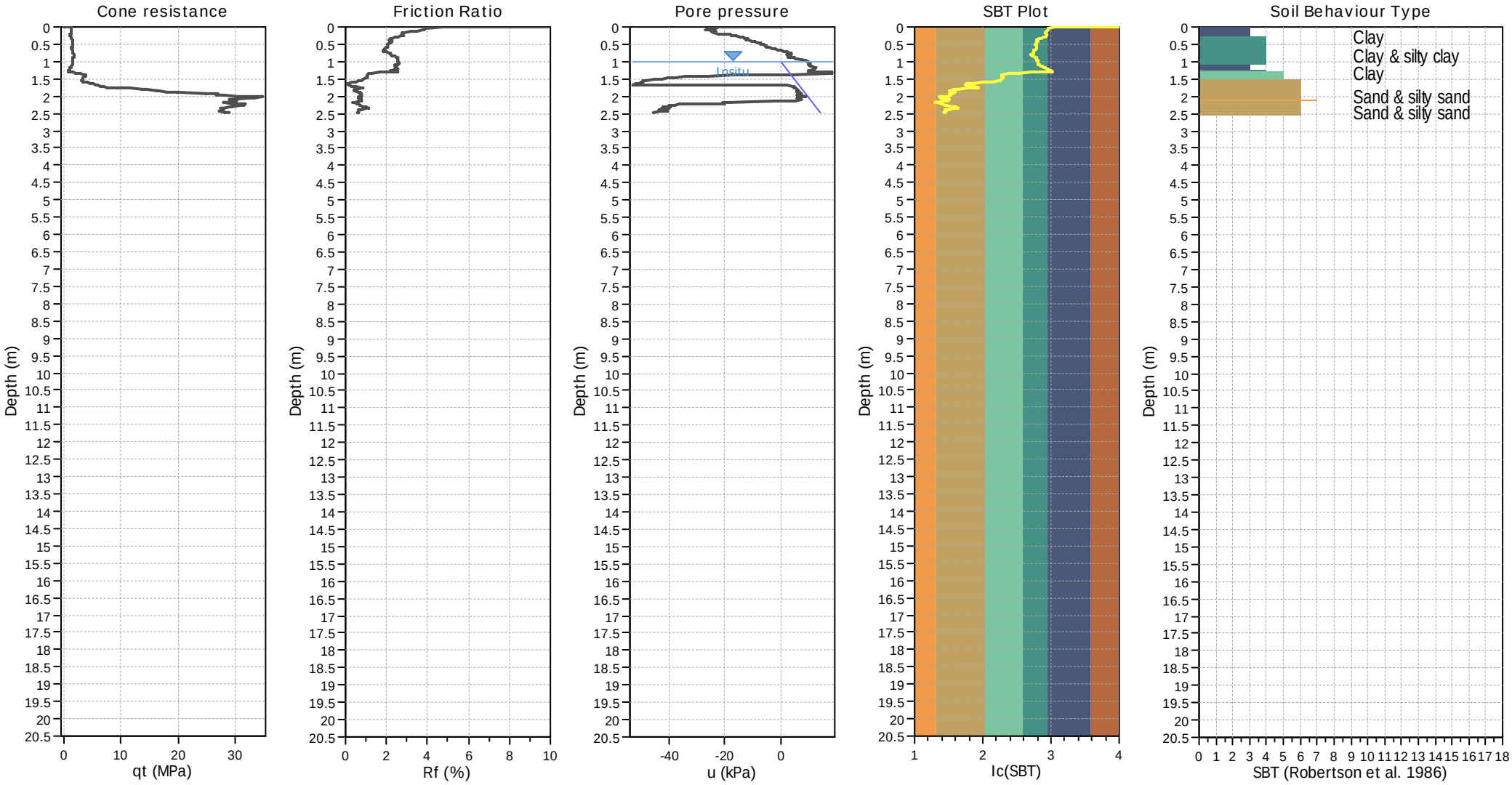
CPT basic interpretation plots



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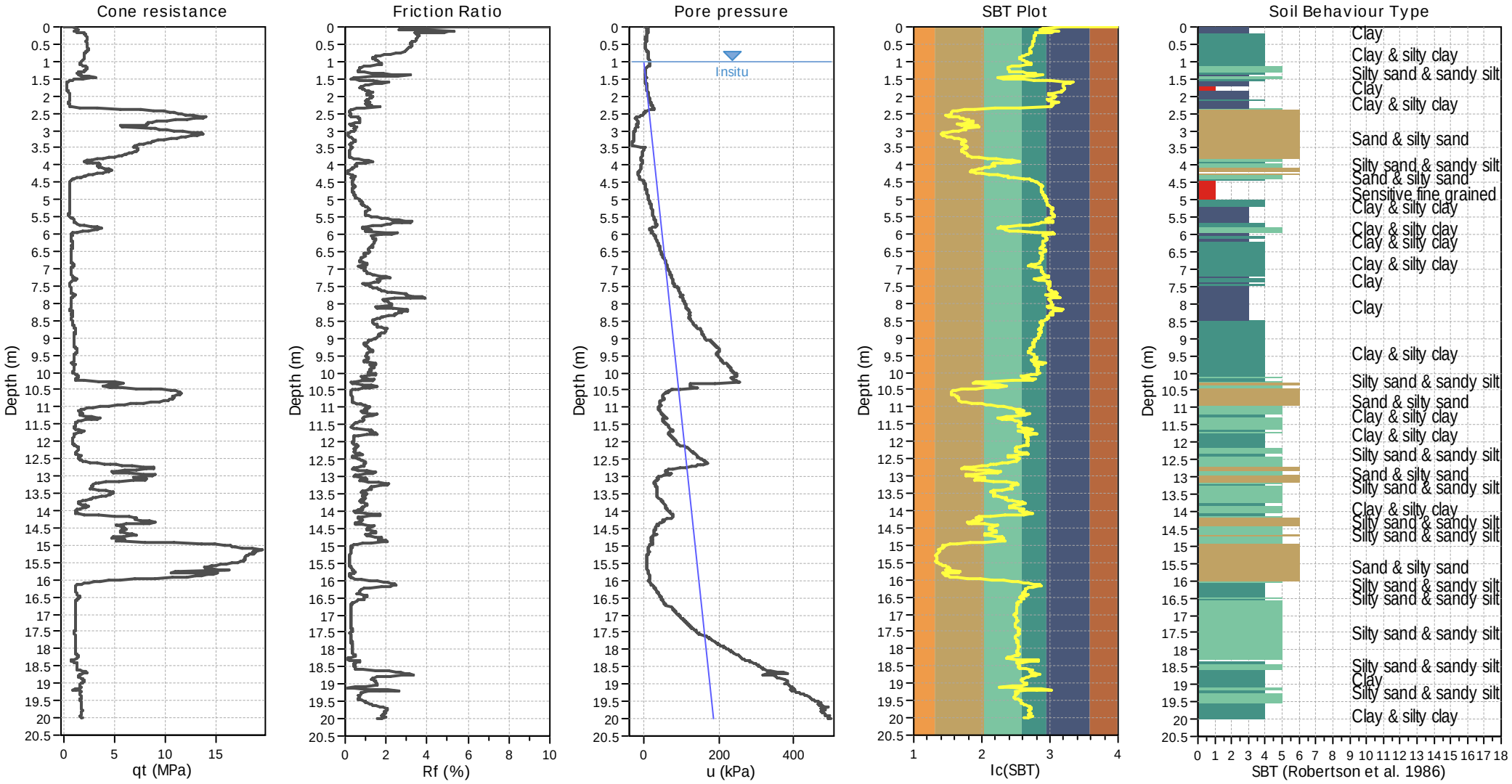
CPT basic interpretation plots



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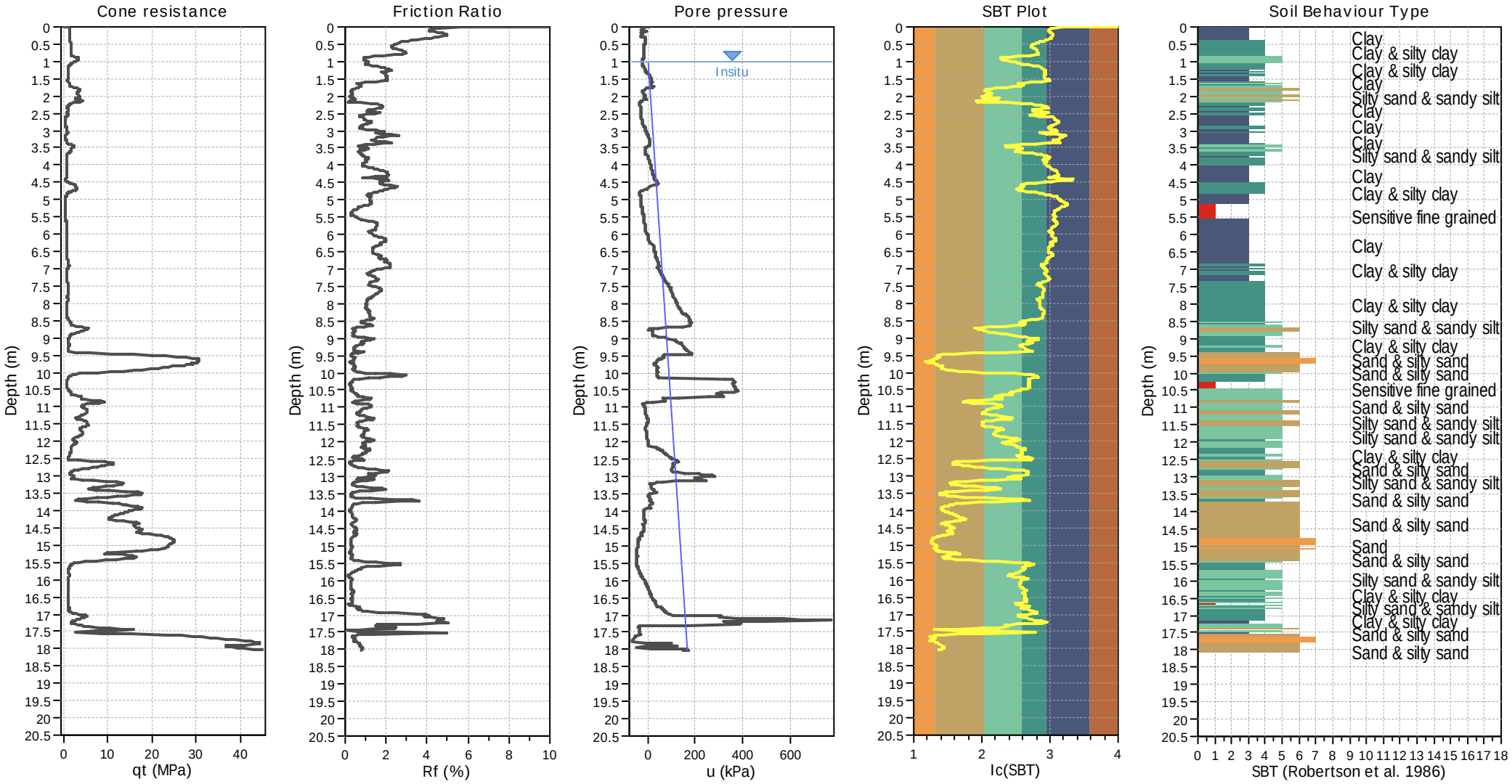
CPT basic interpretation plots



Input parameters and analysis data

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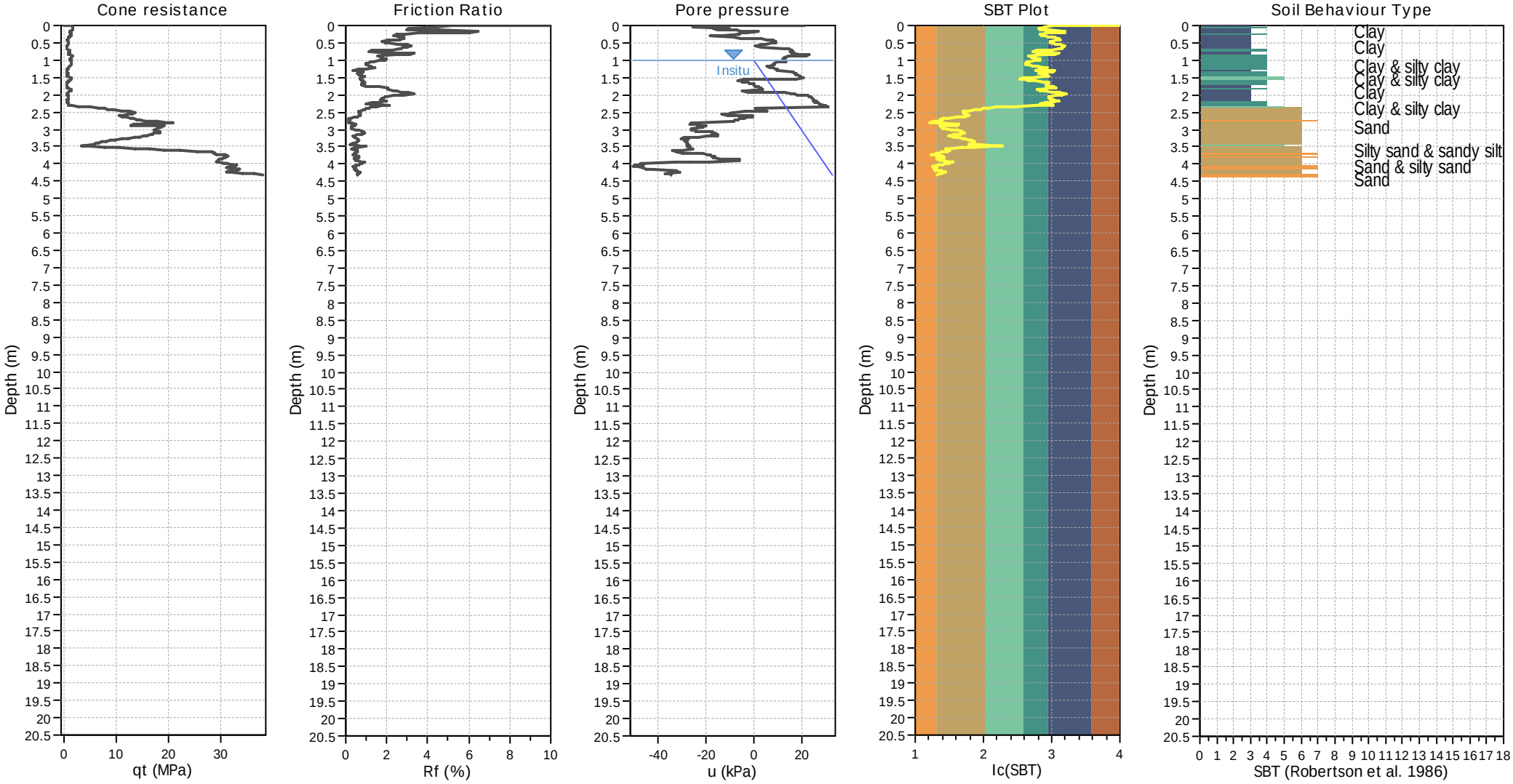
CPT basic interpretation plots



Input parameters and analysis data

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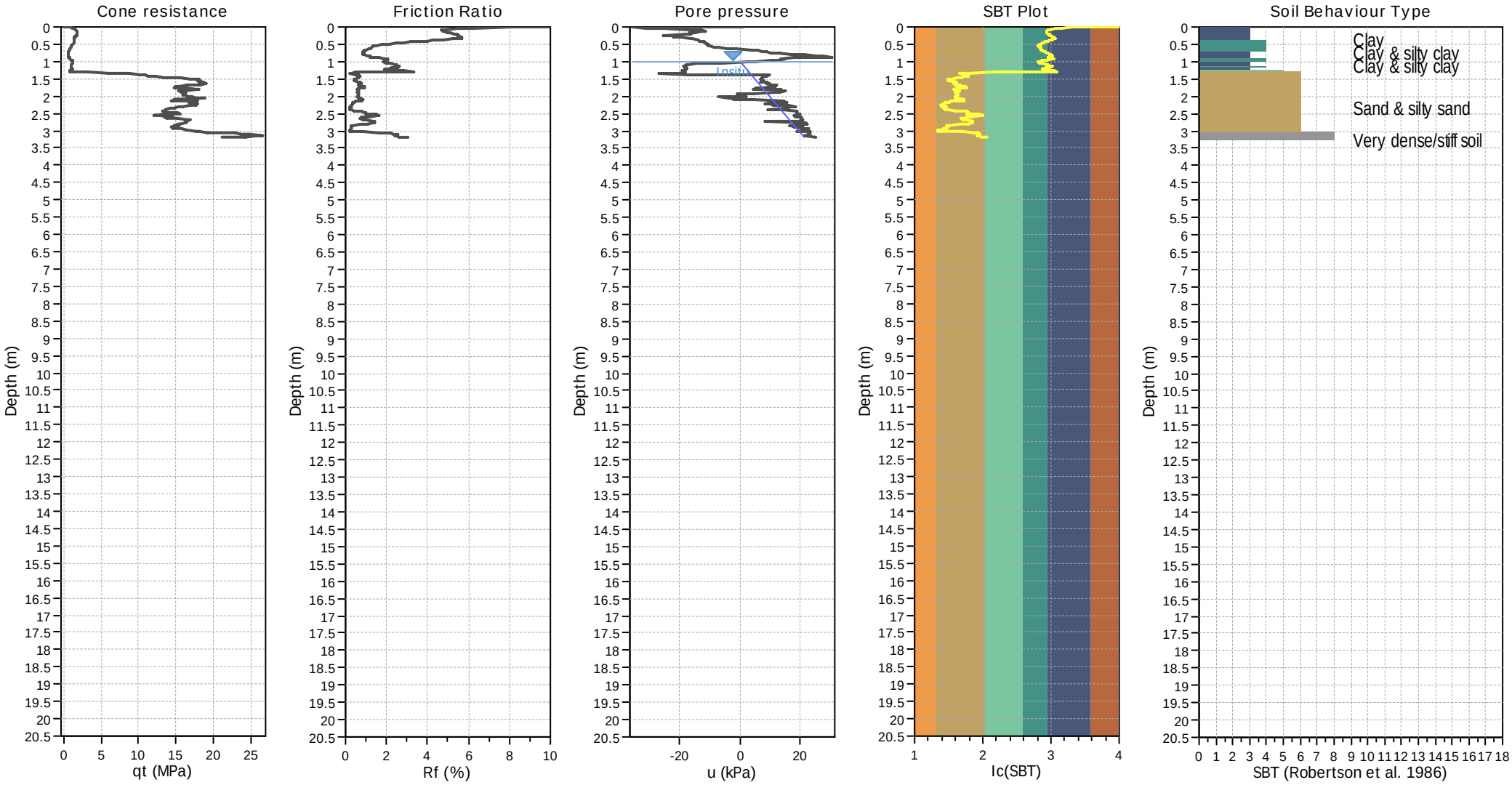
CPT basic interpretation plots



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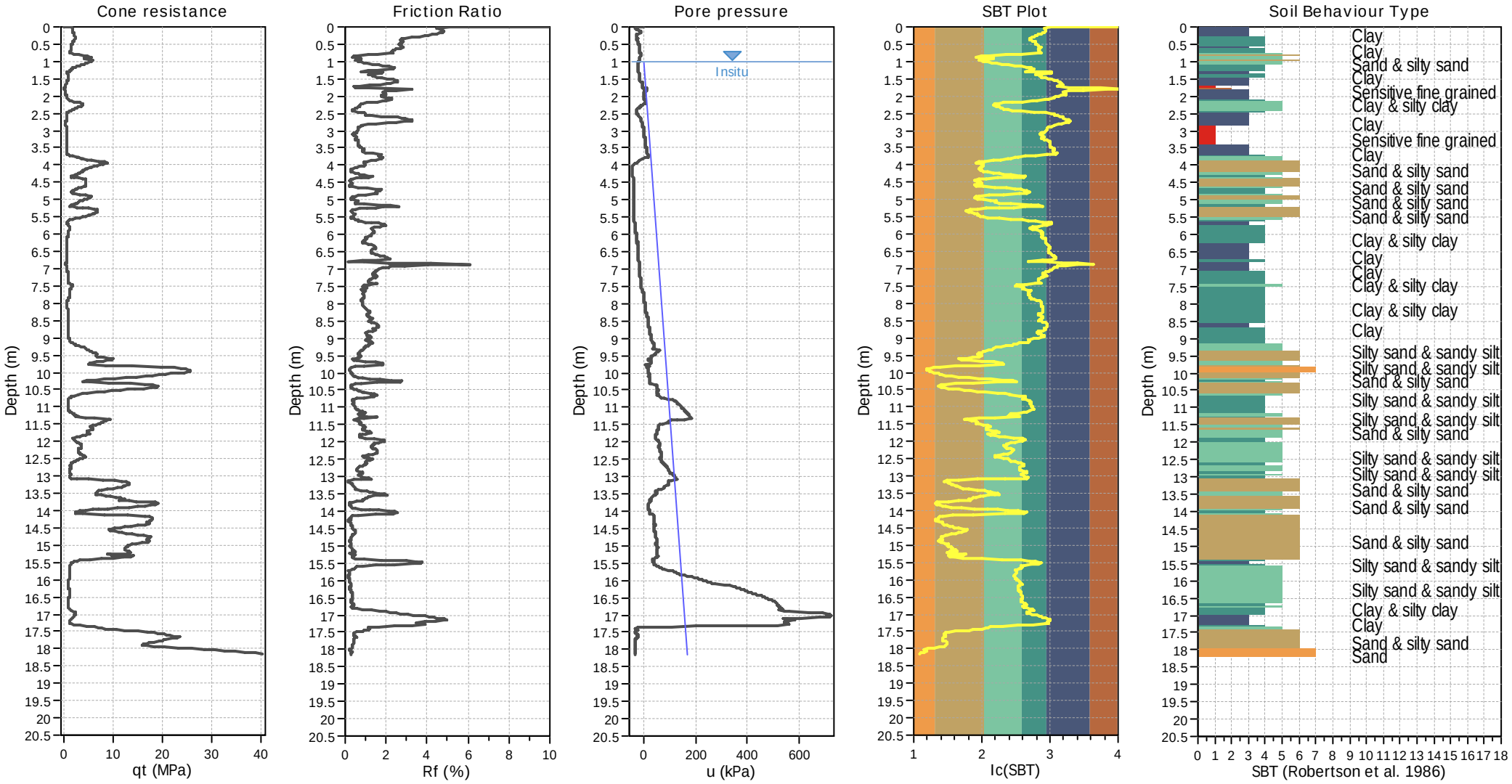
CPT basic interpretation plots



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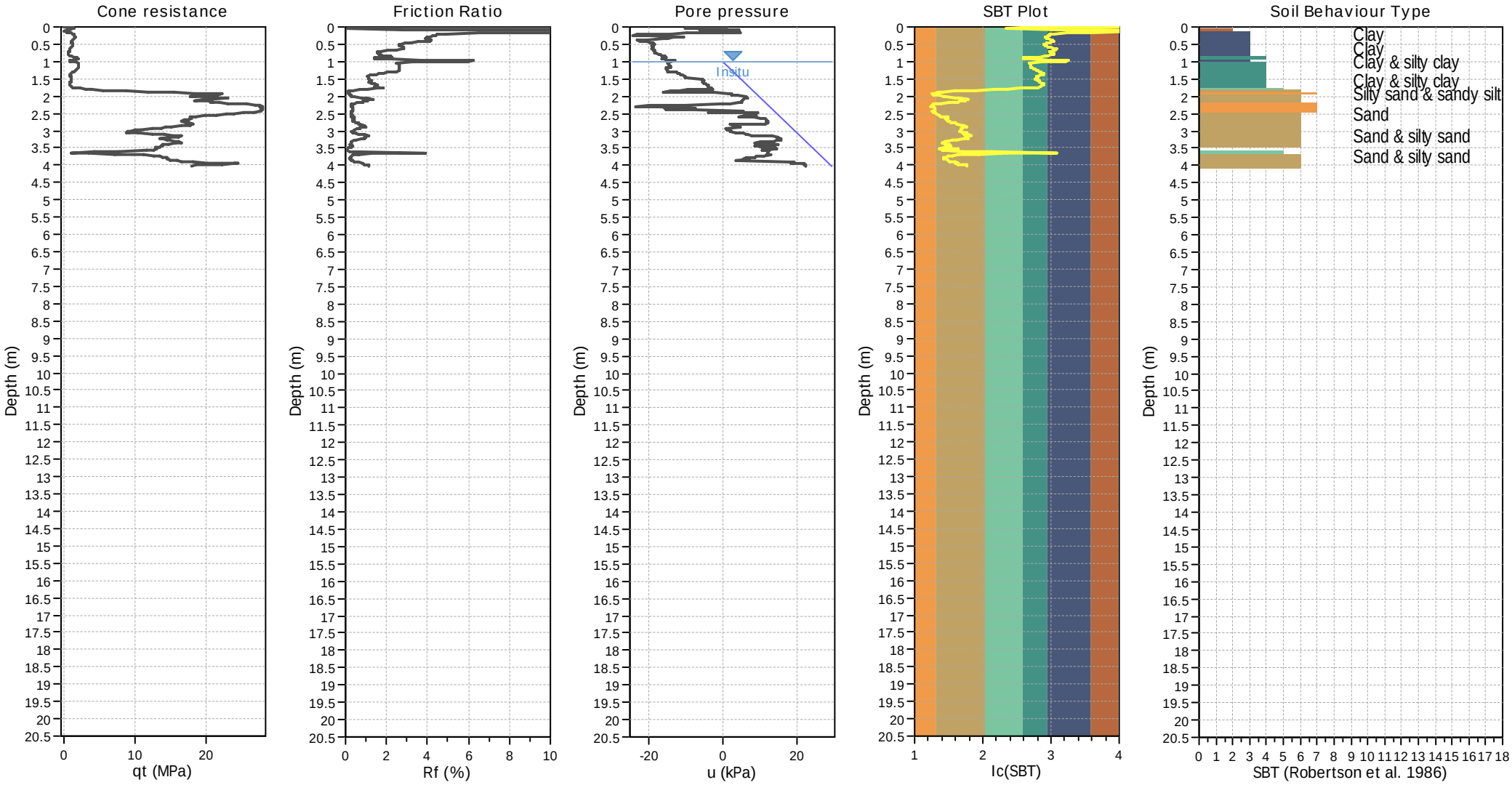
CPT basic interpretation plots



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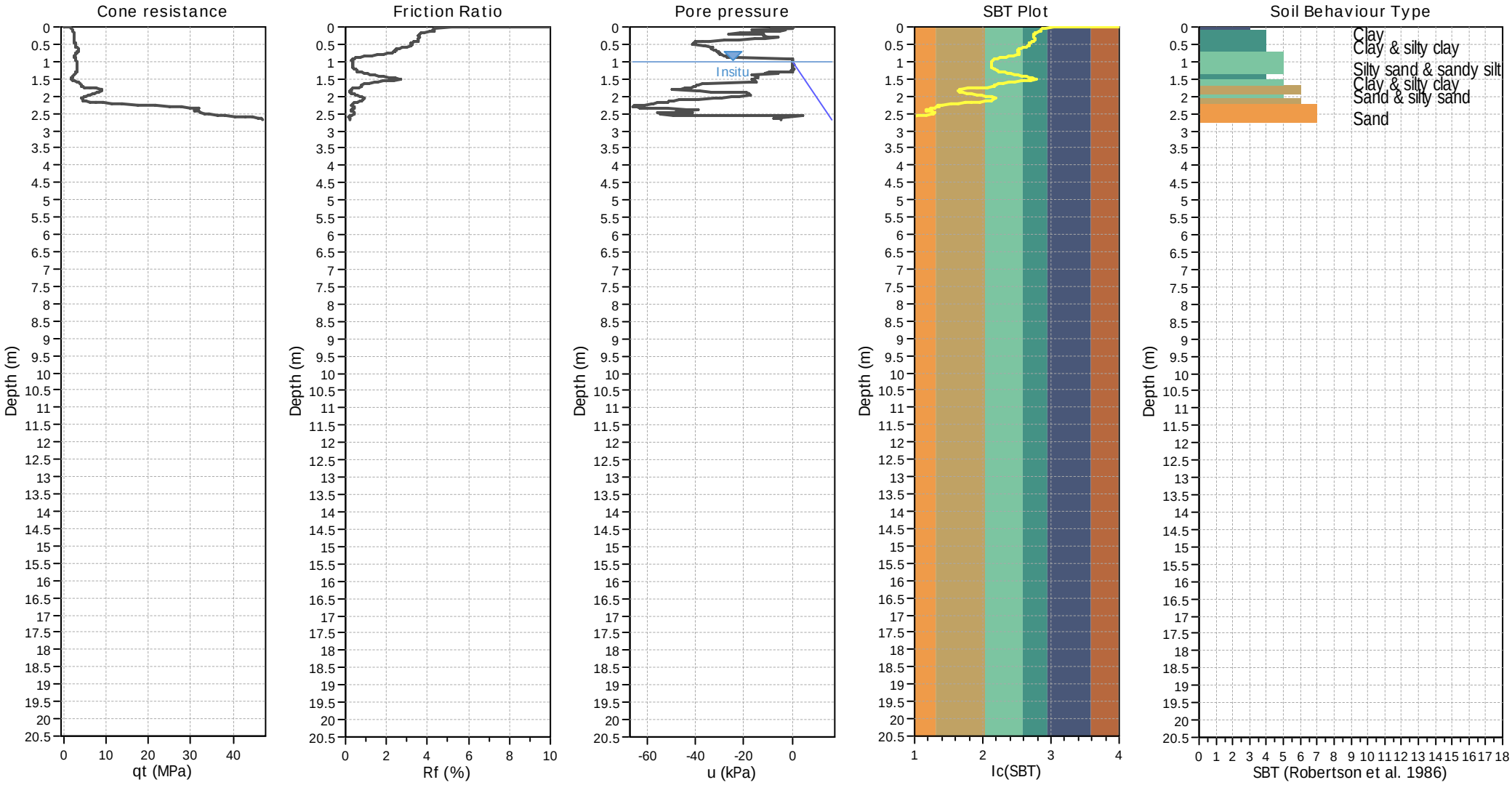
CPT basic interpretation plots



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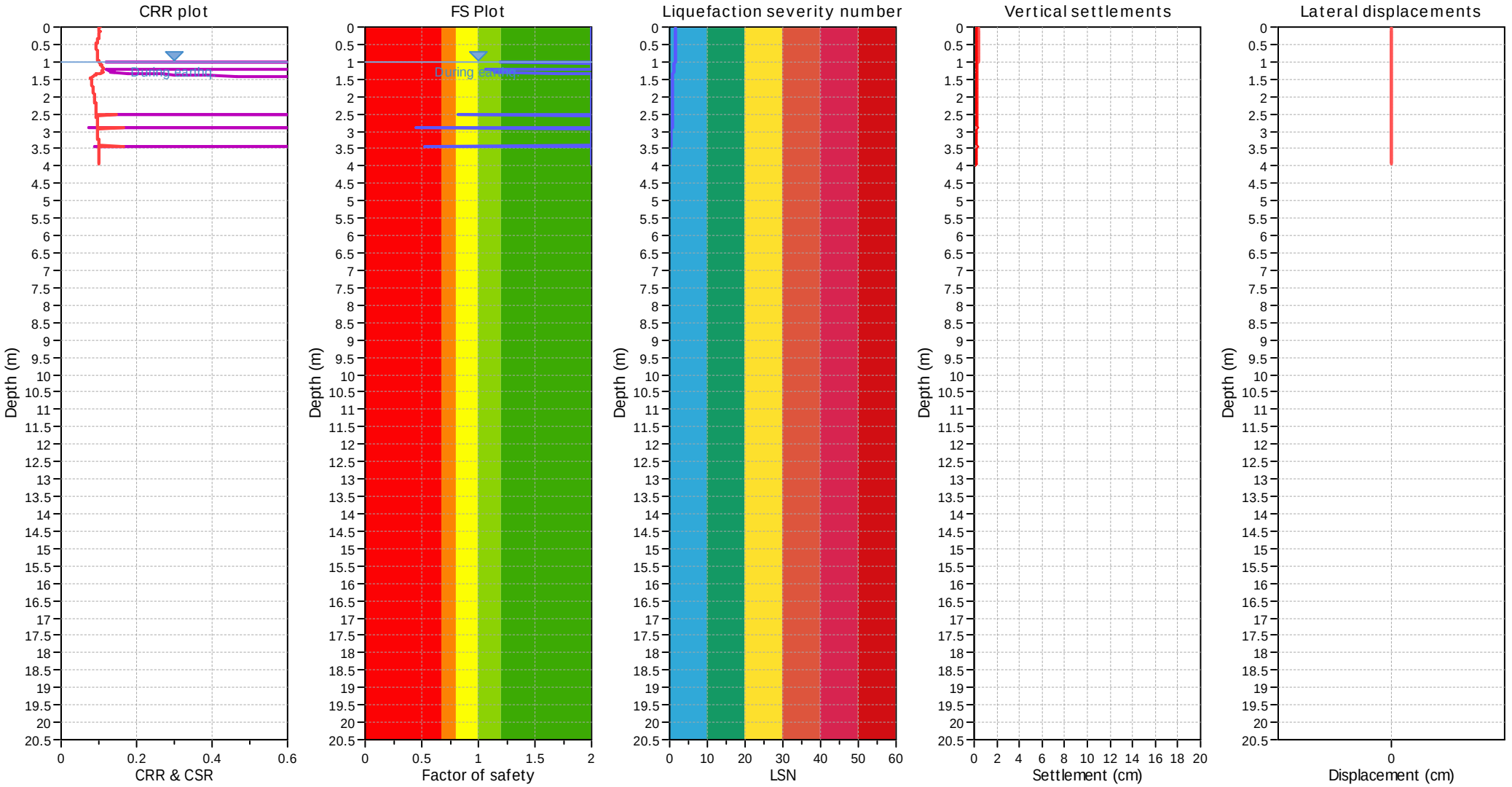
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots SLS1, SLS2, ULS

Liquefaction analysis overall plots



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Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

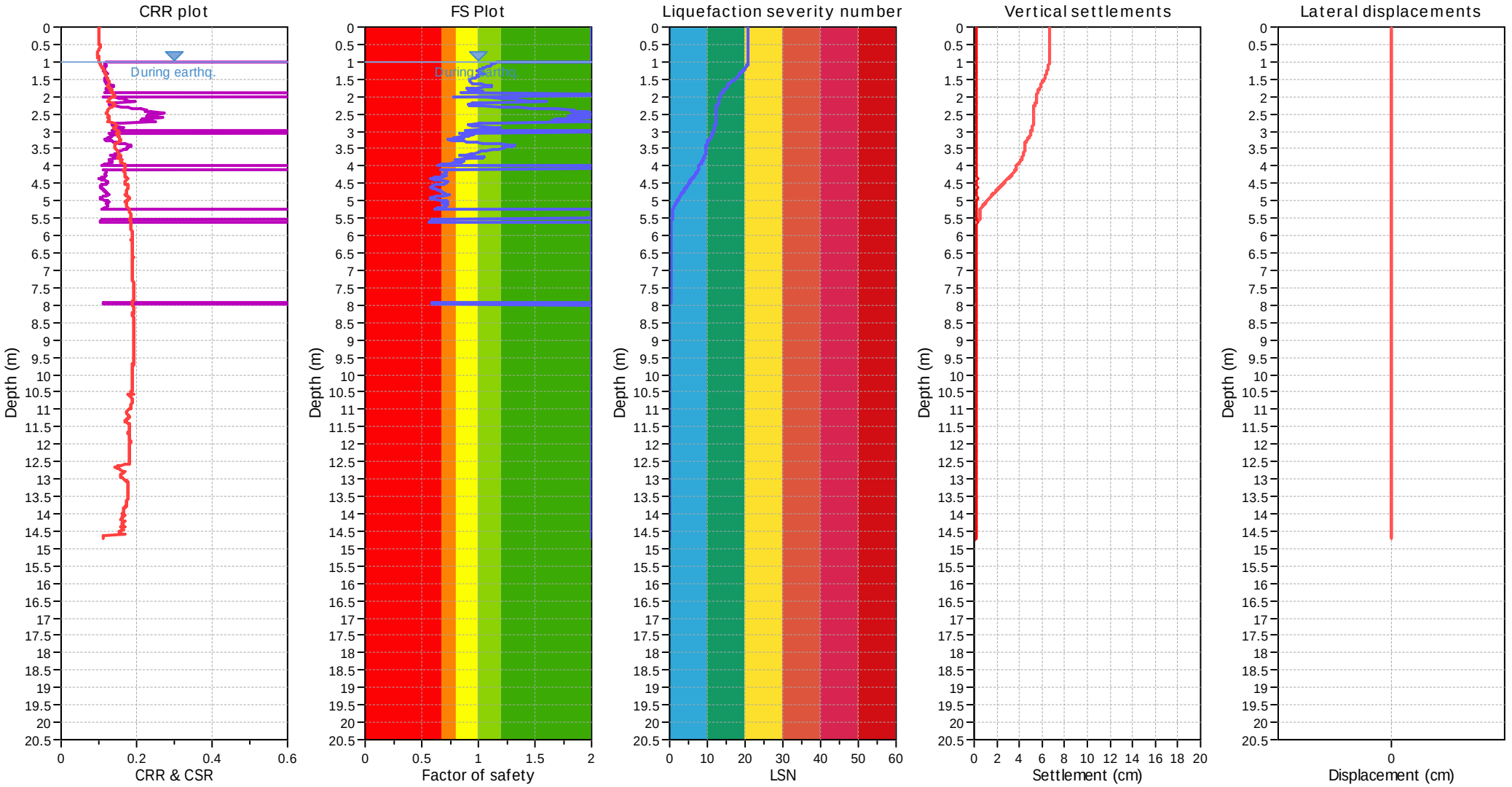
F.S. color scheme

- 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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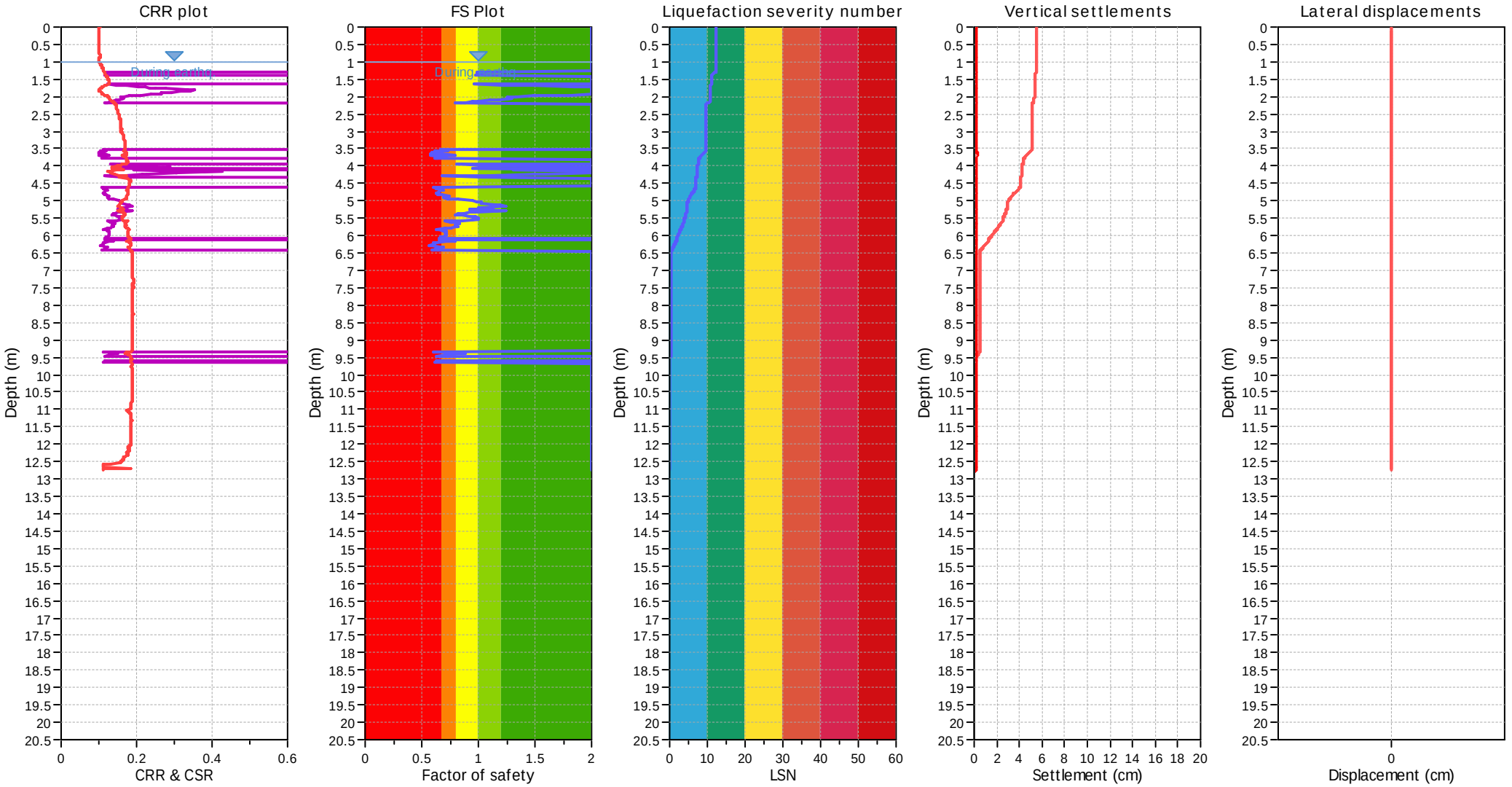
Liquefaction analysis overall plots



Input parameters and analysis data

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- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
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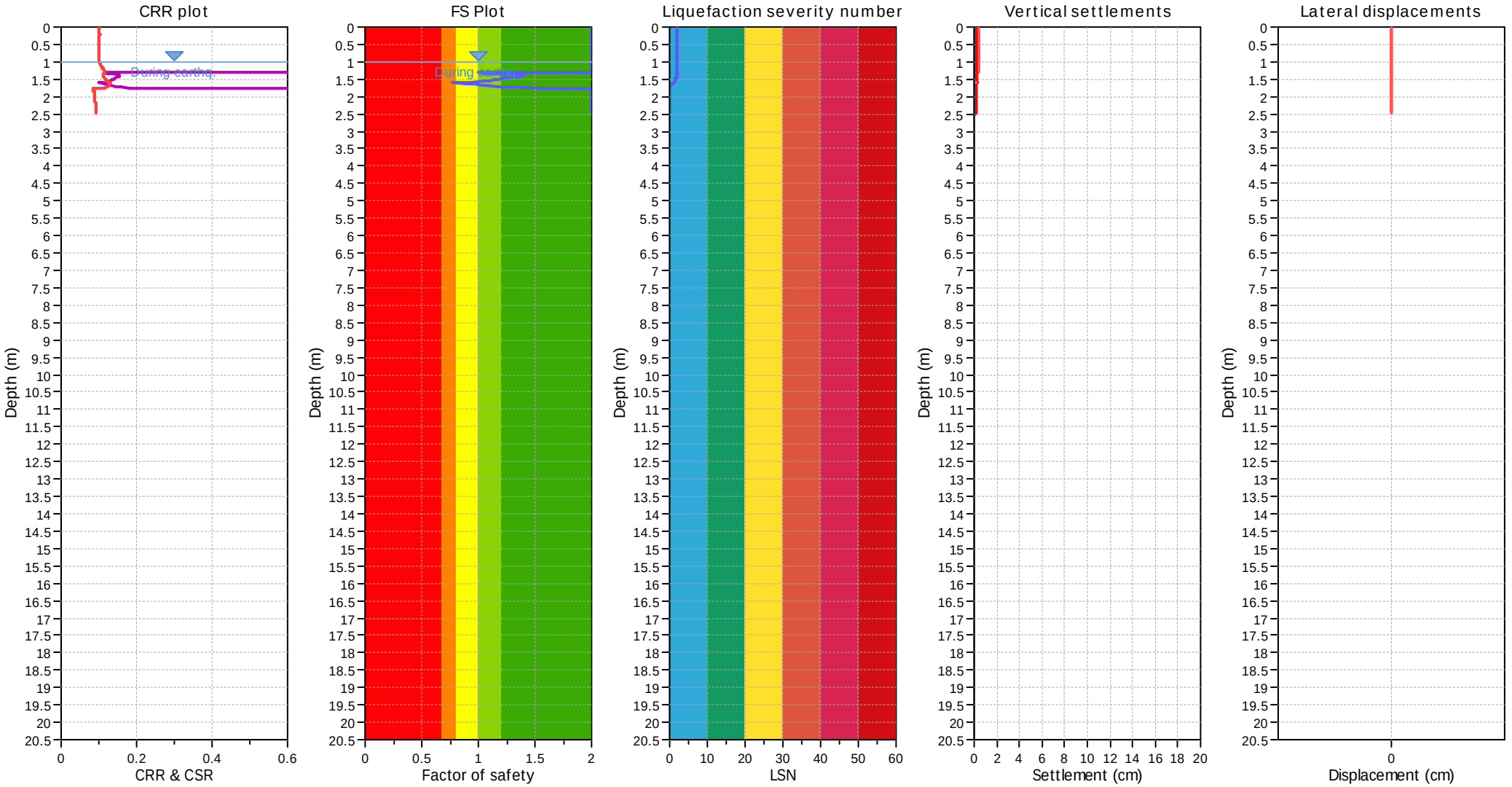
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

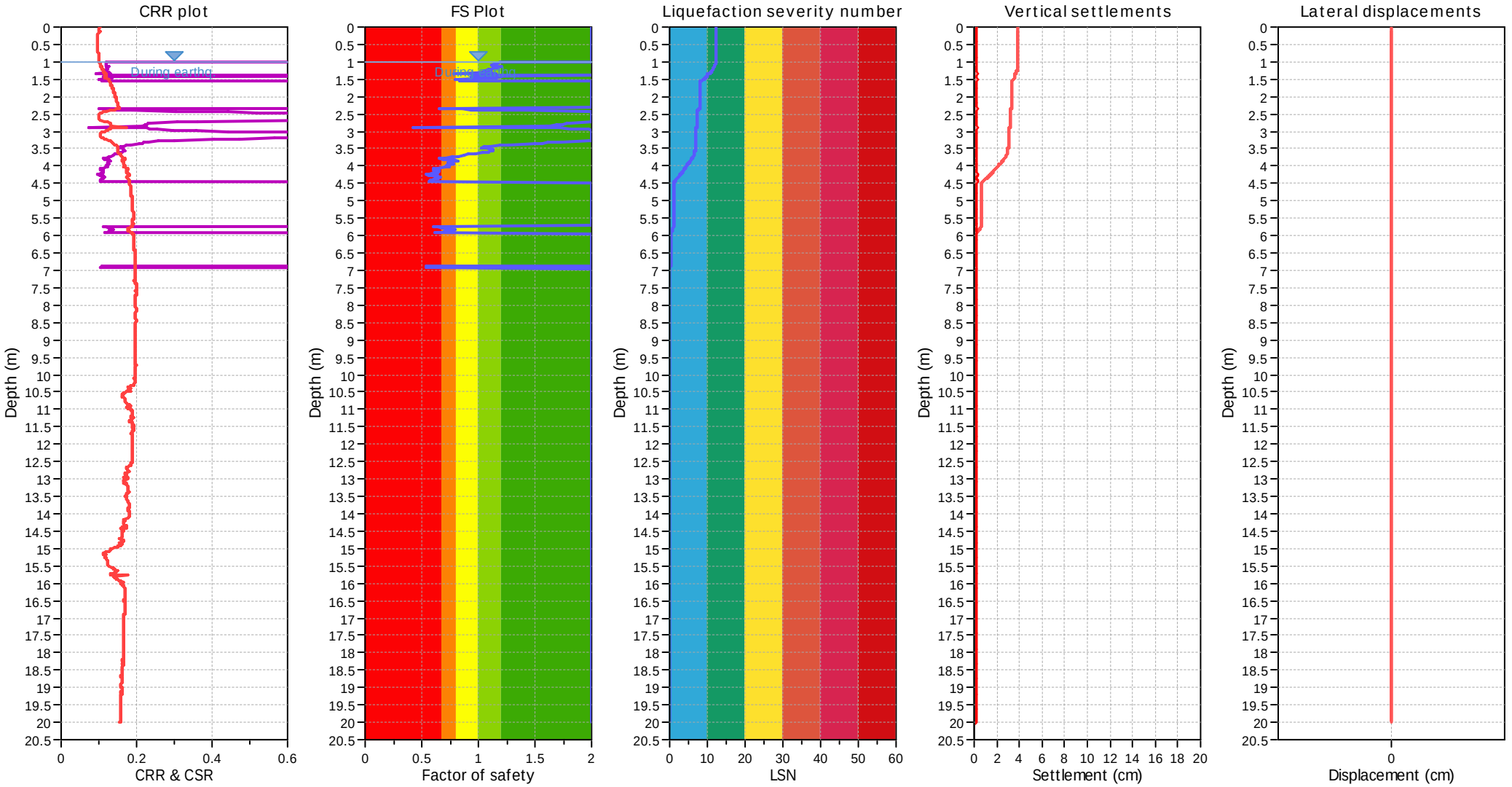
F.S. color scheme

- 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



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Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
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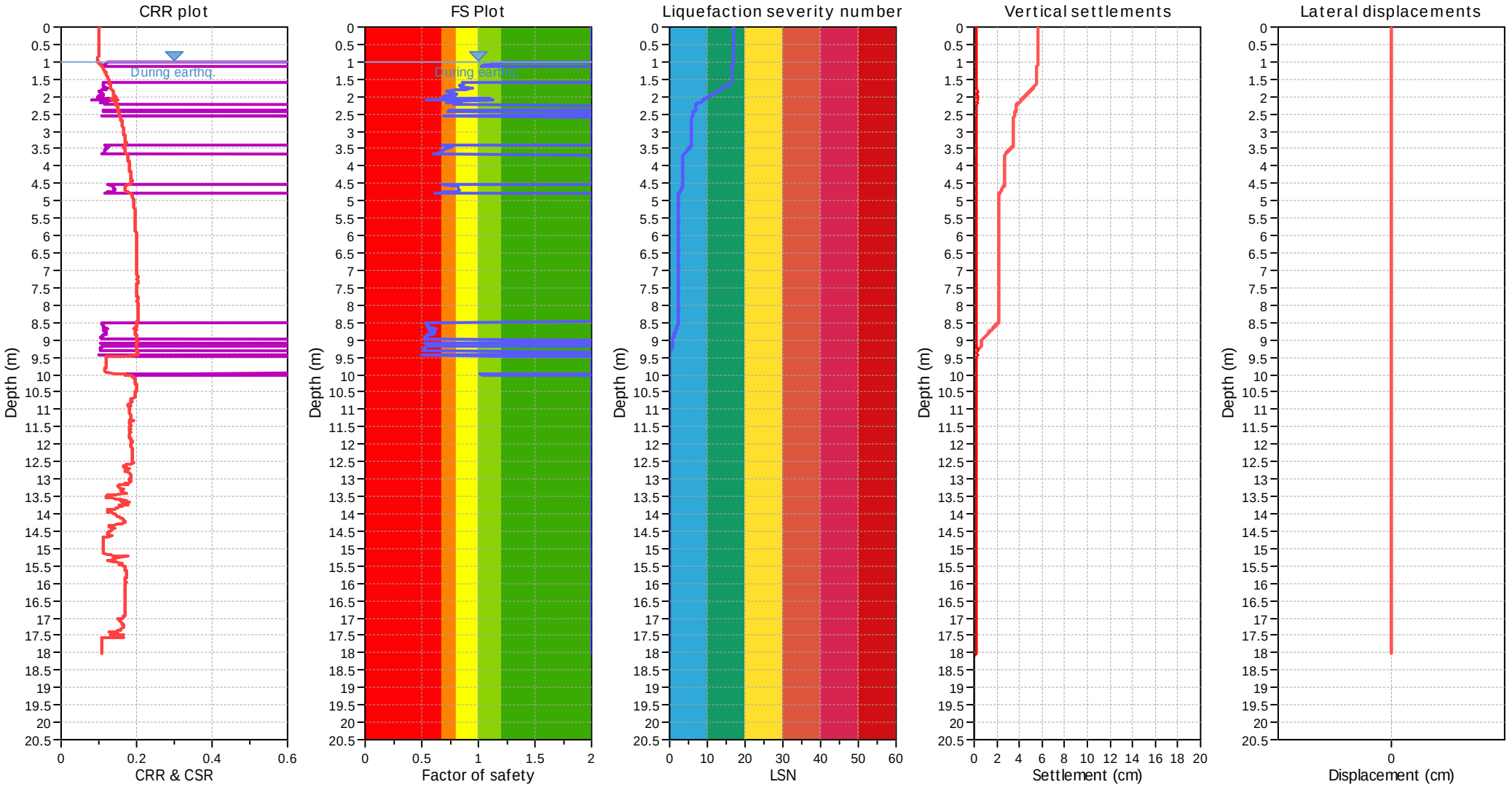

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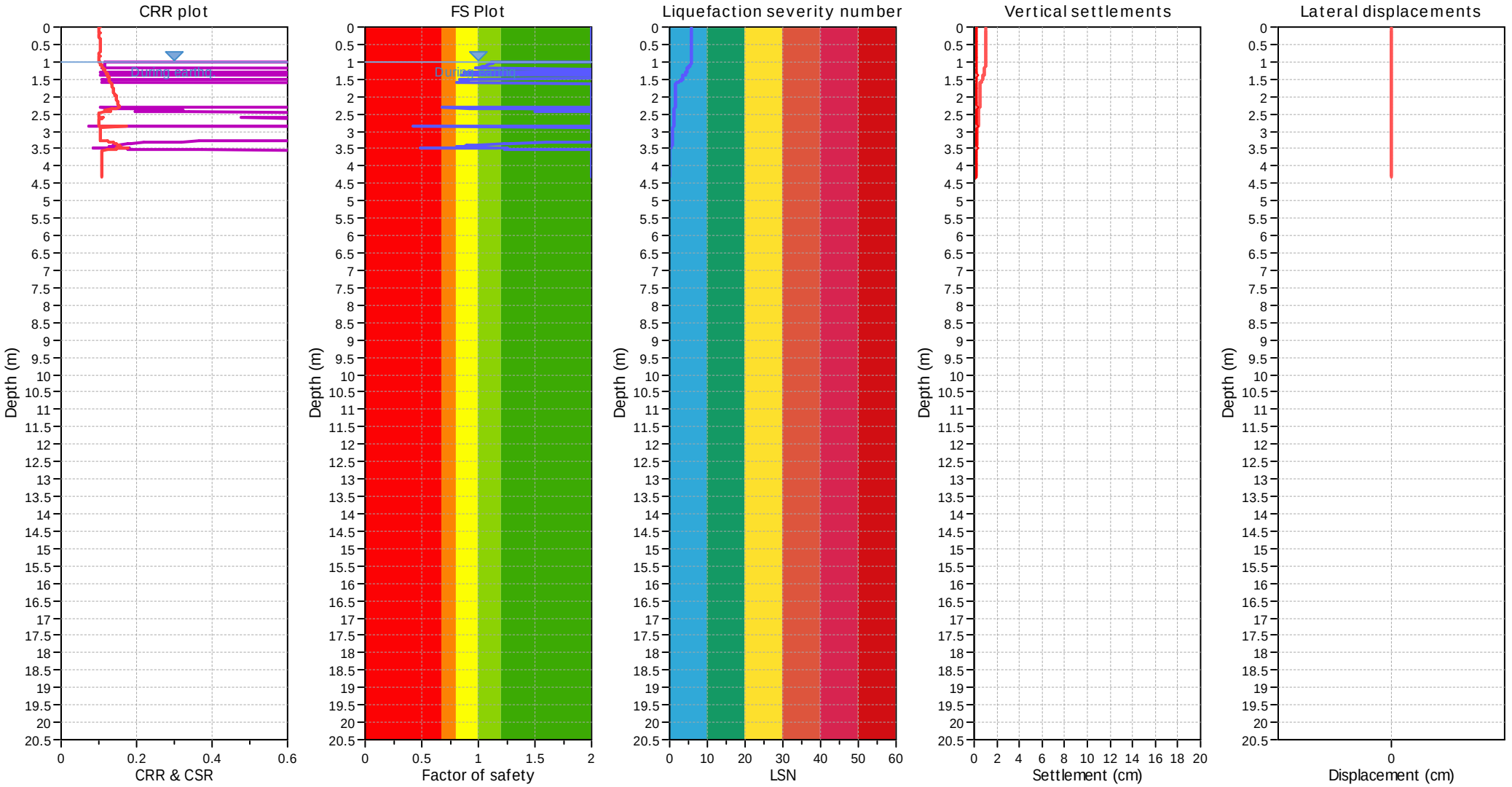

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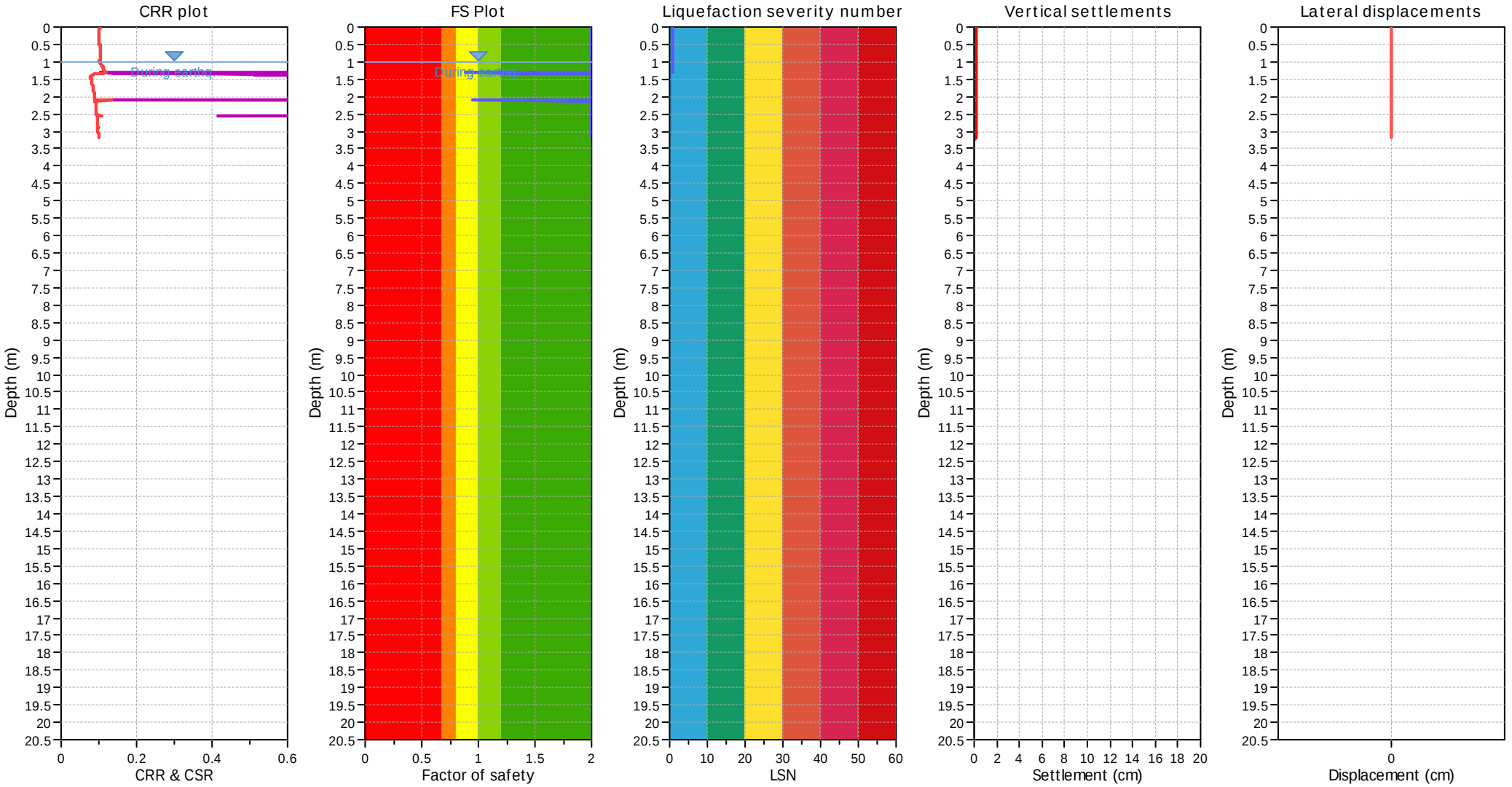

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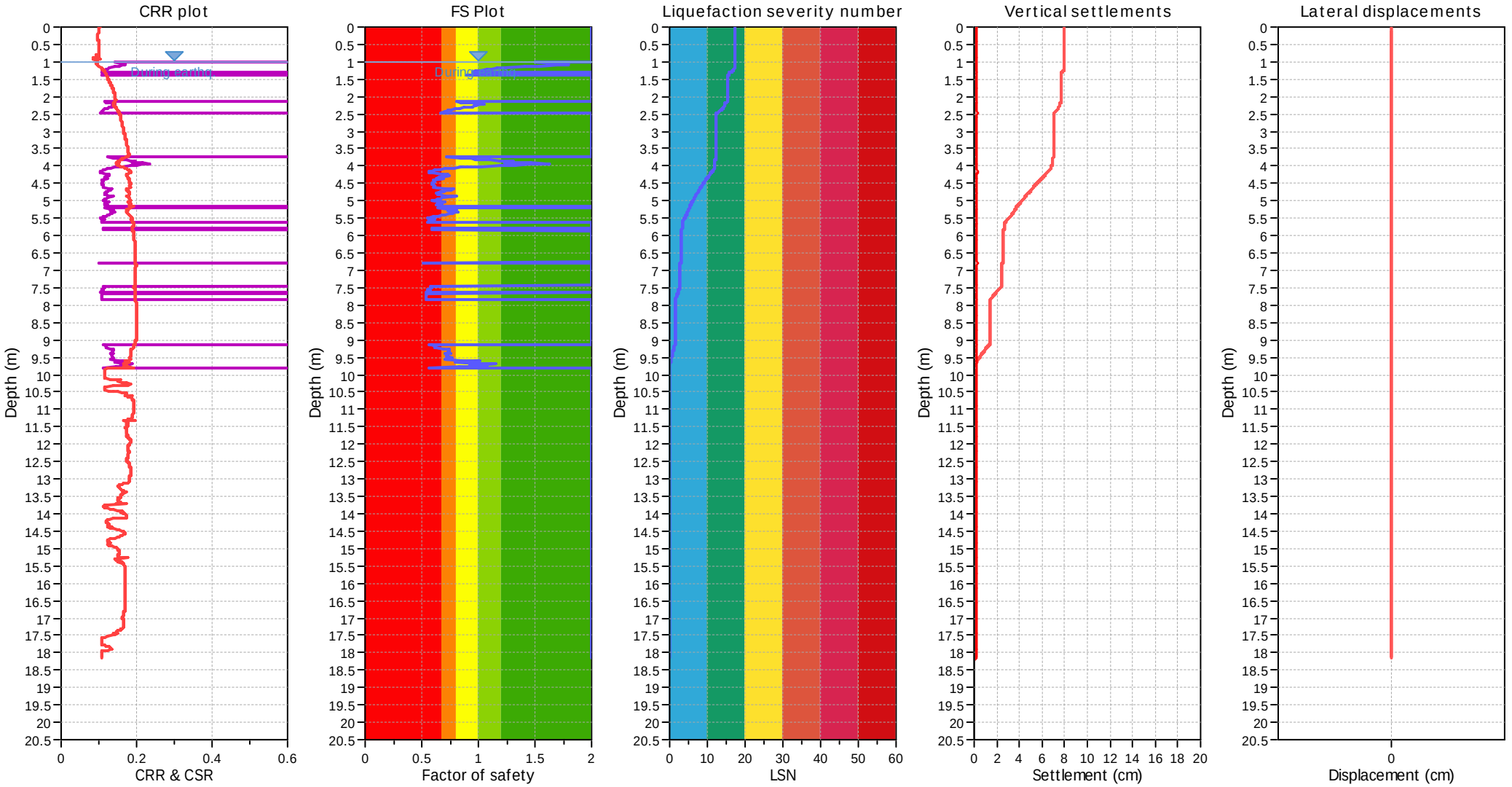

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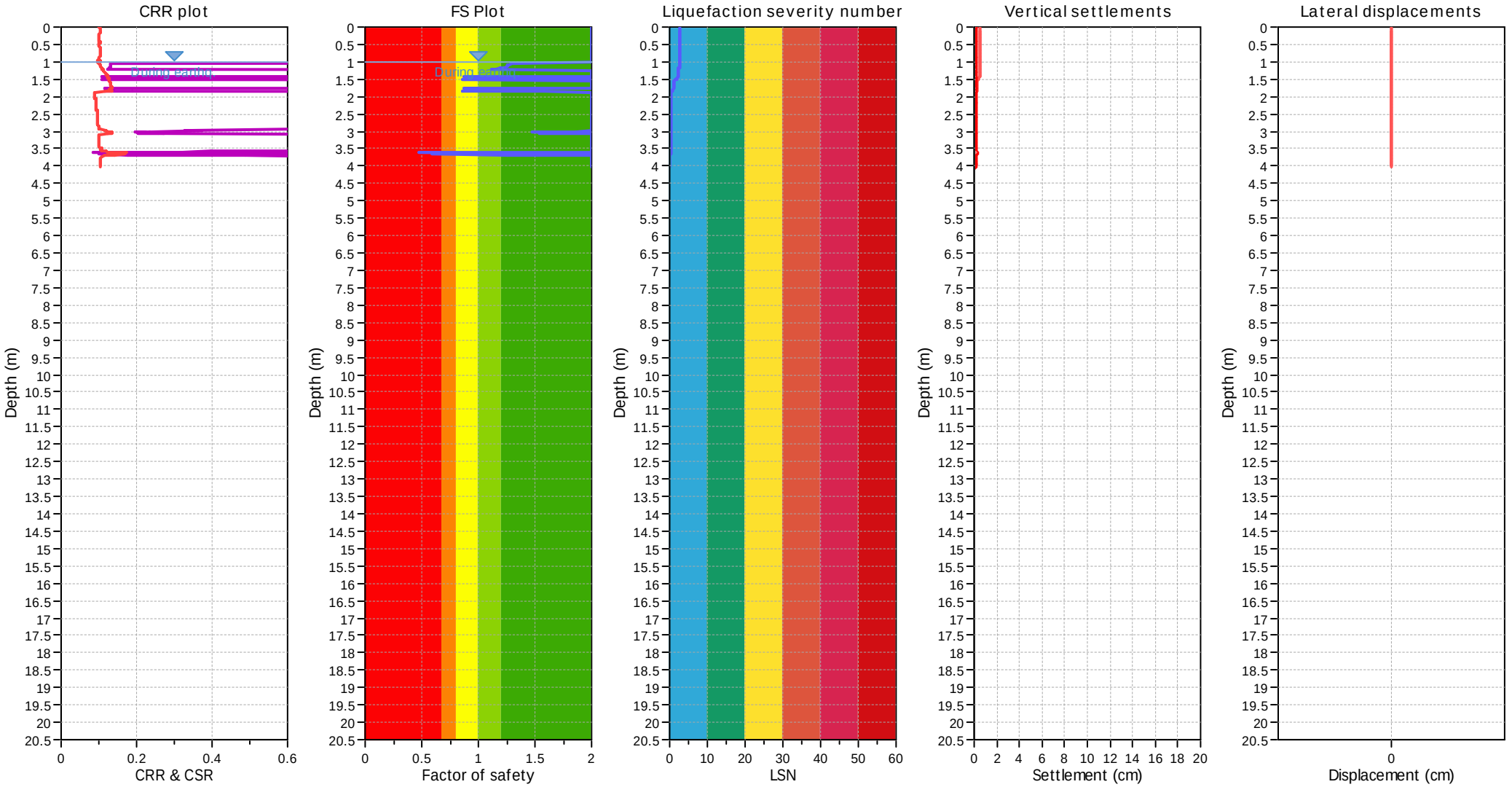

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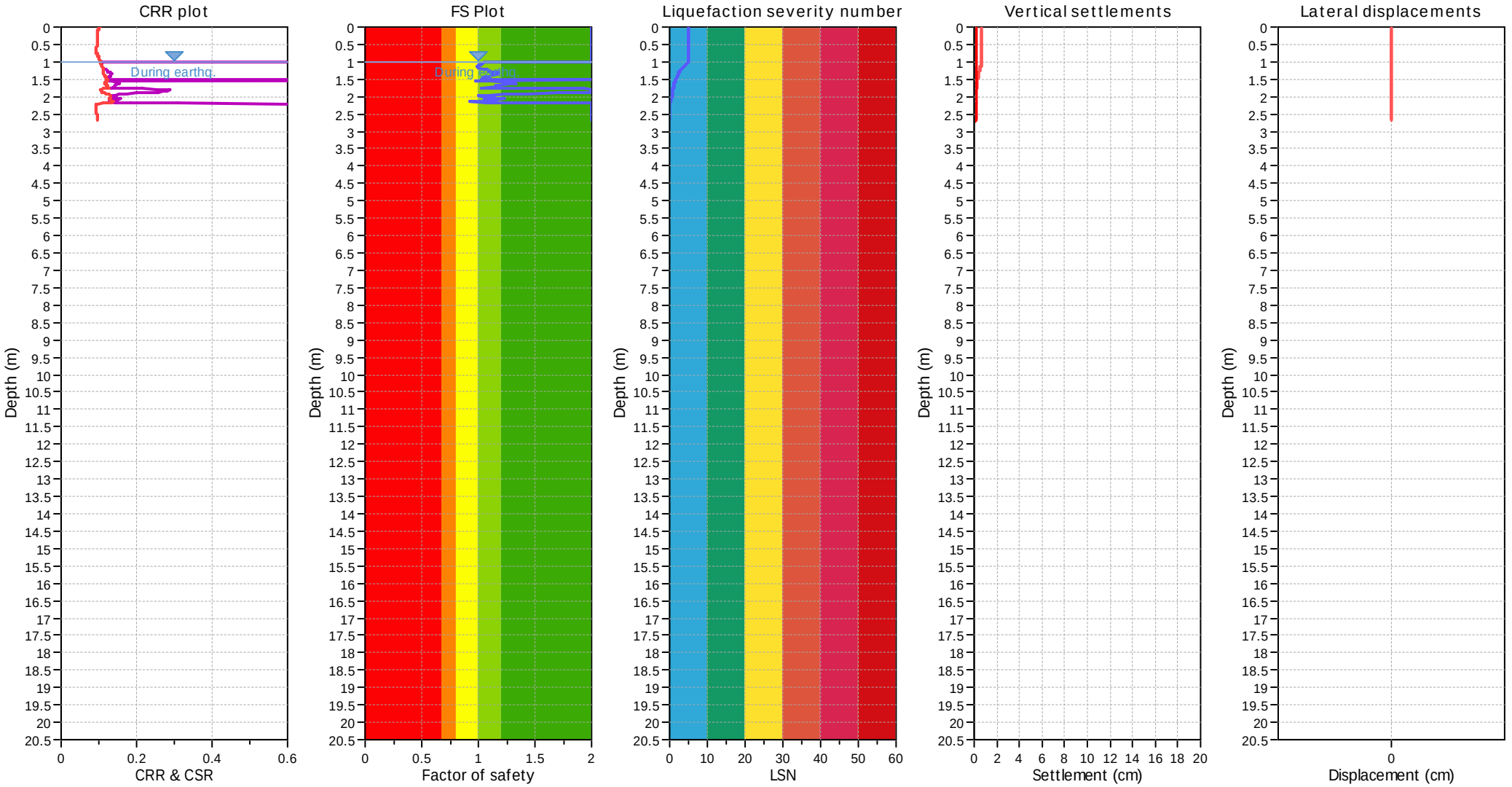

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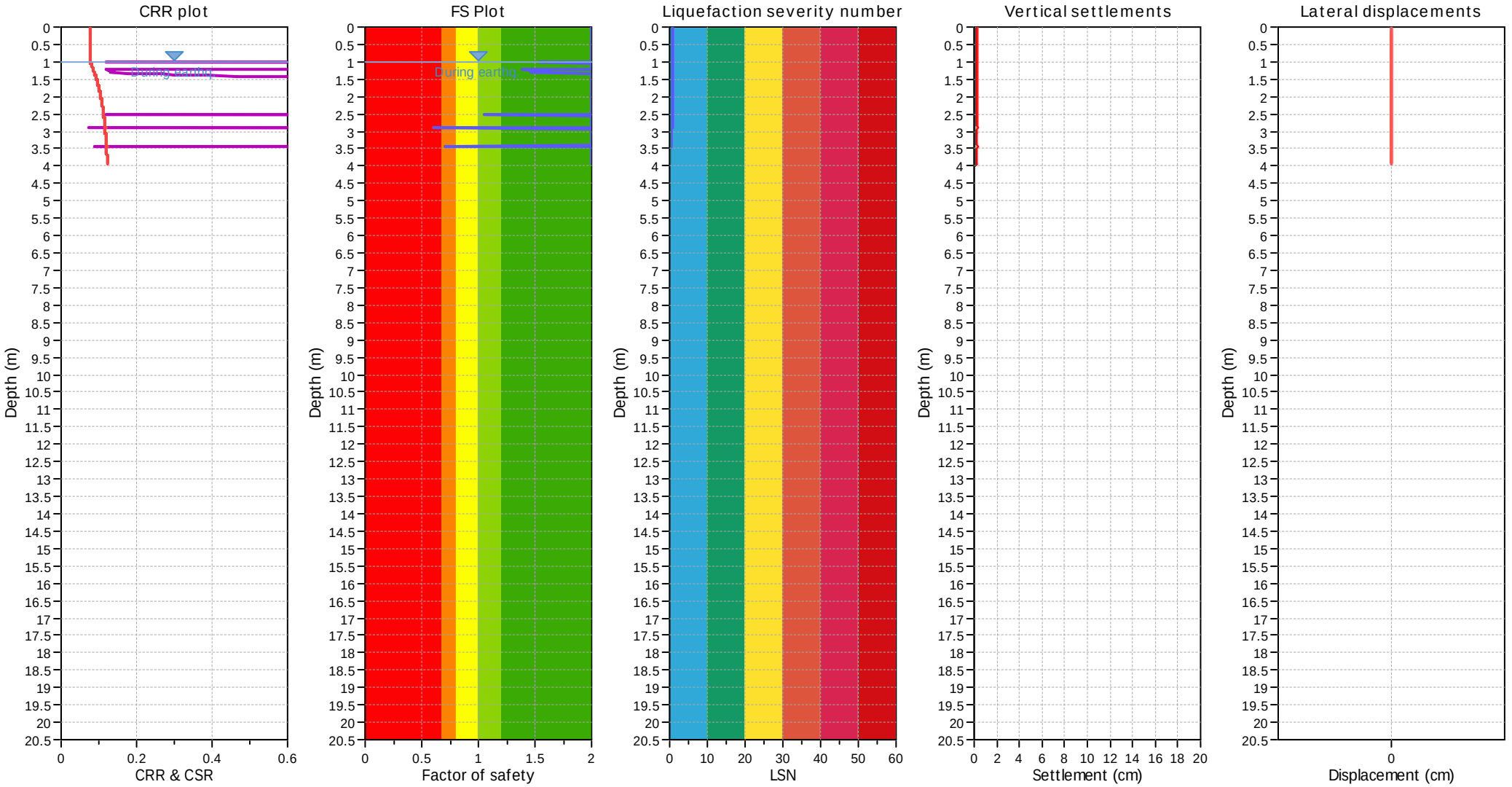

Input parameters and analysis data

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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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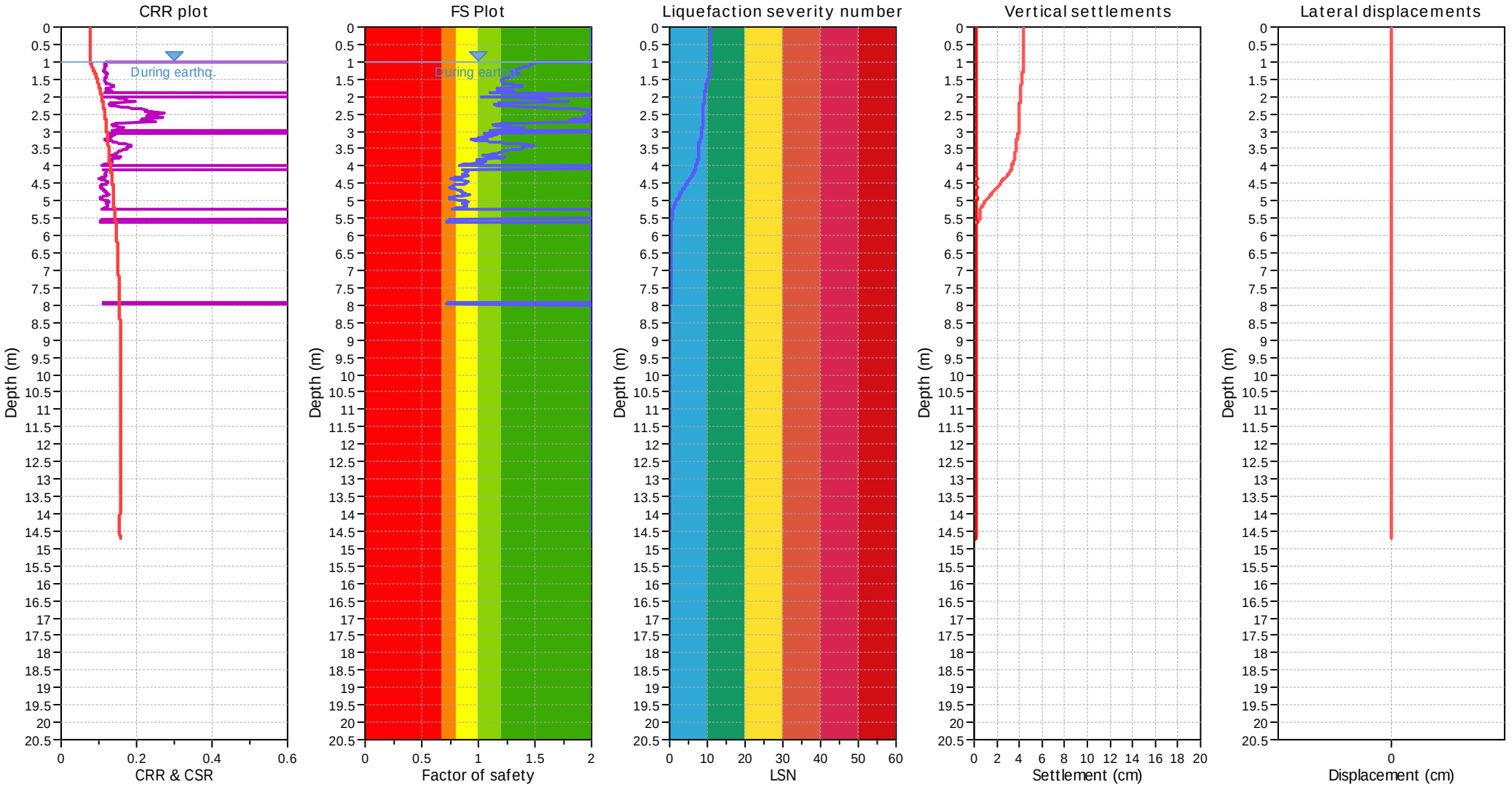

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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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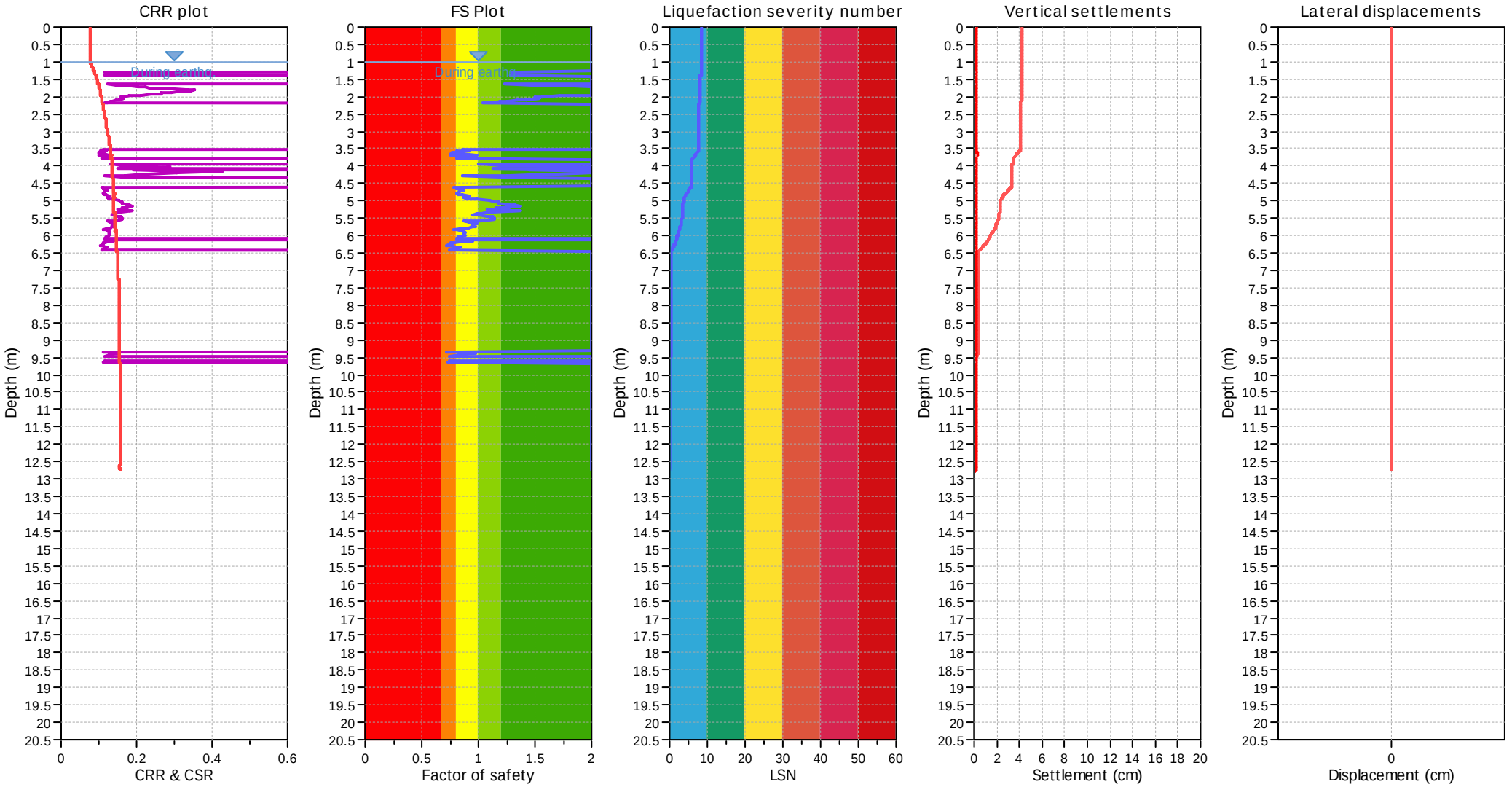

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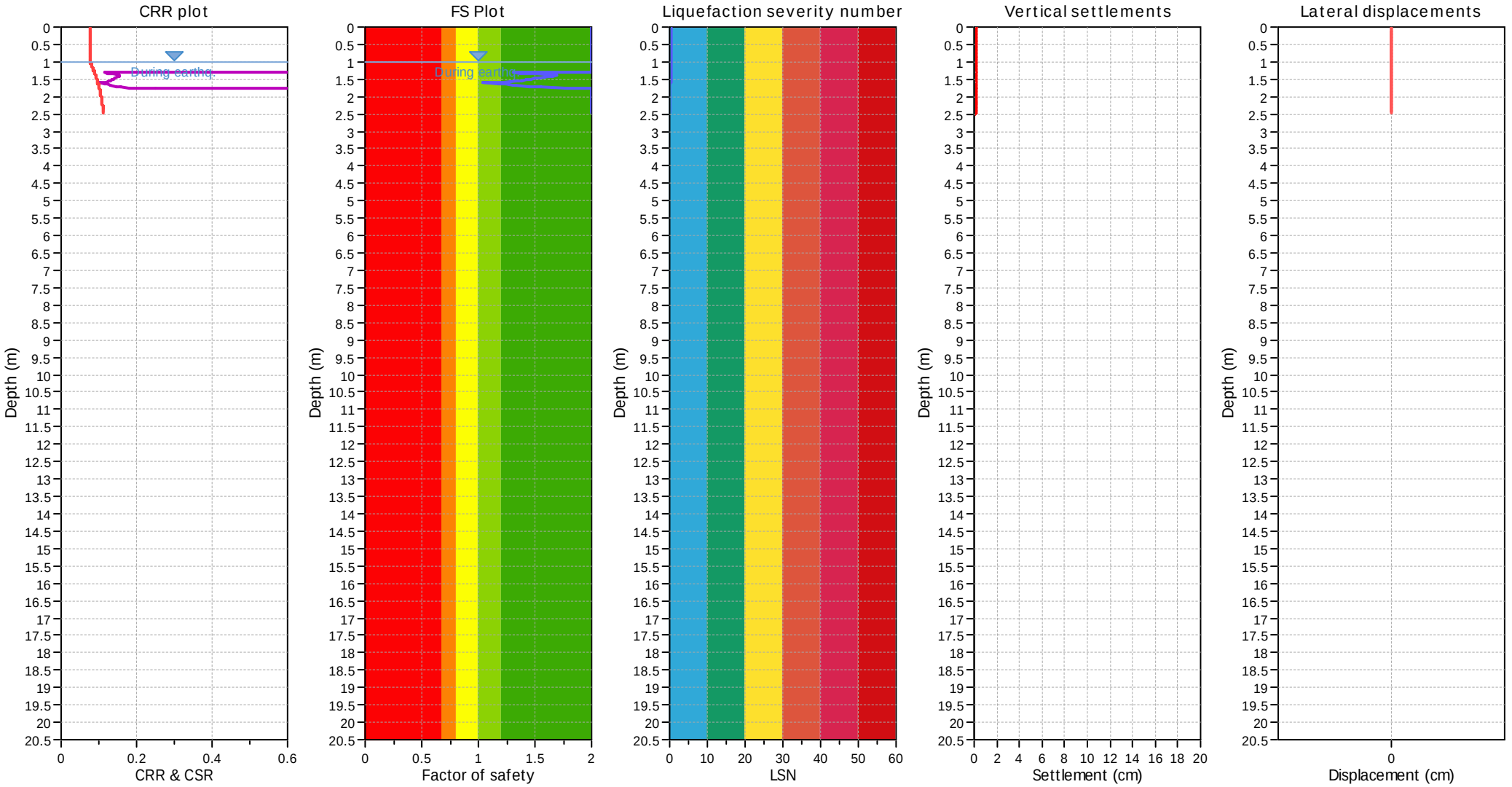

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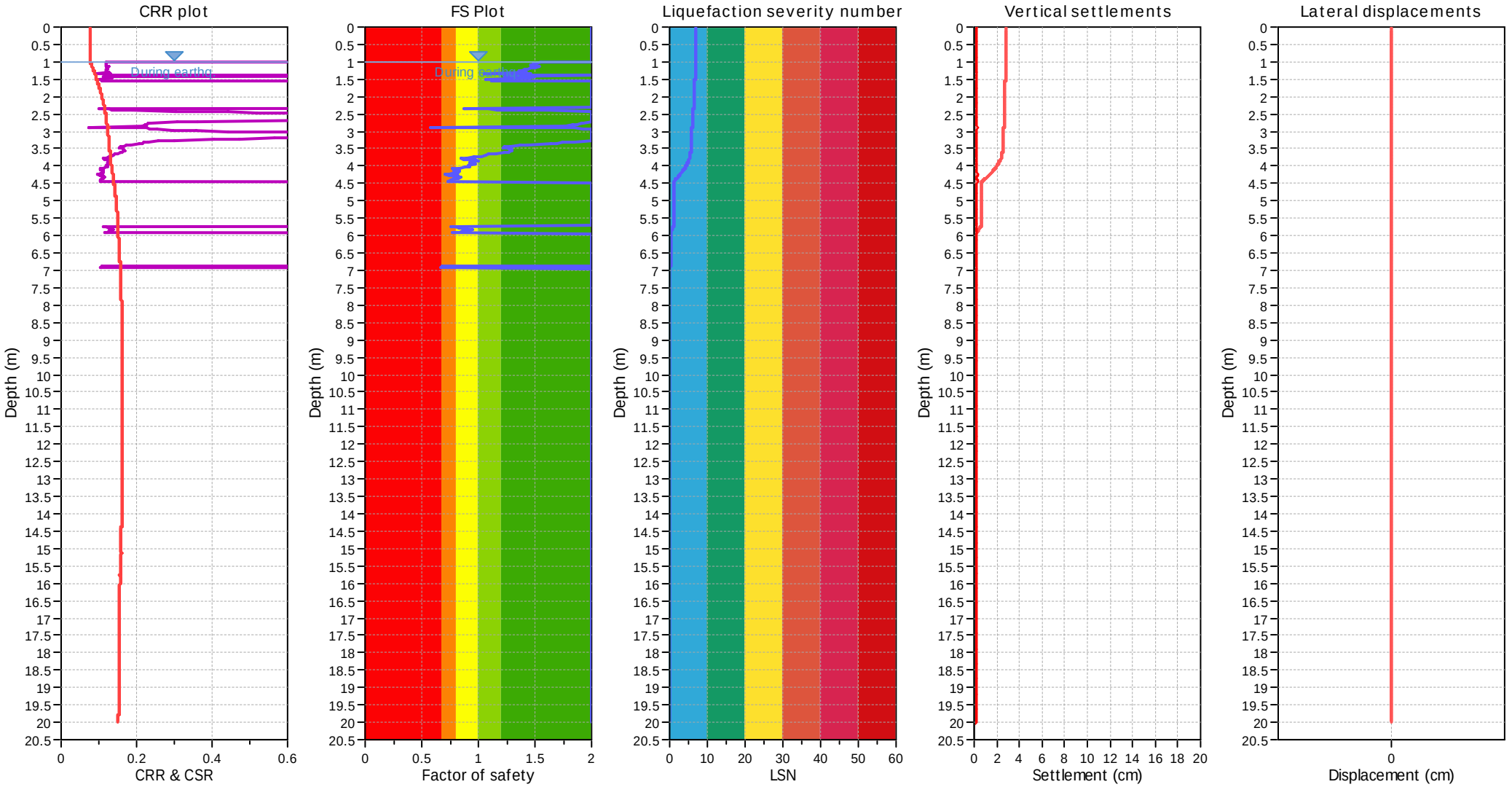

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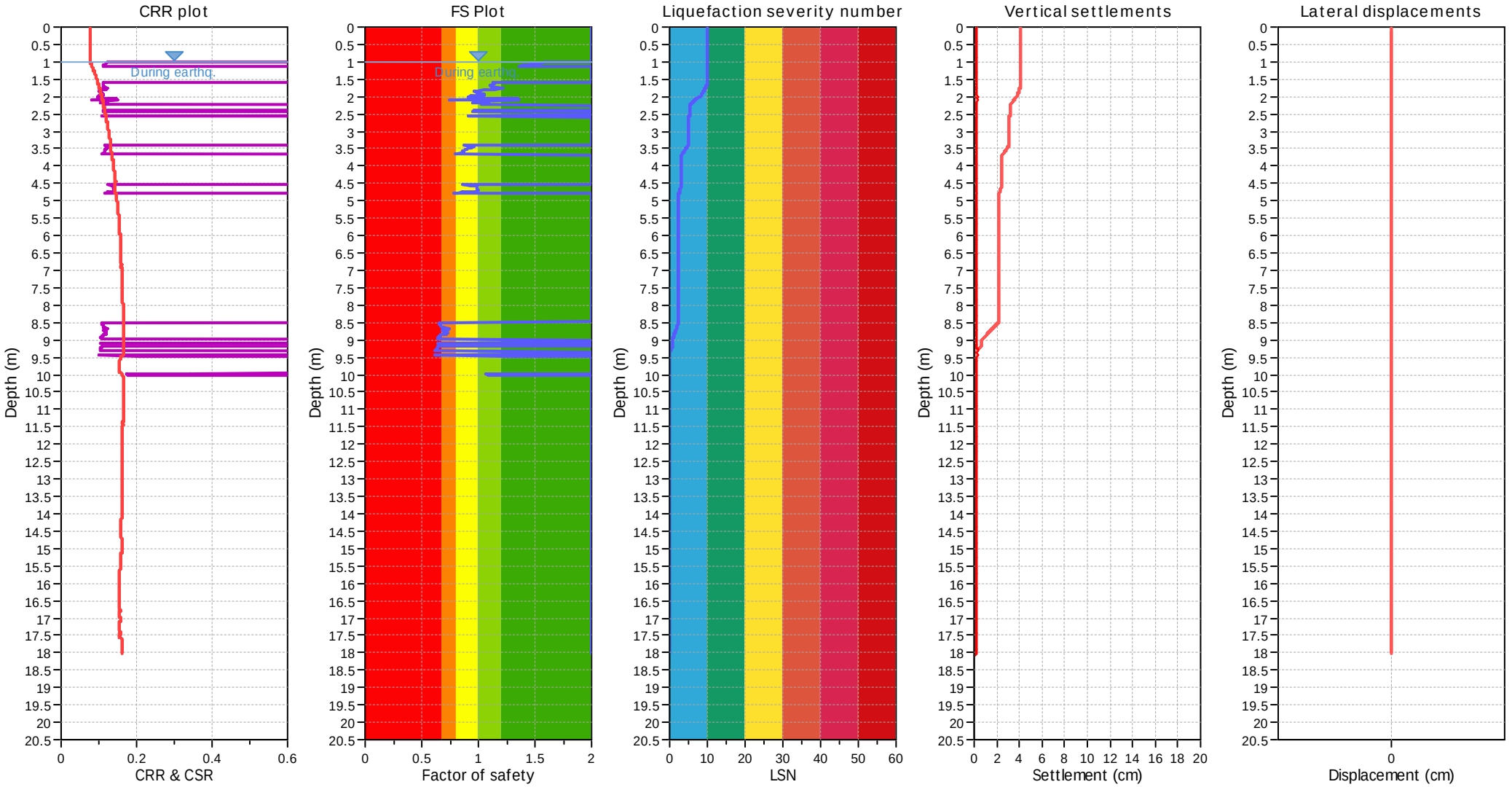

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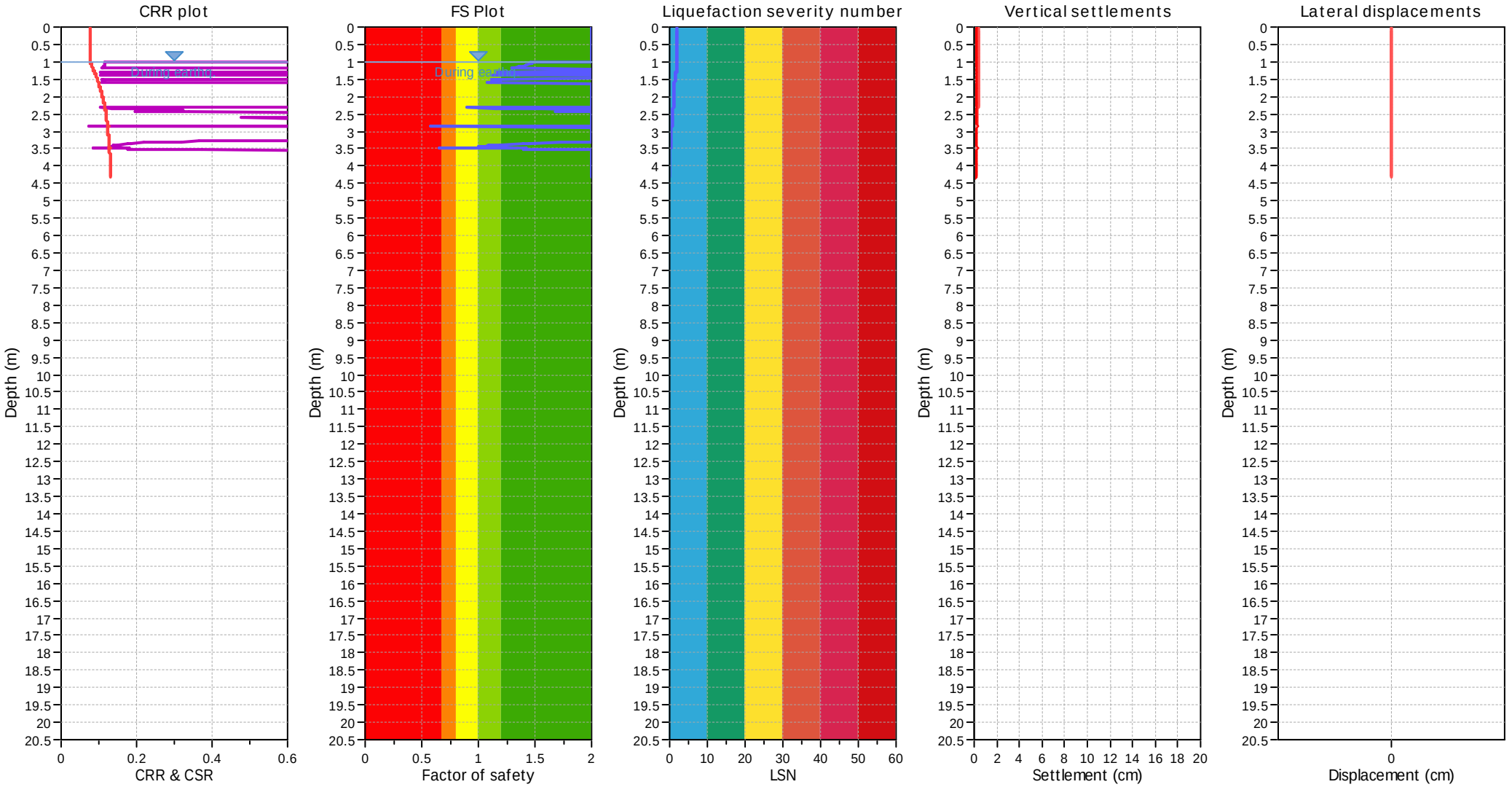

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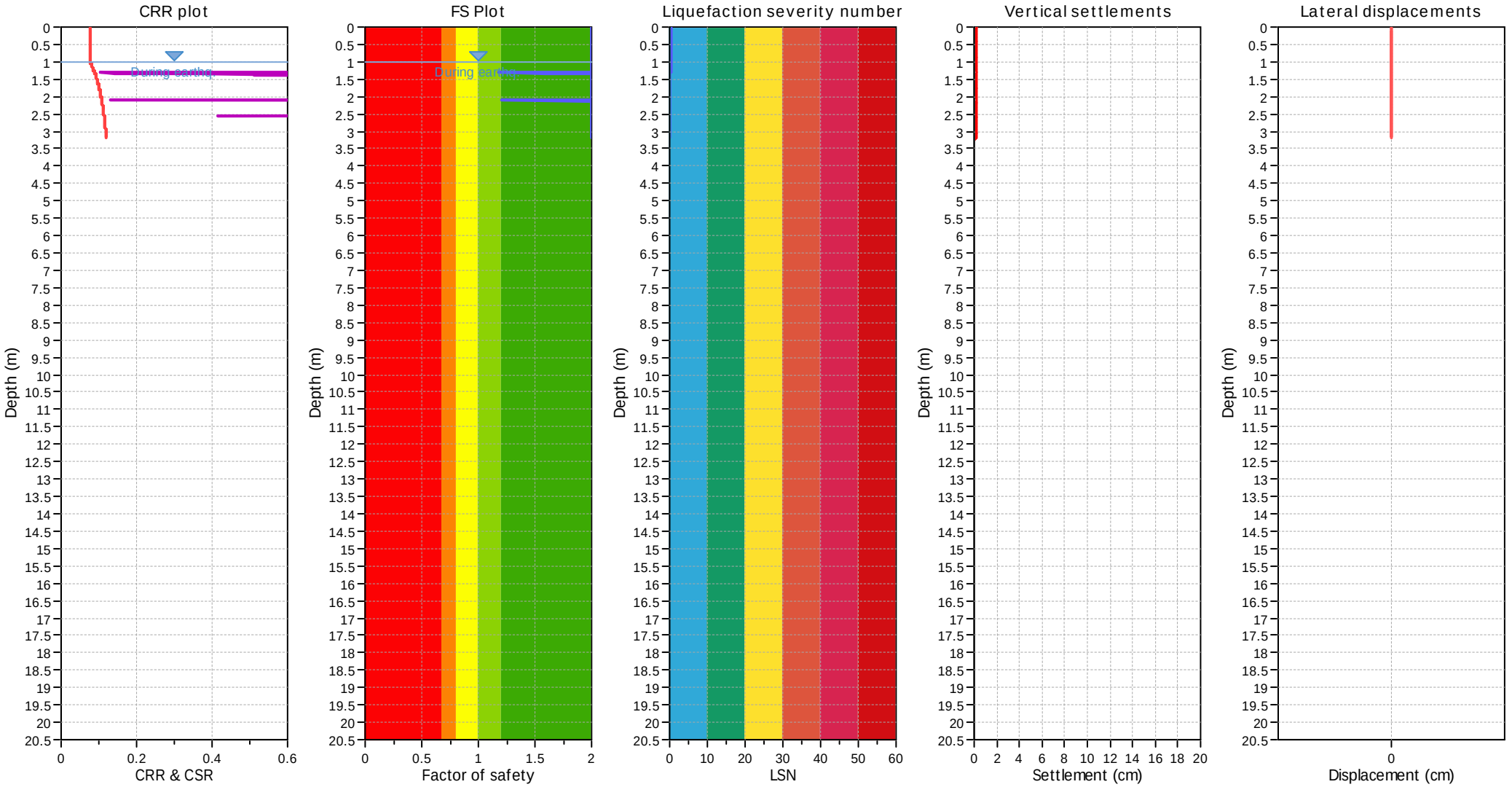

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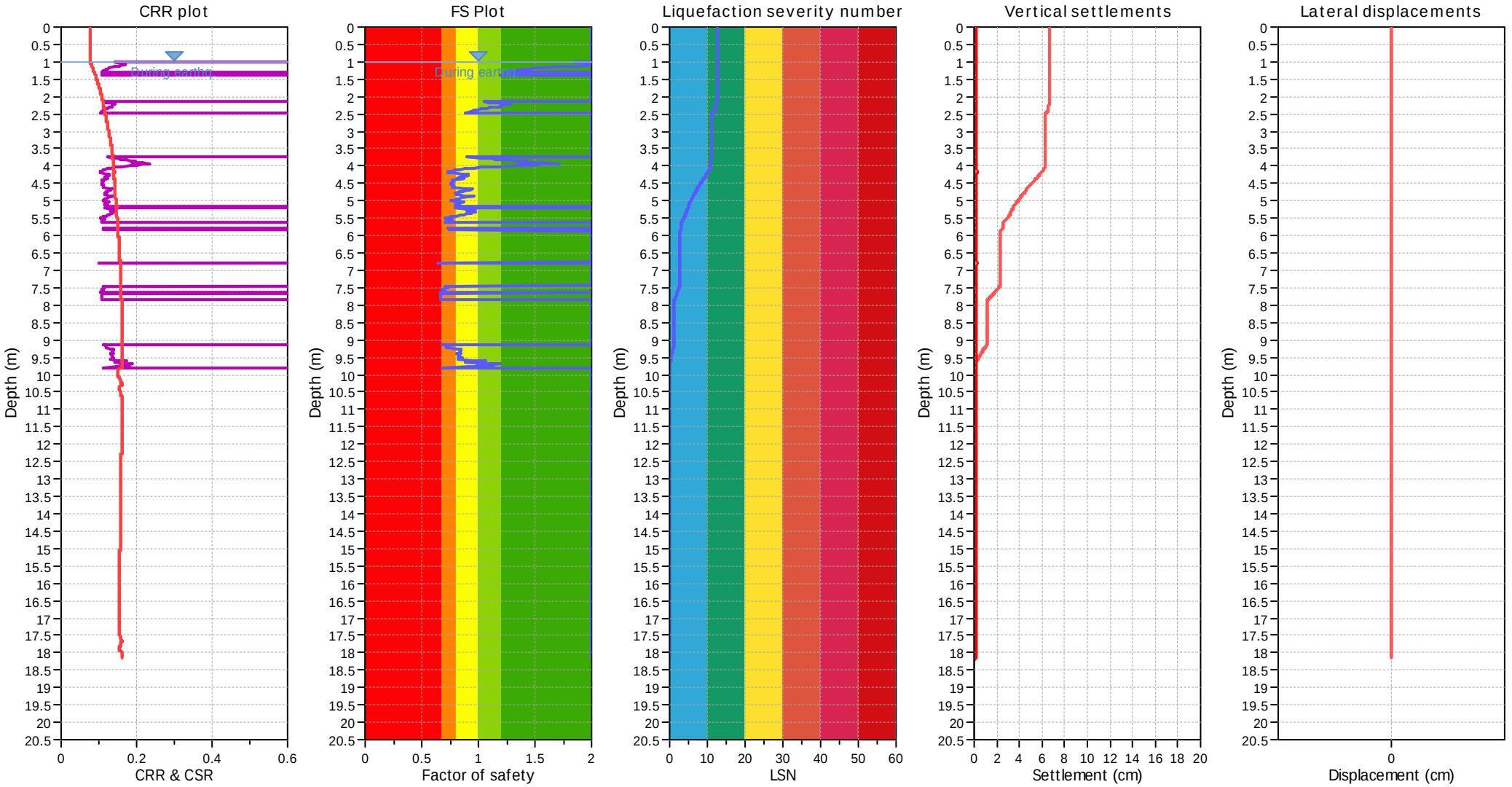

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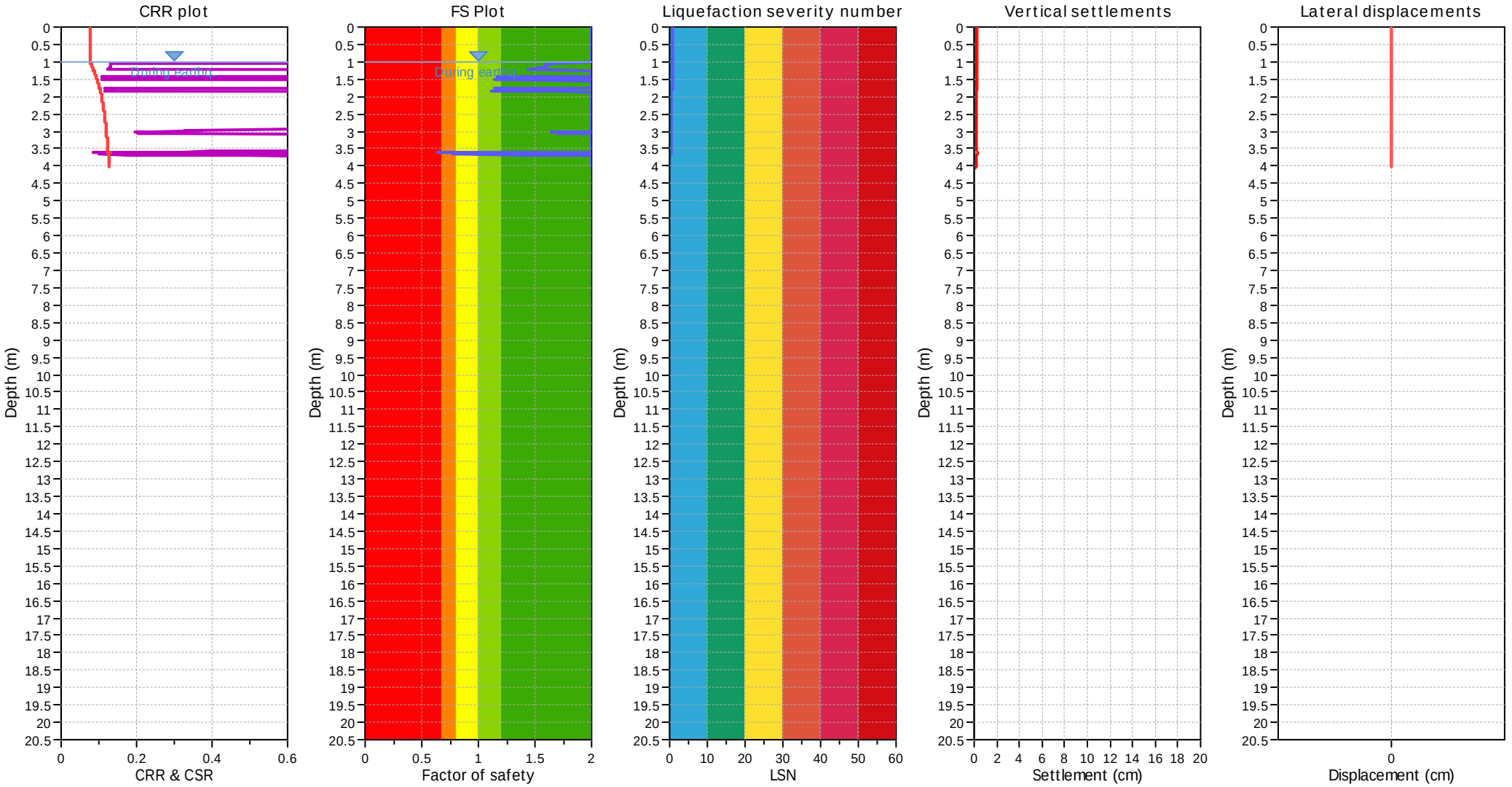

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Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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

- Severe damage
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- Moderate expression of liquefaction
- Minor expression of liquefaction
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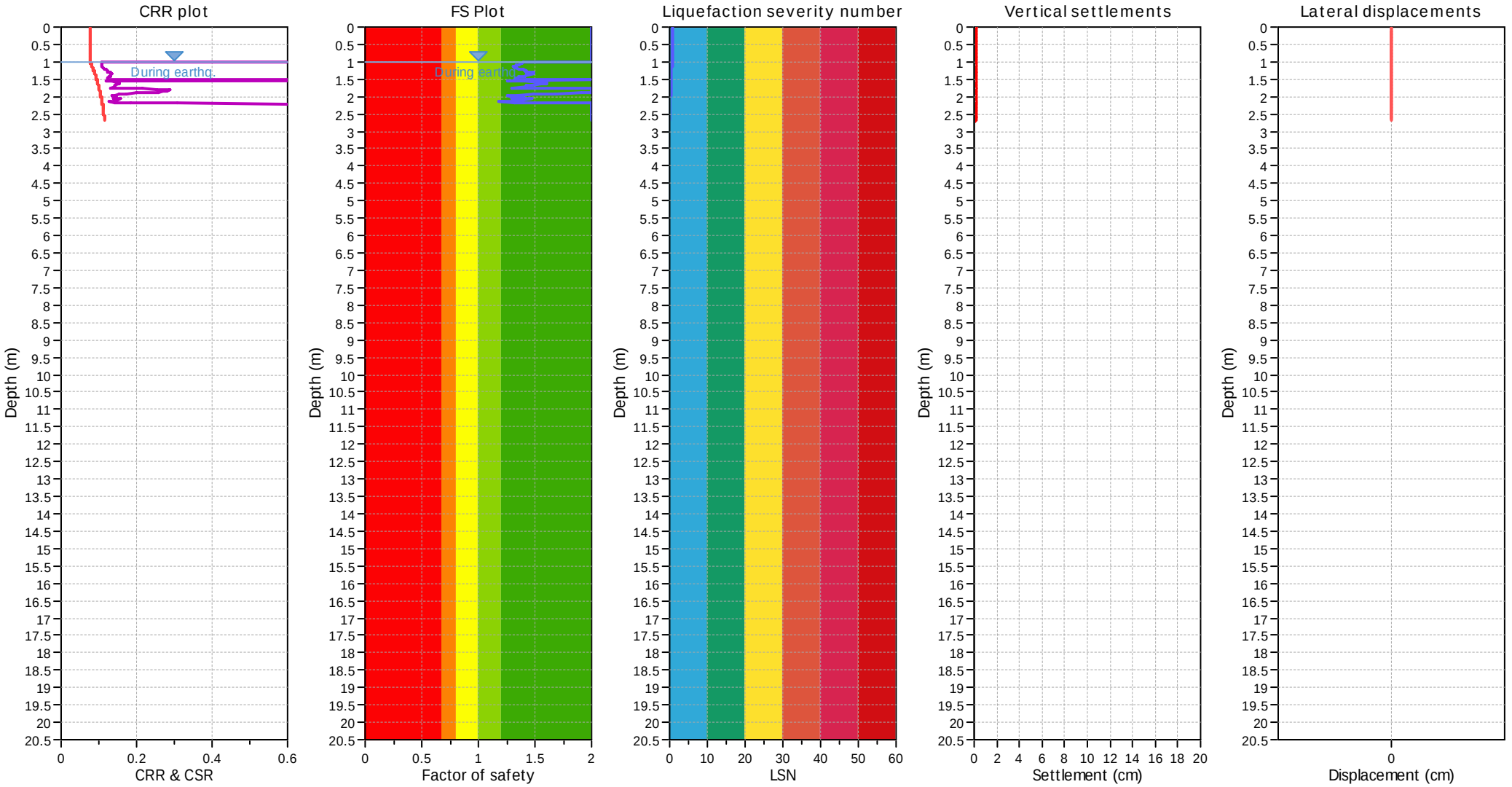
Liquefaction analysis overall plots



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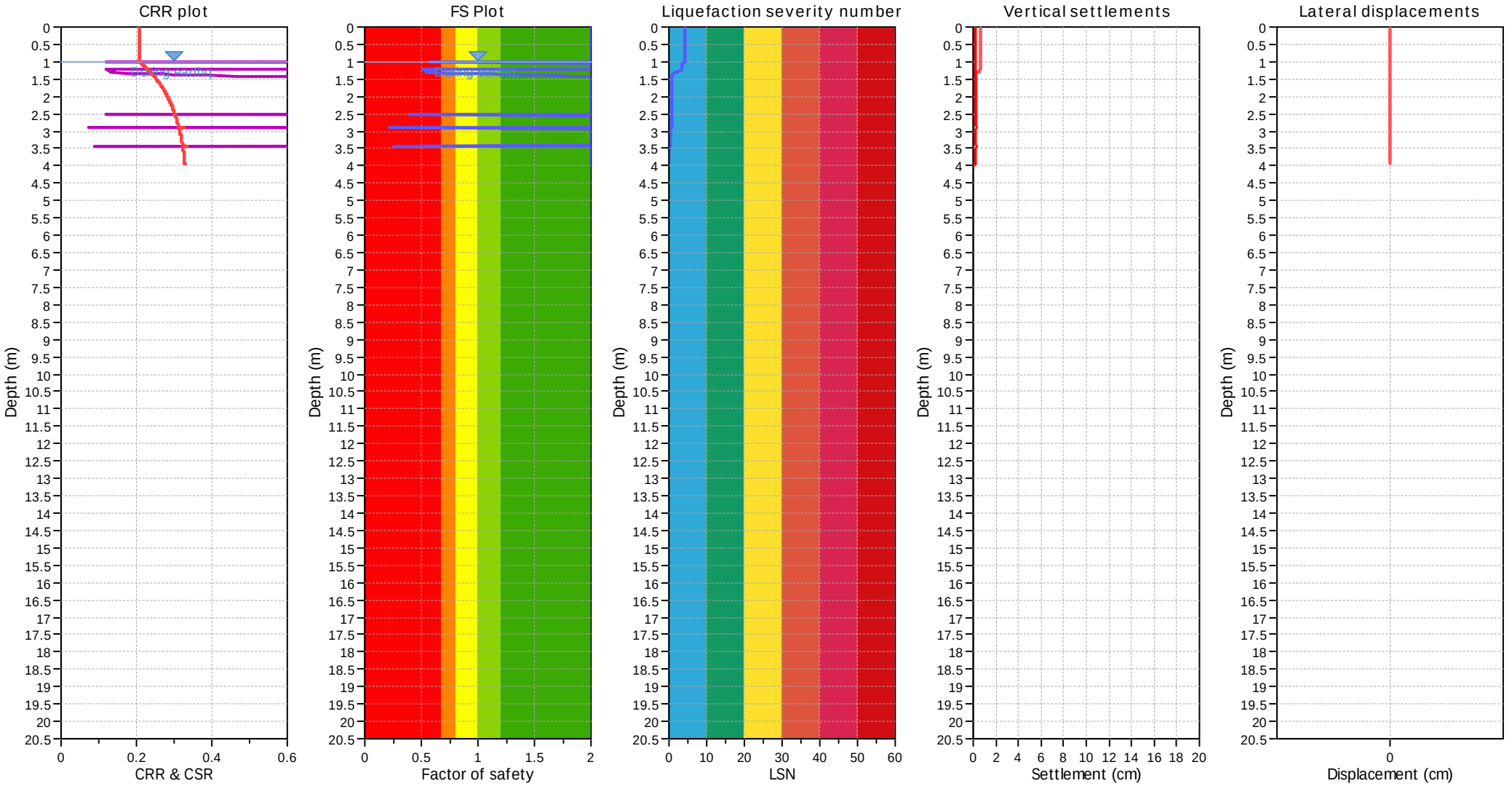

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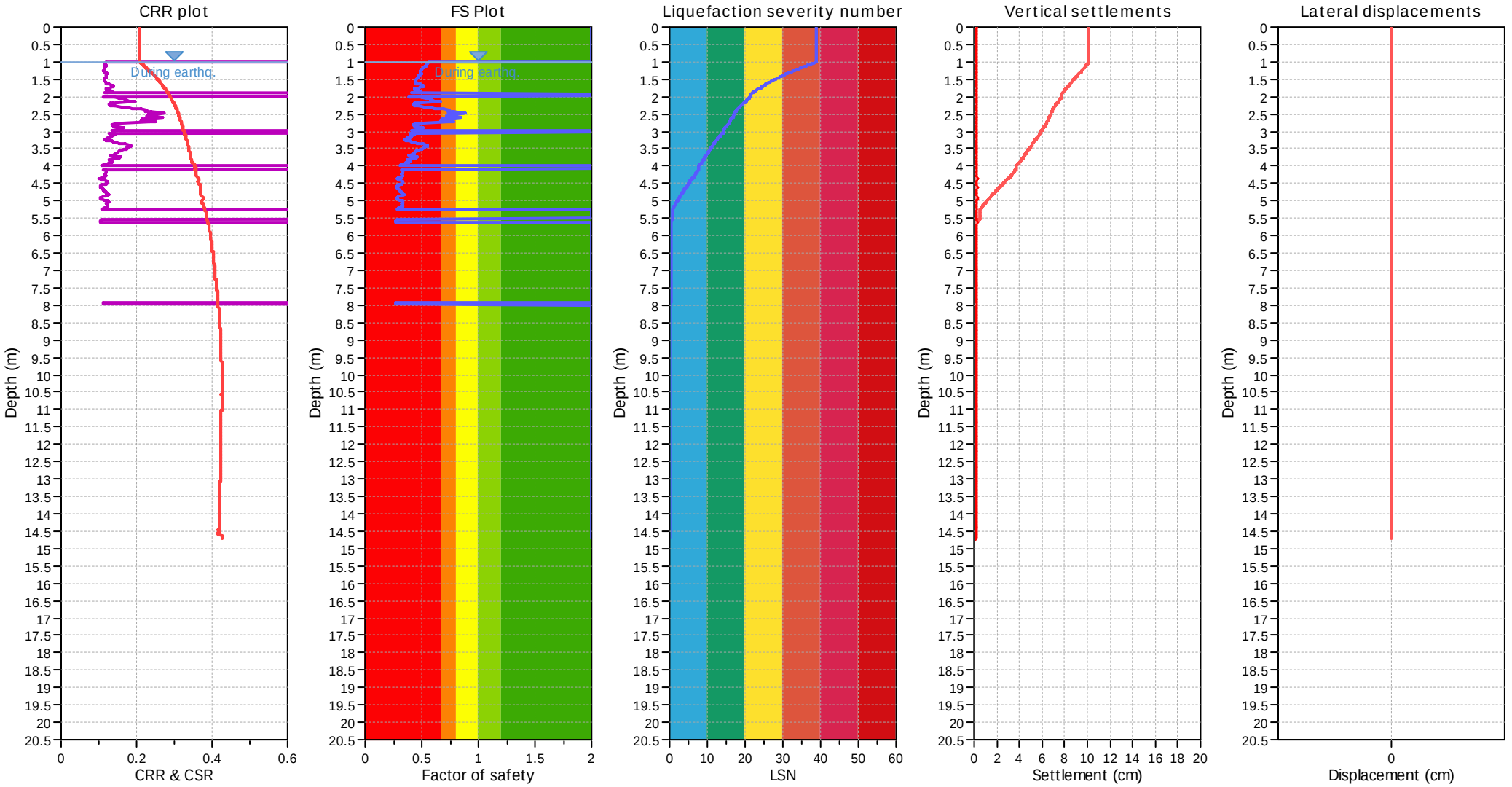

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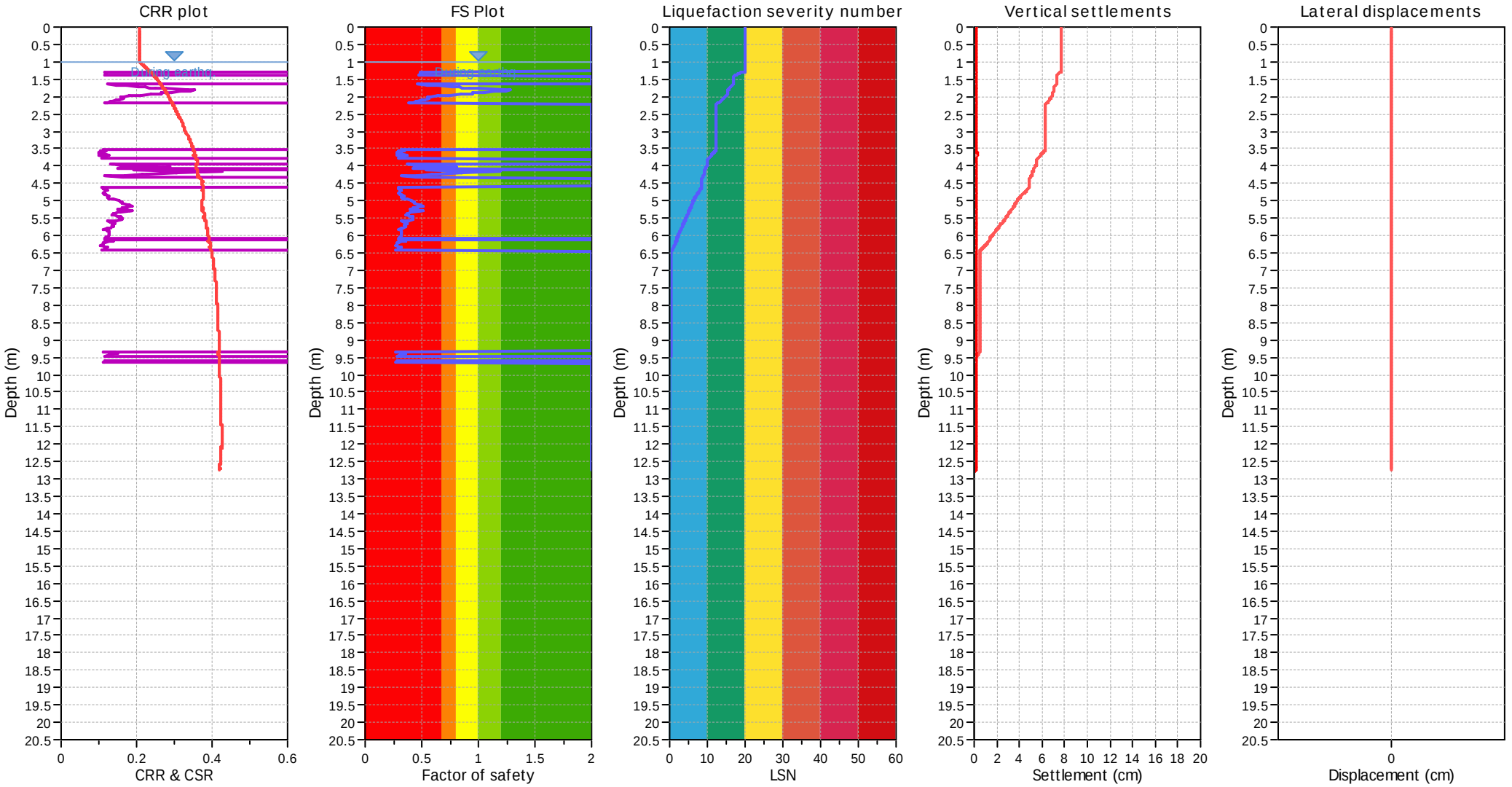

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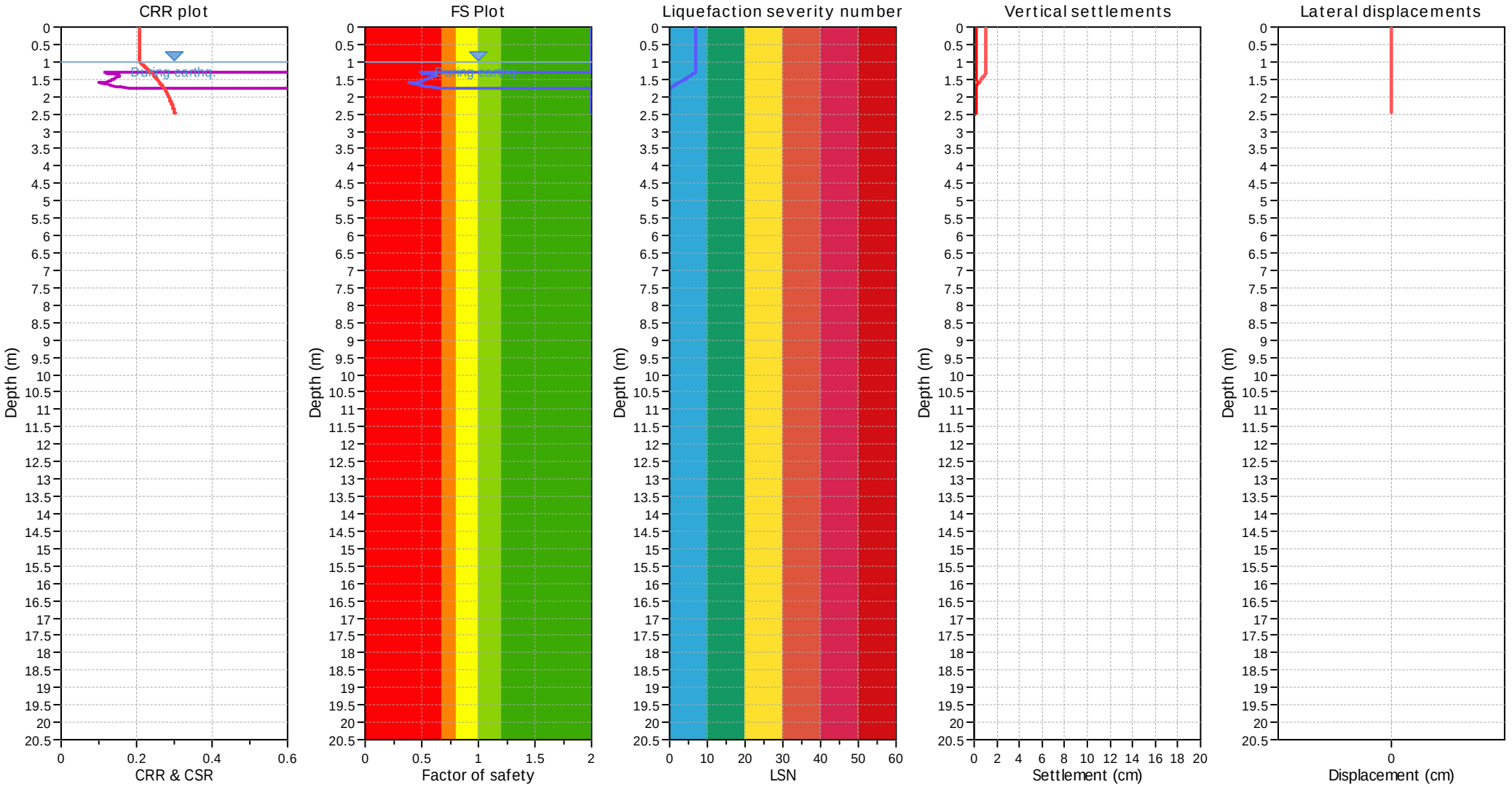

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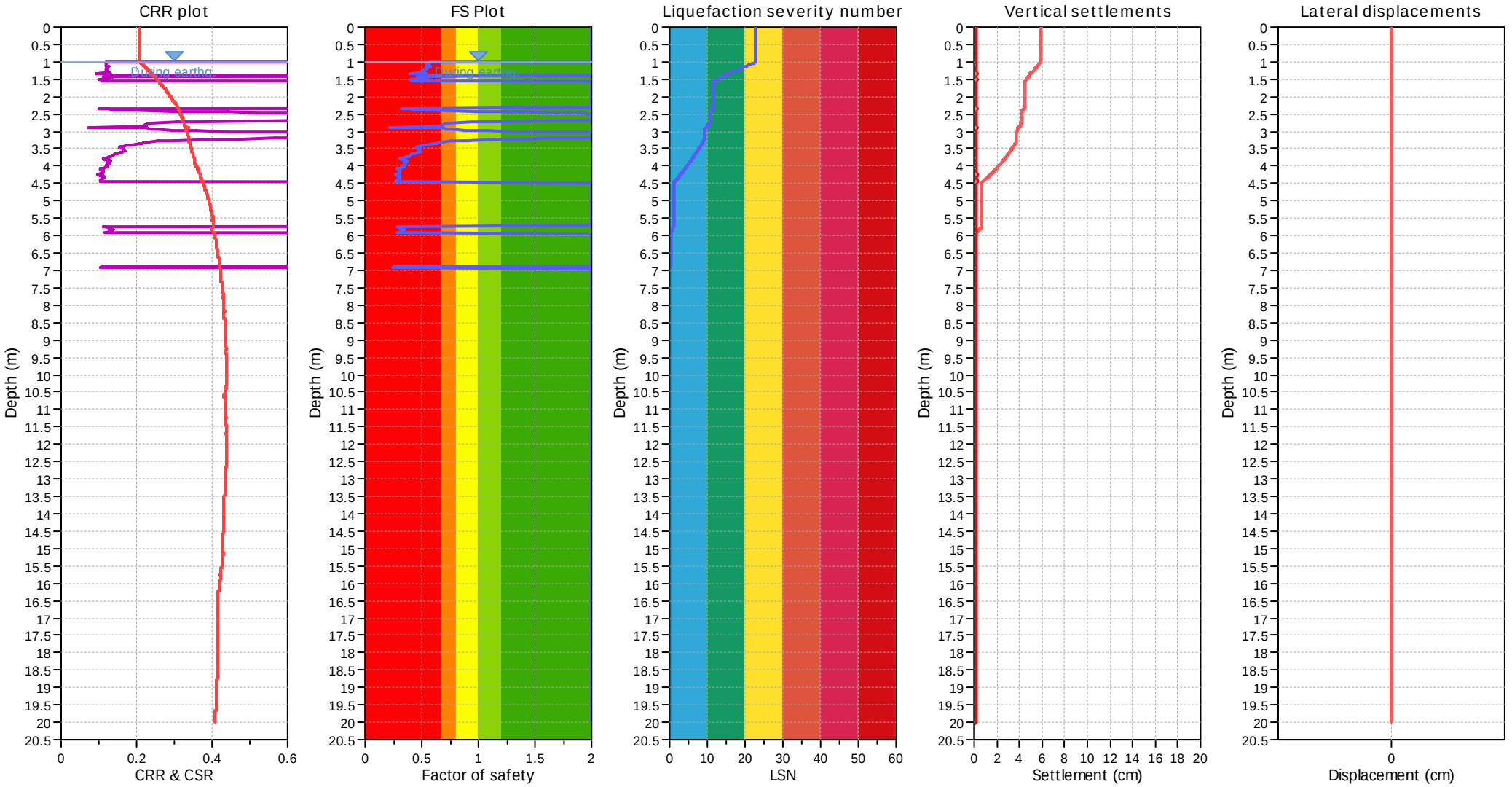

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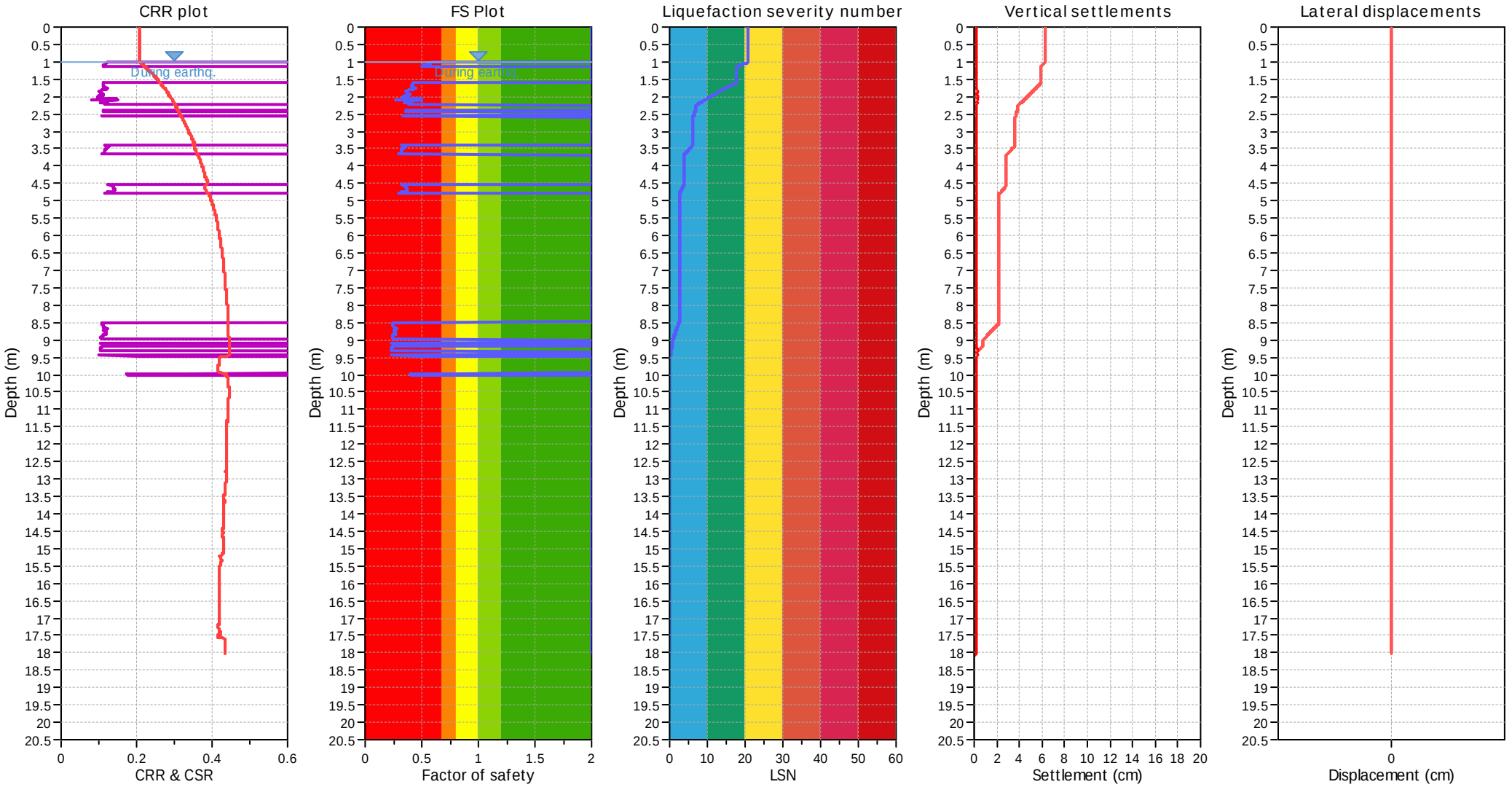

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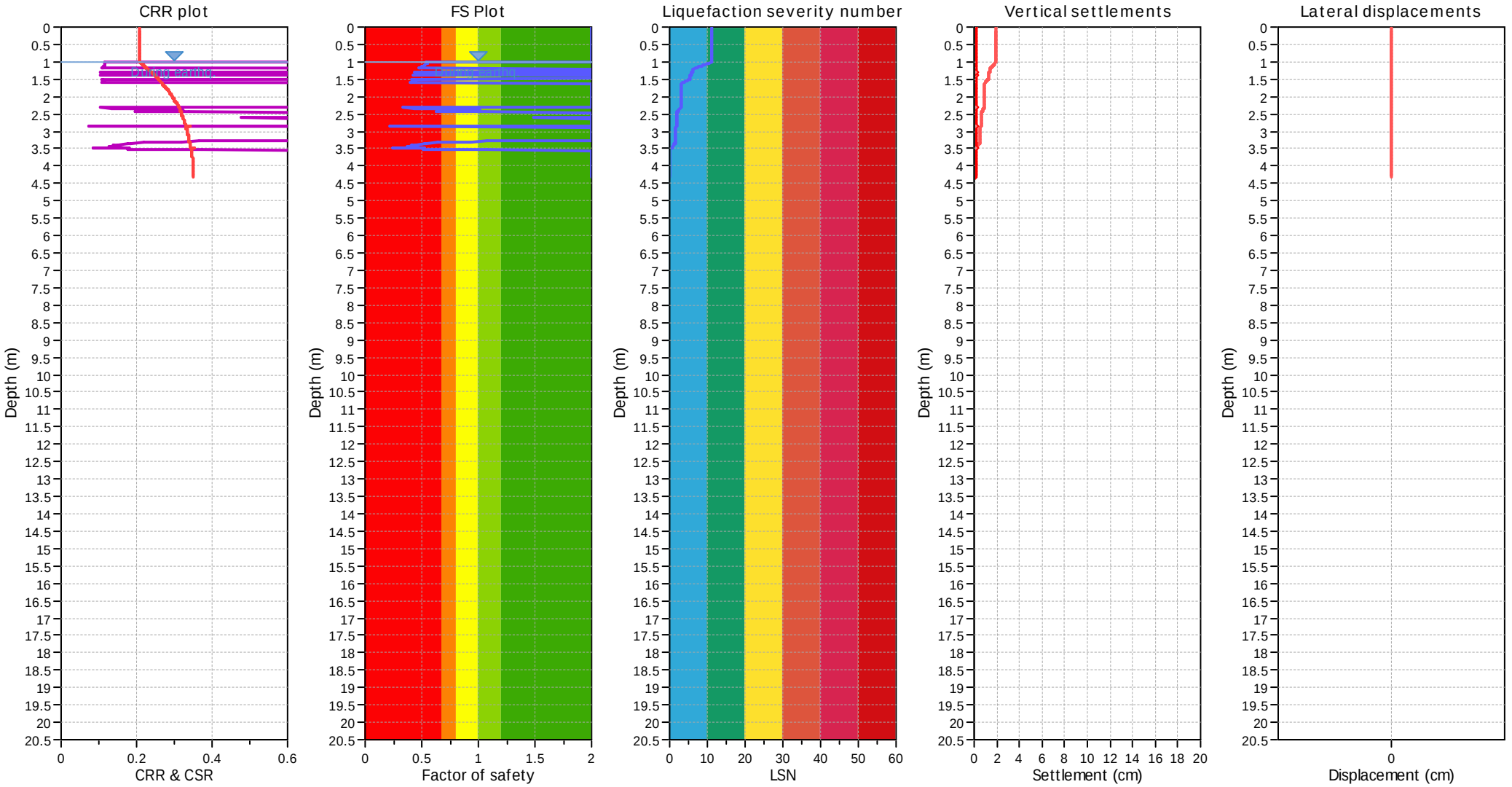

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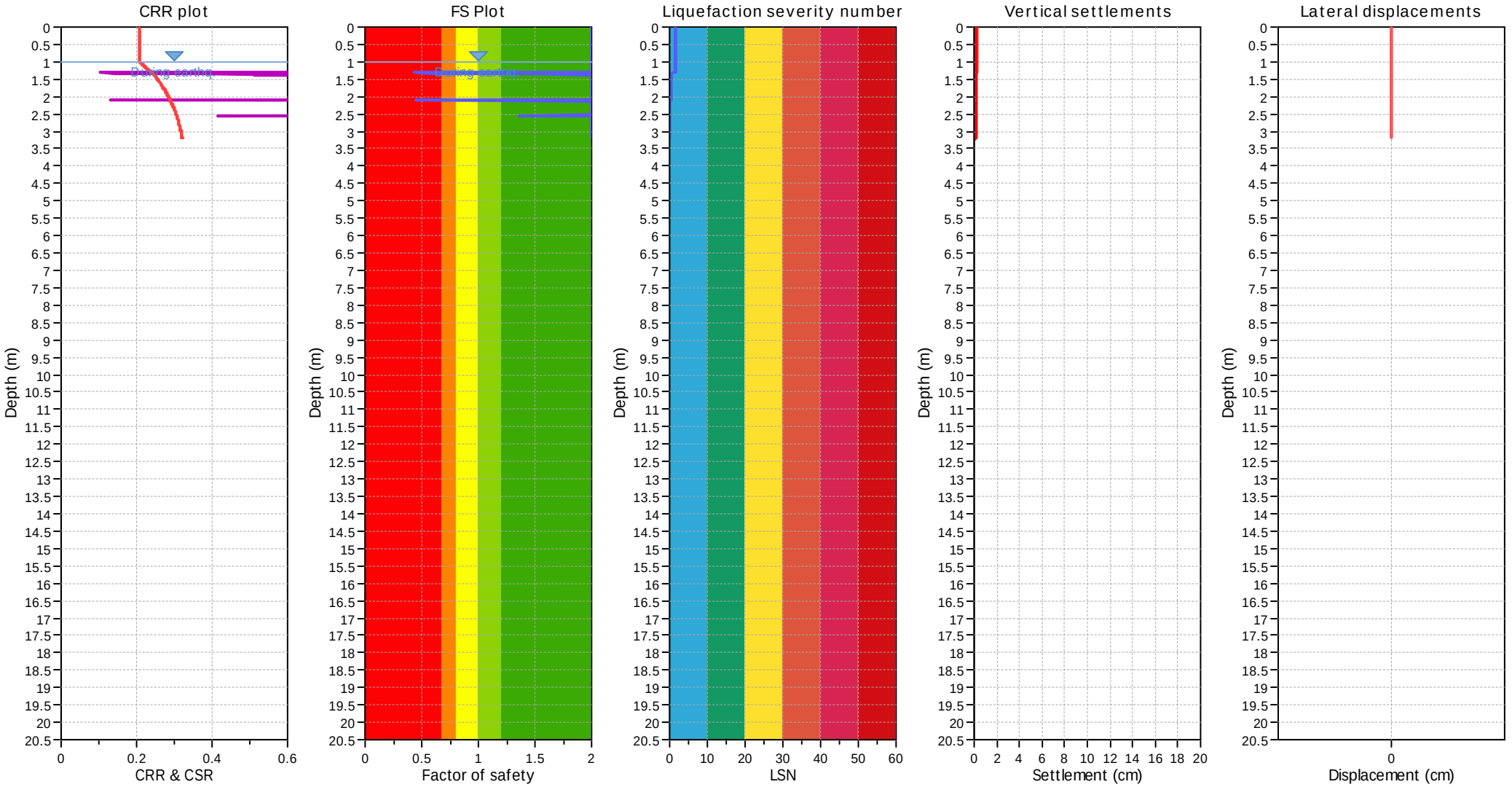

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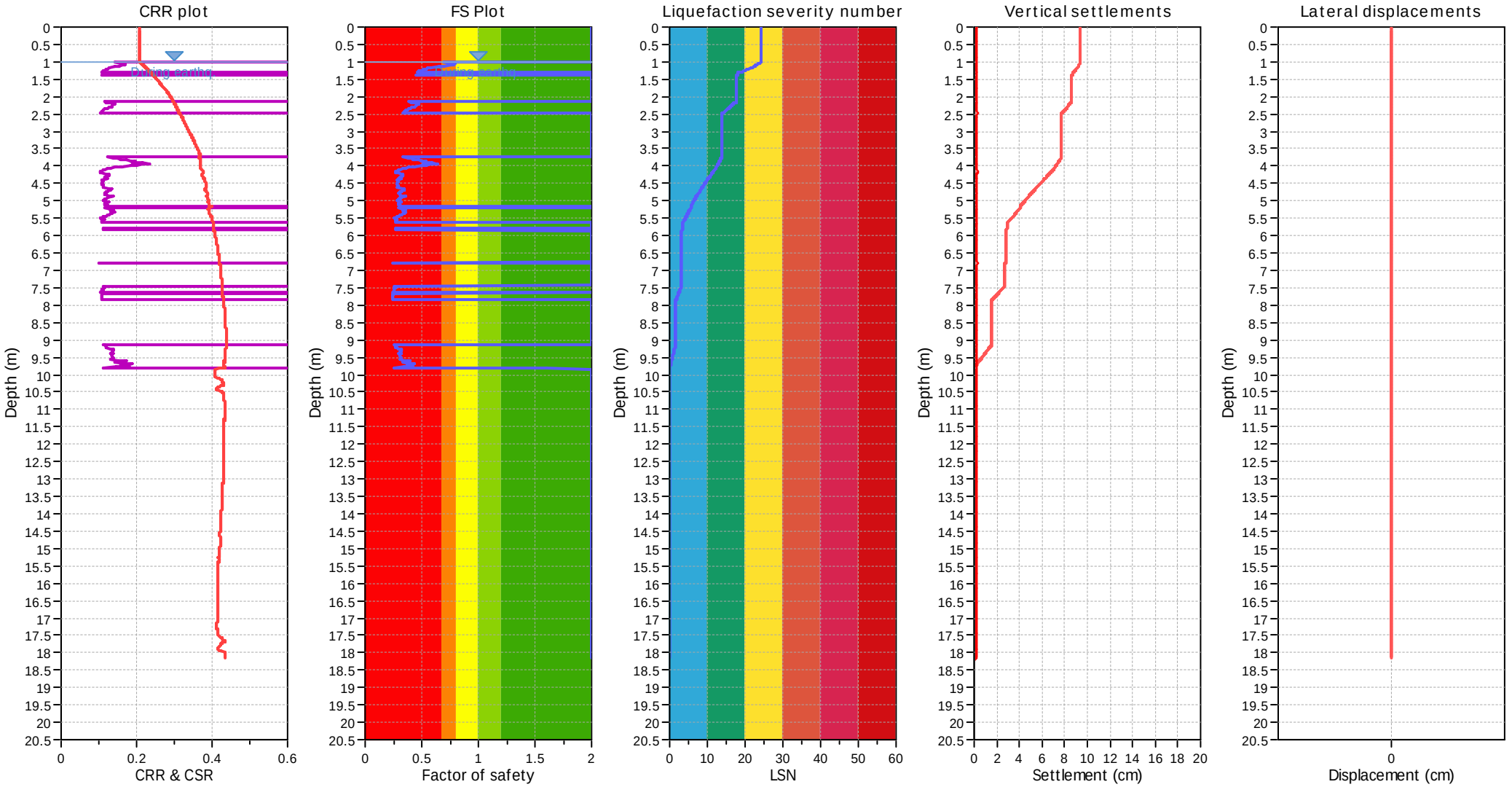

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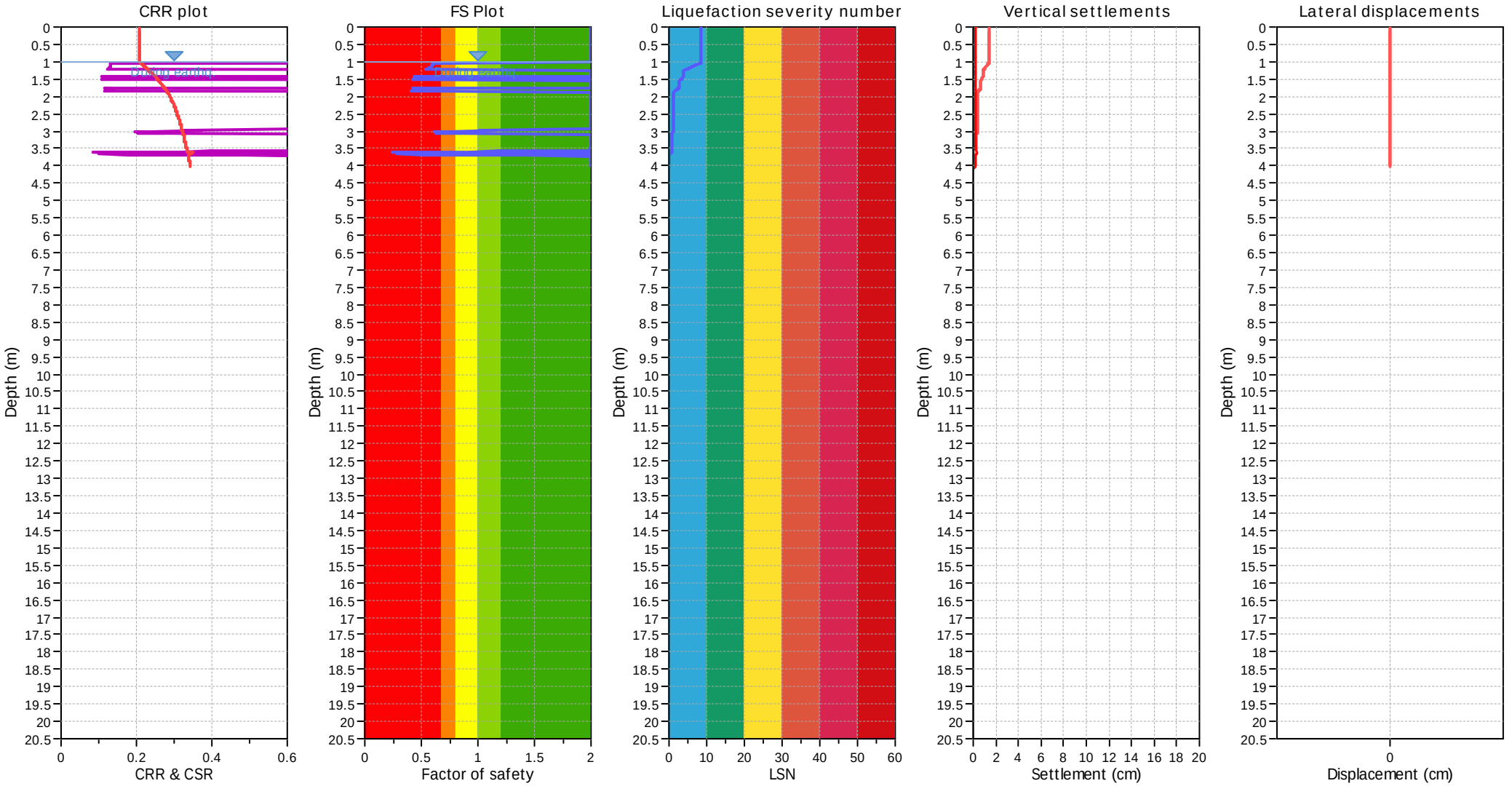

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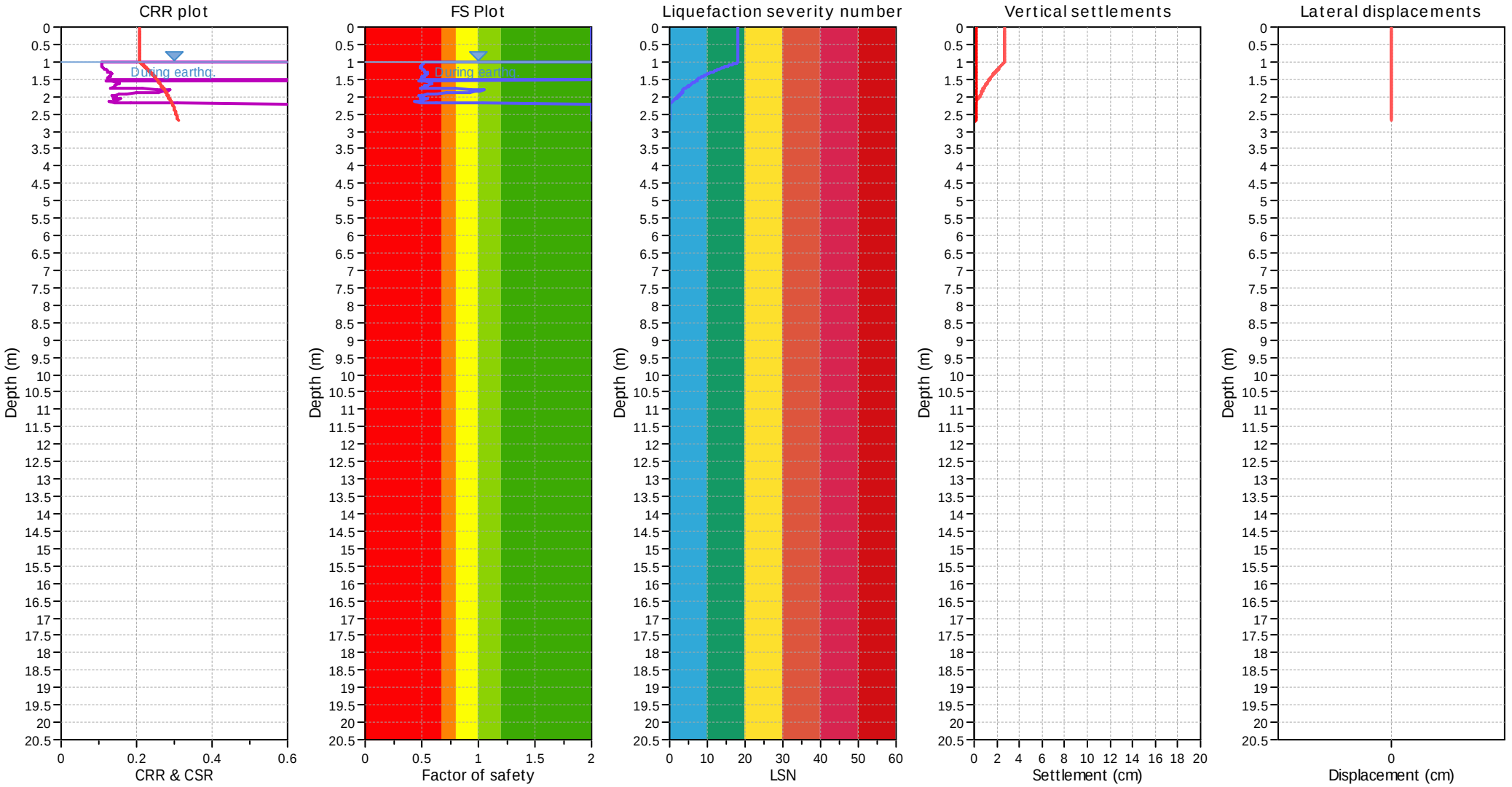

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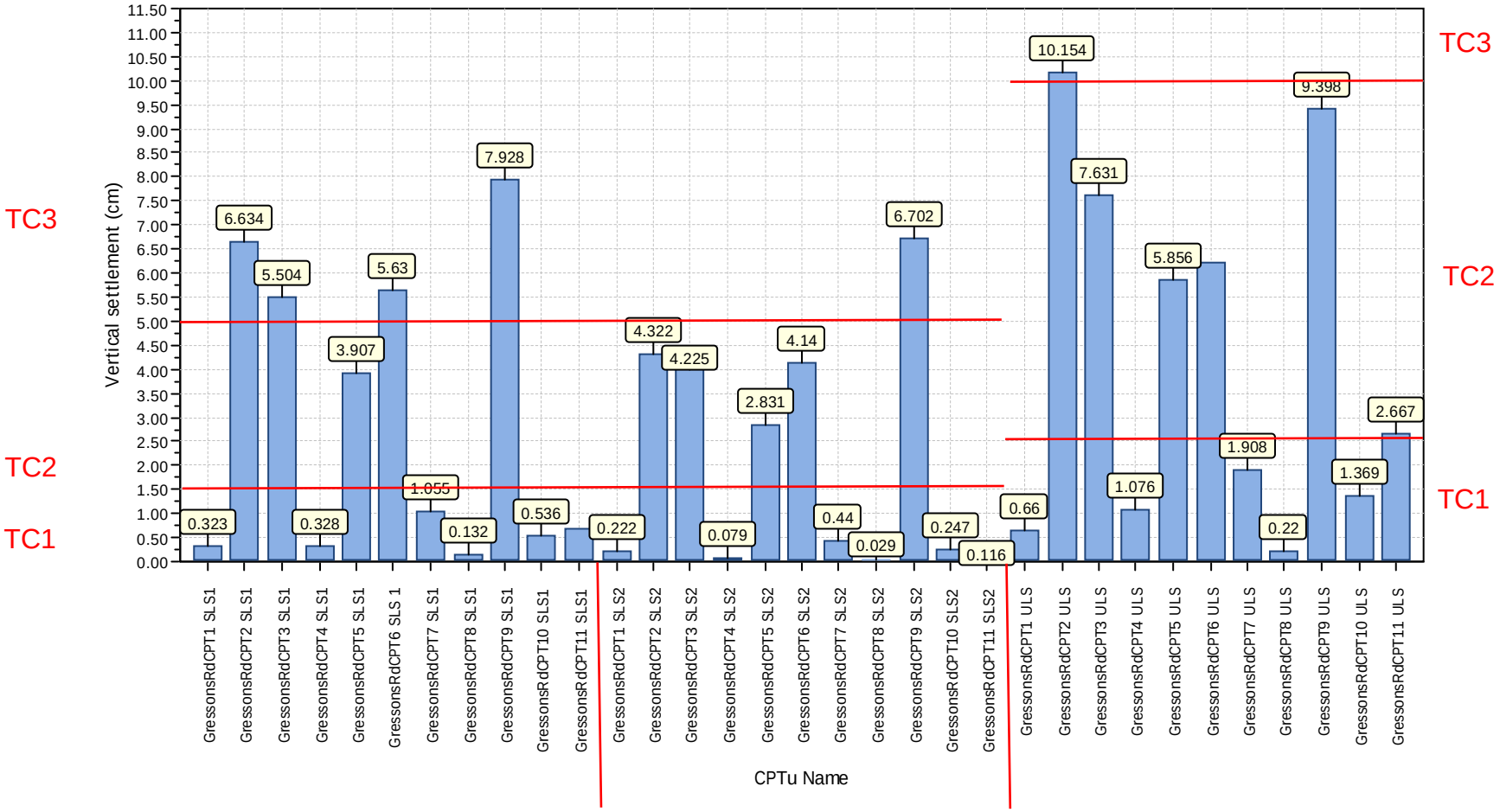
Overall Vertical Settlements

Eliot Sinclair & Partners
PO Box 9339
Christchurch 8149
www.eliotsinclair.co.nz

Project title : Northside Country

Location : 81 Gressons Road

Overall vertical settlements report



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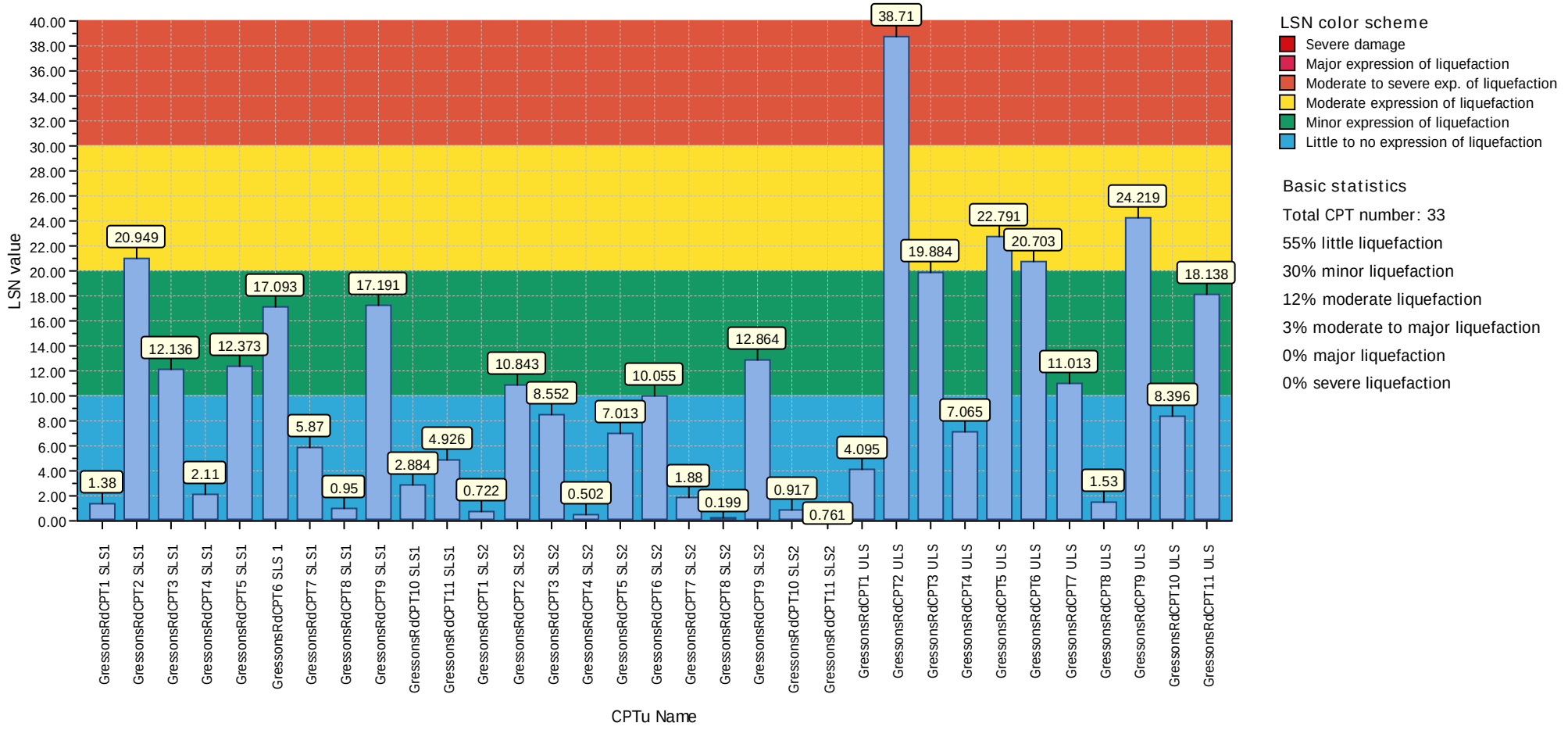

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Basic statistics

Total CPT number: 33

55% little liquefaction

30% minor liquefaction

12% moderate liquefaction

3% moderate to major liquefaction

0% major liquefaction

0% severe liquefaction

APPENDIX 5

ELLIOT SINCLAIR – CONTAMINATION ASSESSMENT (2020)

Ground Contamination Assessment

81 Gressons Road and 1375 Main North Road, Waikuku

Prepared for Northside Country Limited

350494

eliot sinclair

Ground Contamination Assessment

81 Gressons Road and 1375 Main North Road, Waikuku

Prepared for Northside Country Limited

350494

Quality Control Certificate

Eliot Sinclair & Partners Limited

eliotsinclair.co.nz

Action	Name	Signature	Date
Prepared by:	Jeffrey Fleming Geotechnical Engineering Technician NZDE Civil		27 November 2020
Reviewed by:	Kristel Franklin Engineering Geologist BSc MSc (HAZM)CMEngNZ PEngGeol (1163943)		27 November 2020
Directed and approved for release by:	John Aramowicz Geotechnical Engineer Director BEng(Hons) Mining CMEngNZ IntPE(NZ) CPEng (1008112)		27 November 2020
Status:	Final		
Release date:	27 November 2020		
Reference no:	350494		
Distributed to:	Northside Country Limited		

Limitations

This report has been prepared for Northside Country Limited according to their instructions and for the particular objectives described in this report. The information contained in this report should not be used by anyone else or for any other purposes.

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Appendix A. Site Plan

Appendix B. Site Photographs

Appendix C. Listed Land Use Register (LLUR)

Appendix D. Historical Aerial Photographs and Satellite Images

Appendix E. Environment Canterbury Resource Consents

The National Environmental Standard for and Managing Contaminants in Soil to Protect Human Health (MfE 2011), and associated contaminated land management guidelines make abundant use of acronyms. Some commonly used abbreviations are:

ACM	Asbestos containing material
AST	Above ground storage tank
BAP	Benzo-alpha-pyrene
bgl	Below ground level
CCC	Christchurch City Council
CoC	Chain of Custody (Transport and Laboratory Quality Assurance), or
CoC	Contaminants of Concern
CSM	Conceptual Site Model
DSI	Detailed Site Investigation (often referred to as Phase 2)
DQO	Data Quality Objectives
ECan	Environment Canterbury Regional Council
HMs	Heavy metals screen; GC scan for Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Zinc
LLUR	Listed Land Use Register (ECan database of land with known or suspected contamination)
LWRP	Proposed Canterbury Land and Water Regional Plan (ECan 2012)
MfE	Ministry for the Environment
MMP	Monitoring and Management Plan (Phase 5)
NES(soil)	National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health. Regulations 2011.
NRRP	Natural Resources Regional Plan (Environment Canterbury 2011)
OCP	Organochlorine Pesticides
ONOP	Organophosphorus Pesticides
PAH	Polycyclic Aromatic Hydrocarbons
PEF	Potency Equivalent Factors, synonym with TEQ
PCP	Pentachlorophenol
PSI	Preliminary Site Investigation (often referred to as Phase 1)
QC/QA	Quality Control/Quality Assurance
RAP	Remedial Action Plan, often joint with a Health and Safety Plan (HSP) (Phase 3)
SCS(health)	Soil Contaminant Standard for health for inorganic substances
SPLP	Synthetic Precipitation Leaching Procedure
SVOC	Semi Volatile organic Compounds
SVR	Site Validation Report (Phase 4)

TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin, persistent carcinogenic pollutant of 2,4,5-T; was widely used in forestry as defoliant (herbicide) in the 1950s-1960s.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalent
TLB	True left bank (of a river, as seen in the direction of flow)
TRB	True right bank (opposite the TLB)
UST	Underground storage tank

1. Executive Summary

This report comprises a ground contamination assessment for land at 81 Gressons and 1375 Main North Road in Waikuku, North Canterbury, and has been prepared to inform a proposed zone change from rural to residential land use.

This report is a Preliminary Site Investigation (PSI), prepared in accordance with the National Environmental Standard (NES), which ensures that potential contamination from recent or historical HAIL[1] activities is identified and assessed at the time of development and, if necessary, remediated to make the land safe for the intended use. Eliot Sinclair carried out an initial assessment and reporting for the site in December 2013 and have subsequently carried out a further site visit and desk study in November 2020.

The PSI is based on:

- A site walkover and interview with the site owner in September 2013 and November 2020,
- Investigation of a high-resolution aerial photograph from 1942, 1963, 1976, 1980, 1984, 2000 and satellite images from 2005 and 2013 to 2019,
- A search of Waimakariri District Council's property file,
- A search of Environment Canterbury's Listed Land Use Register (LLUR), and Resource Consent Database.

Most of the land has been in the ownership of Mr and Mrs Stokes since 1991 with other areas acquired between 2002 and 2003. The historical land use comprised cattle and sheep grazing, and barley cropping. The current land use is pastoral; i.e. Mr and Mrs Stokes currently use the land to graze dairy cattle (presently 400 cows/140 ha; i.e. approx. 3 cows/ha).

Farm chemicals are stored and formulated off-site, and site investigations did not reveal any farm pits, livestock dips or spray race operations, change in the natural contour of the land from excavation or fill, discoloured soils, or stressed vegetation. Apart from a historical disused well shed at 81 Gressons Road with an electric well and a historical hay shed at the southern boundary, there are no other buildings or structures are on the land or, according to the owner, have been on the land.

Other than three small burn pads, no other historical or current activities have been identified during the site investigation and interview with the owner, the investigation of aerial photographs, the search of the property file, LLUR and Resource Consent Database that might have led to intentional or accidental release of hazardous substances. Consequently, acknowledging the three burn pads will need to be removed or remediated before subdivision, this preliminary site investigation concludes that it is unlikely that HAIL activities have taken place or are taking place on the land. On this basis, it is considered that it is "highly unlikely" that ground contamination is present that exceeds the NES soil contaminant standards for residential land use.

[1] Hazardous Activities and Industries List, published by the Ministry for the Environment (MfE, 2011).

A tabular summary of the ground contamination assessment is provided in Table 1.

Table 1. Summary of Ground Contamination Assessment.

Site Addresses	81 Gressons Road, 1375 Main North Road and three parcels in between without associated street address in Waikuku, North Canterbury
Local Authority	Waimakariri District Council
Resource consents	Two expired water take consents, no discharge consents, no hazardous storage consents
Legal Description	Lot 2 DP 428676, Lot 2 DP 62186, Lot 2 DP 303387, Lot 3 DP 62186, Lot 1 DP 470921; all on certificate of title 512583; Pt RS 3101 (paper road, 0.7852 ha)
Area	34.0768 hectares
Owner/occupier	Brian & Anne Stokes, and unknown (paper road)
Current land use	Pastoral (dairy cattle grazing), shelterbelts
Proposed land use	Residential
LLUR ID	None
HAIL	None

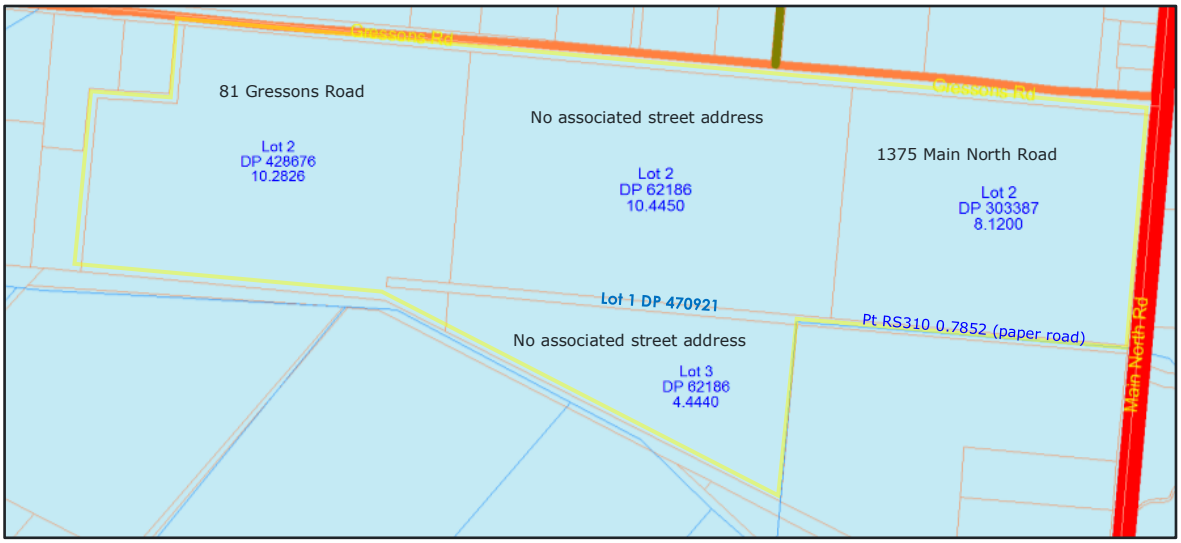


Figure 1 Site plan with Legal Description, source Qmap.

2. Introduction

Mr and Mrs Stokes have engaged Eliot Sinclair to undertake a ground contamination assessment of 34.0768 hectares at 1375 Main North Road (SH1) and 83 Gressons Road in Waikuku, North Canterbury.

The investigation has been carried out to inform a proposed zone change from rural to residential land use.

The report has been prepared in accordance with the National Environmental Standard (NESSoil[2]) and MfE's Contaminated Land Management Guidelines 1-5[3]. This ensures that potential contamination from recent or historical HAIL[4] activities is identified and assessed at the time of development and, if necessary, remediated to make the land safe for human use.

[2] Resource Management; National Environmental Standard (NES) for Assessing and Managing Contaminants in Soil to Protect Human Health; Regulations 2011/361.

[3] Ministry for the Environment (2004, 2006, 2011) Contaminated Land Management Guidelines Vol. 1-5.

[4] Hazardous Activities and Industries List, published by the Ministry for the Environment (MfE, 2011).

The scope of this report comprises:

- A description of the site and its surrounding environment to support a conceptual site model,
- Review of the Listed Land Use Register and Resource Consent Database from Environment Canterbury,
- Review of available information from the property file from the Waimakariri District Council,
- Review of a historical aerial photograph and a recent satellite images,
- A Site investigation and interview with the site owner,
- Conclusion and recommendations.

3. Site Description

The site is bordered by State Highway 1 at the southern fringes of the Waikuku settlement and Gressons Road. The site comprises five land parcels at 81 Gressons Road and 1375 Main North Road (SH1), and three parcels between without street addresses. Site plans are appended in Appendix A.

Legal Description: The legal description, associated street address, area and owner of the land area summarised in **Table 2.**

Table 2. Legal description of the site.

Lot	Title	Owner	Street Address	Area [ha]
Lot 2 DP 428676	512583	B&A Stokes	81 Gressons Rd	10.2826
Lot 2 DP 62186	512583	B&A Stokes	No street address associated	10.4450
Lot 2 DP 303387	512583	B&A Stokes	1375 Main North Road (SH1)	8.1200
Lot 3 DP 62186	512583	B&A Stokes	No street address associated	4.4440
Lot 1 DP 470921	512583	B&A Stokes	No street address associated	0.6410
Pt RS 3101	-	-	(paper road)	0.7852
			Total	**34.7178**

Topography: The land is classified as 'flat'[5] and has no significant topographical features. The lowest elevation of the site is approximately 5m asl (metres above sea level) in the north-eastern corner near SH1 (Main North Road). From there the land gently rises to approximately 10m asl towards the western boundary. This results in an average gradient of 1:240.

Surface Water: The nearest surface water is located in an open drain along the southern boundary of the site, which are part of the Stokes Drain catchment. No water quality management unit has been allocated to the drains in the proposed Land and Water Regional Plan. Waikuku Stream flows approximately 100m north of the site in a north-to east direction.

[5] LandCare Research soil classification / slope classes

Land Use: Most of the area is currently held in pasture (i.e. irrigated and fertilised) and grazed by cattle. Several shelterbelts (mostly poplars and eucalypts) which previously separated the four principal land parcels have been removed since our 2012/13 site inspection. A poplar shelter belt still remains at the western end of Lot 2 DP 428676. A small area near the southern boundary was previously a pine plantation but was felled during 2015/2016.

Soils and Underlying Geology: The soil of the three blocks closest to Gressons Road is described as Wakanui Deep Silt Loam[6]. Landcare Research classifies the soil as 'imperfectly drained' (drainage class 3 out of 5[7]). The triangular shaped parcel along the southern boundary (Lot 3 DP 62186) has poorly drained Temuka Deep Silt Loam (drainage class 4 out of 5).

The underlying geology comprises alluvial deposits of silts and sandy gravels over sandy gravels.

Groundwater: Groundwater under the southwestern portion of the site is within the Coastal Confined Gravel Aquifer System. Groundwater under the north-eastern part of the site is assumed to be unconfined or semiconfined (Figure 2).

Seven piezometers were placed evenly across the site by Eliot Sinclair staff in July 2013 and monitored monthly until October 2017. Results indicate that groundwater can increase to around 1m to 2m below ground level seasonally around 1m to 2m below ground level and at or near the existing ground level and in winter and spring conditions.

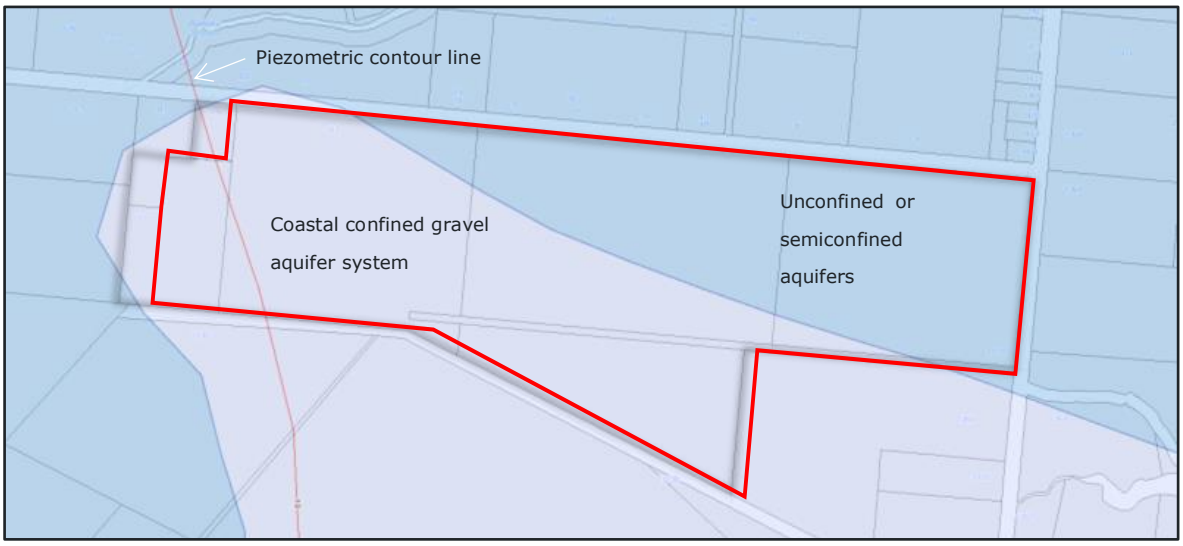


Figure 2 Approximate extent of groundwater systems under the site.

Waimakariri District Plan Zoning: The current zoning of the site is 'Rural'. The zoning of the adjacent land north of Gressons Road is zoned 'Residential'. The adjacent land to the west, south and east is zoned 'Rural' (Figure 3). The proposed zoning for the site is for residential land use.

[6] ECan GIS

[7] LandCare Research Soil Drainage Classes
Class 1: well drained, Class 2: moderately well drained, Class 3: imperfectly drained, Class 4: poorly drained, Class 5: very poorly drained.

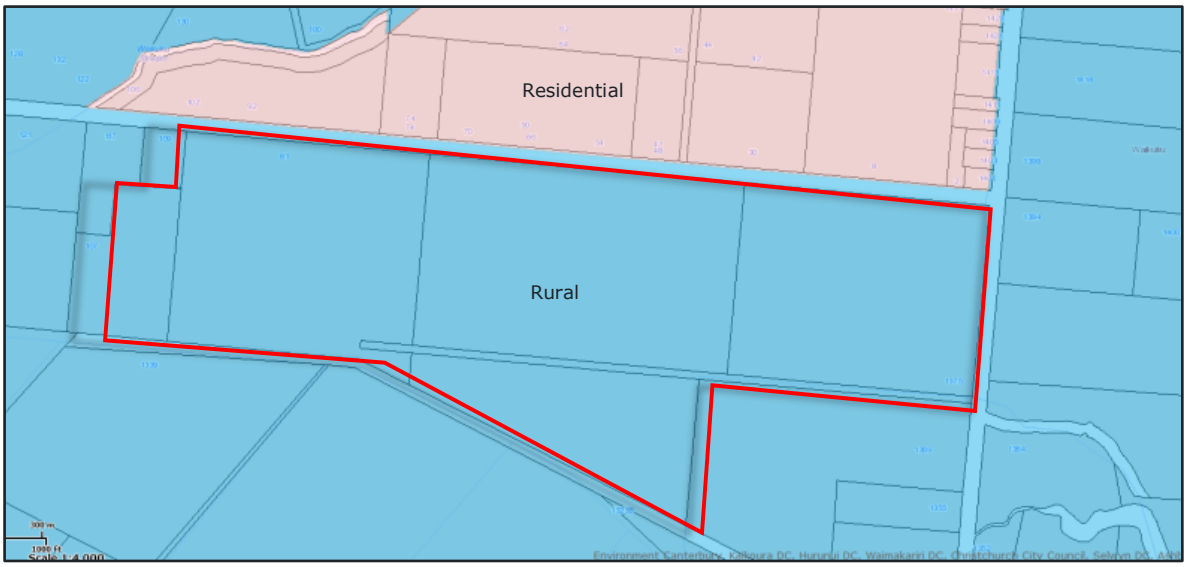


Figure 3 Waimakariri District Plan zoning of the site.

4. Site History

4.1. Environment Canterbury Listed Land Use Register (LLUR)

A search of Environment Canterbury's Listed Land Use Register (LLUR) has been undertaken. The LLUR is a database containing all known contaminated and potentially contaminated sites in Canterbury.

Environment Canterbury states that there are currently no known or anticipated HAIL activities on the site or within the area of enquiry. This does not necessarily mean that contamination has never occurred, or is not currently occurring. However, it confirms that no past or present sources of contamination are known and recorded.

The LLUR statements are appended in Appendix C.

Conclusion: Neither the site nor any of the surrounding land is recorded on Environment Canterbury's Listed Land Use Register.

4.2. Environment Canterbury Resource Consent Database

Environment Canterbury's resource consent database indicates two resource consents on the site, referring to the historical installation of a well and a surface water take. The well has been disused long time ago, and the consent for the surface water take expired in 1997.

No discharge consents, or consents for above or below ground storage of hazardous substances are recorded on Environment Canterbury's resource consent database.

Further details of the two expired resource consents on the site is appended in Appendix E.

Conclusion: Environment Canterbury's Resource Consent Database does not raise any specific concern about potential contamination from current or past consented activities.

4.3. Waimakariri District Council Records (Property File)

The property files held in the Waimakariri District Council were inspected on 26 September 2013. The files relate to several parcels that are not part of the site and include consent applications documents and approvals granted by the Council under the Building Act, and other information such as:

- Application forms,
- Construction details of a dairy shed and milk room,
- Project information memorandums (PIMs),
- Groundwater testing undertaken by Environment Canterbury. Wells M35/8110 (near the southern boundary of the site), M35/8759 (1.7km NE), M35/1160 (570m S of the site) and M35/4227 (1.7km E of the site) were found to have arsenic levels that are above NZ Drinking Water Standards; however, the water is considered safe for stockwater use.
- Most of the information contained in the property files relates to buildings that are on other land beyond the site.
- Our discussions with the landowner confirm no further consent applications have been made for the site since our review of the property file in 2013.

Conclusion: The property files do not raise any concerns about contamination of the site.

4.4. Site Inspection and Landowner Interview

- The site was inspected on 26 September 2013 and 10 November 2020 with the objective of identifying potential contaminants listed on MfE's Hazardous Activities and Industries List (HAIL [8]) such as:
- Above ground storage tanks/underground storage tanks (AST/UST) for fuel, chemicals or liquid waste,
- Storage, formulation and disposal of herbicides/pesticides,
- Sheep dips or spray races including remnants of it,
- Fibrous material potentially containing asbestos in deteriorated condition,
- Soils that are discoloured (stained e.g. with hydrocarbons or bleached),
- Soil mounds or excavations; change in natural contours of the land,
- Deposits of refuse, drums, canisters etc., historical landfills,
- Vegetation that is disturbed, stressed or discoloured,
- Any other activity that might have led to intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment.

Photographs taken during the site investigations in September 2013 and November 2020 are in Appendix B.

An interview with the existing landowners, Mr and Mrs Stokes, was conducted during Eliot Sinclair's site inspection on 26 September 2013.

The information from the site inspection and interview is summarised as follows:

- Mr and Mrs Stokes have owned parts of the site since 1991 and further acquired the remainder in 2002/2003.
- The land is used to graze dairy cattle.
- Fronterra's milk screening programme did not detect organochlorine pesticides in the milk.

[8] Ministry for the Environment 2011. Hazardous Activities and Industries List (HAIL).

- A derelict well shed near Gressons Road (constructed of timber and corrugated iron) contains remnants of an electric well. The shed and well are disused. A hay storage shed was located near the paper road along the paper road/southern boundary of the site. According to the owner, no other structures have been erected on the site.
- No soil mounds, or excavations, or change in the natural contours of the land were identified.
- No other activity that might have led to contamination has been identified.

A follow up interview with Mr Stokes was conducted on the 9 November 2020.

The information from the interview is summarised as follows:

- Irrigation lines were installed on site for the centre pivot irrigation systems in 2015.
- Further irrigation trenches were excavated in 2020 to the Centre Pivot Irrigator at the east end of the site on Lot 2 DP303387.
- Wood and vegetation was stock piled at the southeast corner of Lot 2 DP 428676.
- Evidence of burn pads was observed during our site inspection. These were located at the east and western end of Lot 2 DP 428676 and are in the areas where some of the shelter belts were removed. Soil has been mounded up over the burn pads and further timber and vegetation has been placed over these areas including partially burnt logs and stumps. Soil sample were taken from each burn pad and analysed with an XRF (X-ray Fluorescence) to determine the elemental composition of the soil.

  The soil sample taken from the burn pad at the eastern end of Lot 2 DP428676 was found to have concentrations of Arsenic between 22 to 40 mg/kg and is above the NESC (2011) rural residential standard of 17mg/kg. The area of the burn pad is around 5m x 5m.

  Soil samples taken from the burn pad at the western end of Lot 2 DP 428676 were found to have concentrations of Arsenic below 17mg/kg.

  The wood and vegetation stock piled at the southeast corner of Lot 2 DP 428676 may also be covering a burn pad, however, no evidence of burnt wood was located in this area during our inspection.

  These areas should be remediated as a condition of subdivision.

Conclusion: Other than the small burn pads, the site investigation did not raise any other concerns about persistent ground contamination of the site. The burn pads should be removed or remediated before subdivision of the site, however, this should not prevent the rezoning of the site to rural-residential.

4.5. Historical Aerial Photographs and Satellite Images

A historical aerial photograph from 15 May 1963 has been obtained from New Zealand Aerial Mapping Ltd. Historical aerial photography has also been obtained from Retrolens for 1942, 1976, 1980, 1984, 2000, as summarised in Table 3. In addition, recent satellite images from 2005 and 2013 to 2019 have been analysed.

Key features are identified on the 2005, 2013 and 2019 satellite images in Attachment D.

The analysis of the historical photos and recent satellite images are summarised in Table 3.

Conclusion: The historical aerial photo from 1963 confirms that no buildings or structures were established on the site apart from the well shed near Gressons Road and the hay storage shed at the paper road along the southern boundary. No excavation or fill or other land use is visible that raises concerns about persistent ground contamination.

Table 3. Summary of information from historical aerial photographs and recent satellite images.

Date (source)	Scale	Description
■ 6/06/1942 (Retrolens)	**1:16000**	■ The entire site is either cropped or grazed (sheep/cattle). ■ Farming activity can be seen on Lot 2 DP 62186 and Lot 2 DP 303387.
■ 15/05/1963 (NZAM)	**1:16,000**	■ The entire site is either cropped or grazed (sheep/cattle). ■ No excavation or fill is visible. ■ Watering troughs are located at the northern boundary along Gressons Road. ■ A hay shed is located near the paper road at the southern boundary. The shed is shown in Photo 3 in Attachment D. An electric well shed is located at 81 Gressons Road. ■ No further structures or land uses are visible.
■ 1/10/1976 (Retrolens)	**1:50,000**	■ The hay shed located near the paper road at the southern boundary is no longer there. ■ No further significant changes in land use are visible.
■ 1/02/1980 (Retrolens)	**1:25,000**	■ No further significant changes in land use are visible.
■ 28/09/1984 (Retrolens)	**1:25,000**	■ No further significant changes in land use are visible.
■ 5/12/2000 (Retrolens)	**1:50,000**	■ No further significant changes in land use are visible.
■ 22/04/2005 (Google)	**n/a**	■ Several watering troughs are established throughout the site. ■ The block at 1375 Main North Road is newly sown; the remaining area is grazed. ■ The disused power pole and pump shed remains at 81 Gressons Road. ■ No further built structures or earthworks are visible.
■ 17/02/2013	**n/a**	■ No further significant changes in land use are visible.

(Google)		
■ 1/11/2015	**n/a**	■ Centre Pivot irrigation system starting to be installed. ■ Trees removed west end of Lot 2 DP 428676.
■ 23/7/2016	**n/a**	■ Centre Pivot irrigation system visible ■ Trees removed at southeast end and east end of Lot 2 DP 428676.
■ 2/2/2017	**n/a**	■ No further significant changes in land use are visible.
■ 16/1/2018	**n/a**	■ No further significant changes in land use are visible.
■ 19/1/2019	**n/a**	■ Three Centre Pivot irrigation systems visible on site. ■ Two burn pads visible, plus stock pile of wood. ■ No further significant changes in land use are visible.

5. Arsenic in Groundwater

The property file held by the Waimakariri District Council identifies that elevated arsenic levels can be present in the groundwater of coastal and near coastal areas of the Canterbury Plains. While the concentration of Arsenic is generally low, in some cases the concentration exceeds the maximum allowable value (MAV) of 0.01mg As/l. The highest concentrations of arsenic are generally found in groundwater from the first confined aquifer (Riccarton Gravels) at a depth of approximately 20m, but groundwater from some wells screened in the second aquifer (Linwood Gravels) at a depth of approximately 40m has also shown elevated arsenic levels.

The arsenic is associated with buried swamp deposits and is derived from the degradation of organic matter. This consumes dissolved oxygen and leads to anoxic (reduced) conditions in groundwater, which can lead to naturally elevated concentrations of iron, manganese, arsenic and/or hydrogen sulphide.

Groundwater containing naturally occurring concentrations of arsenic that are above NZ Drinking Water Standards should not be used for potable water.

6. Conclusion and Recommendation

The investigations undertaken in this report have not raised any concerns about ground contamination sources and/or indicators such as farm chemicals (they are stored and formulated off-site), farm pits, livestock dip or spray races, changes in the natural contour of the land from excavation or filling, discoloured soils, or stressed vegetation. Apart from a historical hay shed that was removed before 1976, and a well shed at 81 Gressons Road with a disused electric well, no buildings or other structures have been, or are, on the site.

This Preliminary Site Investigation concludes that on the balance of probabilities, it is unlikely that HAIL activities have taken place, or are taking place on the site[9] . It is accepted that there are two burn pads that contain concentrations of Arsenic, with results that exceed the NES threshold for rural residential land. These areas are small and will be removed or remediated before subdivision. On this basis, it is considered highly unlikely that ground contamination from past or current activities will exceed the NES soil contaminant standards for the proposed rural residential land use.

[9] Including the migration and intentional or accidental release of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment.

7. Accidental Discovery Protocol

If any of the following materials are encountered during any future earthworks, such as:

- Stained or odorous soil (e.g. black, green, grey; or smells of rotting organic material, petroleum hydrocarbons or solvents)
- Slag, ash, charcoal
- Rubbish comprising putrescible waste, or hardfill
- Potential asbestos containing-material (for example fragments from cement fibre sheets, or loose fibres from insulation, etc.)

Then we recommend:

i) Excavation and earthworks cease, the site secured to stop people entering the area where potential contamination was encountered, and then:

ii) Contact a contaminated land specialist for further advice. If required, **Eliot Sinclair (03) 379 4014** can inspect the area, assess the material determine if it is contaminated or hazardous, and then determine a practical course of action.

This report does not relieve contractors and landowners of their responsibilities under the Health and Safety at Work Act 2015.

8. Limitations

The comments made in this report are based on a desktop review and site walkover inspections on 26 October 2013 and 10 November 2020. It is possible these may not provide a complete or accurate assessment of the entire site. As a result, Eliot Sinclair provides this information on the basis that it does not guarantee that the information is complete or without error and accepts no liability for any inaccuracy in, or omission from, this information.

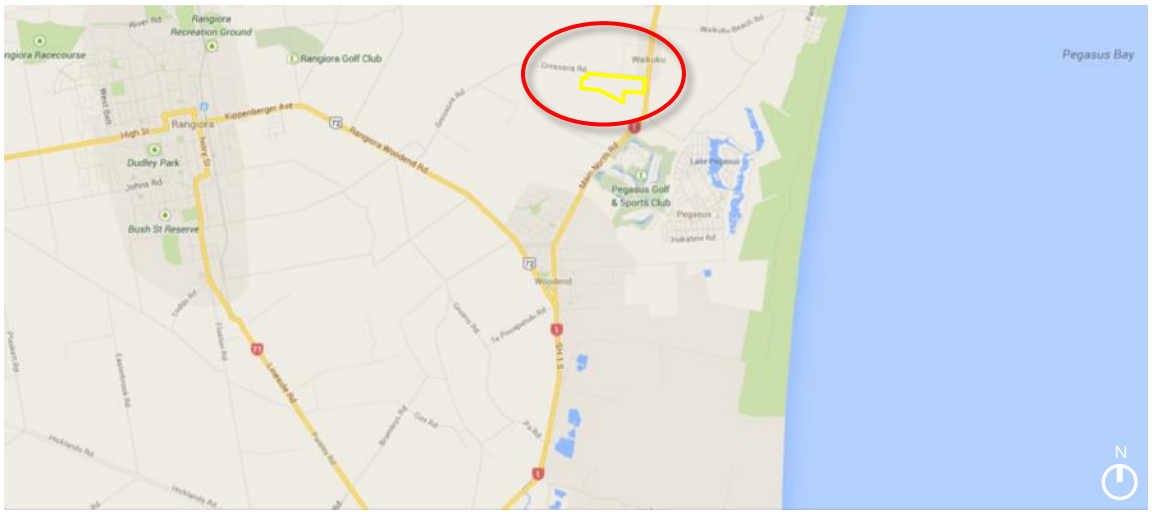
All reasonable effort has been made to ensure that the conclusions drawn in this report are correct at the time of reporting. However, the activities described on the HAIL may change in the future as knowledge about potentially hazardous activities develops over time.

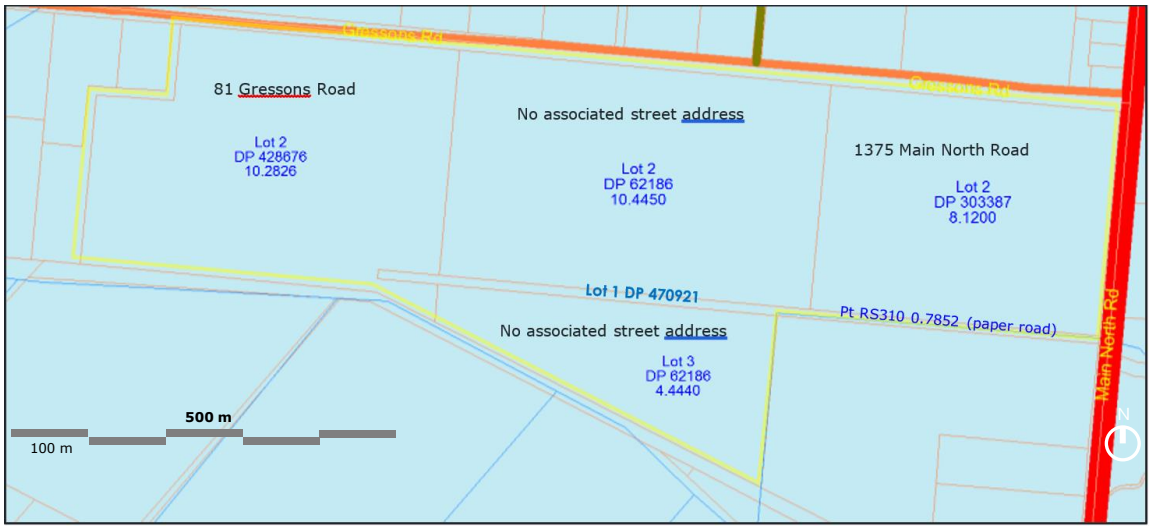
It is possible there may be unidentified subsoil conditions that are not obvious from the information obtained by our investigations and site inspection, and that differ from the conclusions of this report. Should unusual geotechnical conditions be encountered during future earthworks such as historical uncontrolled fill materials, then Eliot Sinclair should be advised. They can review any new information and to advise if the recommendations of this report are still valid.

This report has been prepared for the benefit of Waimakariri District Council. No liability is accepted by this company or any employee of this company with respect to the use of this report by any other party or for any other purpose other than what is stated in our scope of work.

This report does not relieve contractors of their responsibilities under the Health and Safety at Work Act 2015. Site conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided.

Appendix A: Site Plan





QuickMap
Customer Software Ltd
1/19/2019
N
Waikuku
Untitled Placemark
Untitled Placemark
Untitled Placemark
Pump shed (disused well)
(Photo 3)
81 Gressons Road
Grazed (cattle)
Centre Pivot Irrigation
Grazed (cattle)
Eucalypt/poplar shelterbelt
Burn pad + Pile of wood
Watering troughs
Watering troughs
Centre Pivot Irrigation
Centre Pivot Irrigation
Paper road (unformed)
Burn pad + Pile of wood
Pine trees removed
Pile of wood
may be over
burn pad
Watering trough
Hay shed was previously
located in this area.
N
CERA
Canterbury Earthquake
Recovery Authority
GNS SCIENCE
Image © 2020 Maxar Technologies
Google Earth
2005
Imagery Date: 1/19/2019 43°17'53.09" S 172°40'34.53" E e
19/01/2019

DRAFT

GRESSONS ROAD Collector Road - see WDC Planning Map 135 - Road Hierarchy

MAIN NORTH ROAD (STATE HIGHWAY) (Limited Access Road)

LEGAL ROAD

UNFORMED LEGAL ROAD

PREECES ROAD

Lot 1 DP 428676

61 Pedestrian Accessway 1422m²

1 5027m² 2 4437m² 3 5038m² 4 4662m² 5 5058m²

6 5001m² 7 2970m² 8 3102m² 9 4026m² 10 3227m² 11 3036m² 12 5001m²

13 4669m² 14 4650m² 15 4886m² 26 7987m²

63 Road to vest in Waimakariri District Council 112m²

43 5513m² 44 3192m² 45 2739m² 46 3340m² 47 2672m² 48 3273m² 49 3006m² 50 3230m²

51 5087m² 52 3424m² 53 4556m² 54 3268m² 55 4712m² 56 3192m² 57 5087m²

16 4986m² 17 4805m² 18 5054m²

42 4317m² C 133m² B 133m² 39 3148m²

60 Road to vest in Waimakariri District Council 2.7271ha

59 Stormwater Detention Basin 1.4926ha

41 5881m² 40 5558m² 38 6494m² 37 6732m² 36 6503m² 35 6881m² 34 8018m² 33 7075m² 32 6862m² 31 7293m²

23 3287m² 22 5561m² 21 4756m² 20 6207m² 19 7248m²

Stormwater Easement

Stormwater (Open Drain)

A 1679m²

24 4541m² Easement 4.0 metres wide

Pt R S 3101

Land subject to Claim by Adverse Possession defined on LT 470921 - 935m²

Possible Future Road

30 9982m² 29 6857m² 28 4166m² 27 7070m² 25 7691m²

62 Stormwater Detention Basin 8061m²

Pt R S 3101

Pt R S 3101

Pt R S 3101

Lot 2 DP 428676

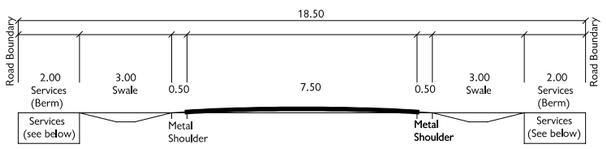
Lot 2 DP 62186

Lot 2 DP 303387

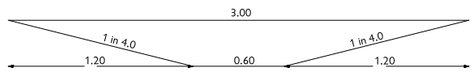
NOTES

All roads are 18.50 metres wide.

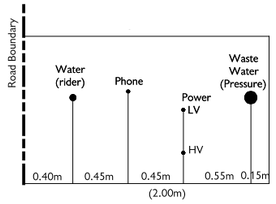
Piped Stormwater Easements are 2 metres wide unless shown otherwise



TYPICAL ROAD CROSS SECTION
Scale 1:100



TYPICAL SWALE CROSS SECTION
Scale 1:20



SERVICES LOCATION
Scale 1:5

no.	amendment	initial	date
A	Lot 61 added - pedestrian access, swale moved across, note re bnd in LT 470921	rksg	25.6.14
B	Road widened to 18.5m and revised Road Cross Section added	rksg	24.7.14
C	Stormwater amended - two ponds . Lot 26 cnr SH 1 and Gressons. Lot 58 removed	rksg	18.8.14
D	Possible Future Road added to Lot 27	rksg	

designed Bob Greening
manager Bruce Sinclair
drawn Bob Greening
checked

surveyed Roger Claessens
surv.date Feb 2014

origin of levels UA 87
Main North Road (SH1) RL 6.271
LINZ Dec 2013
datum Lyttelton 1937 post Dec 2013

Projection NZGD 2000
Circuit Mount Pleasant 2000

Scale: 1:2000 (A1) 1:4000(A3)
Date: 20/3/2014

Drawing Set 350494 C4
PLOT 350494 C4 140312.PDF

Sheet 1 of 1
rev D

Eliot Sinclair
surveyors | engineers | planners

20 Troup Drive, PO Box 9339, Tower Junction, Christchurch 8149, Phone: 03 379-4014, Fax: 03 365-2449, info@eliotsinclair.co.nz
www.eliotsinclair.co.nz

Proposed Subdivision of 81 Gressons Road and 1375 Main North Road (SH1), Waikuku (Lot 1 LT 470921, Lots 1 and 2 DP 428676, Lots 2 and 3 DP 62186 and Lot 2 DP 303387 for Northside Country

[plotted: Wednesday, September 10, 2014 11:26:22] [computer operator: rksg] [Project: G:\Jobs\35\350494\12d\SURVEY\RCON\Proposed Subdivision Gressons Road Waikuku\Proposed Subdivision Gressons Road Waikuku]

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Appendix B: Site Photographs (taken on 26/09/2013)

Photo 1. View across the site looking west.

Photo 2. View across the site looking southeast towards Main North Road (SH1).

Photo 3. Power pole and disused well shed at 81 Gressons Road (looking south).

Site Photographs (taken on 10/11/2020)

Photo 4. Power pole and disused well shed at 81 Gressons Road (looking east).

Photo 5. 81 Gressons Road (looking west).

Photo 6. 1375 Main Road and 81 Gressons Road (looking west)

Appendix C: Listed Land Use Register (LLUR)

Search of Listed Land Use Register 18 September 2013

81 Gressons Road

Environment Canterbury
Regional Council
Kaunihera Taiao ki Waitaha

Customer Services
P. 03 353 9007 or 0800 324 636

PO Box 345
Christchurch 8140

P. 03 365 3828
F. 03 365 3194
E. ecinfo@ecan.govt.nz

www.ecan.govt.nz

Dear Sir/Madam

Thank you for submitting your property enquiry in regards to our Listed Land Use Register (LLUR) which holds information about sites that have been used, or are currently used for activities which have the potential to have caused contamination.

The LLUR statement provided indicates the location of the land parcel(s) you enquired about and provides information regarding any LLUR sites within a radius specified in the statement of this land.

Please note that if a property is not currently entered on the LLUR, it does not mean that an activity with the potential to cause contamination has never occurred, or is not currently occurring there. The LLUR is not complete, and new sites are regularly being added as we receive information and conduct our own investigations into current and historic land uses.

The LLUR only contains information held by Environment Canterbury in relation to contaminated or potentially contaminated land; other information relevant to potential contamination may be held in other files (for example consent and enforcement files).

If your enquiry relates to a farm property, please note that many current and past activities undertaken on farms may not be listed on the LLUR. Activities such as the storage, formulation and disposal of pesticides, offal pits, foot rot troughs, animal dips and underground or above ground fuel tanks have the potential to cause contamination.

Please contact and Environment Canterbury Contaminated Sites Officer if you wish to discuss the contents of the LLUR statement, or if you require additional information.
For any other information regarding this land please contact Environment Canterbury Customer Services.

Yours sincerely

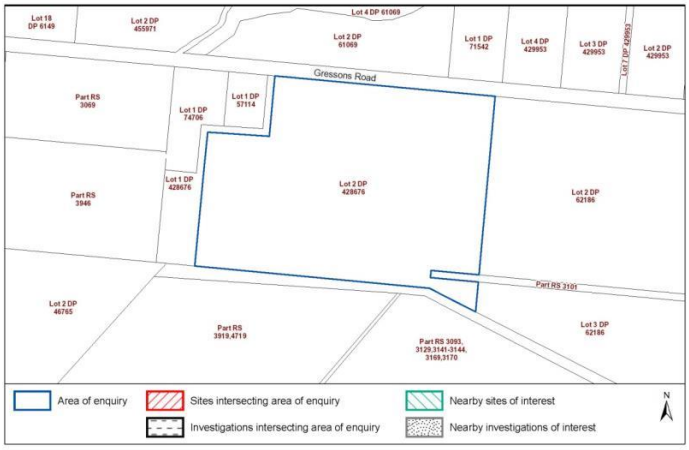
Contaminated Sites Team

Statement from the Listed Land Use Register

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

PO Box 345, Christchurch
General enquiries: 03 365 3828 Customer services: 03 353 9007
Fax: 03 365 3194 or: 0800 EC INFO (0800 324 636)
Email: ecinfo@ecan.govt.nz Website: www.ecan.govt.nz

Date:	18 September 2013
Land Parcels:	• Lot 2 DP 428676 Valuation No(s):



Summary of sites:

There are no sites associated with the area of enquiry.

Please note that the above table represents a summary of sites intersecting the area of enquiry within a 50m buffer.

Our ref: ENQ 20647
Produced by: CHISVC_LLURIntegration 18 September 2013

For further information from Environment Canterbury, contact the Contaminated Sites Officer and refer to enquiry number 20647.

Disclaimer:

The enclosed information is derived from Environment Canterbury's Listed Land Use Register and is made available to you under the Local Government Official Information and Meetings Act 1987 and Environment Canterbury's Contaminated Land Information Management Strategy (ECan 2009).

This information reflects Environment Canterbury's current understanding of this site, which is based only on the information thus far obtained by it and held on record concerning this site. It is released only as a copy of those records and is not intended to provide a full, complete or totally accurate assessment of the site. As a result, Environment Canterbury is not in a position to warrant that the information is complete or without error and accepts no liability for any inaccuracy in, or omission from, this information.

Any person receiving and using this information is bound by the provisions of the Privacy Act 1993.

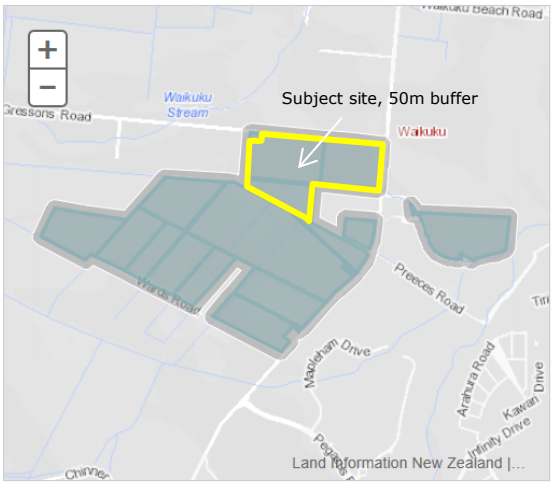
1375 Main North Road and Parcels without Street Address

Multiple parcels (including subject site); none of the parcels is recorded on LLUR.

Listed Land Use Register

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Home | Advice & Info | Services | Our Responsibilities | News & Notices | Get Involved | About Us



Overview | FAQs

What is the Listed Land Use Register (LLUR)?

The LLUR is a land use database that Environment Canterbury uses to manage information about land that is, or has been, associated with the use, storage or disposal of hazardous substances.

We need the LLUR to help us manage information about sites that have had hazardous activities or industries on them. By managing this information, we can then help you to manage any potential risks to your health or the environment that the site may pose from exposure to contaminants.

View LLUR Brochure

We need the LLUR to help us manage the risk posed by hazardous sites to your health and the environment.

Section 30 of the Resource Management Act (RMA) requires Environment Canterbury to collect and manage information about potentially contaminated sites. To do this, we follow guidelines from the Ministry for the Environment (MfE). The information we collect

Type your Street Address or Legal Description

1375 Main North Road, Saltwater Creek-Waimakariri R, Hur | Clear

(having trouble finding your address? more info here ..)

Search of Listed Land Use Register 10 November 2020

Listed Land Use Register (LLUR)

Search

Lot 2 DP 428676

(Having trouble finding your address?)

OVERVIEW | FINDING YOUR ADDRESS | SEARCH SUMMARY

Thank you for your enquiry.

The Listed Land Use Register does not currently have any information about a Hazardous Activities and Industries List site on this land parcel.

If you would like a property statement, please fill in your details below.

Records Found

No records found.

Property Search Results

	Legal Description	Titles	Valuation No	
1323 Main North Road (Sh1) (Wnd-Amb)				
1	Lot 2 DP 428676	512583	2159170000	

Listed Land Use Register (LLUR)

Search

Lot 2 DP 62186

(Having trouble finding your address?)

OVERVIEW | FINDING YOUR ADDRESS | SEARCH SUMMARY

Thank you for your enquiry.

The Listed Land Use Register does not currently have any information about a Hazardous Activities and Industries List site on this land parcel.

If you would like a property statement, please fill in your details below.

Records Found

No records found.

Property Search Results

	Legal Description	Titles	Valuation No	
1323 Main North Road (Sh1) (Wnd-Amb)				
1	Lot 2 DP 62186	512583	2159170000	

Search of Listed Land Use Register 10 November 2020

Listed Land Use Register (LLUR)

Search

Lot 2 DP 303387

(Having trouble finding your address?)

OVERVIEW | FINDING YOUR ADDRESS | SEARCH SUMMARY

Thank you for your enquiry.

The Listed Land Use Register does not currently have any information about a Hazardous Activities and Industries List site on this land parcel.

If you would like a property statement, please fill in your details below.

Records Found

No records found.

Property Search Results

	Legal Description	Titles	Valuation No	
1323 Main North Road (Sh1) (Wnd-Amb)				
1	Lot 2 DP 303387	512583	2159170000	

Listed Land Use Register (LLUR)

Search

Lot 3 DP 62186

(Having trouble finding your address?)

OVERVIEW | FINDING YOUR ADDRESS | SEARCH SUMMARY

Thank you for your enquiry.

The Listed Land Use Register does not currently have any information about a Hazardous Activities and Industries List site on this land parcel.

If you would like a property statement, please fill in your details below.

Records Found

No records found.

Property Search Results

	Legal Description	Titles	Valuation No	
1323 Main North Road (Sh1) (Wnd-Amb)				
1	Lot 3 DP 62186	512583	2159170000	

Listed Land Use Register (LLUR)

Search

Street Address or Legal Description

(Having trouble finding your address?)

OVERVIEW | FINDING YOUR ADDRESS | SEARCH SUMMARY

Thank you for your enquiry.

The Listed Land Use Register does not currently have any information about a Hazardous Activities and Industries List site on this land parcel.

If you would like a property statement, please fill in your details below.

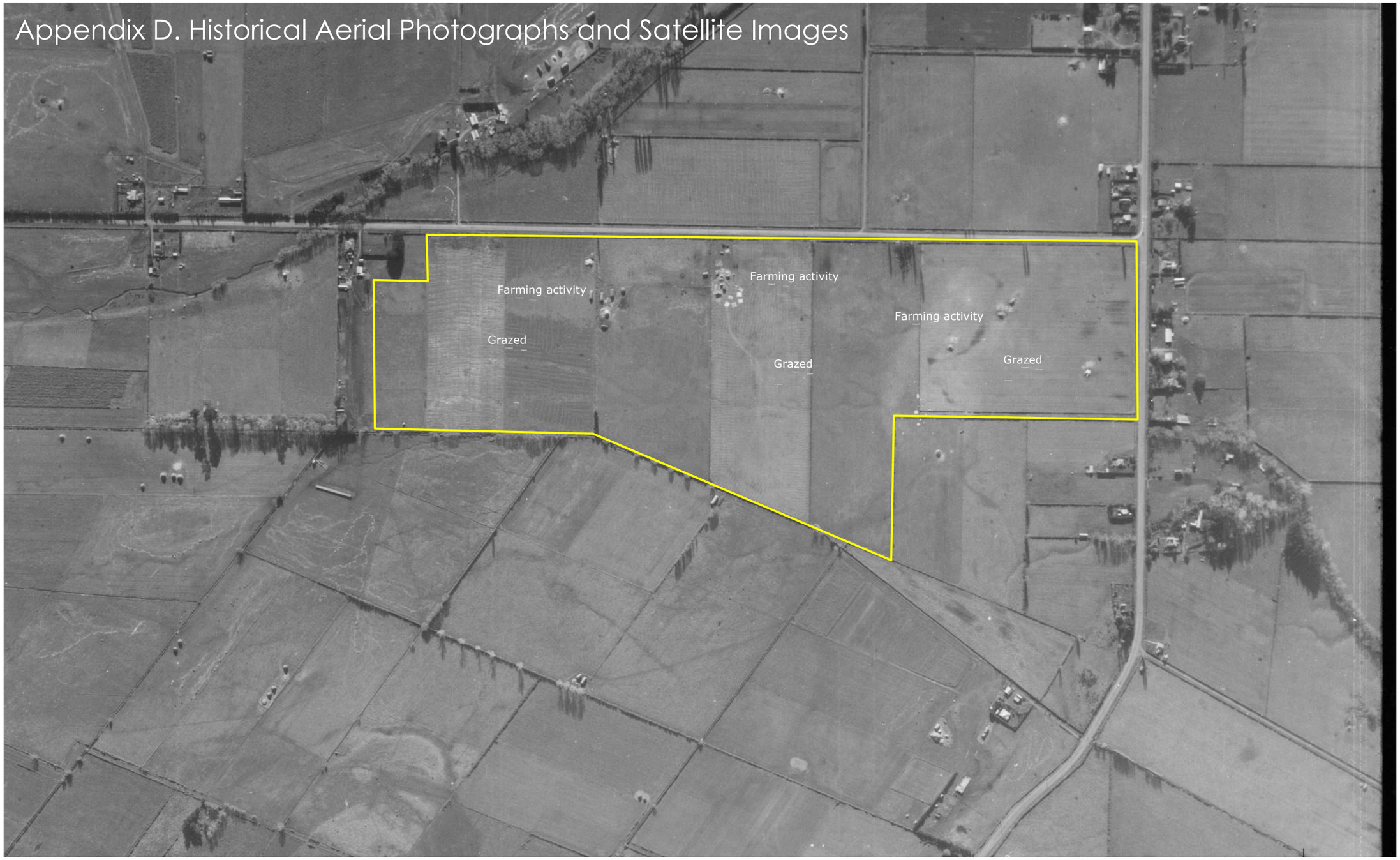
Records Found

No records found.

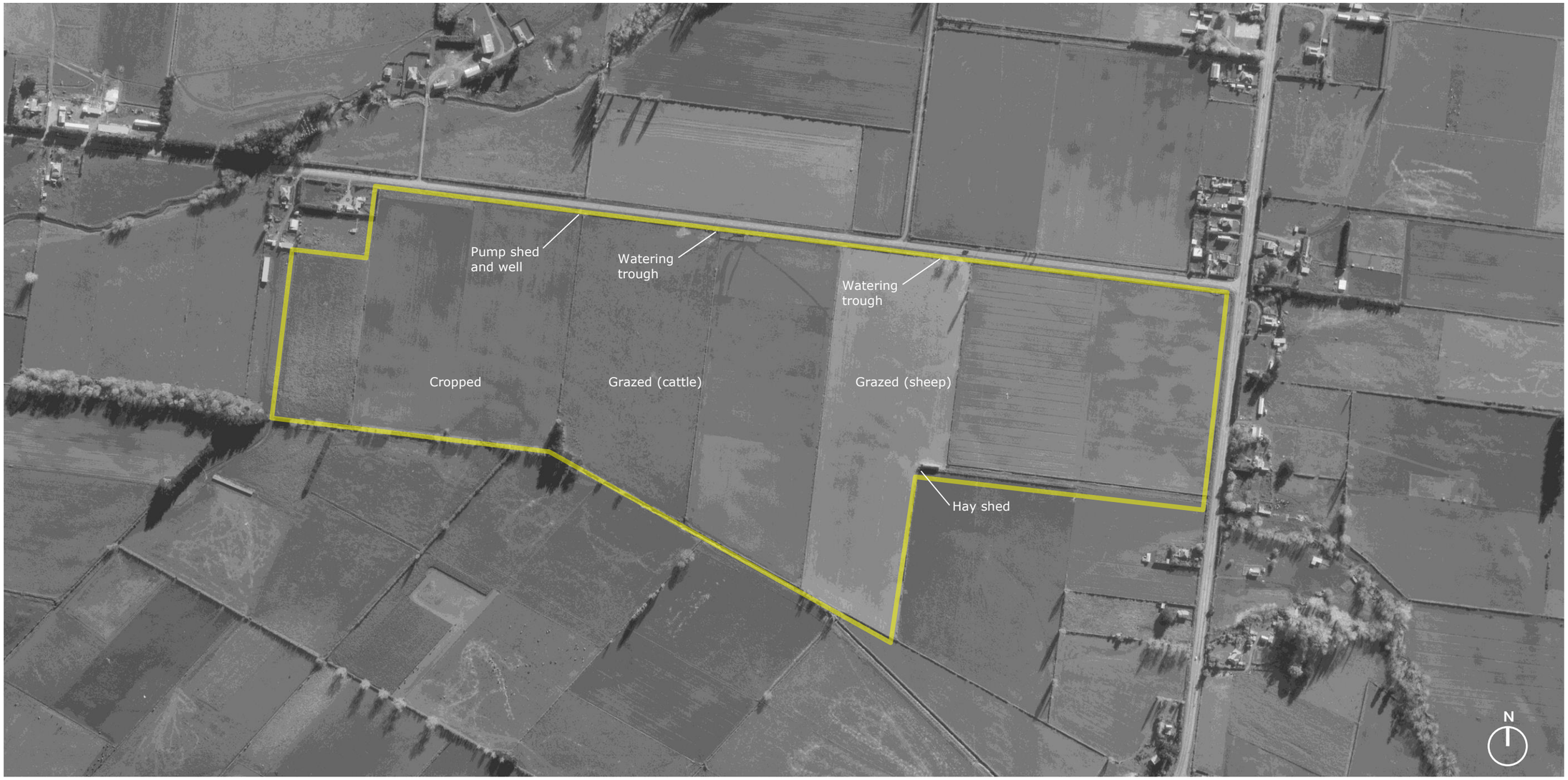
Property Search Results

	Legal Description	Titles	Valuation No	
1323 Main North Road (Sh1) (Wnd-Amb)				
1	Lot 1 DP 470921	637372	2159170000	

Appendix D. Historical Aerial Photographs and Satellite Images



6/06/1942



500 m
100 m

15/05/1963

500 m
100 m

22/04/2005

Gressons Rd
Gressons Rd
Pump shed (disused well)
(Photo 3)
Eucalypt/poplar shelterbelt
Poplar shelterbelt
Eucalypt shelterbelt
Grazed (cattle)
Grazed (cattle)
Grazed (cattle)
Watering troughs
Watering troughs
Pine trees
Cropped
Paper road (unformed)
Watering troughs
Main North Rd
1339
1323E
1375
1369
1355
1403
1401
500 m
100 m

17/02/2013

QuickMap
Customer Software Ltd
1/19/2019
Waikuku
Untitled Placemark
Untitled Placemark Untitled Placemark
Pump shed (disused well)
(Photo 3)
81 Gressons Road
Grazed (cattle)
Centre Pivot Irrigation
Grazed (cattle)
Eucalypt/poplar shelterbelt
Burn pad + Pile of wood
Watering troughs
Watering troughs
Centre Pivot Irrigation
Centre Pivot Irrigation
Paper road (unformed)
Pile of wood
Pine trees removed
Burn pad + Pile of wood
Watering trough
N
CERA
Canterbury Earthquake
Recovery Authority
GNS SCIENCE
Image © 2020 Maxar Technologies
Google Earth
2005
Imagery Date: 1/19/2019
19/01/2019

Appendix E: Environment Canterbury Resource Consents

<u>On the subject site:</u>

1) Well M35/4266: 51mm well in pump shed. Well card status: 'Not used', updated in May 2016. No associated water permit. No dates in wellcard.

2) NCY880160: Surface water take. Expired in 1997.

Notes:

1) No discharge consents, above ground or below ground of hazardous storage consented.

APPENDIX 6

ENGEO – GEOTECHNICAL ASSESSMENT (2021)

ENGEO Limited
124 Montreal Street, Sydenham
Christchurch 8023
PO Box 373, Christchurch 8140, New Zealand
T: +64 3 328 9012 F: +64 3 328 9013
www.engeo.co.nz

Project Number #19640.000.001

Geotechnical Investigation

81 Gresson & 1375 Main North Road, Waikuku,

Submitted to:
Westside Country Ltd
250 Oxford Terrace
Level One, Charles Luney House
Christchurch 8011

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Appendices

Appendix 1: Compressible Material Hazard Map

Appendix 2: Inferred Technical Category Map

Appendix 3: CPT Logs

Appendix 4: Liquefaction Analysis Results

Appendix 5: Liquefaction Analysis Outputs

Appendix 6: Consolidation Analysis Outputs

ENGEO Document Control:

Report Title	Geotechnical Investigation - 81 Gresson & 1375 Main North Road, Waikuku			
Project No.	19640.000.001	Doc ID	02	
Client	Westside Country Ltd	Client Contact	Brian Stokes	
Distribution (PDF)	Westside Country Ltd			
Date	Revision Details / Status	Author	Reviewer	WP
24/11/2021	Issued to Client	DK/RC	RJ	JT

1 Introduction

ENGEO Ltd was requested by Westside Country Ltd to undertake a geotechnical investigation of the property at 81 Gresson & 1375 Main North Road, Waikuku, (herein referred to as 'the site'). The purpose of the assessment was to support plan change of this area from rural to residential land use.

This work has been carried out in accordance with our signed agreement (2021.005.919_02, signed 18 November 2021).

Our scope of works included:

- Site walkover assessment by ENGEO.
- Coordination with a specialist contractor to drill 41 Cone Penetrometer Tests (CPTs) evenly distributed across the site area (excluding the portion previously investigated).
- Assessment of geohazards across the site utilising the CPT data from the investigations - specifically liquefaction and inferred peat deposits.
- Provision of seismic subsoil category based on our understanding of the regional geology – this has not been specifically investigated.
- Analysis of liquefaction potential under Serviceability Limit State (SLS), Ultimate Limit State (ULS) and Intermediate Limit State (ILS) conditions.
- Development of plans indicating:
    - The inferred Technical Categories (TC) across the site; and
    - Other geological constraints on development such as the presence of compressible cohesive and organic material and areas of artesian water.
- Assessment of the site against Section 106 of the Resource Management Act.
- A Geotechnical Report suitable to inform plan change requirements, covering the aspects above.

A report by Elliot Sinclair (dated 27 November 2020, ref. 350494) to support plan change was completed for the northern portion of the site (see Figure 1). We have incorporated the data from their investigation into this current report for completeness and our assessment / recommendations cover this area.

This report should be read in conjunction with our environmental Preliminary Site Investigation report (dated 23 November 2021, ref 19640.000.001_01) which details the site history.

2 Site Description

The site at 81 Gresson & 1375 Main North Road (south of Waikuku) is currently rural farmland with an area of approximately 100 hectares. The landform is generally sub-horizontal with drainage channels through areas of the site. Waikuku Stream runs through the most northern extent of the site, and a smaller unnamed stream runs through the centre of the site. The approximate location of the drainage channels and Waikuku stream are shown in Figure 1.

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Figure 1: Site Location Plan

Image sourced from LINZ and edited in DataNest. Not to scale.

3 Desktop Review

3.1 Regional Geology

The site has been regionally mapped by GNS Science as being underlain by unweathered, variably sorted gravel, sand silt and clay of modern river floodplains or low level degradation terraces. Regional mapping completed by Forsyth et al (2008) indicates that the site is underlain by grey river alluvium beneath plains or low level terraces.

3.2 Geohazards

3.2.1 Seismicity

The nearest faults to the site are the Loburn and Ashley faults (part of the Ashley Fault Zone), mapped approximately 4.5 km northwest and 11 km west of the site respectively. The faults within the Ashley Fault Zone trend roughly east-west, and the fault strands within it are indicated as having equal components of dip-slip and strike-slip movement (Barrell and Van Dissen, 2014). The average recurrence interval of the Ashley Fault Zone is assessed as being between 7,000 and 15,000 years, although it could be as low as 5,000 years. The site is mapped outside of the Ashley Fault Awareness Zone.

Large regional areas of faulting (GNS, 2015) namely the Porters Pass-Amberley Fault Zone, and the Hope and Alpine Faults, are further afield but present a high seismic hazard to the Christchurch area due to the anticipated size of earthquakes generated. The largest of these faults is the Alpine Fault, which has a return period of 250-300 years and is expected to produce a M8 earthquake. The last rupture on the Alpine Fault is believed to have occurred in 1717 (Pettinga et al., 2001).

3.2.2 Canterbury Earthquake Sequence

Ground Shaking

O'Rourke et al (2012) have developed a contour map of the conditional median peak ground accelerations (PGA) interpolated from data measured at various recording stations during the 2010-2011 Canterbury Earthquake Sequence. The nearest monitoring stations to the site are at Kaiapoi North School and Ashley School.

This mapping indicates that the site experienced peak ground motions of approximately 0.21g during the September 2010 Darfield earthquake. The site is therefore likely to have experienced seismic accelerations in excess of SLS. Contour mapping is not available for the February, June or December 2011 earthquakes.

Liquefaction

The site has been mapped by the Waimakariri District Council as being within an area where 'Liquefaction damage is possible' and further assessment is needed.

Mapping by GNS Science following the September 2010 and February 2011 earthquakes identified sand boil formations to the south, west and northeast of the site (Figure 2). No liquefaction ejecta was recorded on-site; however, this mapping was largely based of area wide aerial photography rather than site specific observations.

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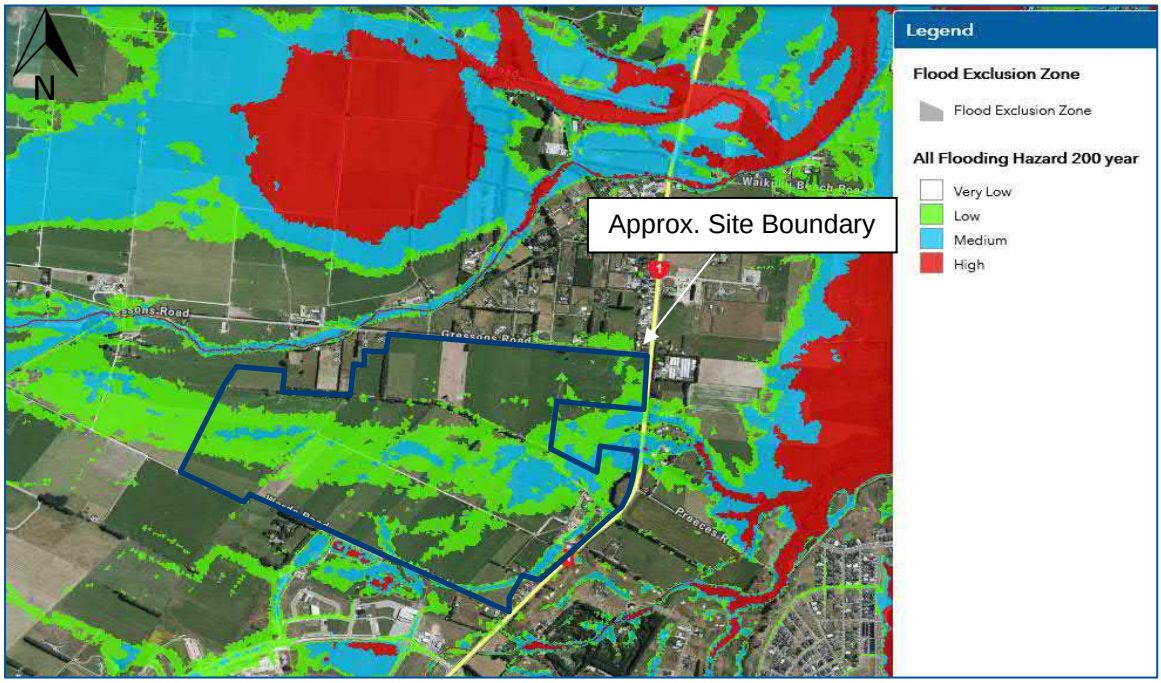
Figure 2: Mapped Liquefaction – September 2010 and February 2011 Earthquakes

Image sourced from Google Maps. Not to scale.

3.2.3 Flooding

We have reviewed the Waimakariri District Council GIS database and have presented a snapshot of the map with the approximate site boundary overlain. The mapping indicates that parts of the site may be subject to a medium flood hazard (defined as inundation depth of greater than 0.3 m) during a 1 in 200 year flood event.

Figure 3: 1 in 200 Year Flood Hazard Map



Sourced from WDC Flooding GIS layer.

3.3 Historic Aerial Photography

We have reviewed historic aerial photographs of the site available through Canterbury Maps (Property Search) dating back to 1940. The site appears to have been used as agricultural grazing land since the earliest available photograph in 1940. In the 1940 photograph, paleo-channels are visible across the site, generally running in a west to east direction. We have highlighted one significant channel in Figure 4, which appears to correlate with an area of compressible material, refer to Section 5.4. Many of these paleo-channels appear to have been filled in the next available photograph, taken in 1960.

Several structures, inferred to be for agricultural use, were constructed in the late 1990s / early 2000s in the eastern part of the site.

Figure 4: 1940 Historic Aerial Photograph

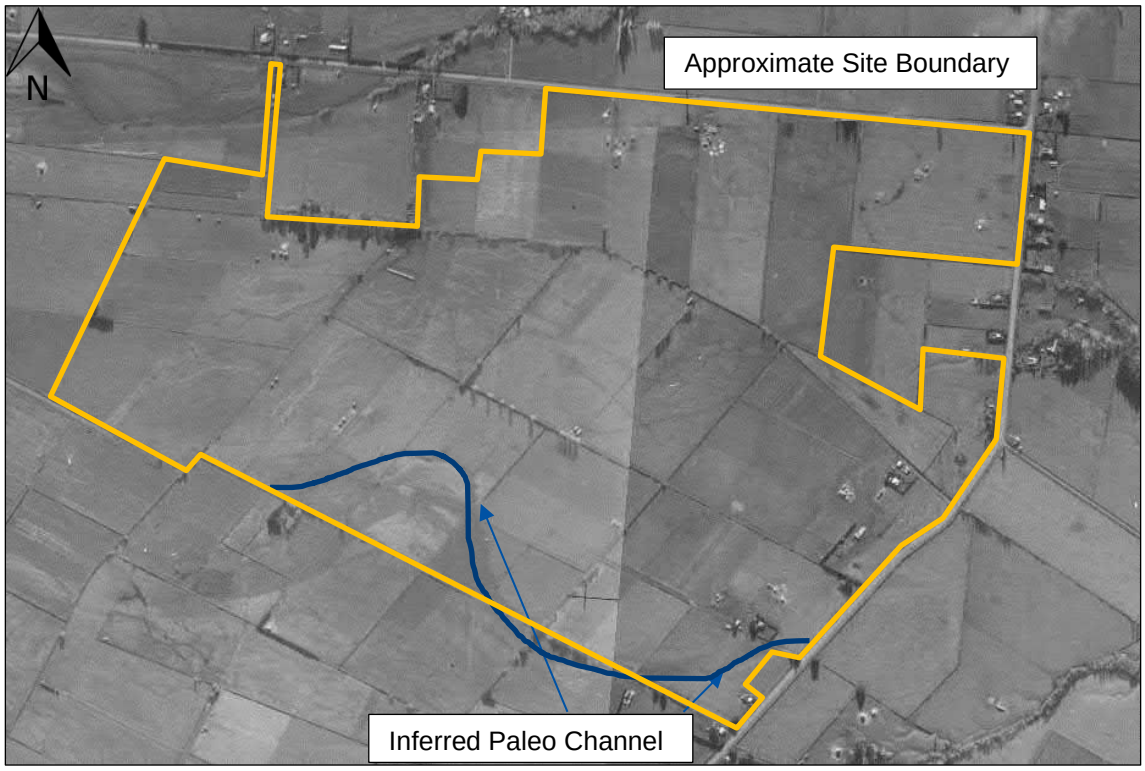


Image sourced from Canterbury Maps. Not to scale.

3.4 Tsunami

Assessing the risk from tsunami is outside of our scope, however, we note the site is located outside of any tsunami excavation zones defined in the Waimakariri District Plan.

3.5 Previous Reporting

Elliot Sinclair Ltd have previously produced a report to support the plan change of the northern part of the site (dated 27 November 2021, ref: 350494). They completed 11 CPTs (shown in Figure 5) across the northern part of the site to inform their report. Elliot Sinclair considered that the most relevant hazards to the site included surface deformation due to liquefaction and inundation due to flooding of the Ashley River. They concluded that, provided these hazards are addressed, there are no significant geotechnical constraints that would prevent the re-zoning of the land.

4 Site Investigation

ENGEO visited the site on 8 November 2021 and made the following observations:

- The site was generally level, agricultural land, with drainage channels and vegetated tree lines separating different paddocks. The Waikuku Stream runs beneath a driveway in the northern tip of the site, whilst another smaller stream runs through the middle of the site (see Figure 1).
- Drainage channels were typically up to 1 m depth on the south-western side of the site, increasing in depth as they flowed into the stream that ran through the site. This stream had a free face of approximately 2 m to 2.5 m depth.

- Drainage channels typically had soft, saturated ground at the base, but no active flows. The stream running through the site had water flowing in it, approximately 300 to 500 mm deep.

4.1 Cone Penetration Testing

The CPT probe gathers raw data including cone tip resistance, friction sleeve resistance, and pore water pressure at 1 cm intervals during the test. This information is used to infer the soil type, soil density and water pressure in undisturbed conditions in the ground and can be used to assess the liquefaction susceptibility of the ground and to calculate geotechnical bearing capacity in the soil.

At our request, McMillan Drilling Ltd pushed 40 CPTs at the approximate location shown on the test location plan in Figure 5. Thirteen tests were pushed to a target depth of 15 m, three were pushed until they met practical refusal and the remaining 24 were pushed to a target depth of 10 m. The CPT logs are attached to this report in Appendix 3.

The CPTs west and southeast of the site generally met practical refusal on an inferred shallow gravel or dense gravelly sand layer. CPTs through the centre of the site did not intercept this layer and generally met target depth.

Figure 5: Investigation Location Plan

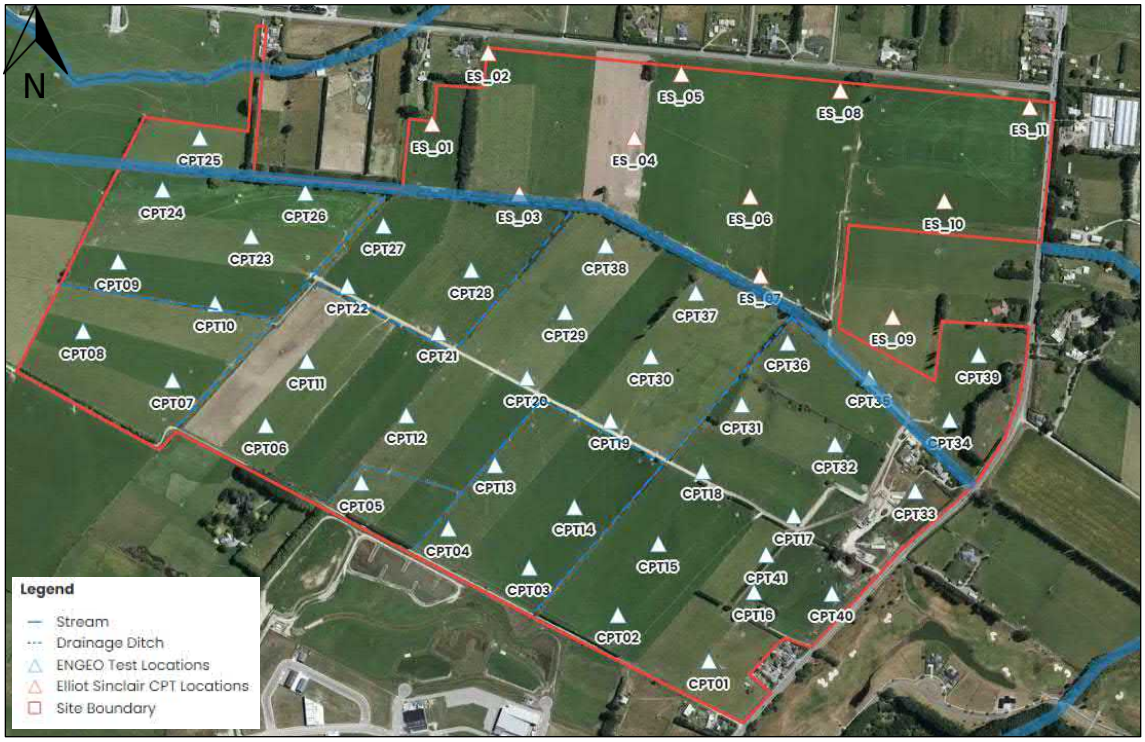


Image sourced from LINZ and edited in DataNest. Not to scale.

4.2 Groundwater

CPT holes were dipped by McMillan Drilling on the completion of each test. The groundwater levels varied between 0 m to 2.6 m across the site. CPTs 7, 8, 10, 11, 21, 22, 28, 29 and 30 encountered artesian conditions where water was flowing at the surface once the CPT rods had been removed from the hole (or encountered very shallow in the CPT hole). These CPTs appear to follow a subsurface channel that extends west to east through the site. Based on high level review of the CPT data it appears that there may be a confined layer of water bearing sand below approximately 3.5 to 4 m depth - it is possible that the artesian pressure is occurring from this layer.

Figure 5, located in Appendix 1, outlines the inferred subsurface channel where artesian water pressures have been observed.

We recommend installing several multi-stage piezometers though this area to better understand where the artesian water pressures are occurring and how they may affect the proposed development.

4.3 Discussion on Inferred Geological Profile

The testing to date indicates that the composition of the subsurface soils is highly variable across the site. This is consistent with the alluvial depositional environment where rivers have avulsed across the landscape over time, creating a layered subsurface profile comprising loose silts, sands, peat, sensitive fine-grained soils and gravel layers. Given the proximity of the site to the coastline, marginal marine deposits may also be present, which are likely to be susceptible to liquefaction.

A comprehensive geological model should be formed during the subdivision consent stage to assist in informing the master planning decisions for the site.

5 Geotechnical Assessment

Based on our review of mapped land damage in the surrounding area of the site and the ground conditions encountered in our investigations, we consider surface deformation due to liquefaction and consolidation settlement of the soft compressible material encountered in our geotechnical investigation to be the primary geotechnical considerations for the site. As such, we have carried out assessments of the liquefaction potential and a preliminary assessment of the long-term consolidation settlement potential of the site using on-site CPT data. Analysis methods, parameters and results are outlined in the following sections.

5.1 Seismic Subsoil Class

For the purpose of seismic design, we consider the soil classification in line with NZS 1170.5:2004 to most likely be ‘Class D – Deep or soft soil sites’.

5.2 Liquefaction Assessment

5.2.1 Soil Liquefaction

Liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. The liquefaction potential of a site depends on the presence, and thickness of potentially liquefiable soil (sands and silts below the groundwater table), and the intensity of earthquake shaking at the site.

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Liquefaction can lead to settlement of the ground surface, sand boil formation (ejected liquefied material), ground cracking and lateral displacement of the ground surface, slope instability, and differential and vertical settlement of foundations.

We have undertaken a liquefaction assessment using the on-site and CPT data and liquefaction procedures described in the following sections. We have included both the Elliot Sinclair CPTs (refer Section 3.5) and the CPTs completed as part of our geotechnical investigation.

5.2.2 Ground Motion Parameters for Liquefaction Assessment

We have assessed the likelihood of liquefaction triggering and post-liquefaction induced vertical settlement occurring at the site for design earthquake scenarios in accordance with NZS 1170, Module 1 of MBIE's Geotechnical Engineering Practice Guidance. Based on our understanding of the intended use and capacity of the development we assume that the proposed buildings will be Importance Level 2 (IL2), with a design life of 50 years. According to NZS 1170.5:2004, Importance Level 2 buildings are required to be designed to resist earthquake shaking with an annual probability of exceedance of 1/500 (i.e. a 500 year return period) at Ultimate Limit State (ULS) design seismic loading. It is necessary that buildings are designed to tolerate the ULS loading without collapse or endangering life. Furthermore, Importance Level 2 buildings should sustain little or no structural damage under a Serviceability Limit State (SLS) design load case, which is based on earthquake shaking with a 25-year return period. The design scenarios and performance requirements for each scenario are outlined in Table 1.

Table 1: Seismic Design Scenarios

Design Case	Seismic Performance Expectations	Assumed Site Class / Importance Level / Design Life	Return Interval	PGA (g)	Magnitude
ULS	Under Ultimate Limit State (ULS) seismic loading the structure should be able to accommodate the potential deformations without structural collapse and protect the safety of the occupants.	Class D/ IL2/ 50 years	500 yrs	0.35	7.5
ILS	Intermediate Limit State (ILS) -. The Waimakariri District Plan liquefaction mitigation design standards (Table 32.3) sets a limit of 100 mm of liquefaction induced vertical settlement and 250 mm of lateral spreading at an intermediate limit state of 1 in 150 year event. This earthquake scenario represents an intensity of shaking that is considered to have a high likelihood of occurring within the land use planning horizon.		150 yrs	0.20	7.5
SLS			25 yrs	0.13	7.5

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Design Case	Seismic Performance Expectations	Assumed Site Class / Importance Level / Design Life	Return Interval	PGA (g)	Magnitude
	Under Serviceability Limit State (SLS) design seismic loading, the expectation is that deflections do not result in damage causing loss of function of the structure and that damage is readily repairable.			0.19[2]	6[2]

[1]ILS scaled from the ULS design case using the Return Period Factor for IL2 from Table B1 of the MoE Structural and Geotechnical Guidelines.
[2]As per Issue 7, Update 50 of the clarifications and updates to the 2012 MBIE Guidance. This second SLS case should be assessed when using the B&I liquefaction triggering procedure.

5.2.3 Liquefaction Triggering

- Liquefaction triggering method: Boulanger and Idriss (2014) as prescribed by MBIE.
- Design ground motions (detailed in Table 1).
- A threshold probability of liquefaction (P_L) of 16% for design earthquake loading.
- A soil behaviour type index (I_c) cut-off value of 2.6 to differentiate between susceptible and non-susceptible to liquefaction soils.
- For purposes of liquefaction analysis, we have adopted the groundwater level that the dip test following each CPT recorded. Where CPTs were not able to be dipped (due to hole collapse) we have averaged the dipped groundwater levels for surrounding CPTs. The assumed water level is shown on the analysis outputs.

Consequences of Liquefaction

- Vertical Settlement - The Zhang, Robertson, and Brachman (2002) procedure for estimating volumetric strain and vertical settlement.
- Surface Expression of Liquefaction - We have estimated surface expression of liquefaction (e.g. sand boil formation) through the index parameter Liquefaction Severity Number (LSN).

5.2.4 Liquefaction Analysis Results

Results of our liquefaction analysis are presented in Appendix 4, with the liquefaction analysis outputs are included in Appendix 5. The site was found to be generally consistent with Technical Category 2 criteria, with localised areas experiencing TC3-like deformations.

Based on the results of our analysis we have mapped these areas across the site, refer to Appendix 2. Also included are areas of uncertainty of the deeper geological profile where the CPTs met shallow refusal. These areas will require further investigation (using machine boreholes); however, we do not consider this needs to be completed until the subdivision consent stage. Note that while the analysis indicated that some areas of the site may be in line with TC1 type performance, we consider that these areas should be considered as TC2 due to the significant variation of the geological profile across the site. This could be further refined through a more detailed testing regime to assess boundaries between the inferred technical categories across the site.

5.3 Lateral Spread

Given the civil / landscaping design of the site wide landform has not yet been developed we have not specifically addressed lateral spread. This should be assessed during the subdivision consent works. We recommend avoiding forming large bodies of water such as those at the neighbouring Pegasus development as these form “free-faces” for the ground surface to move towards during a seismic event when liquefaction occurs.

5.4 Preliminary Consolidation Analysis

Weak cohesive material such as the estuarine deposits identified in the CPTs can be susceptible to consolidation over time. The consolidation rate can be increased when additional load is placed on the site due to the proposed new dwelling. To estimate the consolidation potential on this site, we have completed a preliminary settlement calculation using the geotechnical software CPet-IT. While we have not completed any consolidation or lab testing of the subsurface materials, we consider this is appropriate as a “first-pass” to indicate the likely consolidation potential.

5.4.1 Consolidation Analysis Parameters

As a subdivision earthworks plan has not yet been developed we have considered a generalised fill load across the approximate area of a residential building. We have considered the following parameters for the analysis:

- We have assumed that any fill will be placed on the material directly below topsoil. For this preliminary analysis we have considered a 20 m wide and 1.0 m deep fill platform founded directly below topsoil. This has been modelled as a fill pressure of 20 kPa acting at 0.3 m below ground level.
- This scenario has been modelled for six months of primary settlement and 600 months (50 years) of secondary settlement, which we assume is the design life of the structures within the proposed development.

5.4.2 Analysis Results

Results of our consolidation analysis are presented in Figure 5, with the outputs attached to this report in Appendix 6. The analysis calculates that large areas of the site may be susceptible to consolidation settlement of the soft cohesive material identified in many of the CPTs. More than 25 mm is predicted over the assumed 50 year design life for large parts of the centre and north of the site, whilst over 50 mm is predicted for an area in the south of the site and a small section in the centre of the site. As noted in section 3.3, the area of highly compressible material in the south of the site appears to correlate with an infilled paleo-channel. Also mapped in Figure 5 are areas of large uncertainty, due to shallow CPT refusal.

These settlements are outside of the acceptable tolerance for a residential structure, and as such must be mitigated during subdivision design

6 Geo-Hazard Assessment

Based on our observations and analyses, we consider the primary geohazards to be surface deformation due to liquefaction, and long-term consolidation settlement of soft cohesive or organic material across areas of the site (see Appendices 1 and 2 for our hazard maps – specifically areas mapped as TC3 or over 50 mm of long term consolidation settlement). The risks presented by these

hazards can be mitigated through earthworks, ground improvement or specifically engineered foundations. We therefore do not consider that these hazards should preclude this site from progressing through plan change, however, additional work will be required during the Subdivision Consent phase to refine the geological ground model to more accurately define the boundaries of these areas and the options available to remediate them.

We also recommend that the flooding hazard (noted in Section 3.2.3) is considered during civil engineering subdivision design. Assessment of the effects of tsunami is outside of our scope, however, a brief review of the WDC natural hazards viewer shows the evacuation zones terminating on the eastern side of State Highway 1 (i.e. outside of the site boundary).

7 Conclusions and Future Works

In conclusion, we consider this site can be developed through industry standard practices found in the Canterbury Region and that the ground conditions are generally similar to the Ravenswood and Pegasus Developments. Further geotechnical assessment works will be required as the project progresses into subdivision consent and the works may include:

- Undertaking additional geotechnical testing across the site to further delineate the boundaries between TC1, TC2 and TC3 type performance across the site and the areas through which significant amounts of compressible material may be present. Further testing is also required in the areas of shallow CPT refusal, particularly in the east of the site, to more accurately define the deeper geological profile in these areas.
- Groundwater monitoring, especially in areas that have artesian pressures.
- Laboratory sampling including fines content analyses to refine the liquefaction analyses and 1D Consolidation testing if significant peat deposits are encountered.
- Understanding the implications of artesian water pressures for the proposed development as discussed in Section 4.2.

8 Sustainability

We encourage you to consider sustainability when assessing the options available for your project. Where suitable for the project, we recommend prioritising the use of sustainable building materials (such as timber in favour of concrete or steel), locally sourced (materials readily available to Contractors as opposed to materials requiring import), and installed in an environmentally friendly way (e.g., reduced carbon emissions and minimal contamination). If you would like to discuss these options further, ENGEO staff are available to offer suggestions.

Site won material should be used wherever possible to minimise the environmental impact of the project. Where site won materials are unsuitable first consider mechanical stabilisation of the fill as an alternative to imported material, and when imported material is still required, consider using recycled aggregates such as crushed concrete – which can absorb carbon out of the atmosphere due to the carbonation process.

9 Limitations

i. We have prepared this report in accordance with the brief as provided. This report has been prepared for the use of our client, Westside Country Ltd, their professional advisers and the relevant Territorial Authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.

ii. The recommendations in this report are based on the ground conditions indicated from published sources, site assessments and subsurface investigations described in this report based on accepted normal methods of site investigations. Only a limited amount of information has been collected to meet the specific financial and technical requirements of the client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgement and it should be appreciated that actual conditions could vary from the assumed model.

iii. Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

iv. This Limitation should be read in conjunction with the Engineering NZ/ACENZ Standard Terms of Engagement.

v. This report is not to be reproduced either wholly or in part without our prior written permission.

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned on (03) 328 9012 if you require any further information.

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Senior Engineering Geologist

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Principal Engineering Geologist

Dai Kiddle

Geotechnical Engineer

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We also acknowledge the New Zealand GeoNet project and its sponsors EQC, GNS Science and LINZ, for providing data used in this report.

APPENDIX 1:

Compressible Material Hazard Map

Legend

- ENGEO Test Locations
- Elliot Sinclair CPT Locations
- Site Boundary
- Insufficient Data
- Approximate Area of Artesian Water Pressure
- 0 - 25 mm Settlement Over 50 Year Design Life
- 25 - 50 mm Settlement over 50 Year Design Life
- 50+ mm Settlement over 50 Year Design Life

0 100 m 200 m

LINZ CC BY 4.0 © Imagery Basemap contributors

ENGEO

Produced by **Datanest.earth**

Title: Compressible Soil Areas		
Client: Westside Country Ltd.		Figure No: 5 Size: A3
Project: Gresson and Main North Road	Drawn: DKi	
Date: 22-11-2021	Checked: RC	
Proj No: P2021.005.919	Scale: 1:8250	Version: Final

APPENDIX 2:

Inferred Technical Category Map

Legend

- CPT - (Depth of Investigation) [Liquefaction induced vertical settlement at ULS]
- Site Boundary
- Insufficient Data
- TC2
- TC3

0 100 m 200 m

LINZ CC BY 4.0 © Imagery Basemap contributors

ENGEO

Produced by **Datanest.earth**

Title: Inferred Technical Category Map		
Client: Westside Country Ltd.		
Project: Gresson and Main North Road	Drawn: DKi	Figure No: 6 Size: A3
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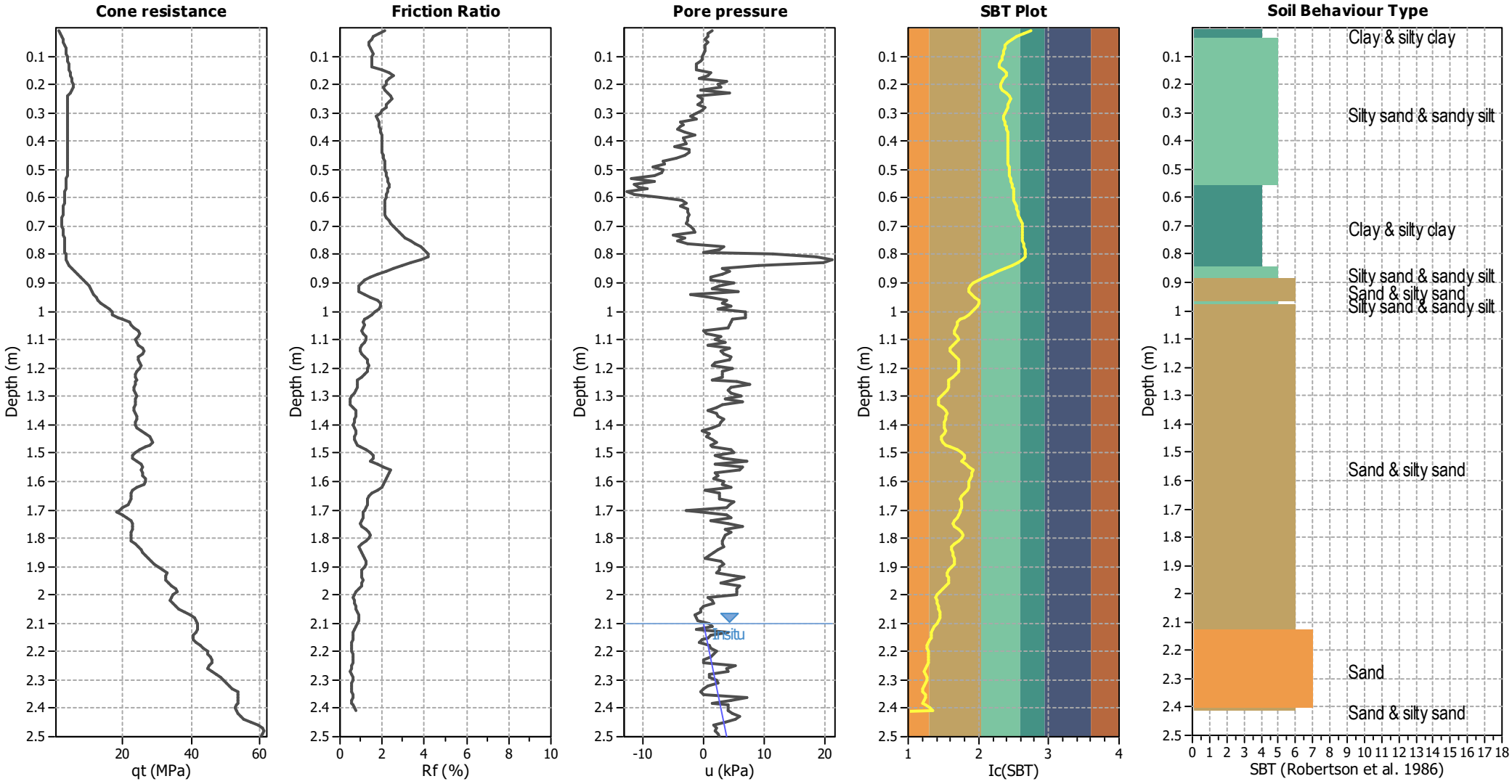
Proj No: P2021.005.919	Scale: 1:8250	Version: Final

APPENDIX 3:

CPT Logs

CPT basic interpretation plots



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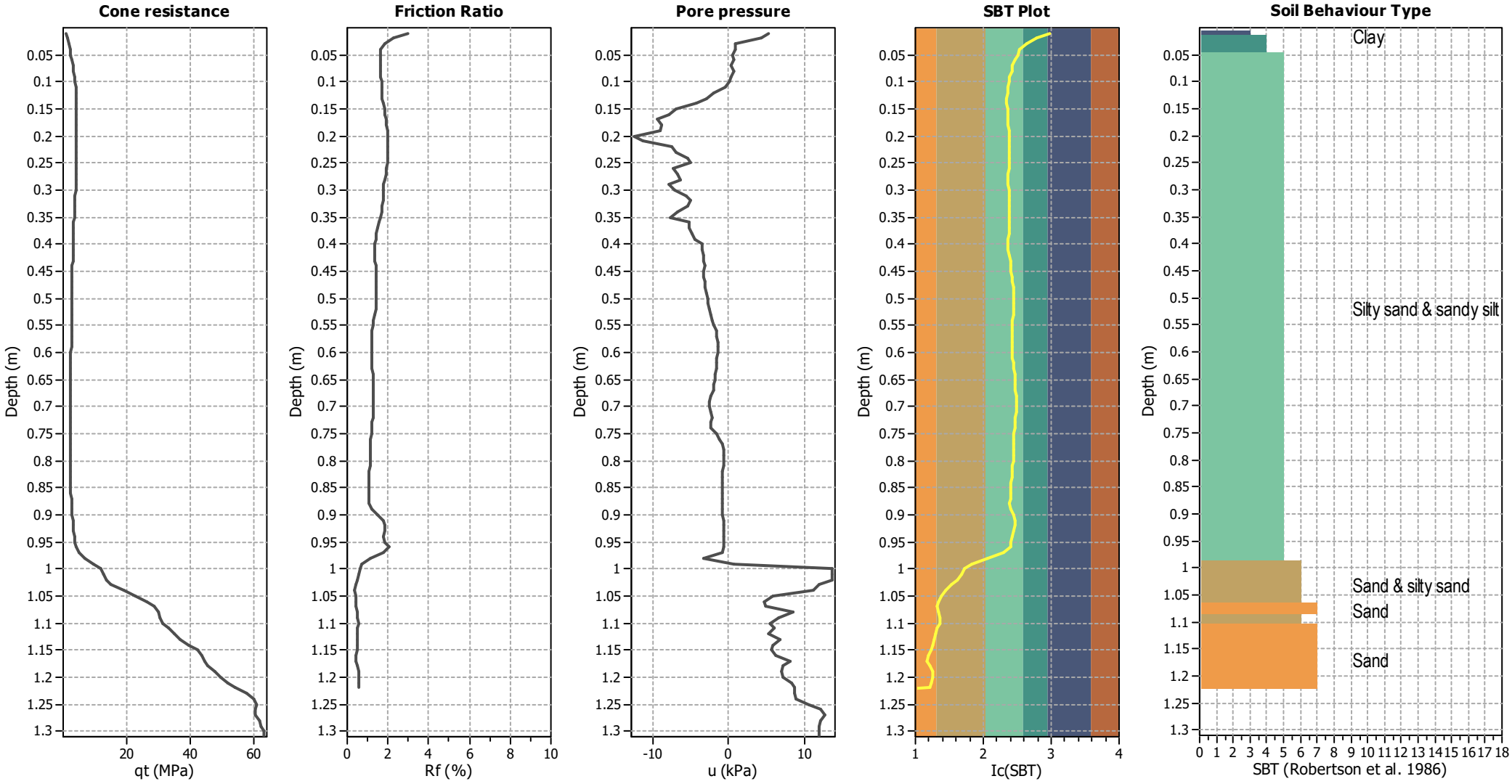
Depth to water table (insitu):	2.10 m	Fill height:	N/A	Limit depth:	10.00 m

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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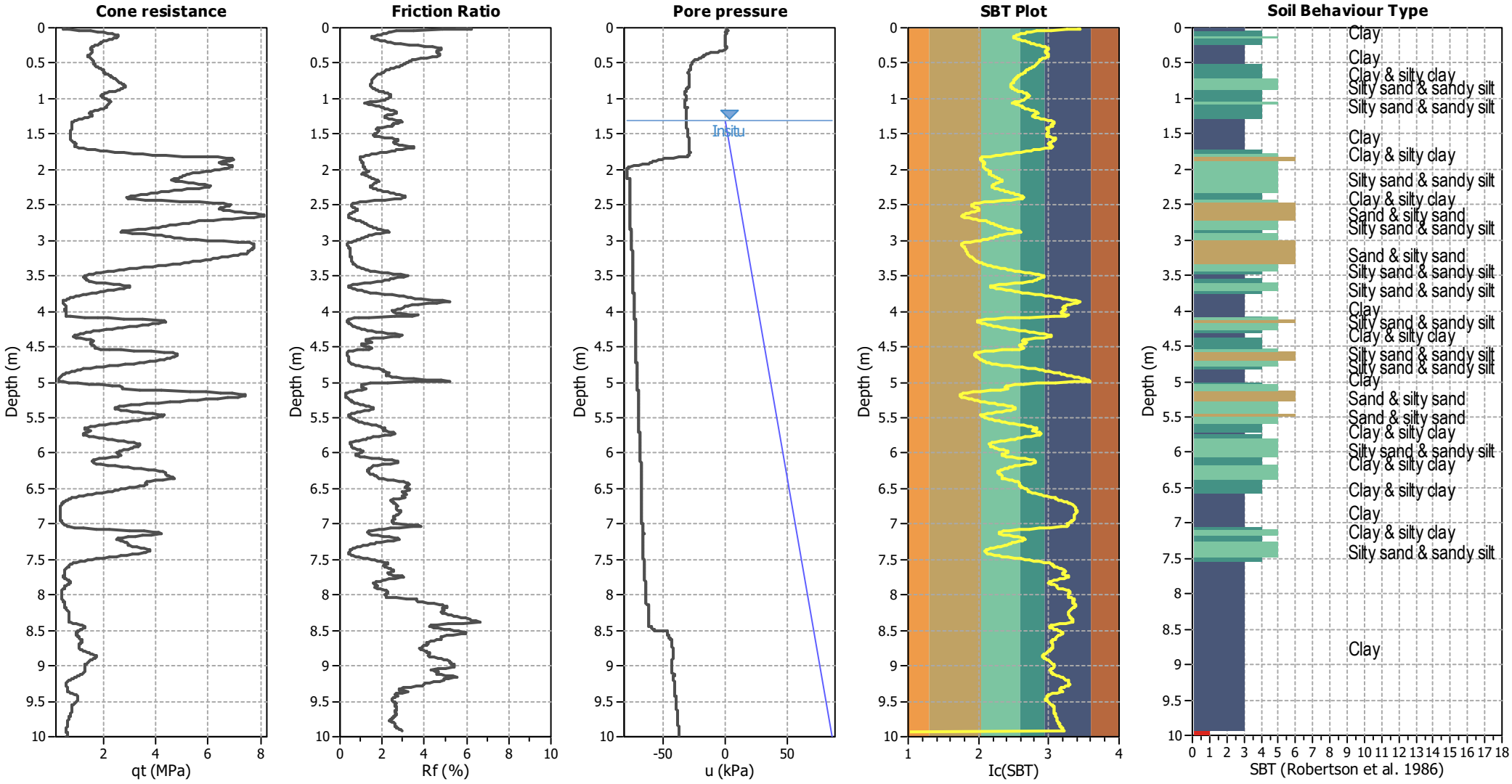
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.10 m	Fill height:	N/A	Limit depth:	10.00 m

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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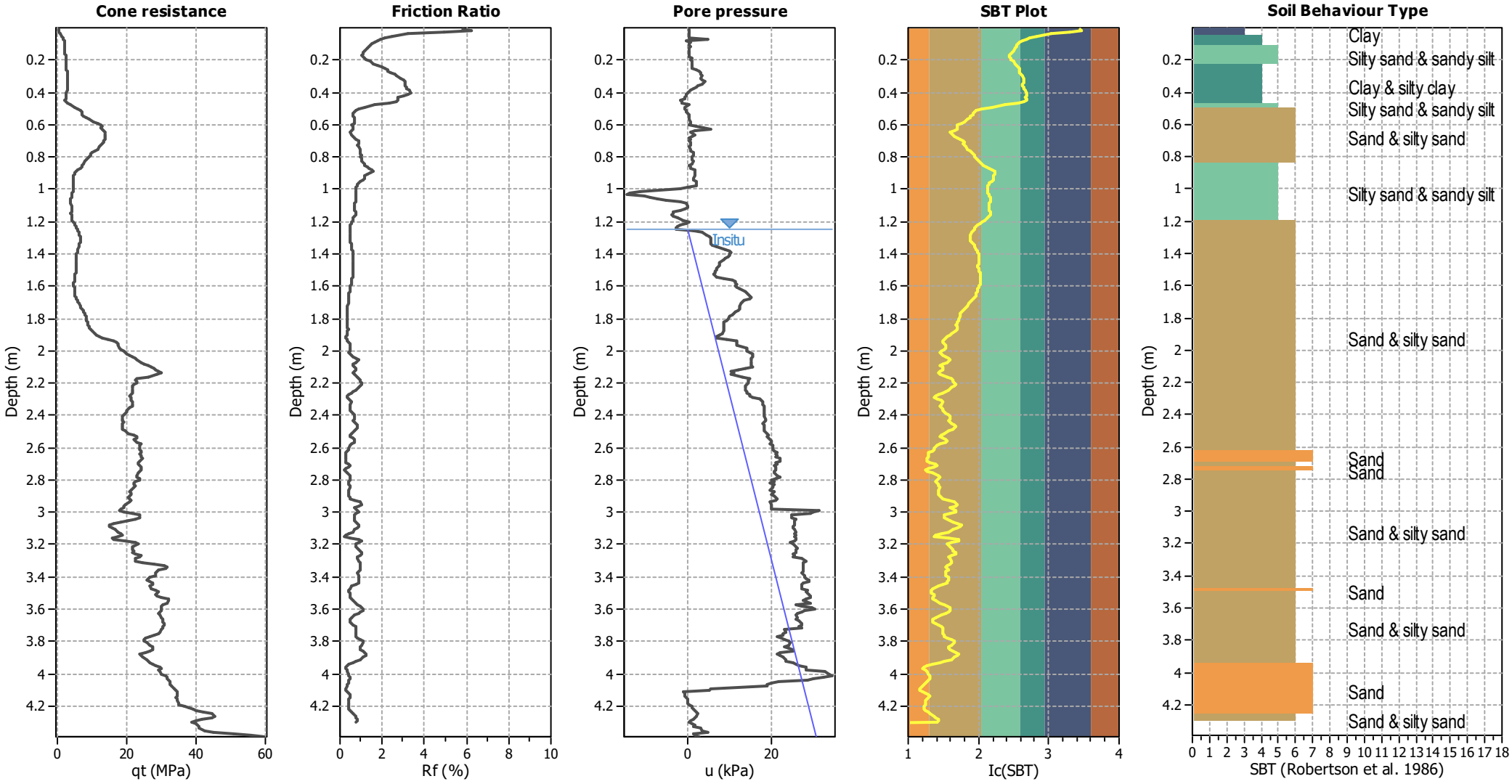
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.30 m	Fill height:	N/A	Limit depth:	10.00 m

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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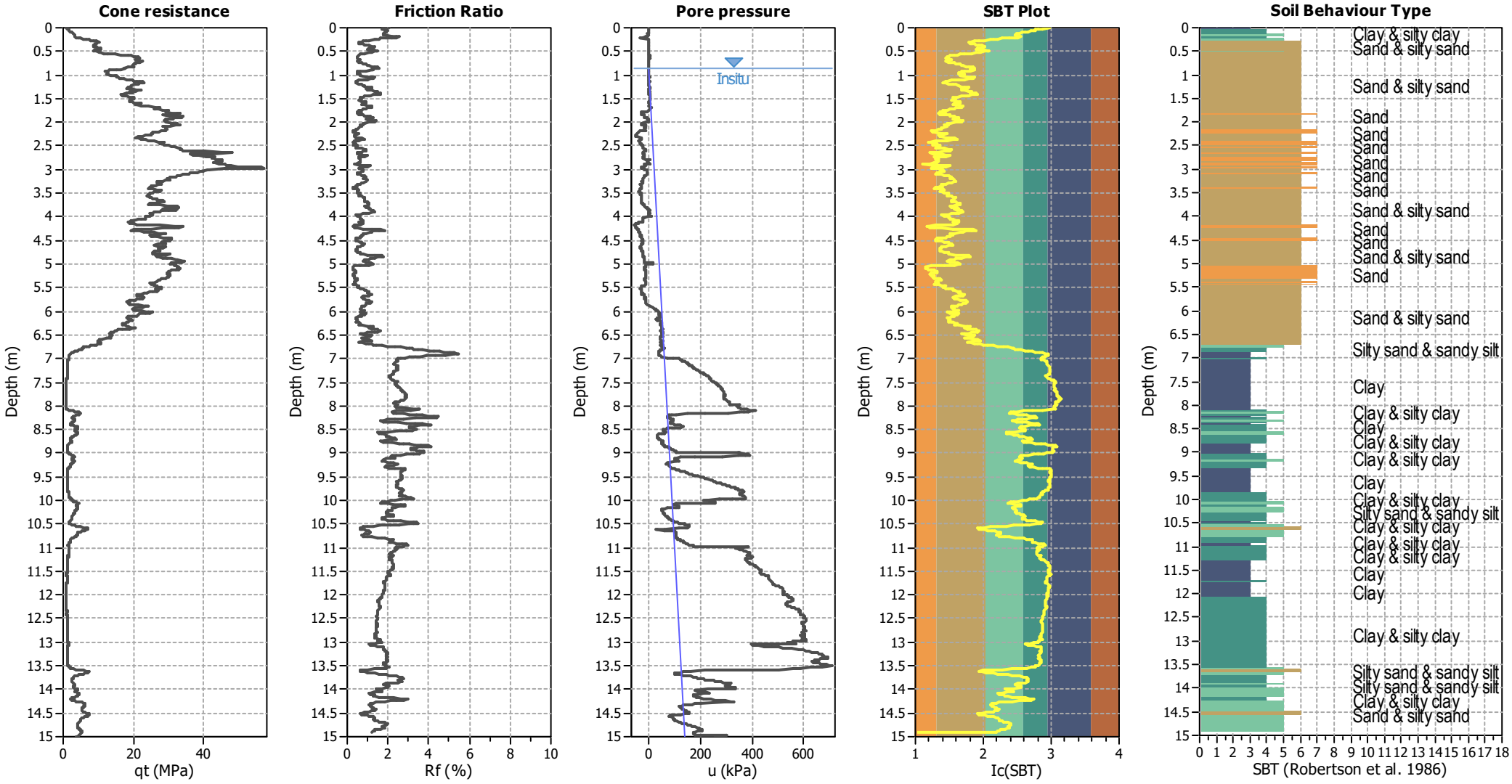
Depth to water table (insitu):	1.25 m	Fill height:	N/A	Limit depth:	10.00 m

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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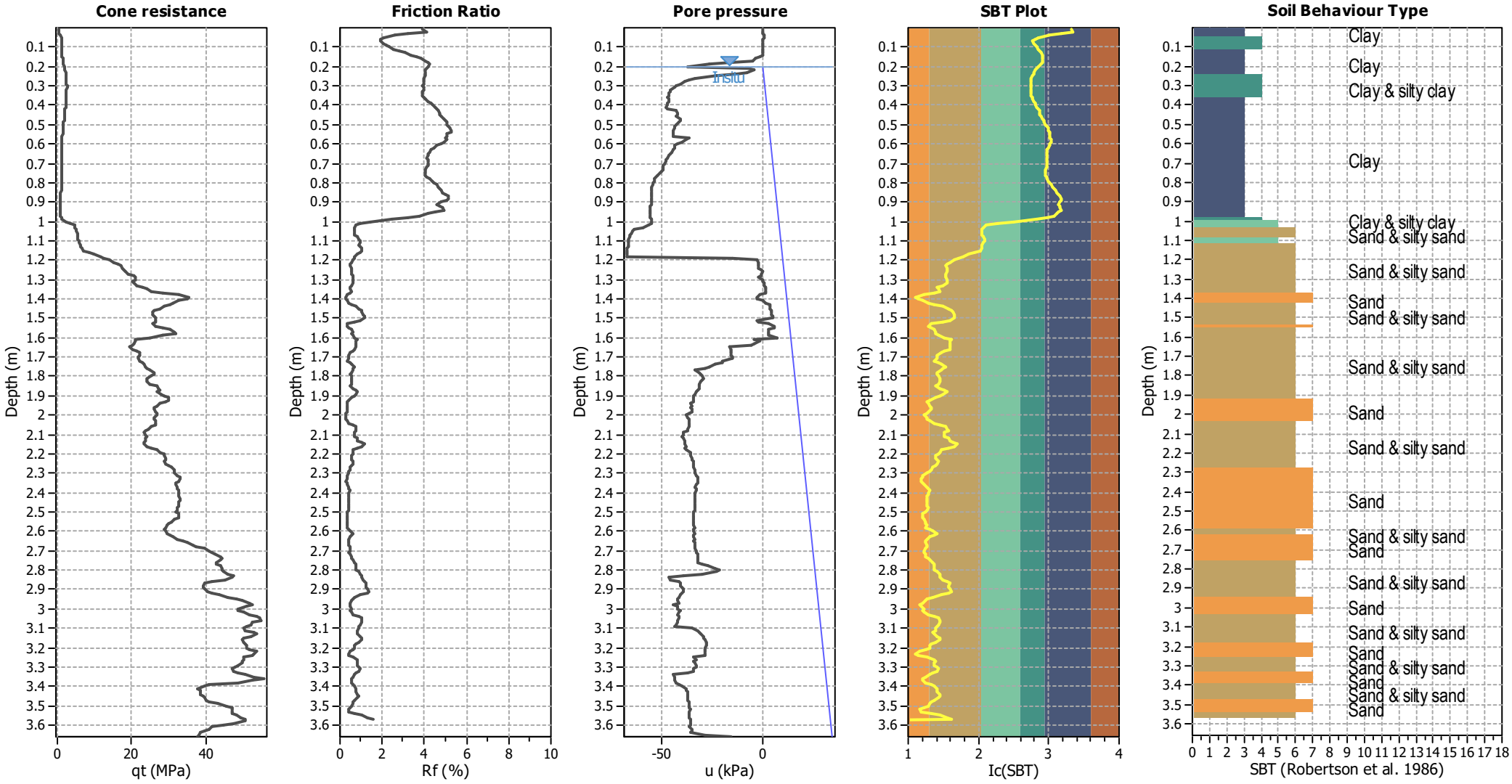
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.85 m	Fill height:	N/A	Limit depth:	10.00 m

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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Depth to water table (insitu):	0.20 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
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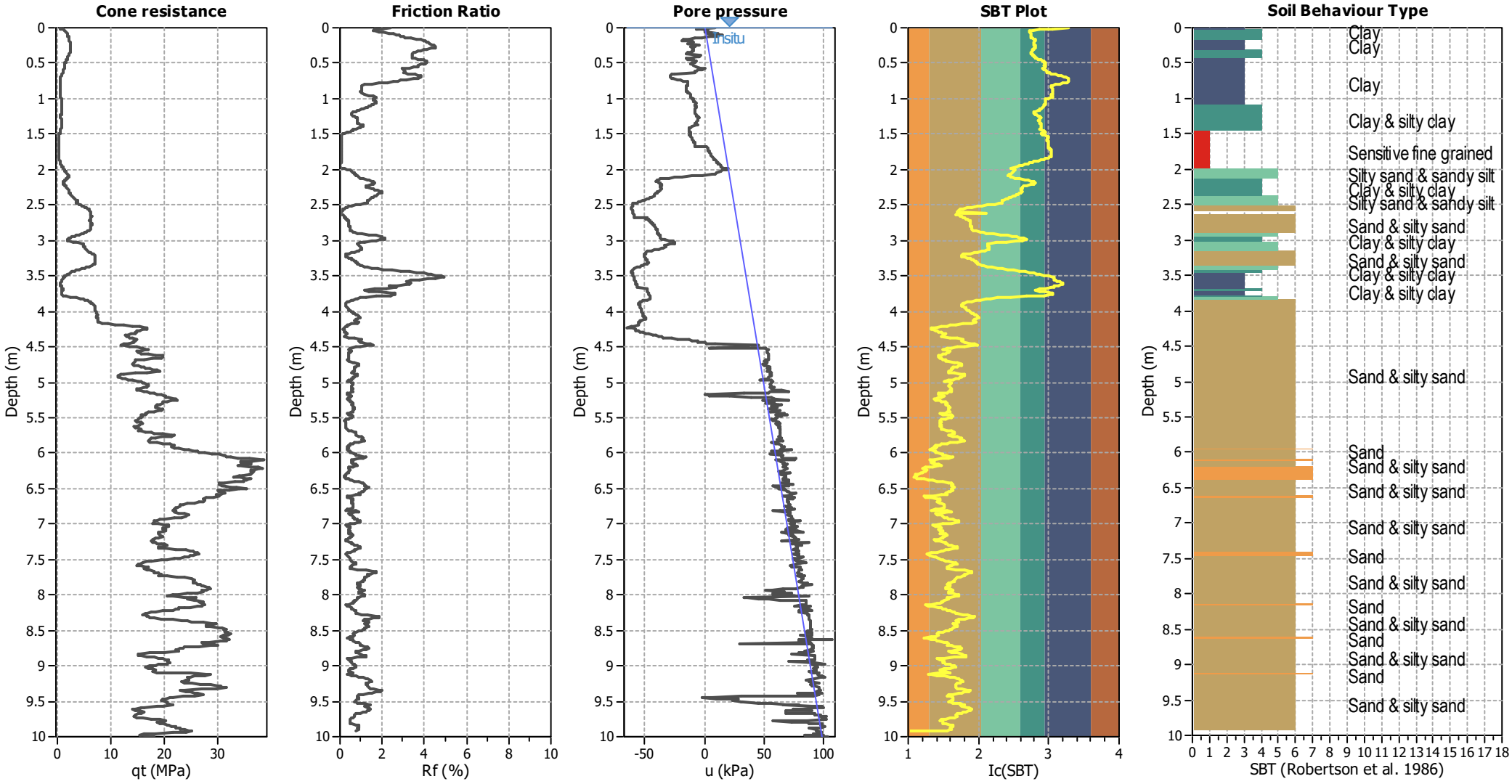
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

CPT basic interpretation plots



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Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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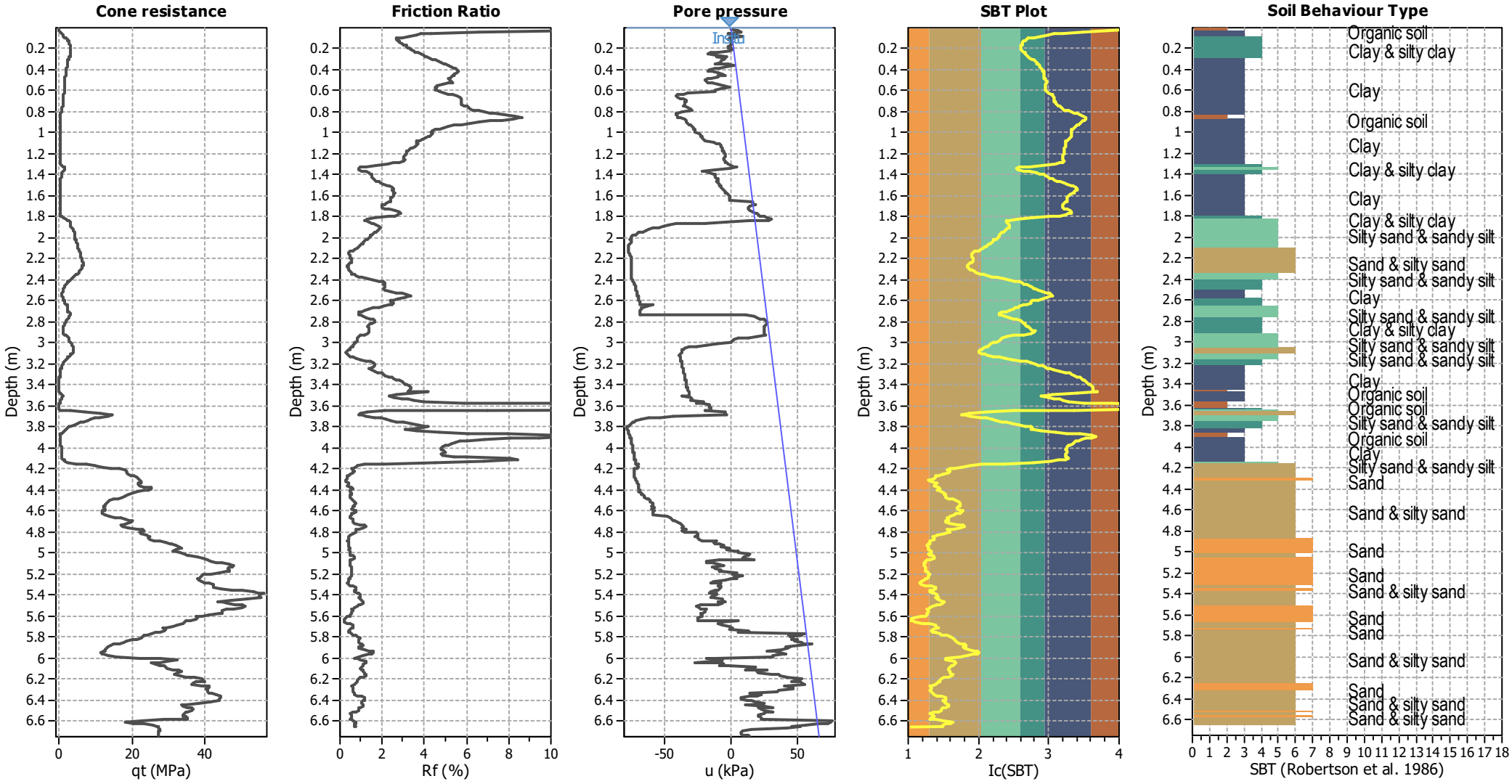
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

CPT basic interpretation plots



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Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

1. Sensitive fine grained
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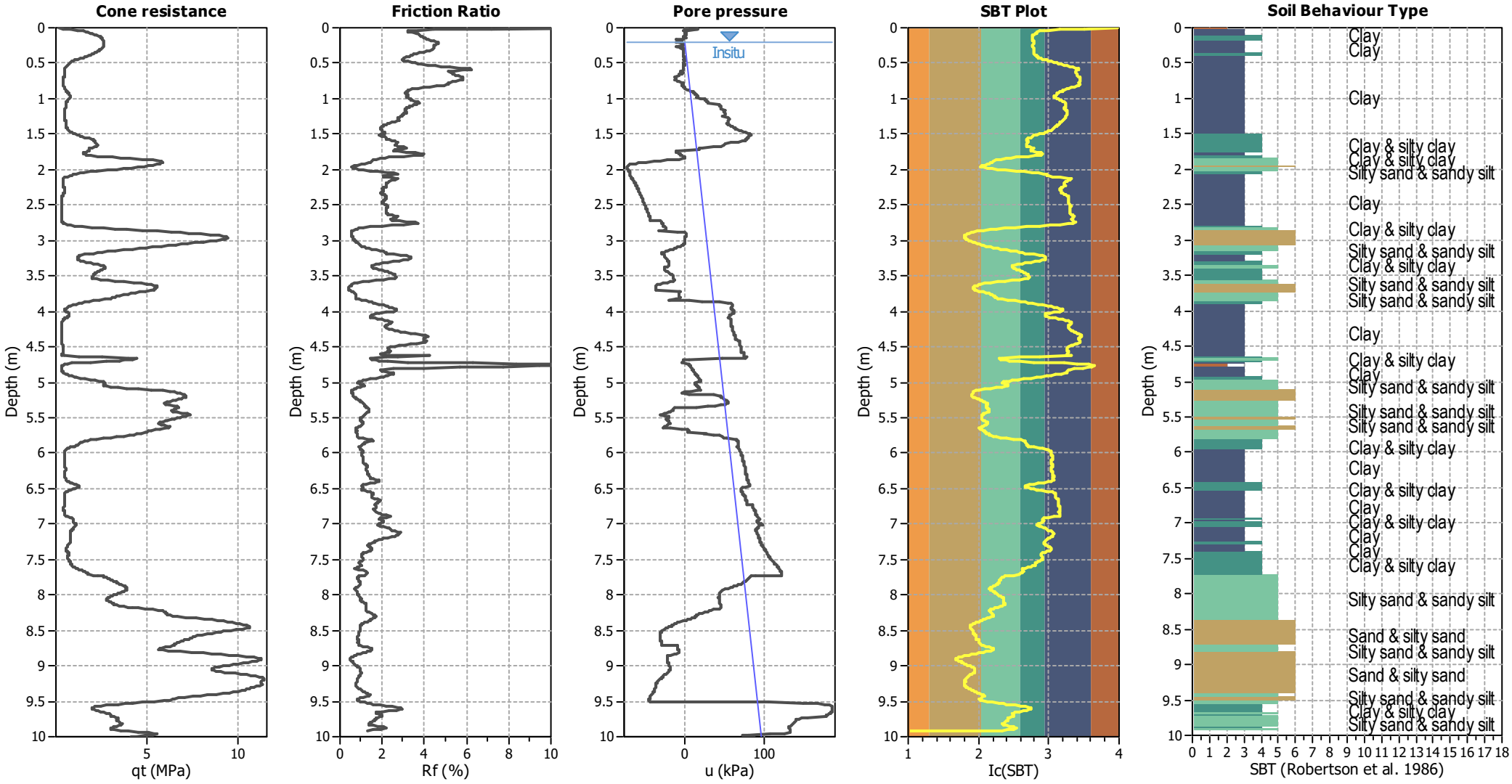
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

CPT basic interpretation plots



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Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.20 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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4. Clayey silt to silty
5. Silty sand to sandy silt
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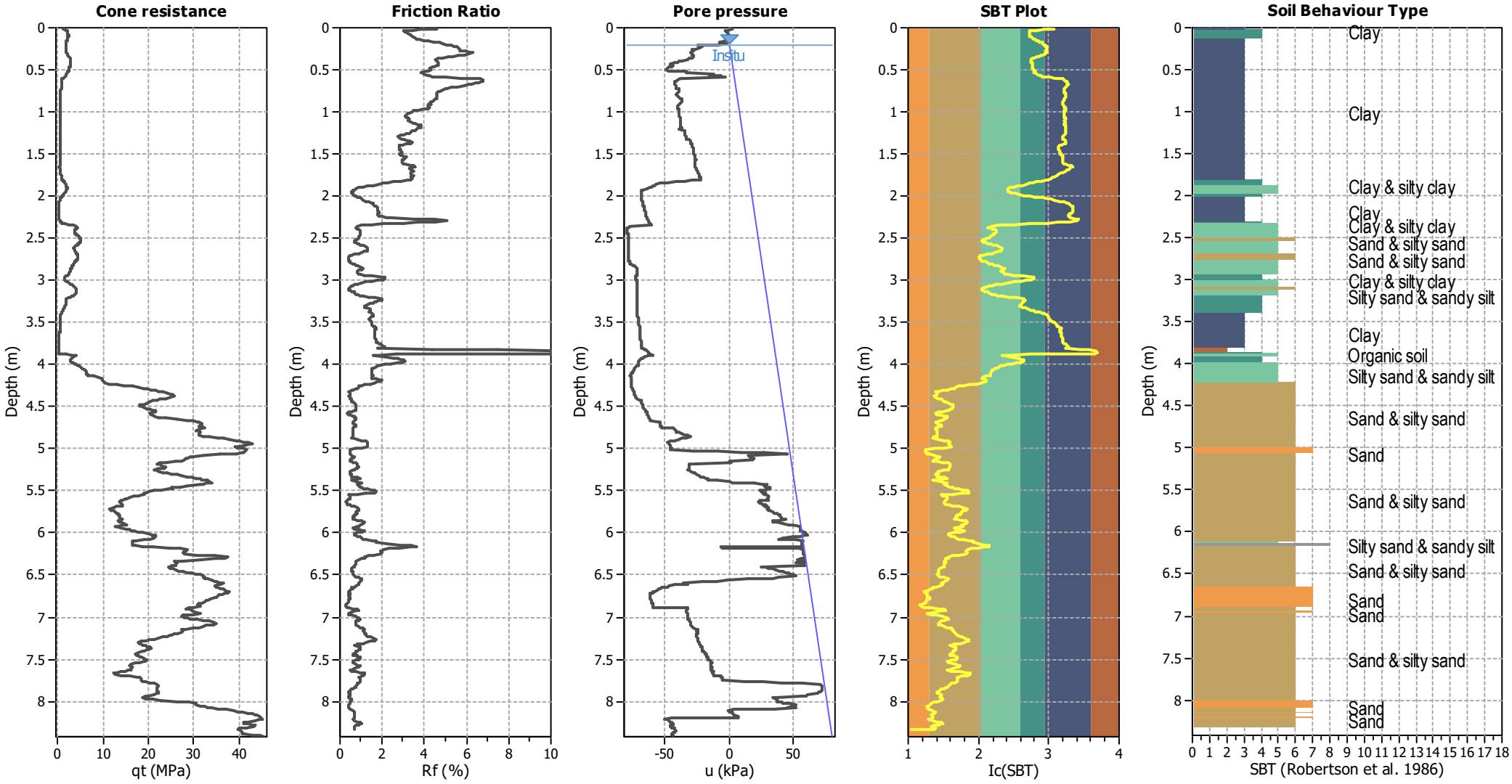
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

CPT basic interpretation plots



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Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.20 m	Fill height:	N/A	Limit depth:	10.00 m

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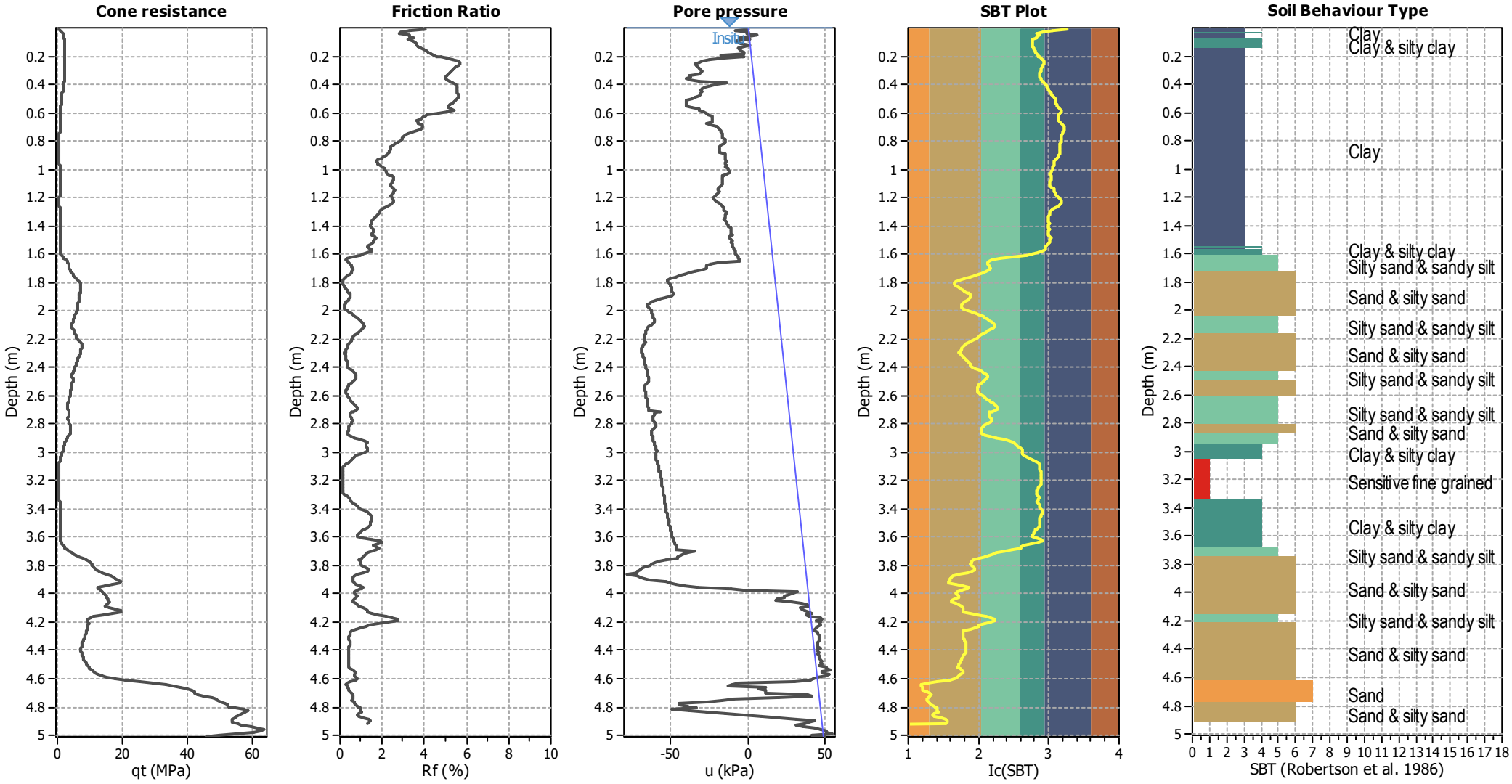
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

CPT basic interpretation plots



Input parameters and analysis data

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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

1. Sensitive fine grained
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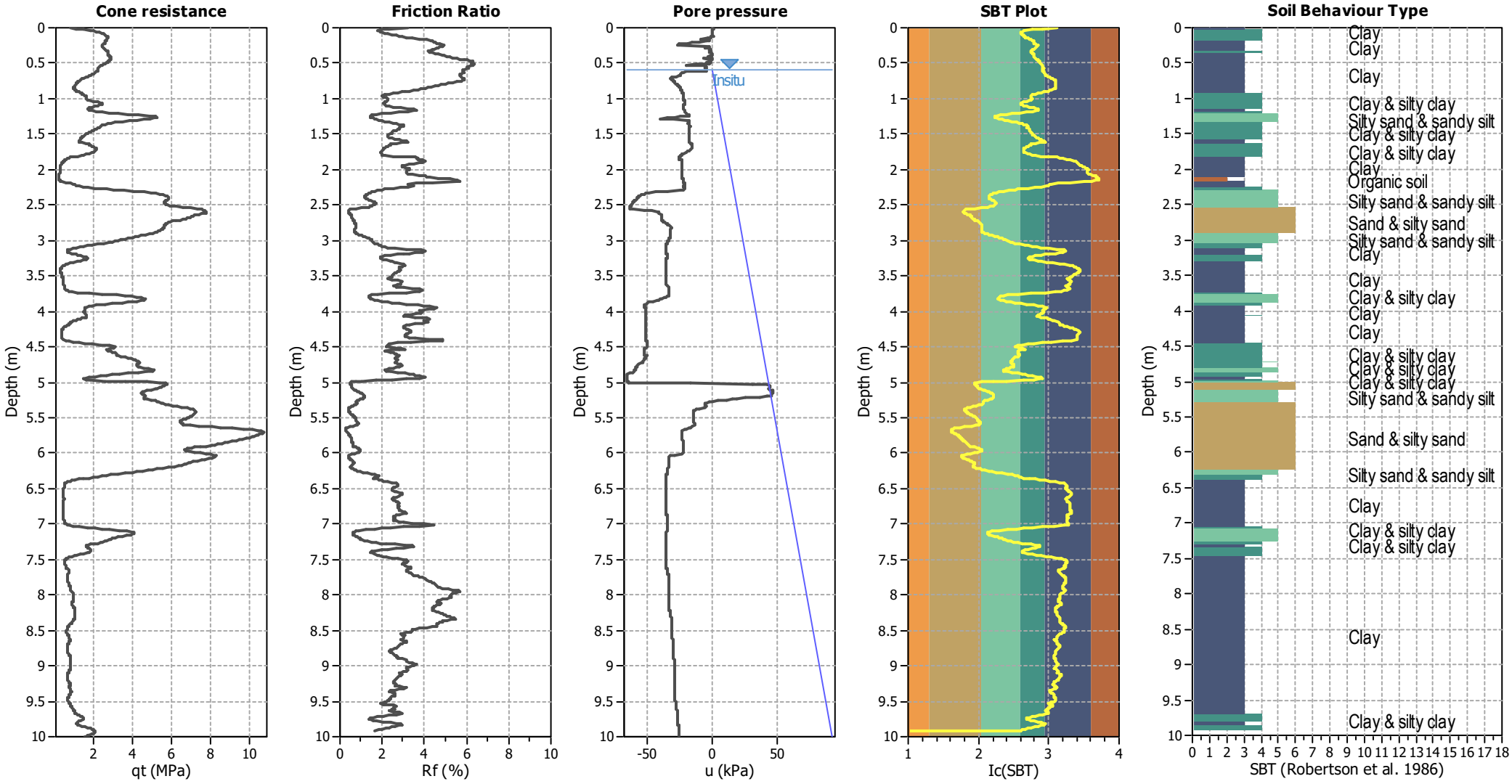
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

CPT basic interpretation plots



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Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.60 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

1. Sensitive fine grained
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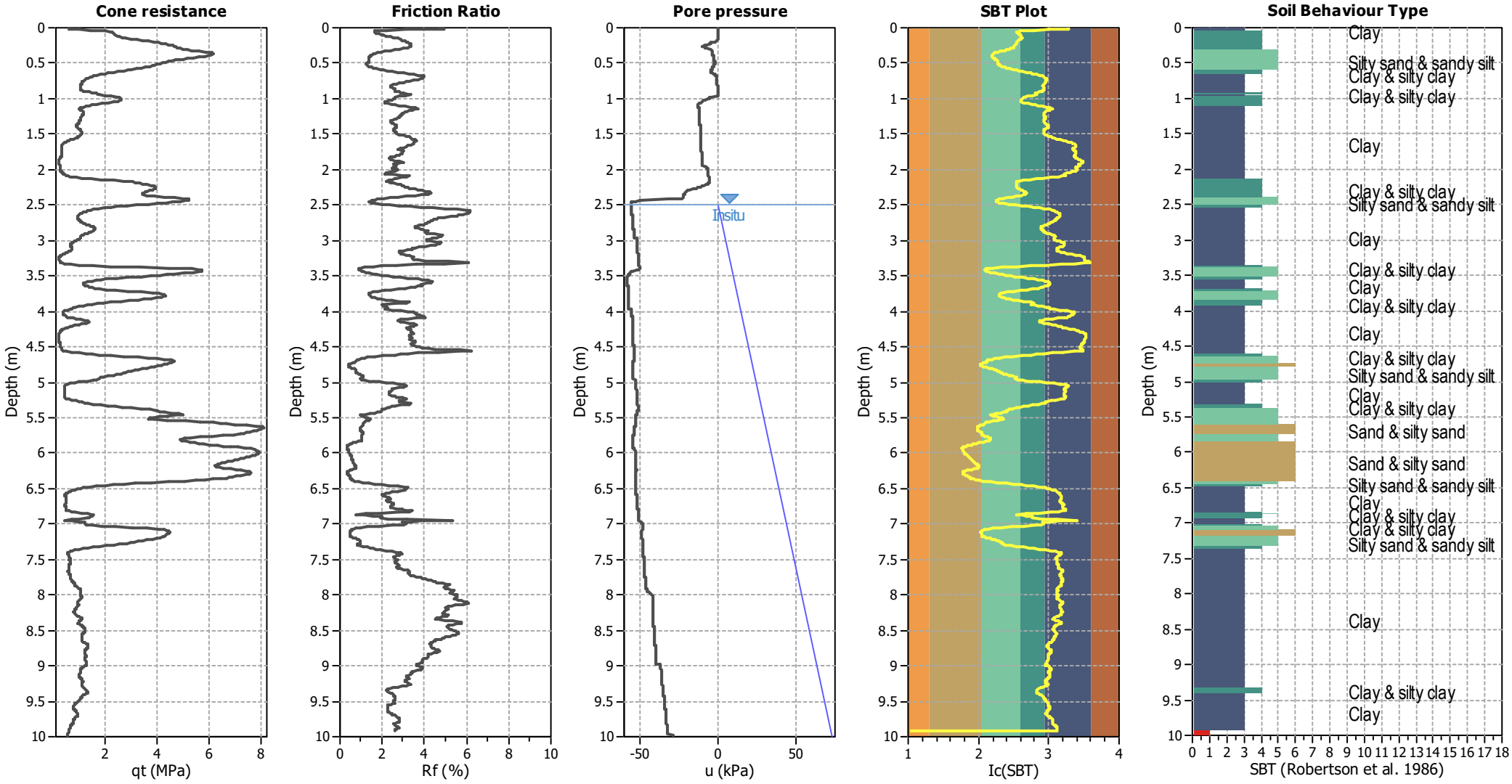
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

CPT basic interpretation plots



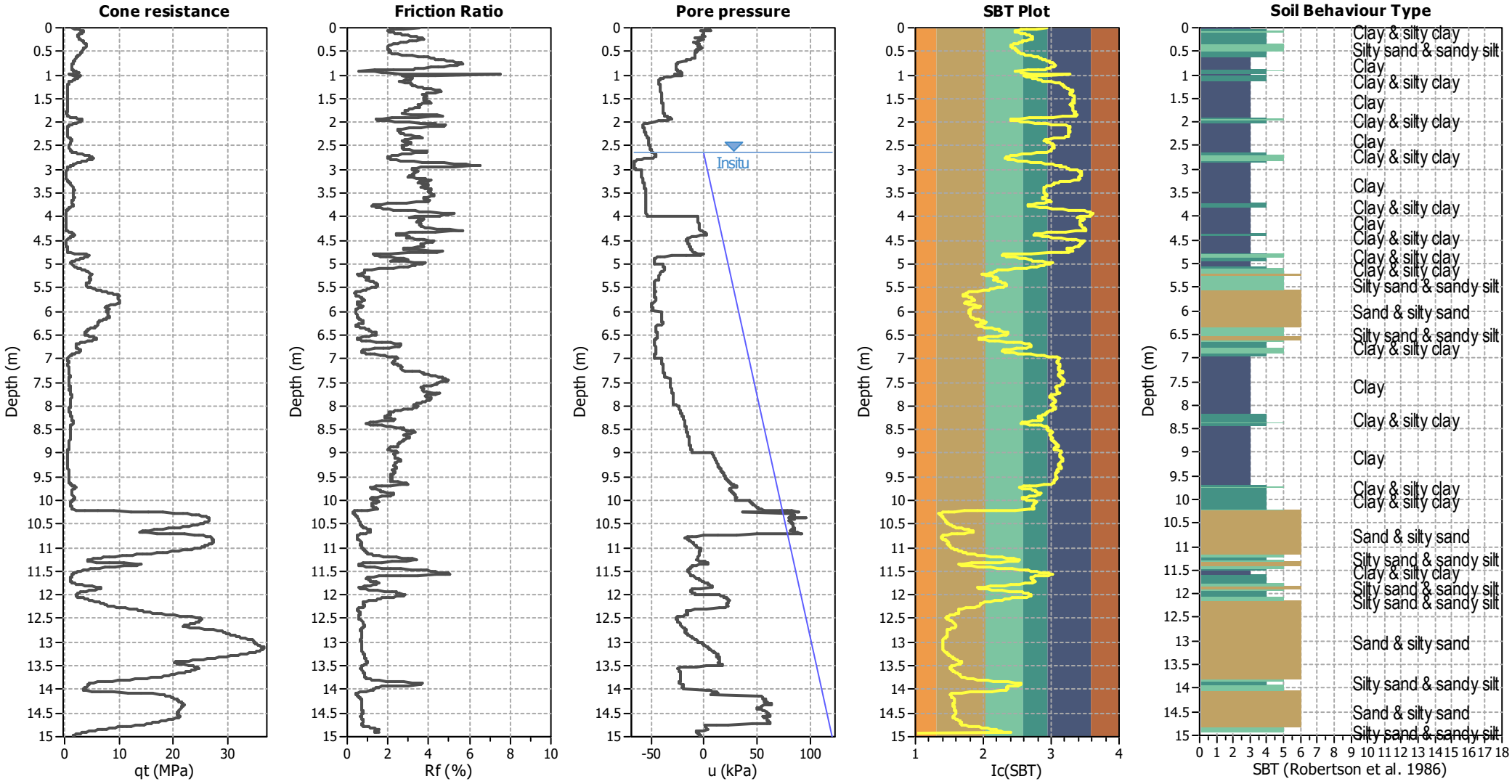
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.50 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



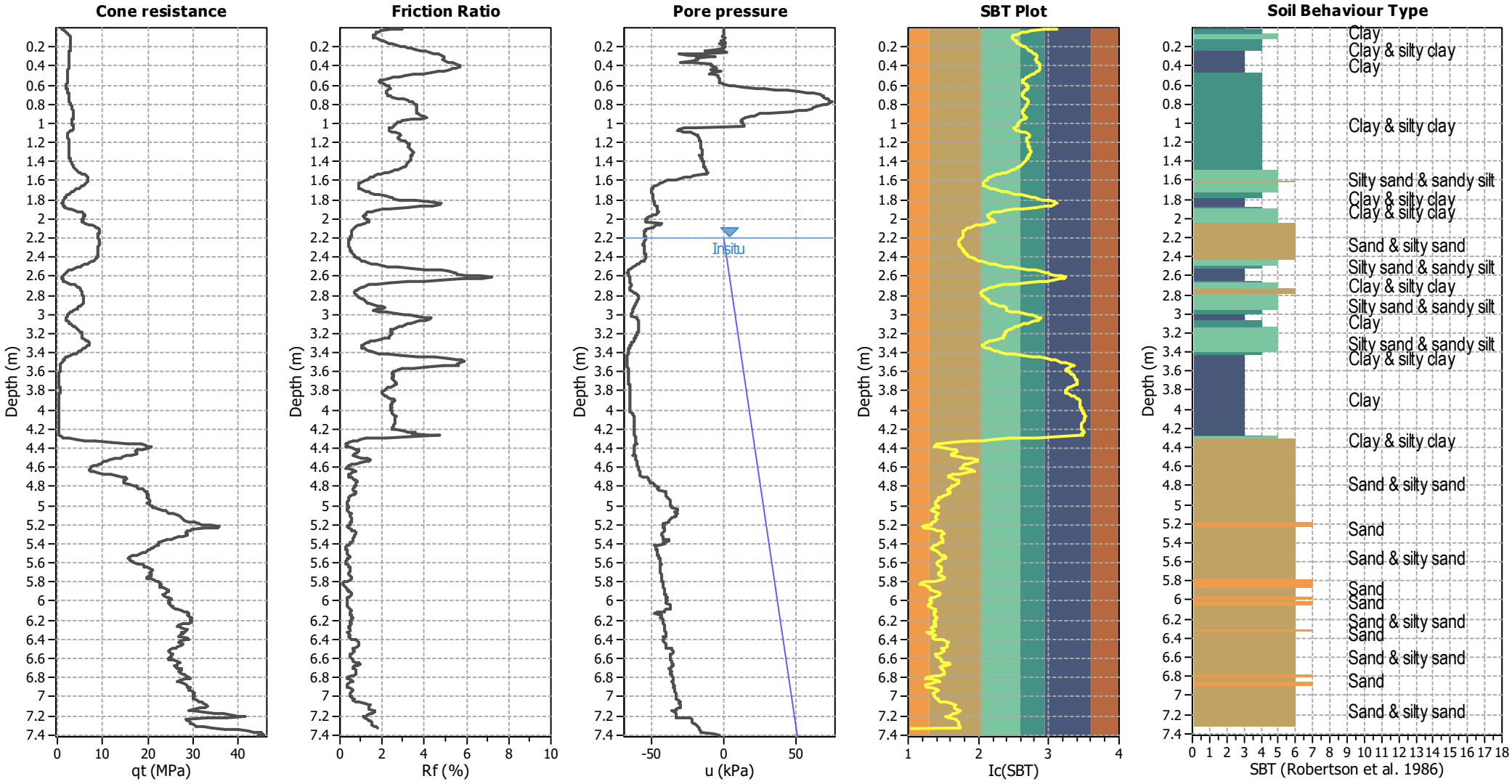
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.65 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



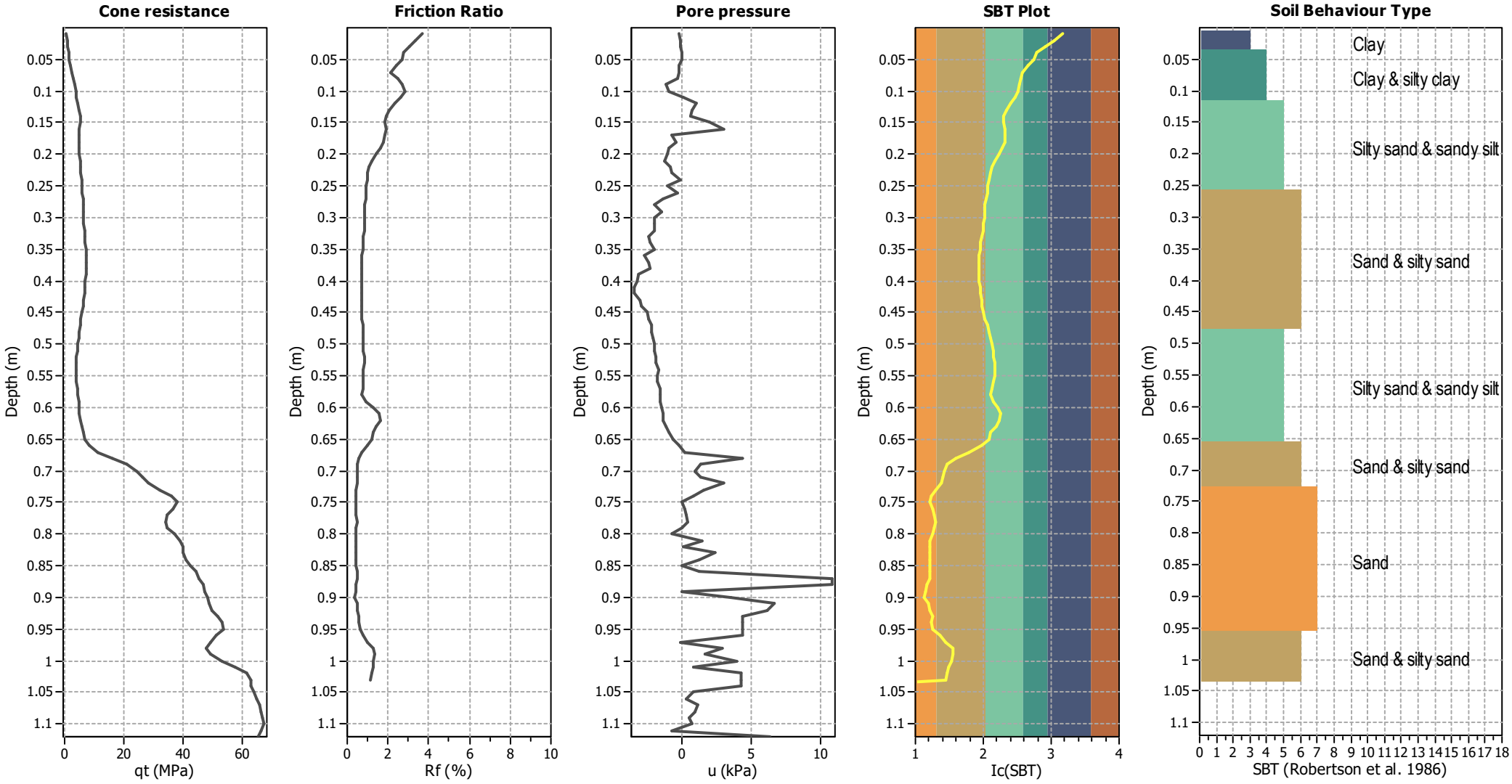
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 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



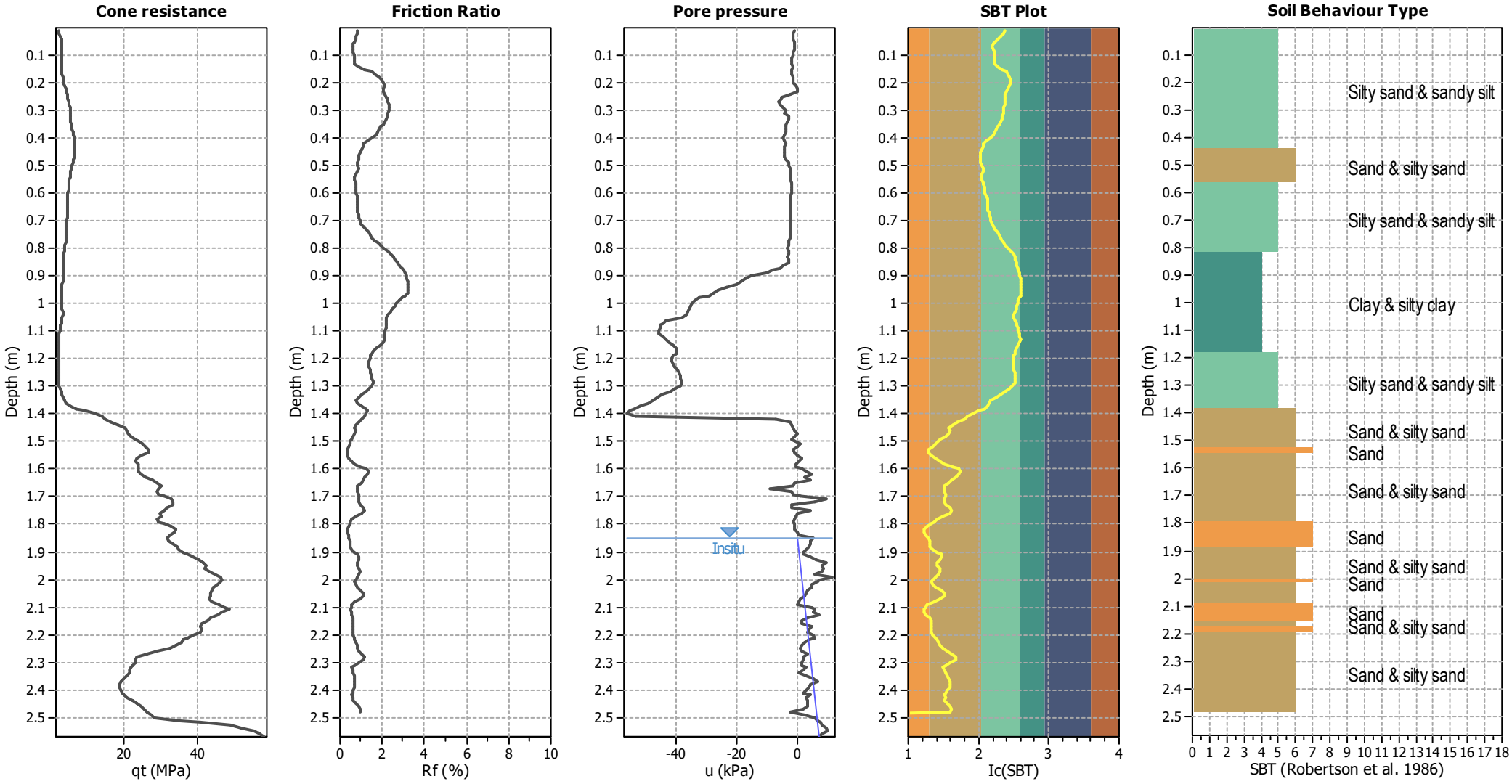
Input parameters and analysis data

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:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	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



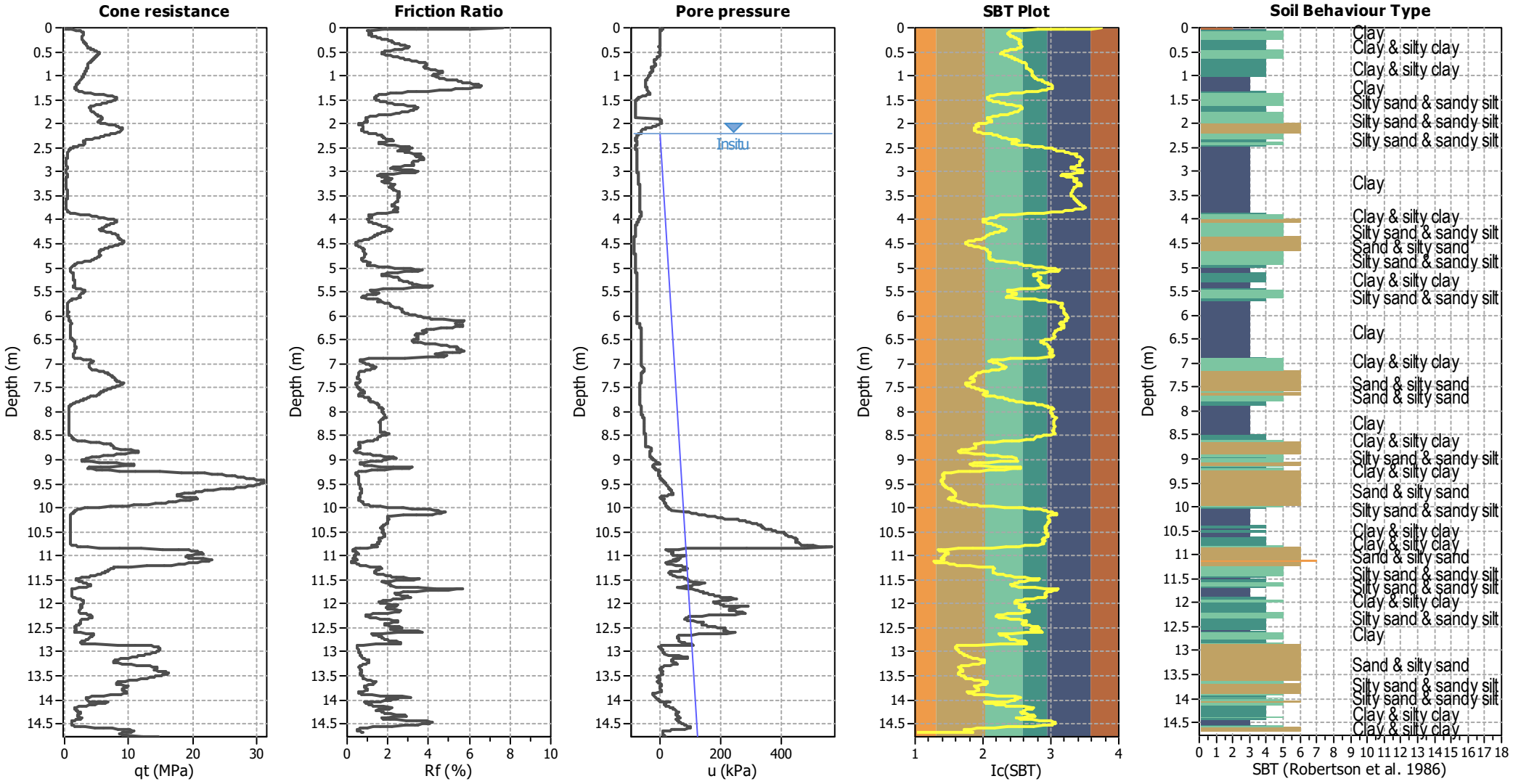
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.85 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.85 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



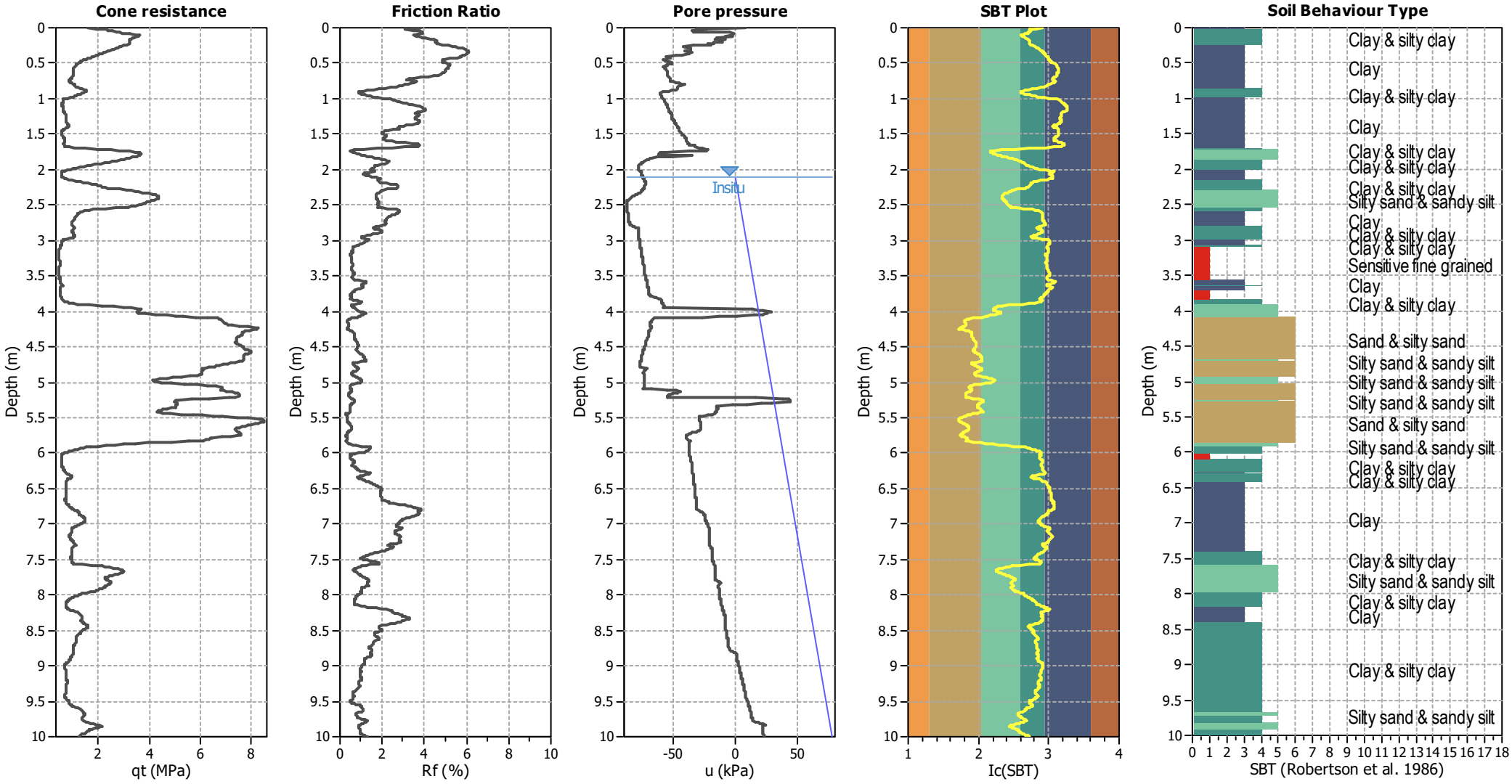
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 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



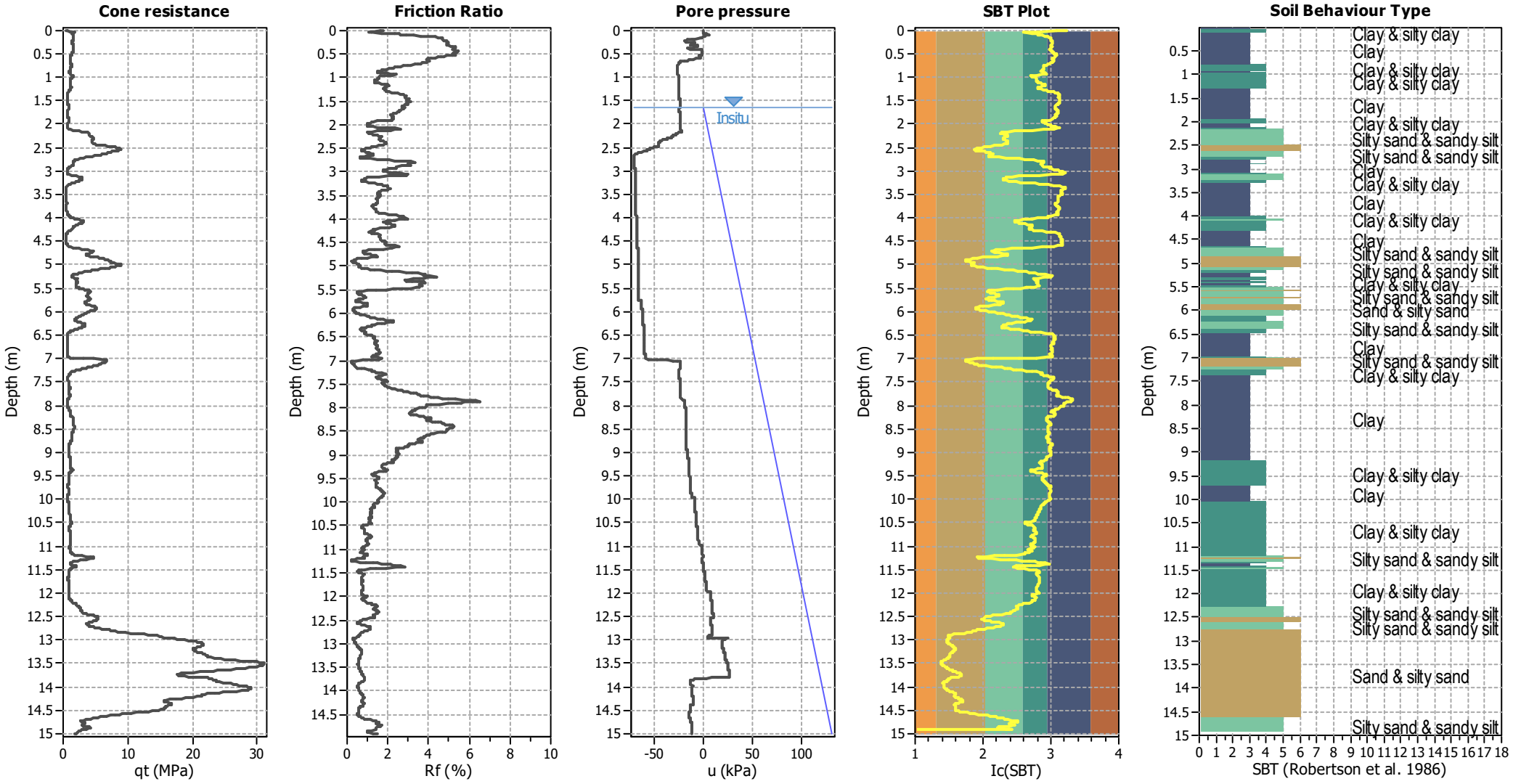
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.10 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



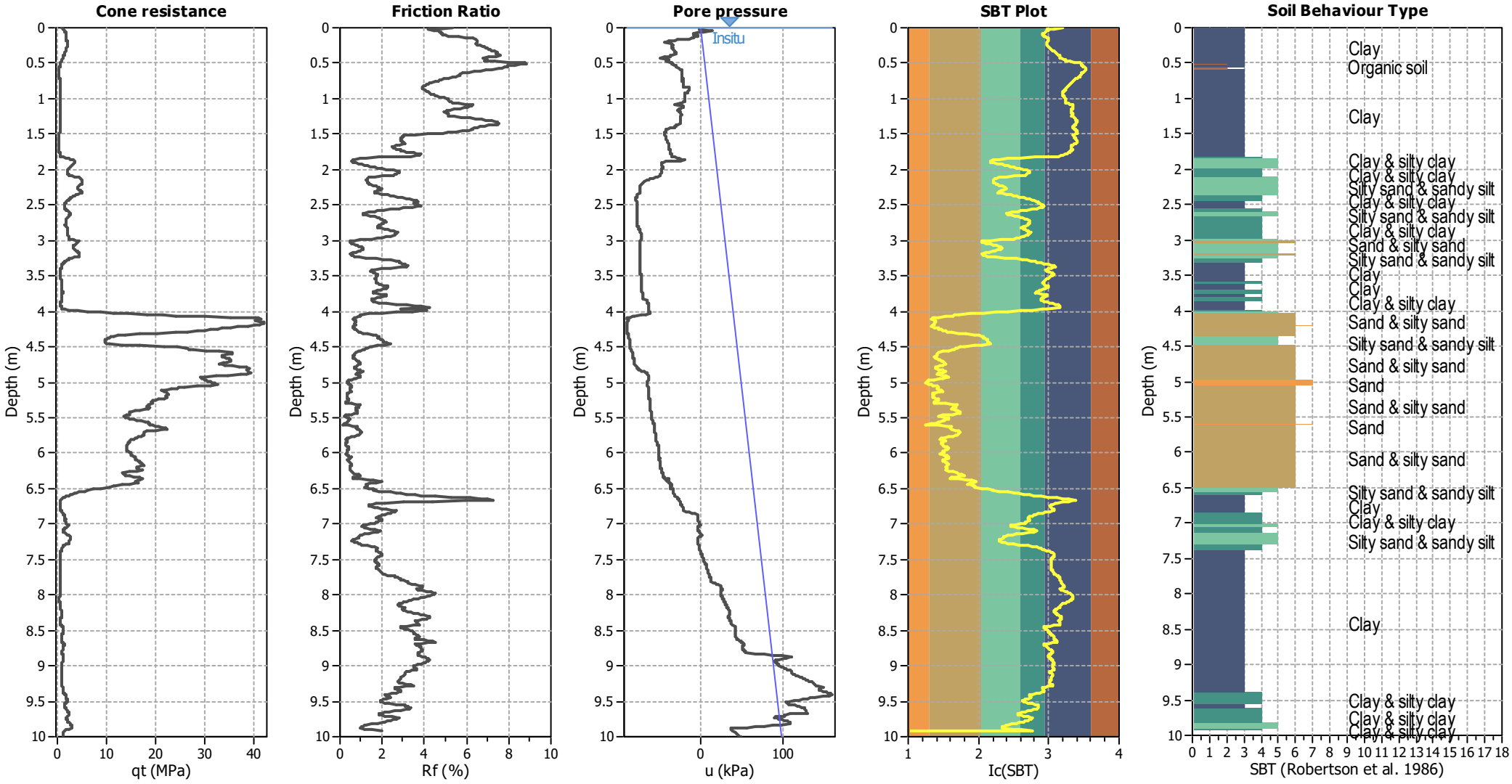
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 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



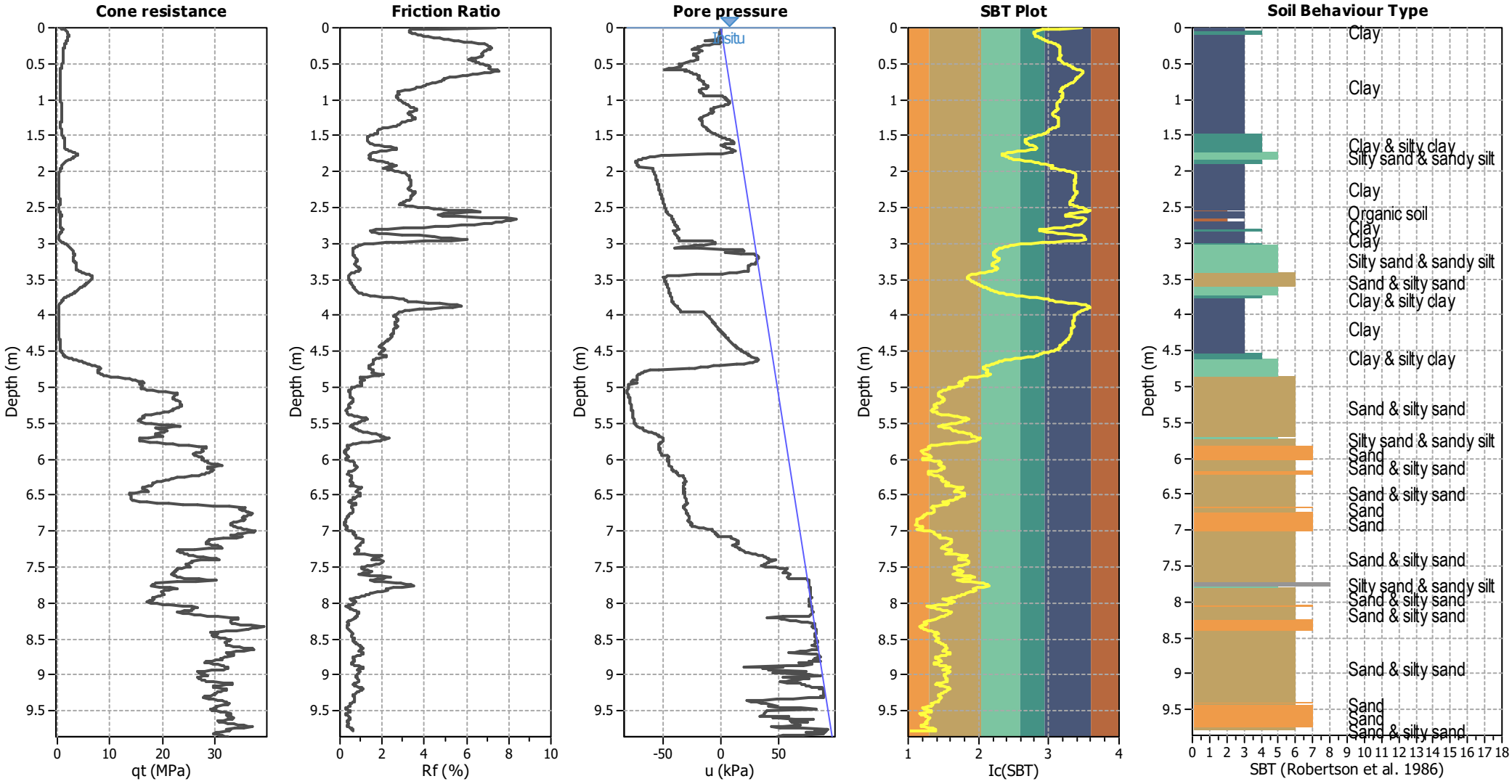
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 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



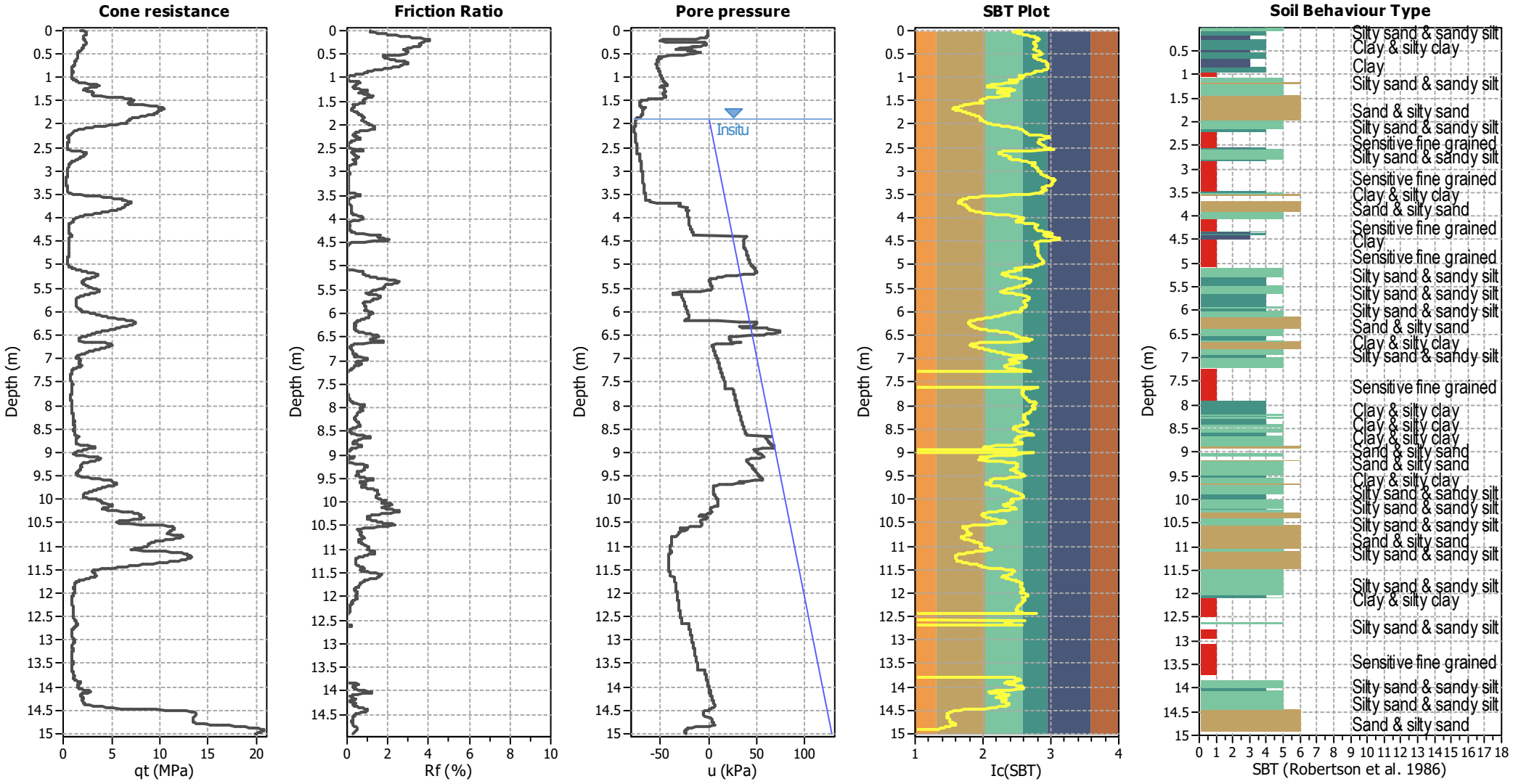
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 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



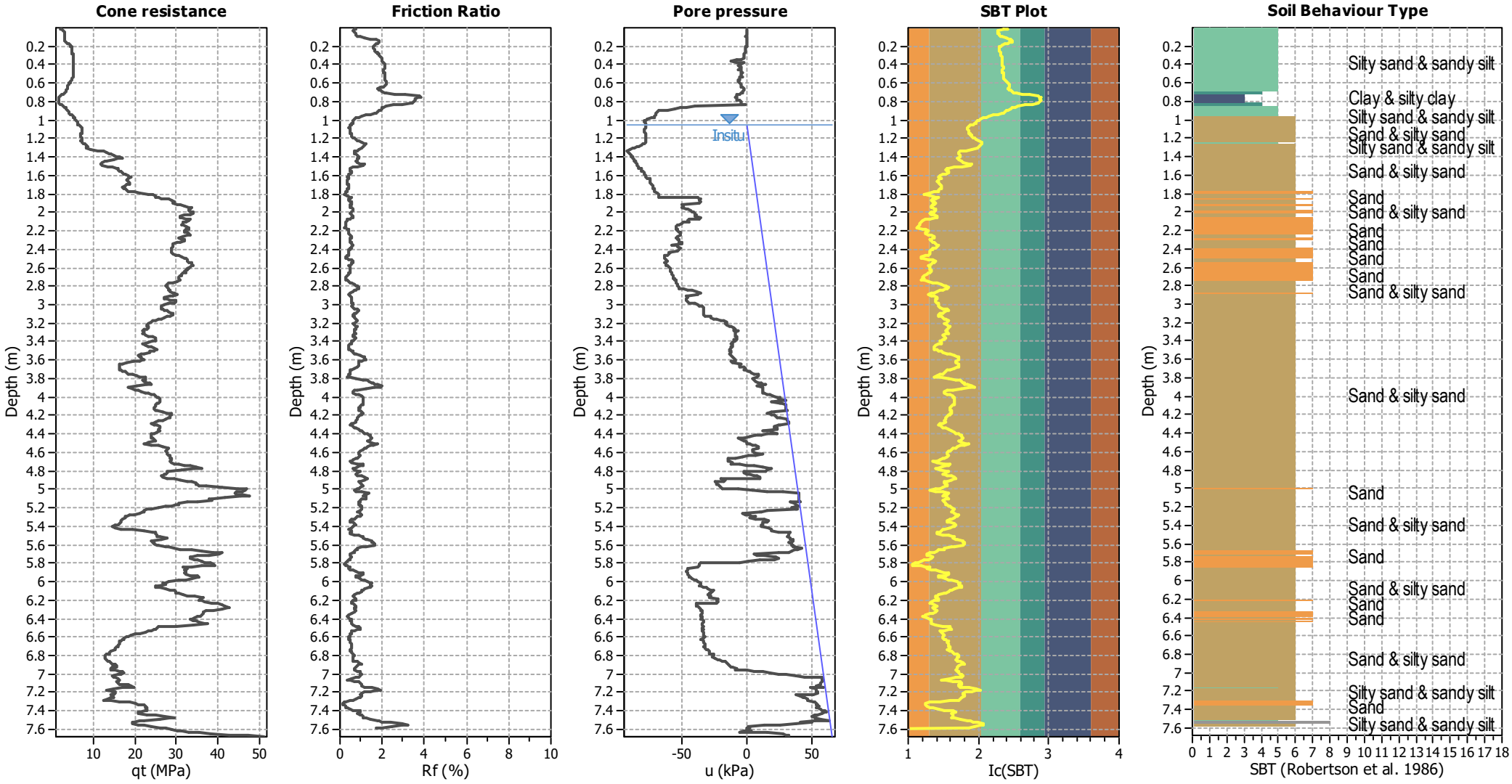
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.90 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



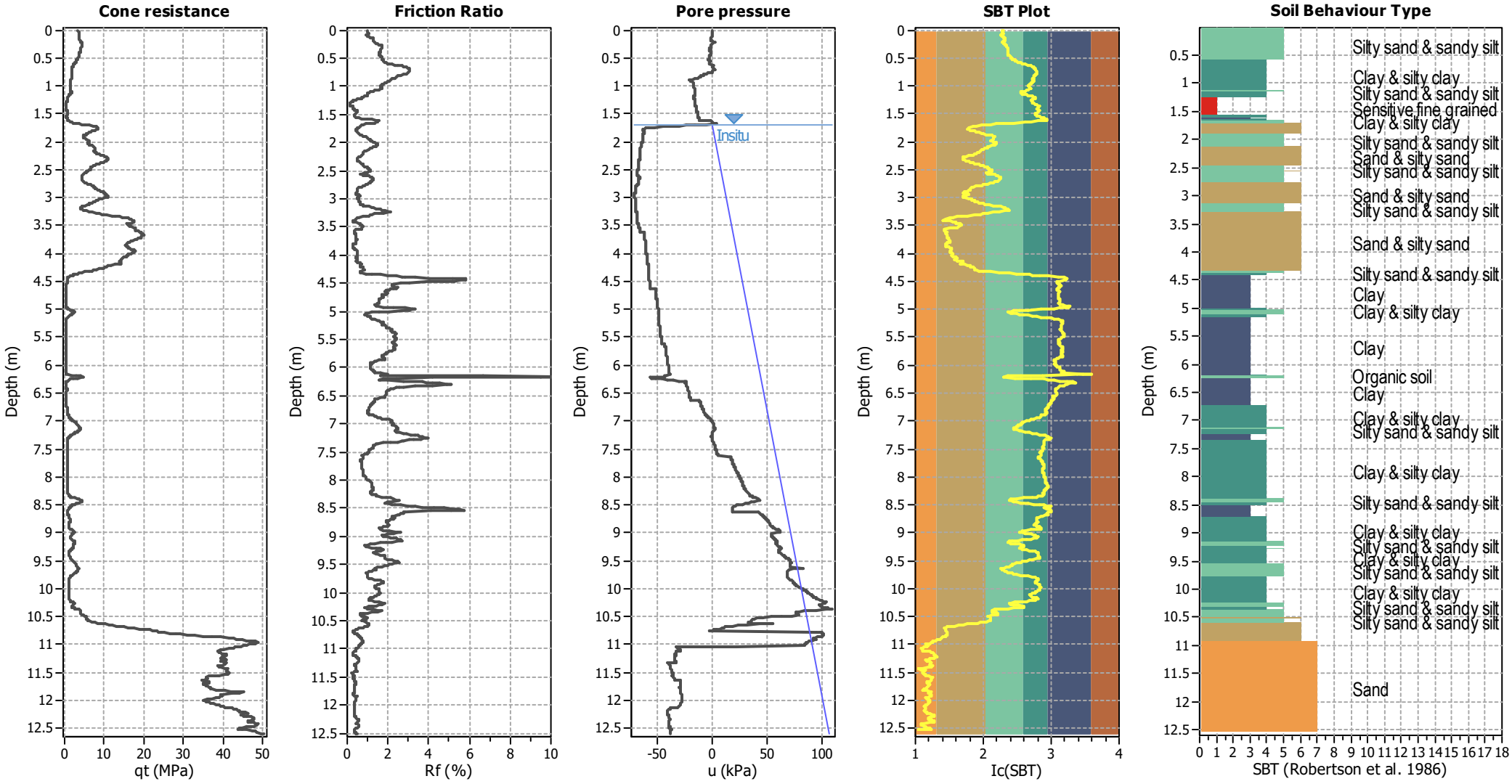
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.05 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.05 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



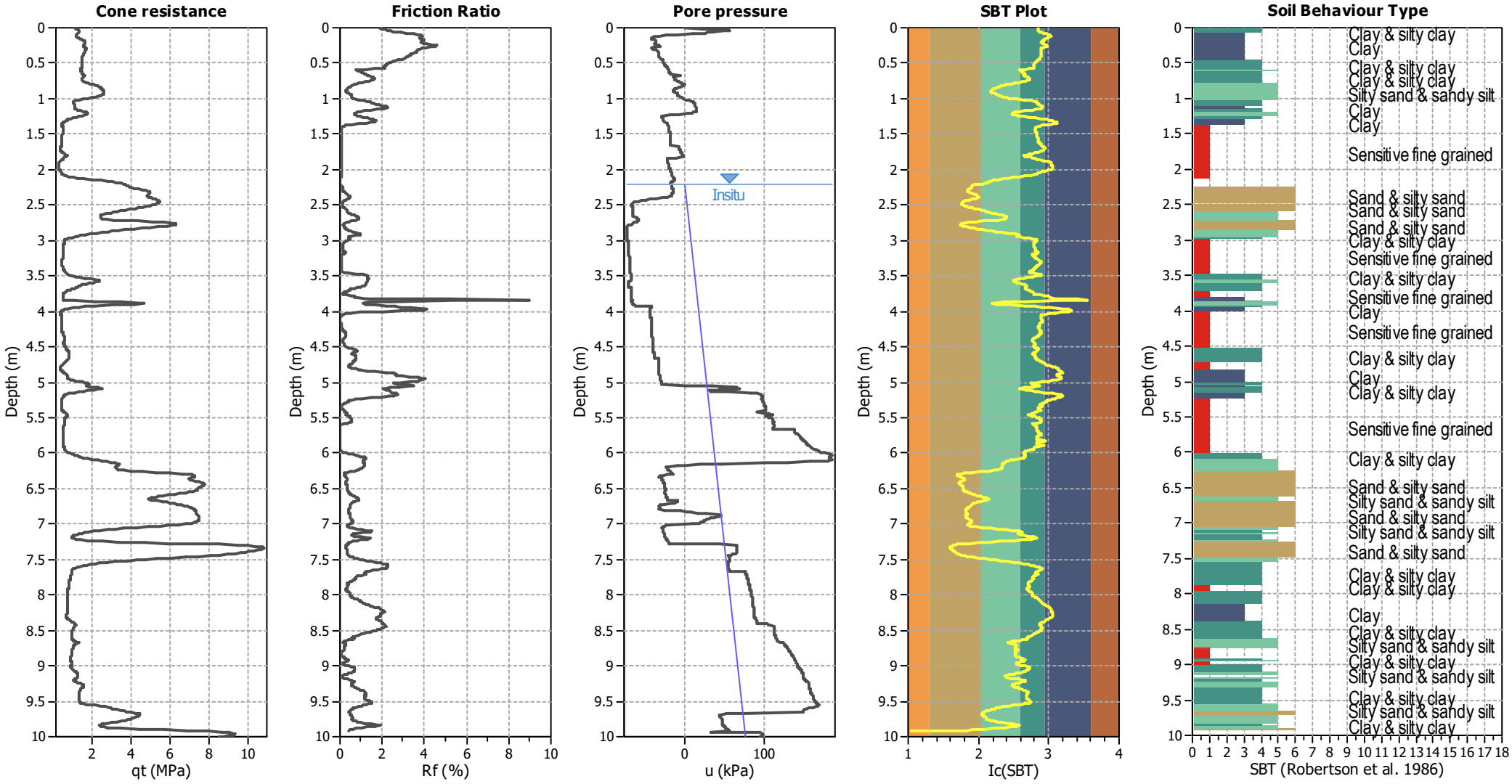
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 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



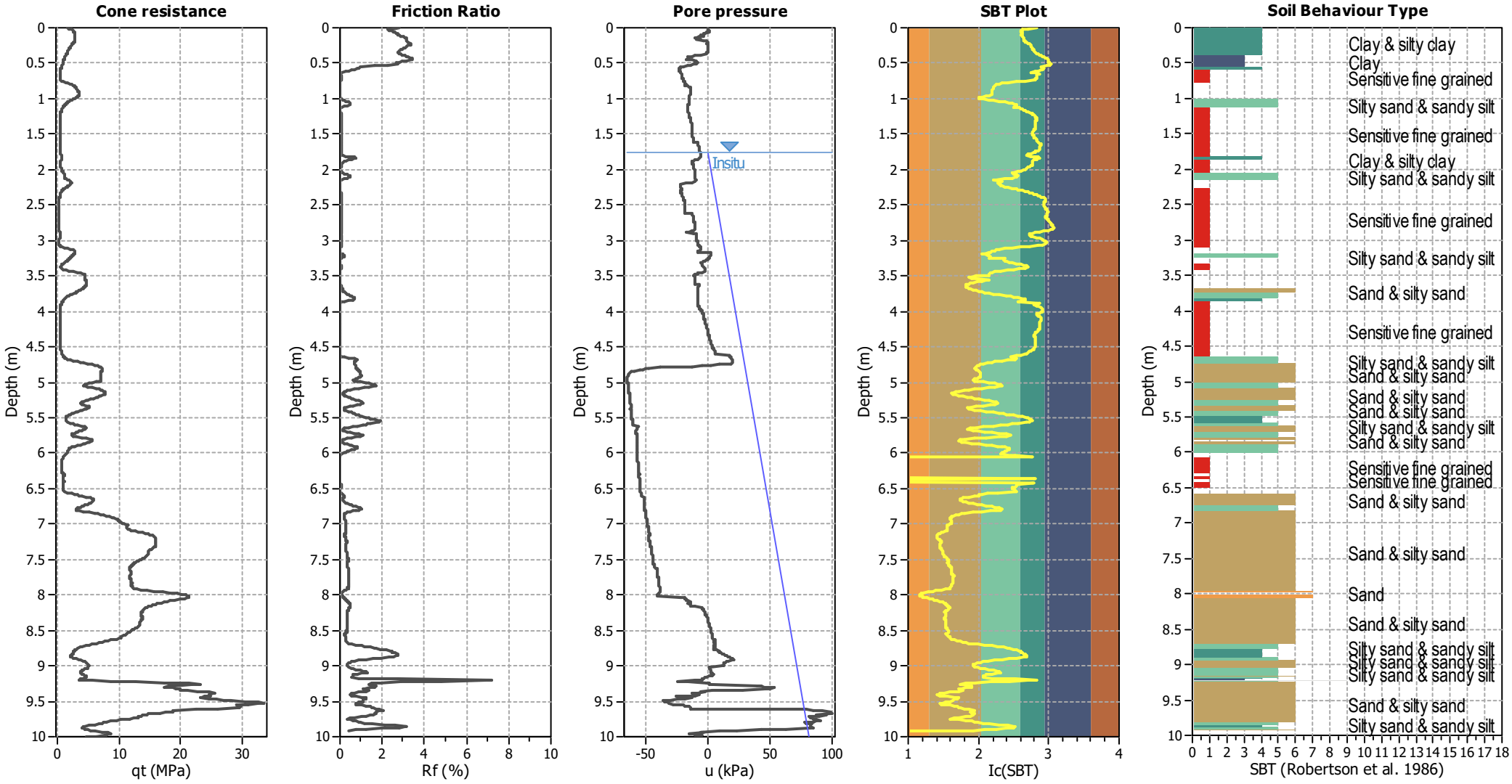
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 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



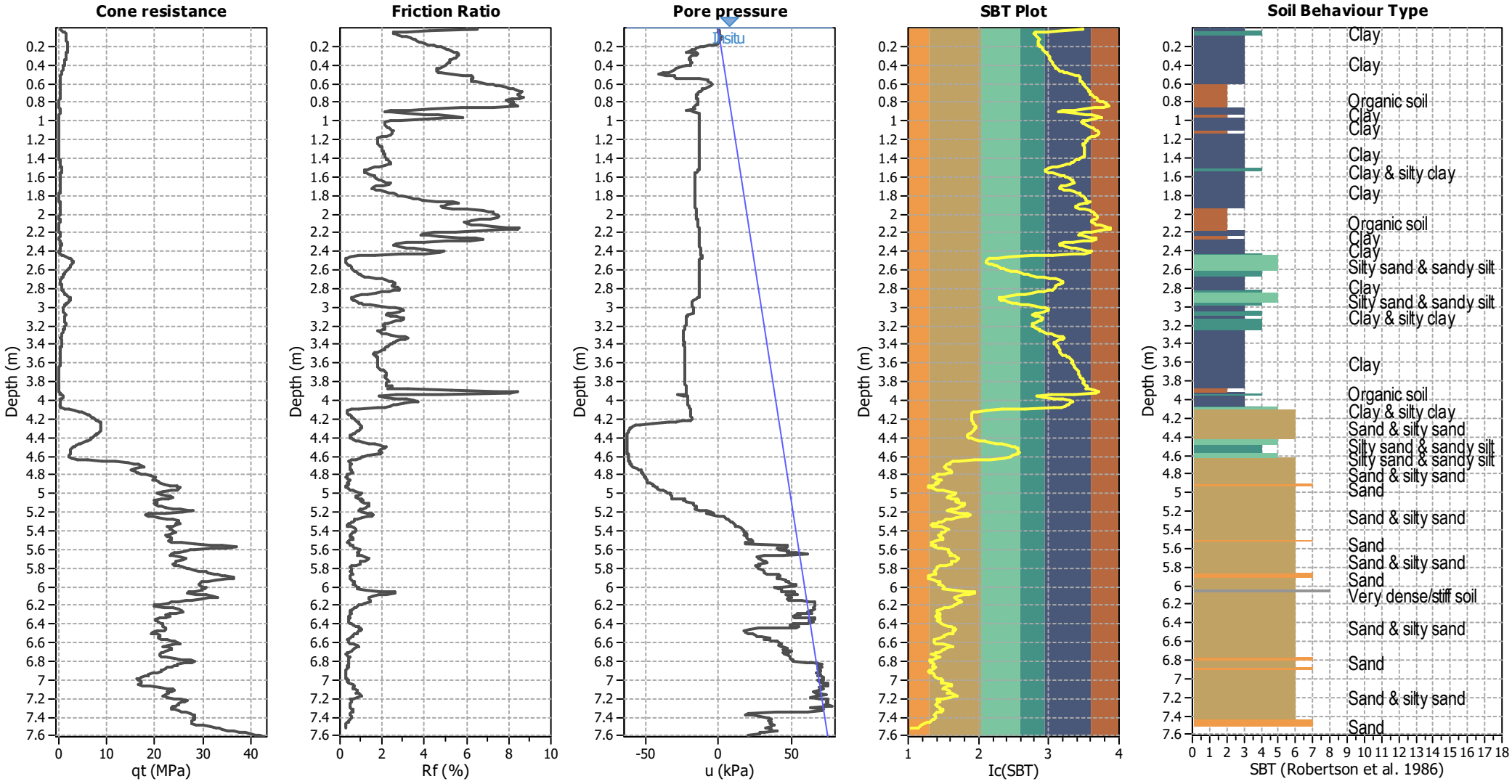
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.75 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.75 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



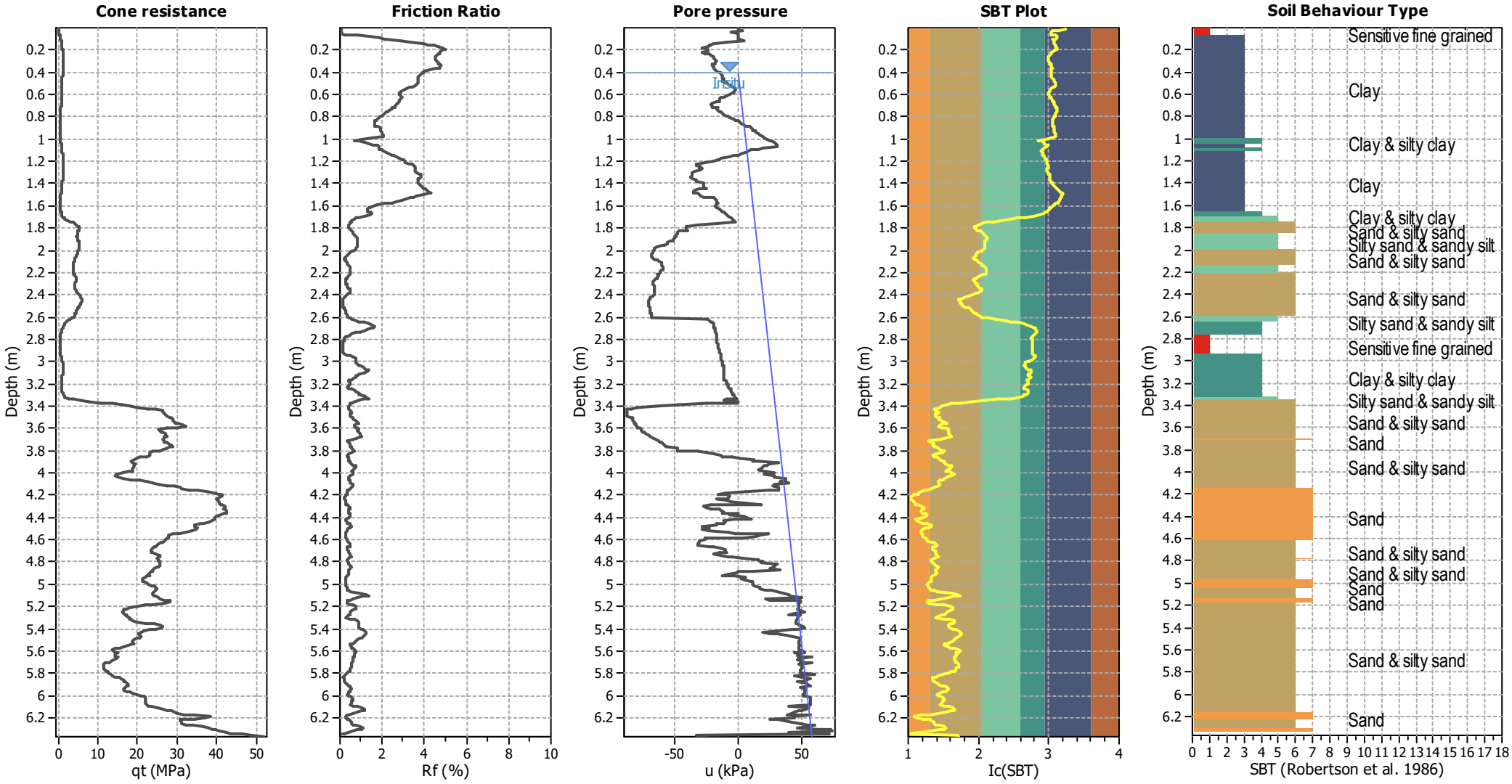
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 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



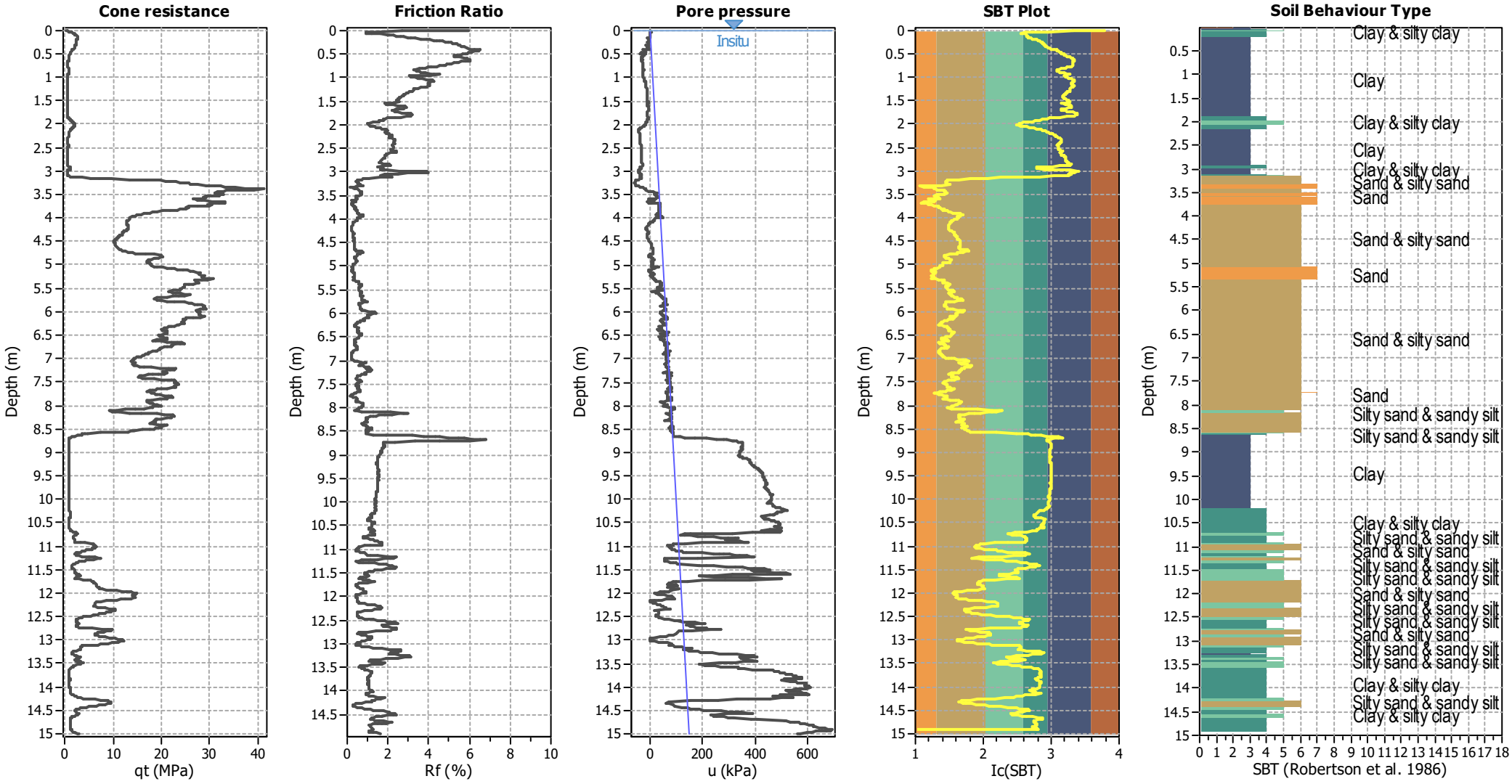
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.40 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



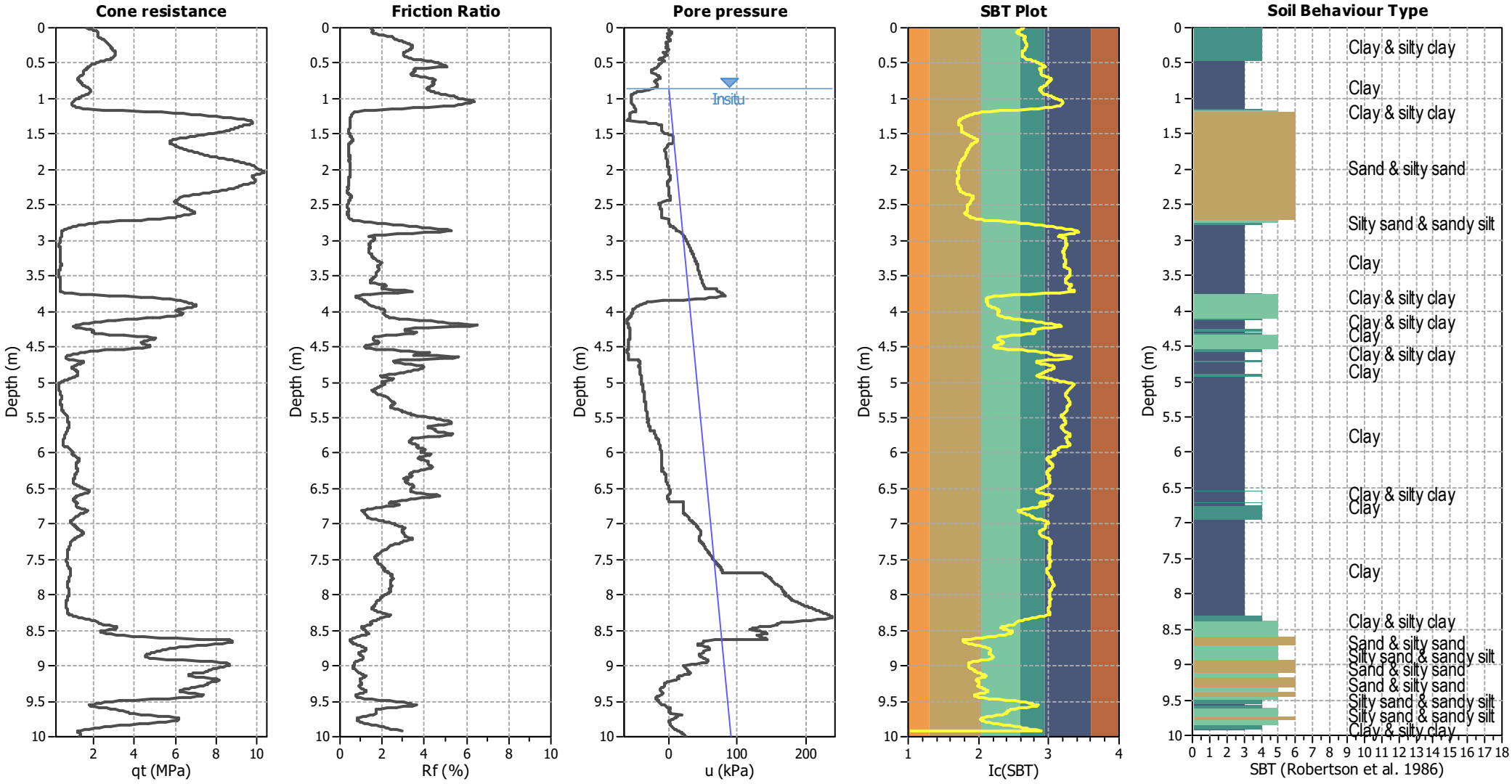
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 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



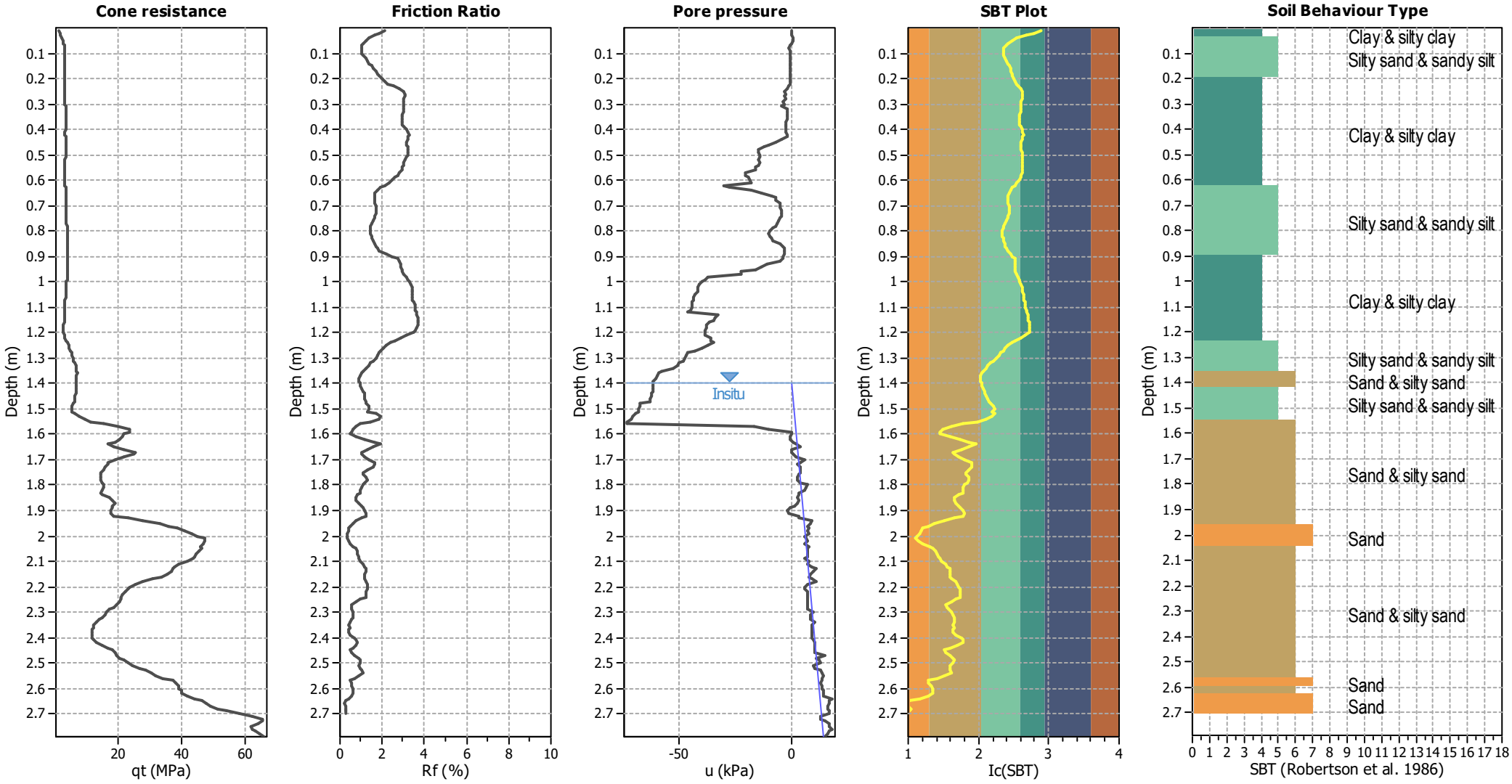
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.85 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.85 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



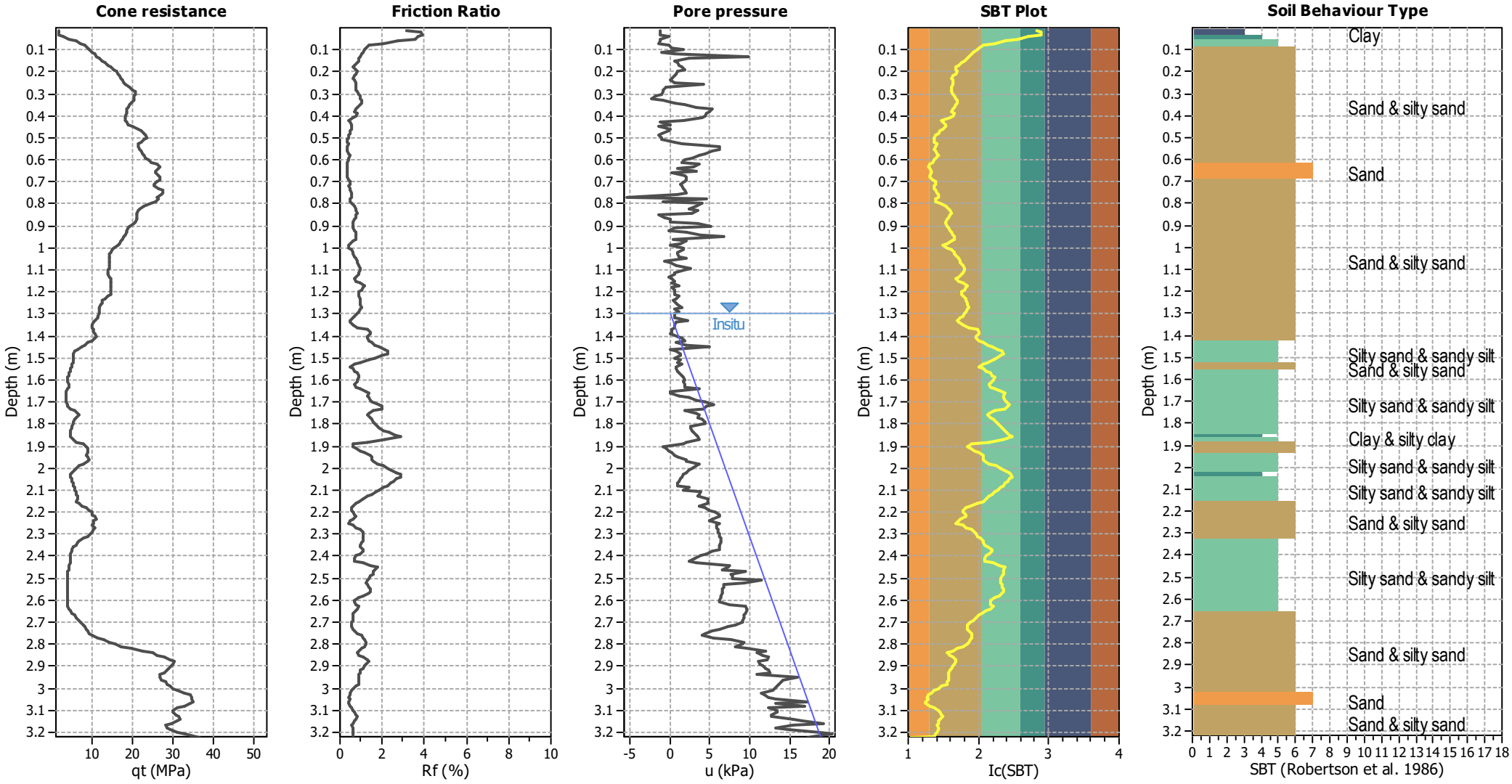
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.40 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



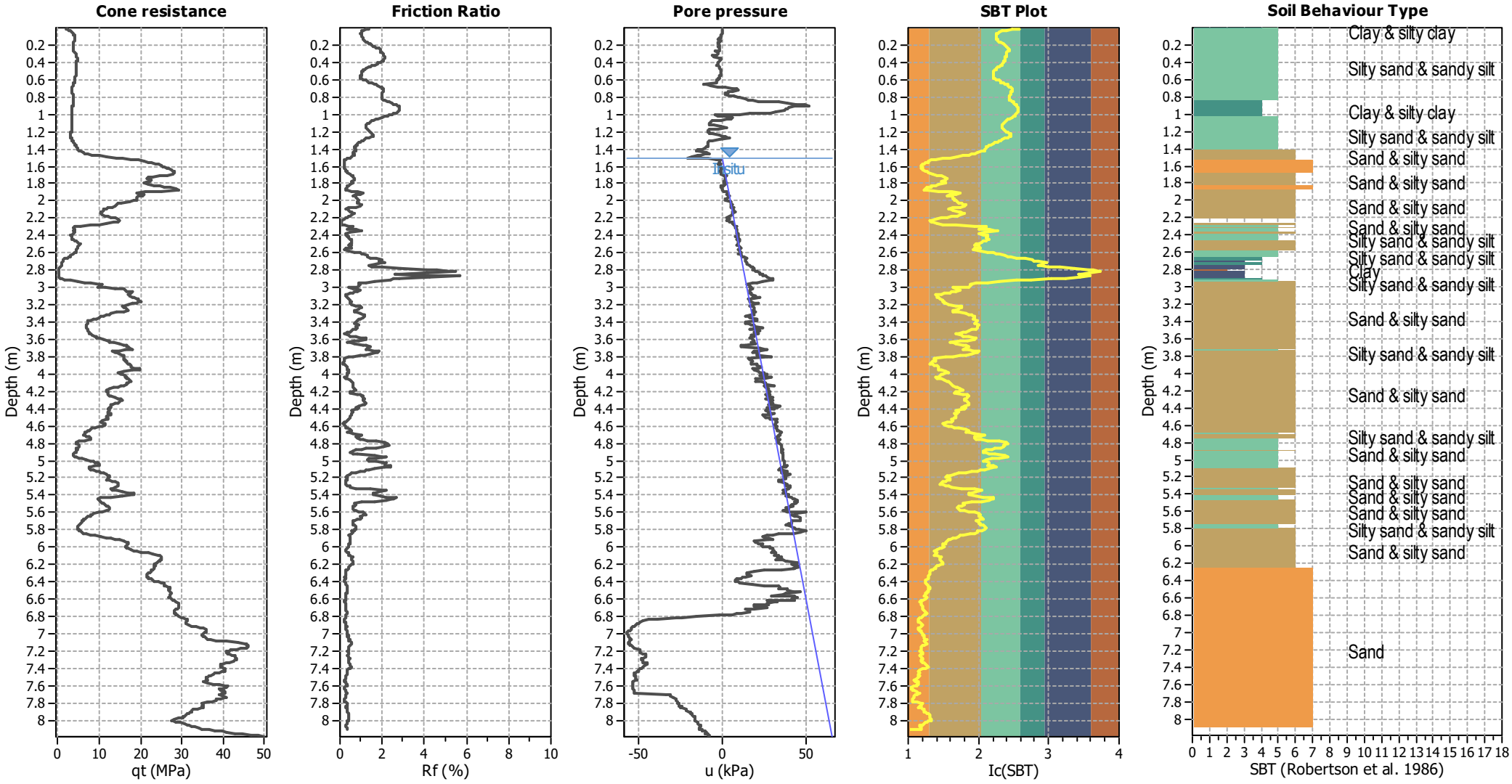
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.30 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



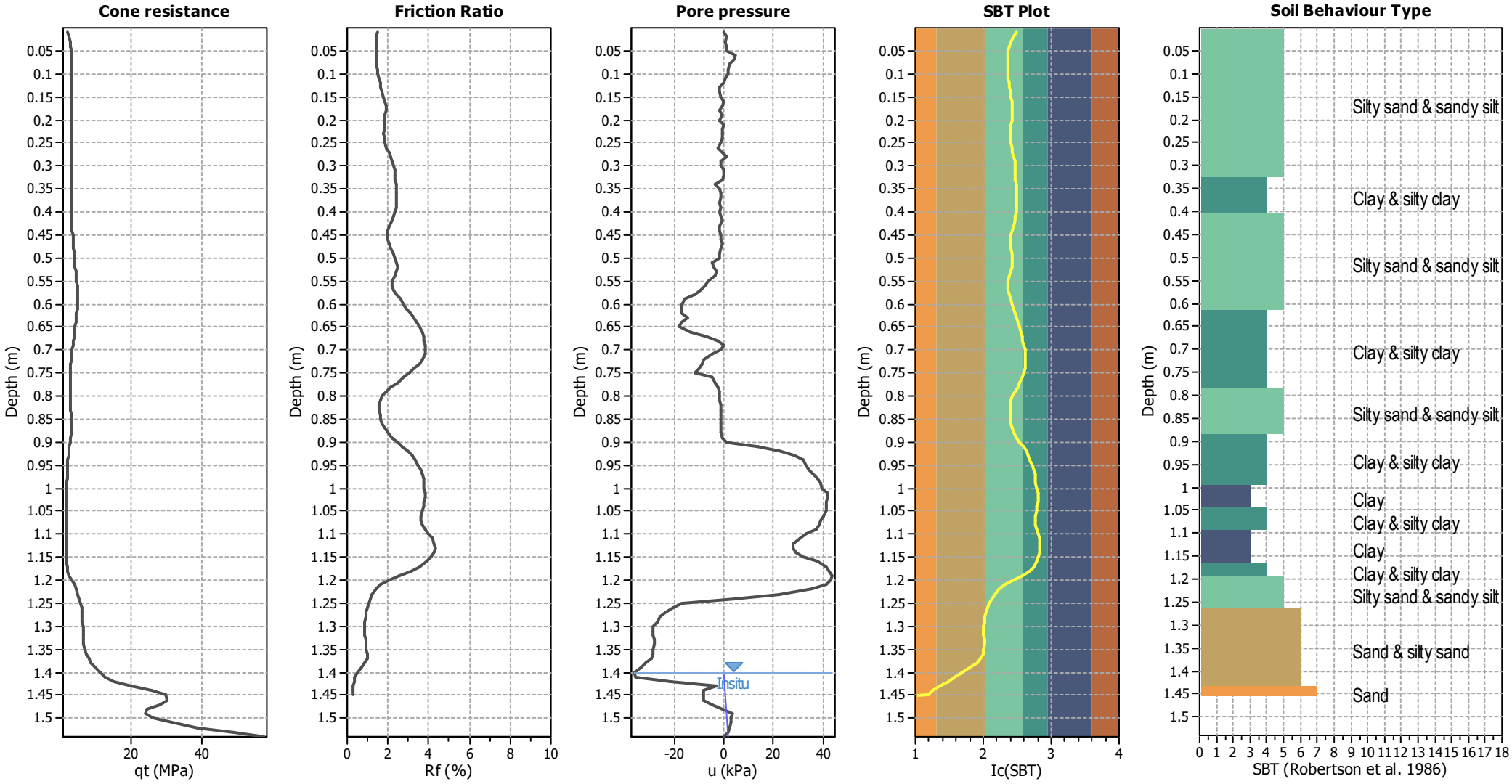
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 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



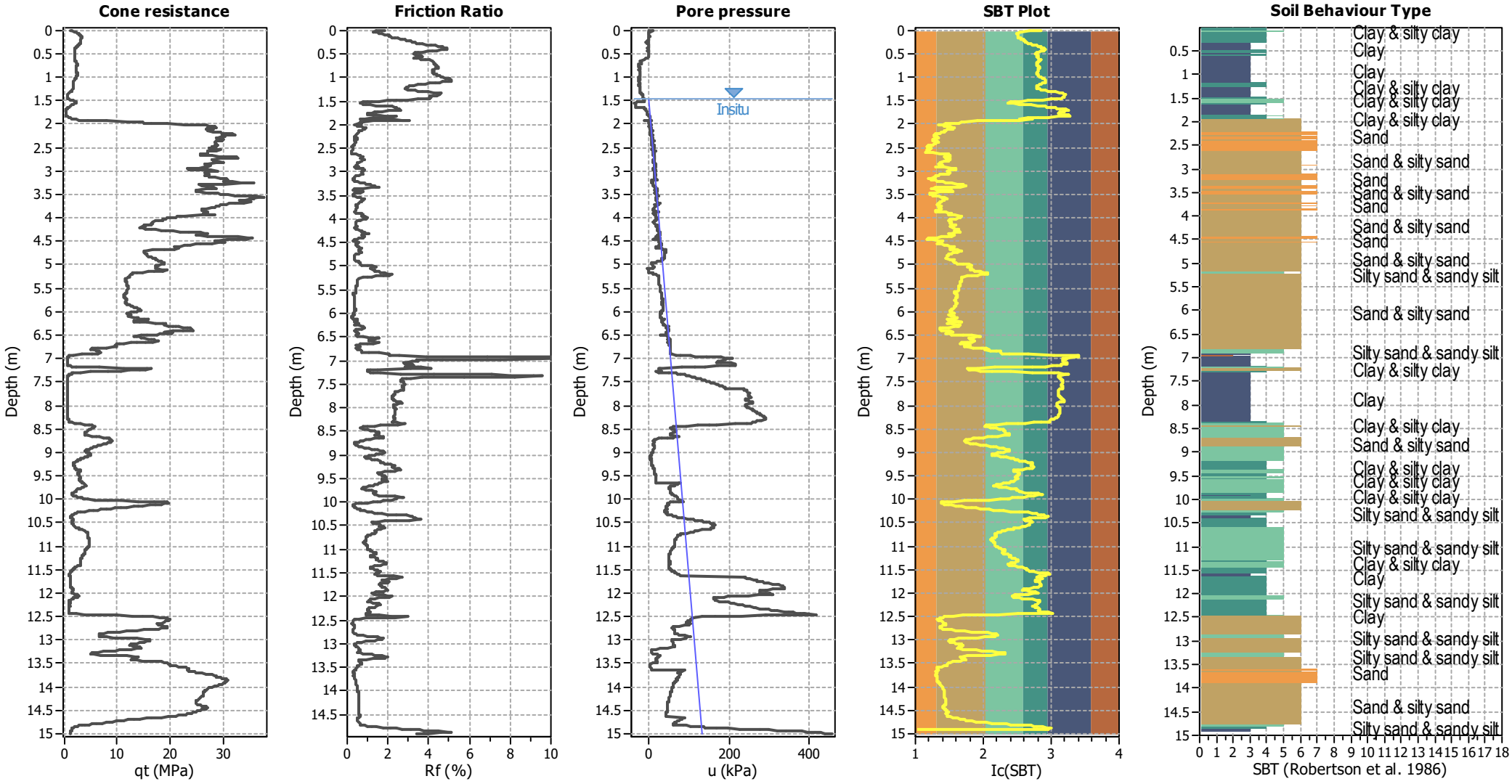
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.40 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



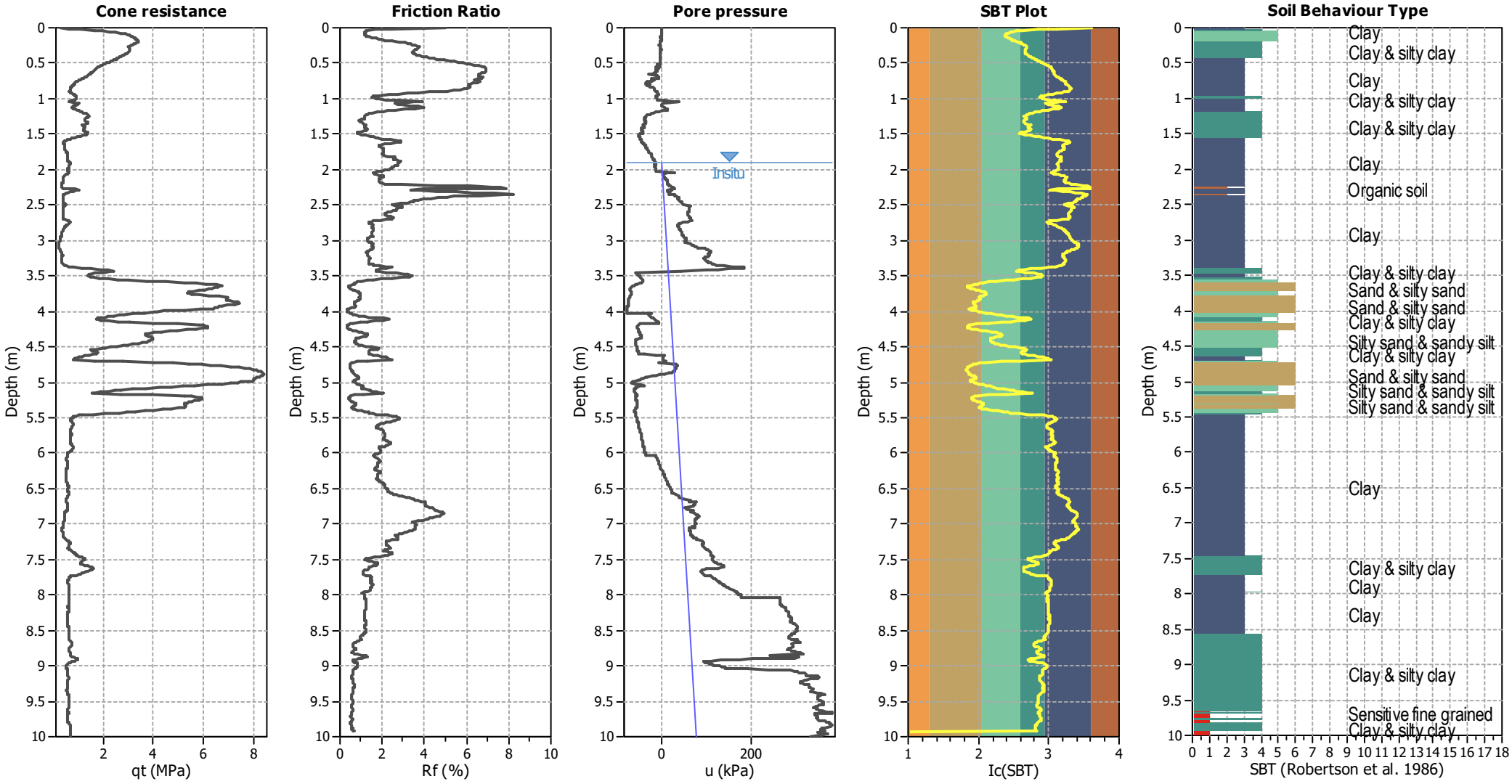
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.45 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.45 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



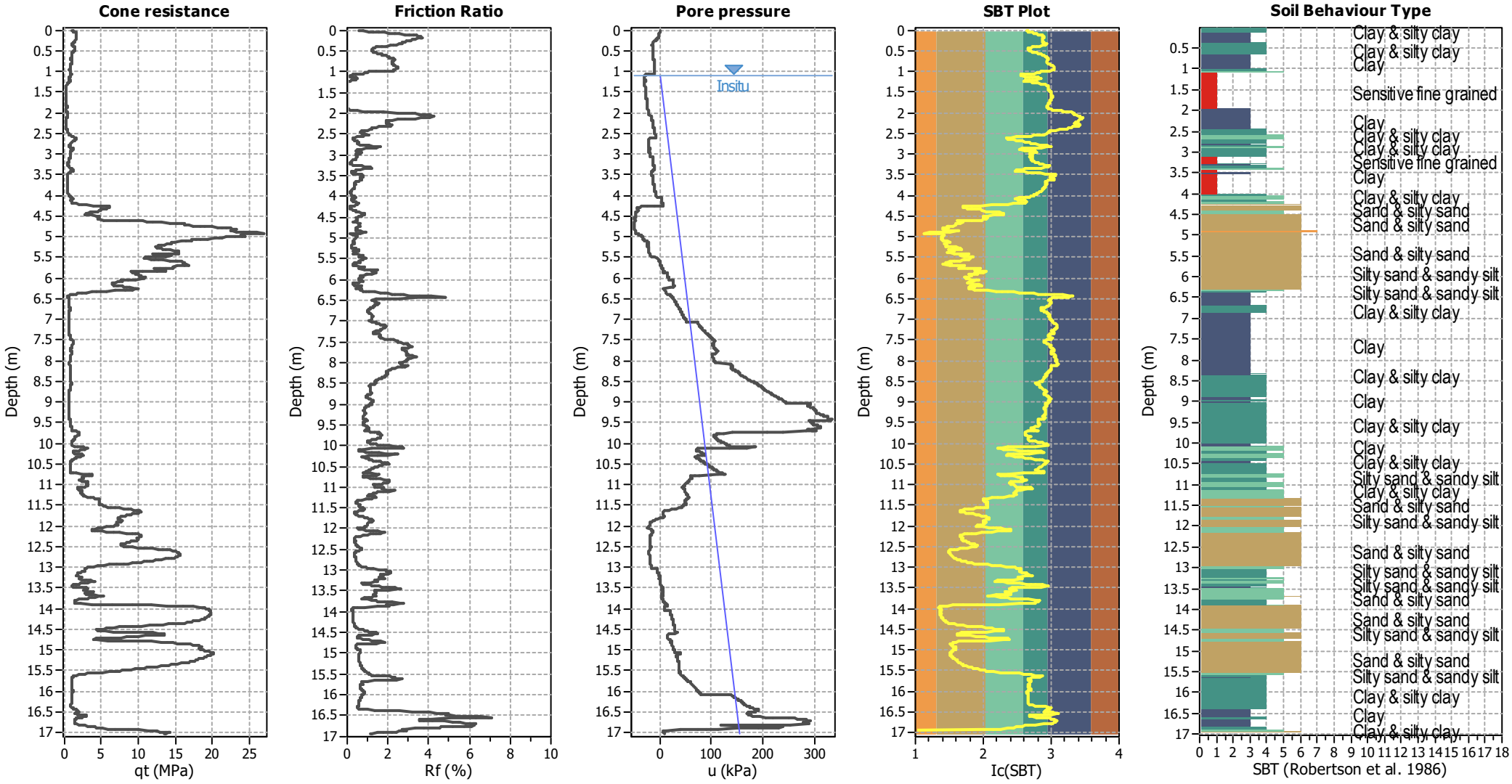
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.90 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



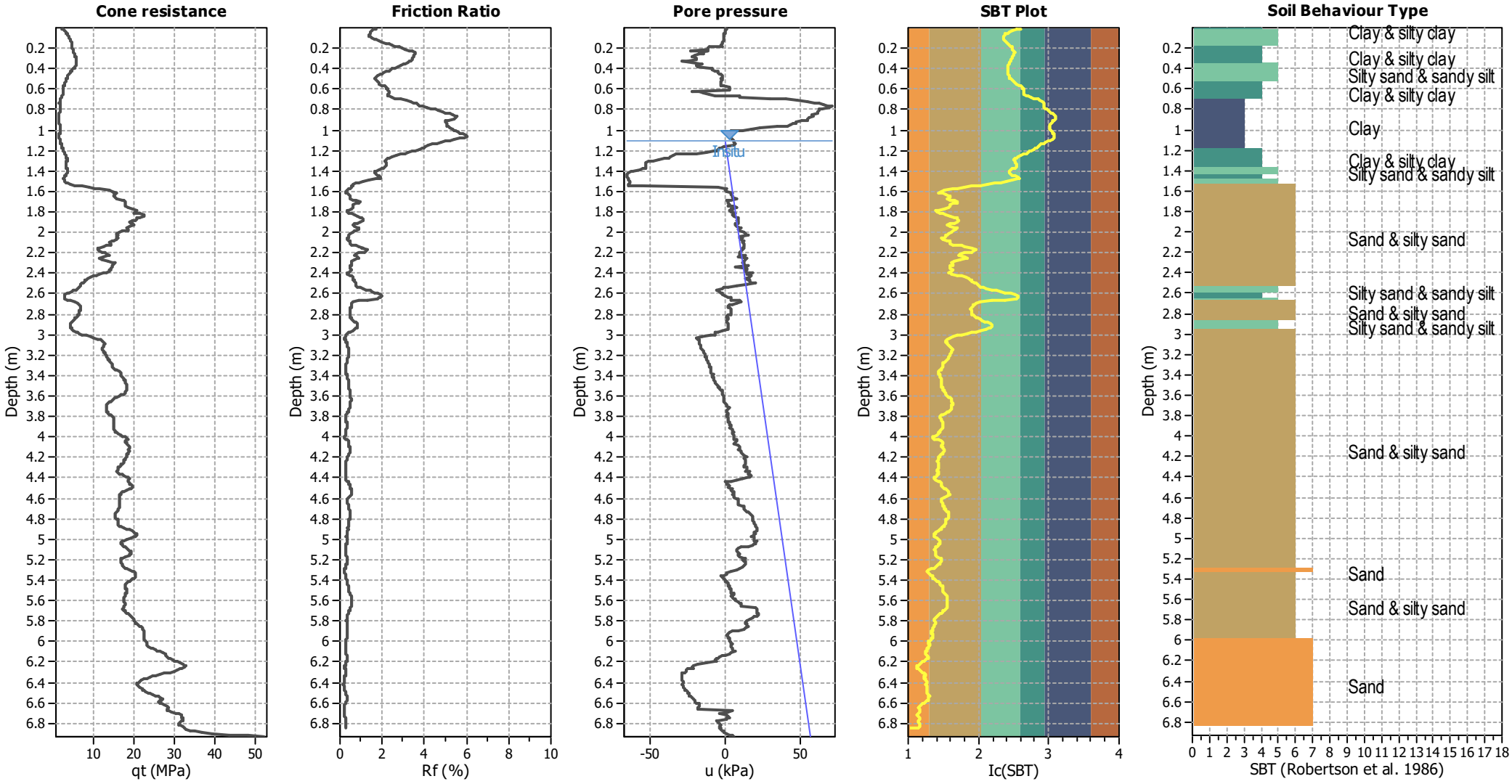
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 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



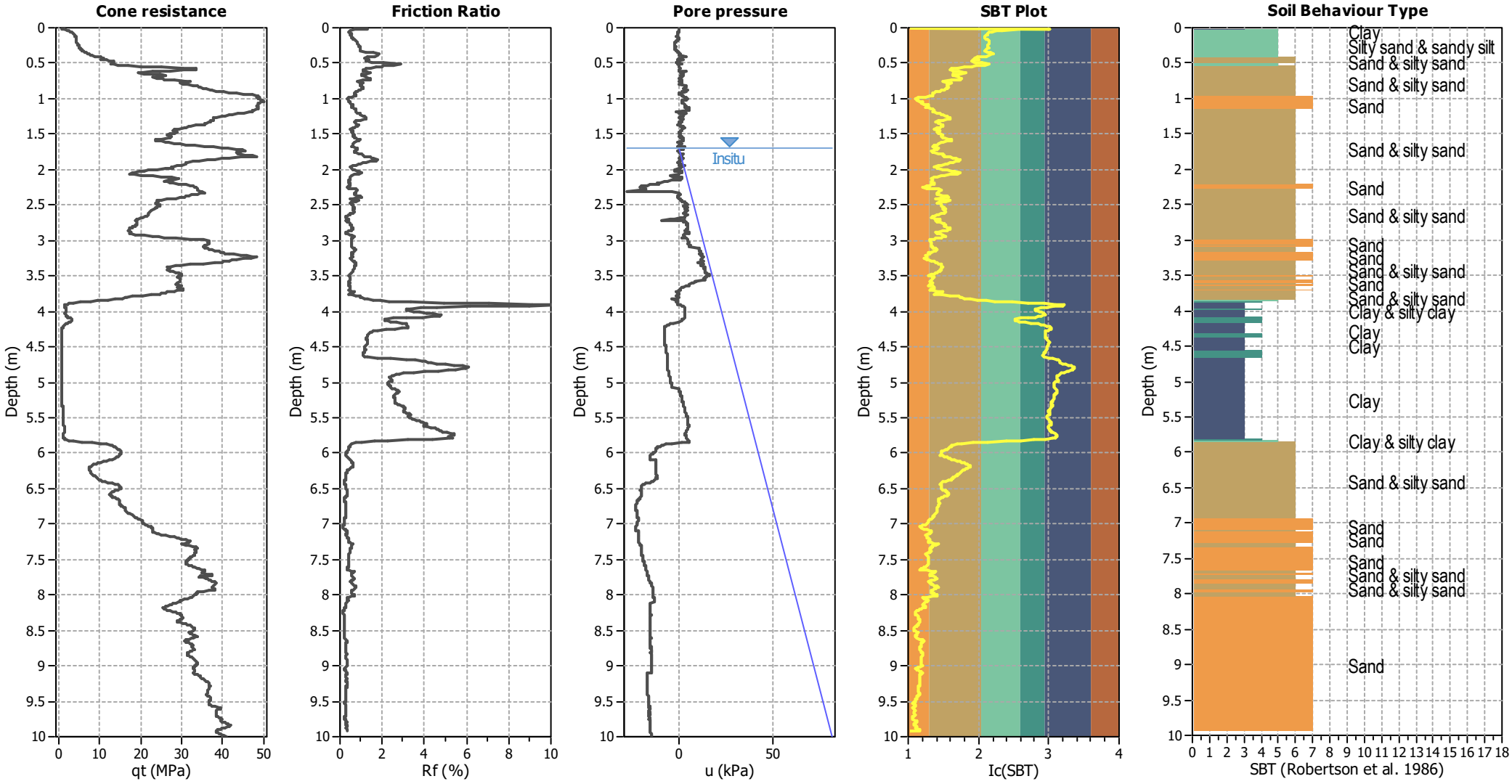
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 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



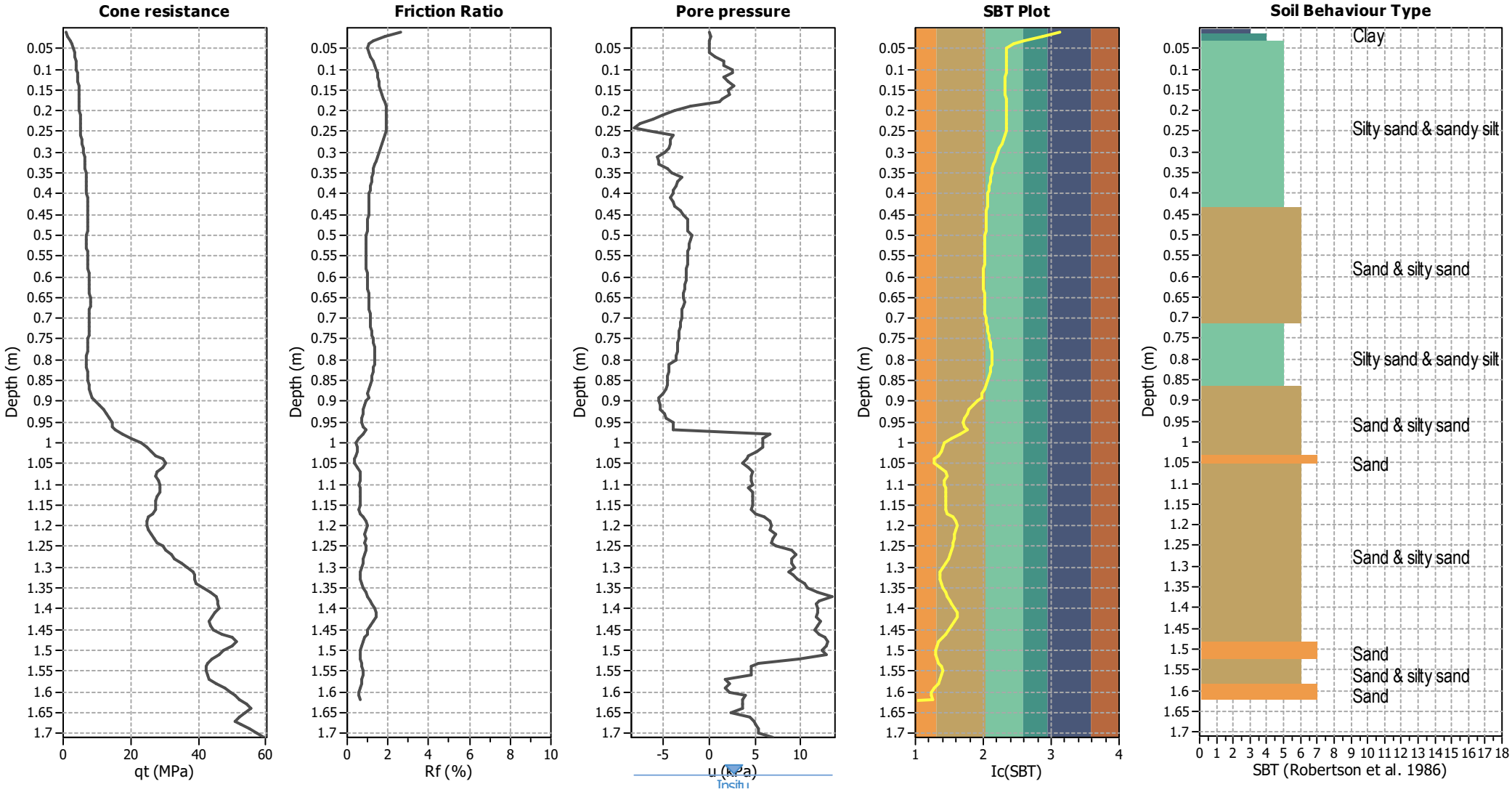
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 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



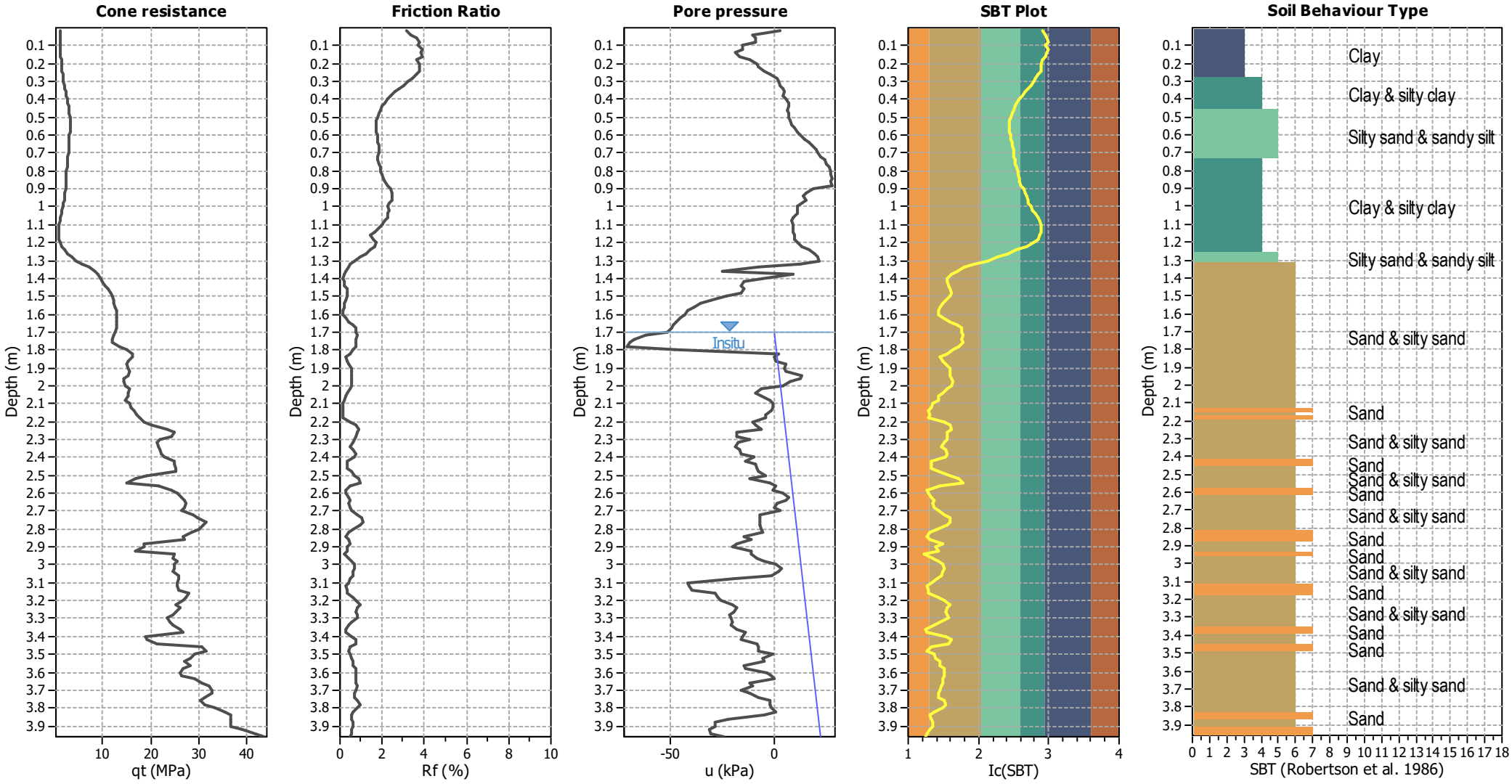
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.80 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.80 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



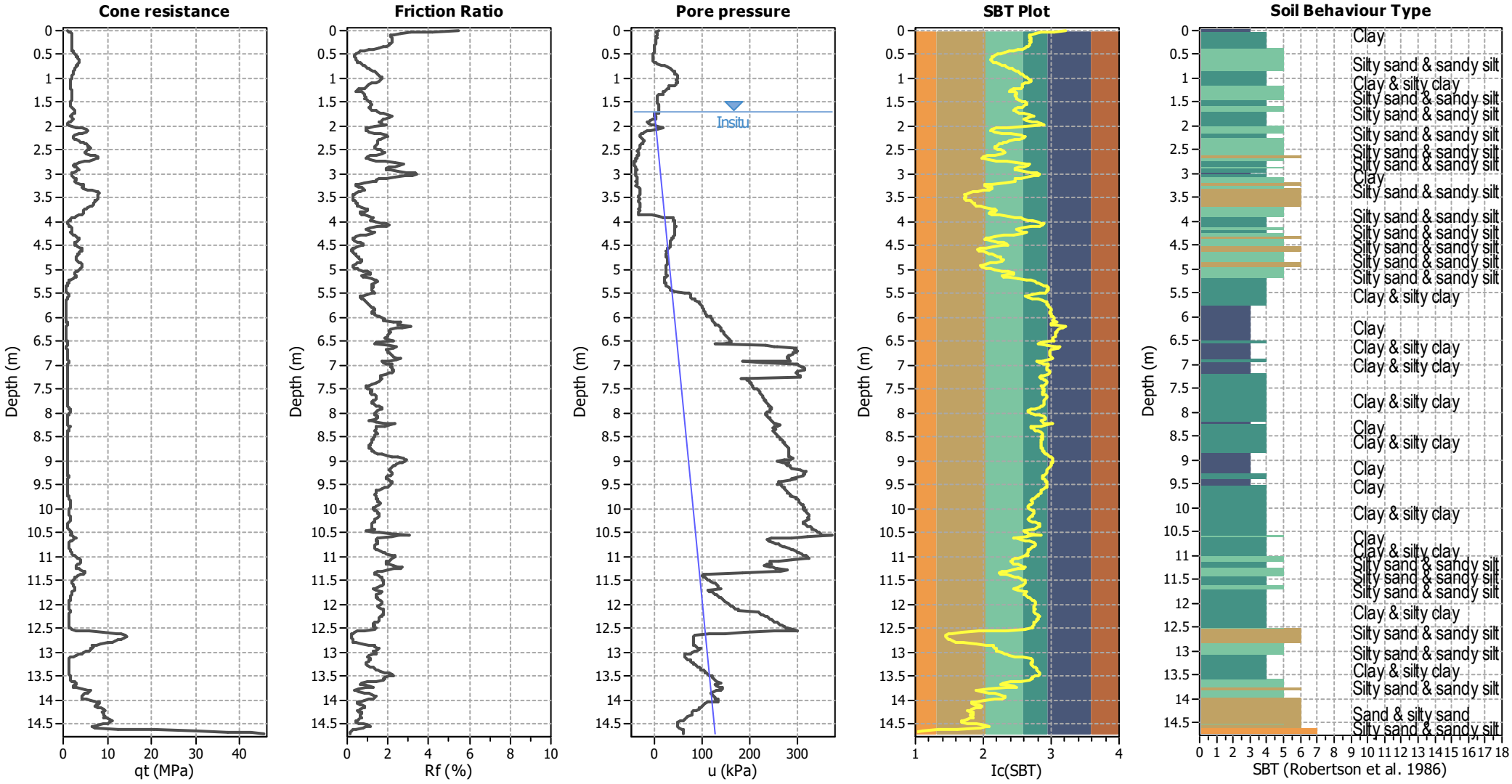
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 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



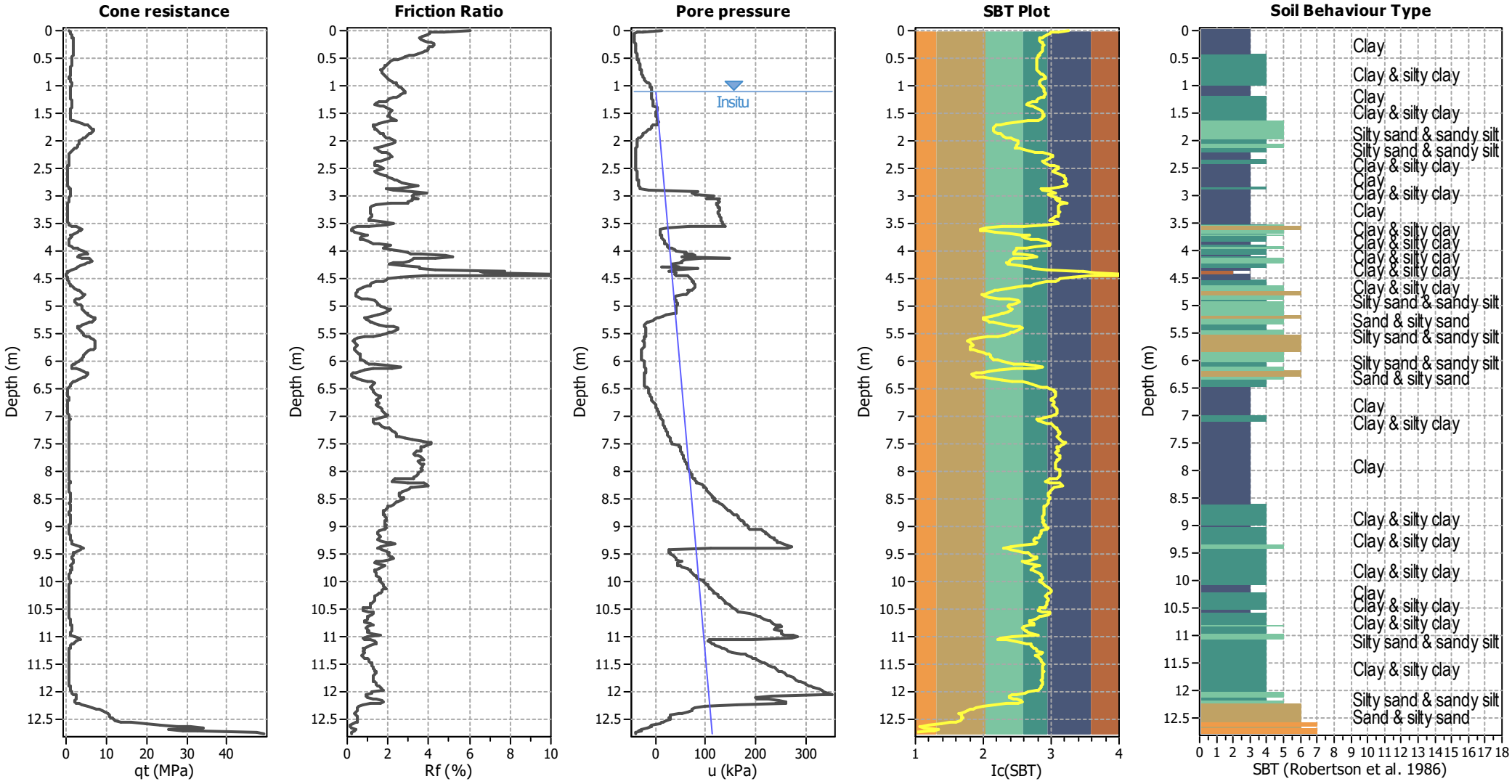
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 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



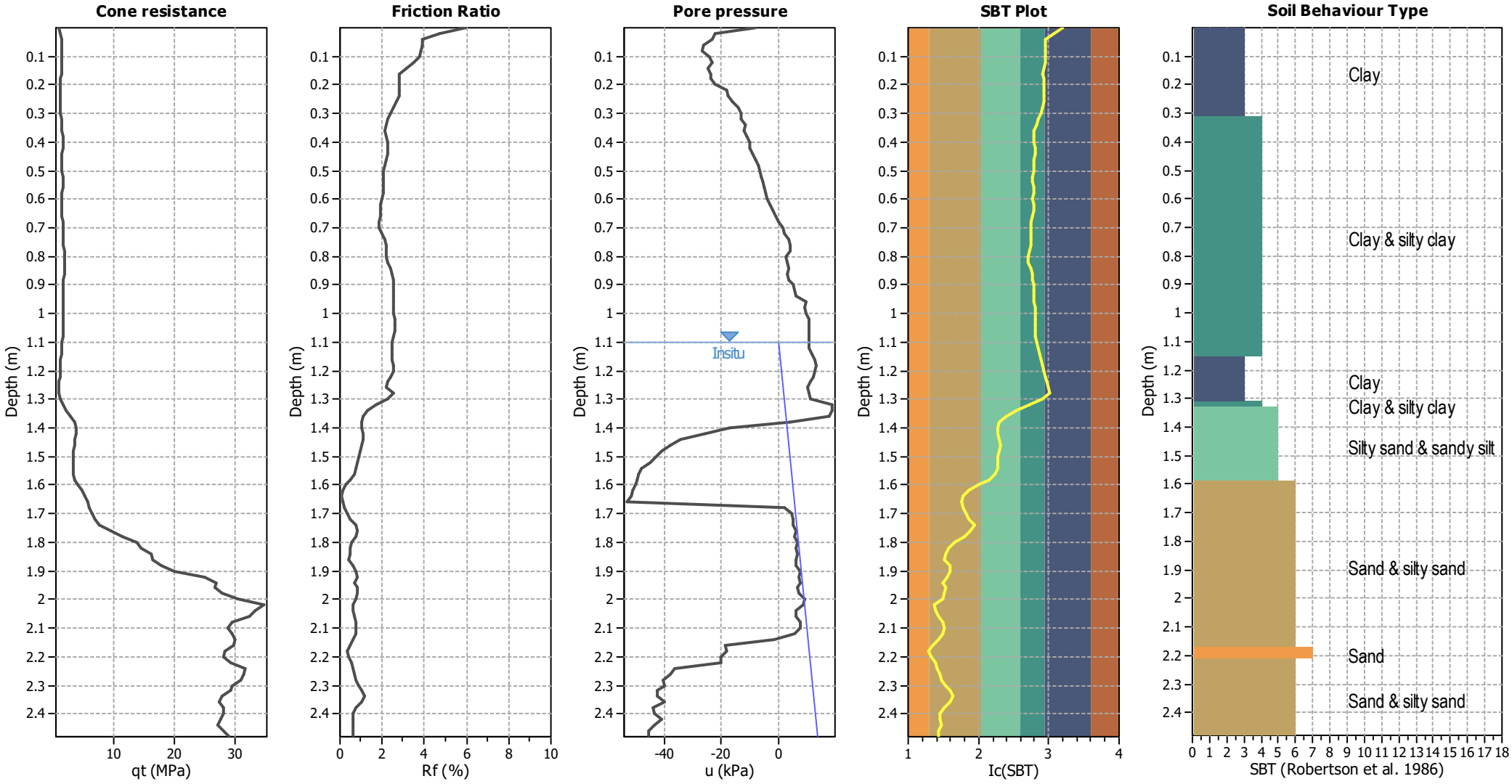
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 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



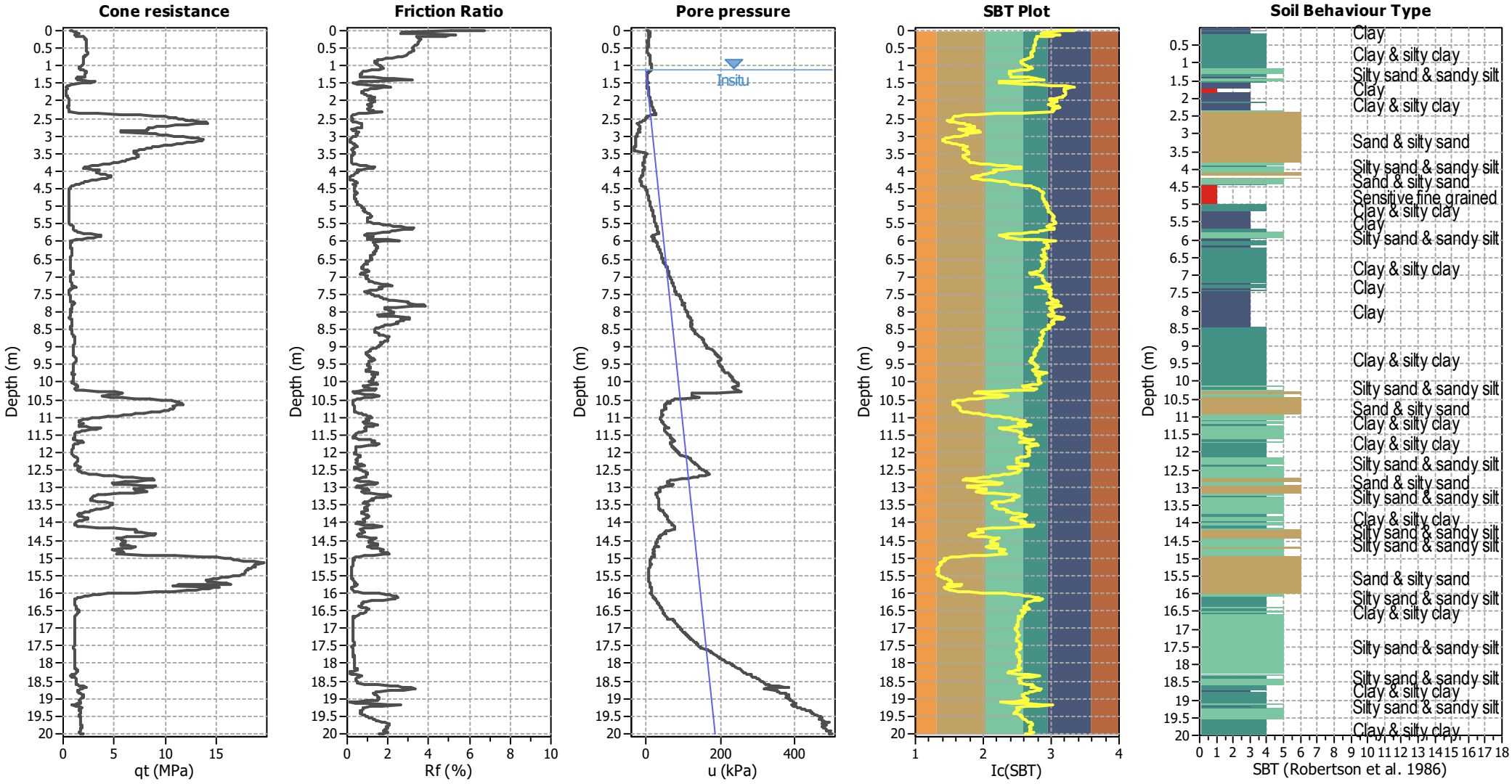
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 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



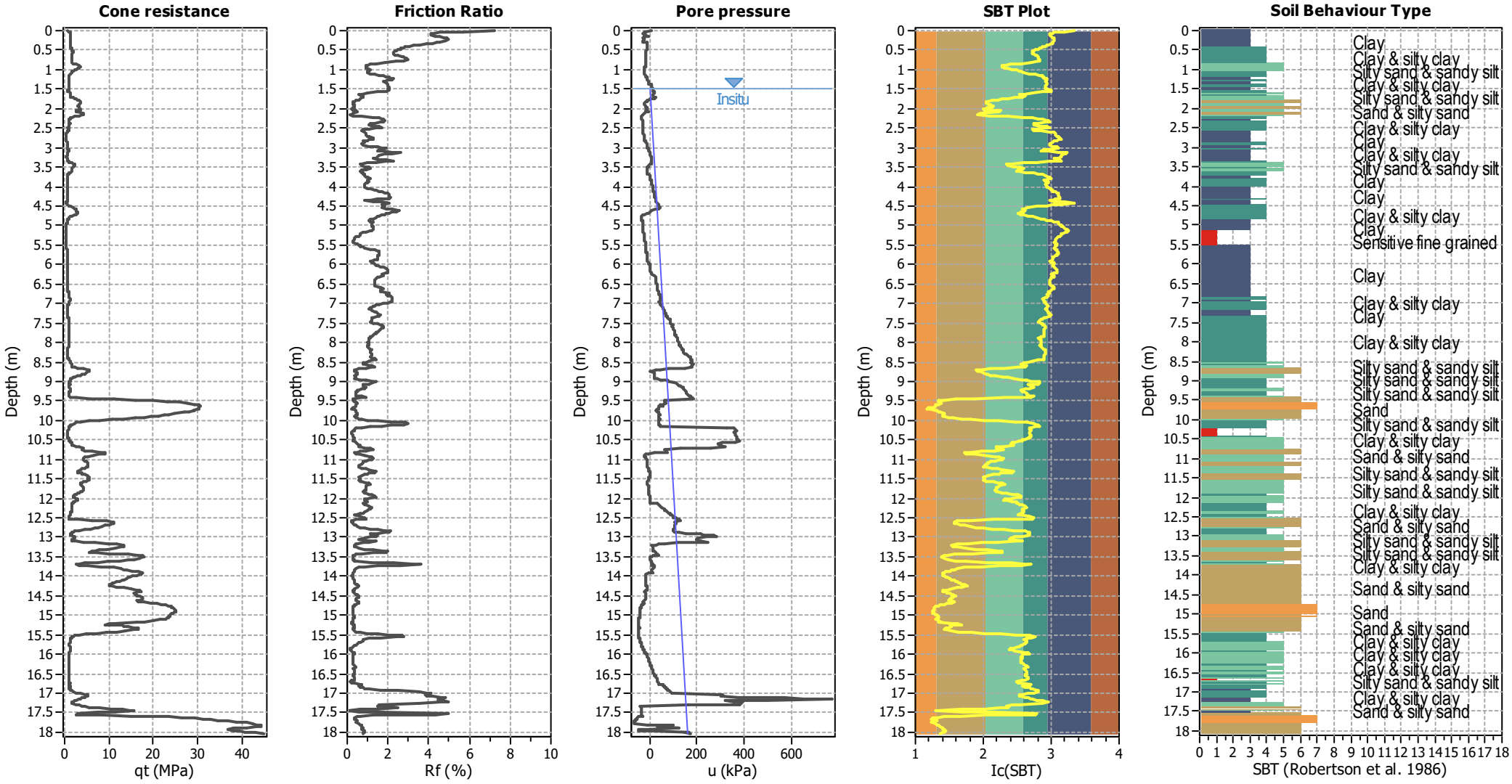
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 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



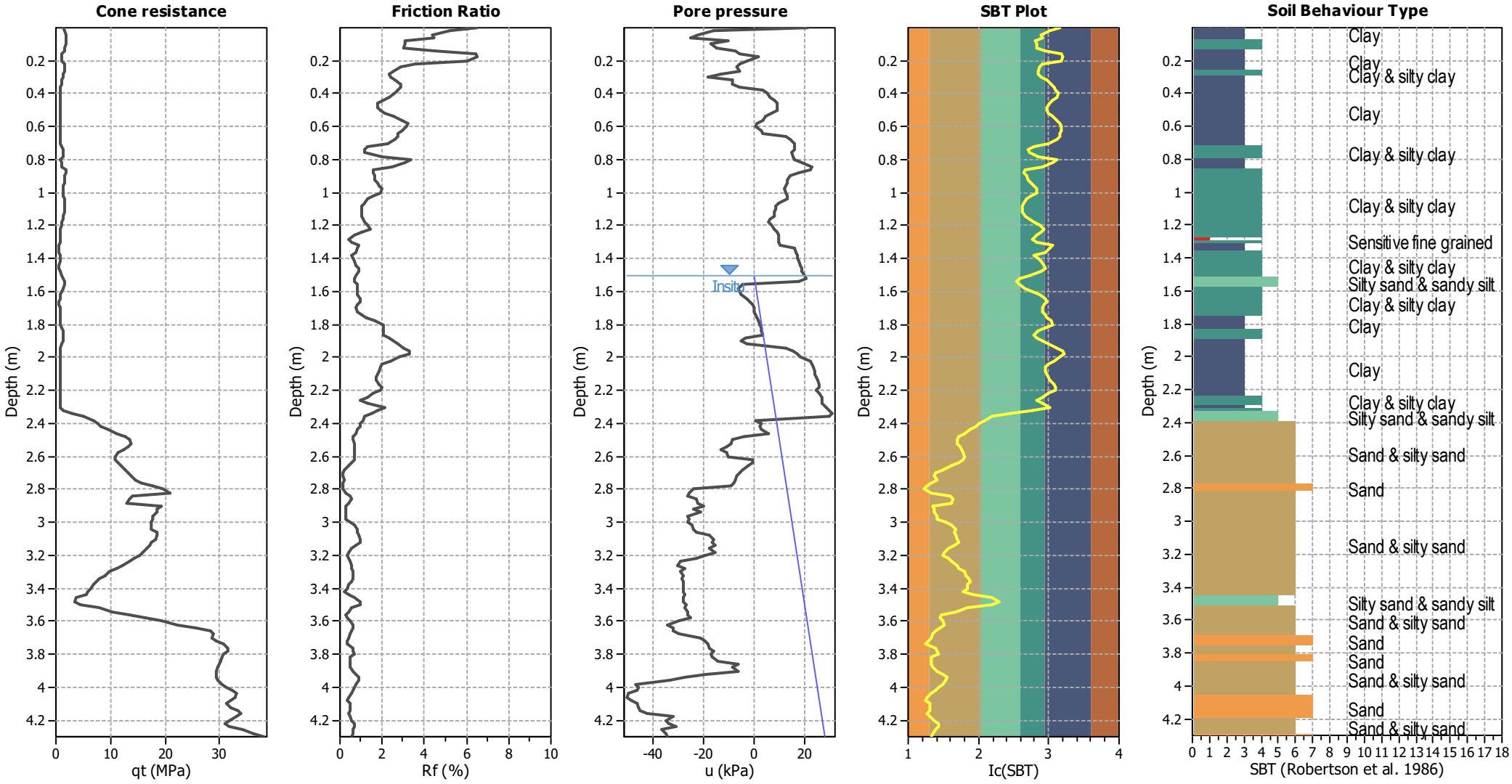
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 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



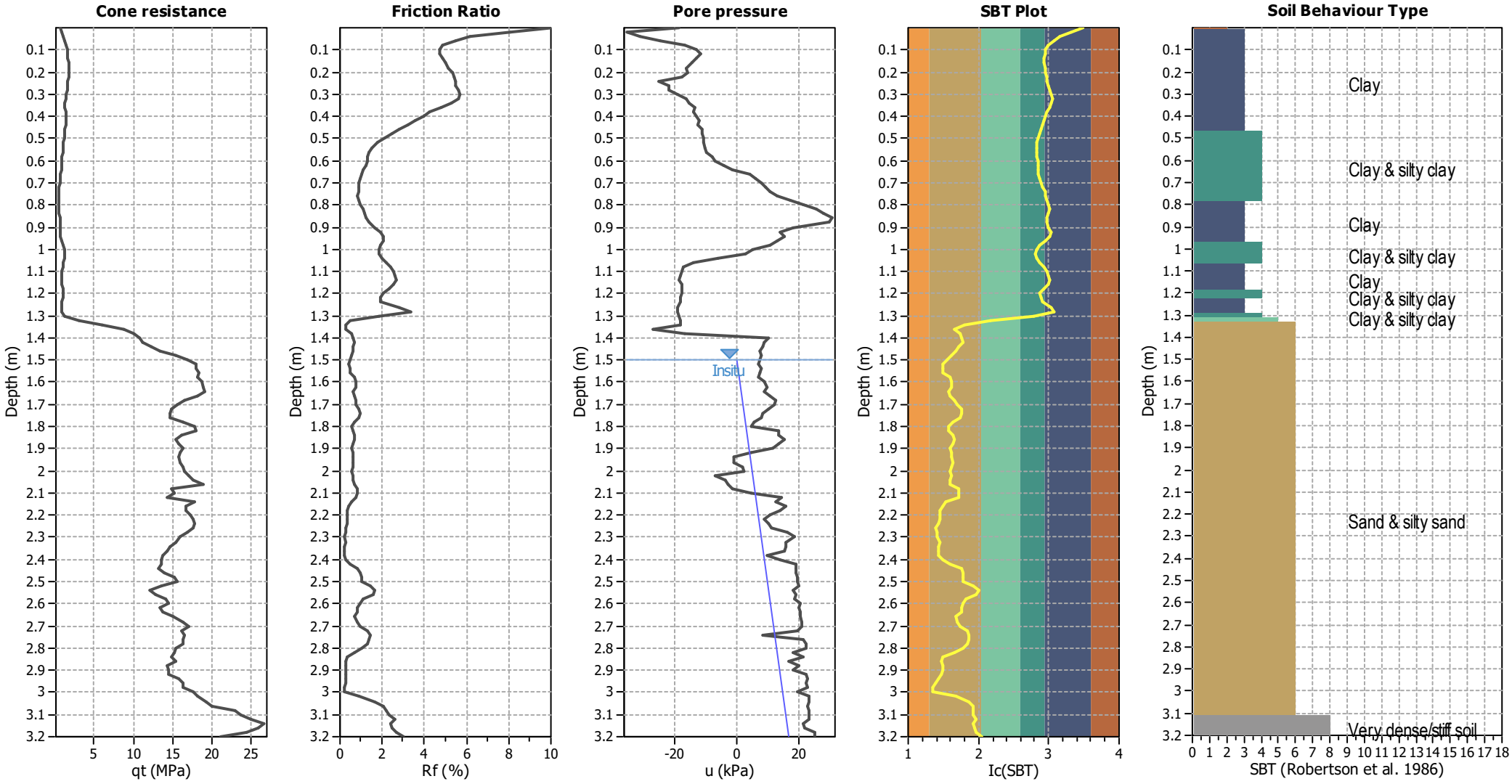
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 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



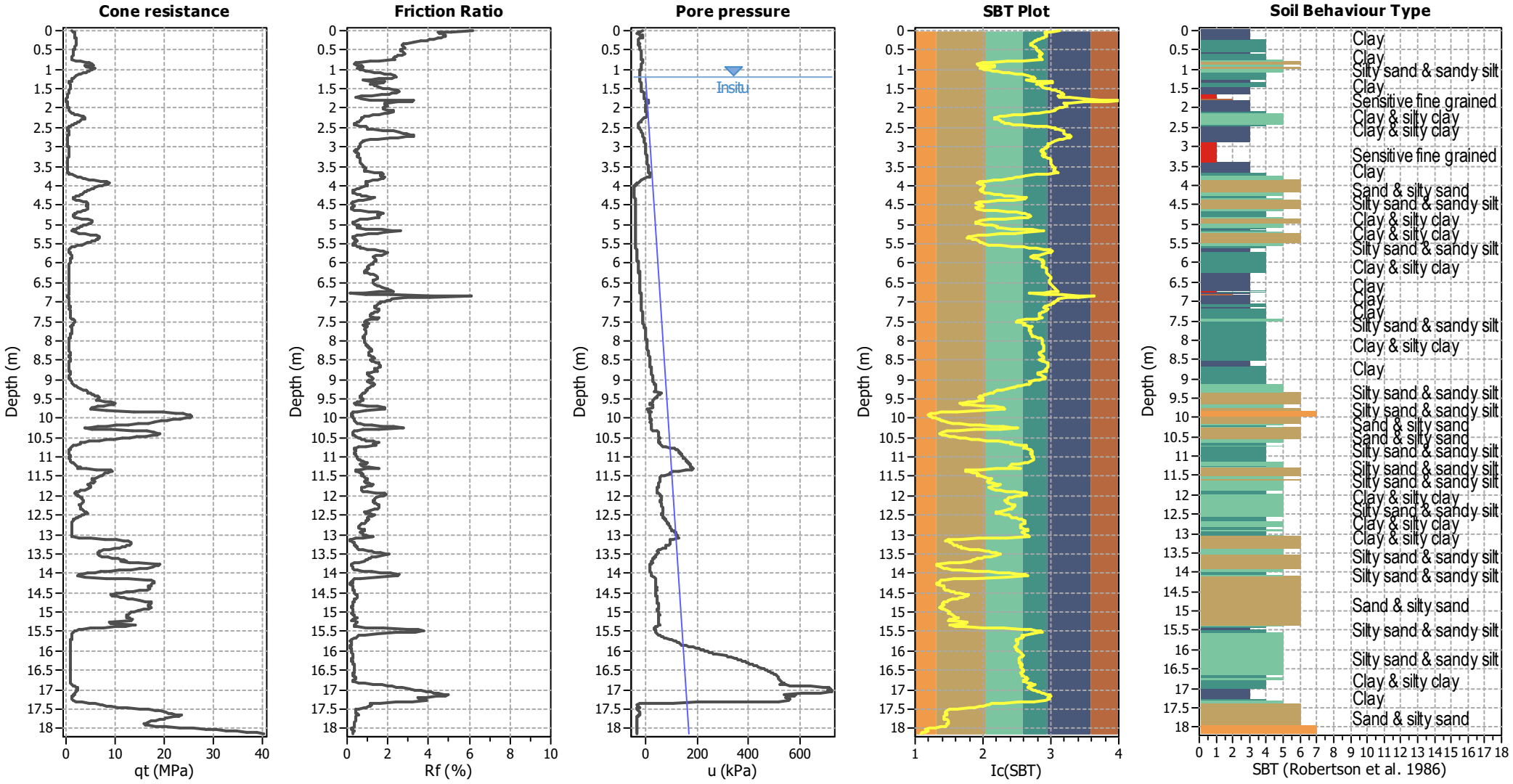
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 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



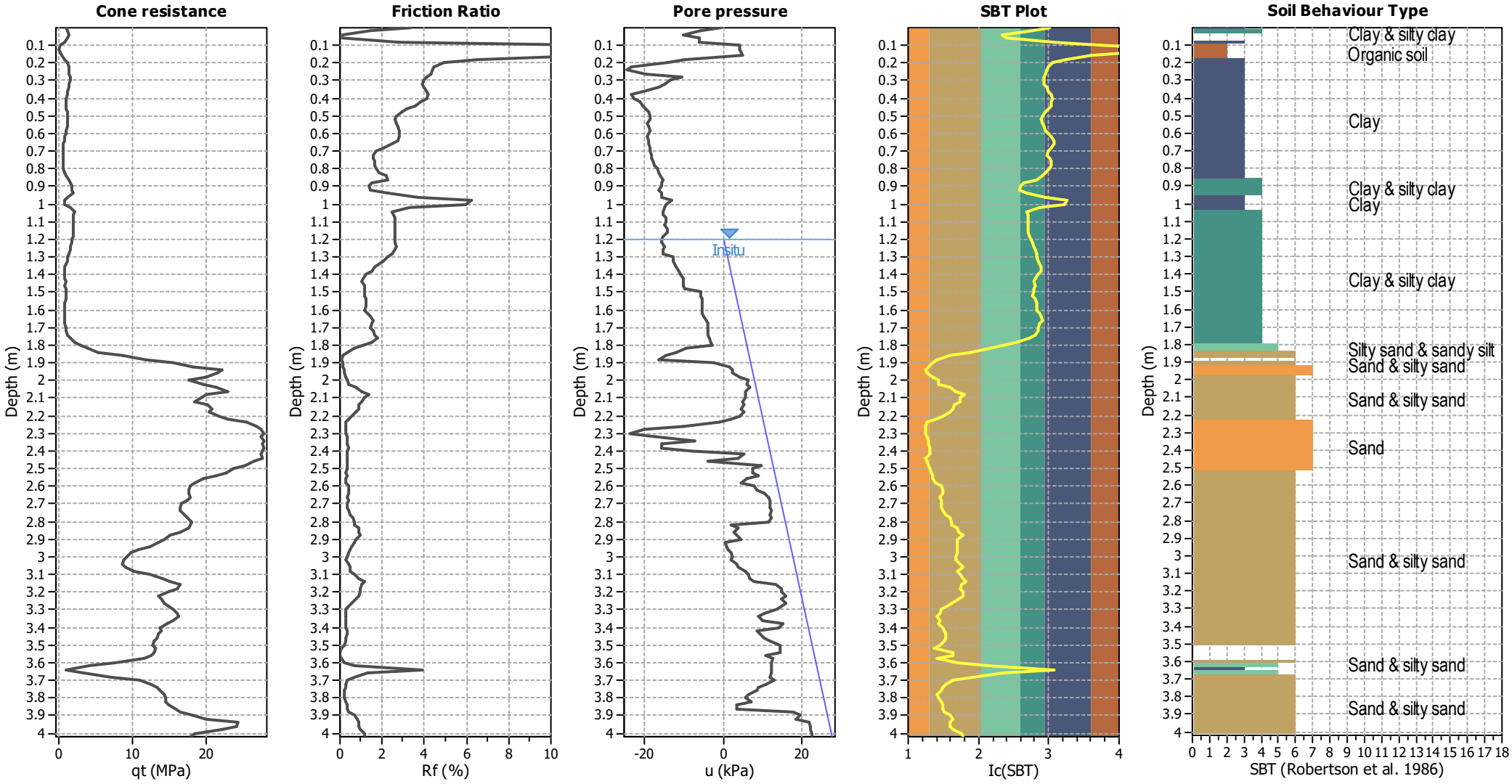
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 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



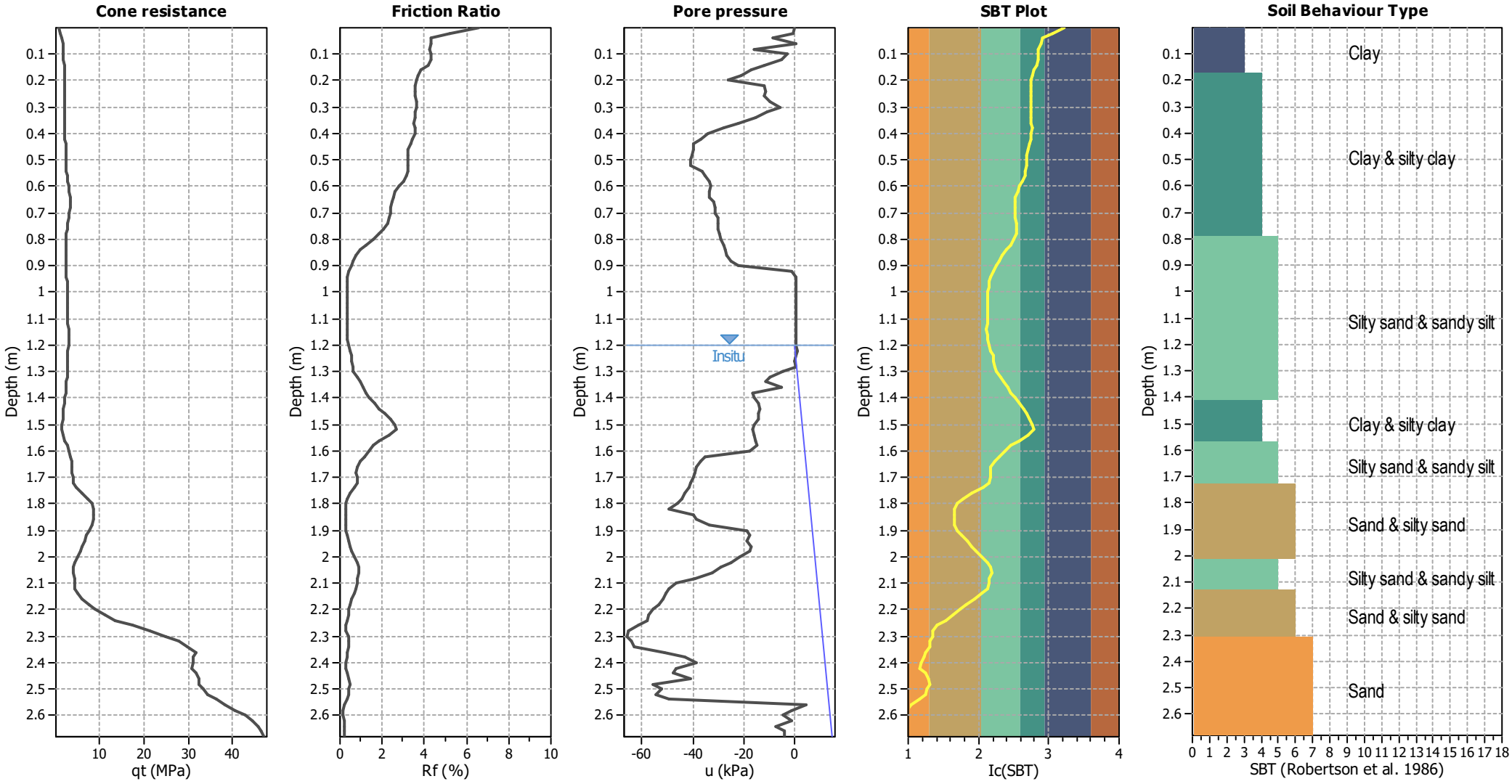
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 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.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 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

APPENDIX 4:

Liquefaction Analysis Results

Summary of Liquefaction Analysis Results and Inferred Technical Category

CPT #	Termination Depth	Assumed Groundwater Level	Calculated Settlements[1]			Inferred Technical Category
			SLS2[2]	ILS	ULS	
CPT-01	2.5 m	2.1 m	0 mm			Insufficient data
CPT-02	1.3 m	1.5 m	0 mm			Insufficient data
CPT-03	10 m	1.3 m	65 mm	80 mm	100 mm	TC3 minor to moderate
CPT-04	4.4 m	1.25 m	< 10 mm		15 mm	Insufficient data
CPT-05	15 m	0.85 m	10 mm	15 mm	20 mm	TC1
CPT-06	3.6 m	0.2 m	< 10 mm			Insufficient data
CPT-07	10 m	0 m	45 mm	50 mm	50 mm	TC2
CPT-08	6.7 m	0 m	35 mm	35 mm	40 mm	Likely TC2
CPT-09	10 m	0.2 m	80 mm	100 mm	105 mm	TC3 minor to moderate
CPT-10	8.4 m	0.2 m	30 mm	35 mm	40 mm	Likely TC2
CPT-11	5 m	0 m	40 mm	45 mm	45 mm	Insufficient data
CPT-12	10 m	0.6 m	55 mm	75 mm	85 mm	TC3 minor to moderate
CPT-13	10 m	2.5 m	30 mm	45 mm	55 mm	TC2
CPT-14	15 m	2.65 m	25 mm	45 mm	55 mm	TC2
CPT-15	7.4 m	2.2 m	< 10 mm		20 mm	Likely TC1
CPT-16	1.1 m	2 m	0 mm			Insufficient data
CPT-17	2.5 m	1.85 m	0 mm			Insufficient data

CPT #	Termination Depth	Assumed Groundwater Level	Calculated Settlements[1]			Inferred Technical Category
			SLS2[2]	ILS	ULS	
CPT-18	14.7 m	2.2 m	35 mm	55 mm	70 mm	TC2
CPT-19	10 m	2.1 m	45 mm	60 mm	75 mm	TC2
CPT-20	15 m	1.65 m	50 mm	60 mm	70 mm	TC2
CPT-21	10 m	0 m	45 mm	50 mm	50 mm	TC2
CPT-22	9.8 m	0 m	25 mm	30 mm	30 mm	TC2
CPT-23	15 m	1.9 m	145 mm	160 mm	160 mm	TC3 potentially significant
CPT-24	7.6 m	1.05 m	0 mm	< 10 mm		Likely TC1
CPT-25	12.6 m	1.7 m	25 mm	30 mm	50 mm	TC2
CPT-26	10 m	2.2 m	80 mm	95 mm	105 mm	TC3 minor to moderate
CPT-27	10 m	1.75 m	100 mm	120 mm	130 mm	TC3 potentially significant
CPT-28	7.6 m	0 m	20 mm	20 mm	25 mm	Likely TC2
CPT-29	6.3 m	0.4 m	45 mm	45 mm	45 mm	Likely TC2
CPT-30	15 m	0 m	< 10 mm	10 mm	15 mm	TC1
CPT-31	10 m	0.85 m	40 mm	55 mm	70 mm	TC2
CPT-32	2.7 m	1.4 m	0 mm		< 10 mm	Insufficient data
CPT-33	3.1 m	1.4 m	< 10 mm		20 mm	Insufficient data
CPT-34	8.1 m	1.5 m	15 mm	25 mm	40 mm	Likely TC2
CPT-35	1.5 m	1.4 m	0 mm			Insufficient data
CPT-36	15 m	1.45 m	30 mm	40 mm	60 mm	TC2

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CPT #	Termination Depth	Assumed Groundwater Level	Calculated Settlements[1]			Inferred Technical Category
			SLS2[2]	ILS	ULS	
CPT-37	10 m	1.9 m	30 mm	45 mm	50 mm	TC2
CPT-38	17 m	1.1 m	50 mm	55 mm	60 mm	TC2
CPT-39	6.9 m	1.1 m	<10 mm	10 mm	20 mm	Likely TC2
CPT-40	10 m	1.7 m	<10 mm		15 mm	TC1
CPT-41	1.7 m	1.8 m	0 mm			Insufficient data
ES-CPT-01[3]	3.9 m	1.7 m	<10 mm			Insufficient data
ES-CPT-02	14.7 m	1.7 m	45 mm	60 mm	80 mm	TC2
ES-CPT-03	12.7 m	1.1 m	55 mm	65 mm	75 mm	TC3 minor to moderate
ES-CPT-04	2.4 m	1.1 m	< 10 mm		10 mm	Insufficient data
ES-CPT-05	20 m	1.1 m	35 mm	45 mm	55 mm	TC2
ES-CPT-06	18 m	1.5 m	45 mm	55 mm	60 mm	TC2
ES-CPT-07	4.3 m	1.5 m	<10 mm		10 mm	Insufficient data
ES-CPT-08	3.2 m	1.5 m	0 mm	<10 mm		Insufficient data
ES-CPT-09	18.1 m	1.2 m	75 mm	85 mm	90 mm	TC3 minor to moderate
ES-CPT-10	4 m	1.2 m	< 10 mm			Insufficient data
ES-CPT-11	2.6 m	1.2 m	<10 mm		20 mm	Insufficient data

[1]For an undeveloped site. Settlements beneath buildings are likely to be different. Only the upper 10.0 metres of the profile are consider in accordance with Section 12 of the MBIE Guidance Document.

[2]Only the SLS2 case was considered as it resulted in a higher liquefaction potential than SLS1. It was therefore considered the critical SLS case.

[3]CPTs denoted at ES-CPT-XX are from the 2020 Elliot Sinclair investigation. The data used in our analysis was sourced from NZGD.

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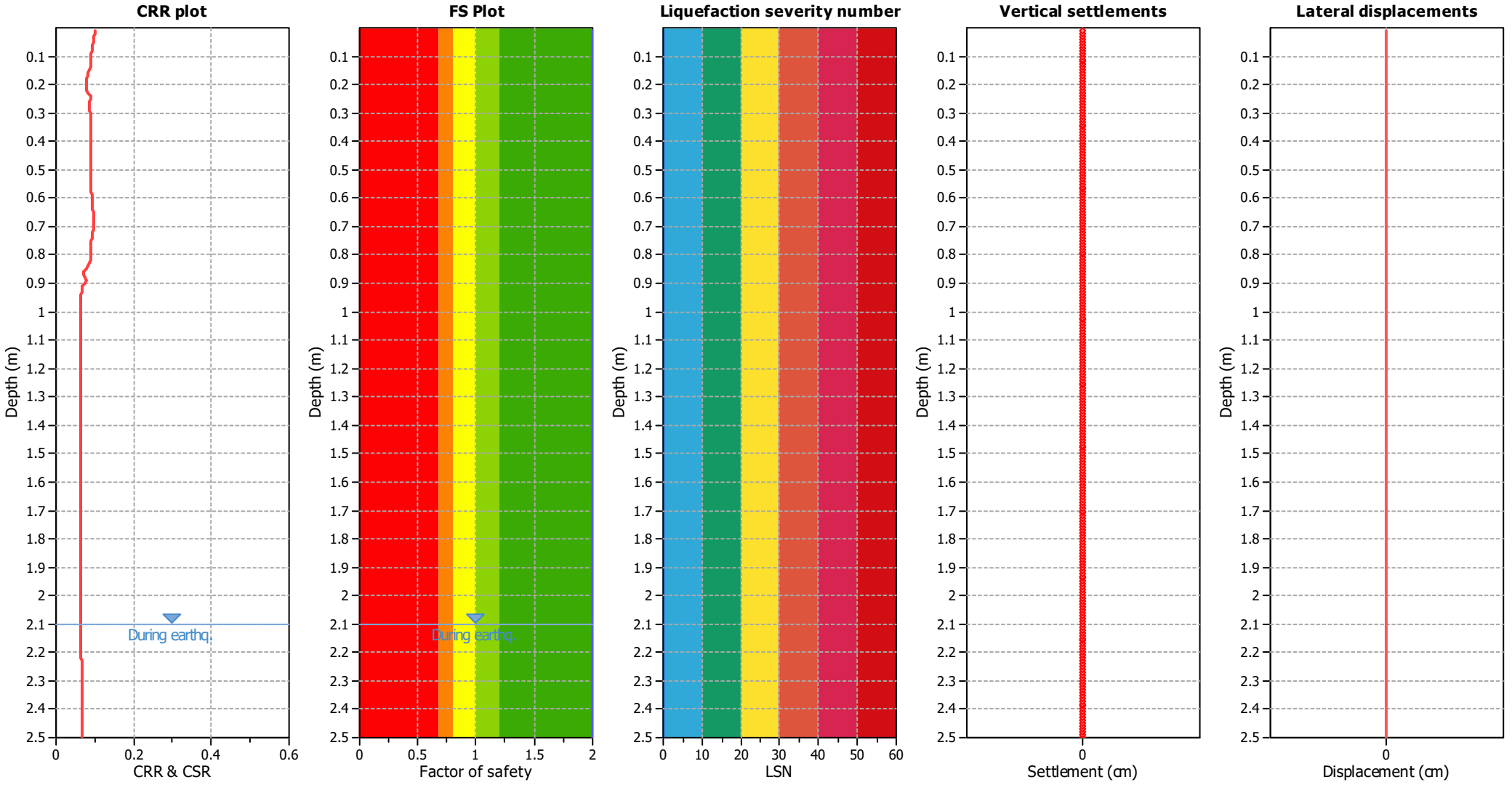
APPENDIX 5:

Liquefaction Analysis Outputs

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.10 m	Fill height:	N/A	Limit depth:	10.00 m

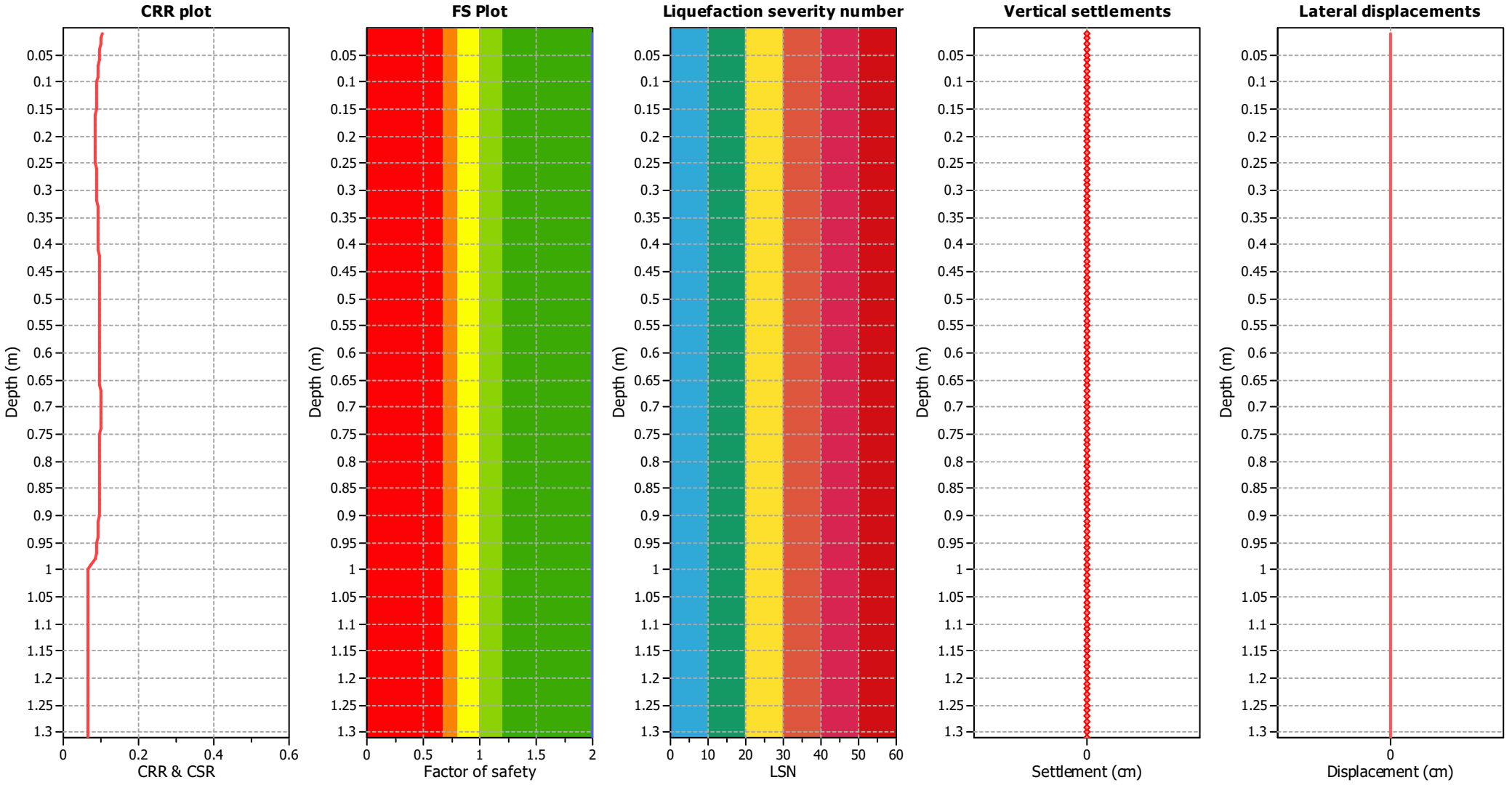
F.S. color scheme

- 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.):	2.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.10 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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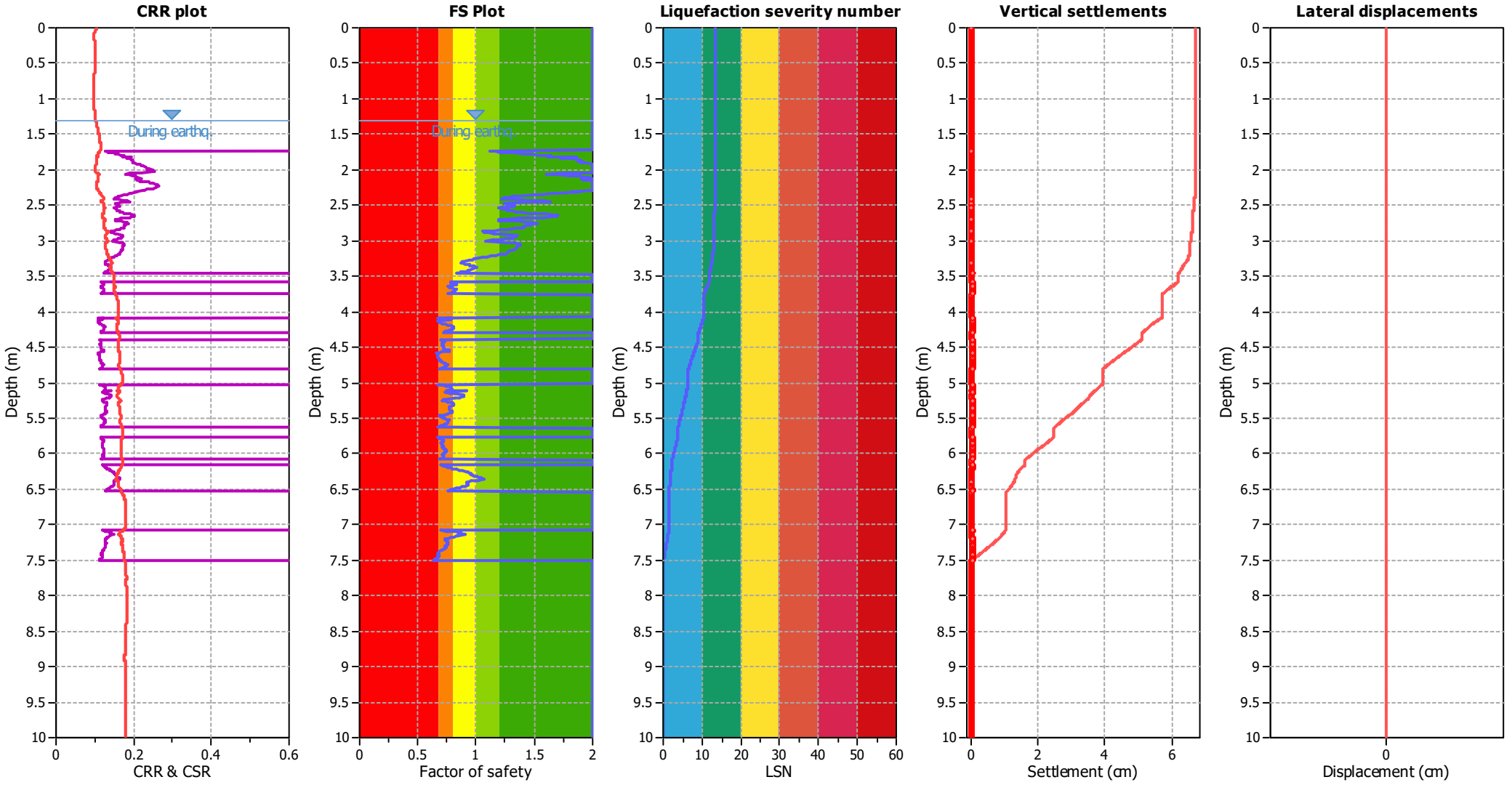
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.30 m	Fill height:	N/A	Limit depth:	10.00 m

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LSN color scheme

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- Minor expression of liquefaction
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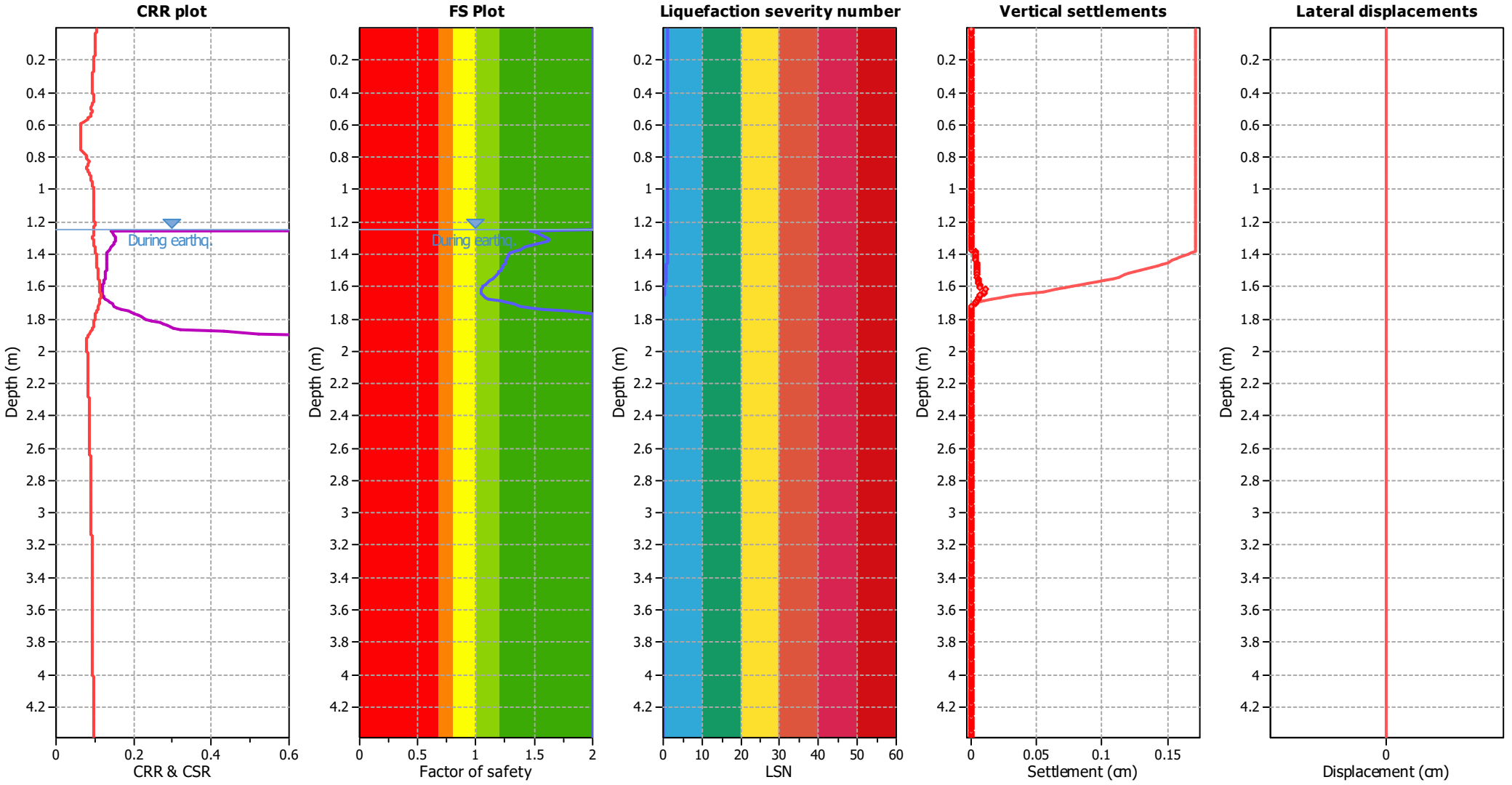
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.25 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.25 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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- Almost certain it will not liquefy

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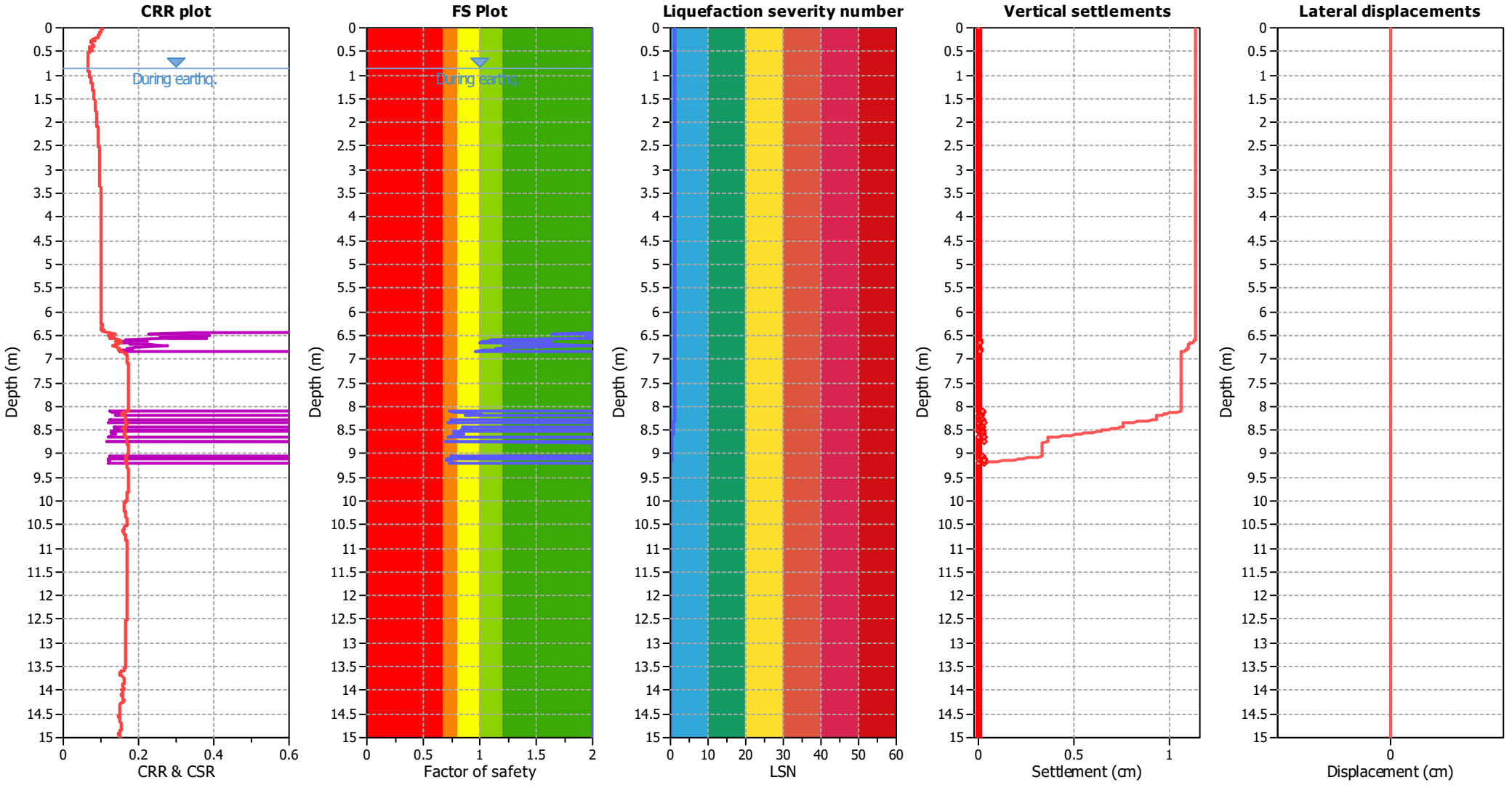
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.85 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.85 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

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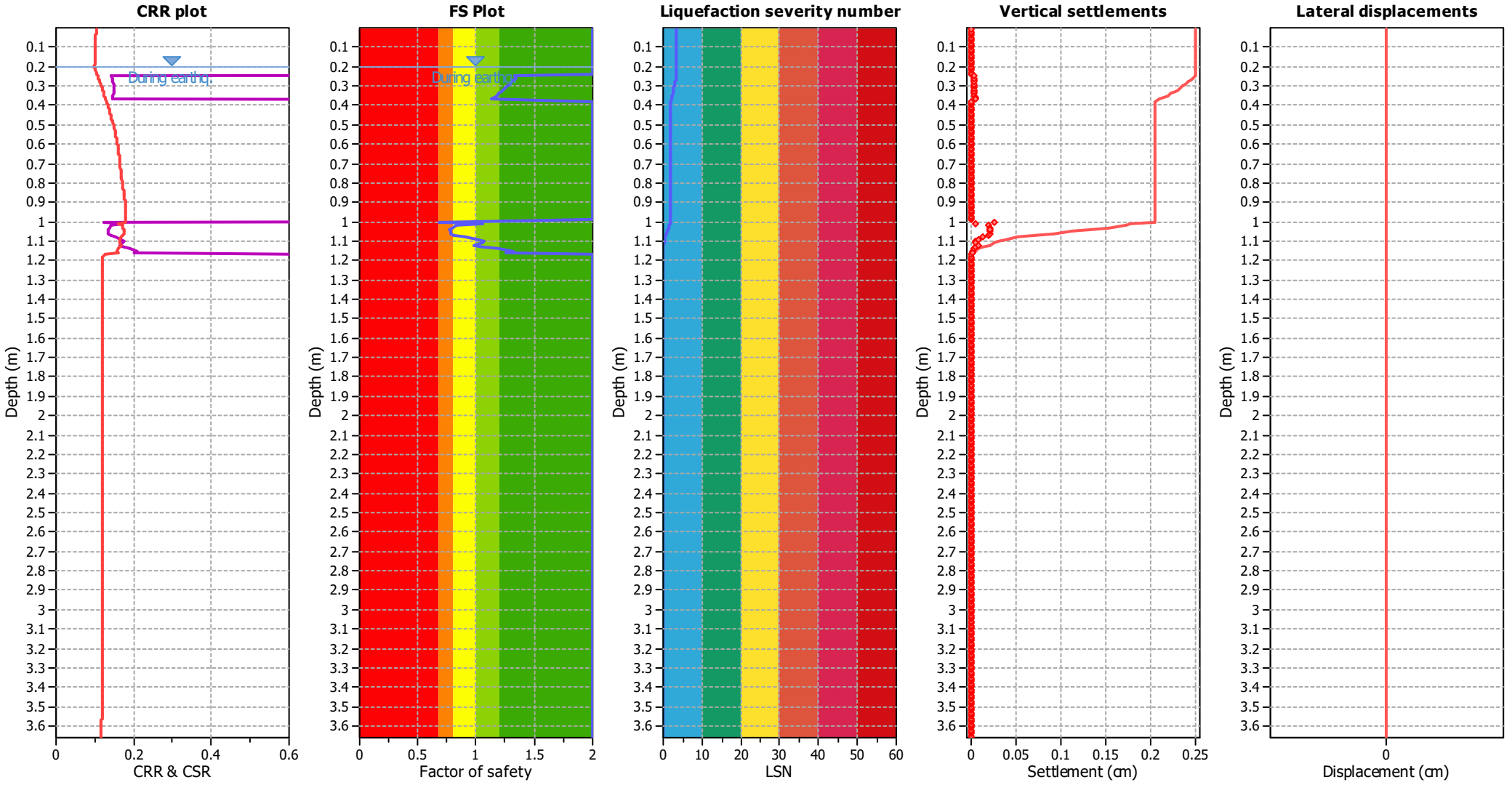
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.20 m	Fill height:	N/A	Limit depth:	10.00 m

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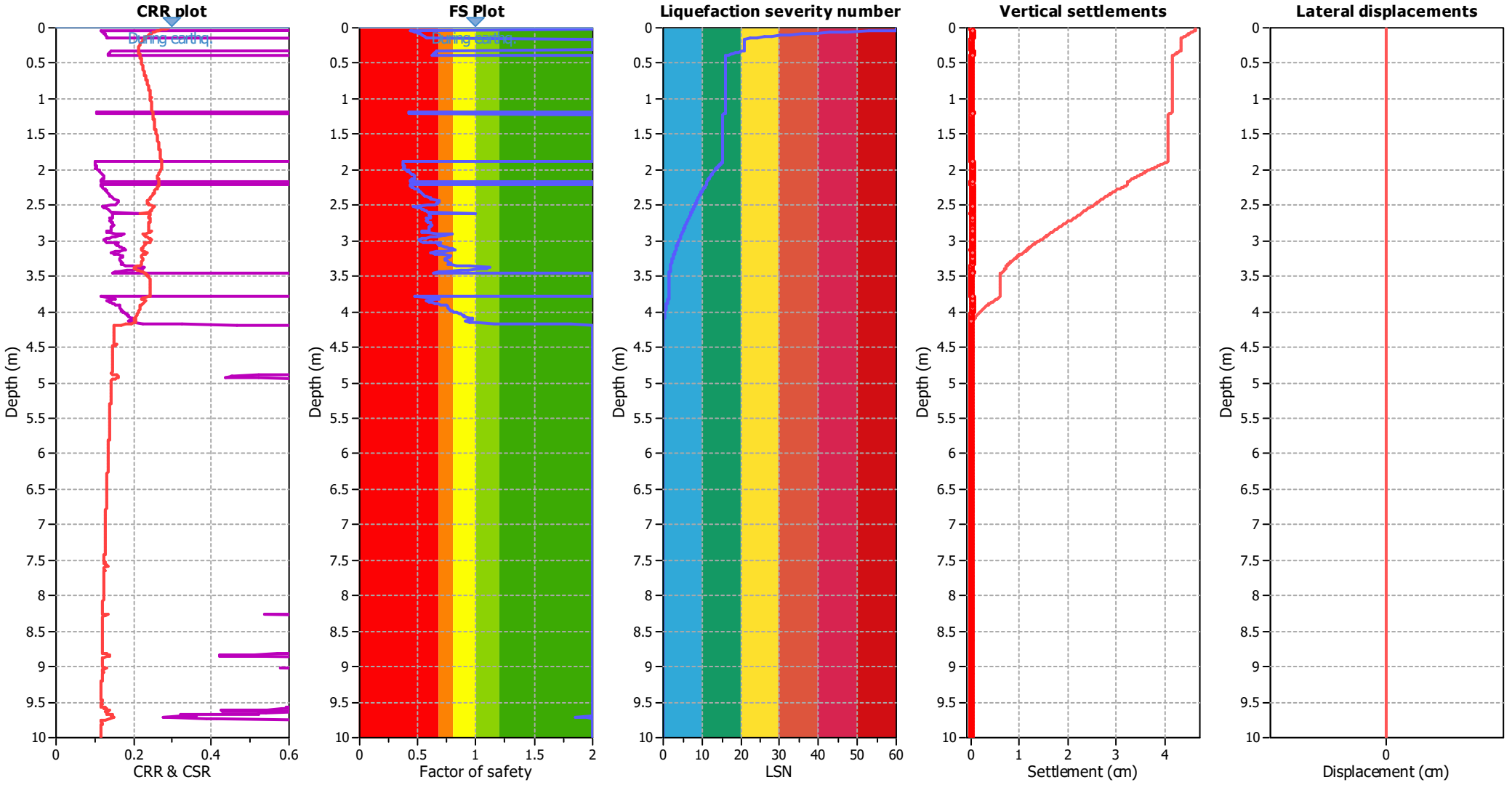
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

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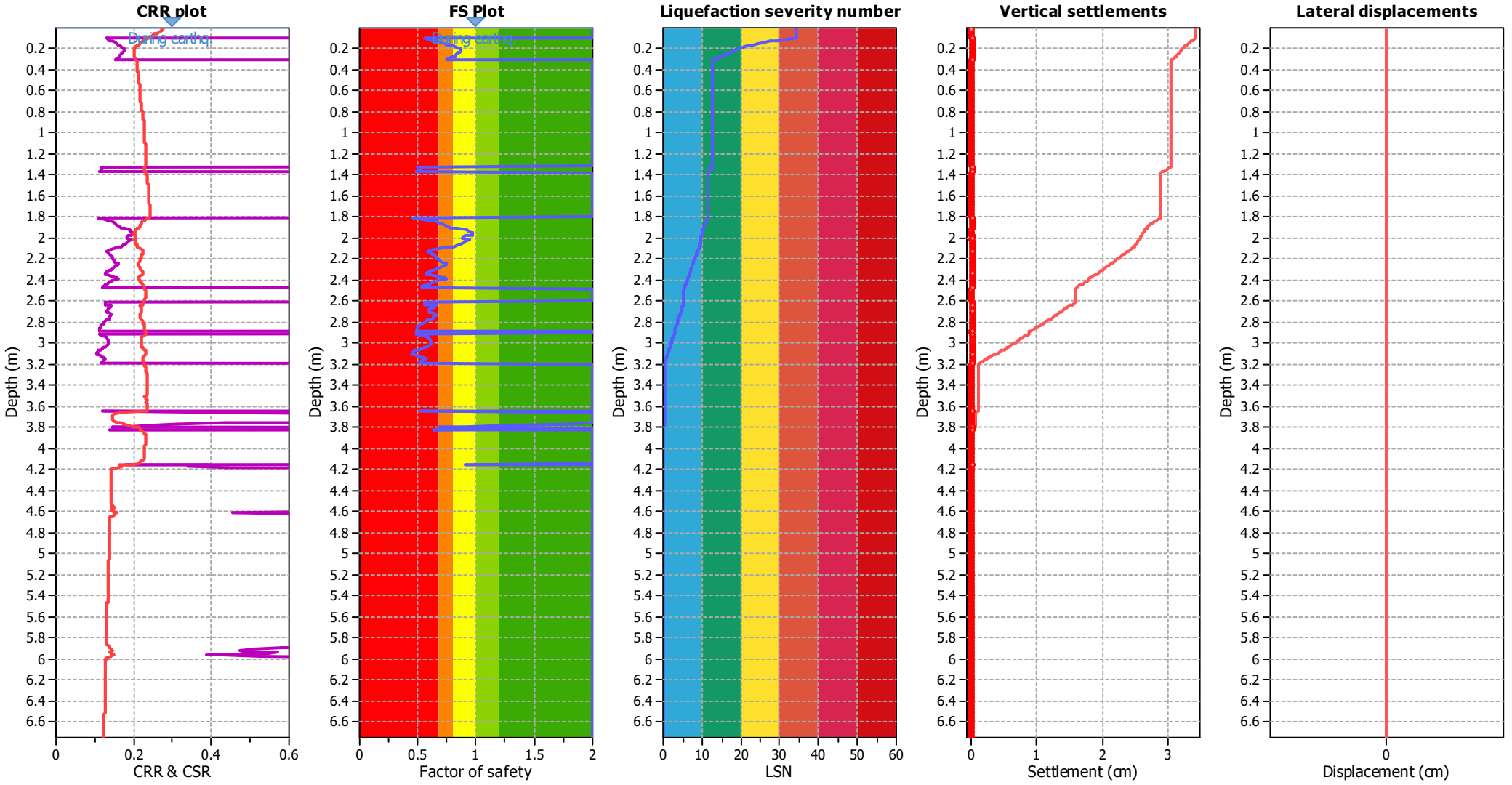
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

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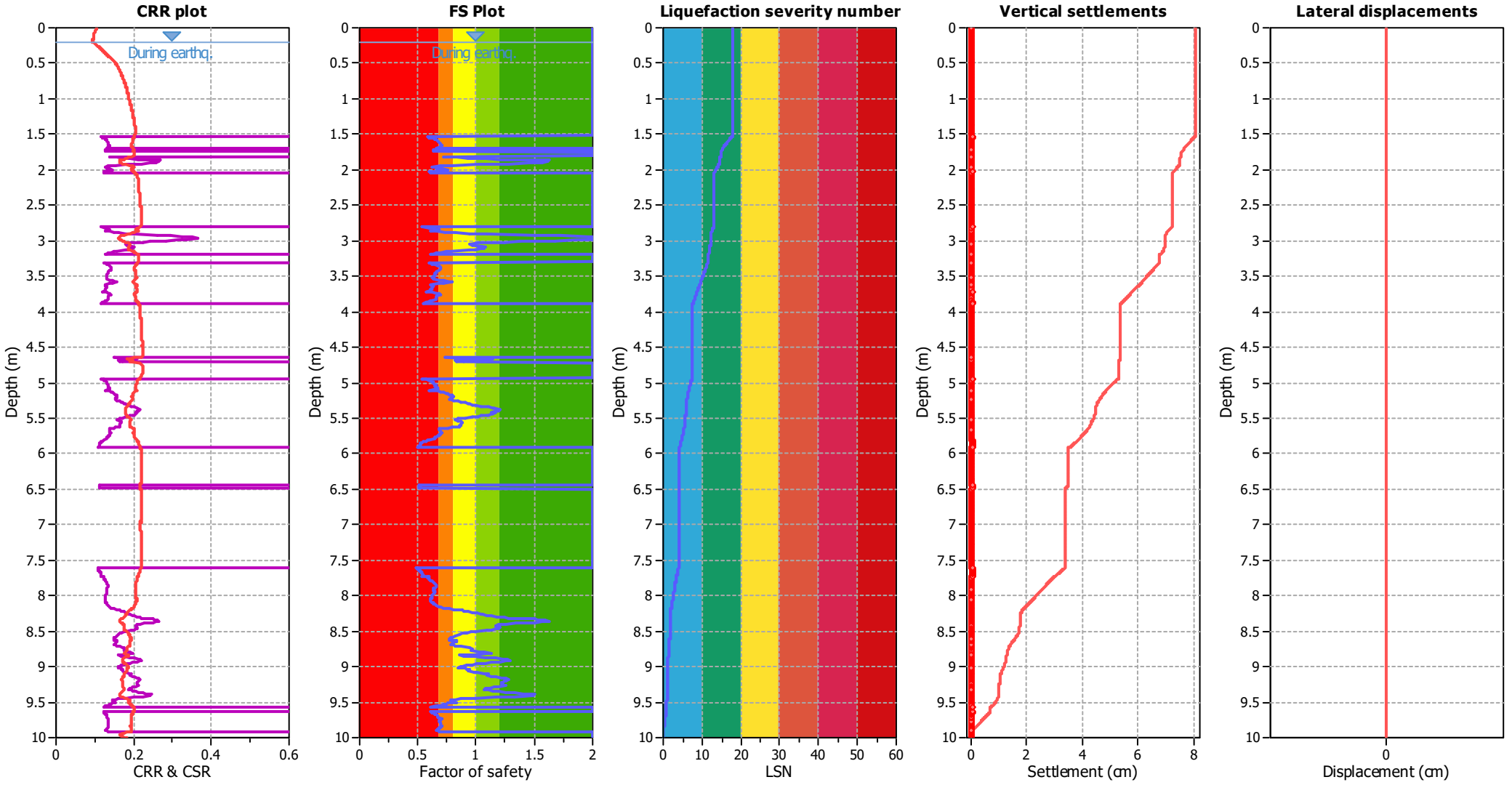
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.20 m	Fill height:	N/A	Limit depth:	10.00 m

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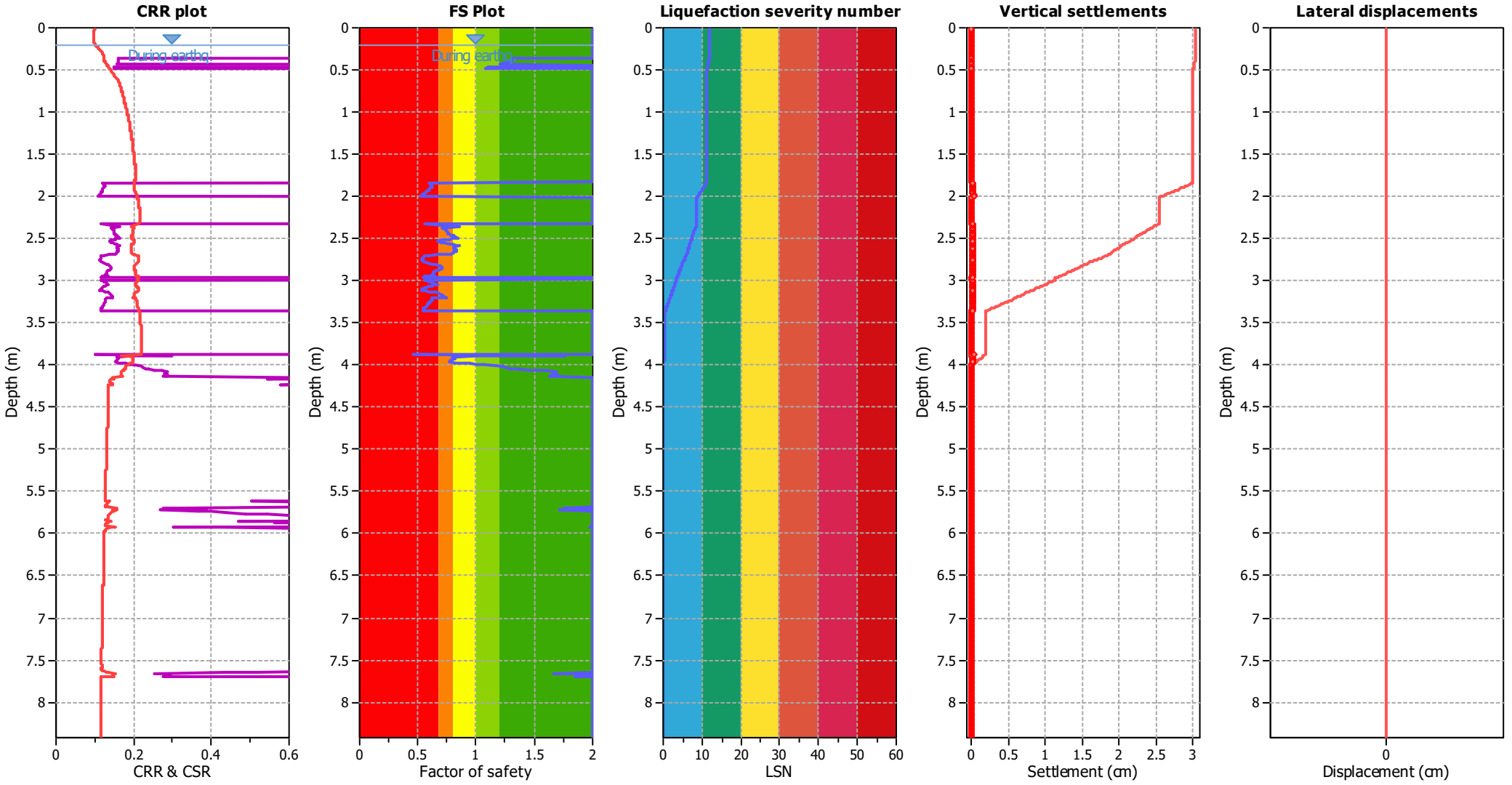
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.20 m	Fill height:	N/A	Limit depth:	10.00 m

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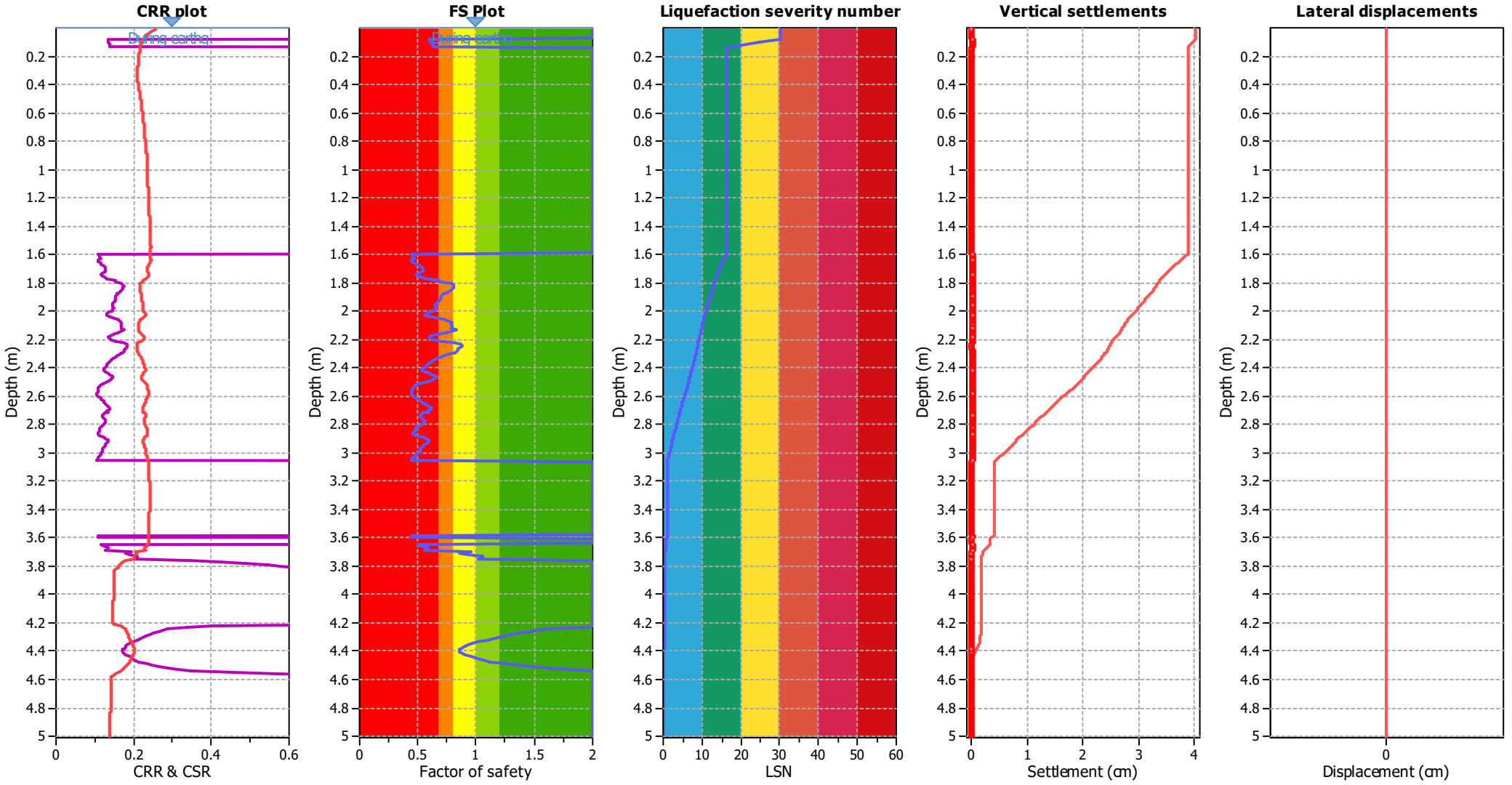
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

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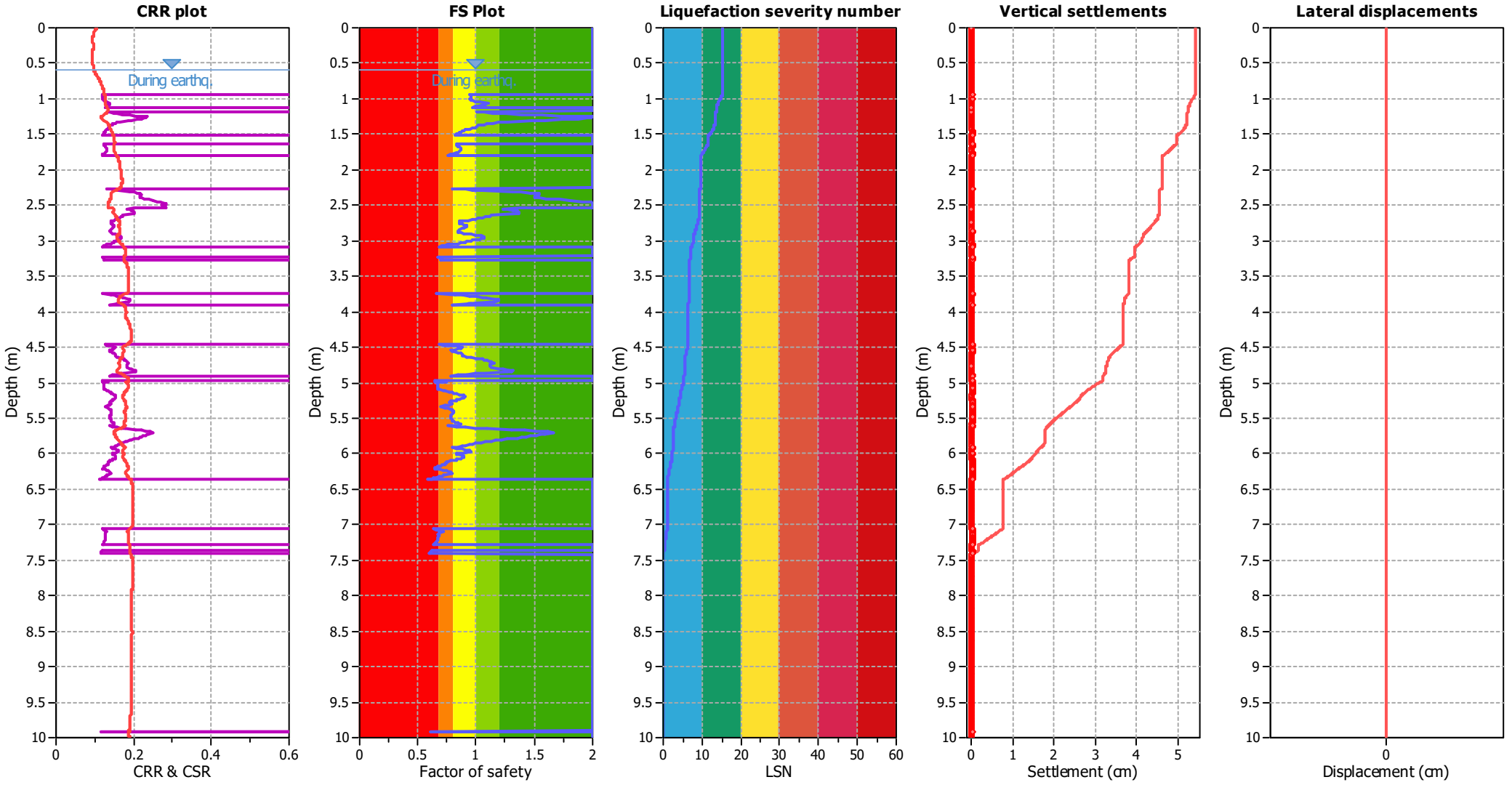
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.60 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.60 m	Fill height:	N/A	Limit depth:	10.00 m

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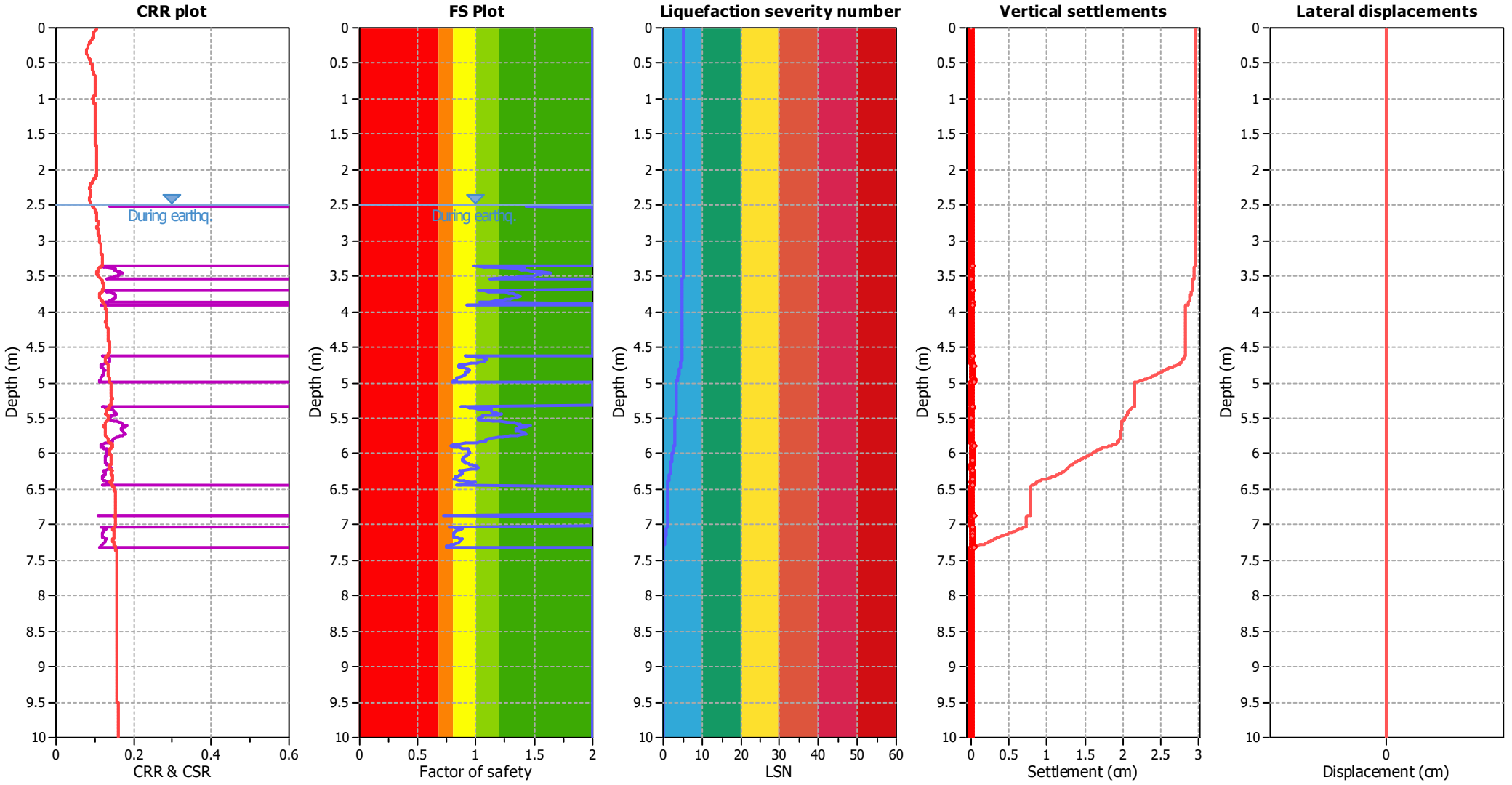
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	10.00 m

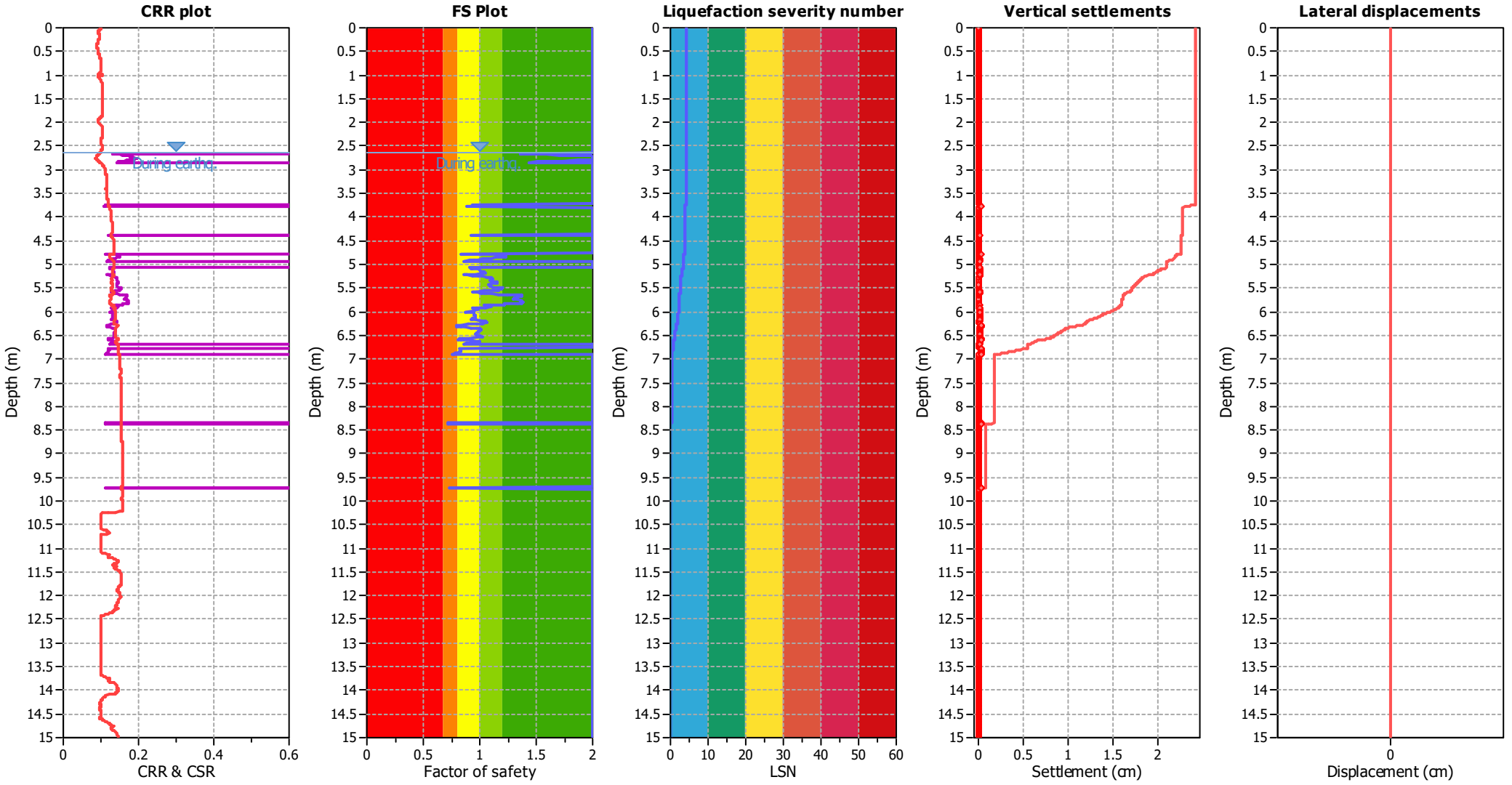
F.S. color scheme

- 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.):	2.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.65 m	Fill height:	N/A	Limit depth:	10.00 m

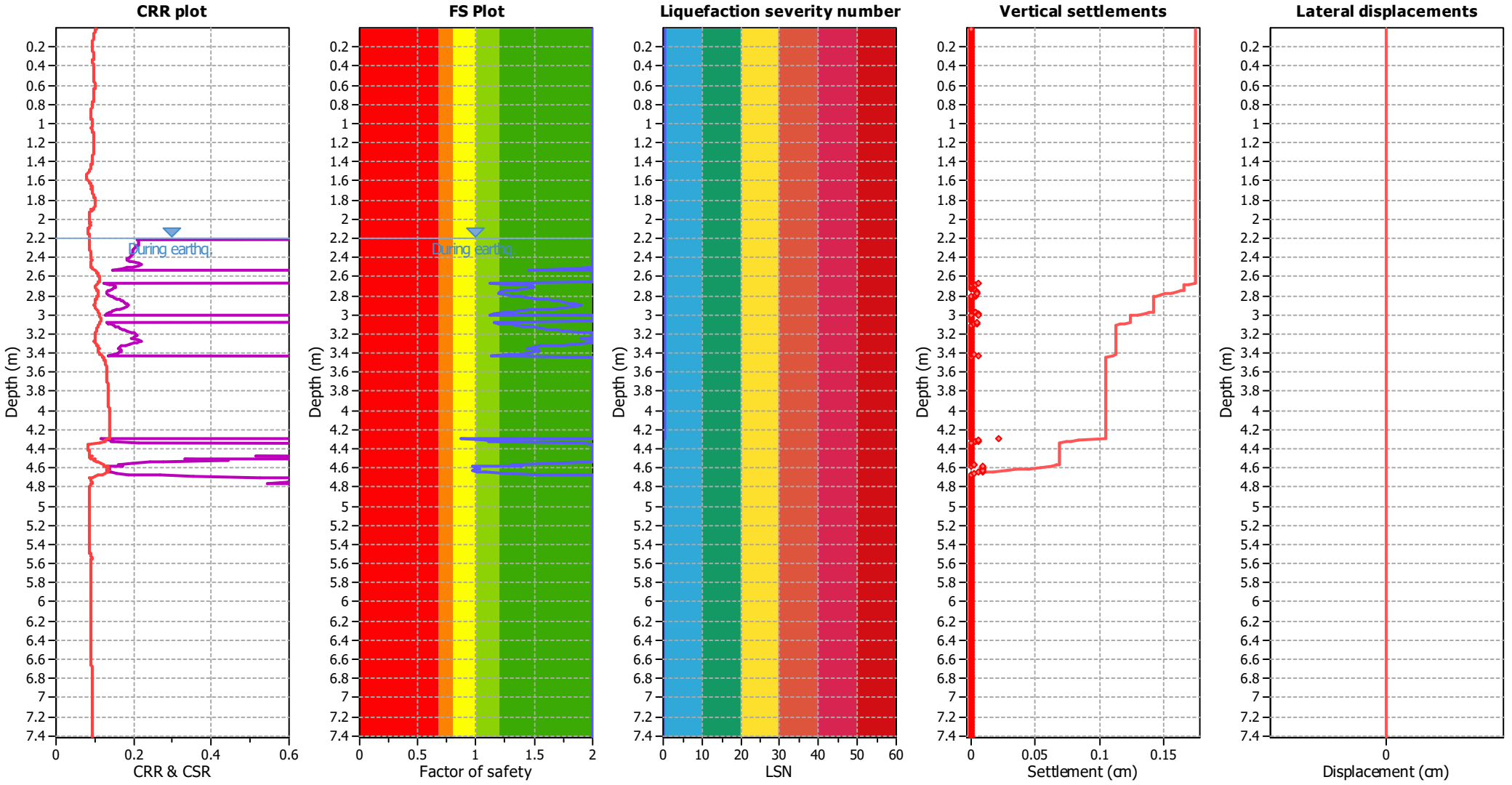
F.S. color scheme

- 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.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 m	Fill height:	N/A	Limit depth:	10.00 m

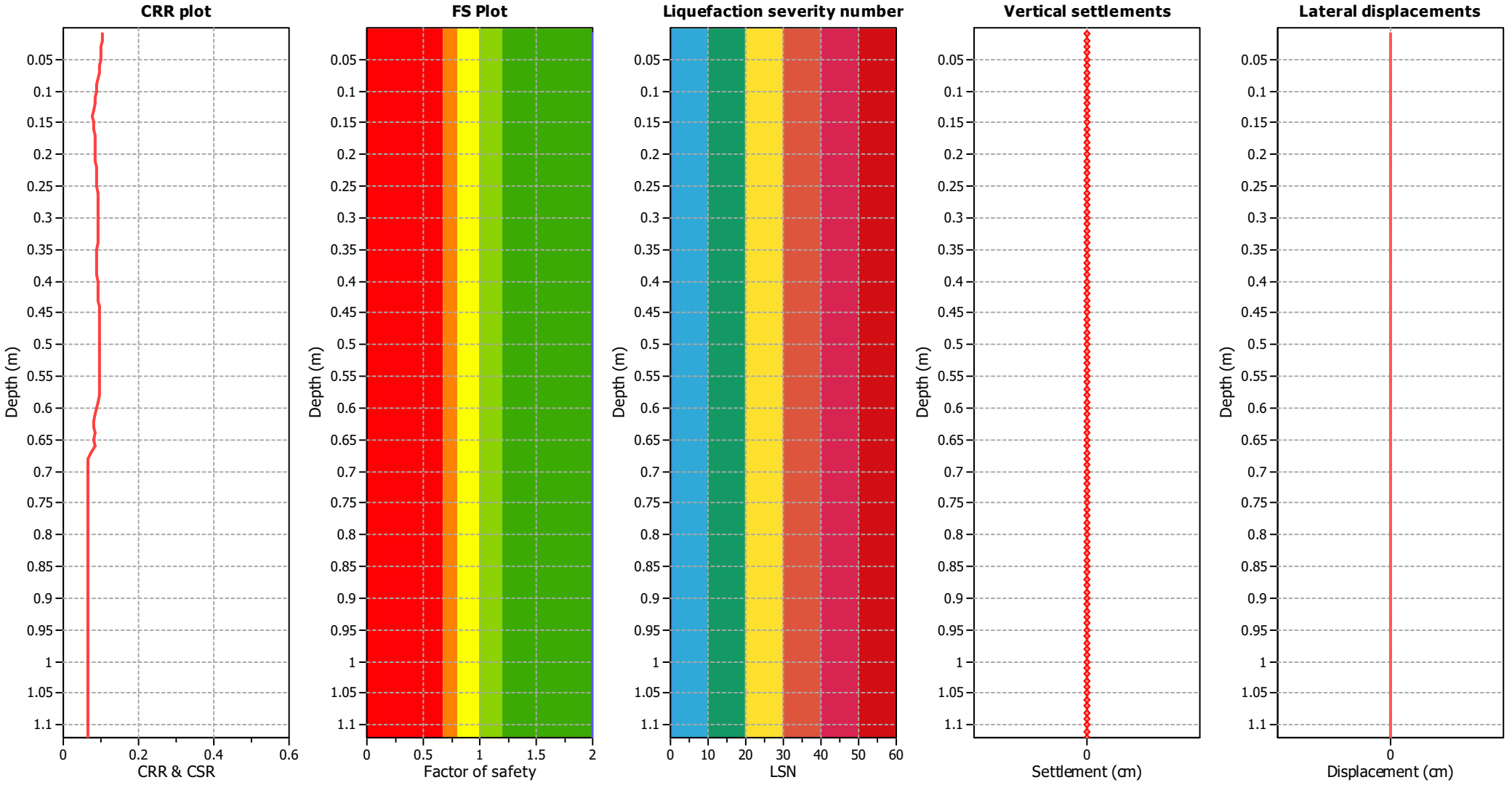
F.S. color scheme

- 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:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

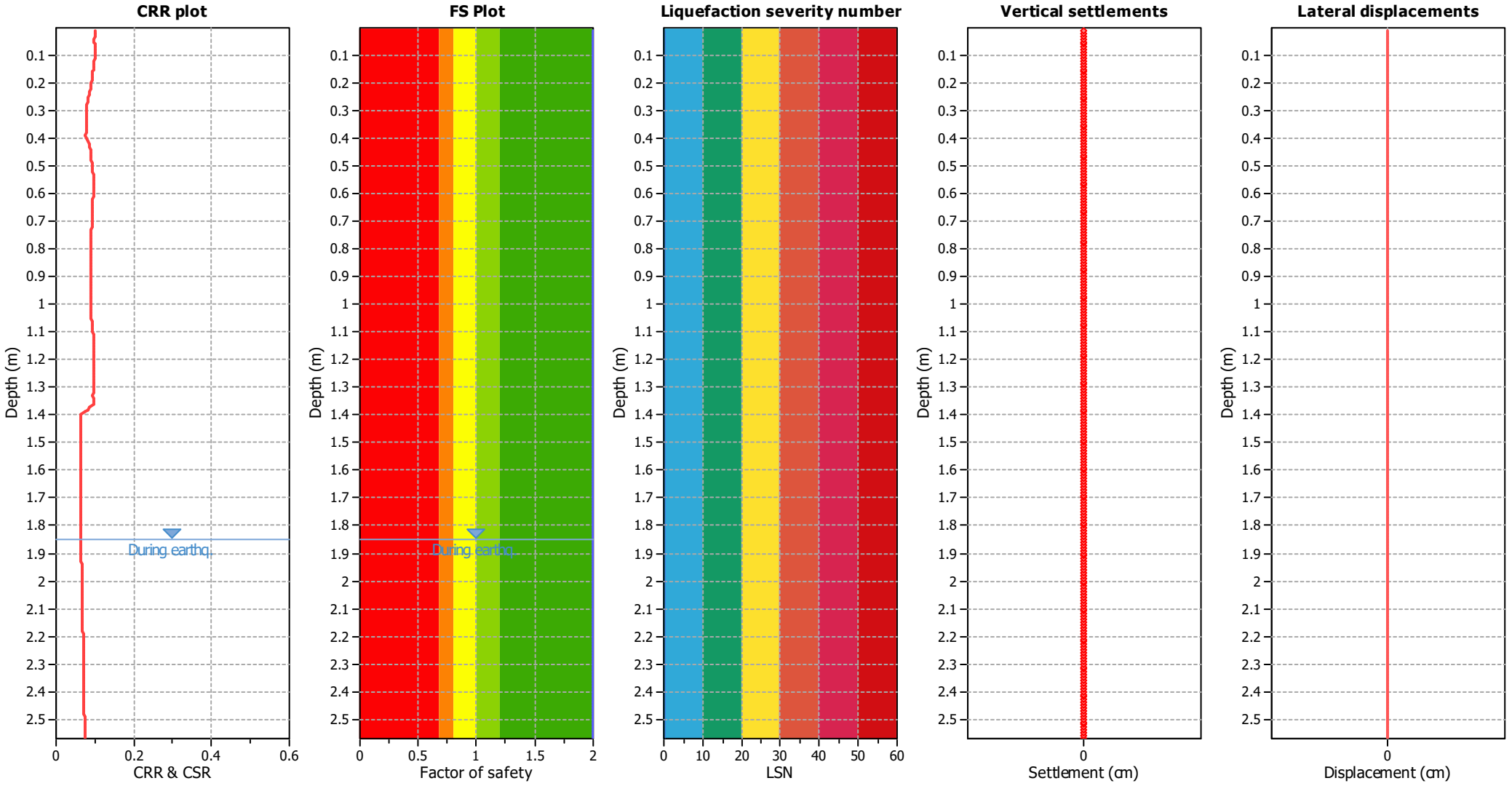
F.S. color scheme

- 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.):	1.85 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.85 m	Fill height:	N/A	Limit depth:	10.00 m

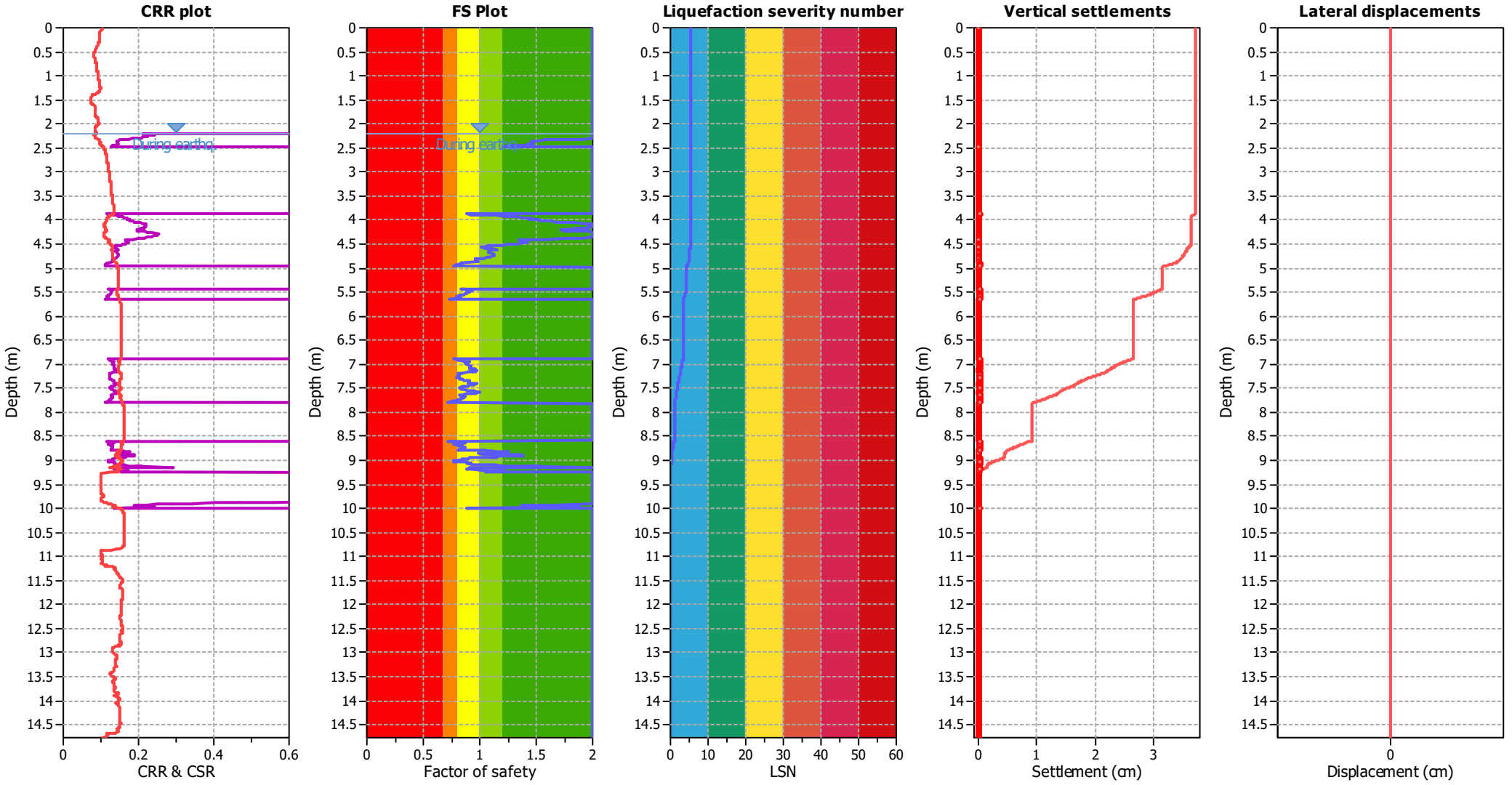
F.S. color scheme

- 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.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 m	Fill height:	N/A	Limit depth:	10.00 m

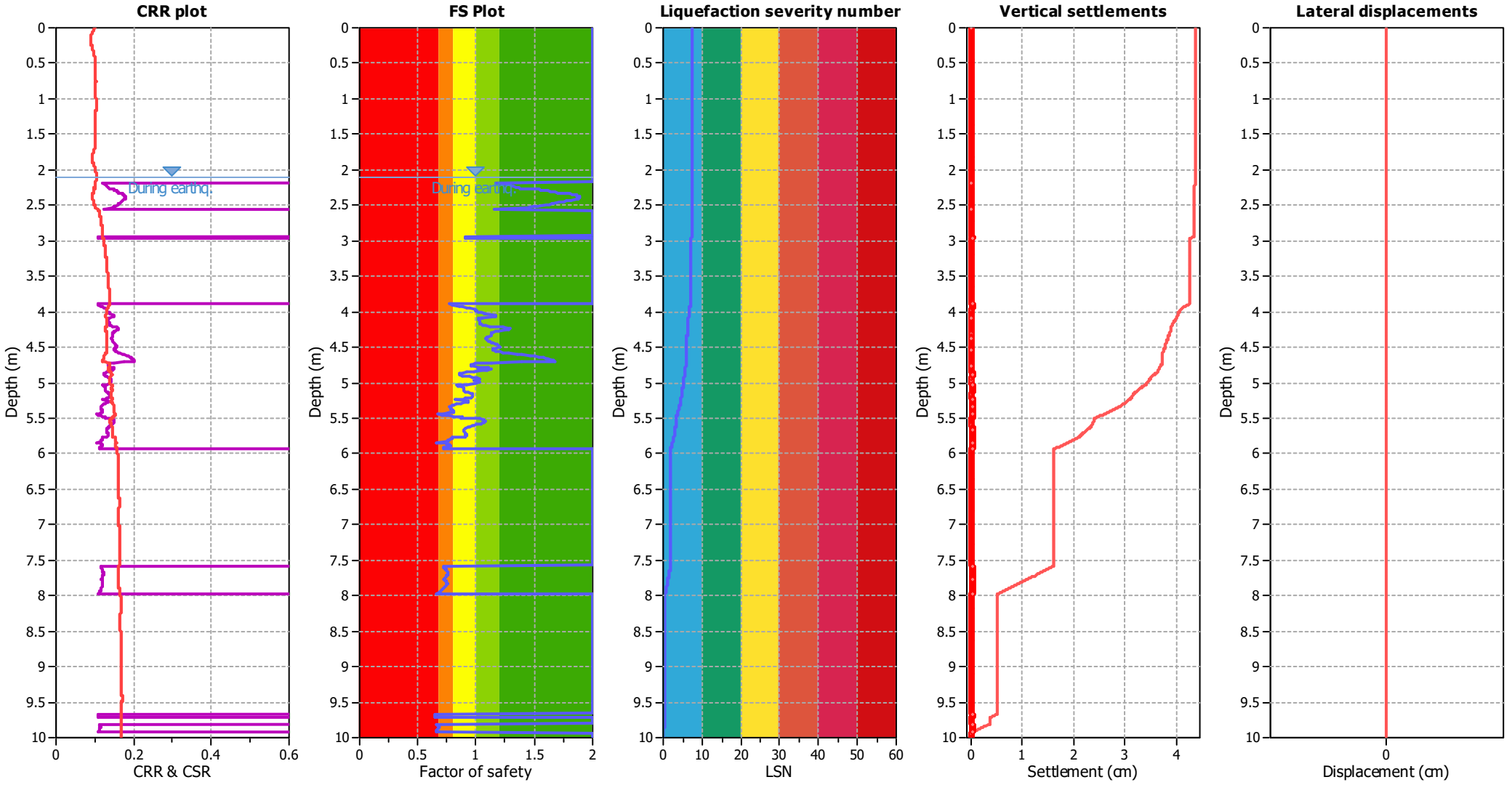
F.S. color scheme

- 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.):	2.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.10 m	Fill height:	N/A	Limit depth:	10.00 m

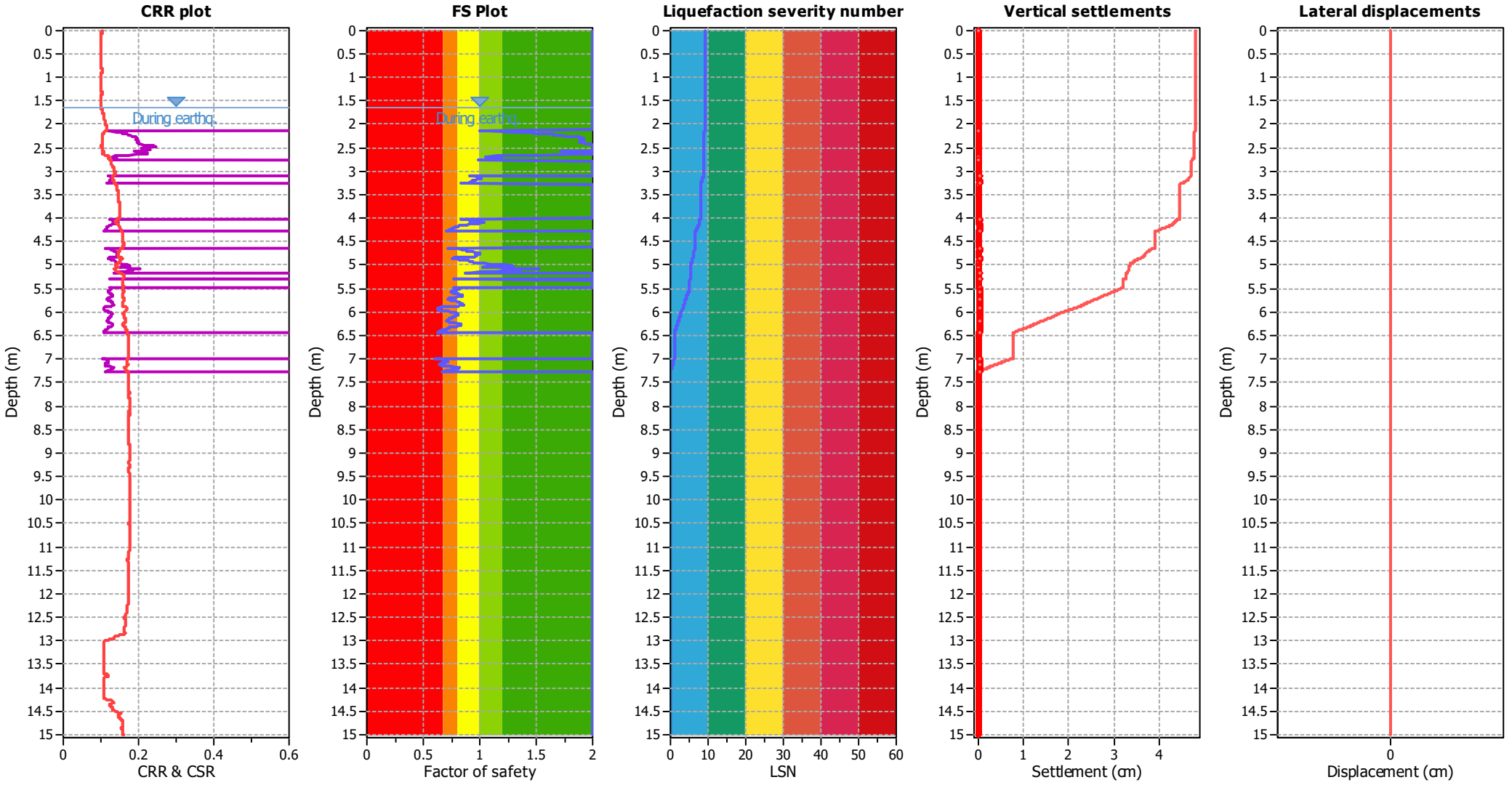
F.S. color scheme

- 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.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

- Almost certain it will liquefy
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LSN color scheme

- Severe damage
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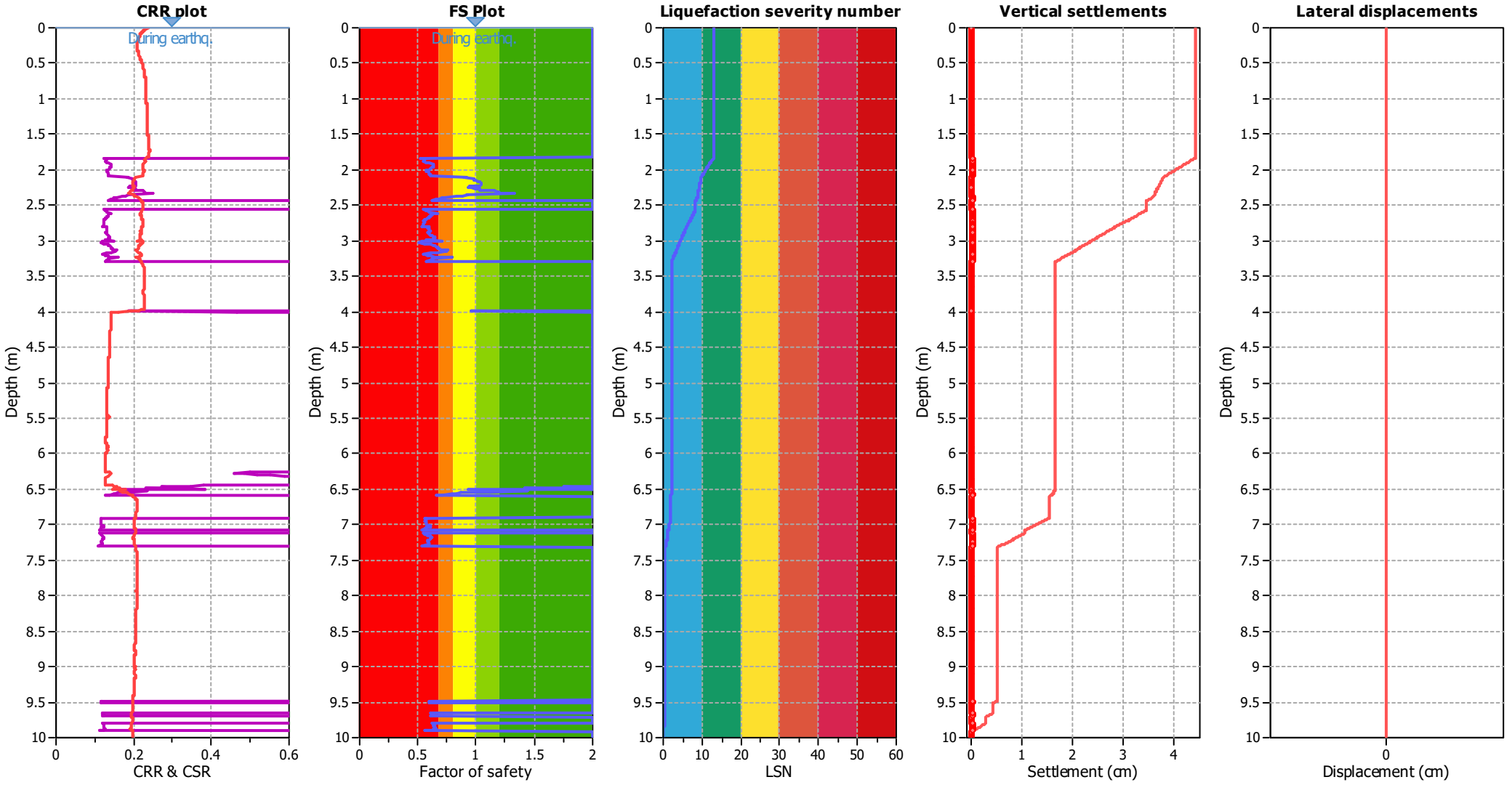
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

- Almost certain it will liquefy
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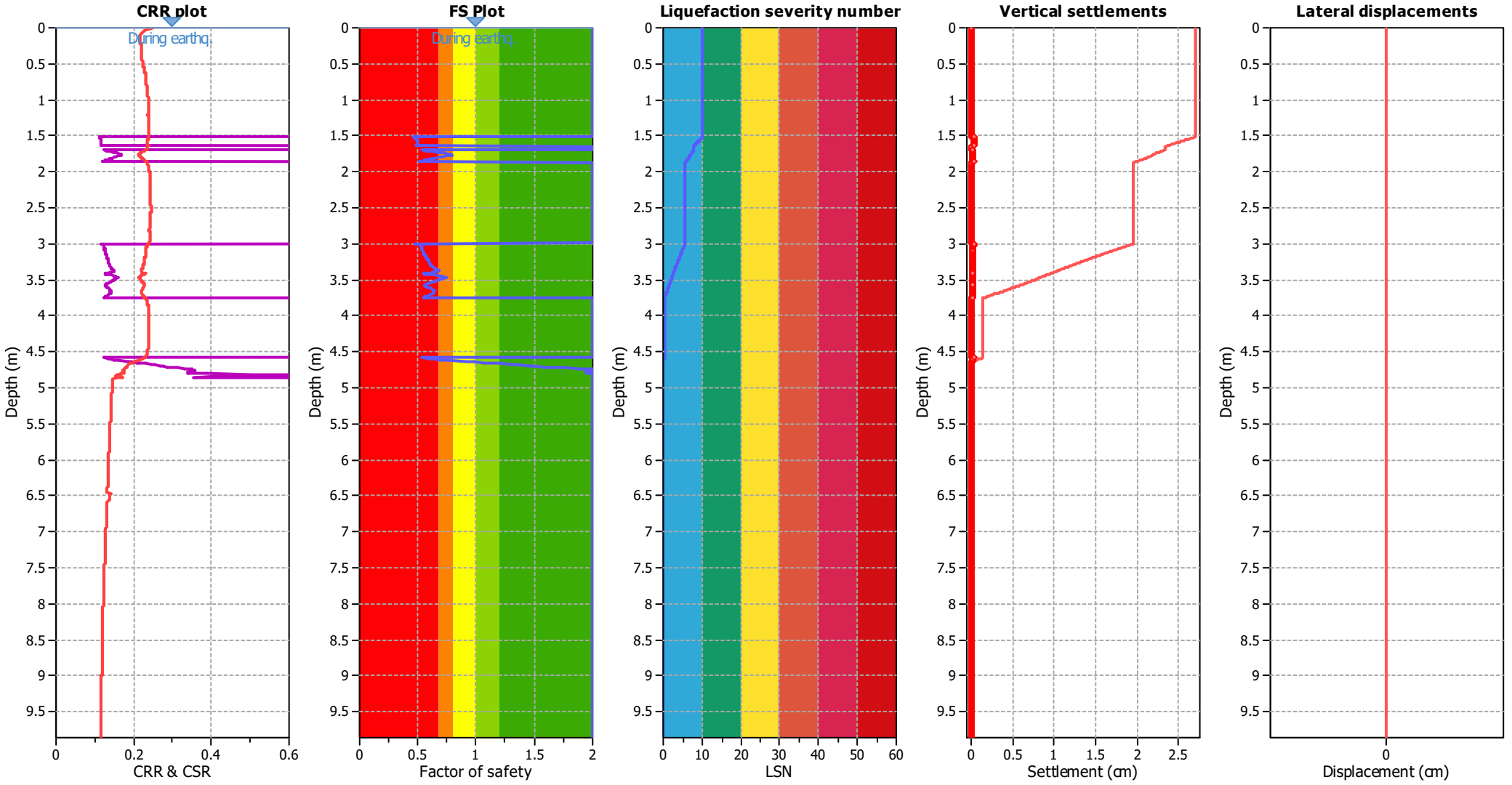
LSN color scheme

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 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
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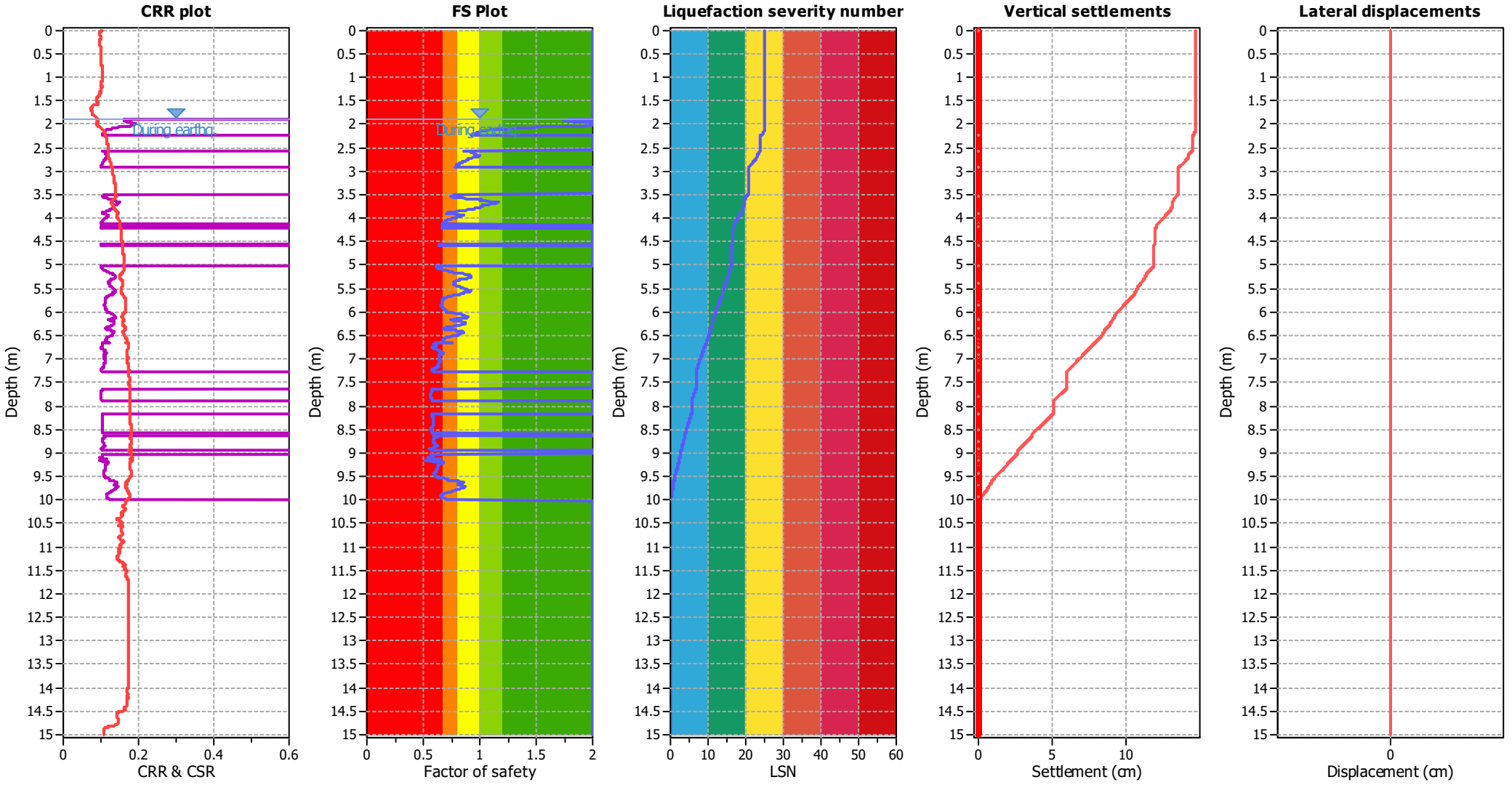
- Almost certain it will not liquefy

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.):	1.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.90 m	Fill height:	N/A	Limit depth:	10.00 m

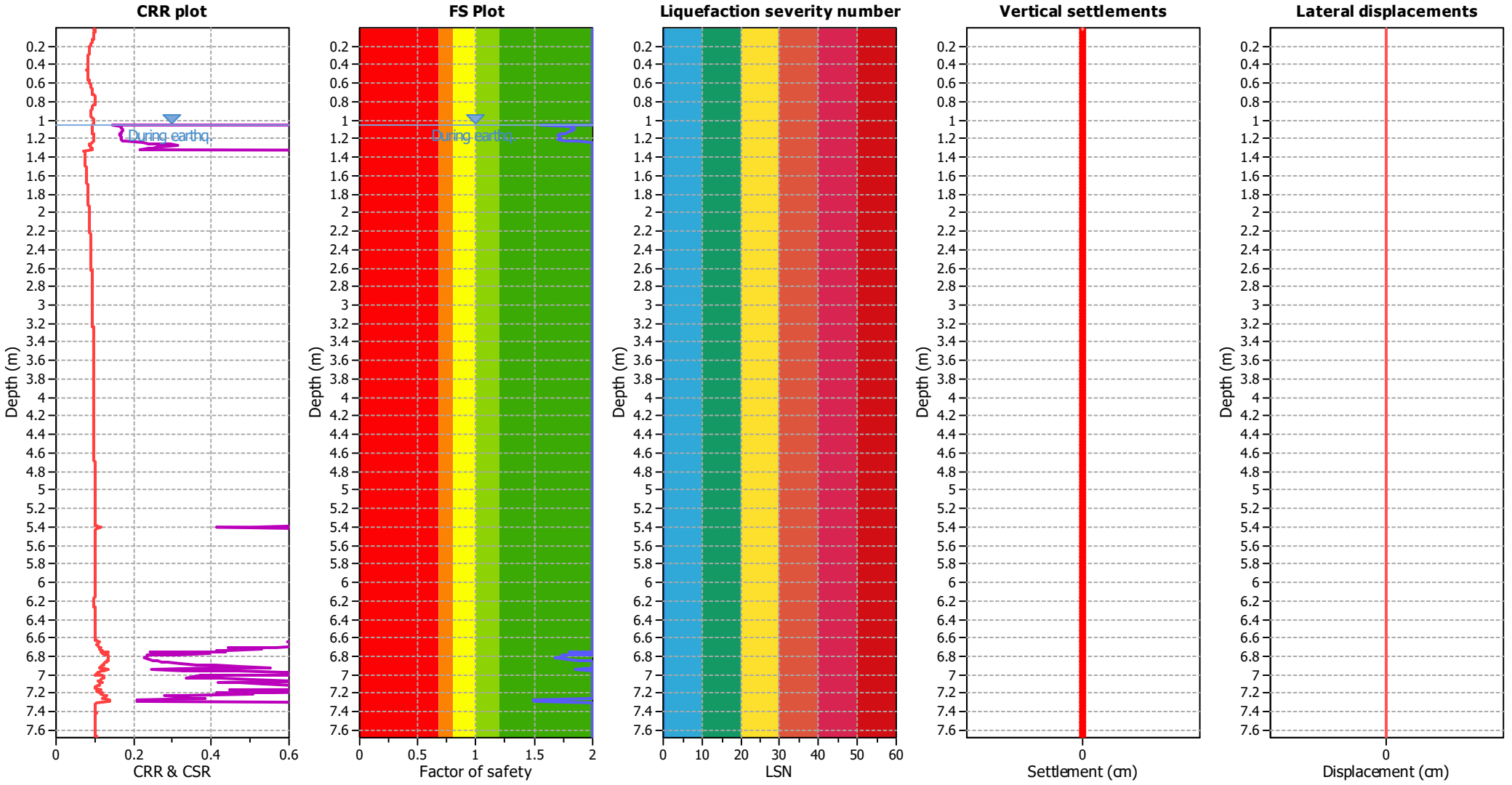
F.S. color scheme

- 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.):	1.05 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.05 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
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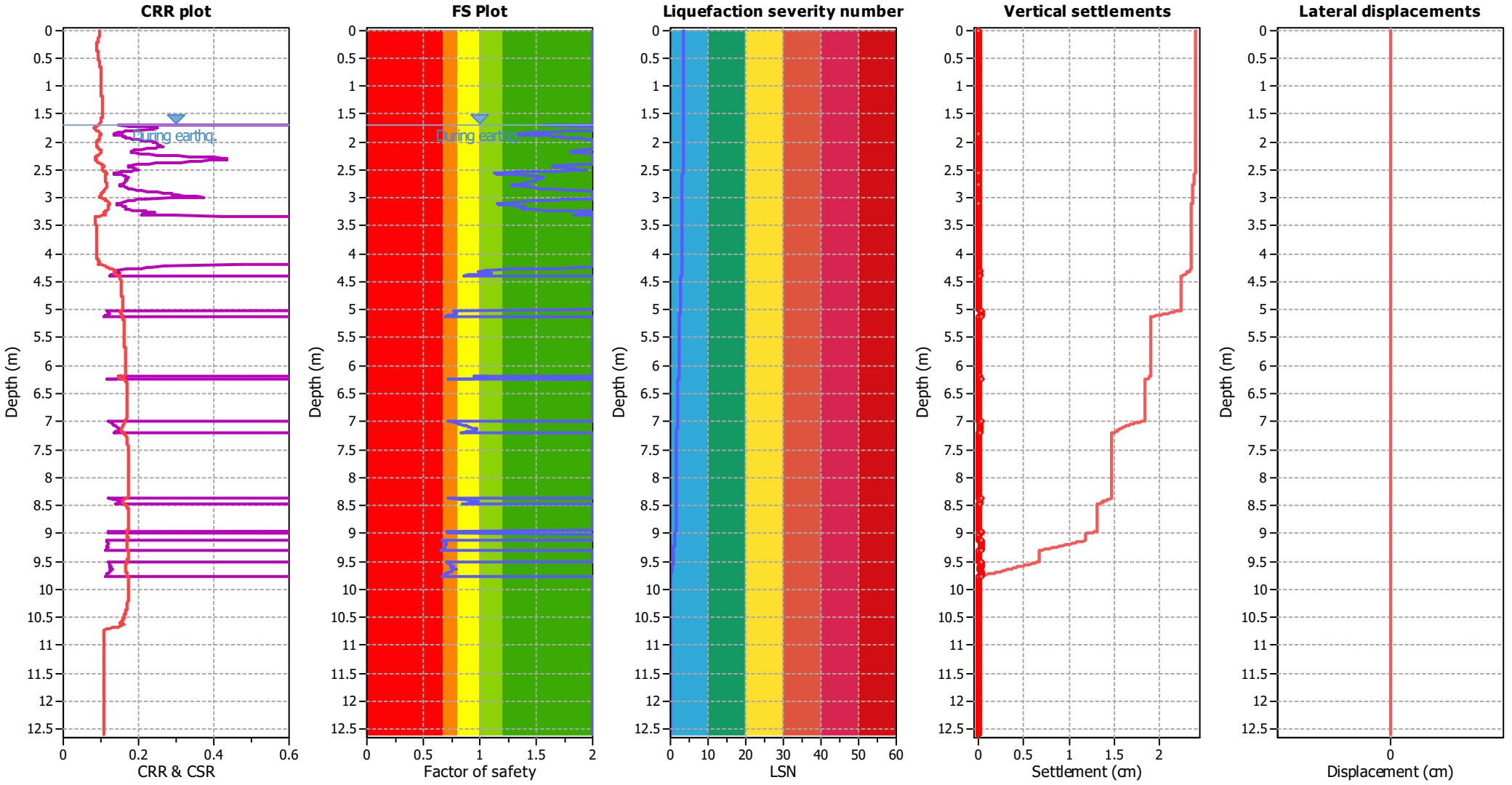
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 m	Fill height:	N/A	Limit depth:	10.00 m

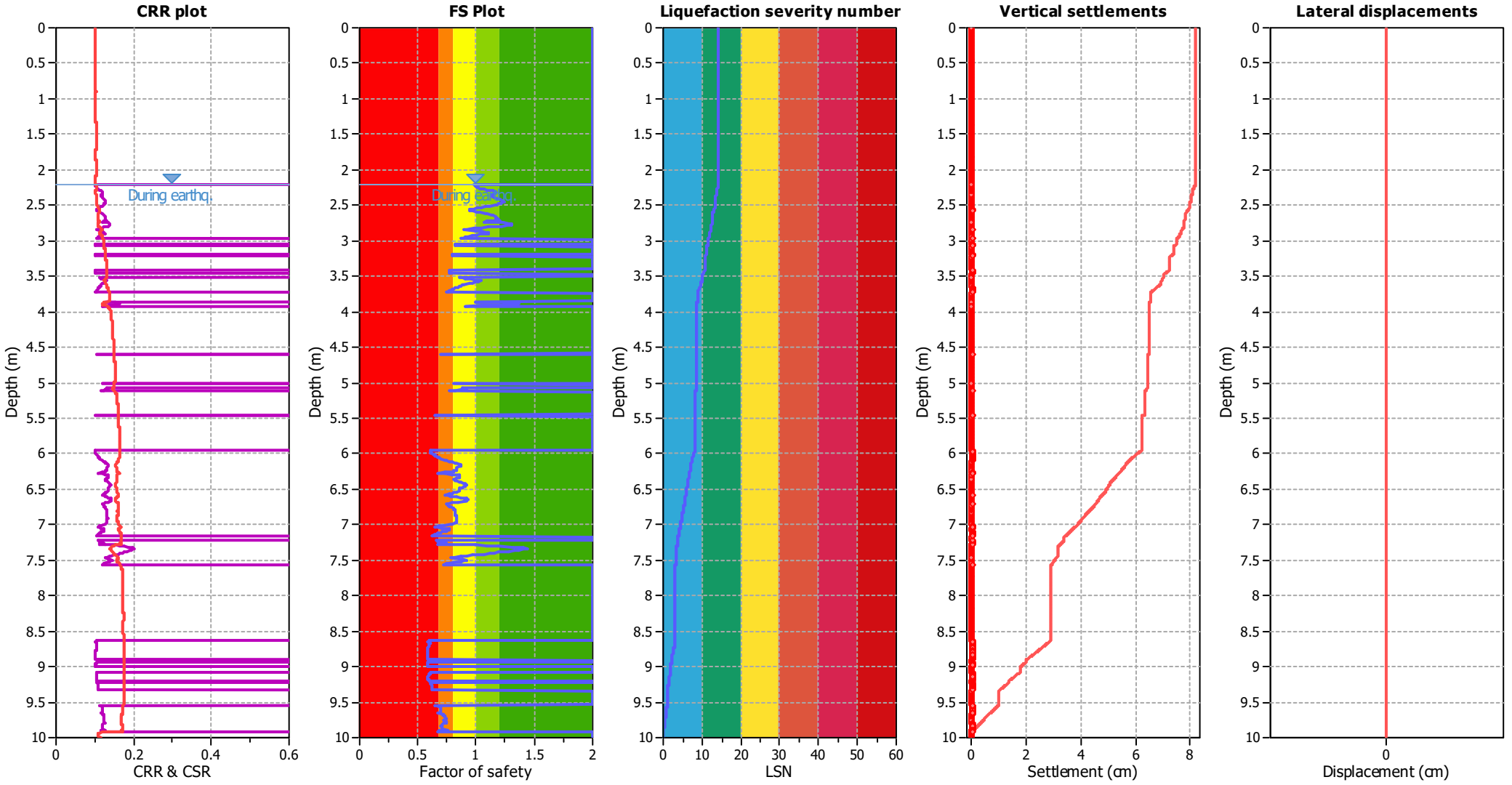
F.S. color scheme

- 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.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 m	Fill height:	N/A	Limit depth:	10.00 m

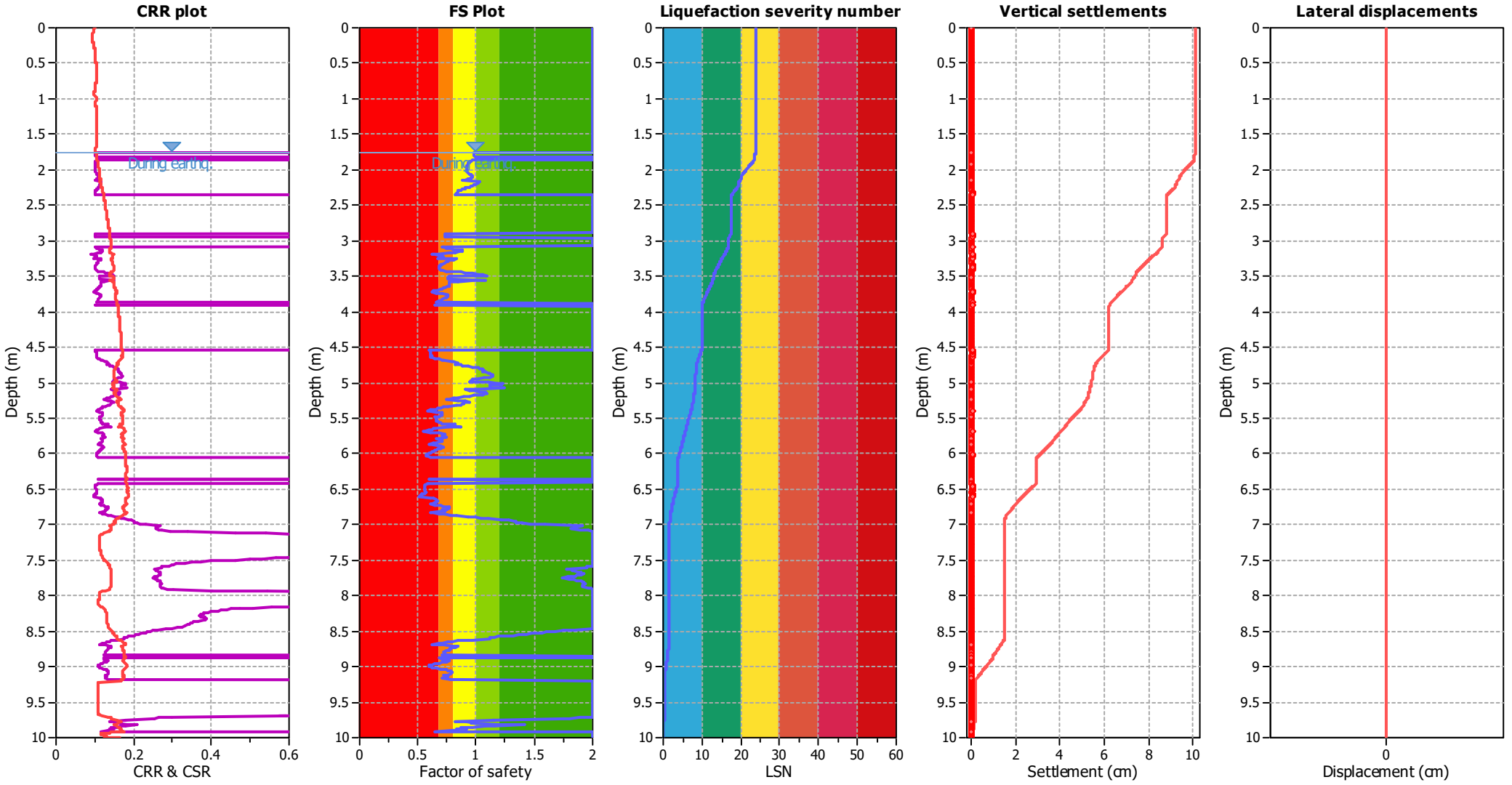
F.S. color scheme

- 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.):	1.75 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.75 m	Fill height:	N/A	Limit depth:	10.00 m

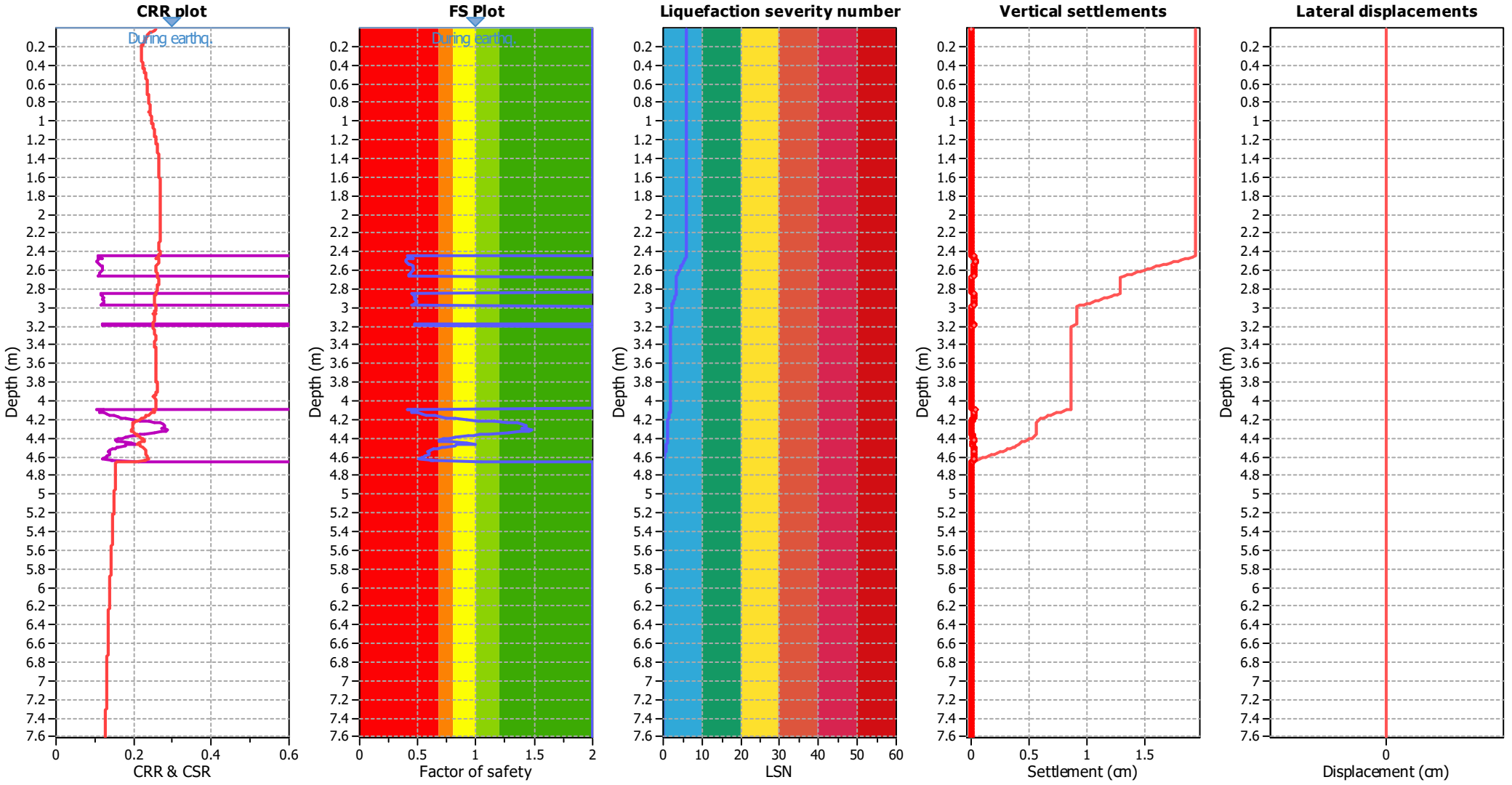
F.S. color scheme

- 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.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

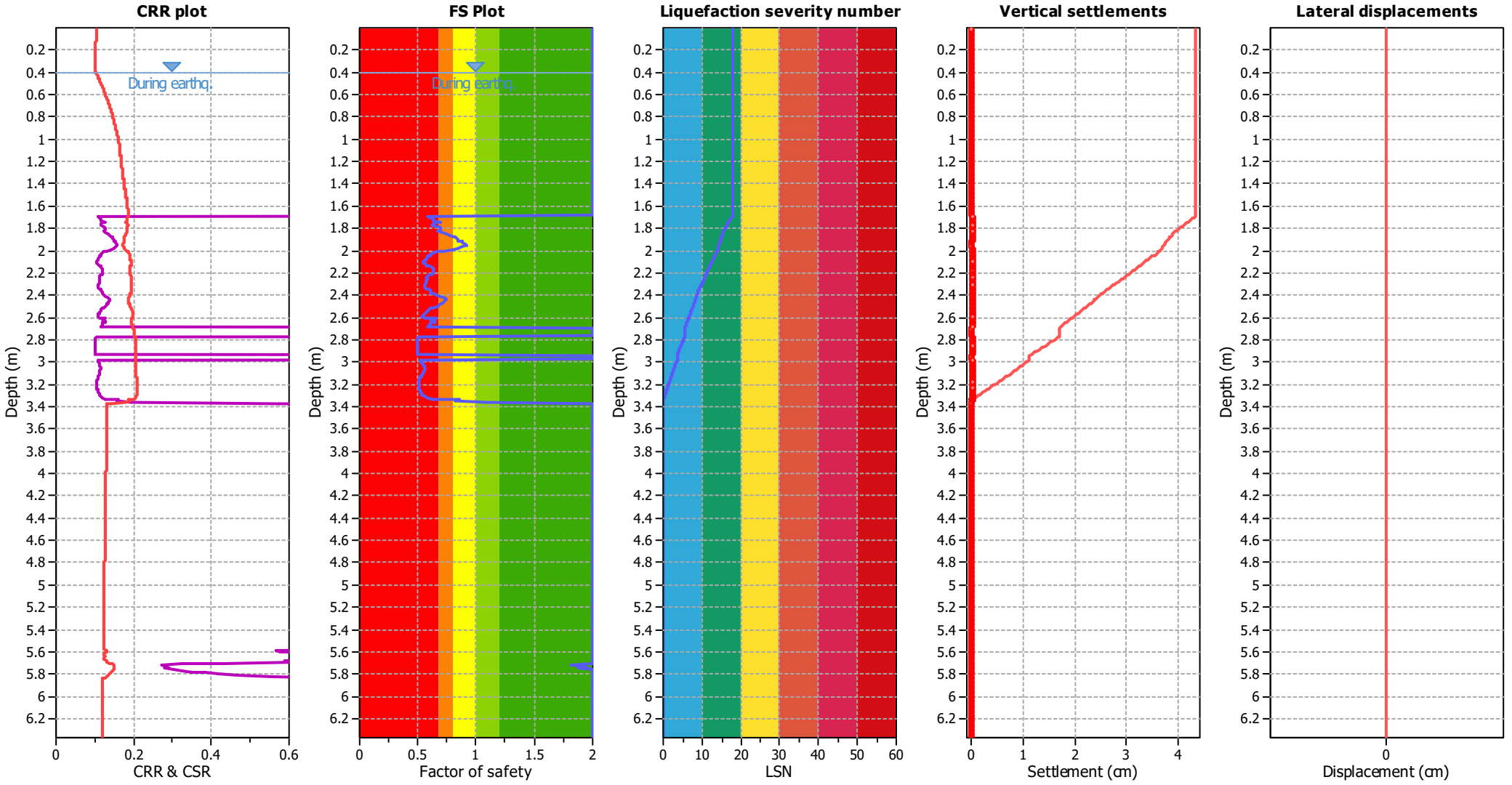
F.S. color scheme

- 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.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	10.00 m

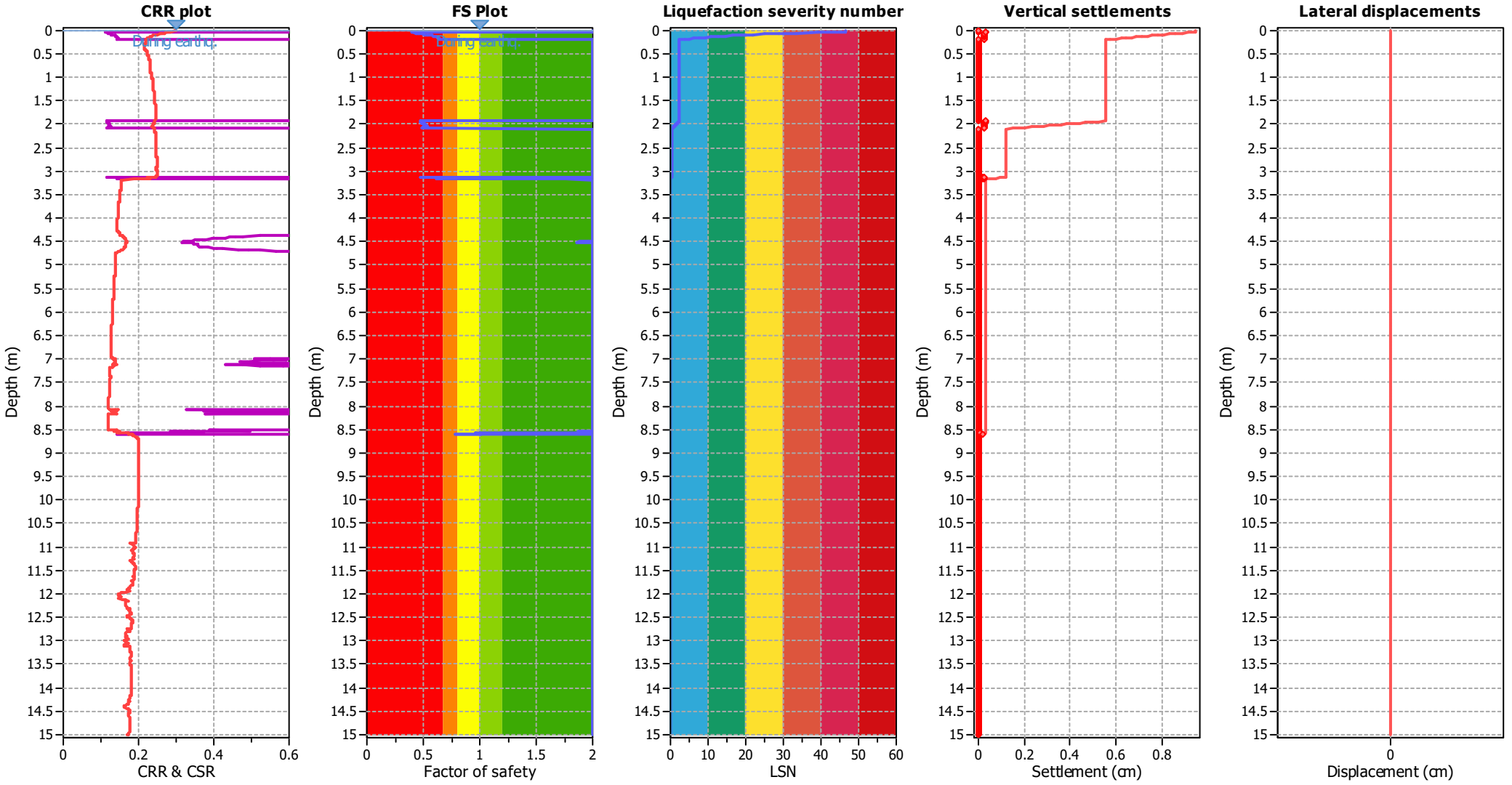
F.S. color scheme

- 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.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

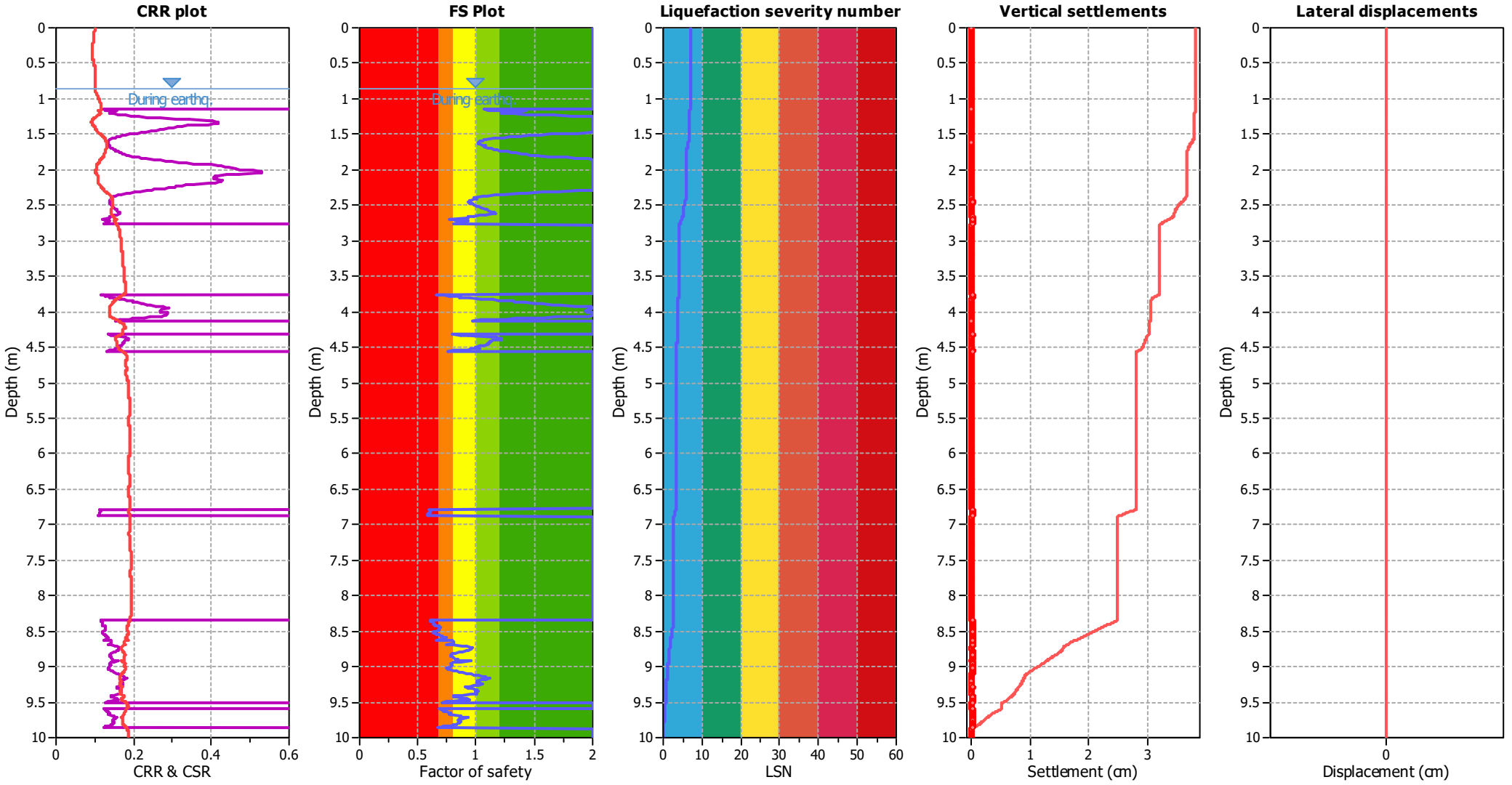
F.S. color scheme

- 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.):	0.85 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.85 m	Fill height:	N/A	Limit depth:	10.00 m

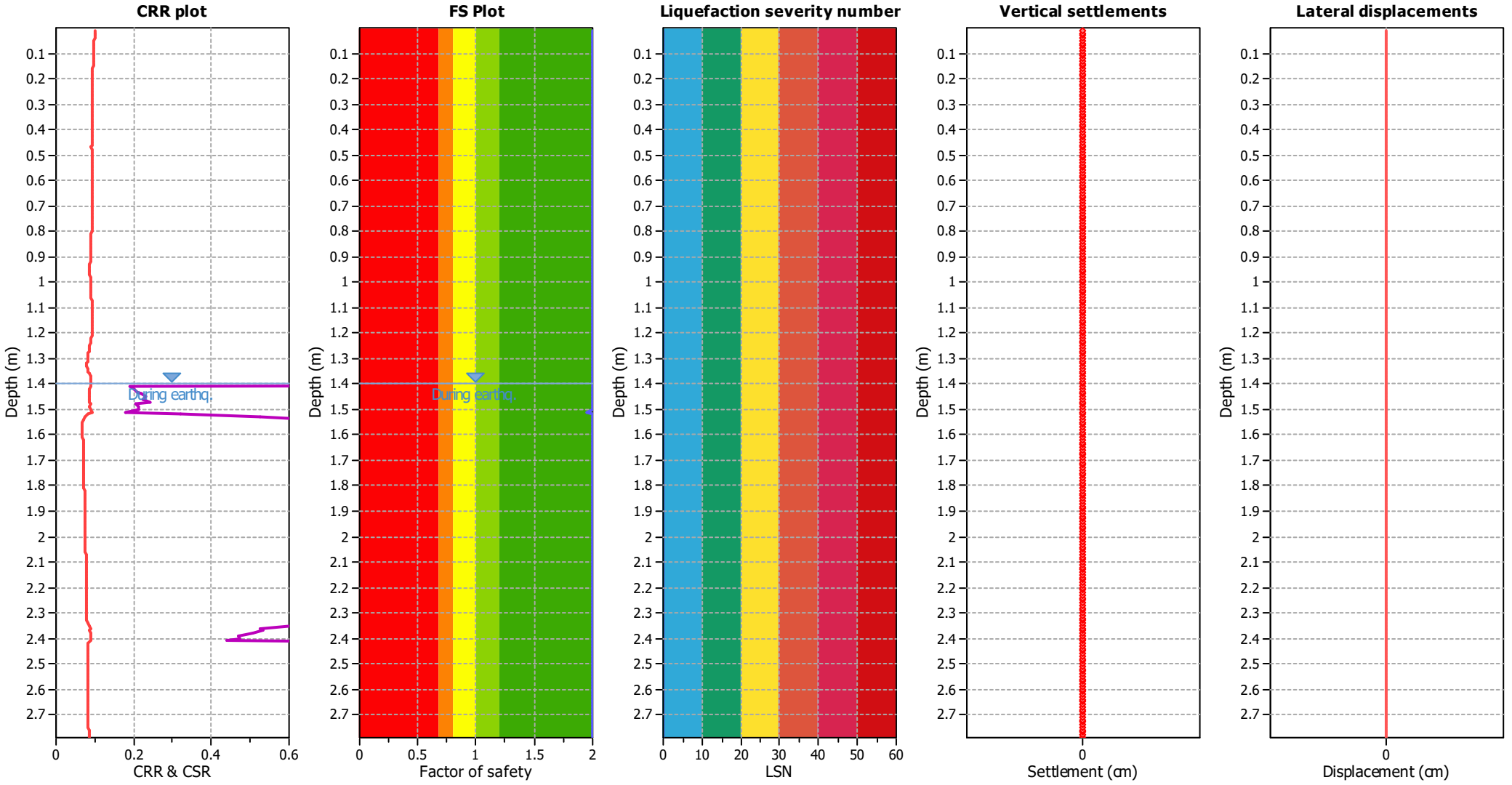
F.S. color scheme

- 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.):	1.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.40 m	Fill height:	N/A	Limit depth:	10.00 m

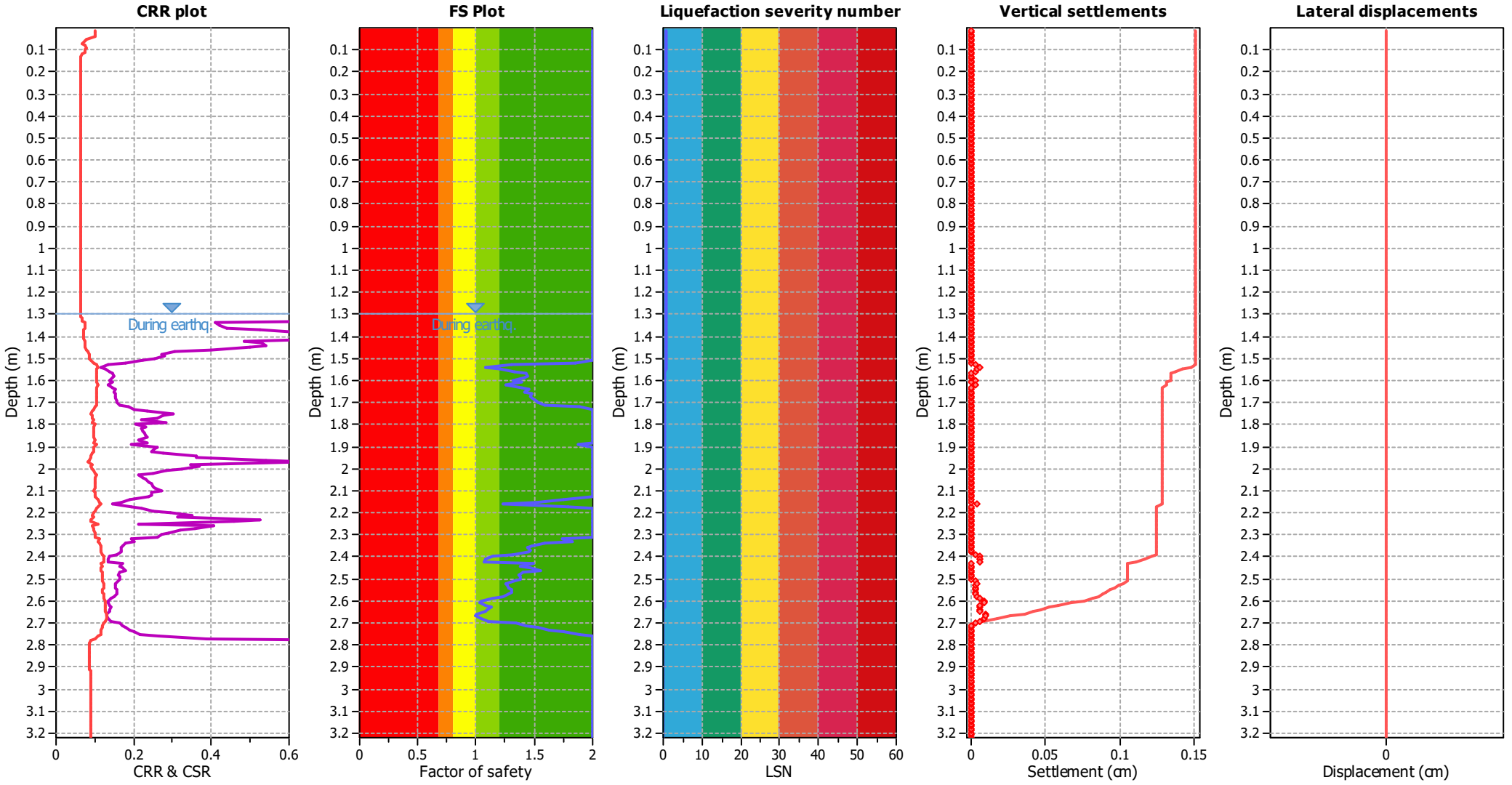
F.S. color scheme

- 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.):	1.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.30 m	Fill height:	N/A	Limit depth:	10.00 m

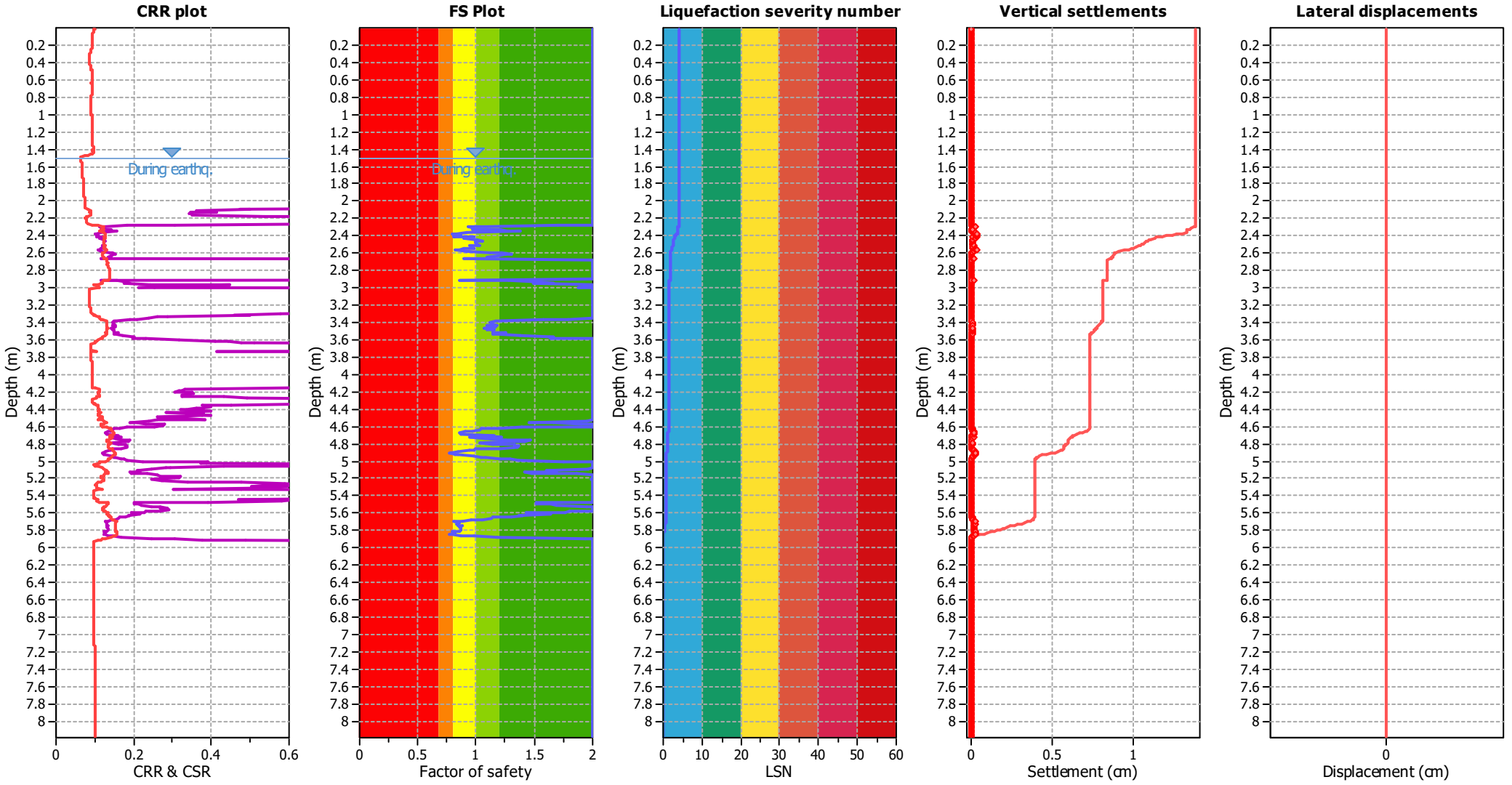
F.S. color scheme

- 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.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

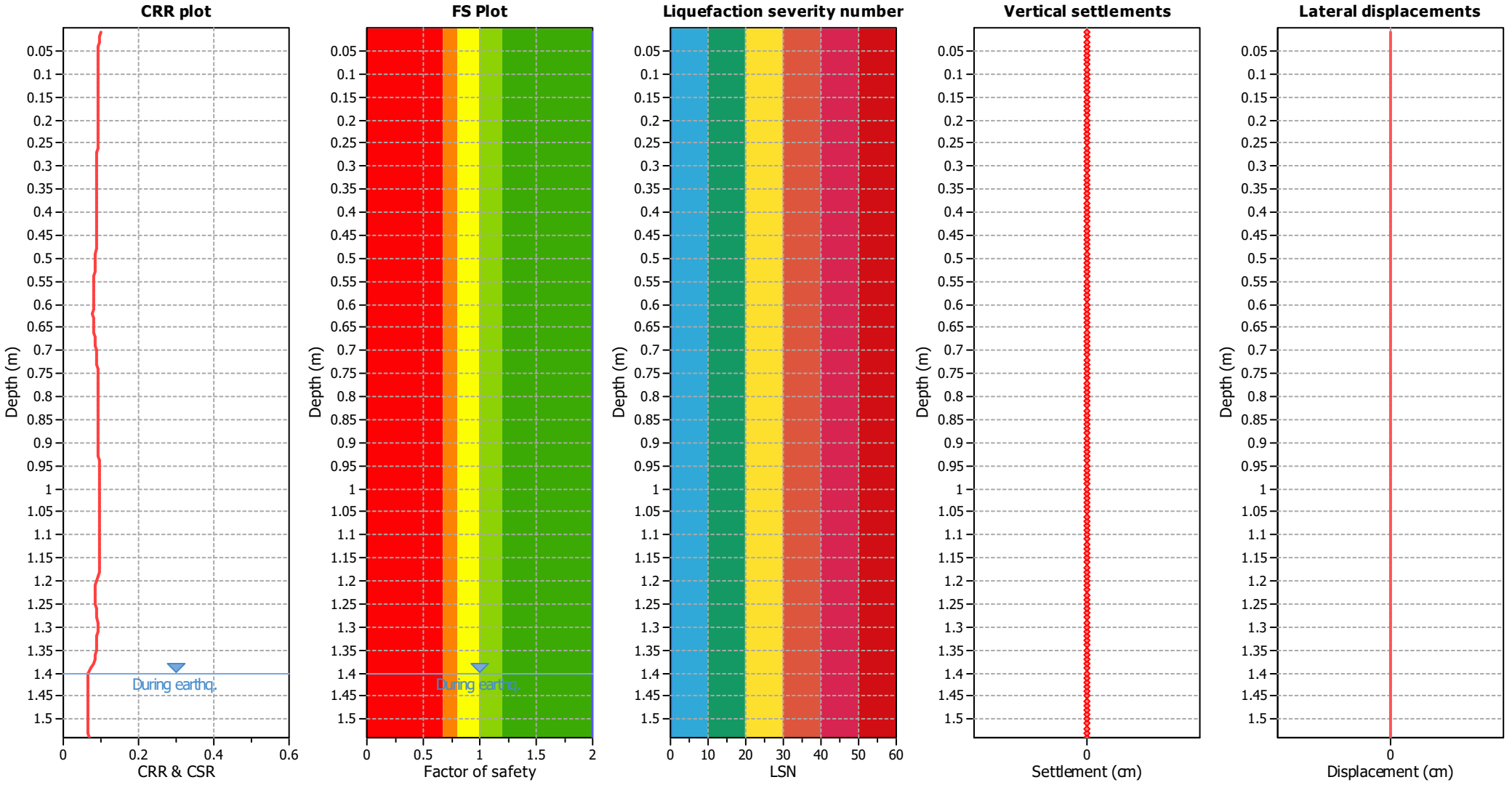
F.S. color scheme

- 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.):	1.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.40 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
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- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
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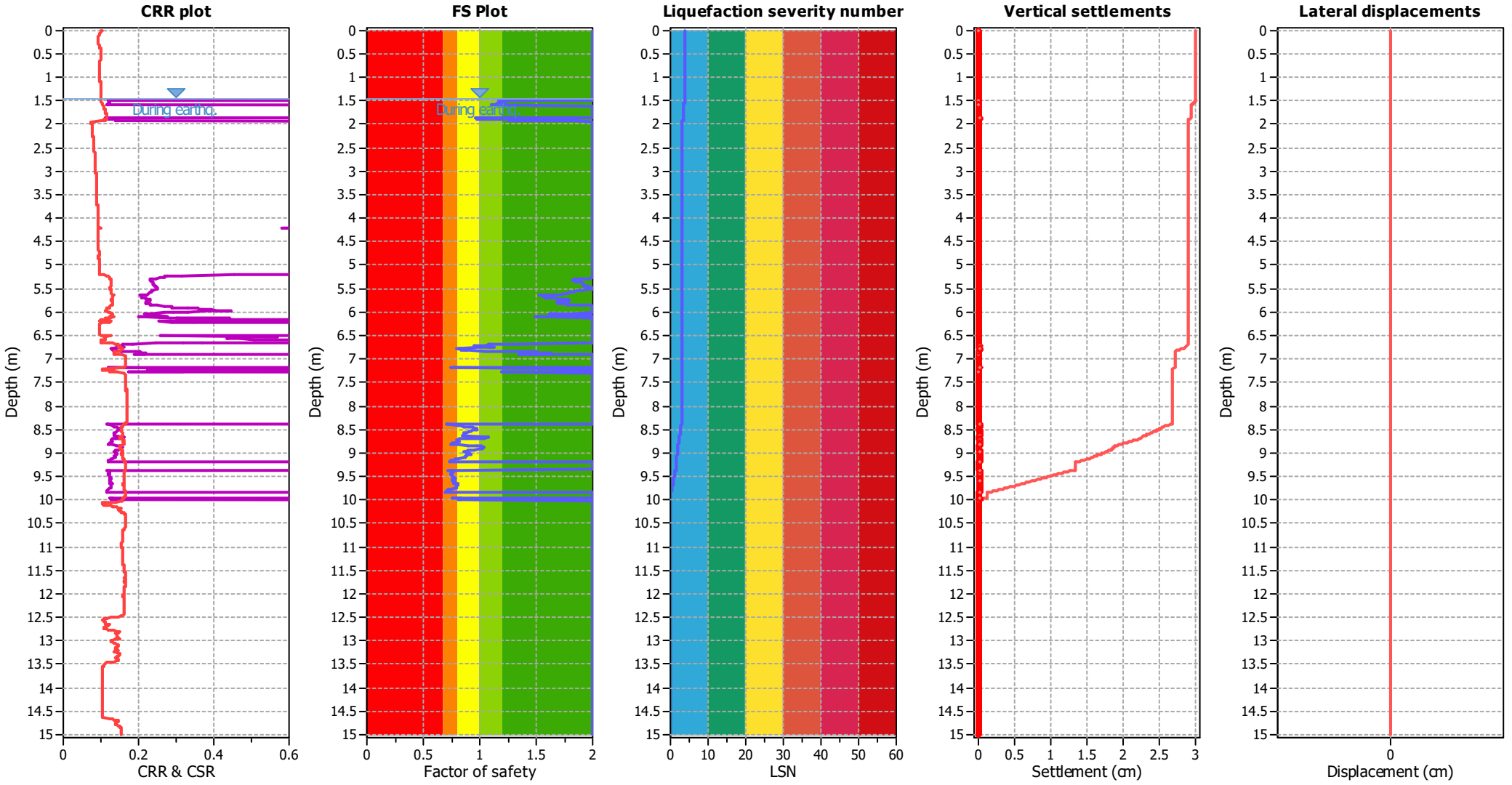
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.45 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.45 m	Fill height:	N/A	Limit depth:	10.00 m

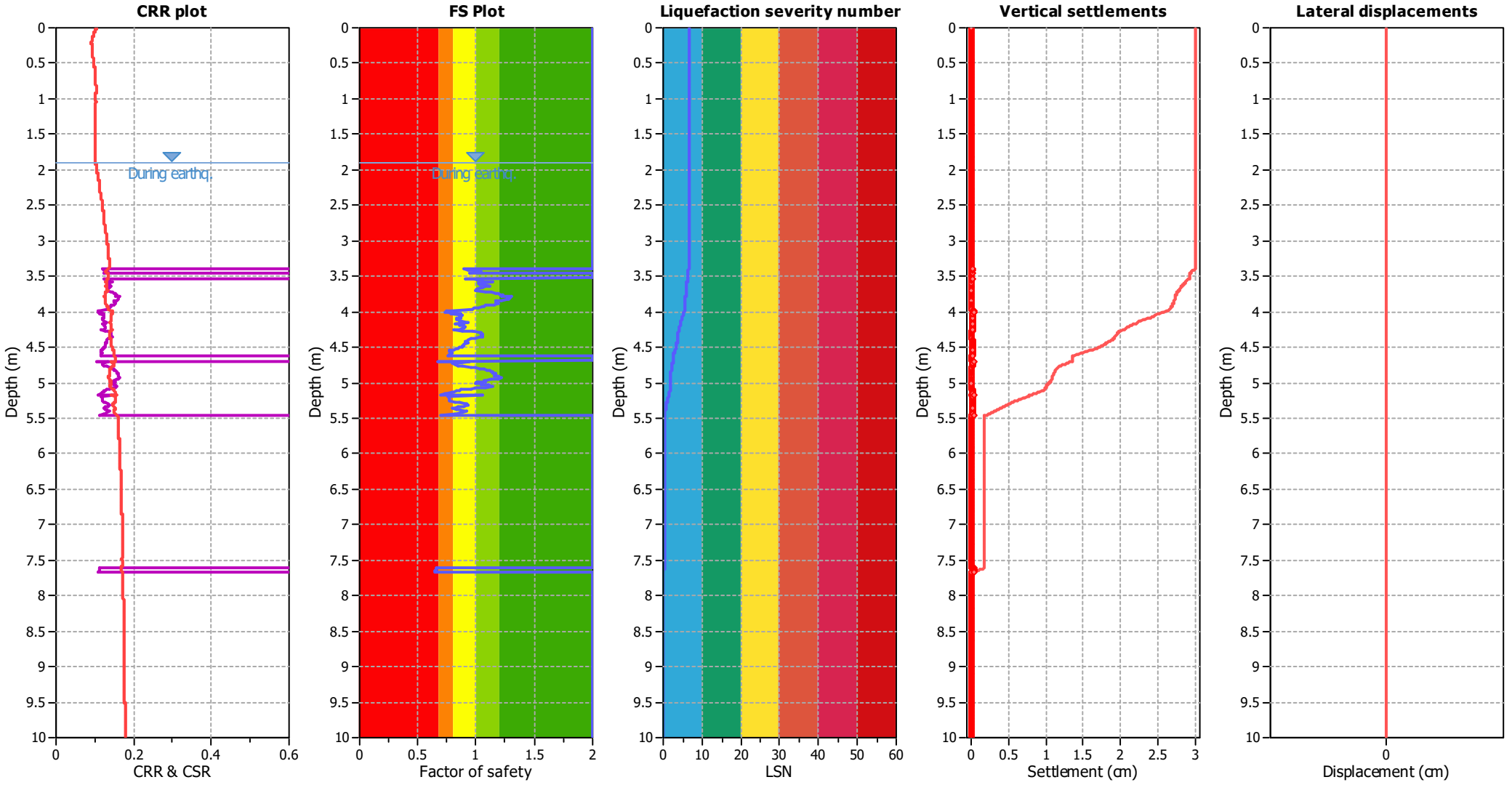
F.S. color scheme

- 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.):	1.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.90 m	Fill height:	N/A	Limit depth:	10.00 m

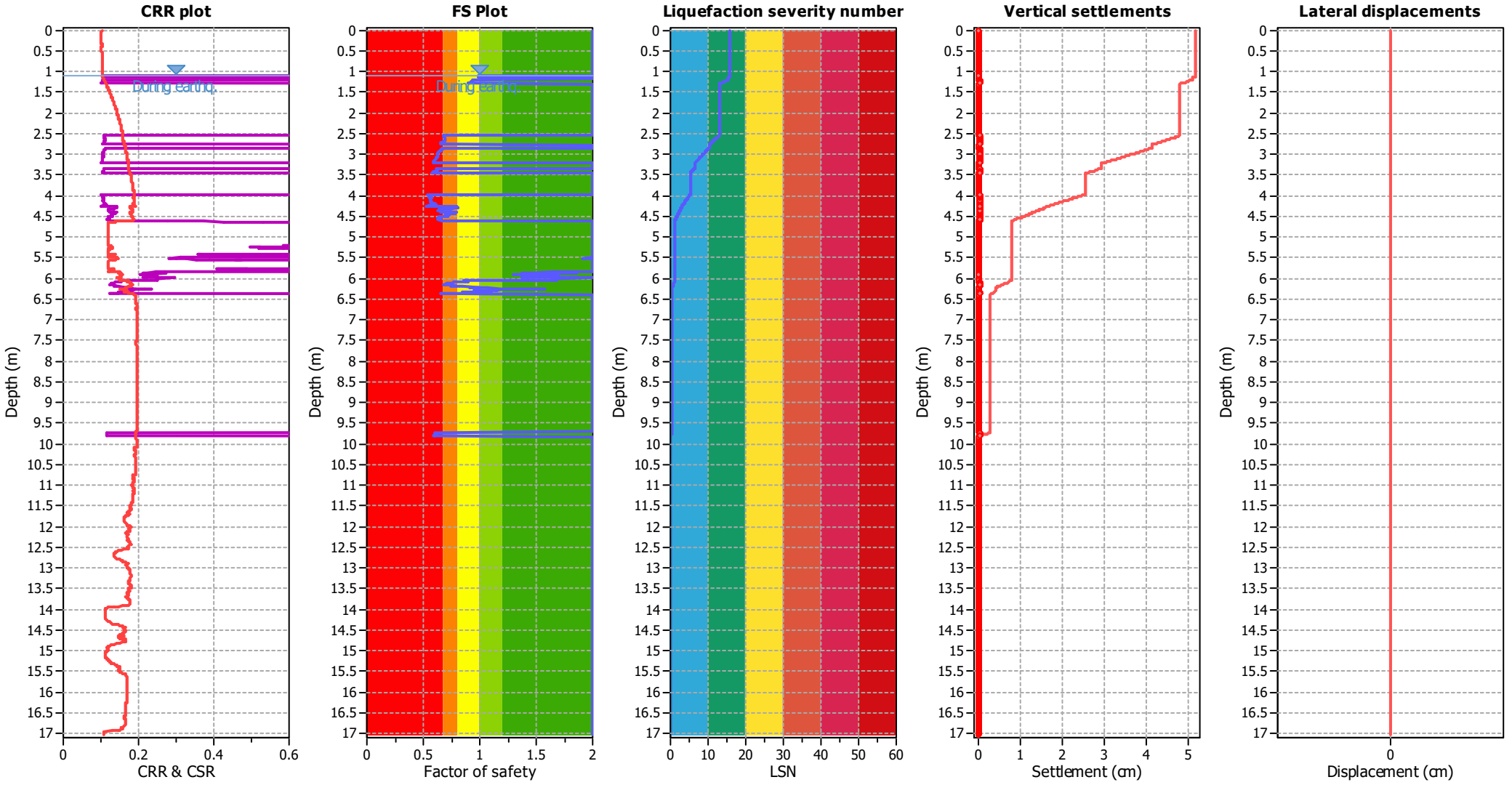
F.S. color scheme

- 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.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 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
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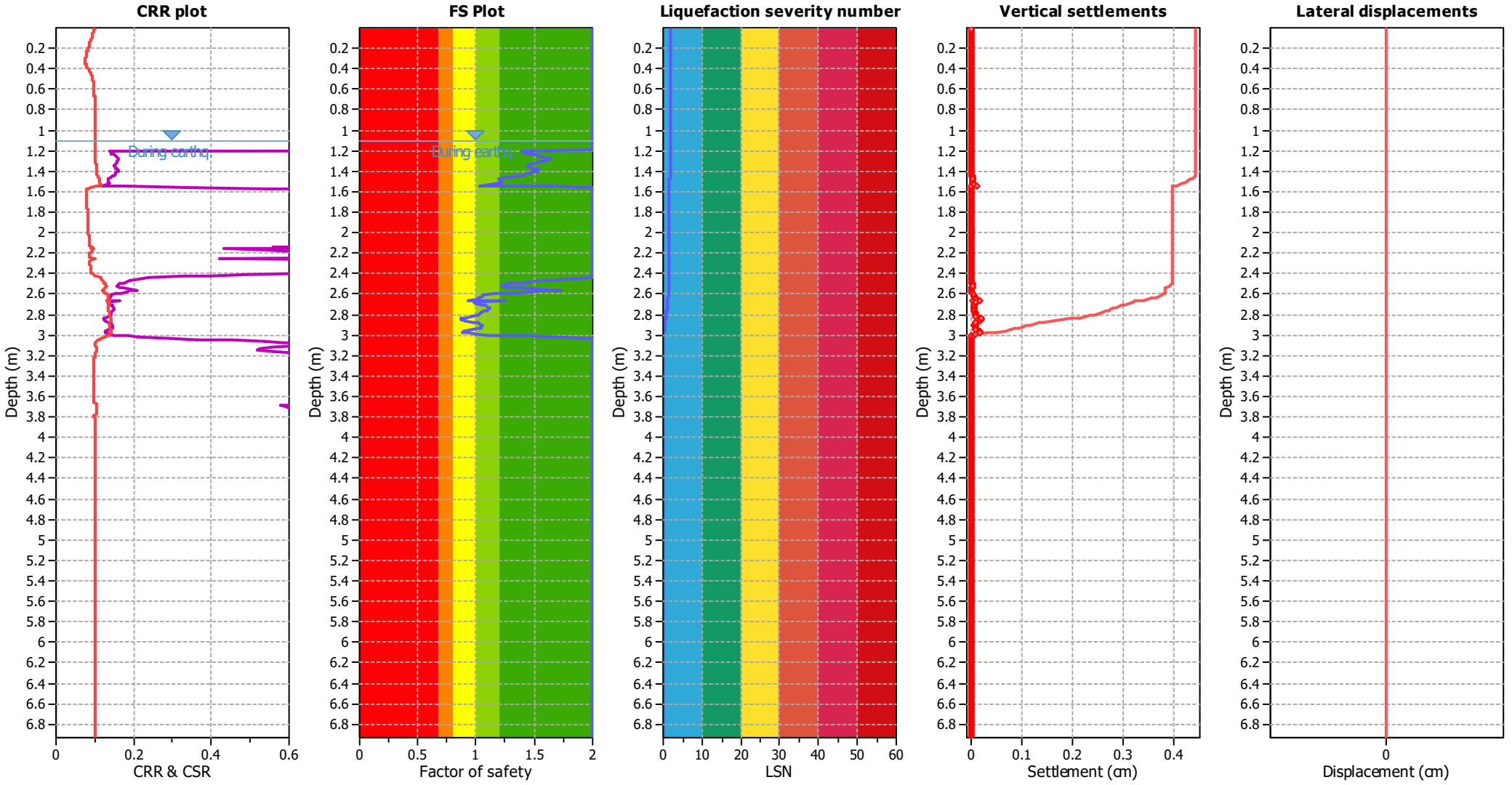
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

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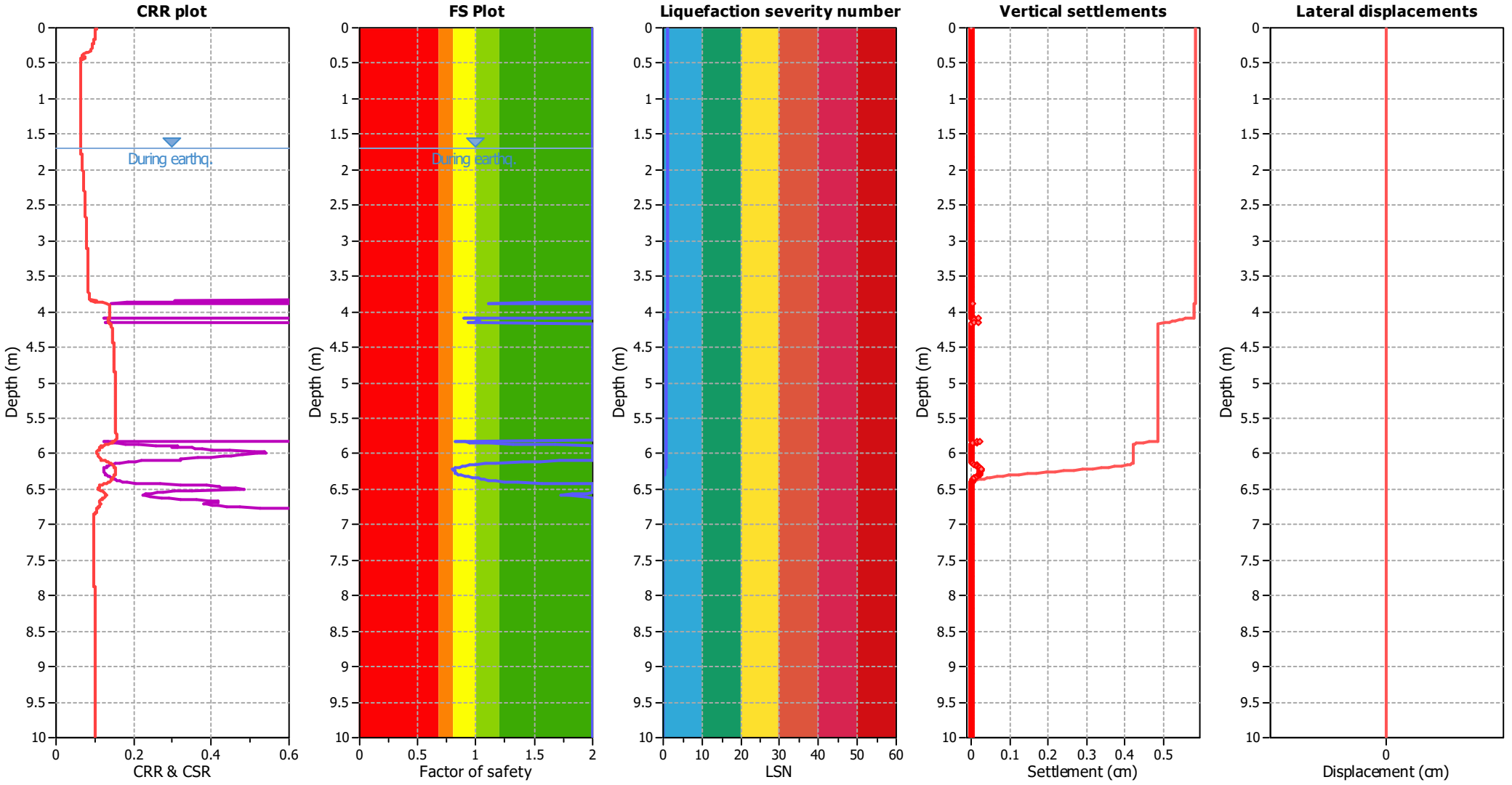
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
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LSN color scheme

- Severe damage
- Major expression of liquefaction
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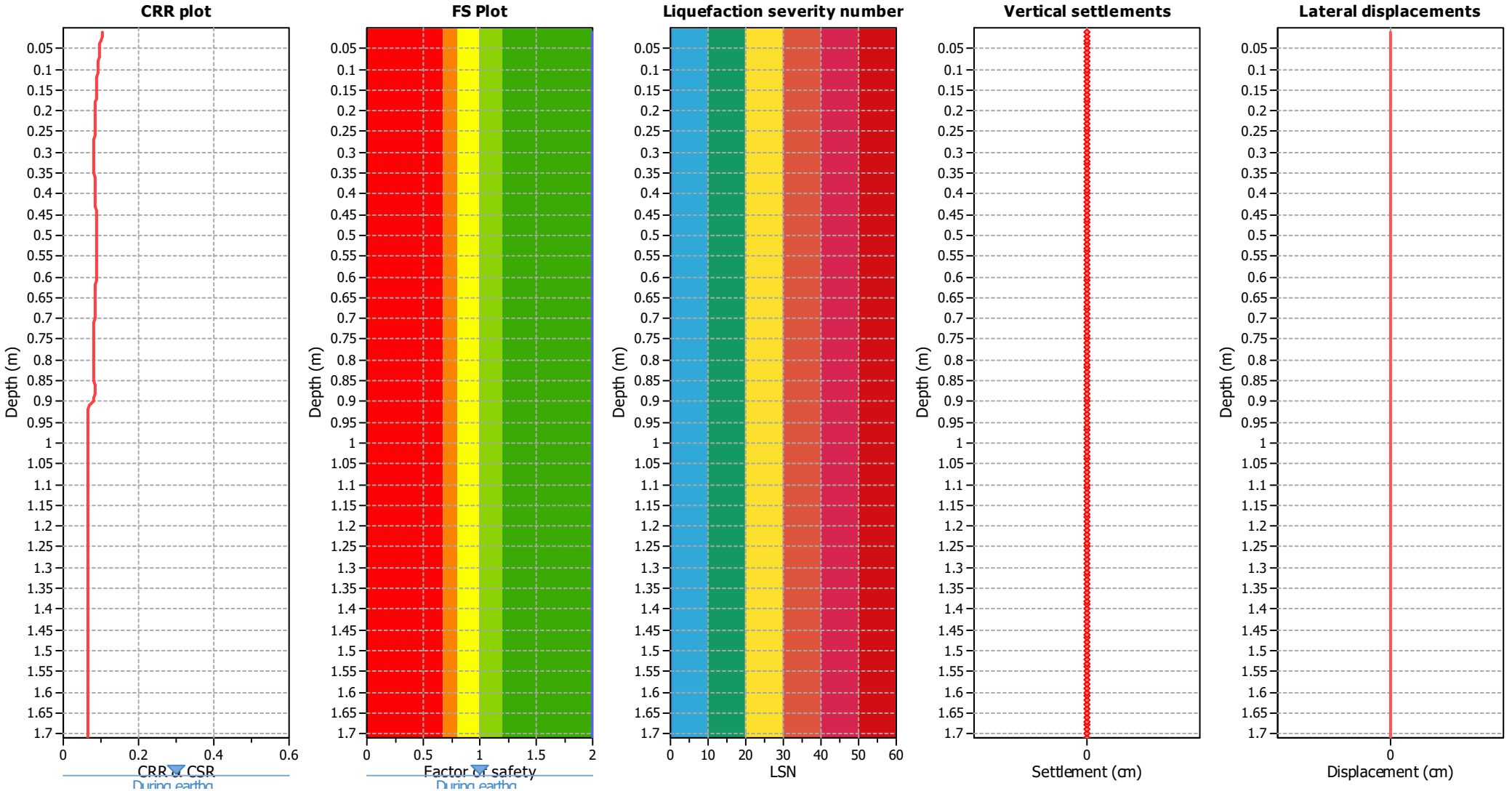
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.80 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.80 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
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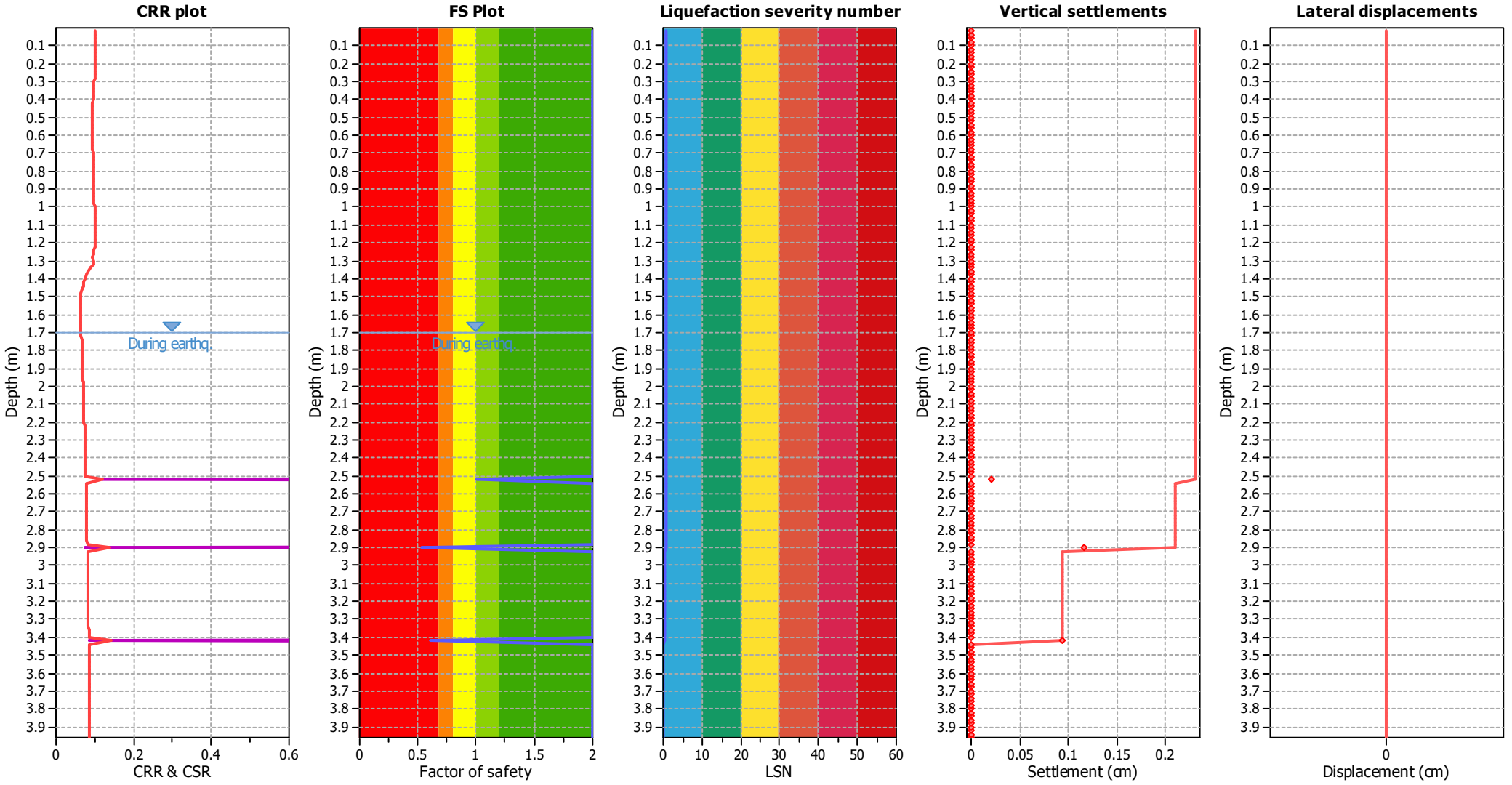
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LSN color scheme

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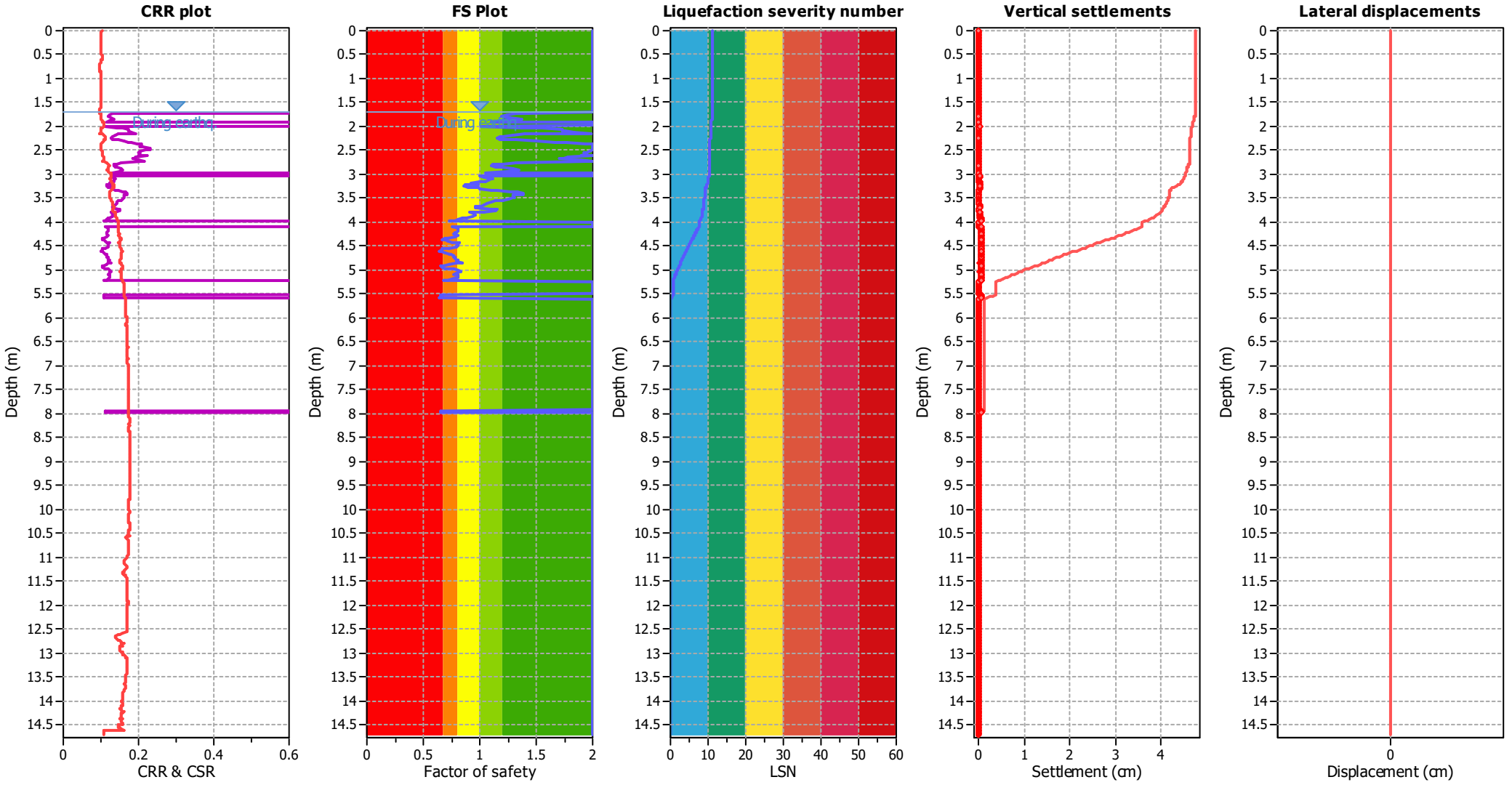
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LSN color scheme

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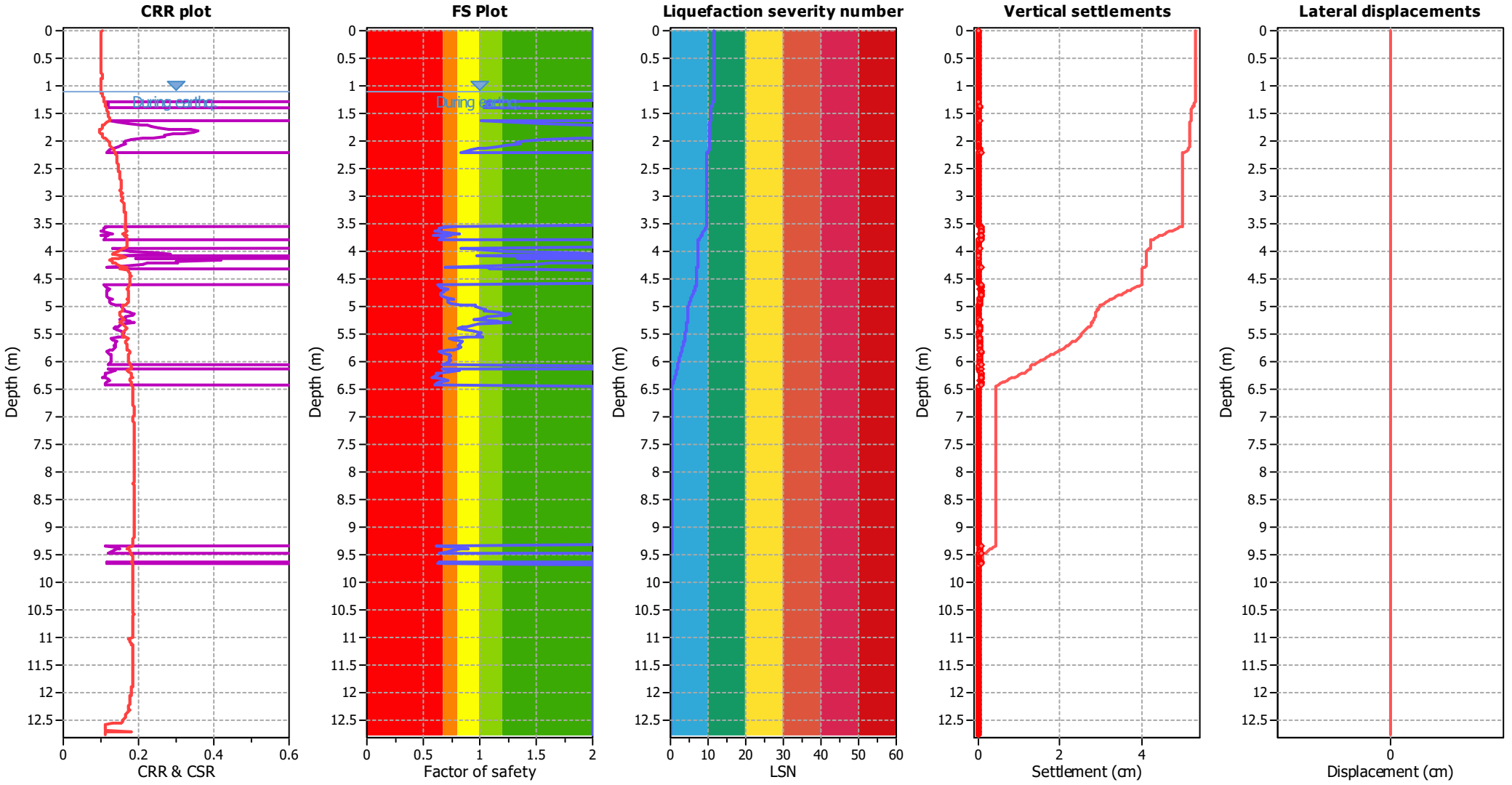
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

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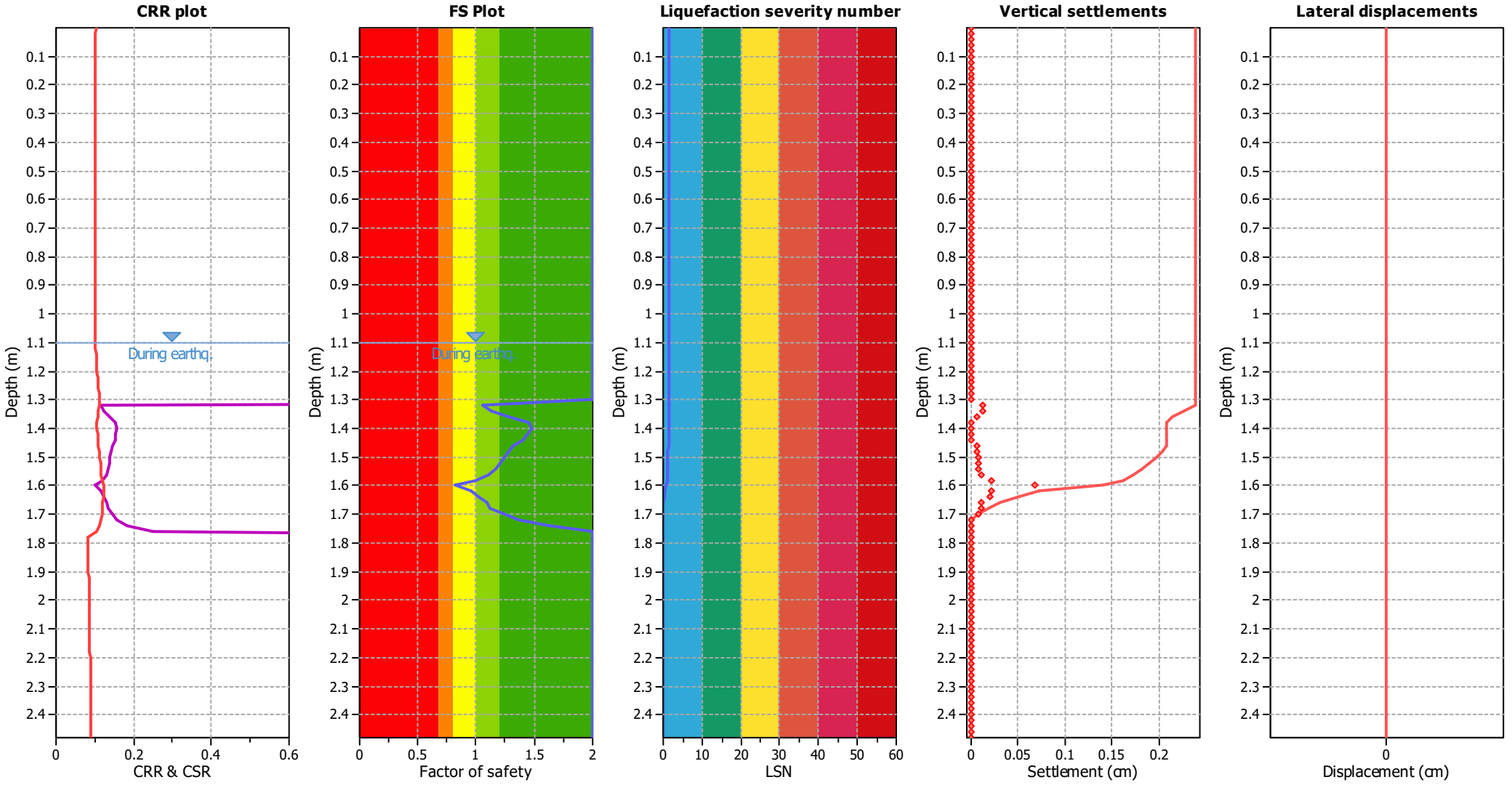
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

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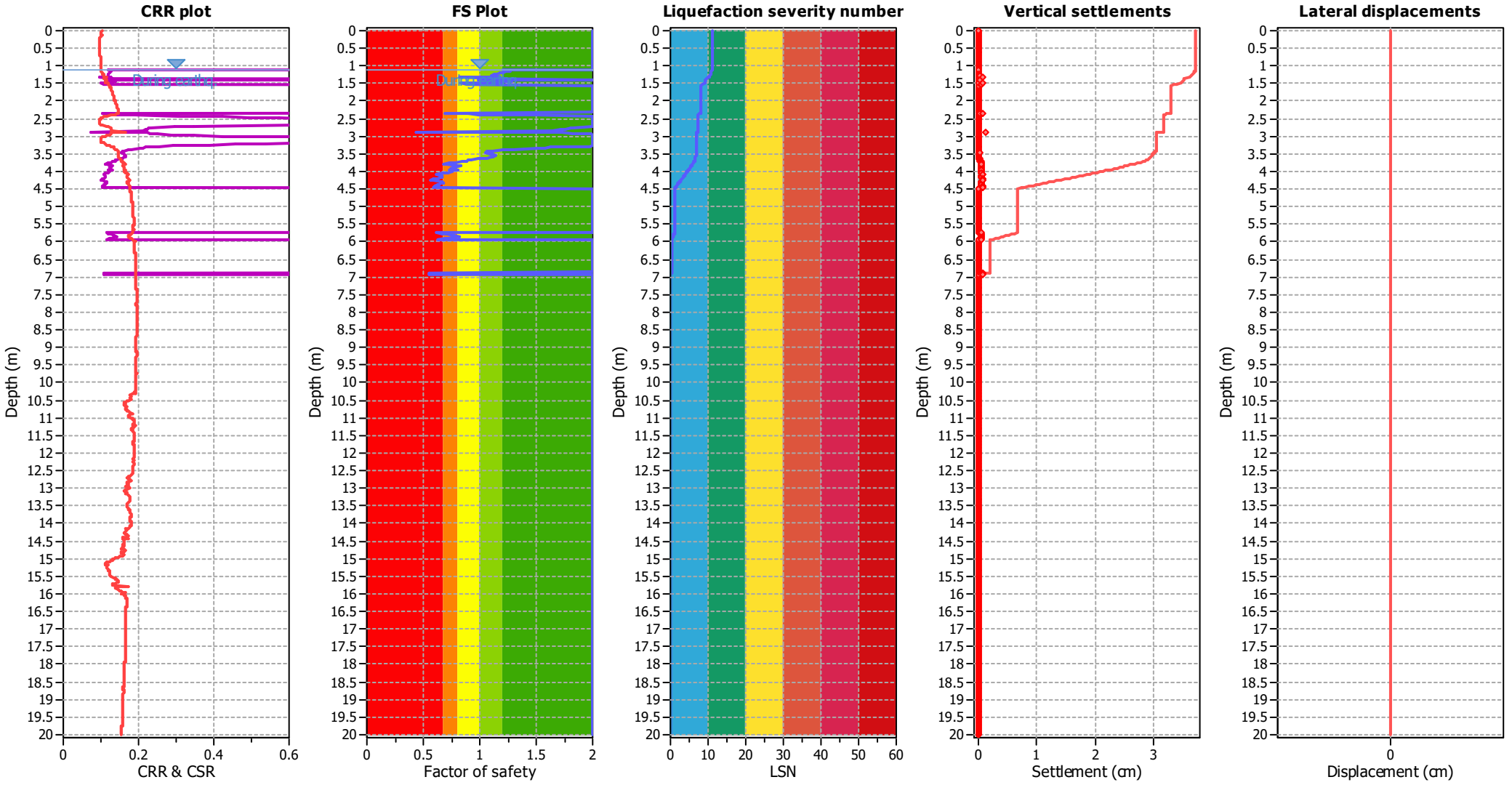
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

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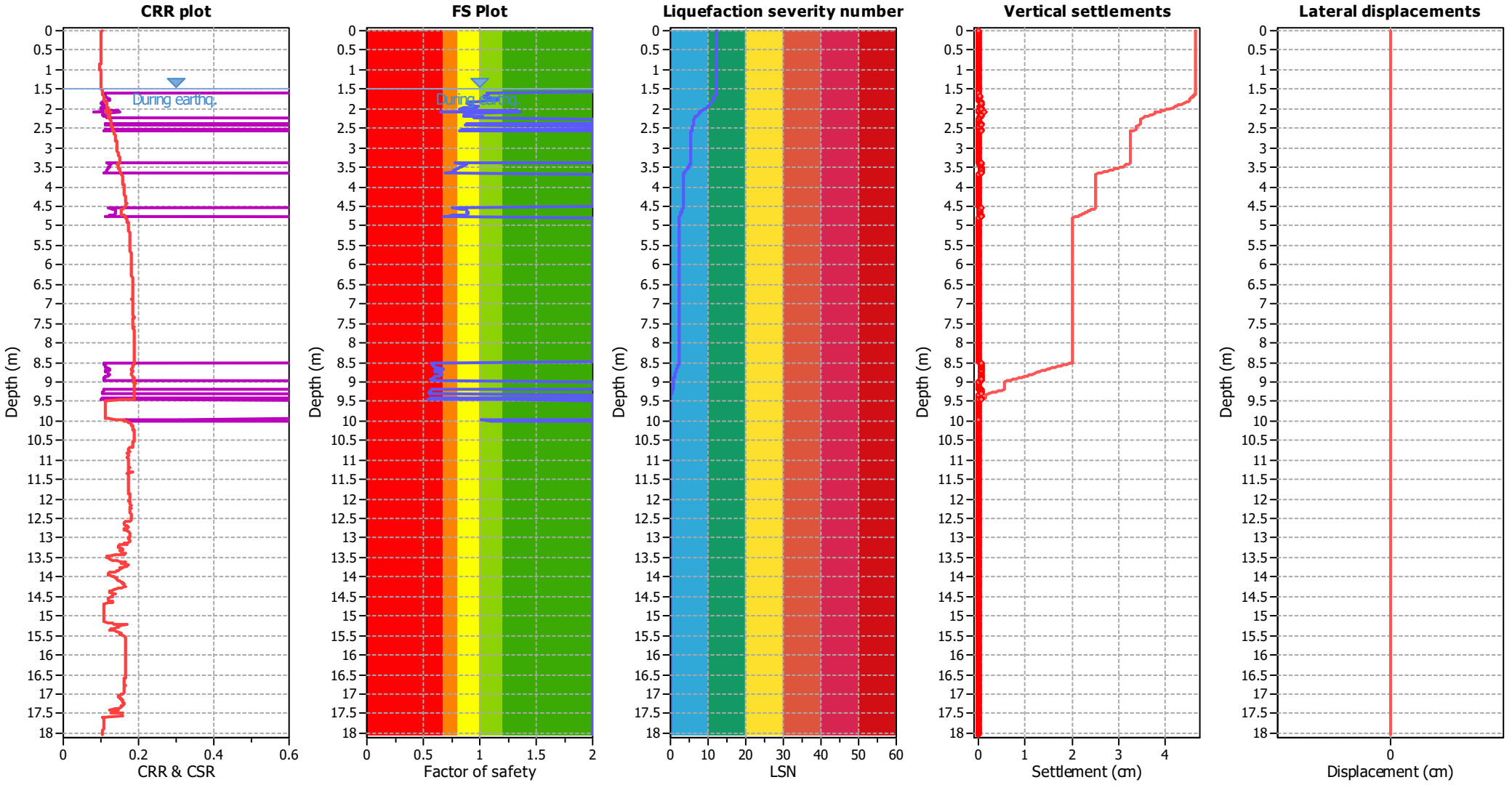
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 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
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LSN color scheme

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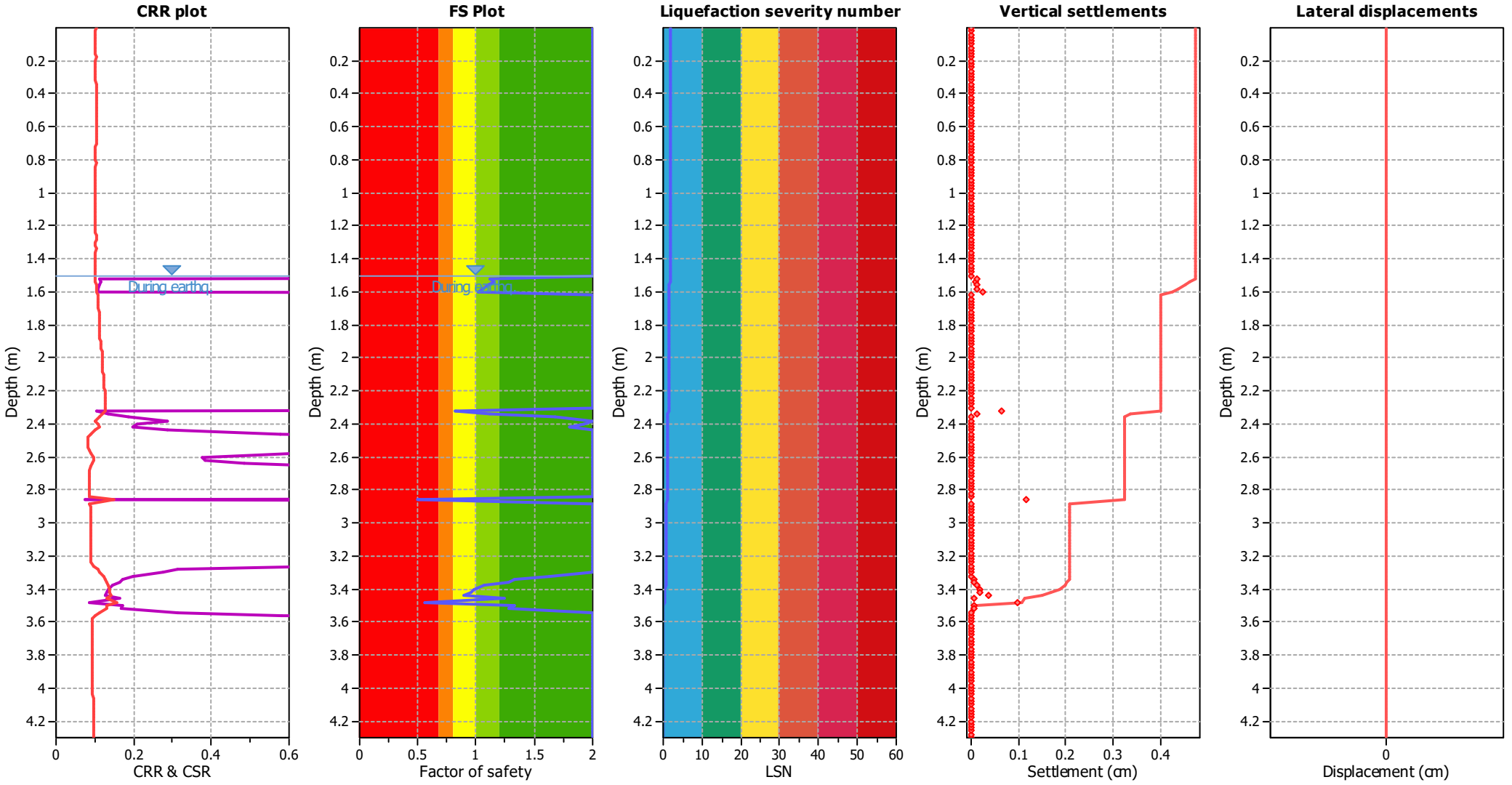
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

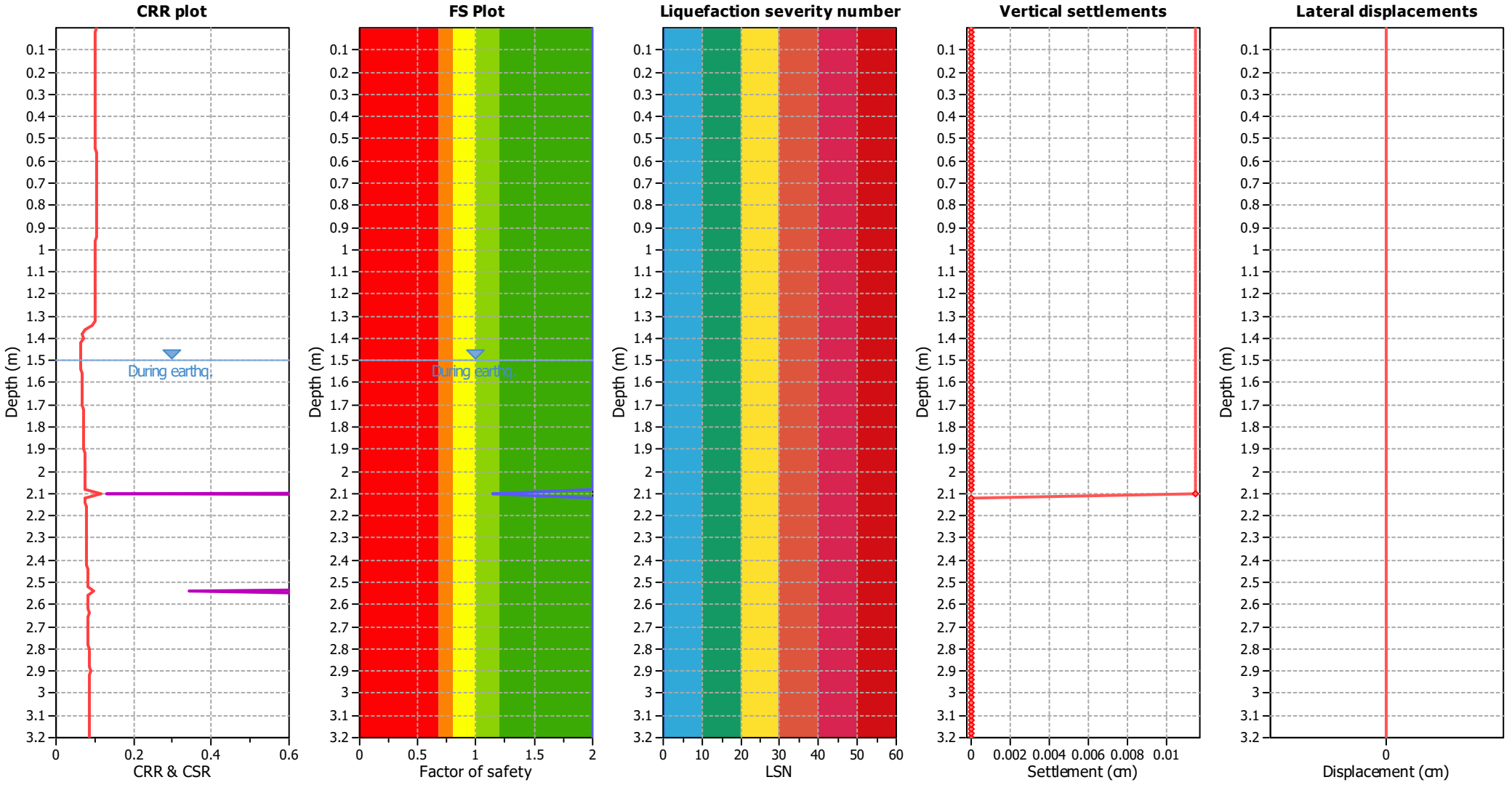
F.S. color scheme

- 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.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

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LSN color scheme

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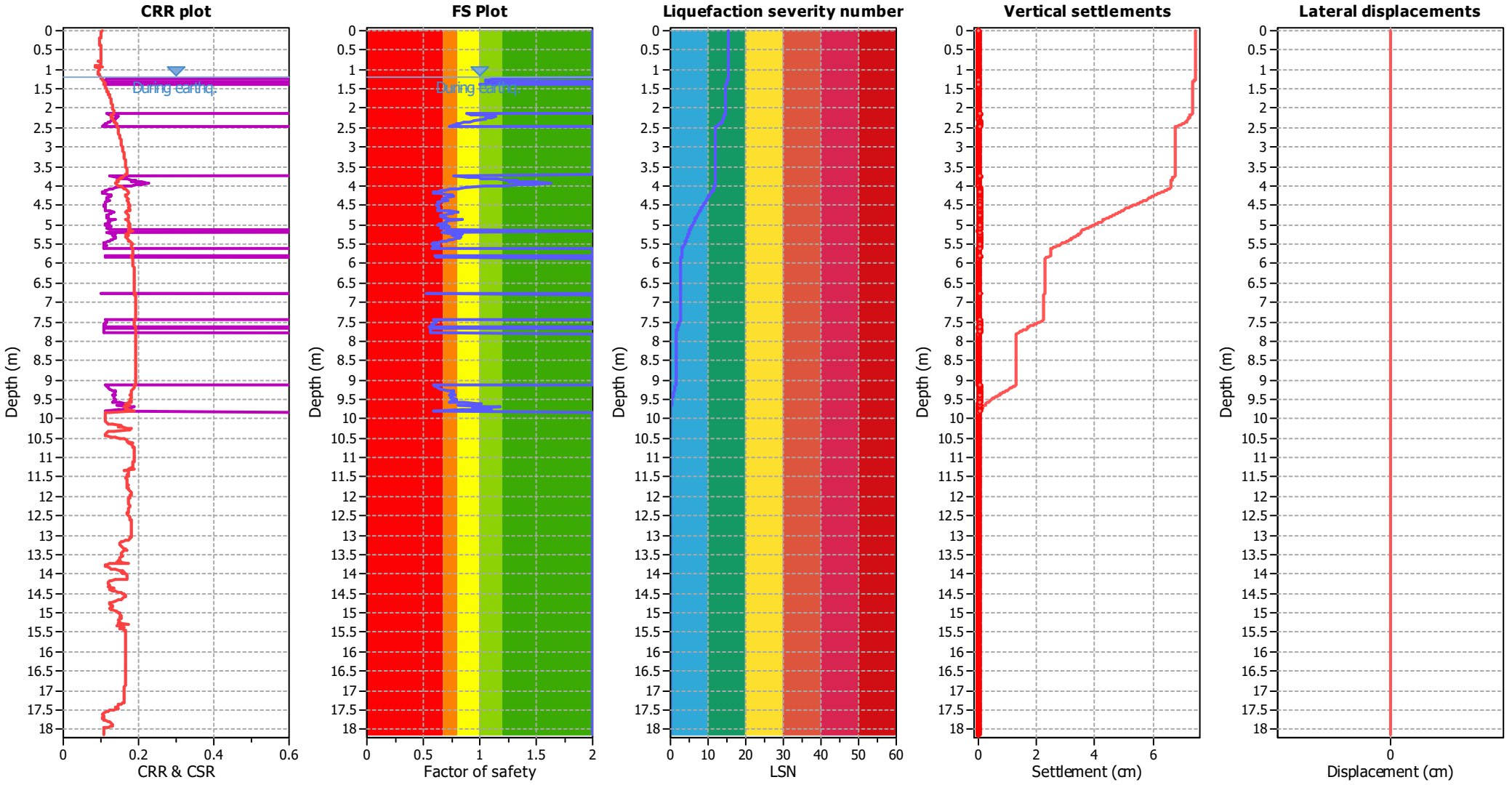
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 m	Fill height:	N/A	Limit depth:	10.00 m

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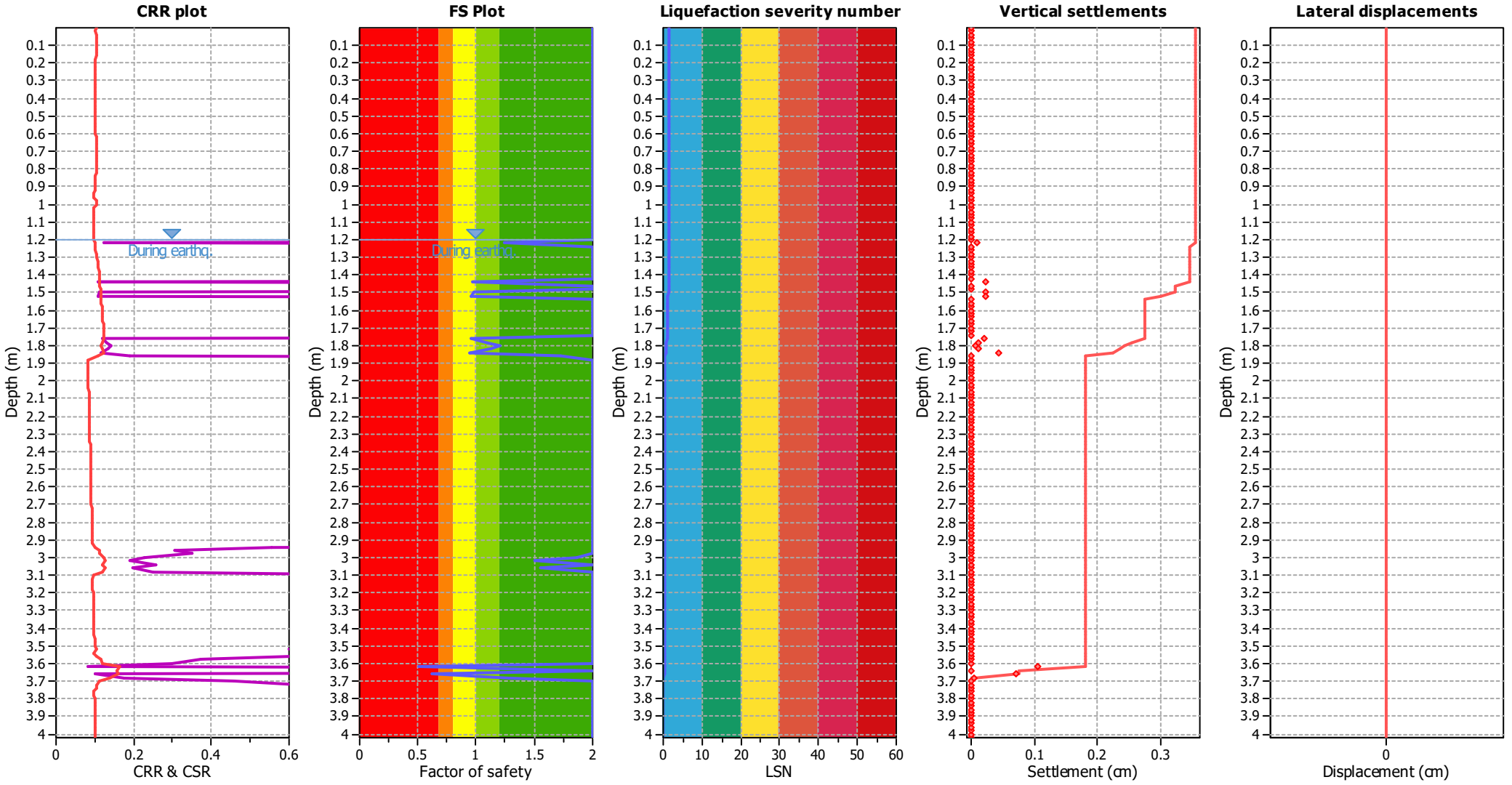
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
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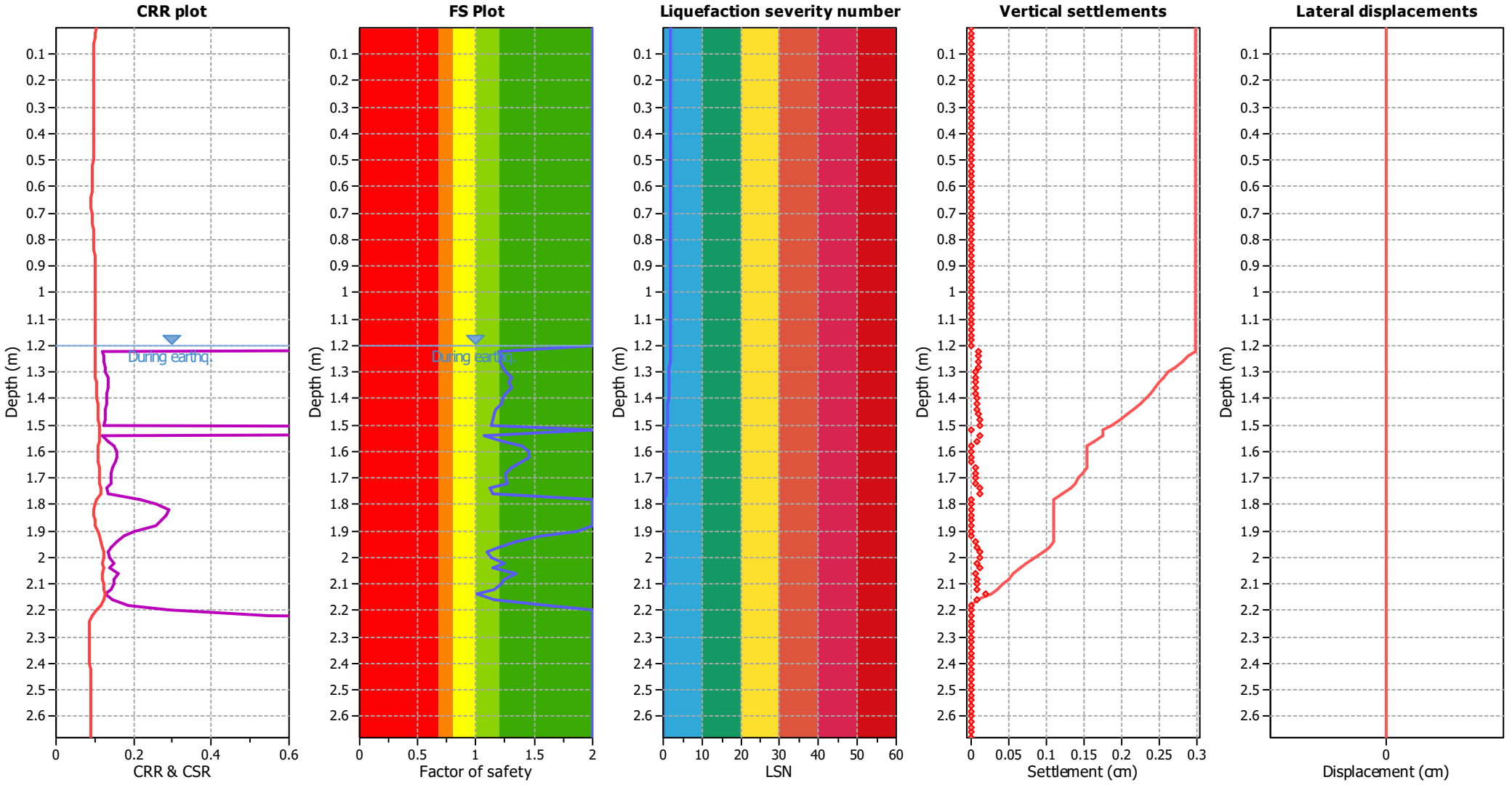
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 m	Fill height:	N/A	Limit depth:	10.00 m

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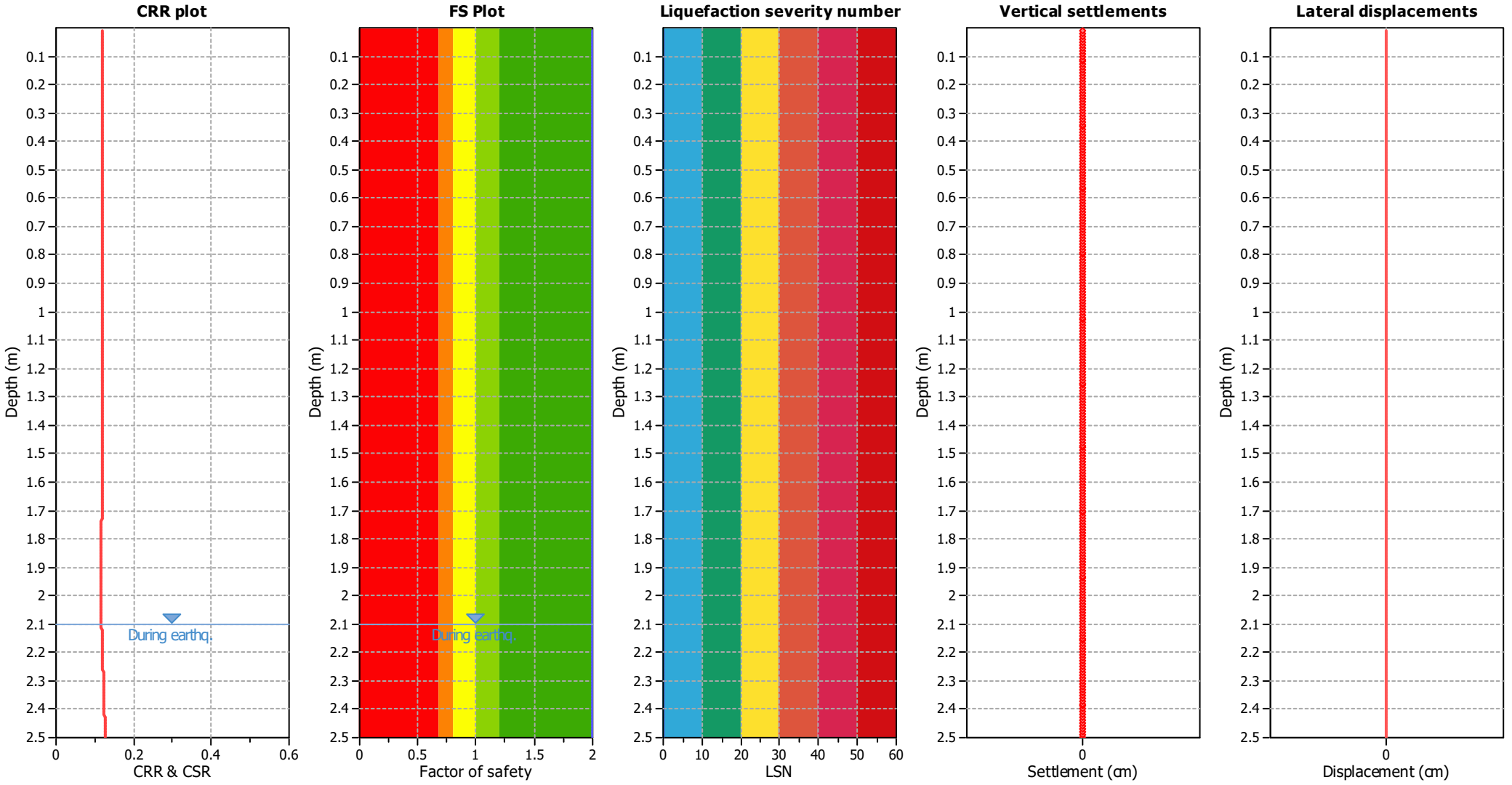
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.10 m	Fill height:	N/A	Limit depth:	10.00 m

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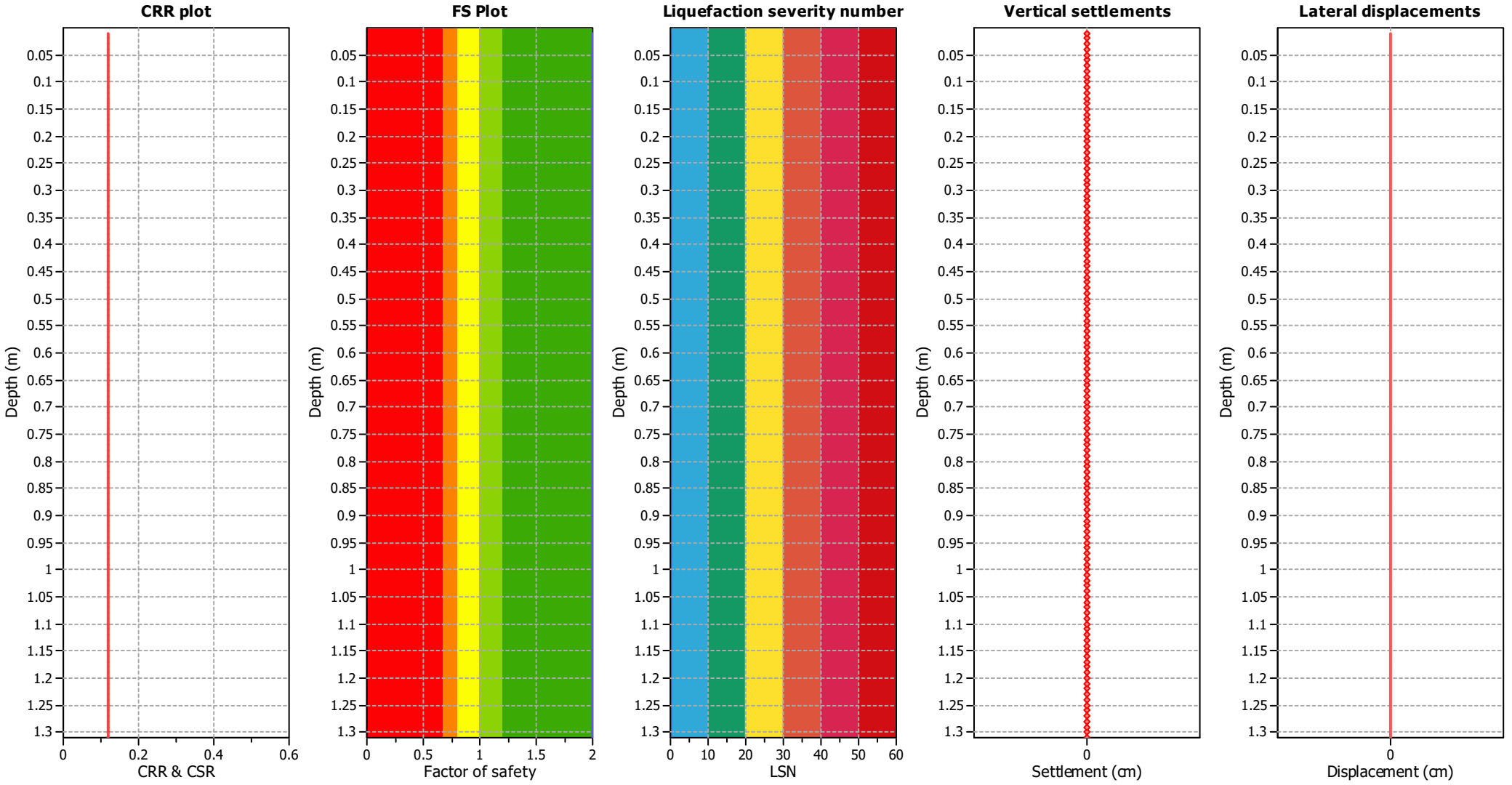
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.10 m	Fill height:	N/A	Limit depth:	10.00 m

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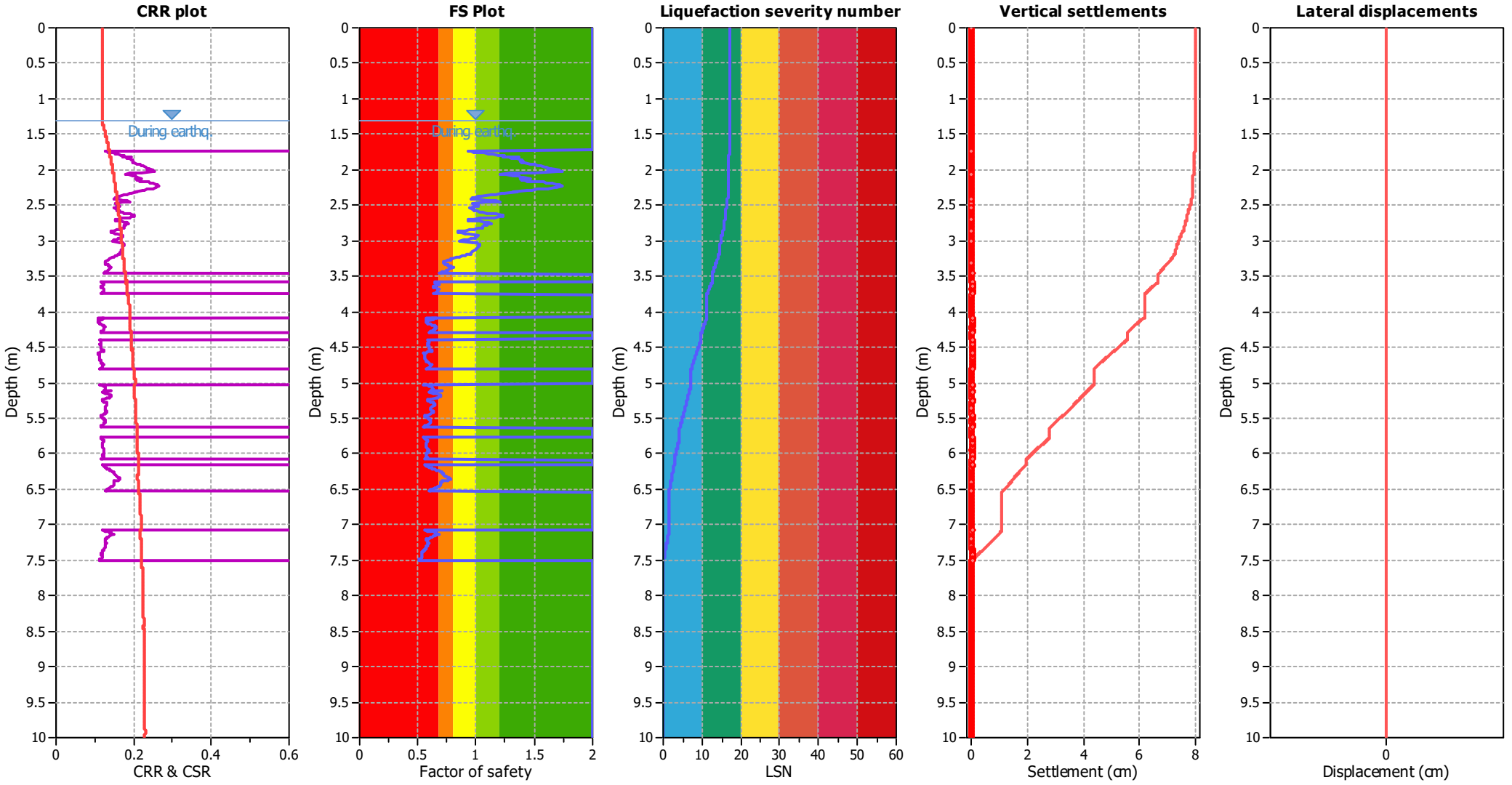
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.30 m	Fill height:	N/A	Limit depth:	10.00 m

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LSN color scheme

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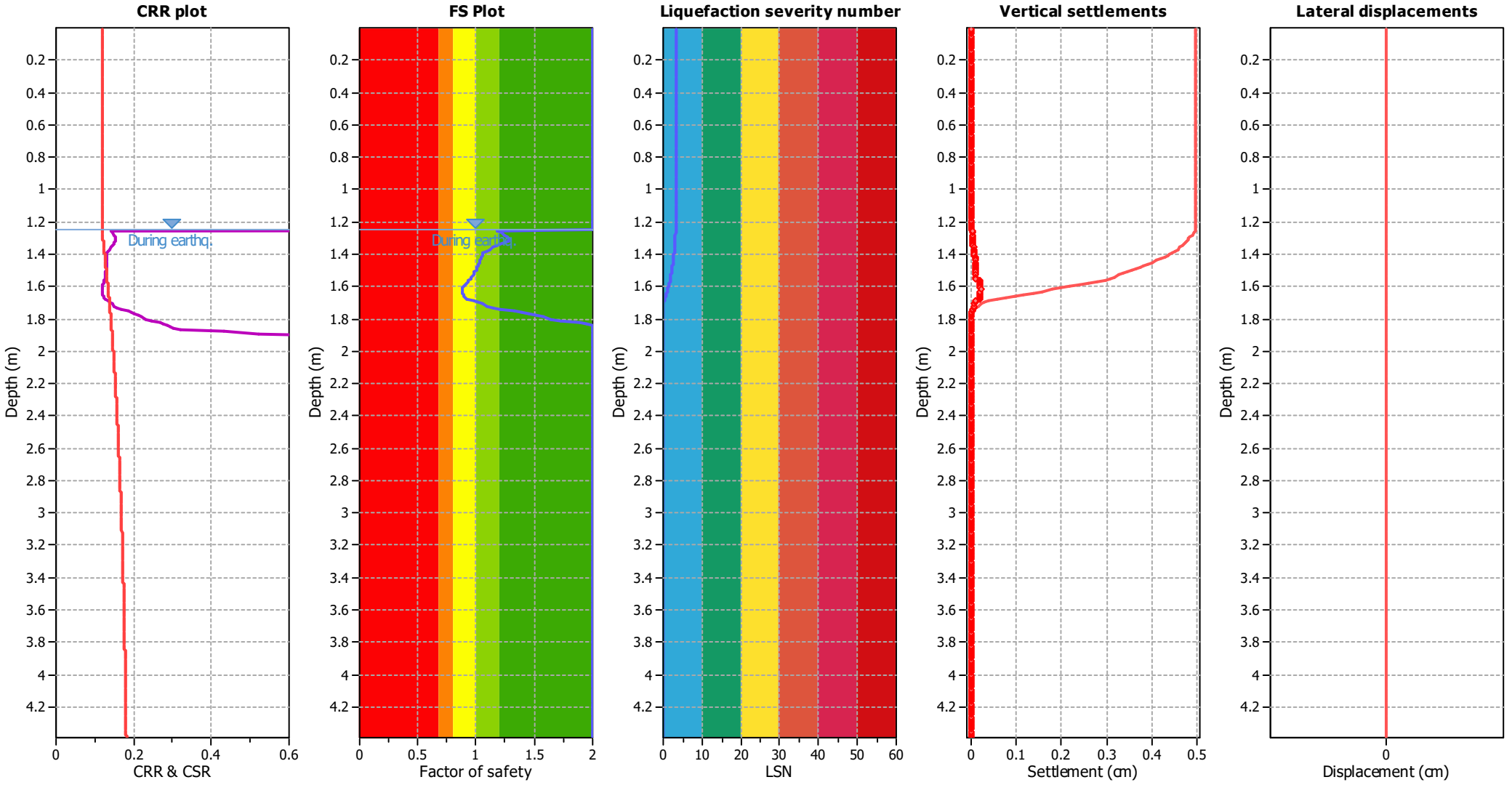
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.25 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.25 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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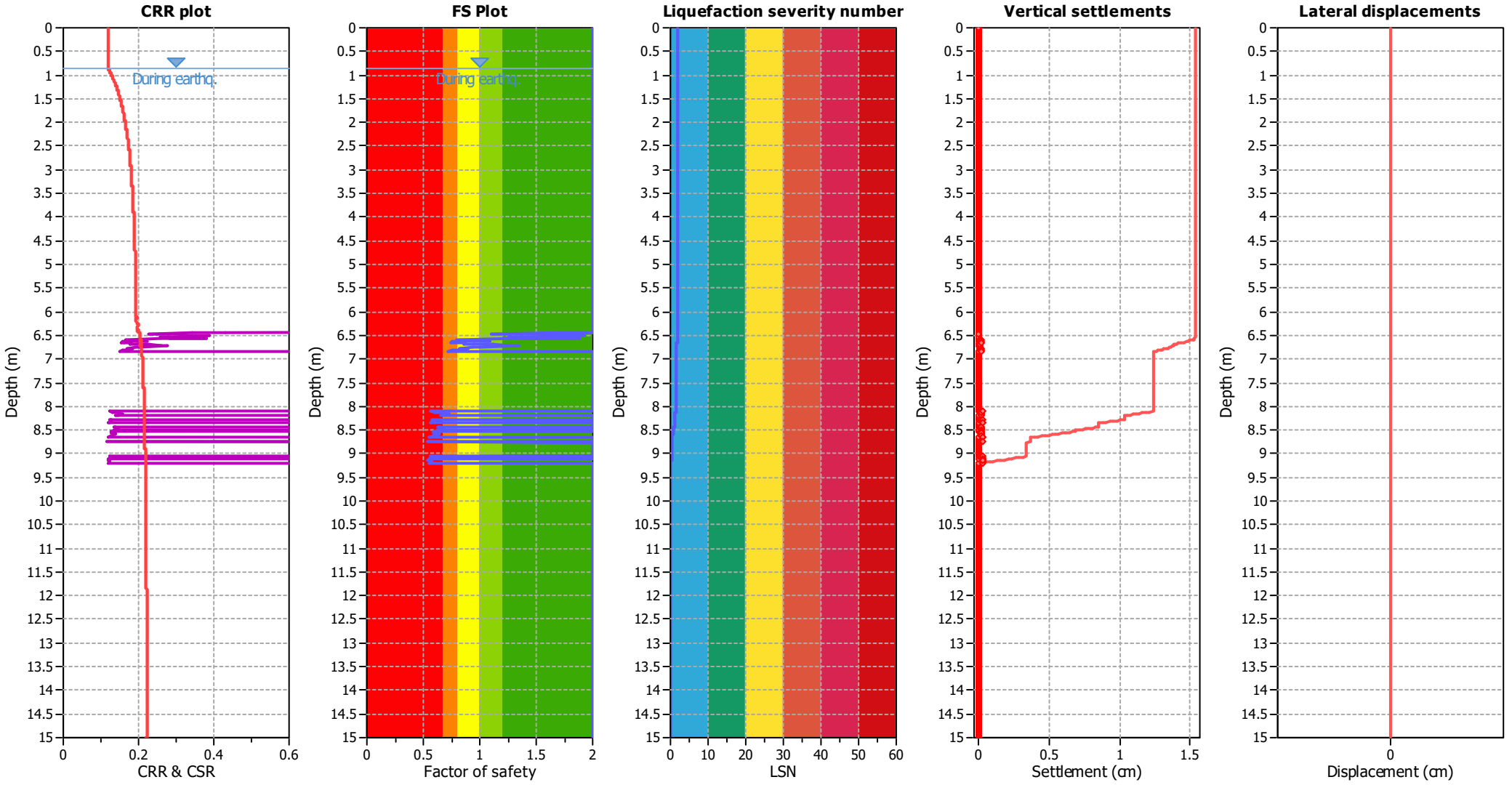
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.85 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.85 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
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LSN color scheme

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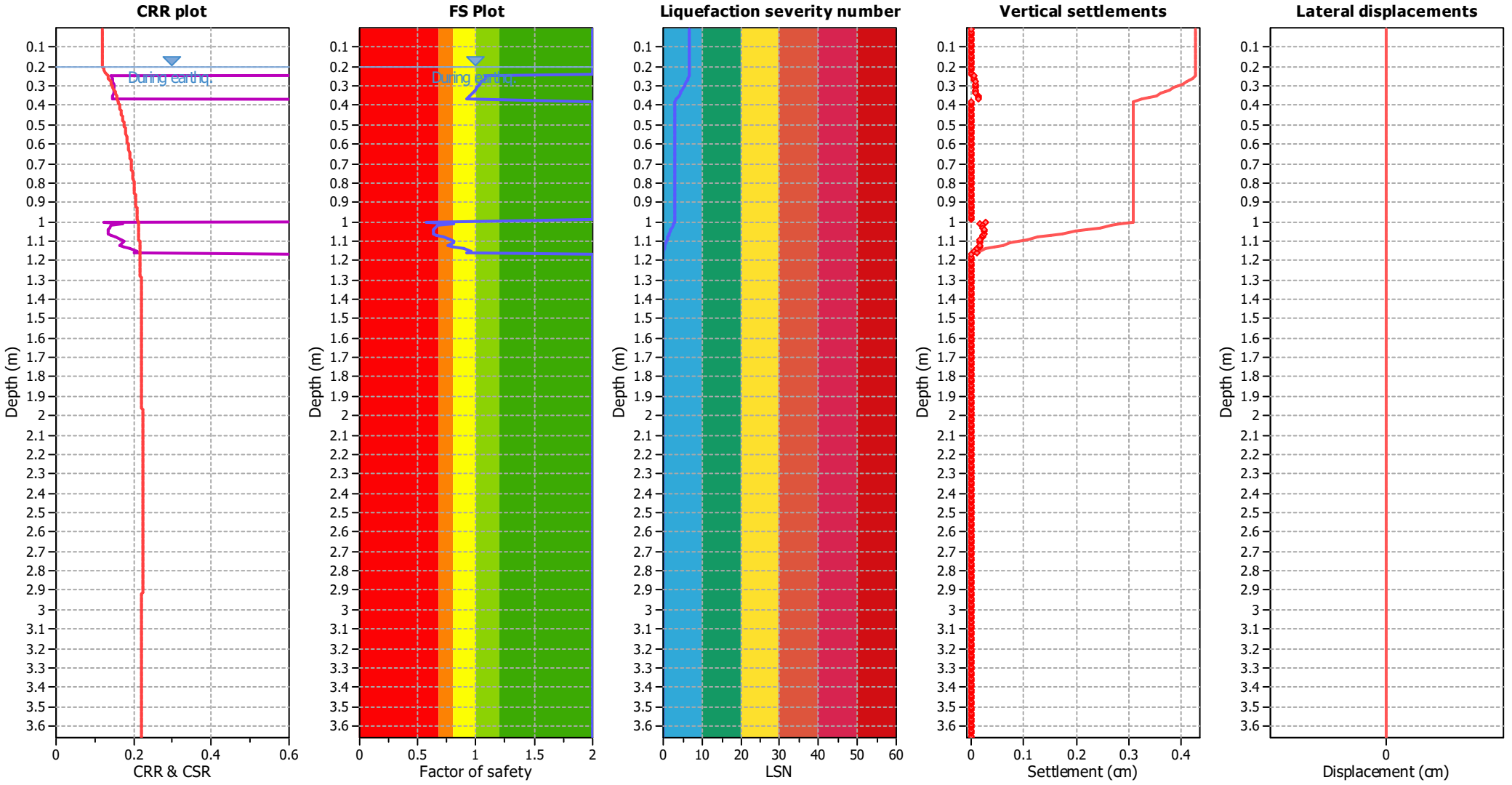
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.20 m	Fill height:	N/A	Limit depth:	10.00 m

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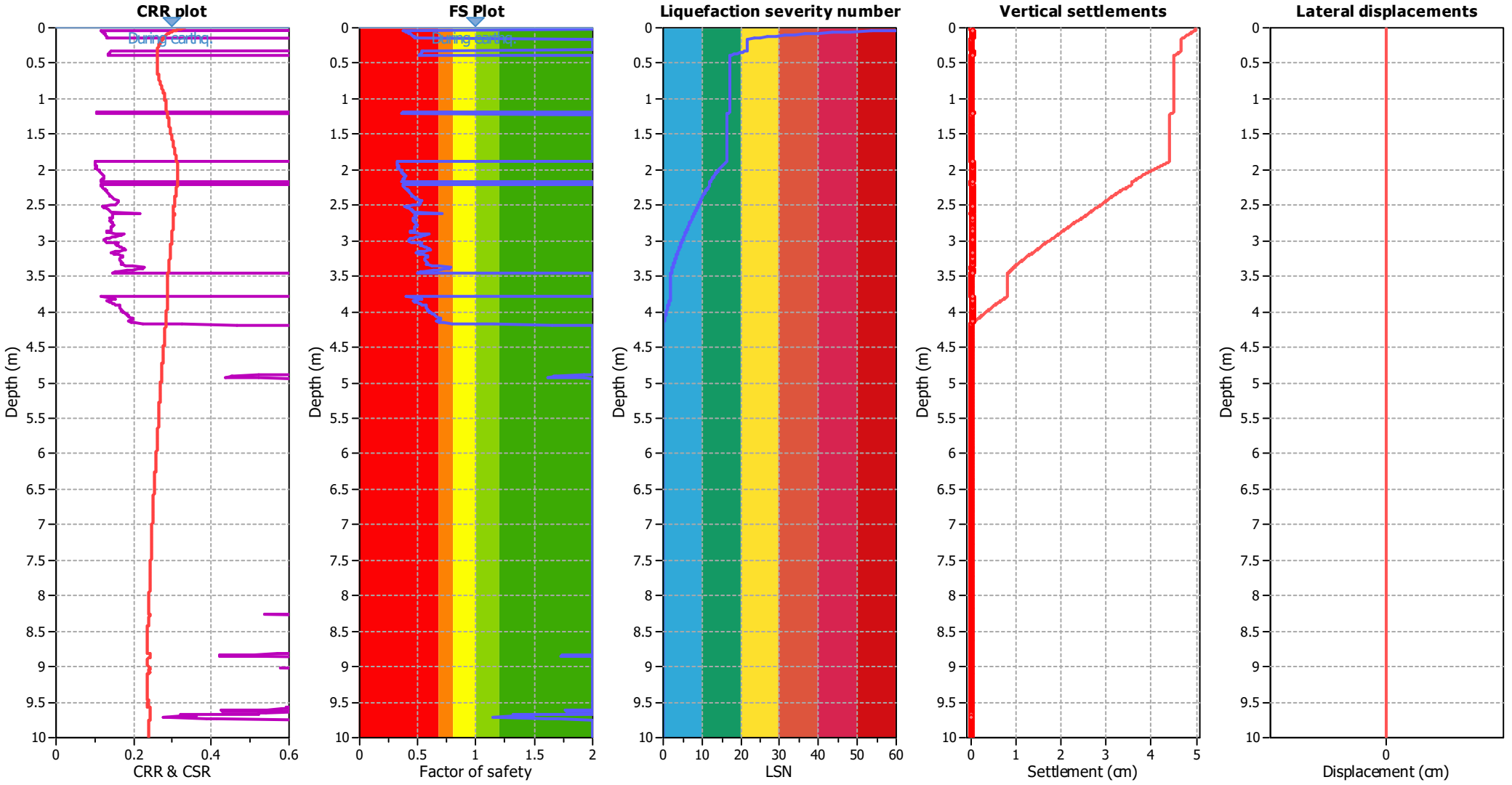
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
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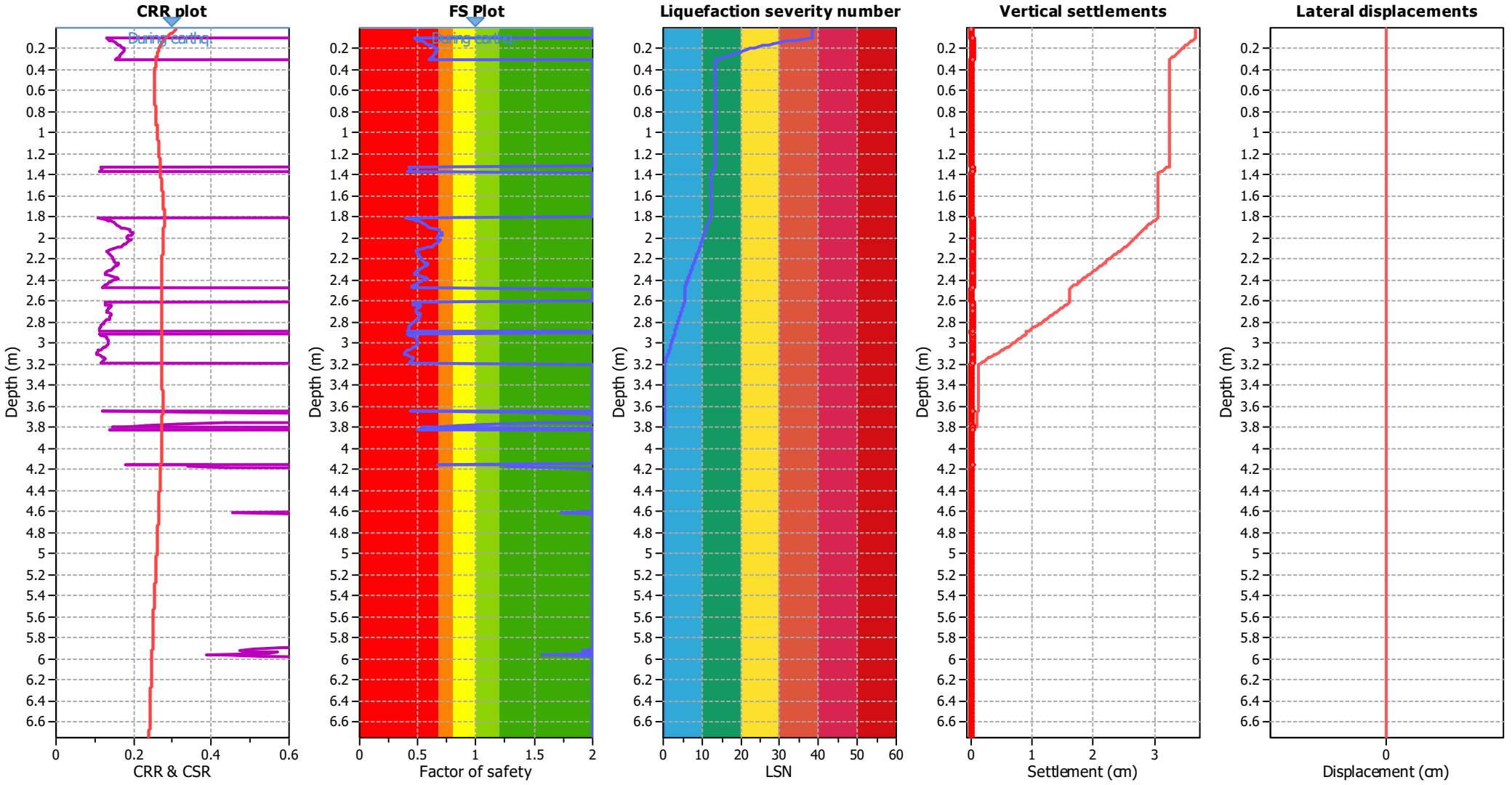

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
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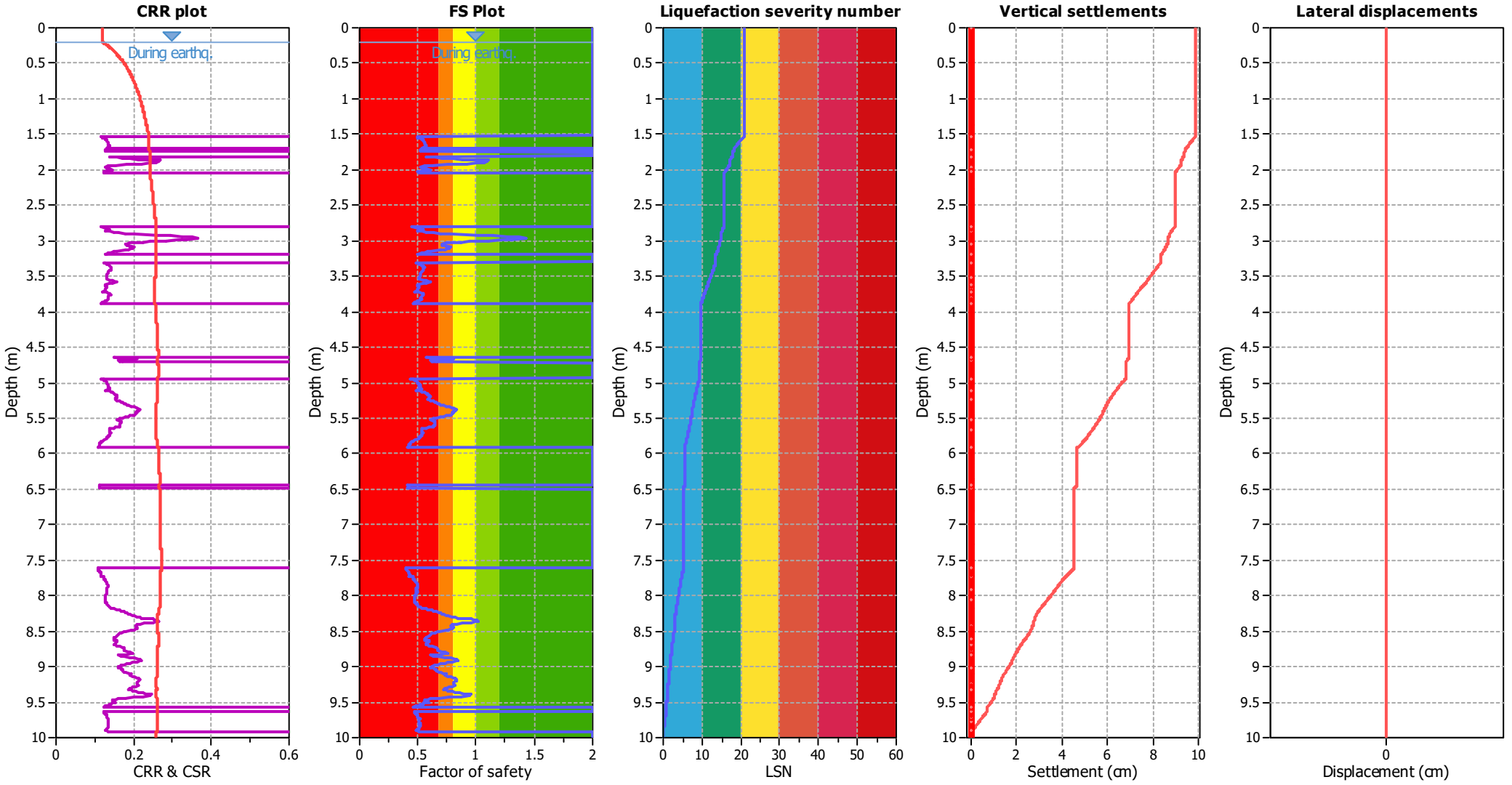

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
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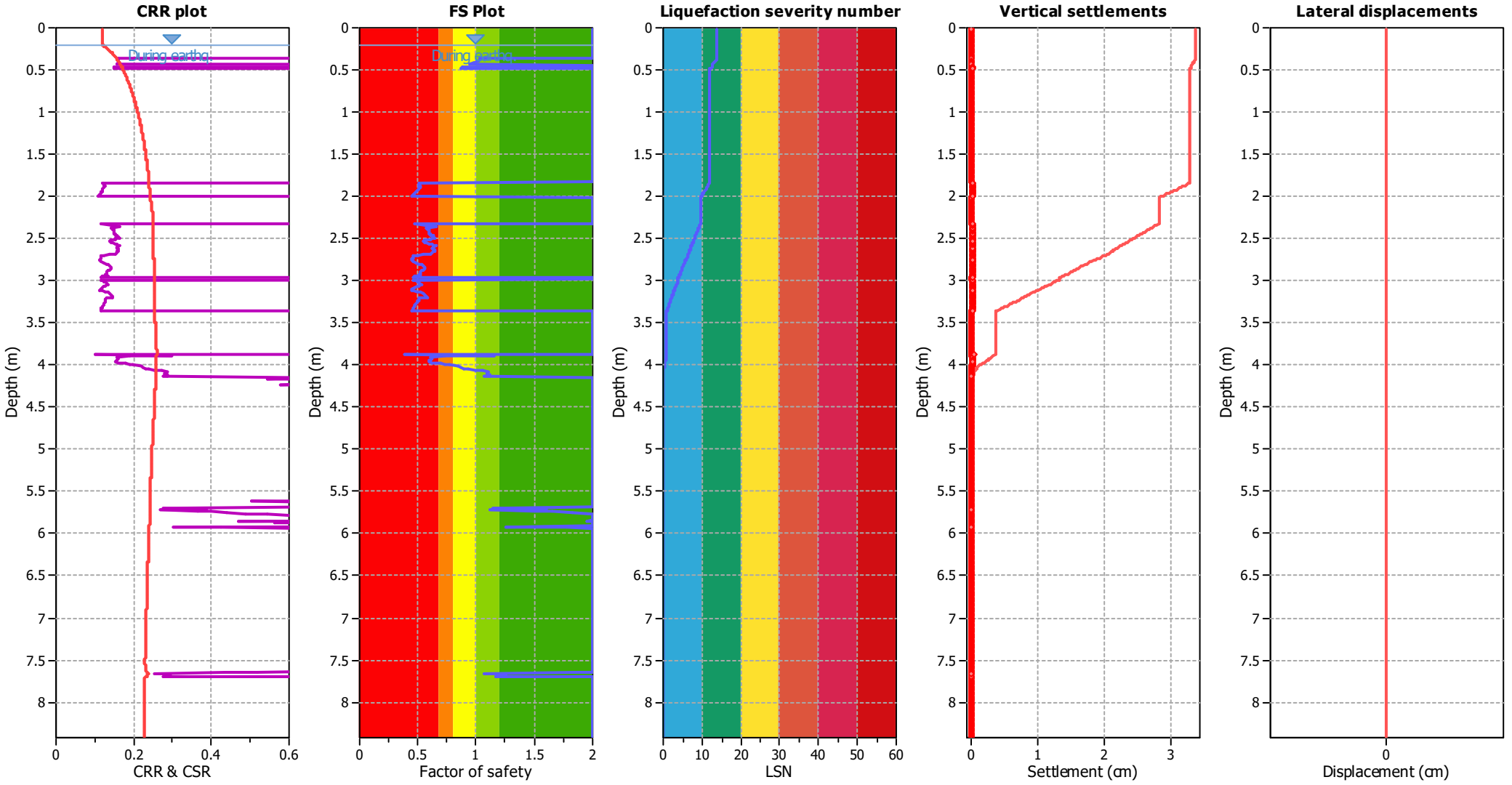

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
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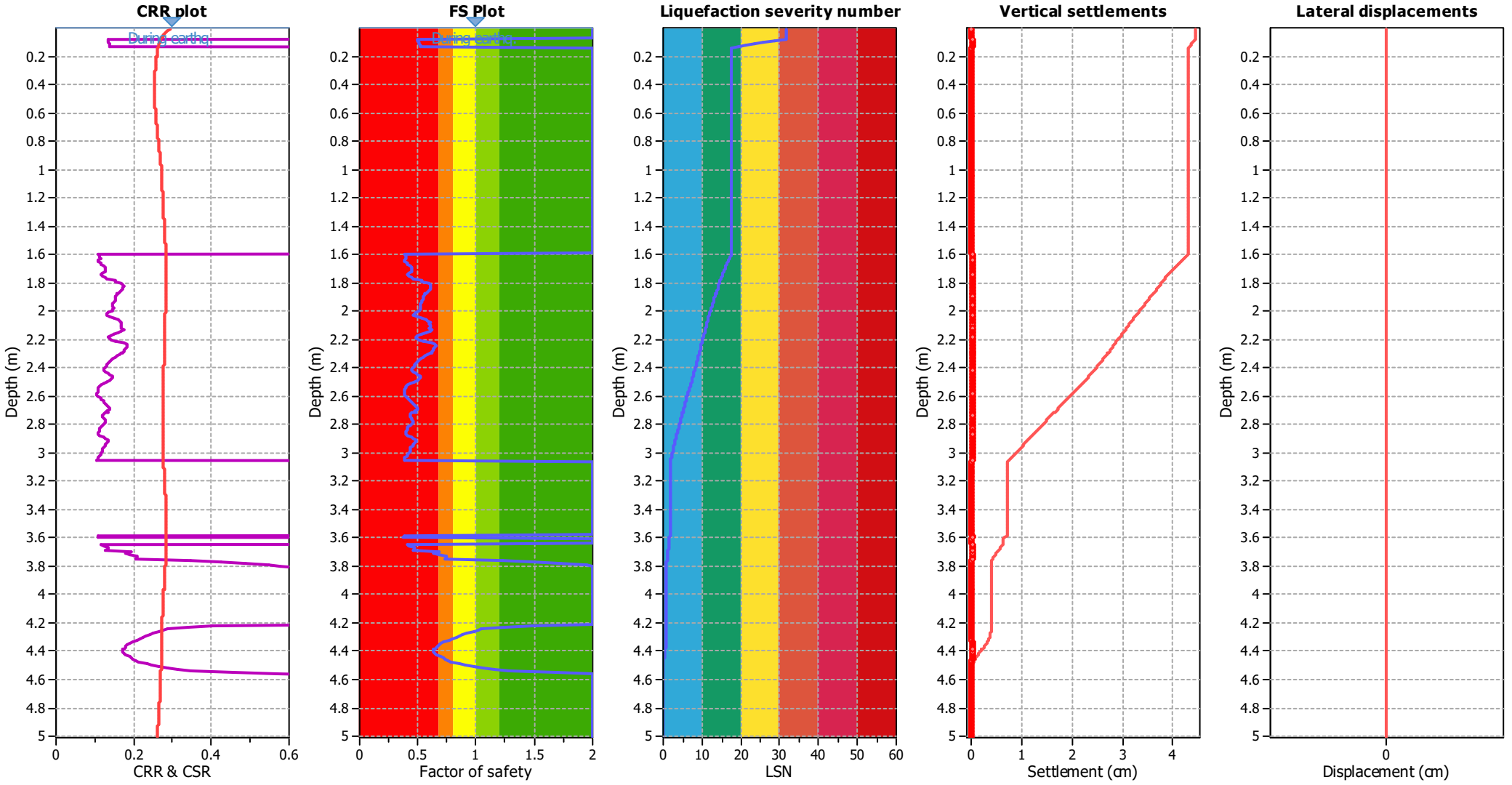

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
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Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

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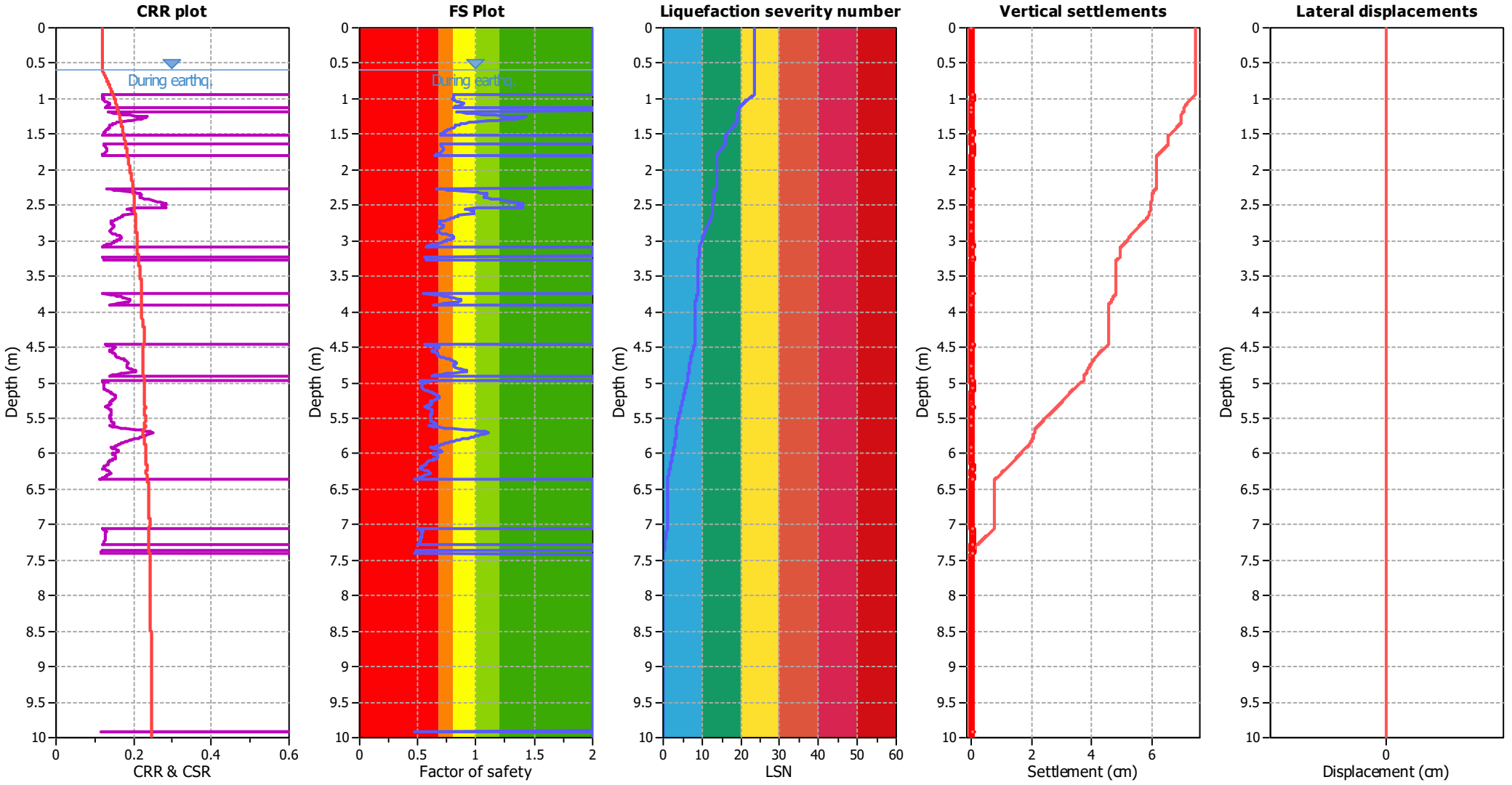
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.60 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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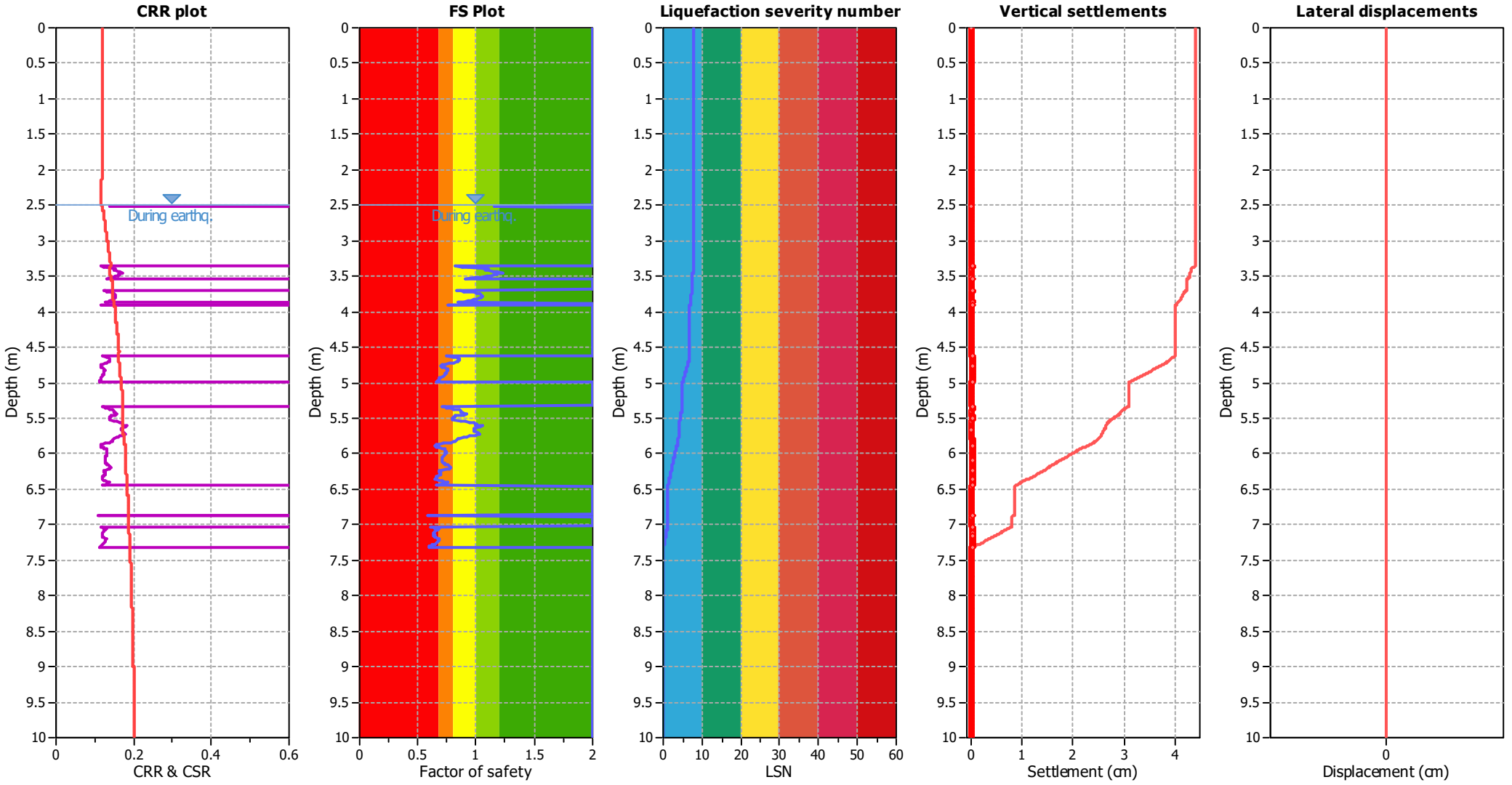

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Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	10.00 m

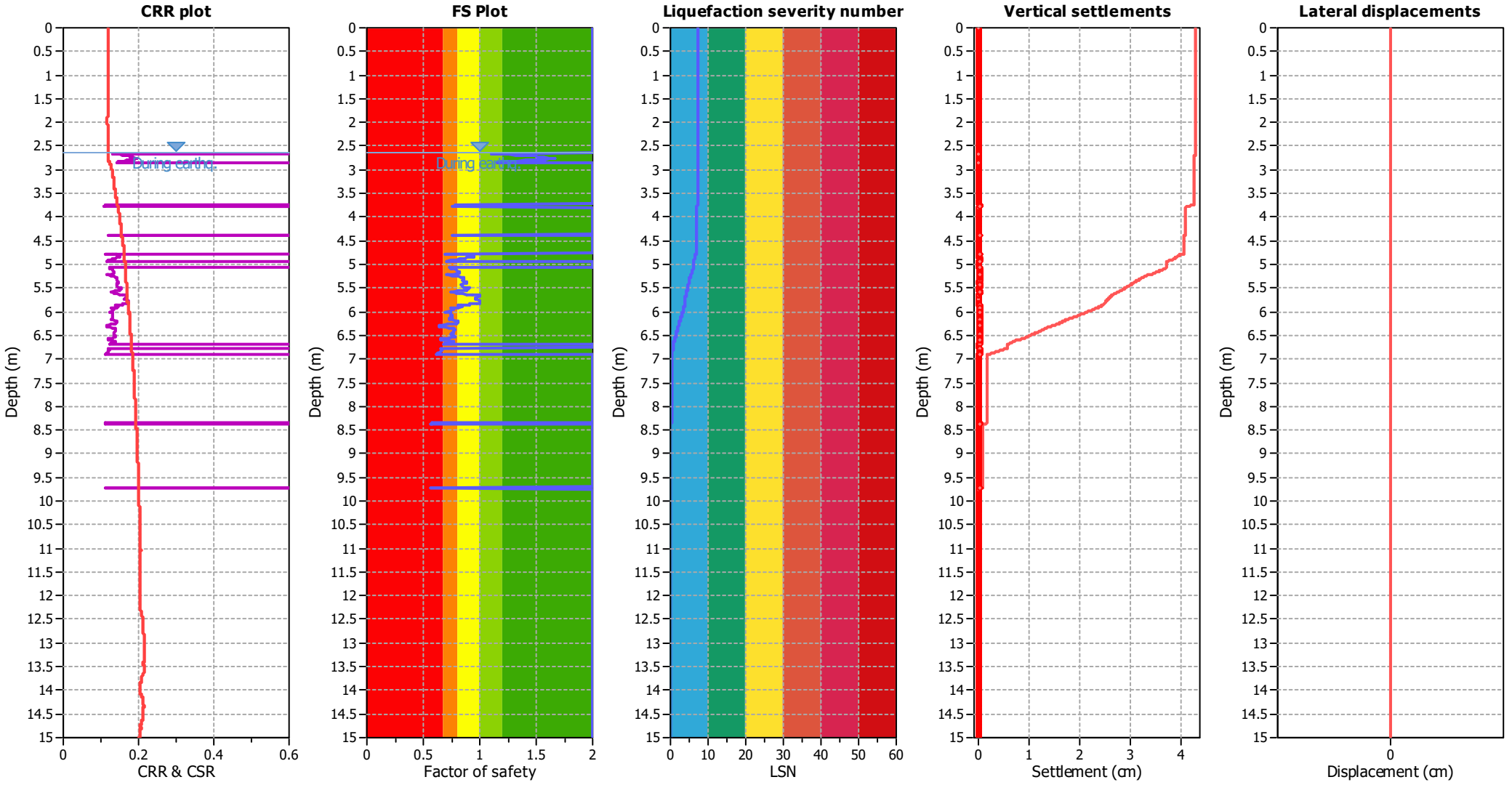
F.S. color scheme

- 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.):	2.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.65 m	Fill height:	N/A	Limit depth:	10.00 m

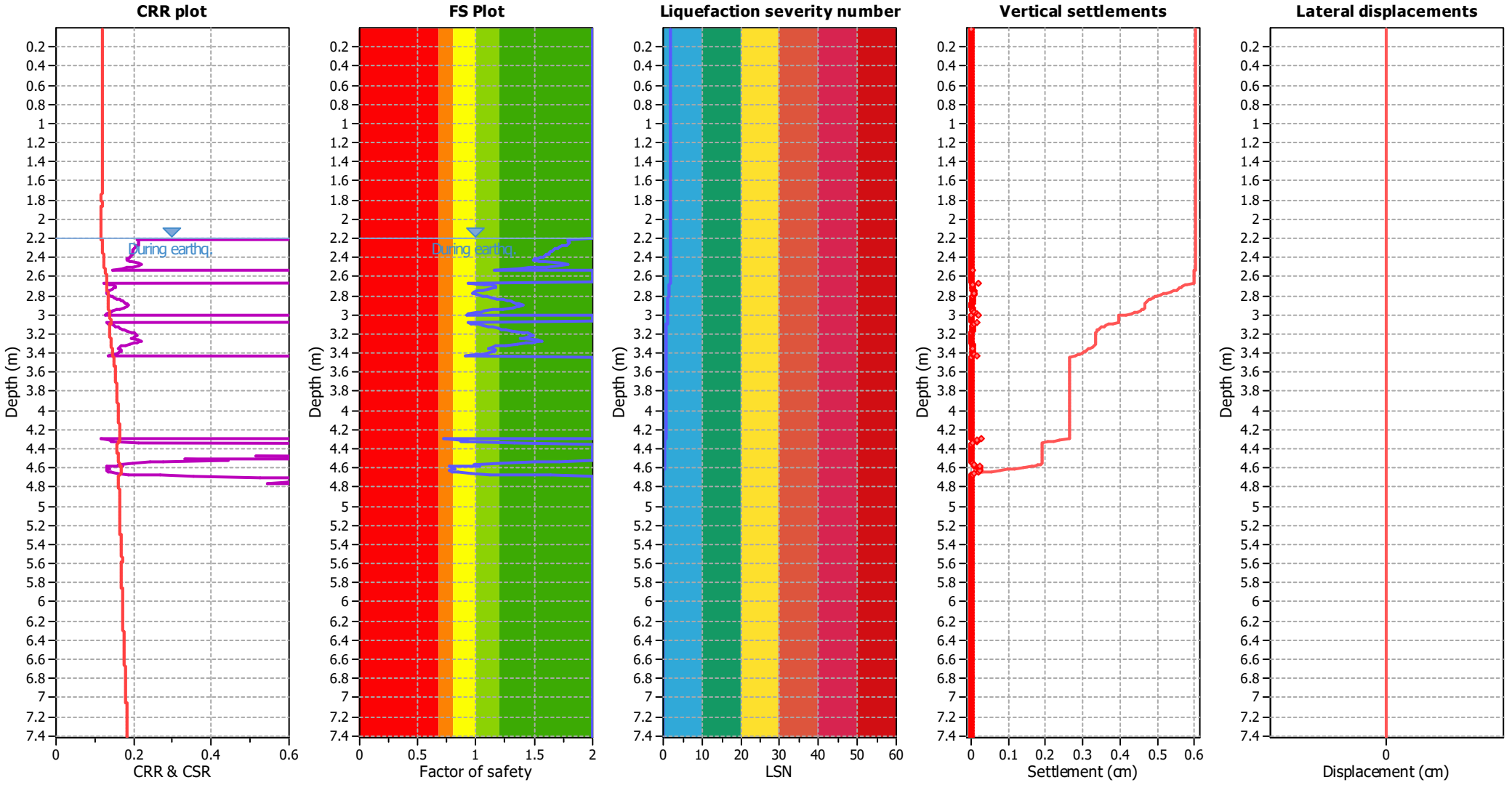
F.S. color scheme

- 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.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 m	Fill height:	N/A	Limit depth:	10.00 m

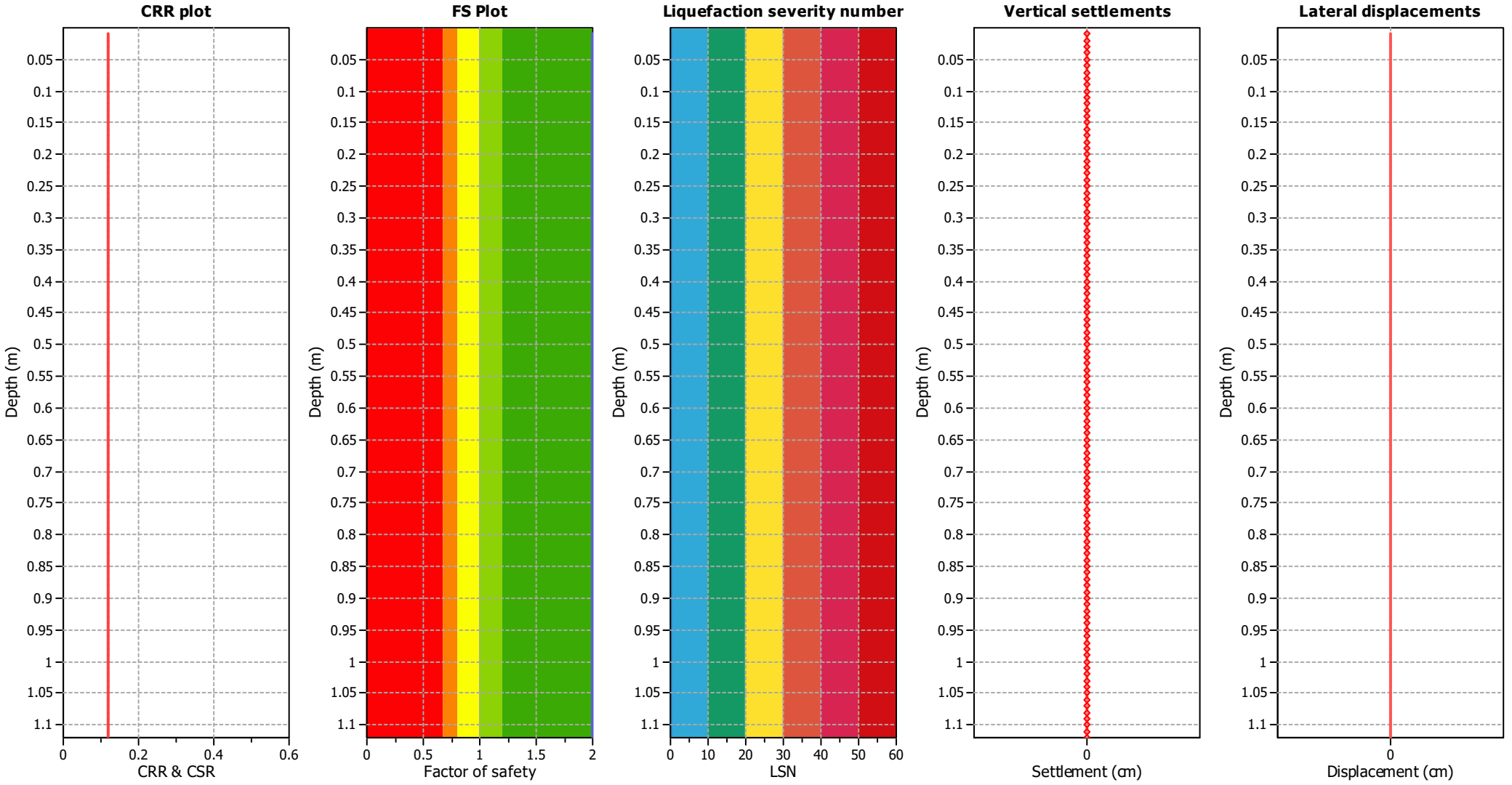
F.S. color scheme

- 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:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

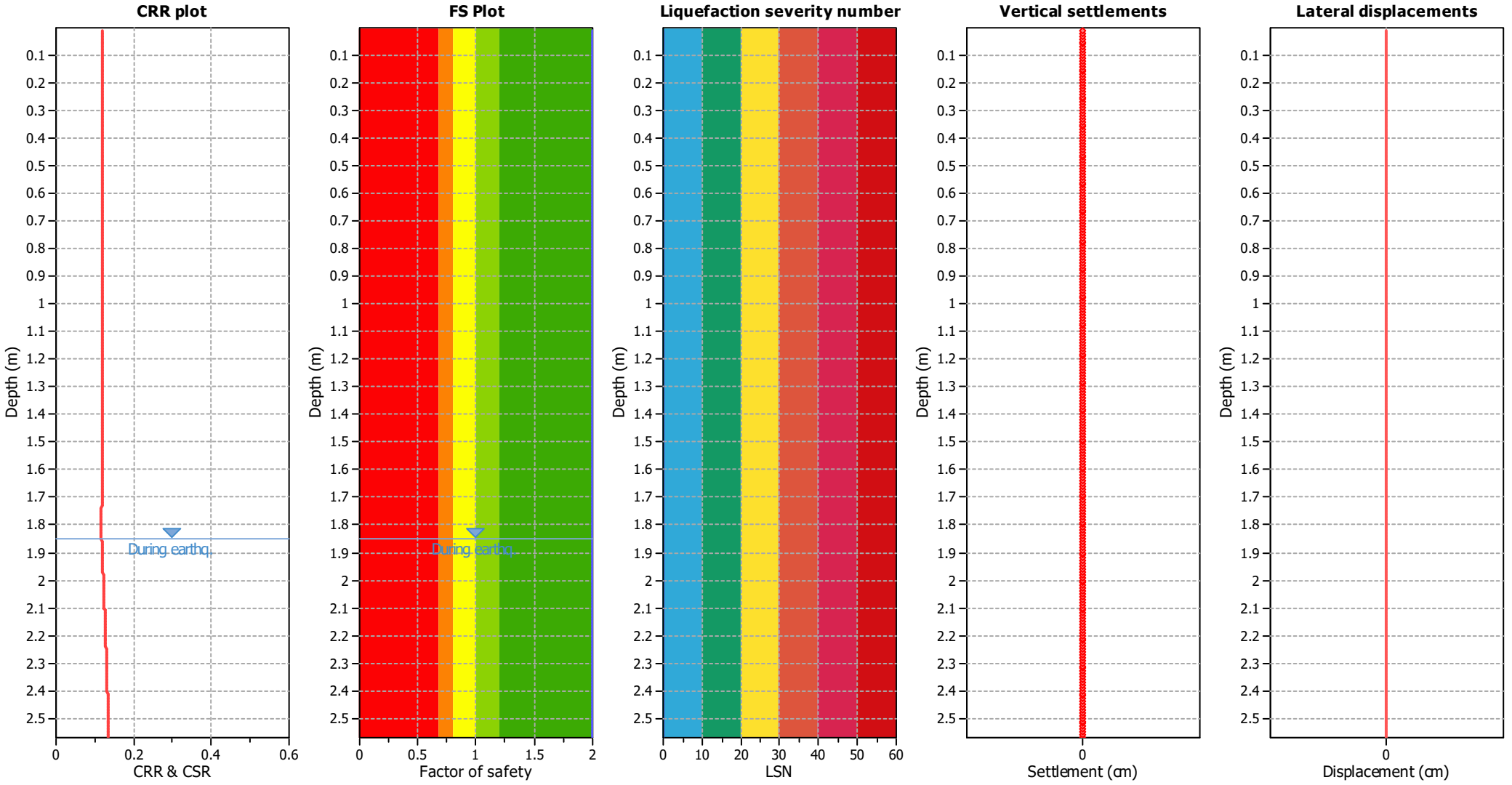
F.S. color scheme

- 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.):	1.85 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.85 m	Fill height:	N/A	Limit depth:	10.00 m

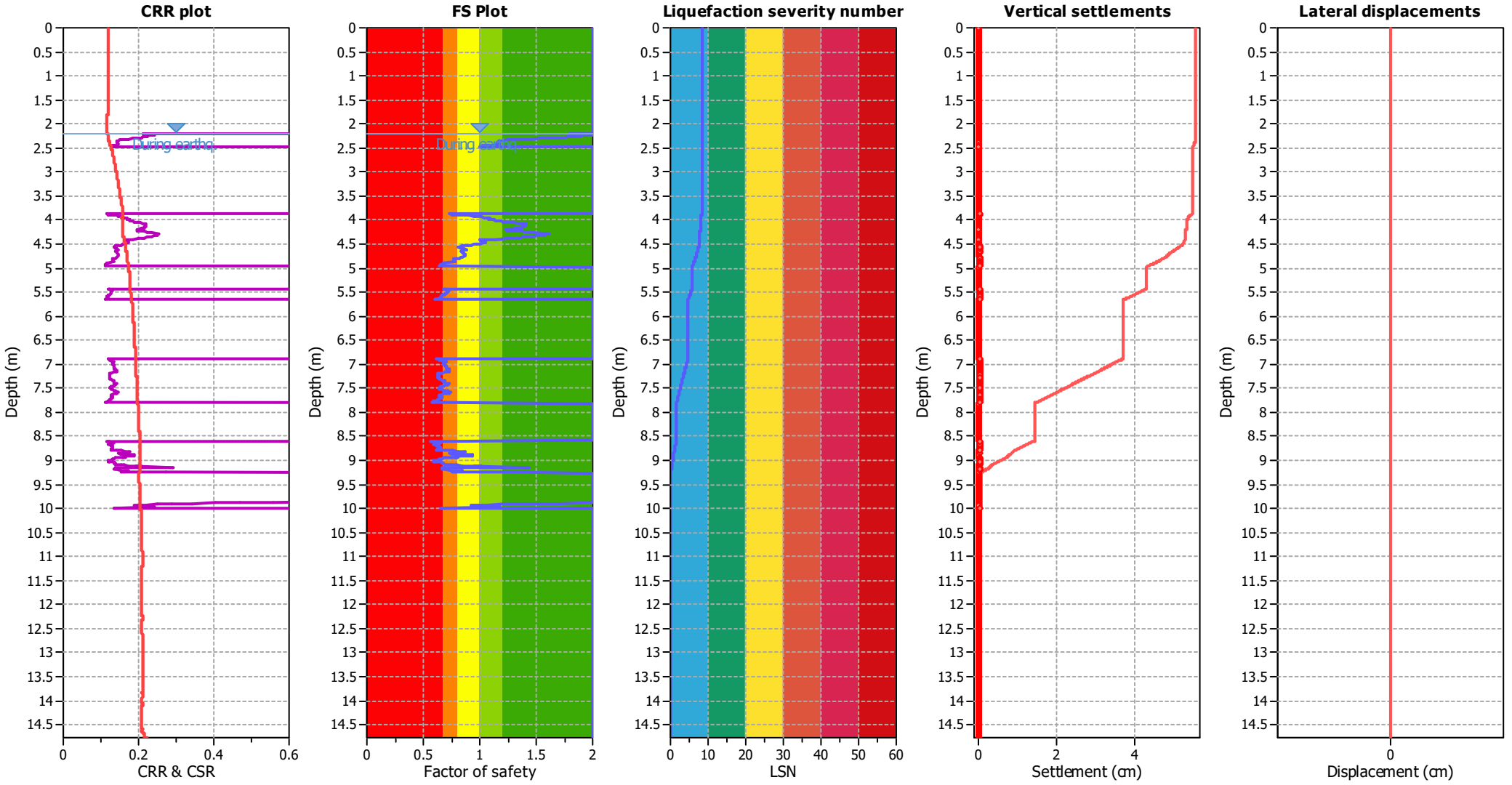
F.S. color scheme

- 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.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 m	Fill height:	N/A	Limit depth:	10.00 m

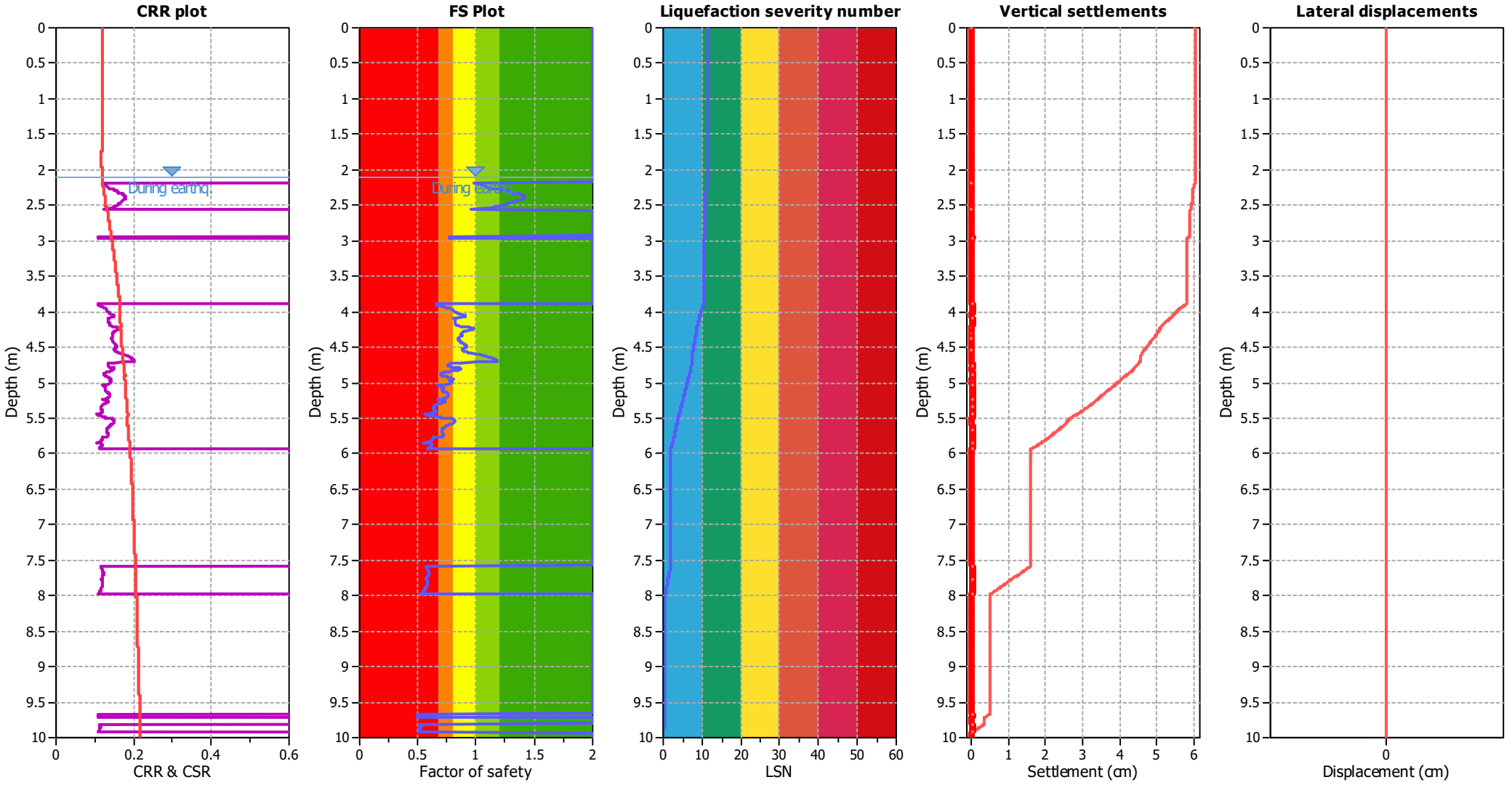
F.S. color scheme

- 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.):	2.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.10 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
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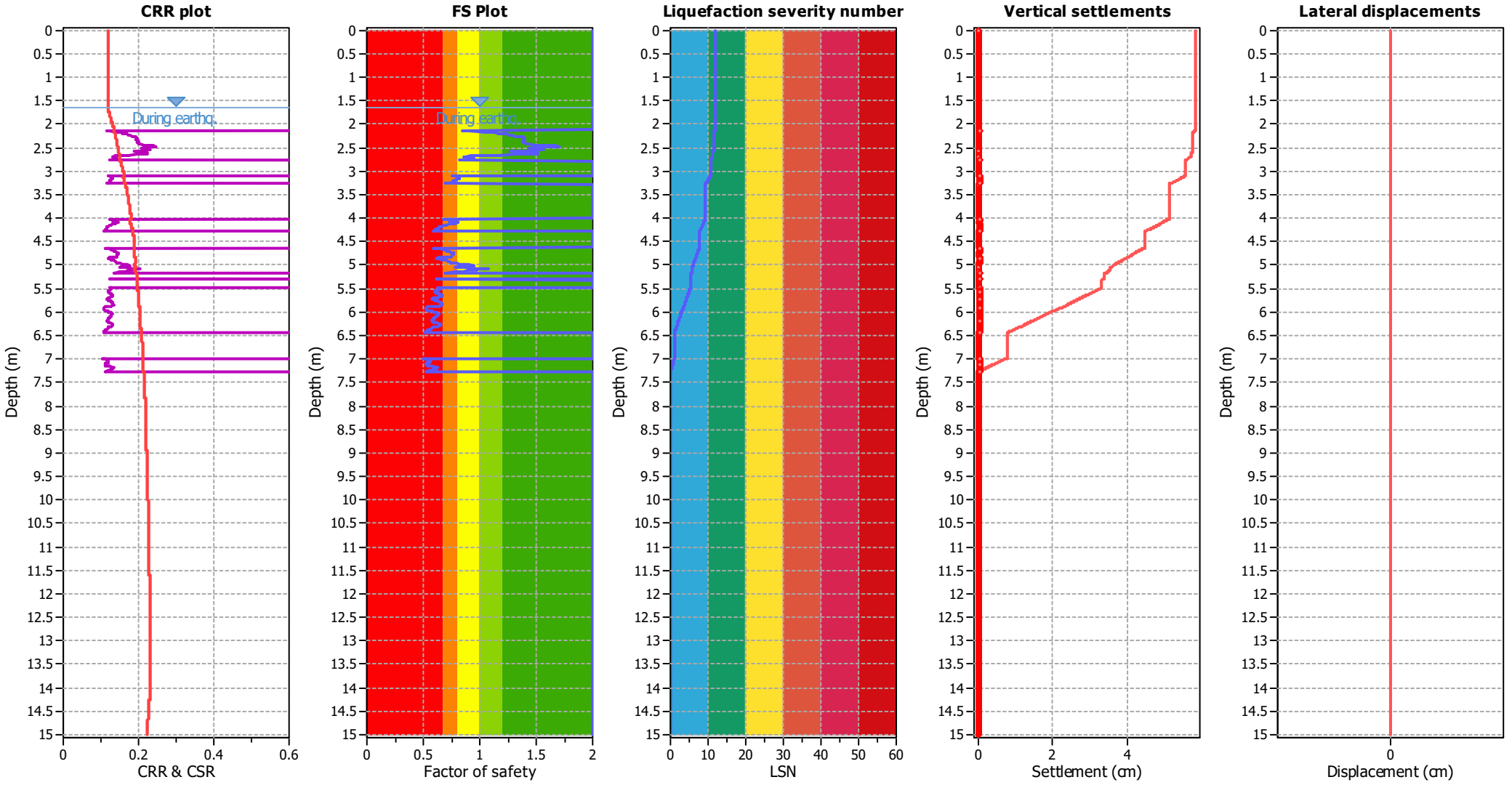
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LSN color scheme

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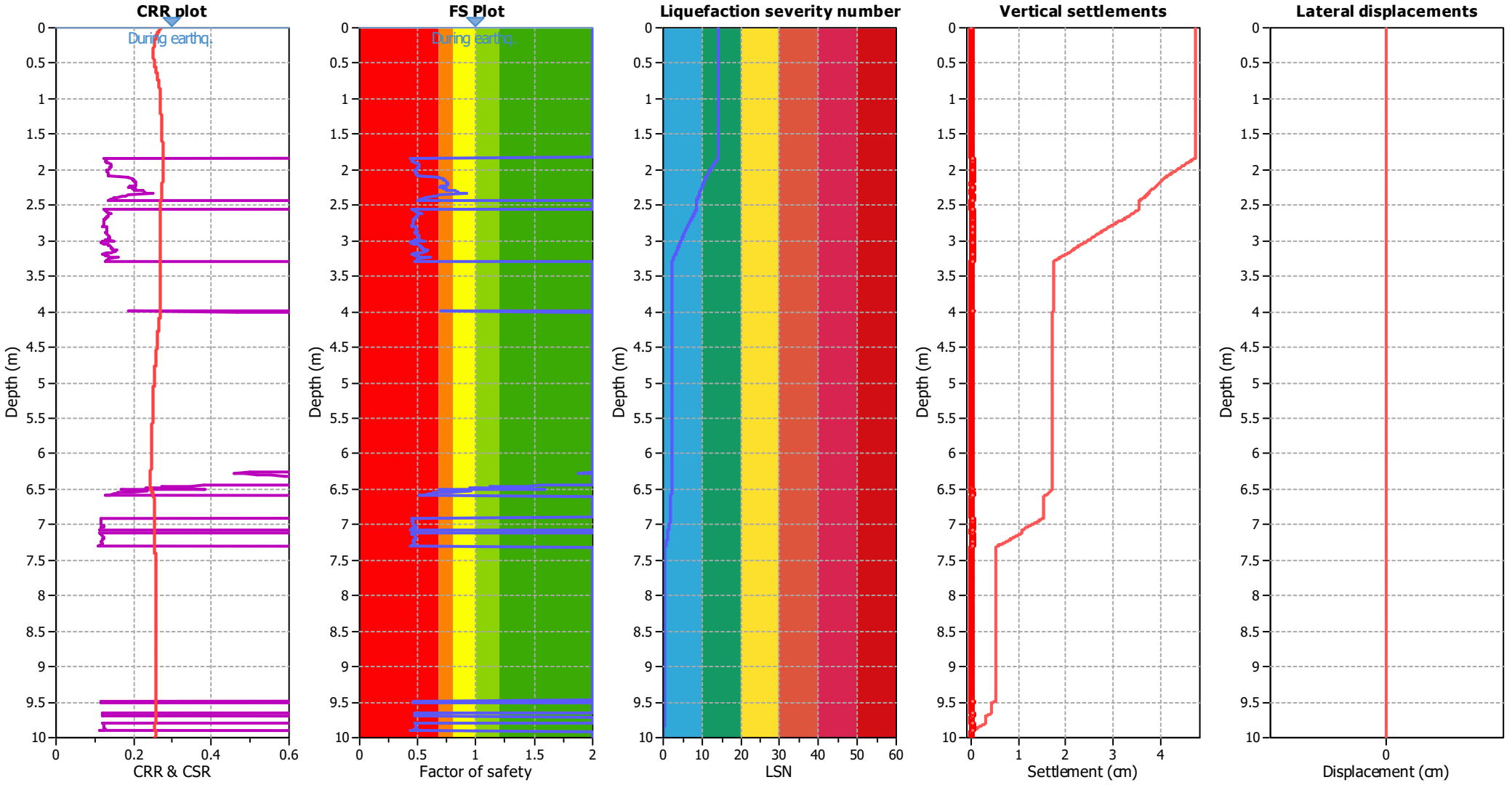
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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

LSN color scheme

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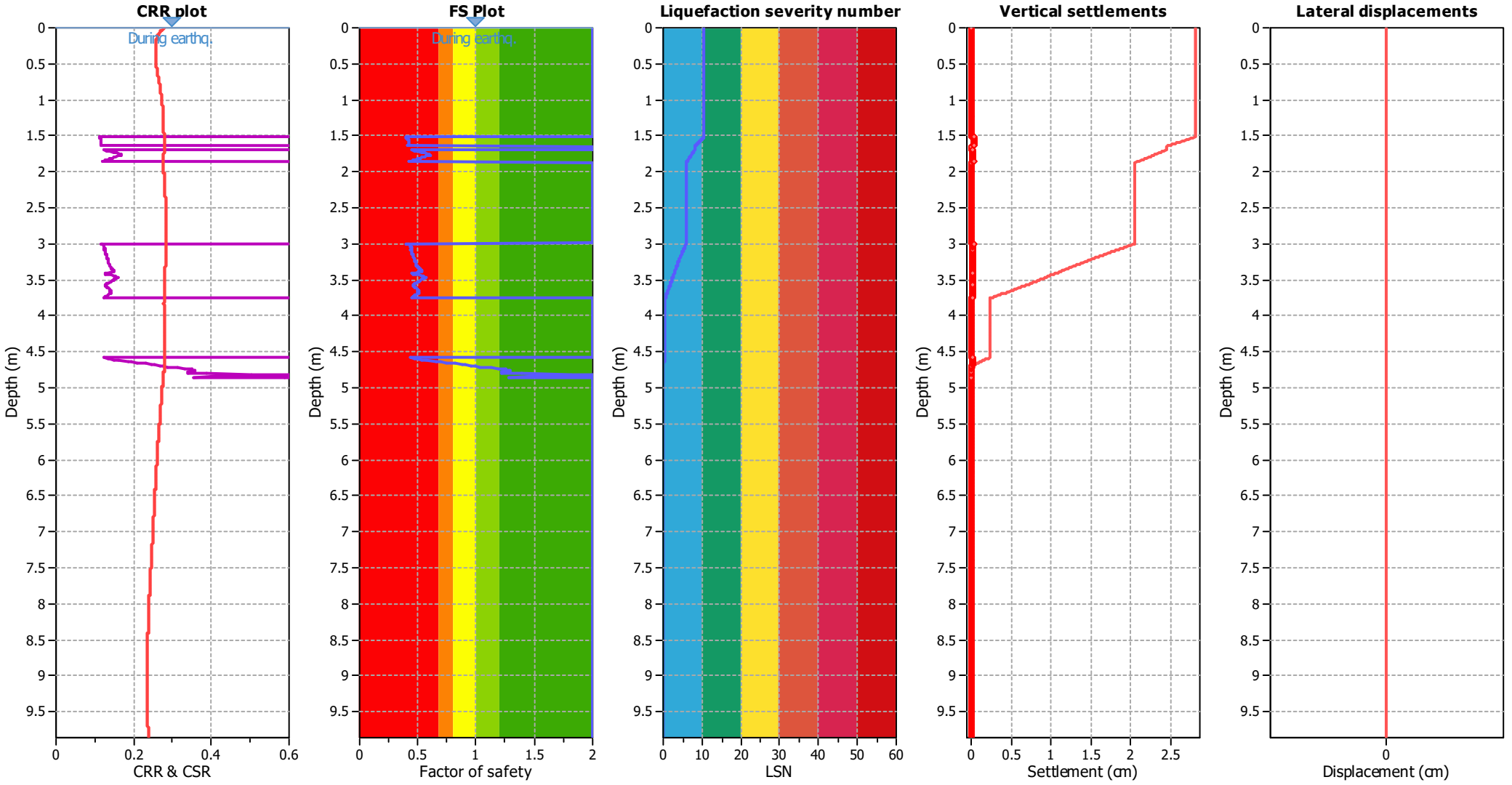
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 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
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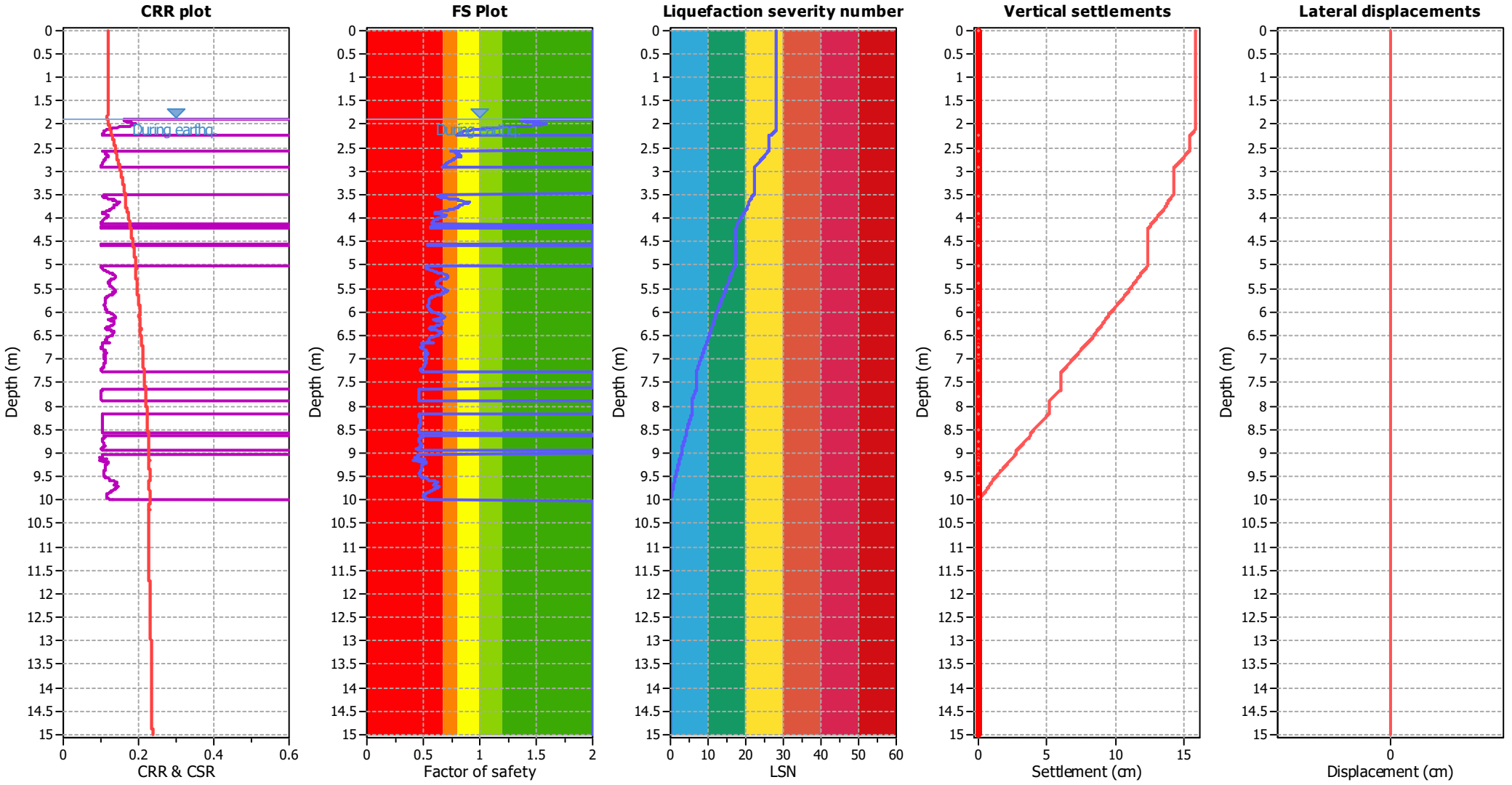
- Almost certain it will not liquefy

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.):	1.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.90 m	Fill height:	N/A	Limit depth:	10.00 m

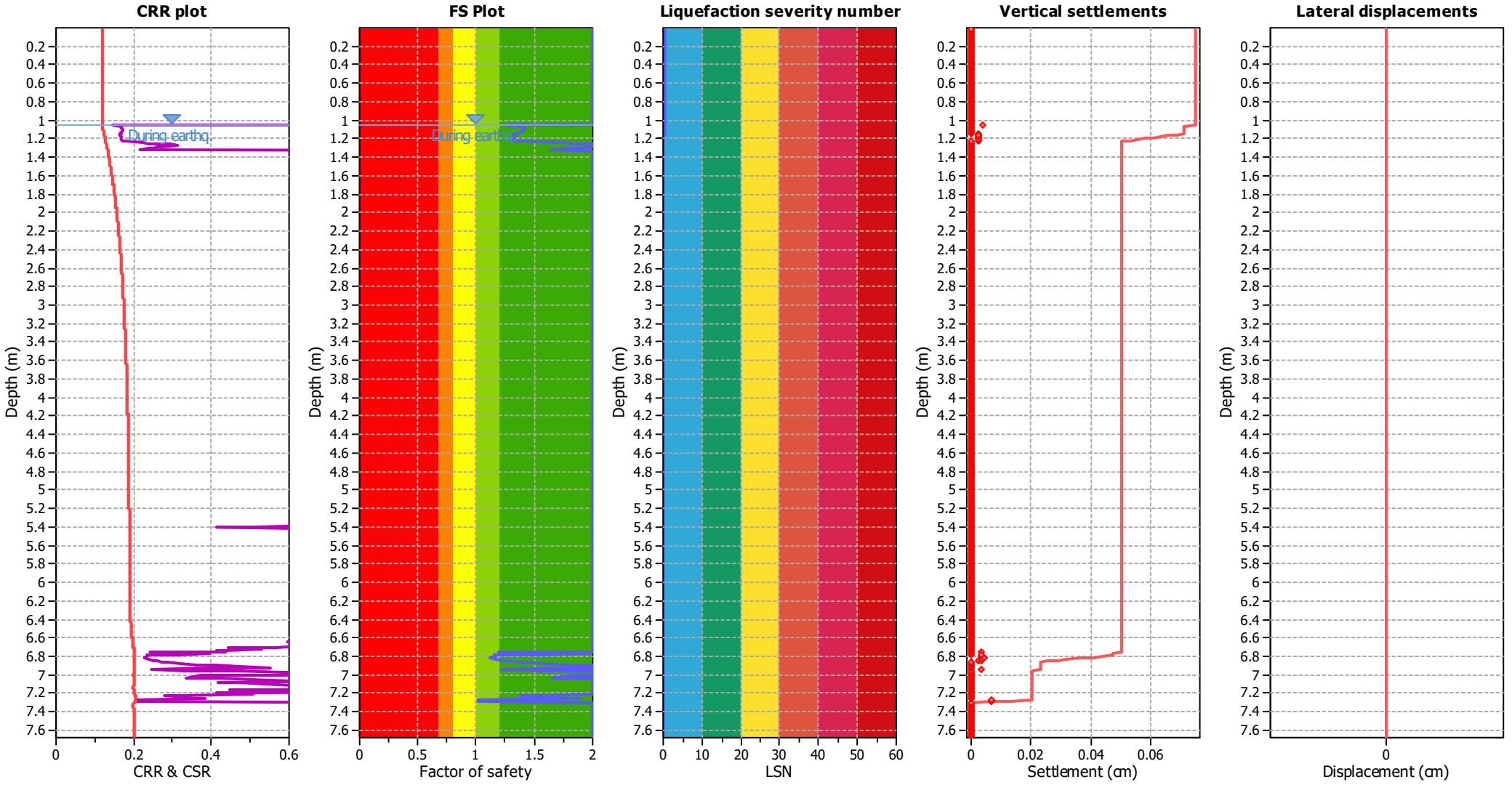
F.S. color scheme

- 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.):	1.05 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.05 m	Fill height:	N/A	Limit depth:	10.00 m

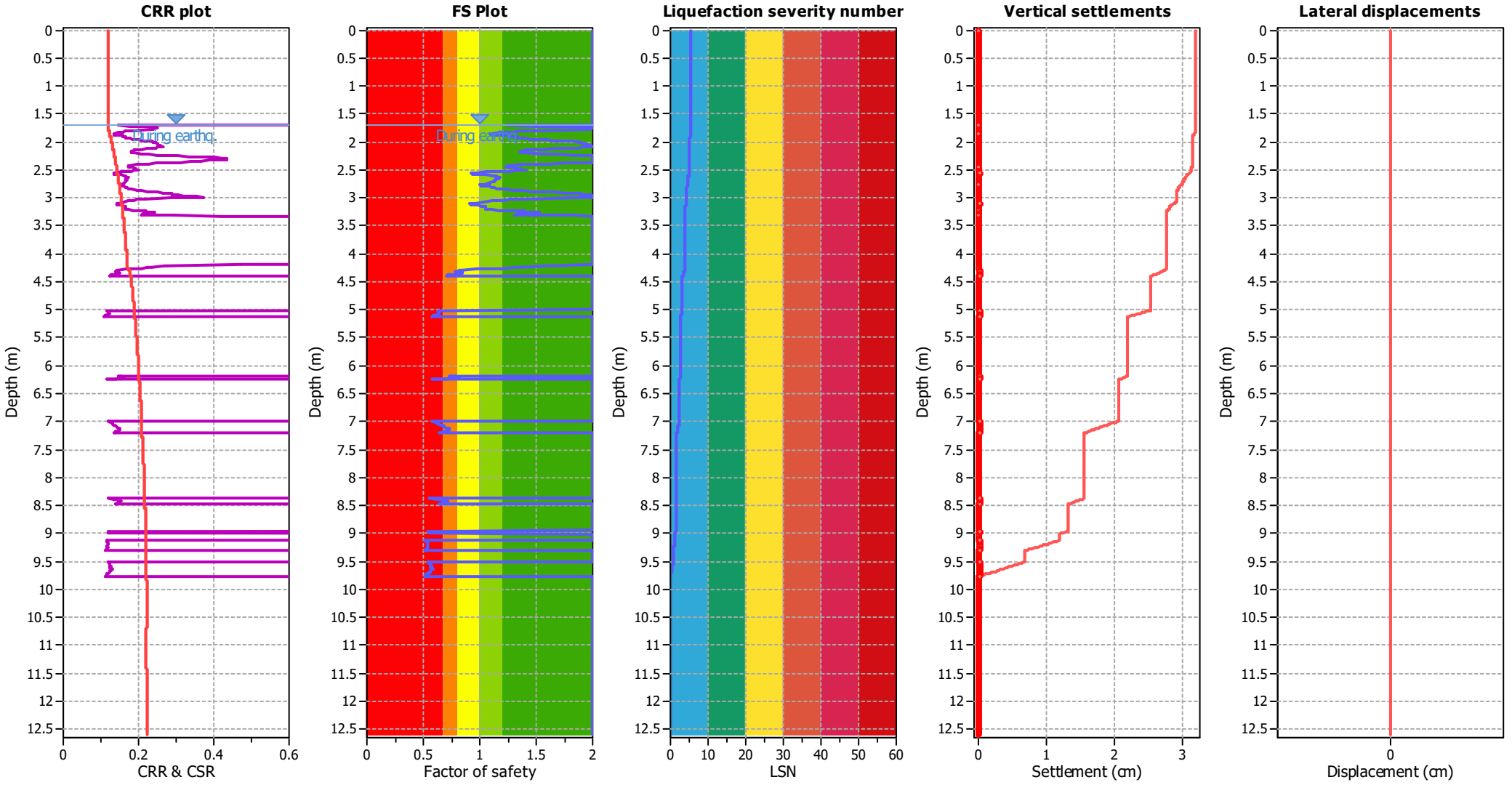
F.S. color scheme

- 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.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 m	Fill height:	N/A	Limit depth:	10.00 m

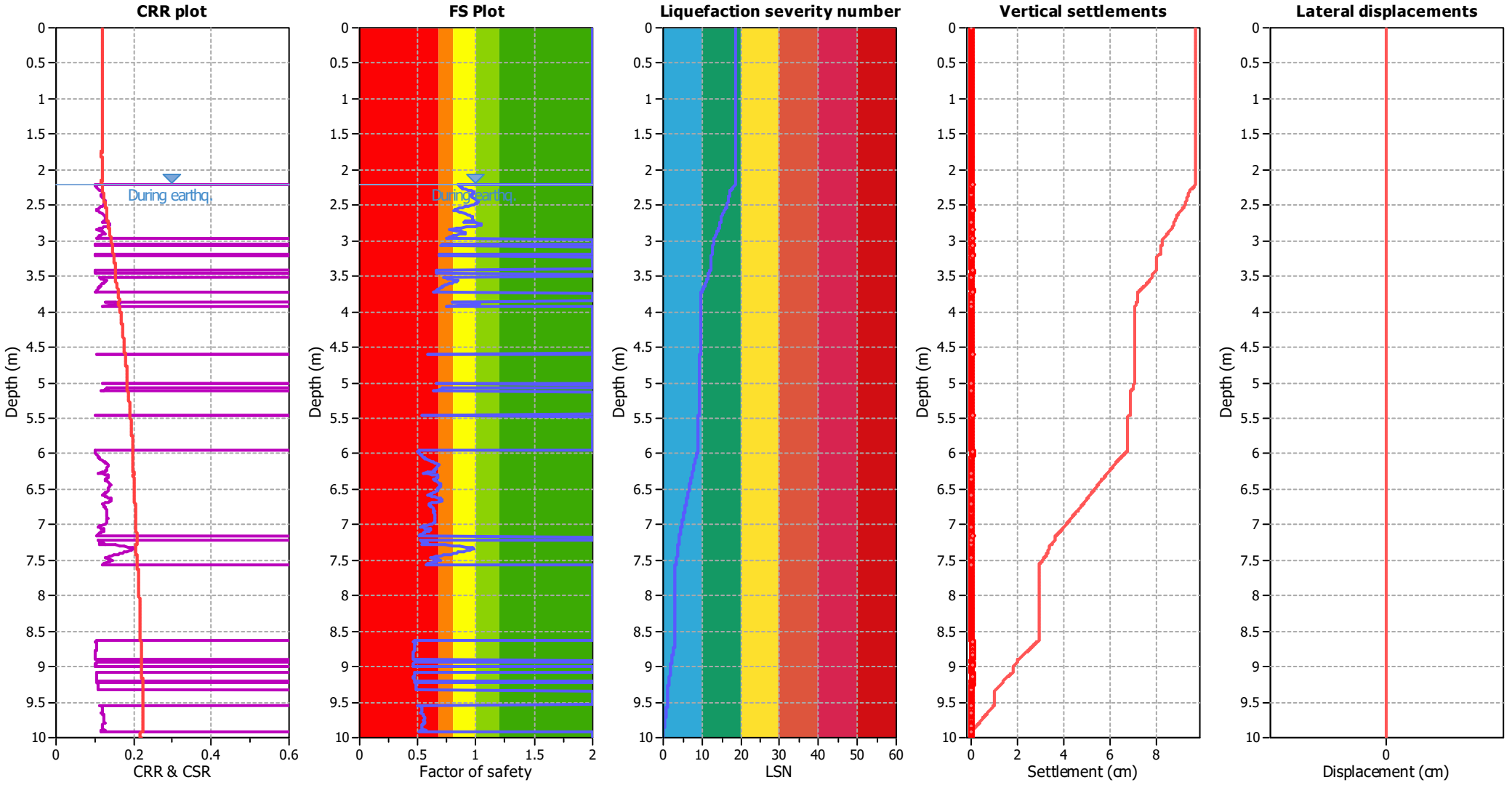
F.S. color scheme

- 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.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 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
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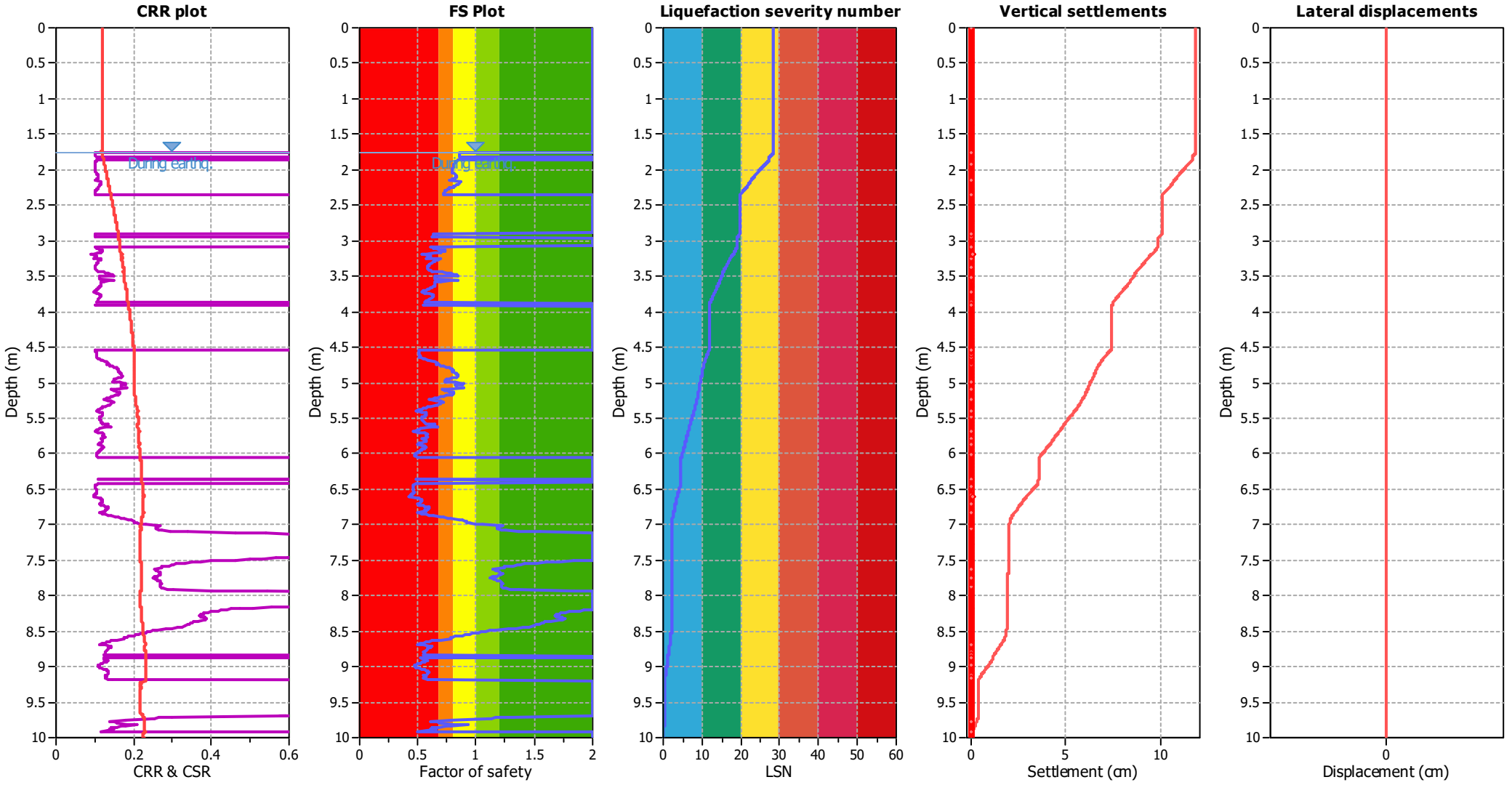
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.75 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.75 m	Fill height:	N/A	Limit depth:	10.00 m

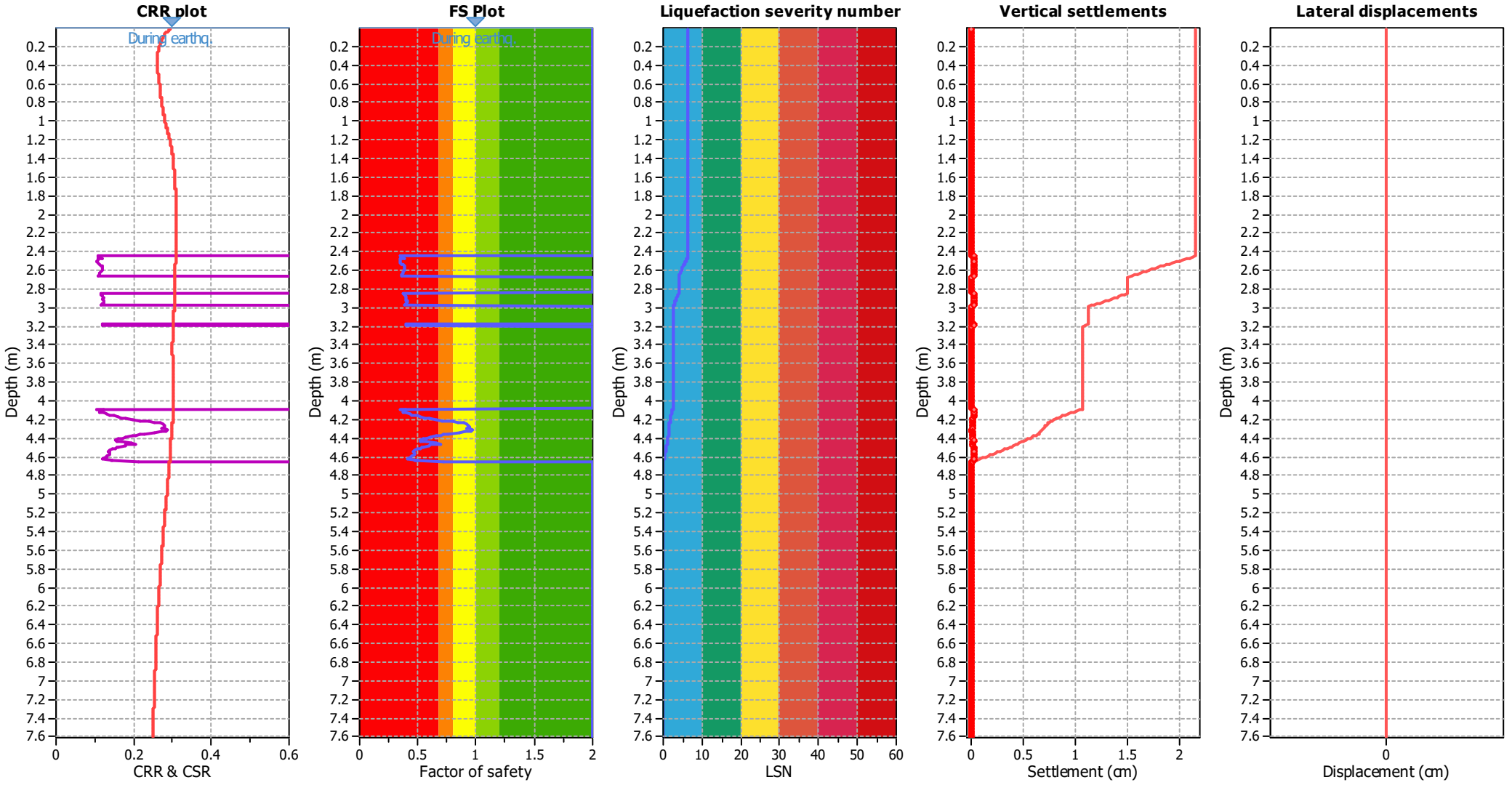
F.S. color scheme

- 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.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 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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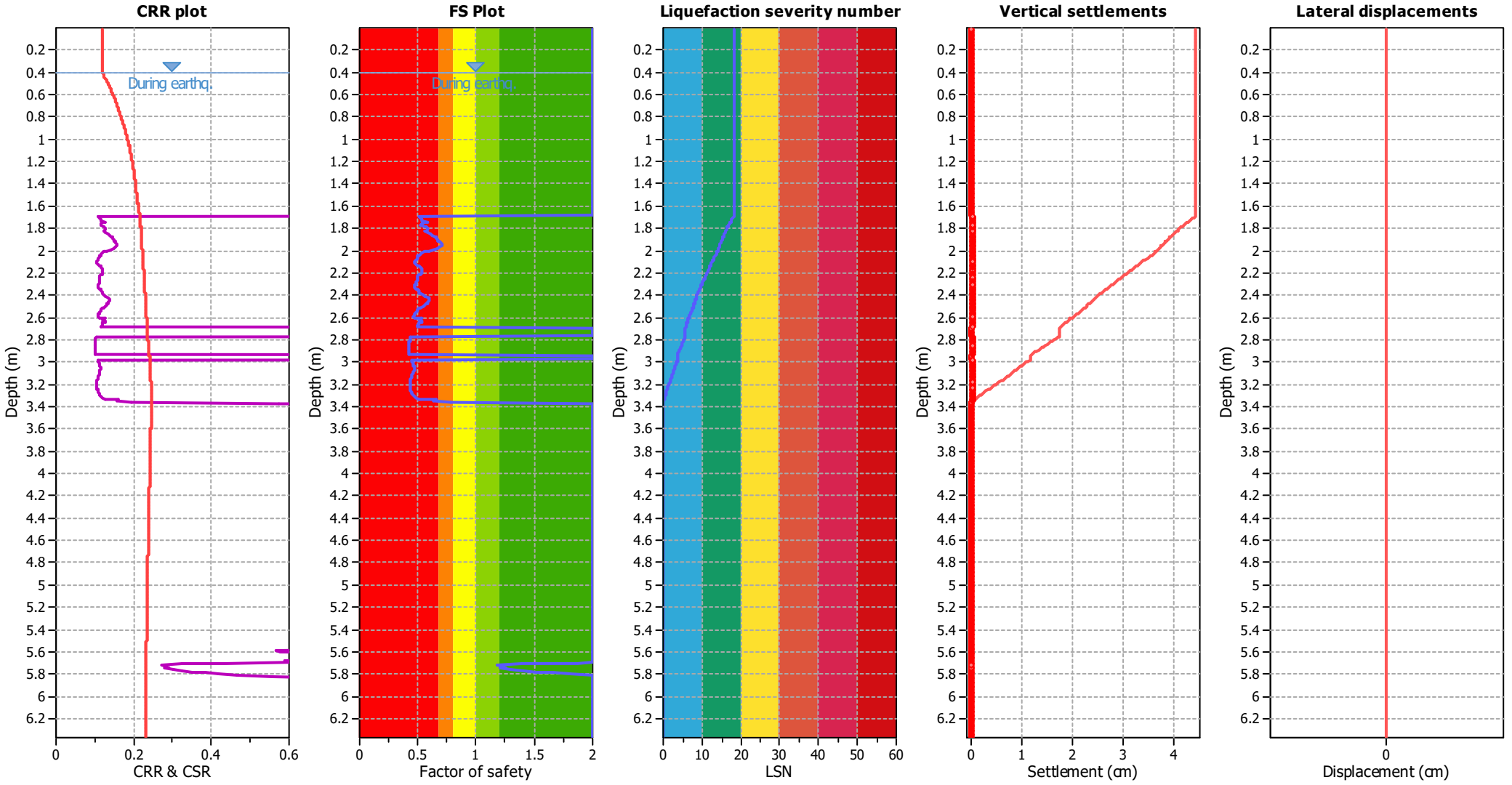
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	10.00 m

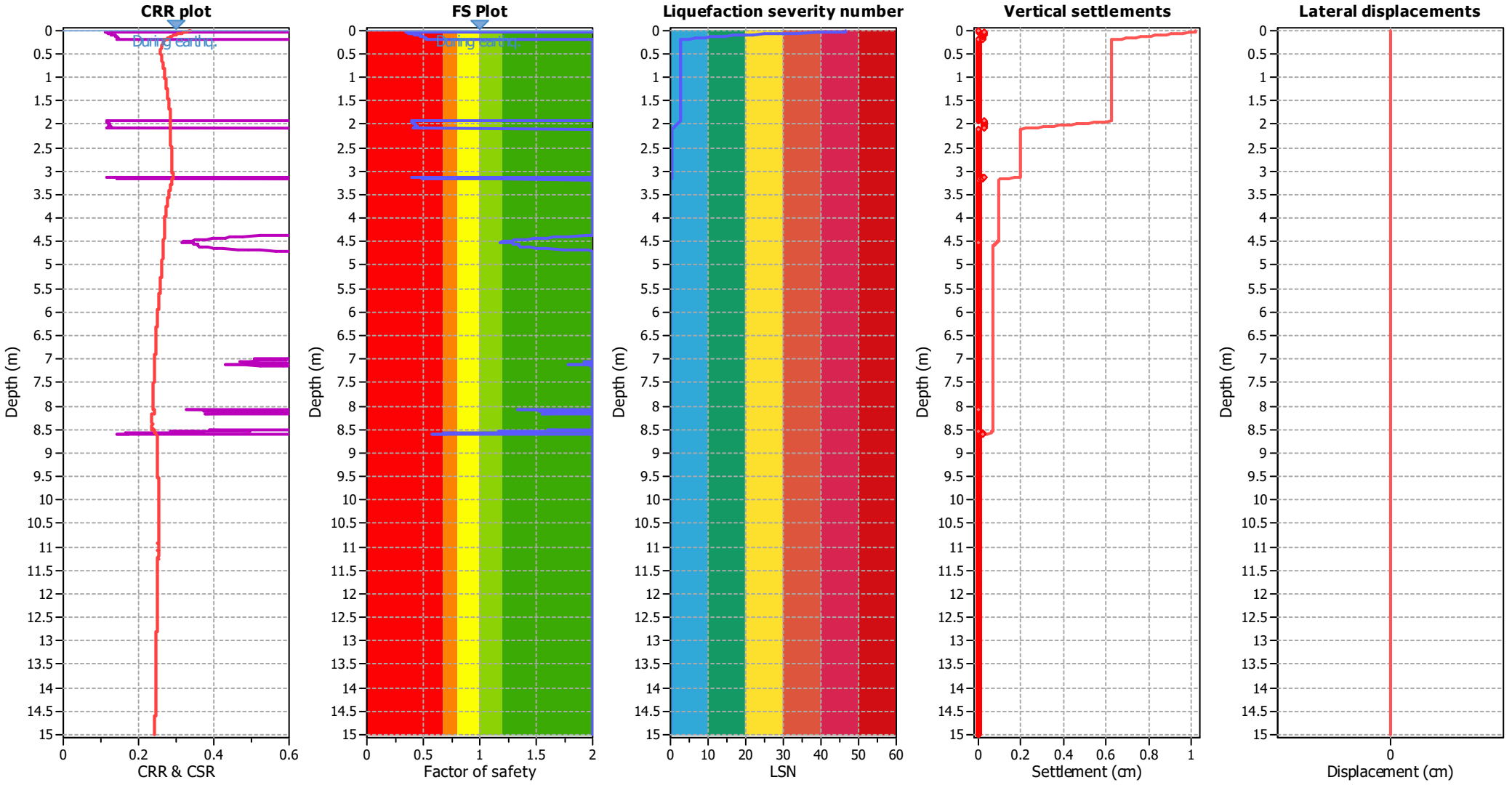
F.S. color scheme

- 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.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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- Very likely to liquefy
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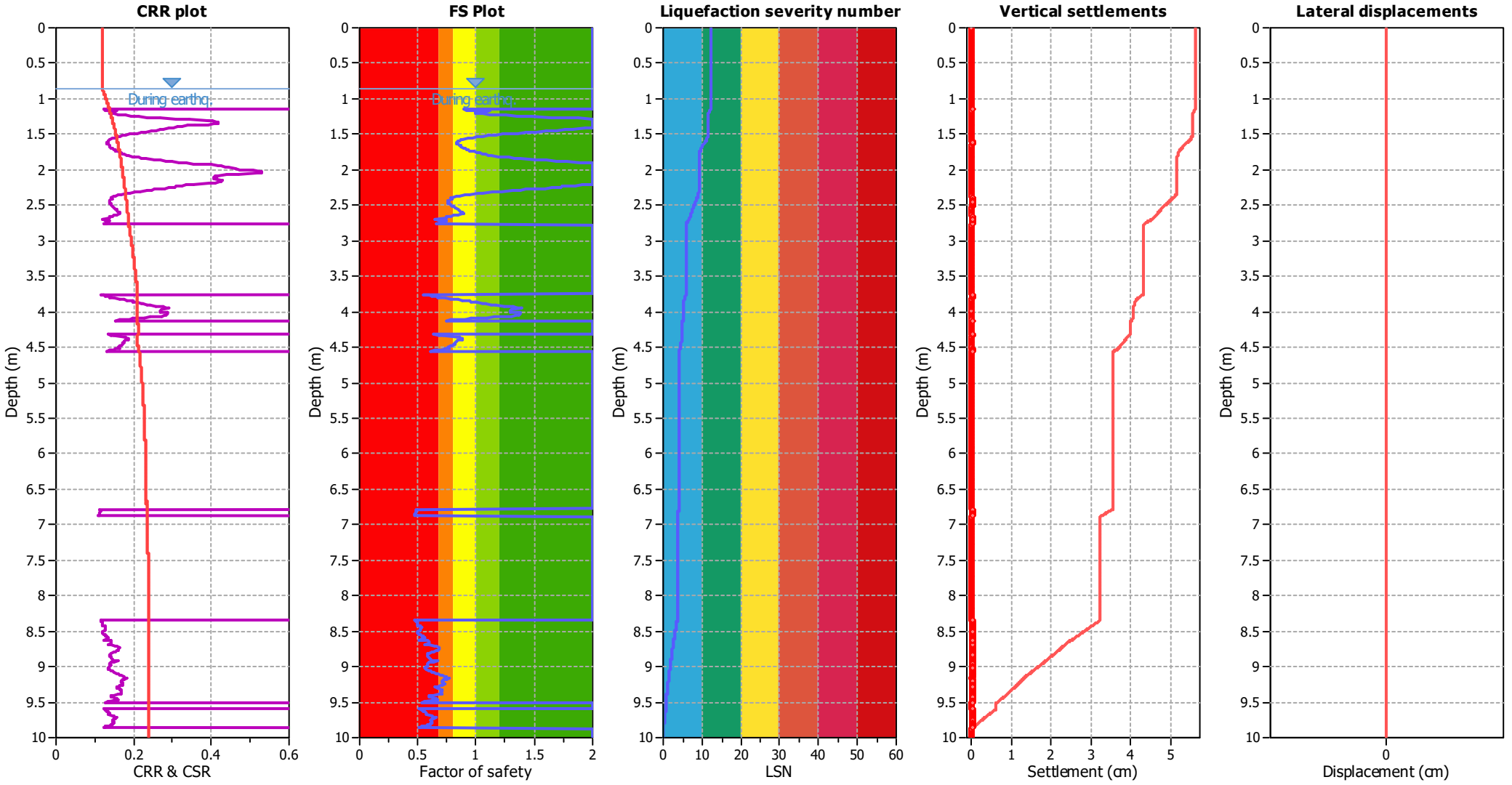
LSN color scheme

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.85 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.85 m	Fill height:	N/A	Limit depth:	10.00 m

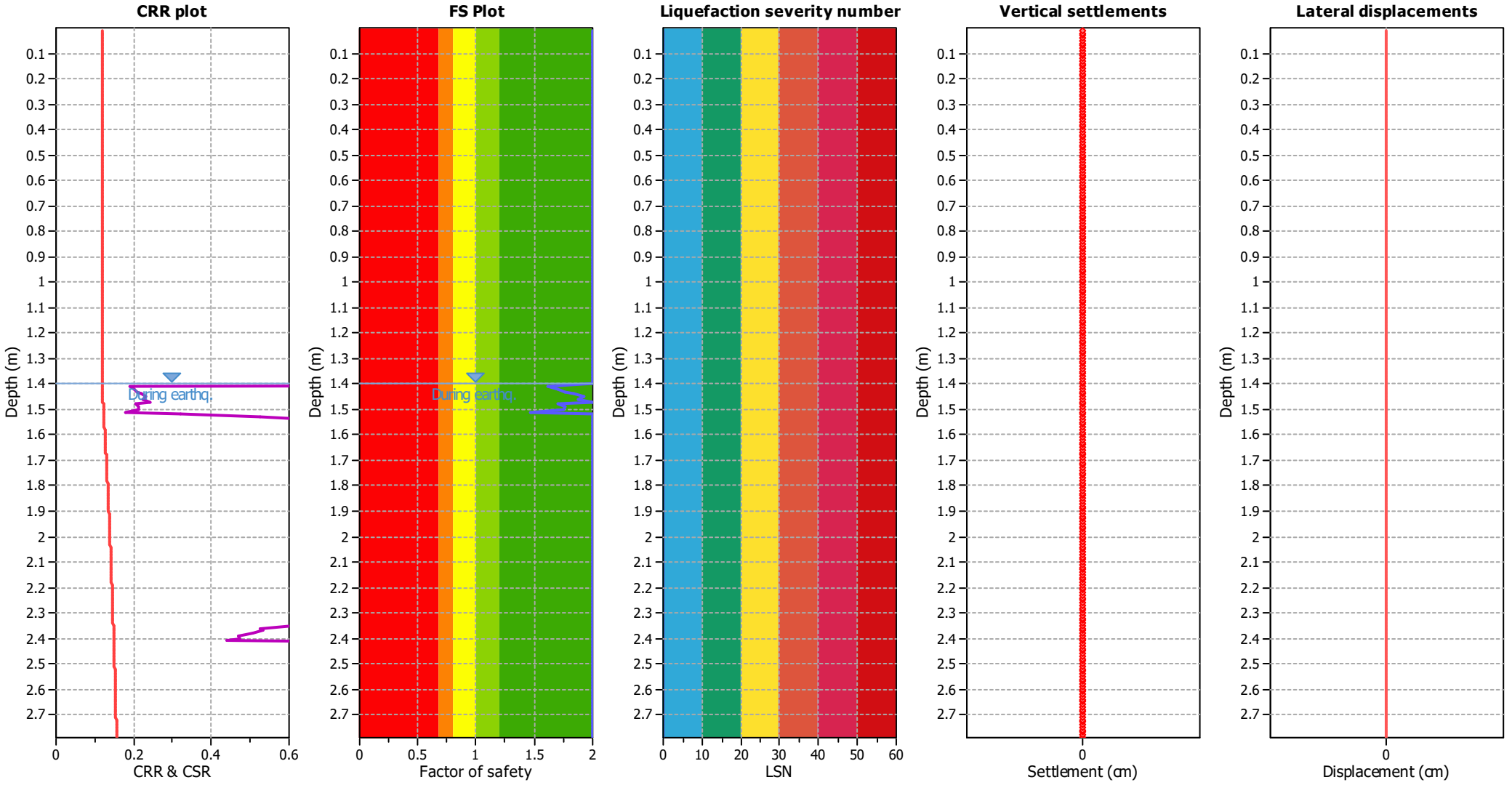
F.S. color scheme

- 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.):	1.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.40 m	Fill height:	N/A	Limit depth:	10.00 m

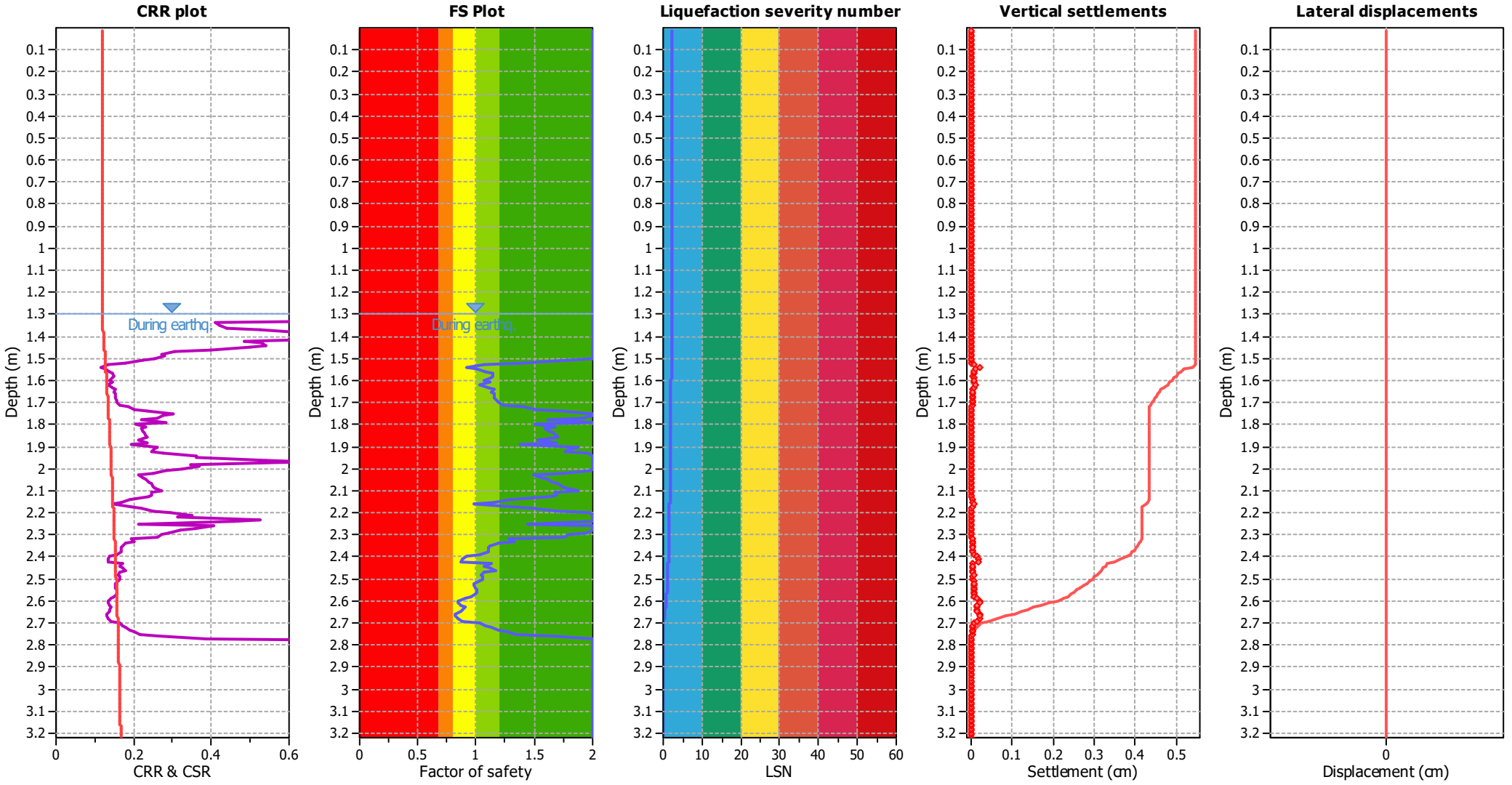
F.S. color scheme

- 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.):	1.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.30 m	Fill height:	N/A	Limit depth:	10.00 m

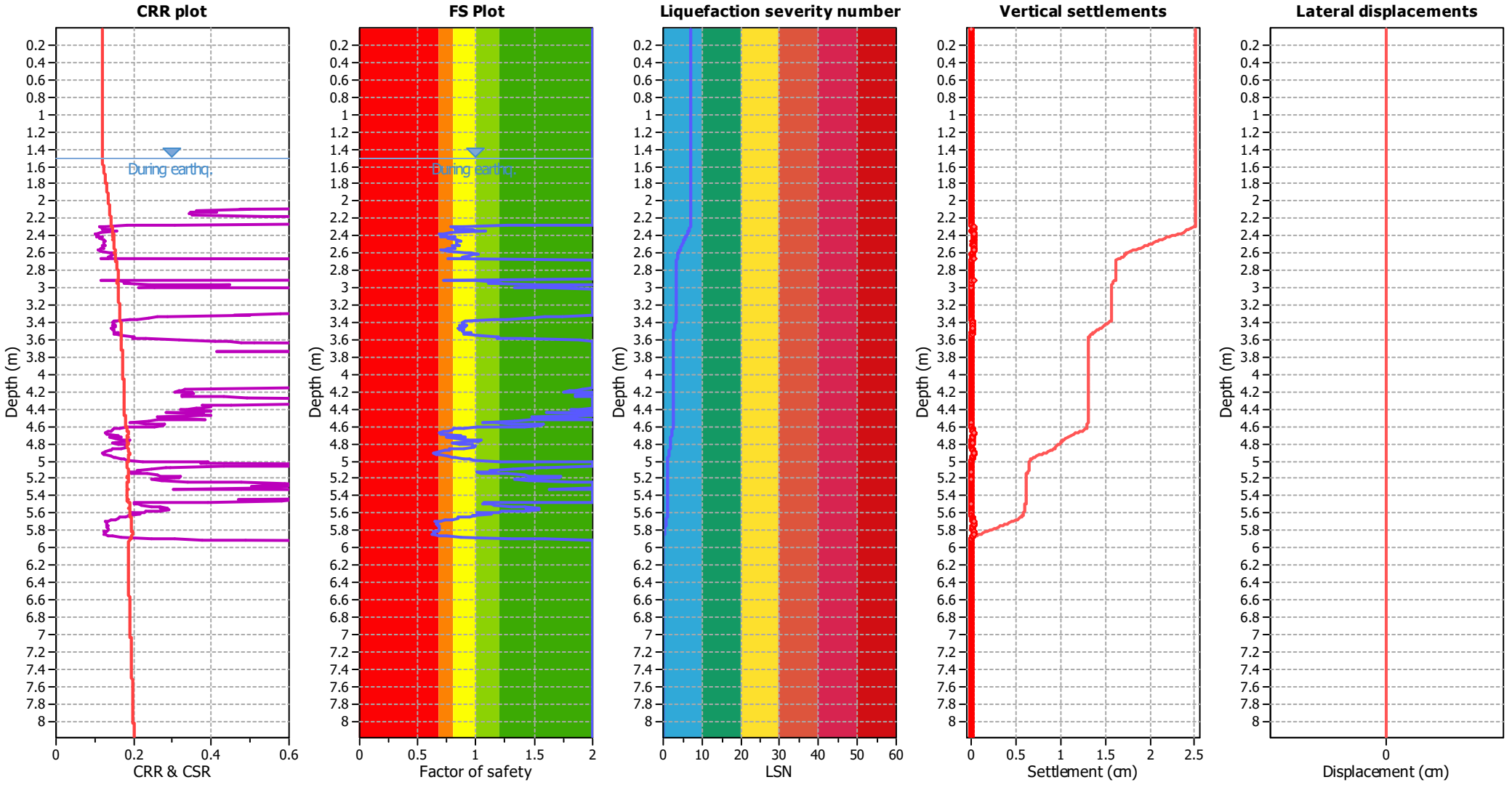
F.S. color scheme

- 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.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

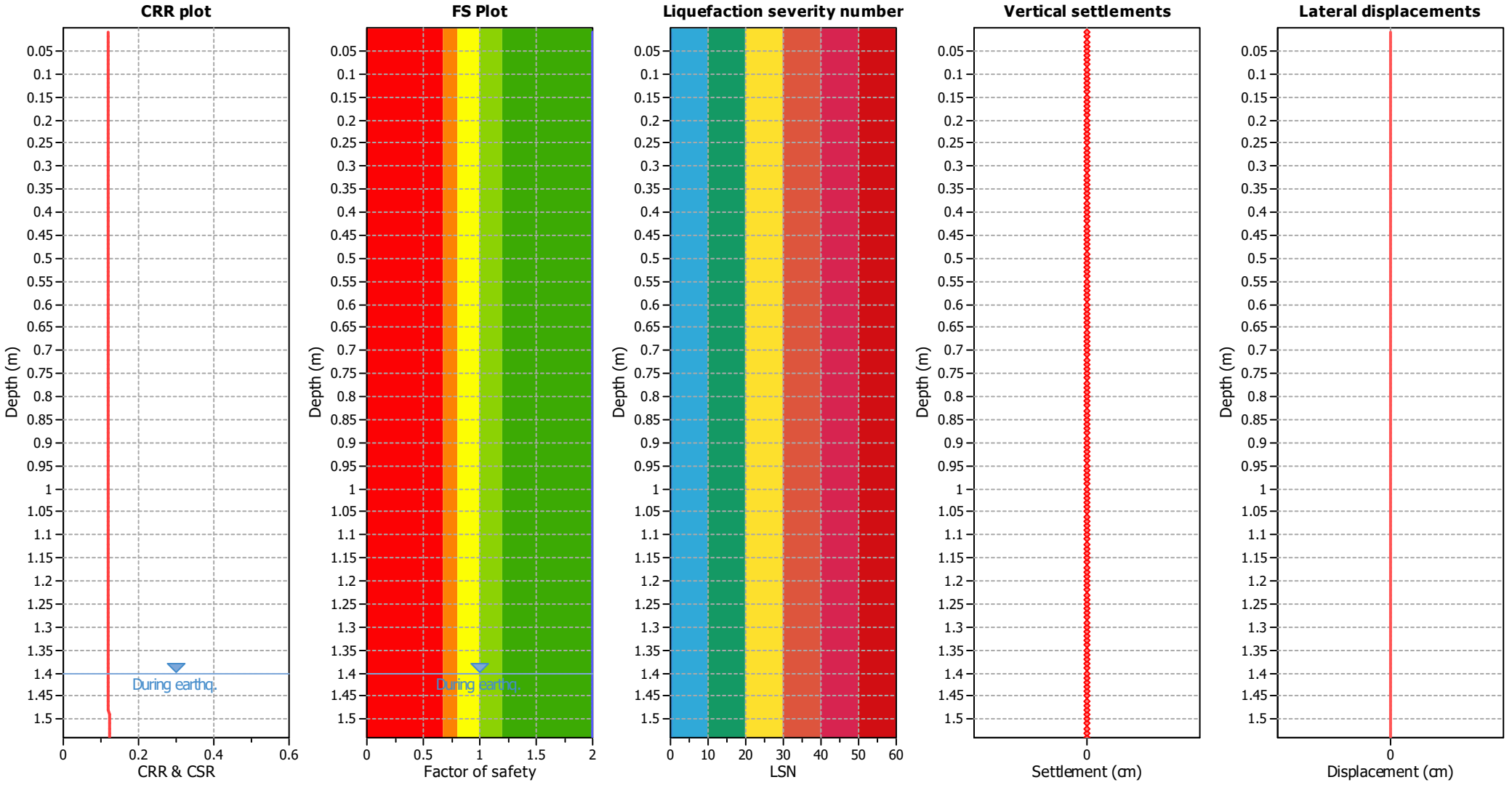
F.S. color scheme

- 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.):	1.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.40 m	Fill height:	N/A	Limit depth:	10.00 m

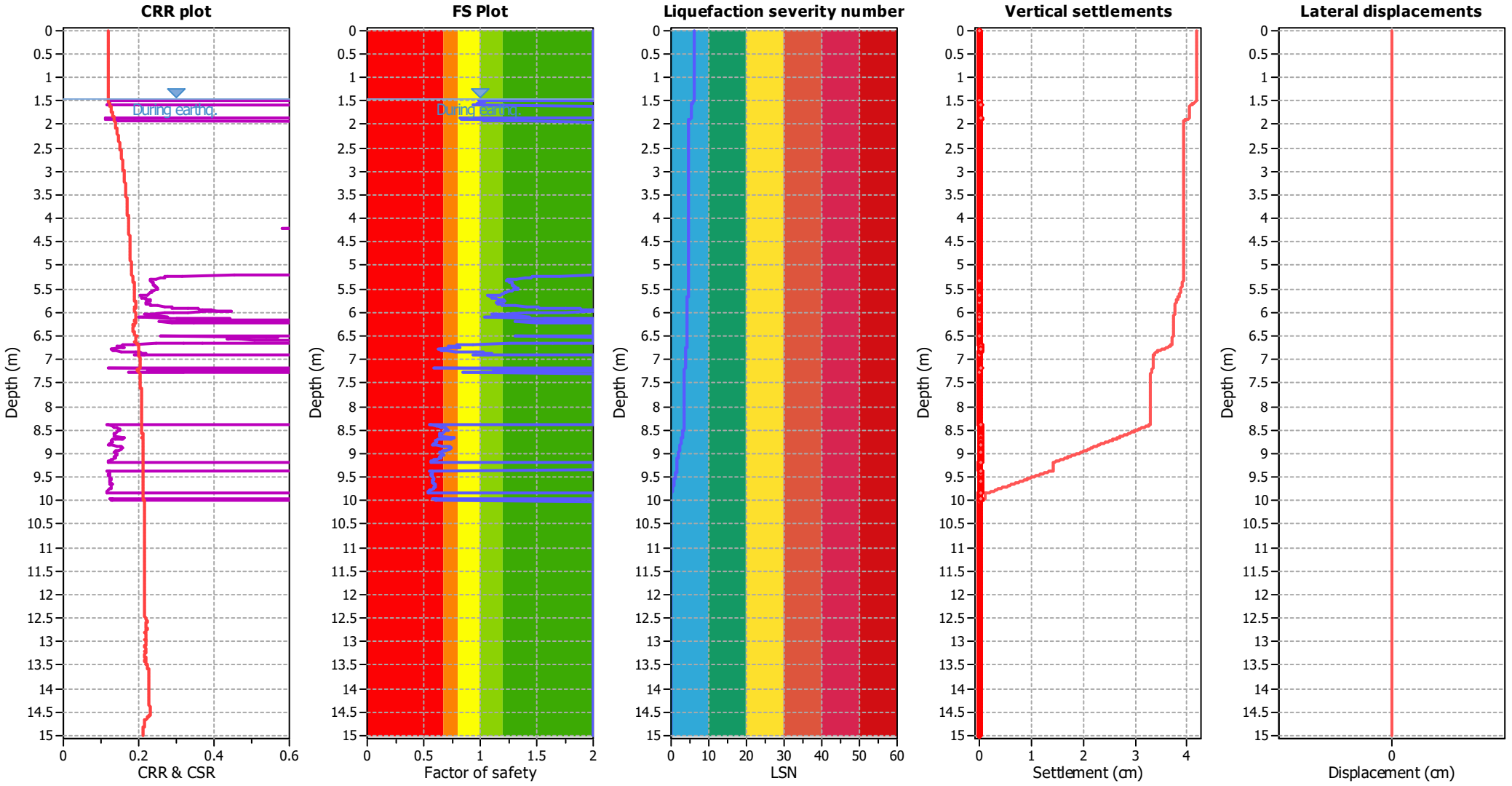
F.S. color scheme

- 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.):	1.45 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.45 m	Fill height:	N/A	Limit depth:	10.00 m

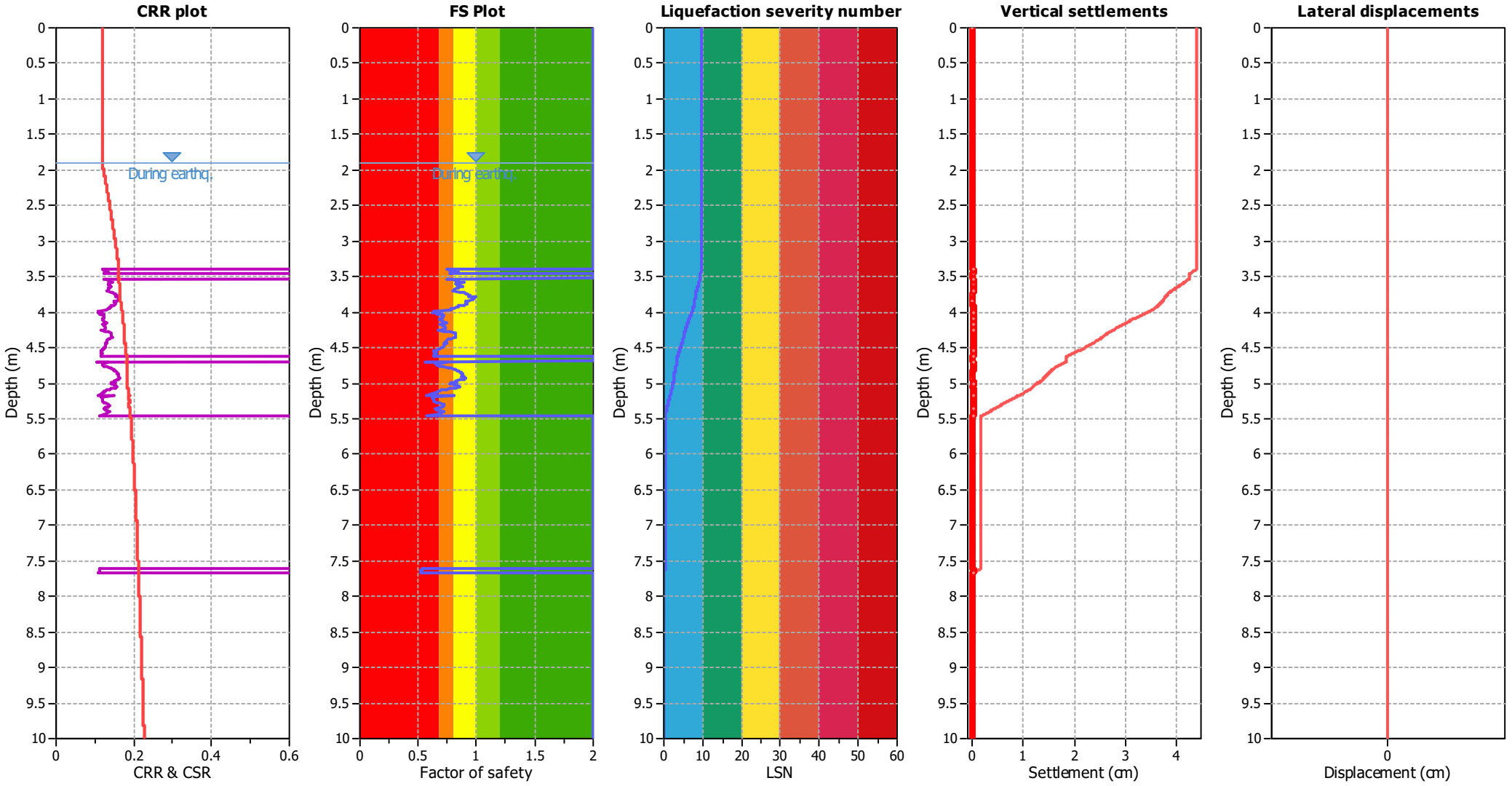
F.S. color scheme

- 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.):	1.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.90 m	Fill height:	N/A	Limit depth:	10.00 m

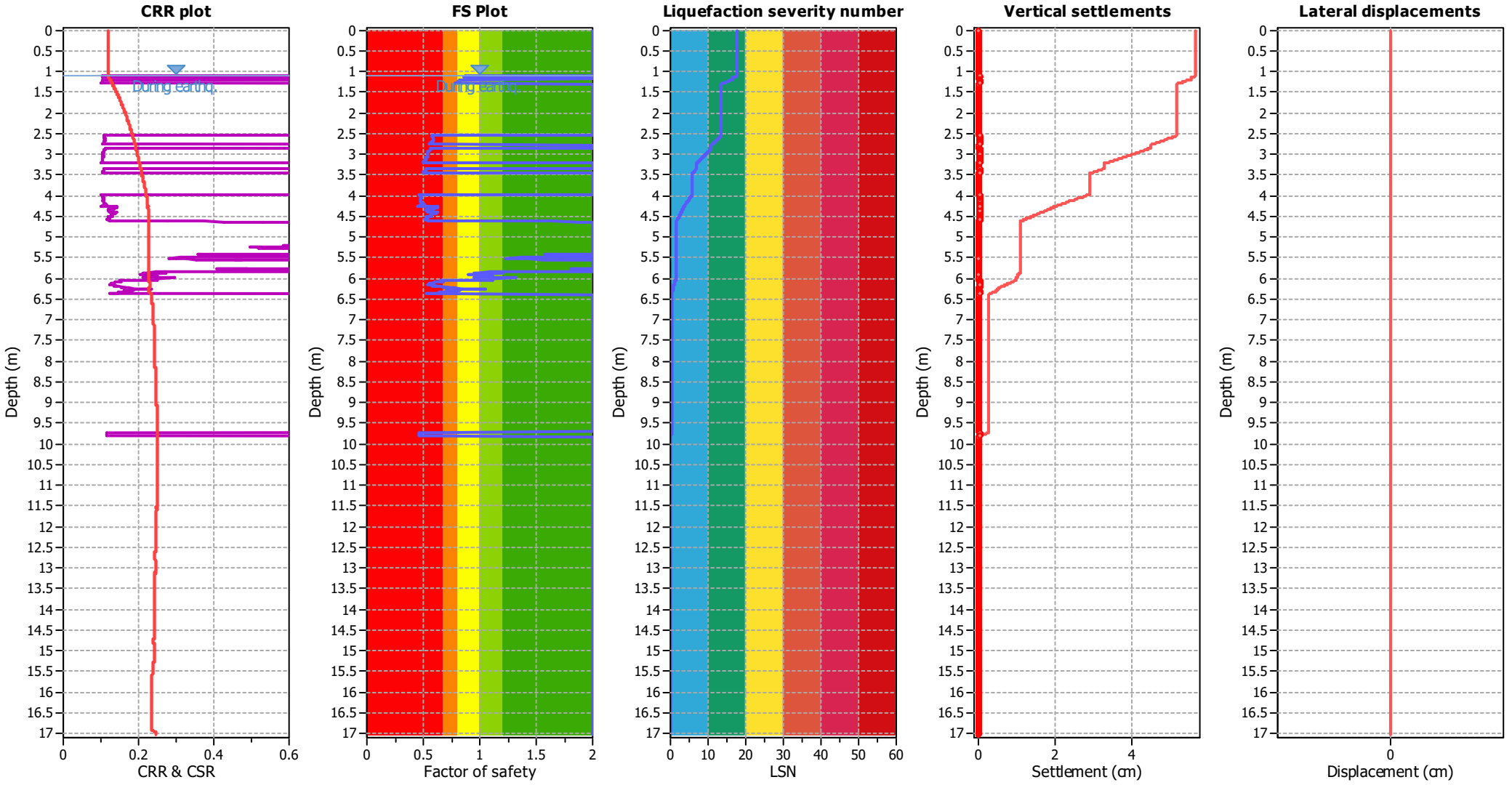
F.S. color scheme

- 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.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

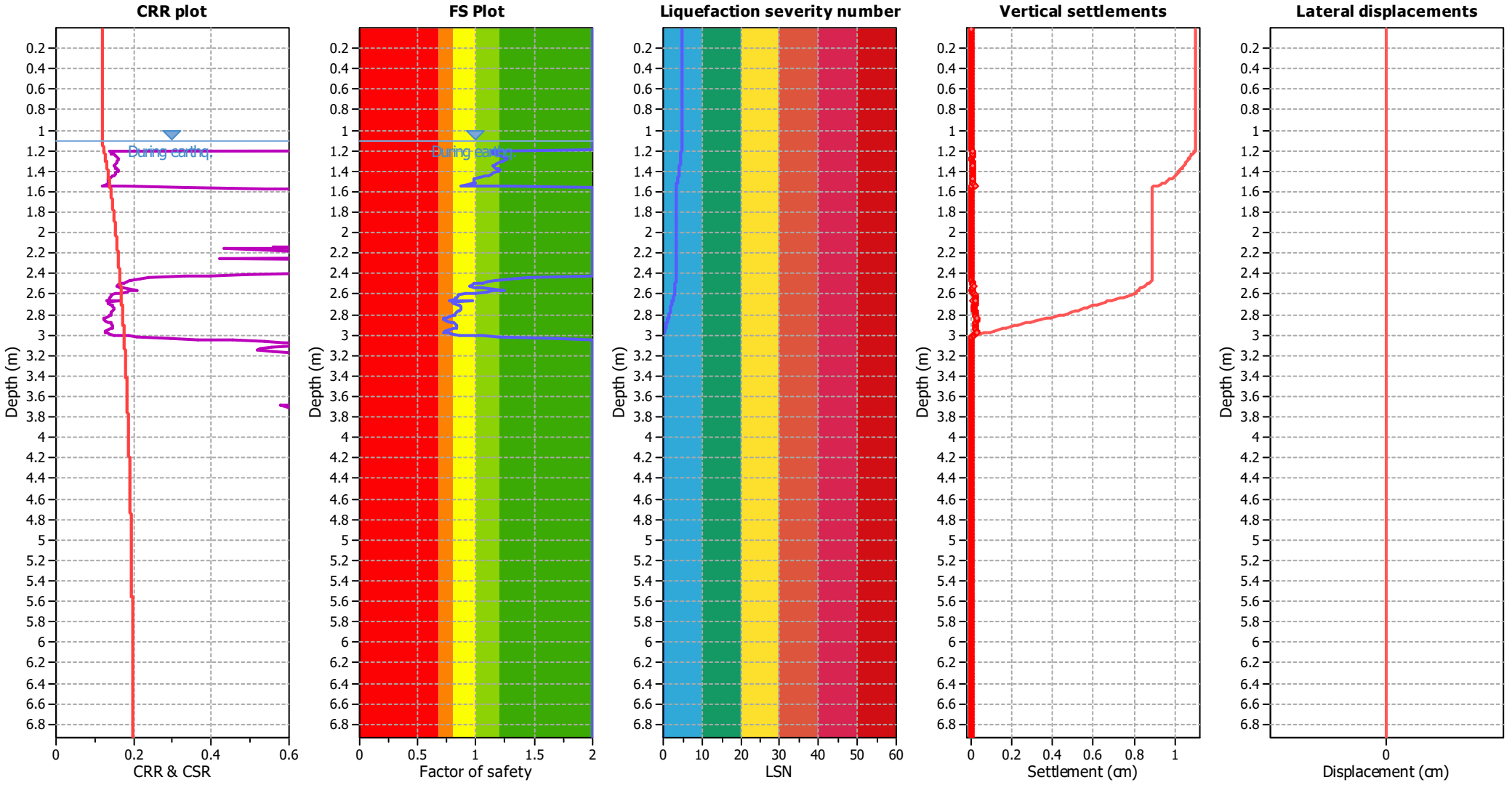
F.S. color scheme

- 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.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

- Almost certain it will liquefy
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LSN color scheme

- Severe damage
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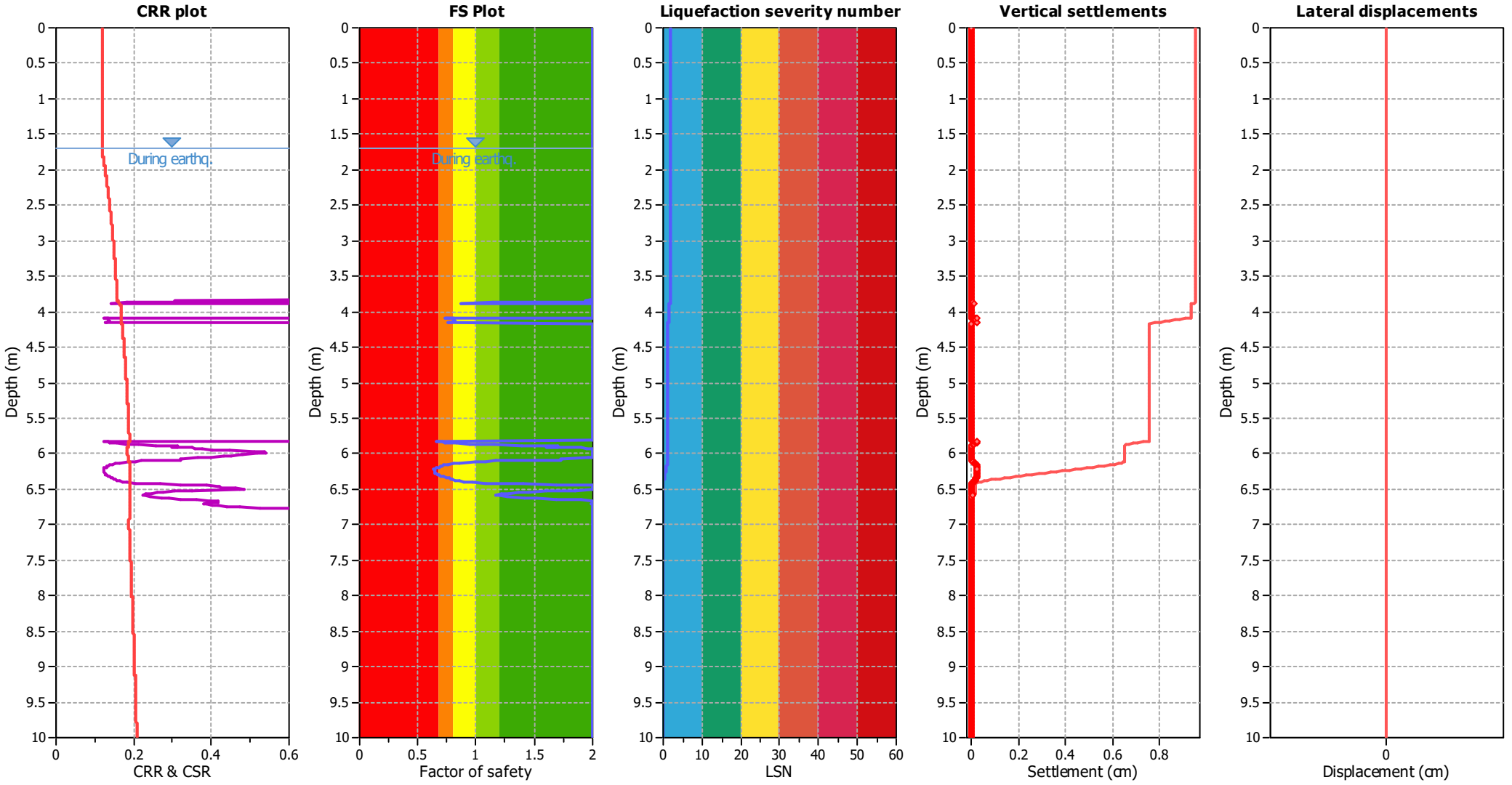
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 m	Fill height:	N/A	Limit depth:	10.00 m

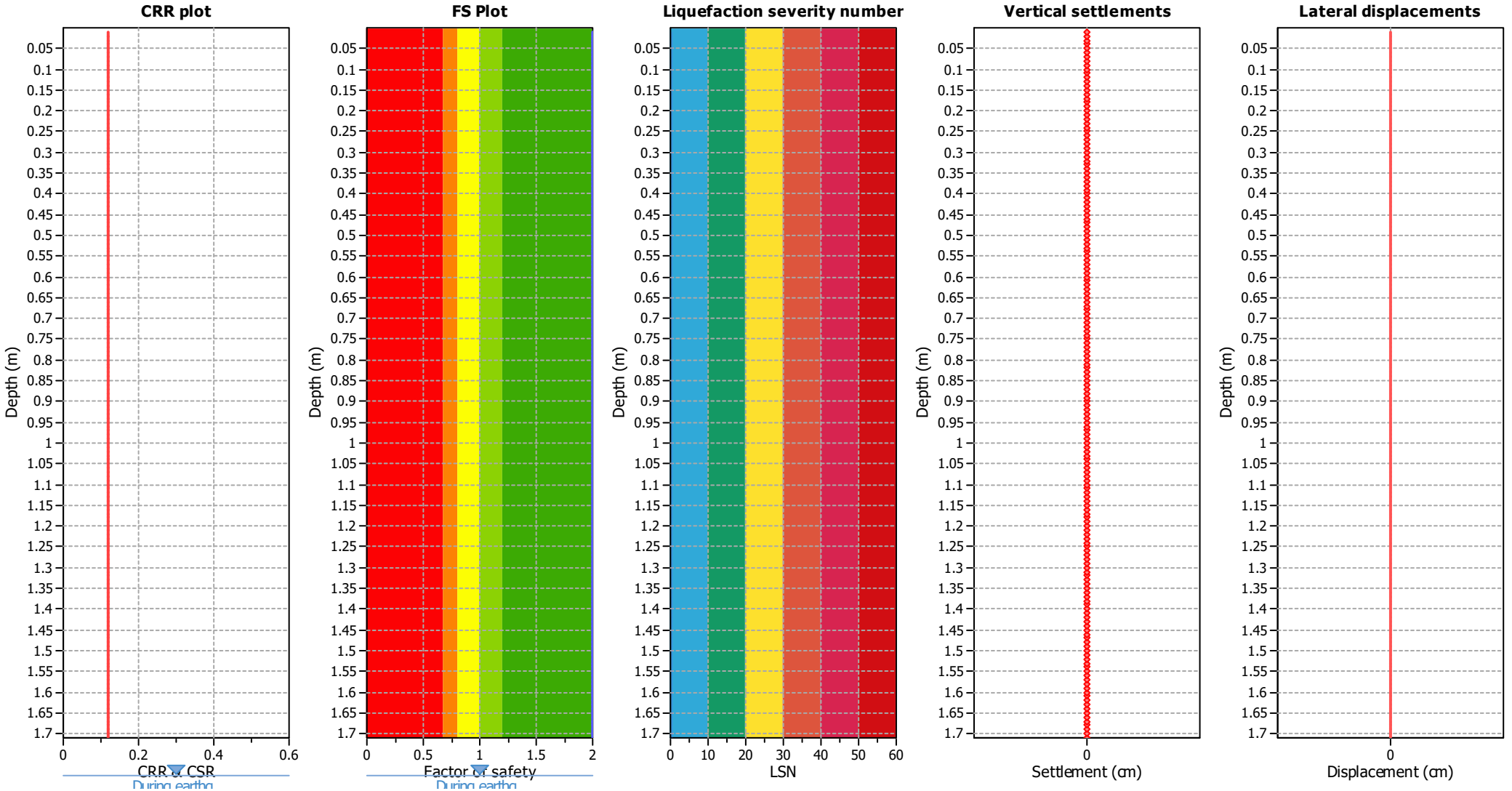
F.S. color scheme

- 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.):	1.80 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.80 m	Fill height:	N/A	Limit depth:	10.00 m

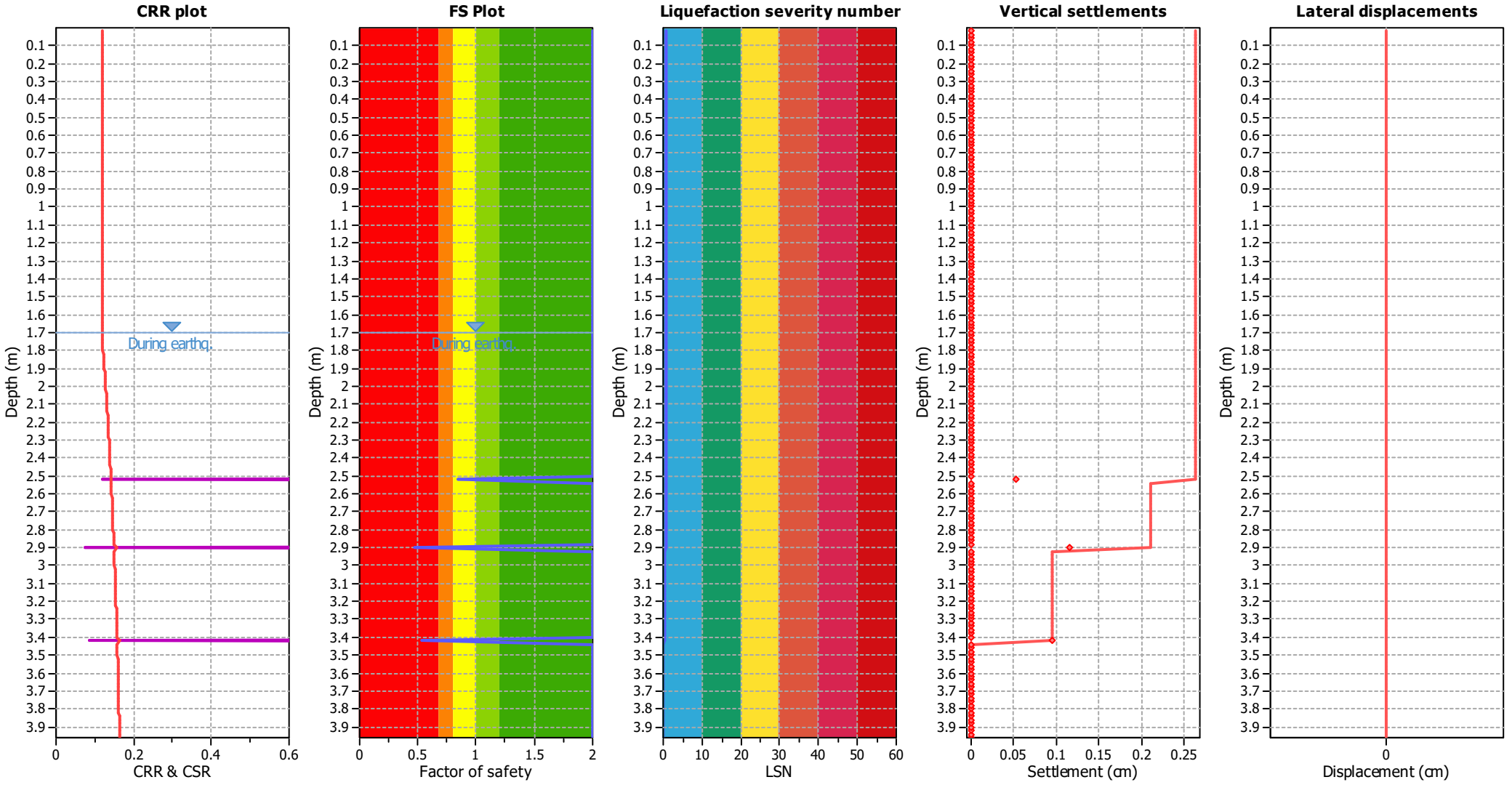
F.S. color scheme

- 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.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

- Almost certain it will liquefy
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- 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
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- Minor expression of liquefaction
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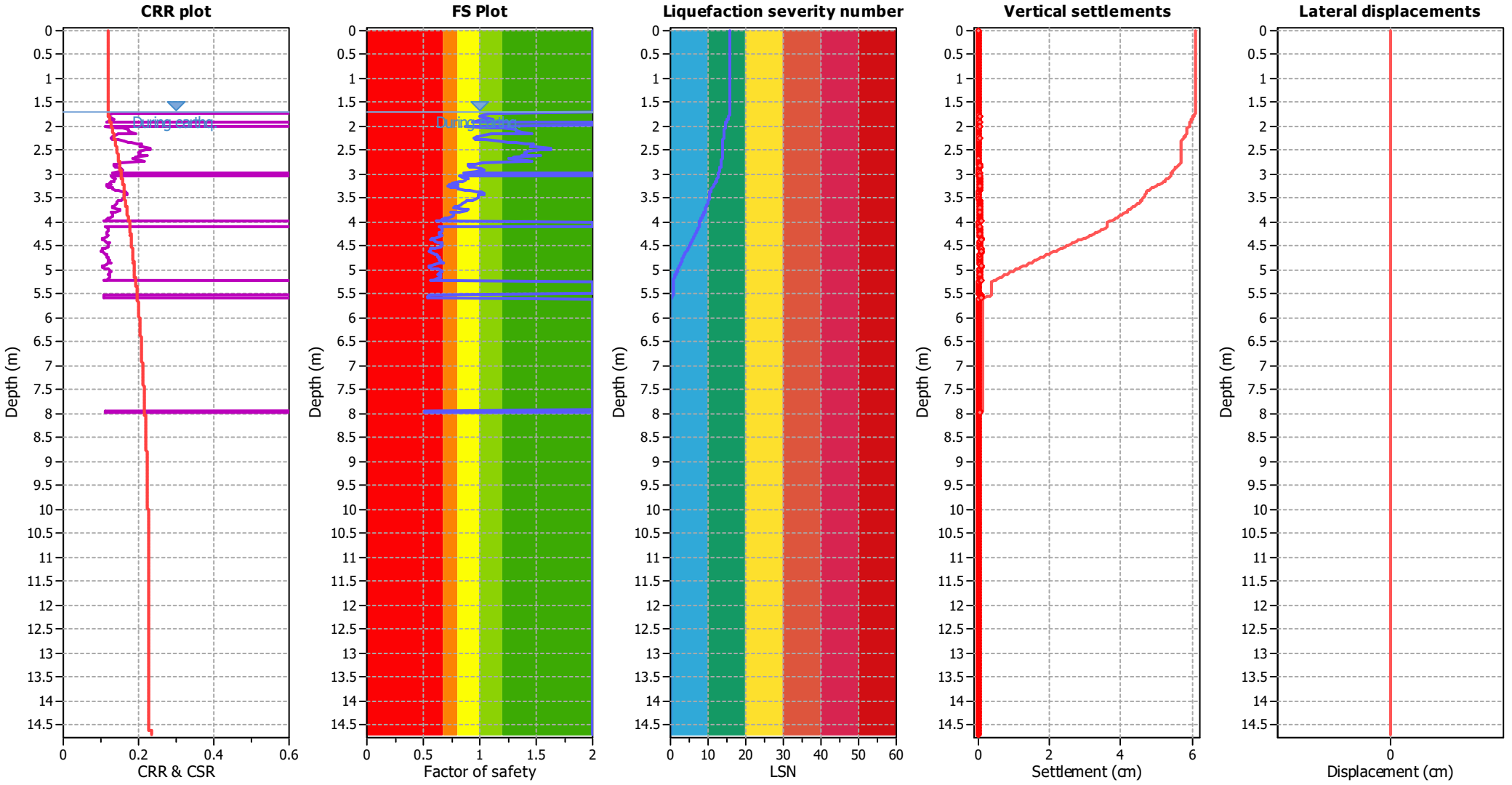
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
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- Almost certain it will not liquefy

LSN color scheme

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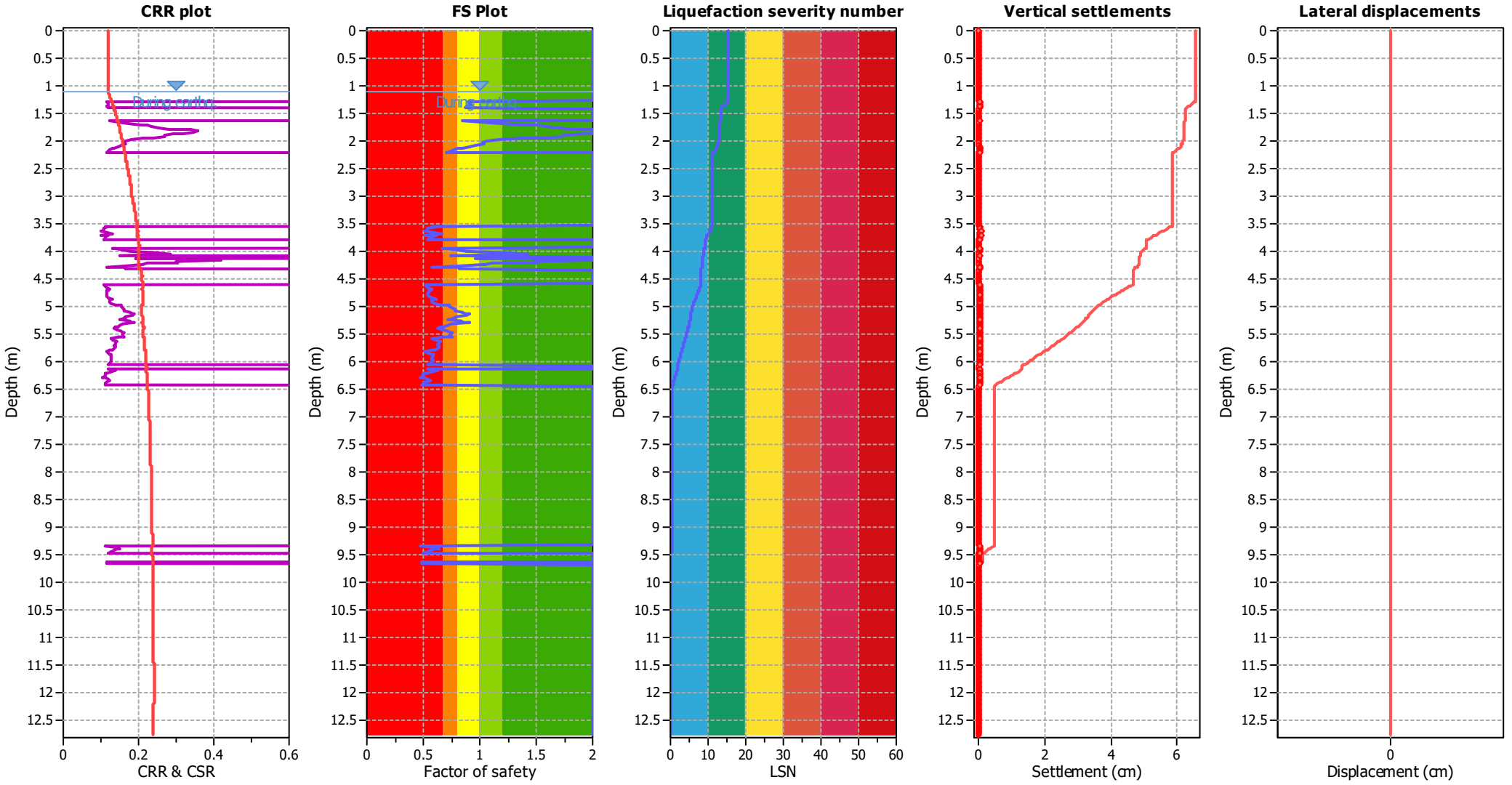
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

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LSN color scheme

- Severe damage
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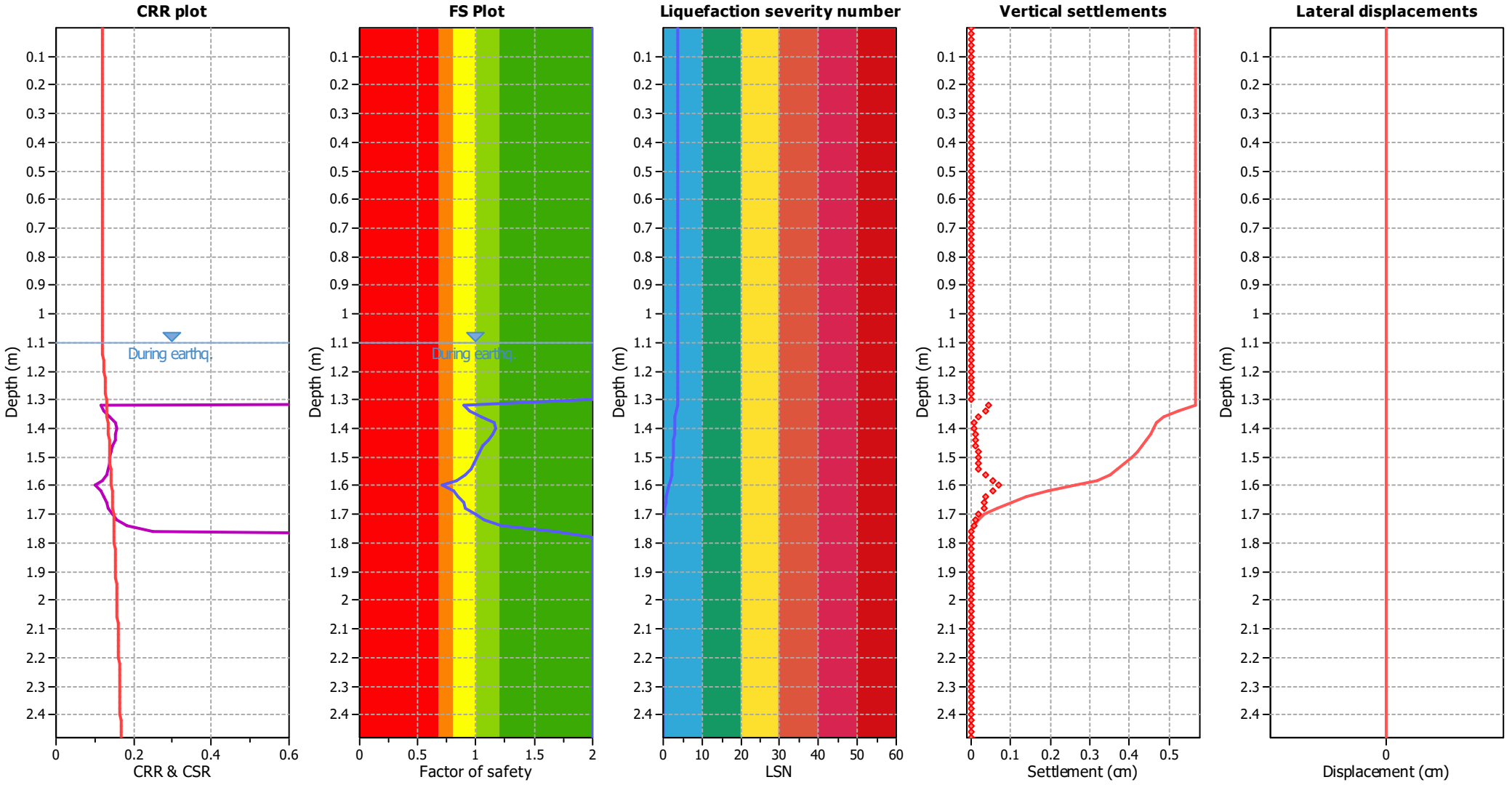
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LSN color scheme

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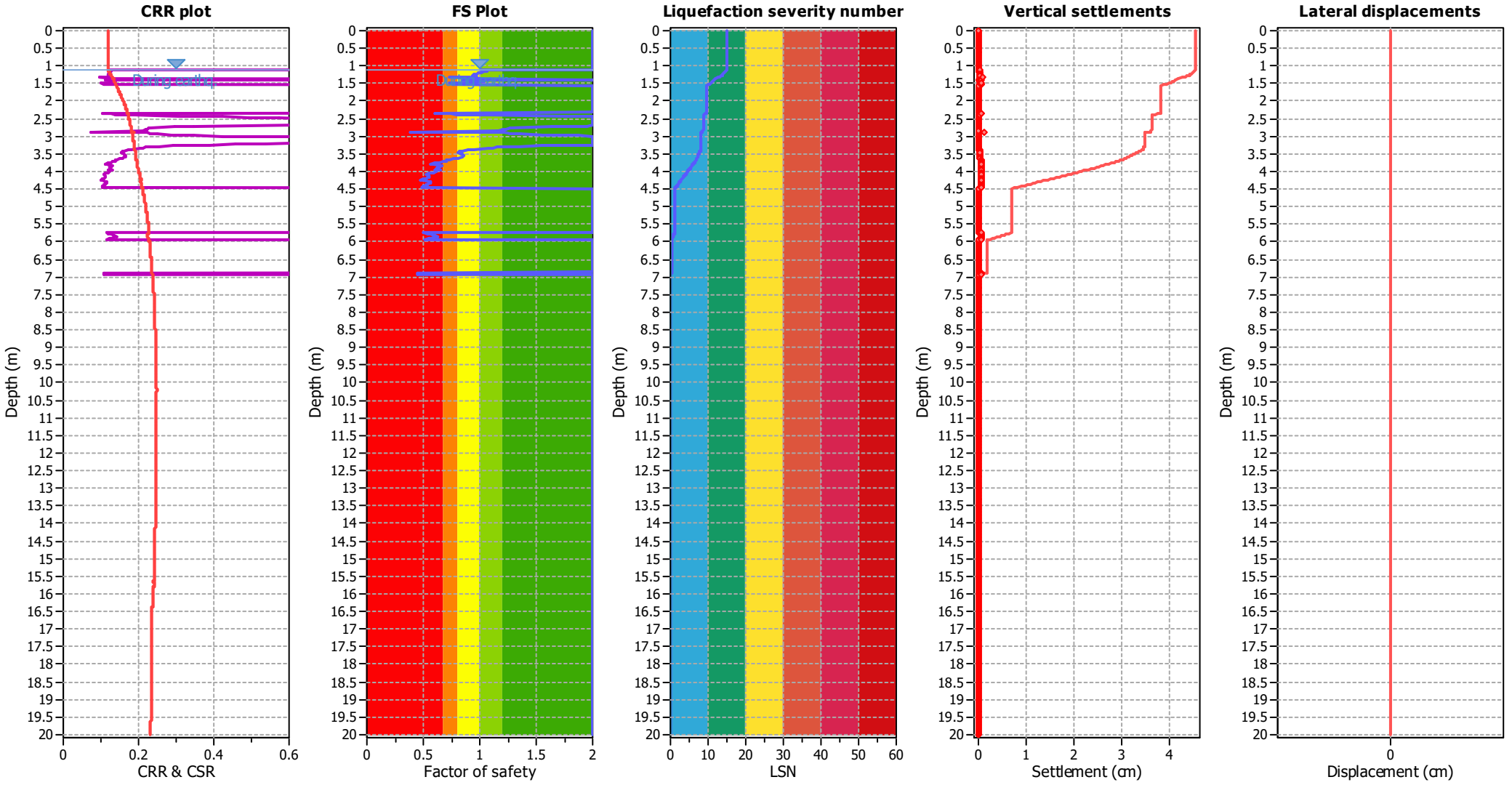
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LSN color scheme

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- Moderate to severe exp. of liquefaction
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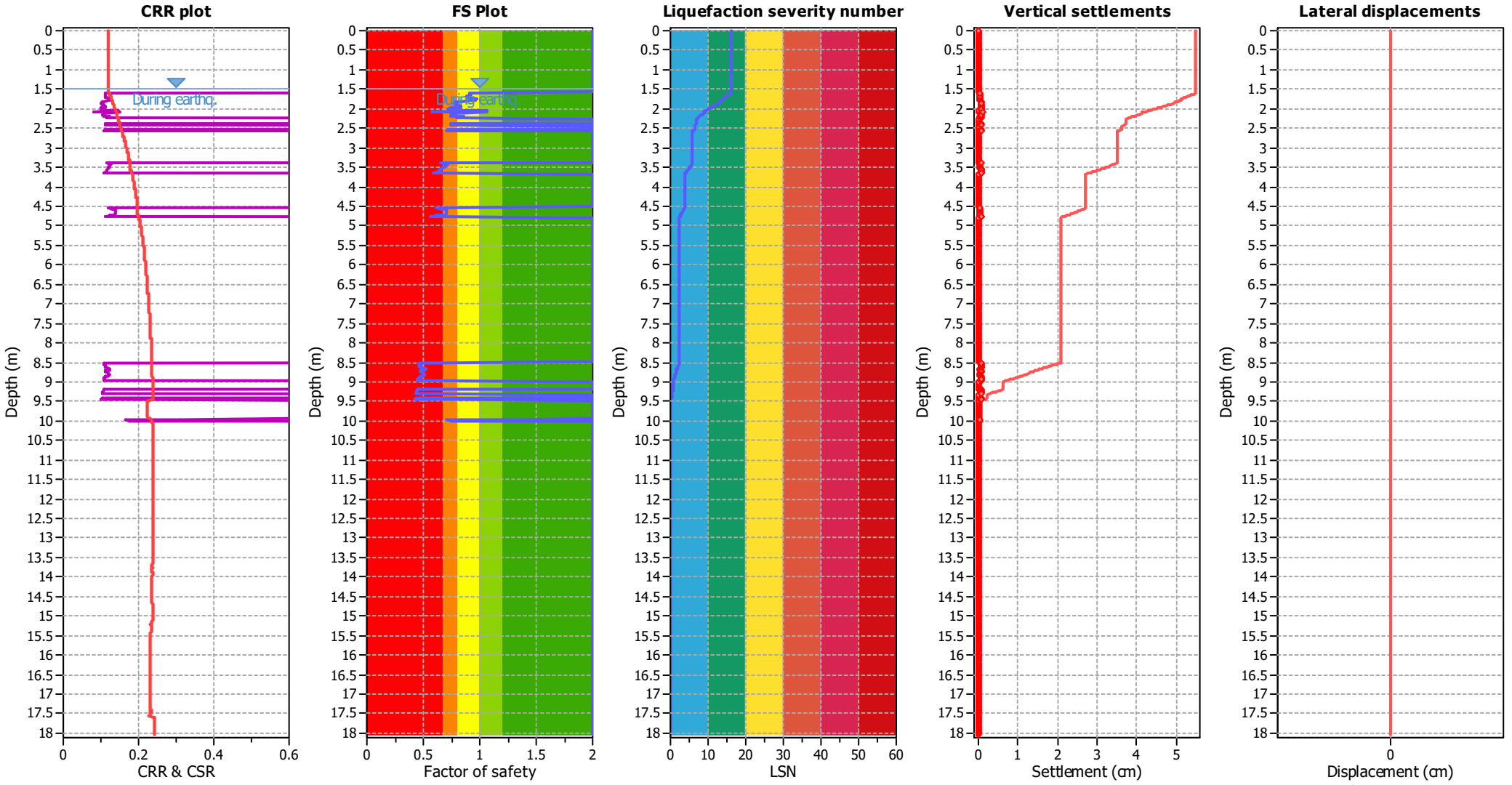
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

- Almost certain it will liquefy
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LSN color scheme

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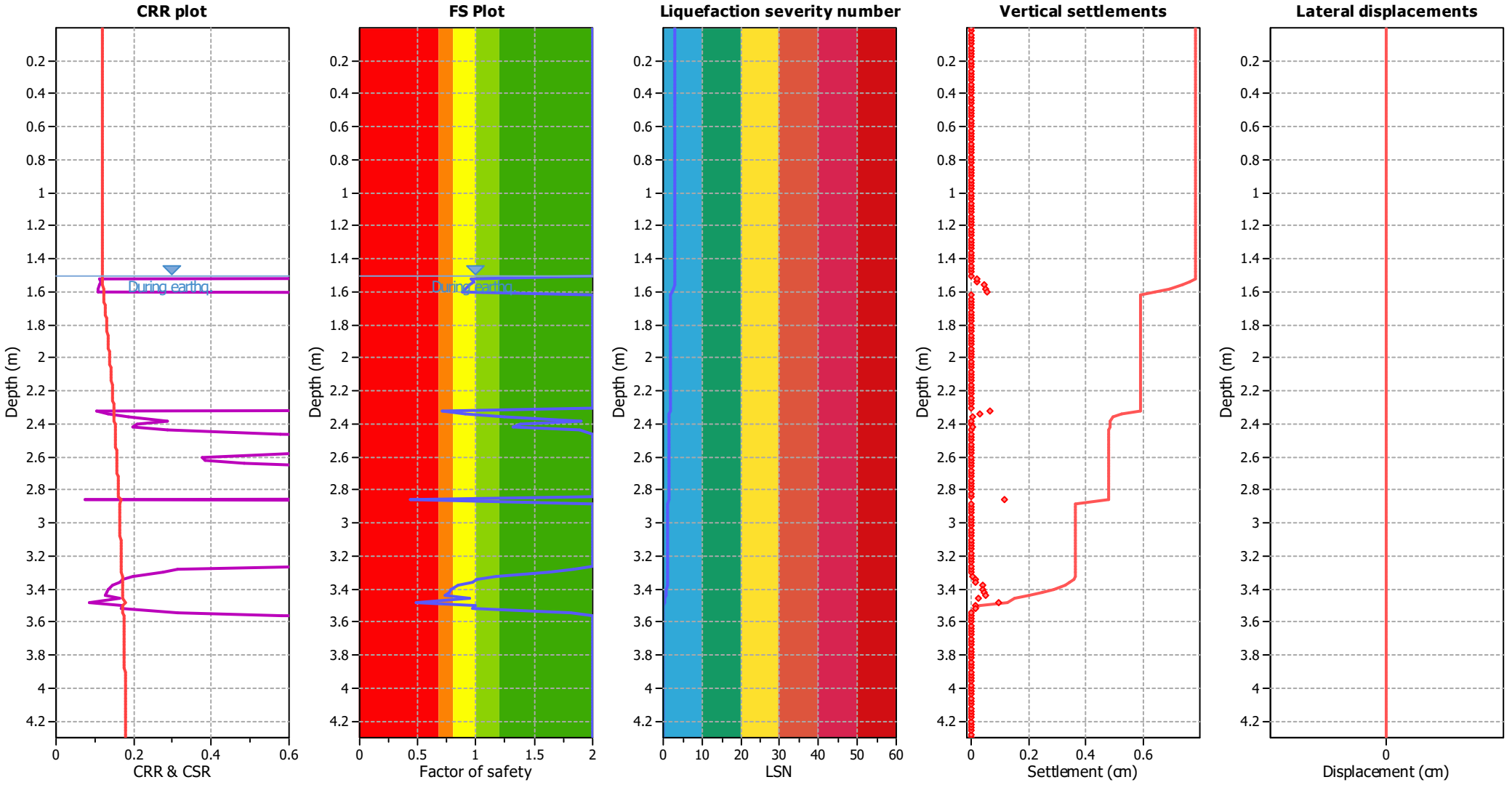
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

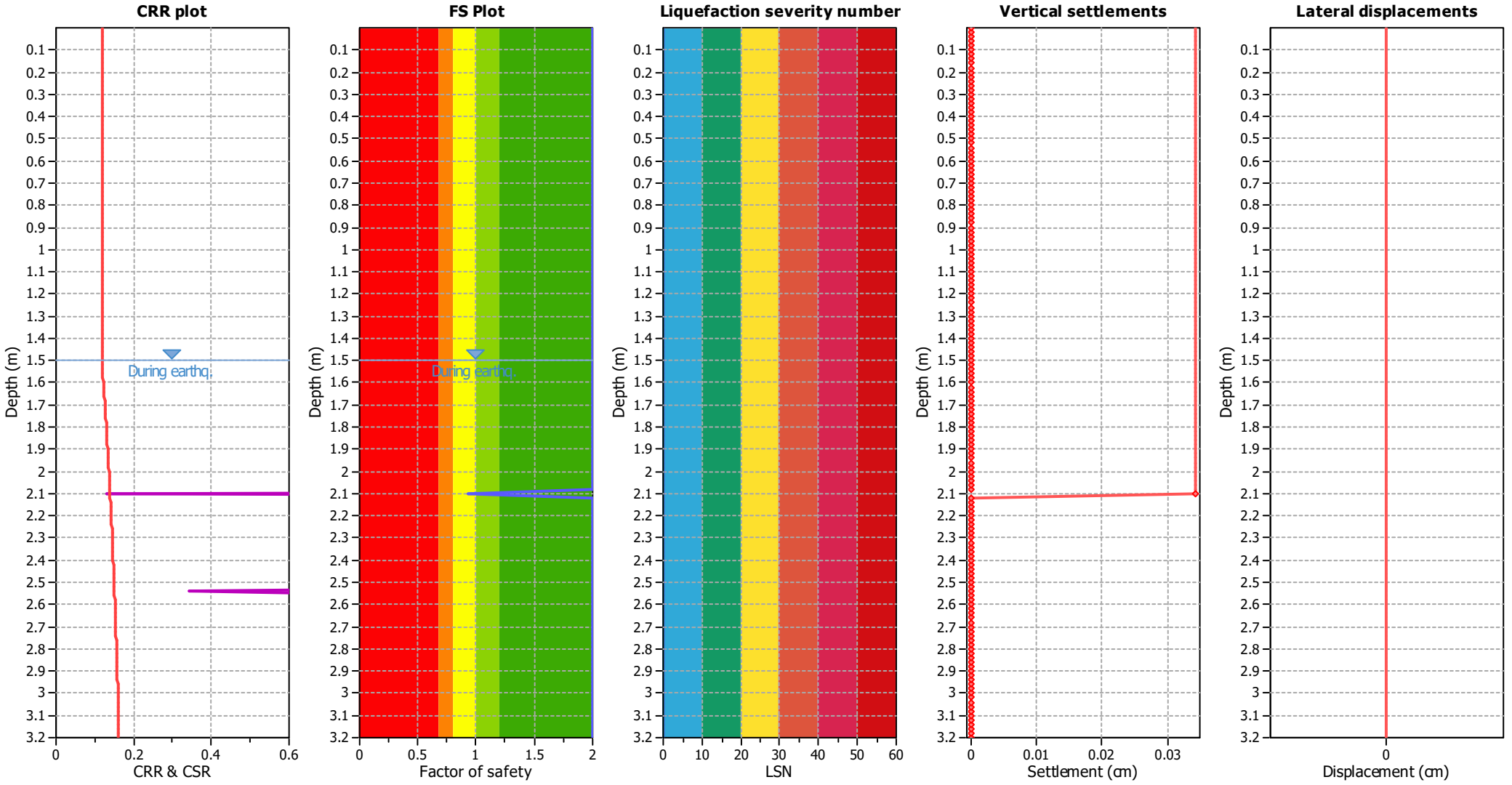
F.S. color scheme

- 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.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

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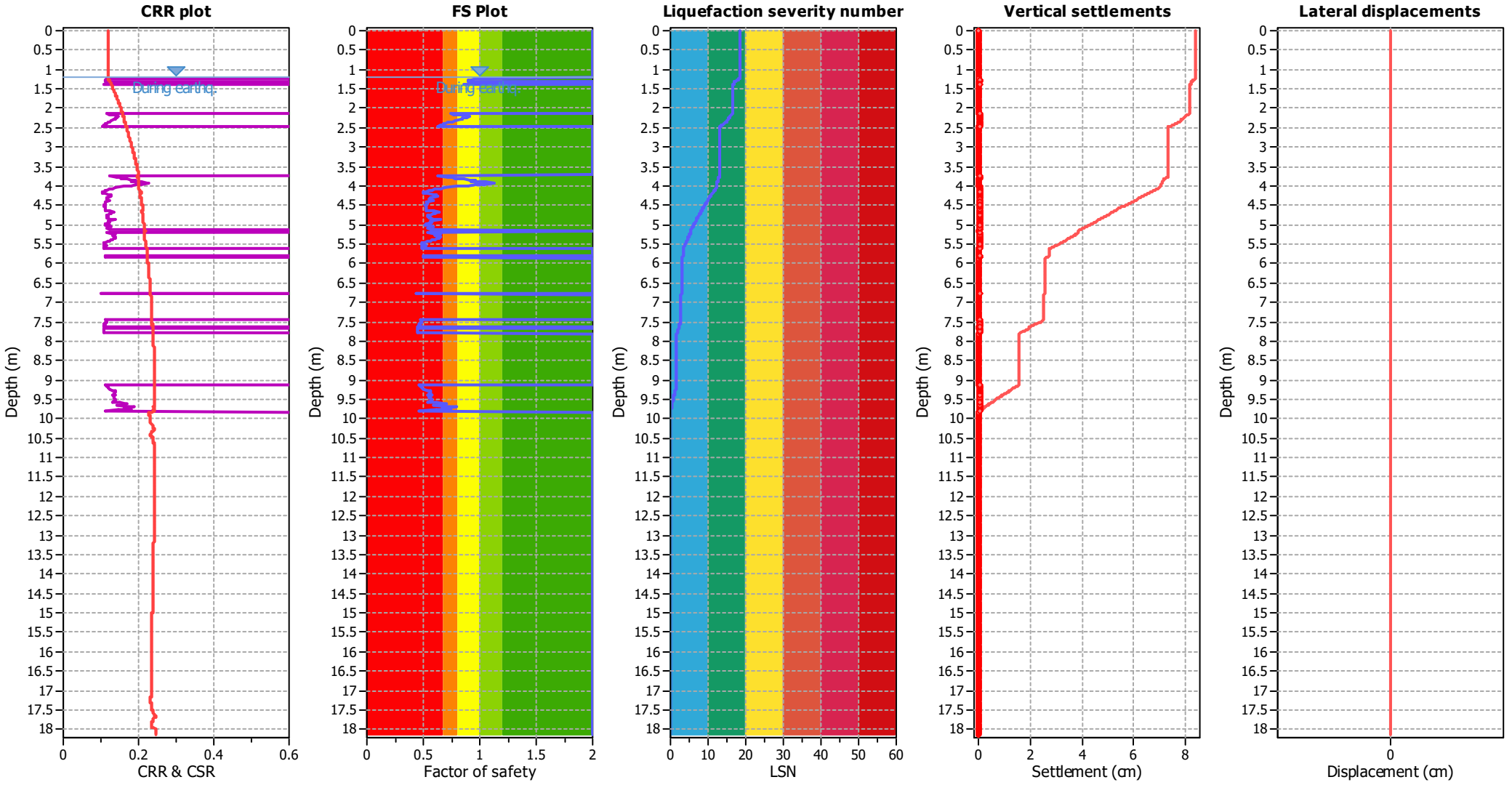

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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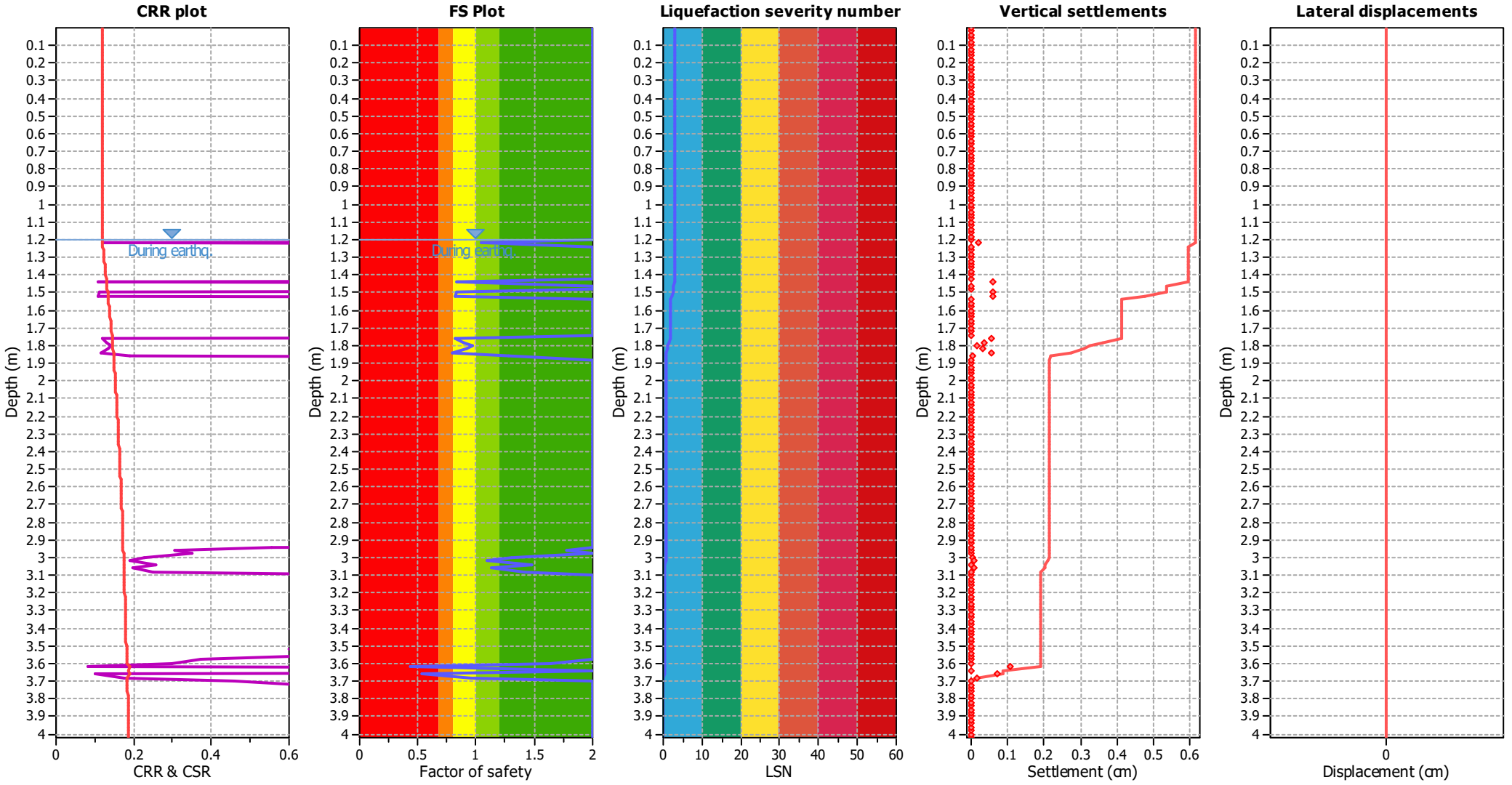

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Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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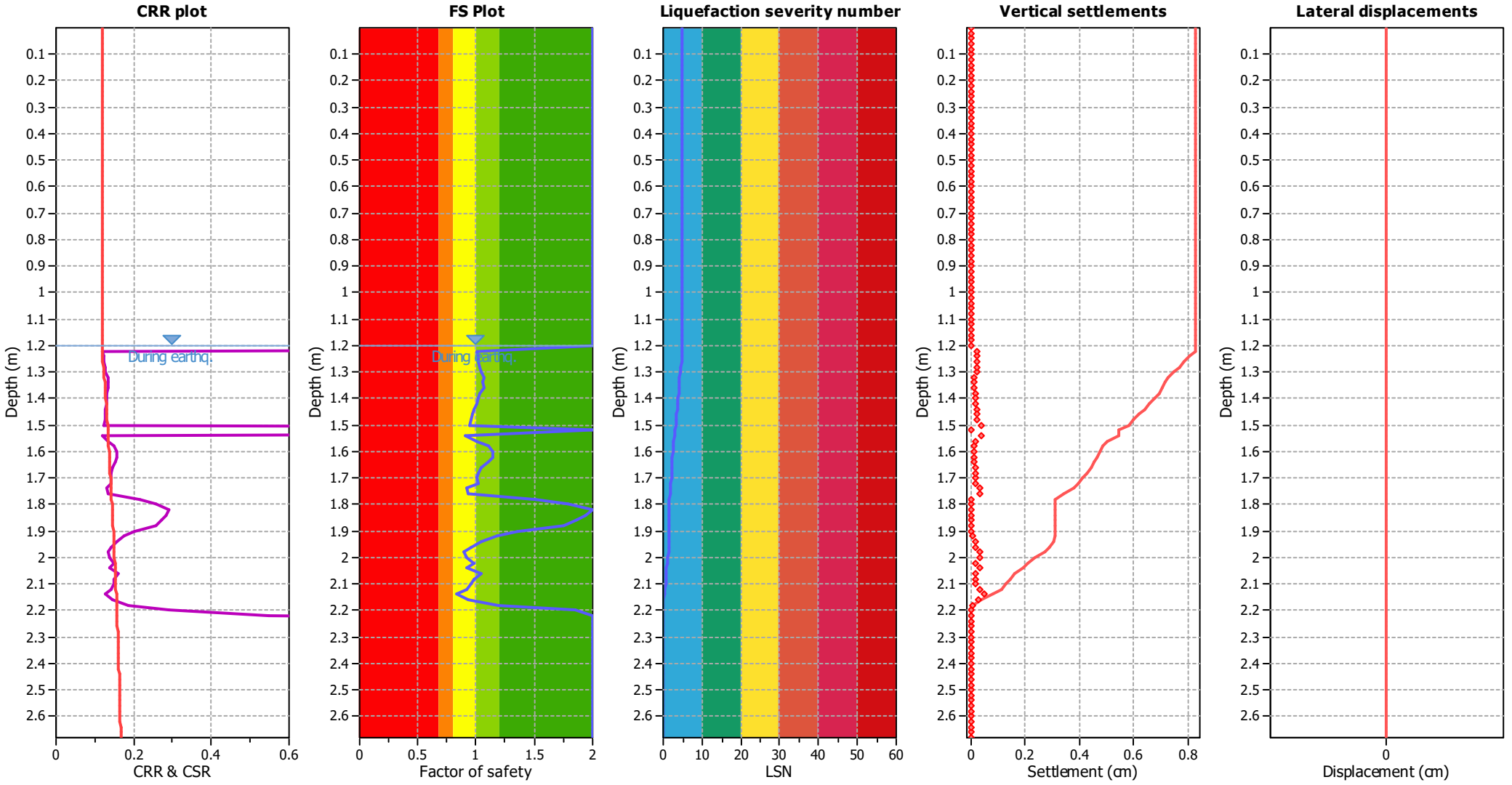

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.20 m	Fill weight:	N/A
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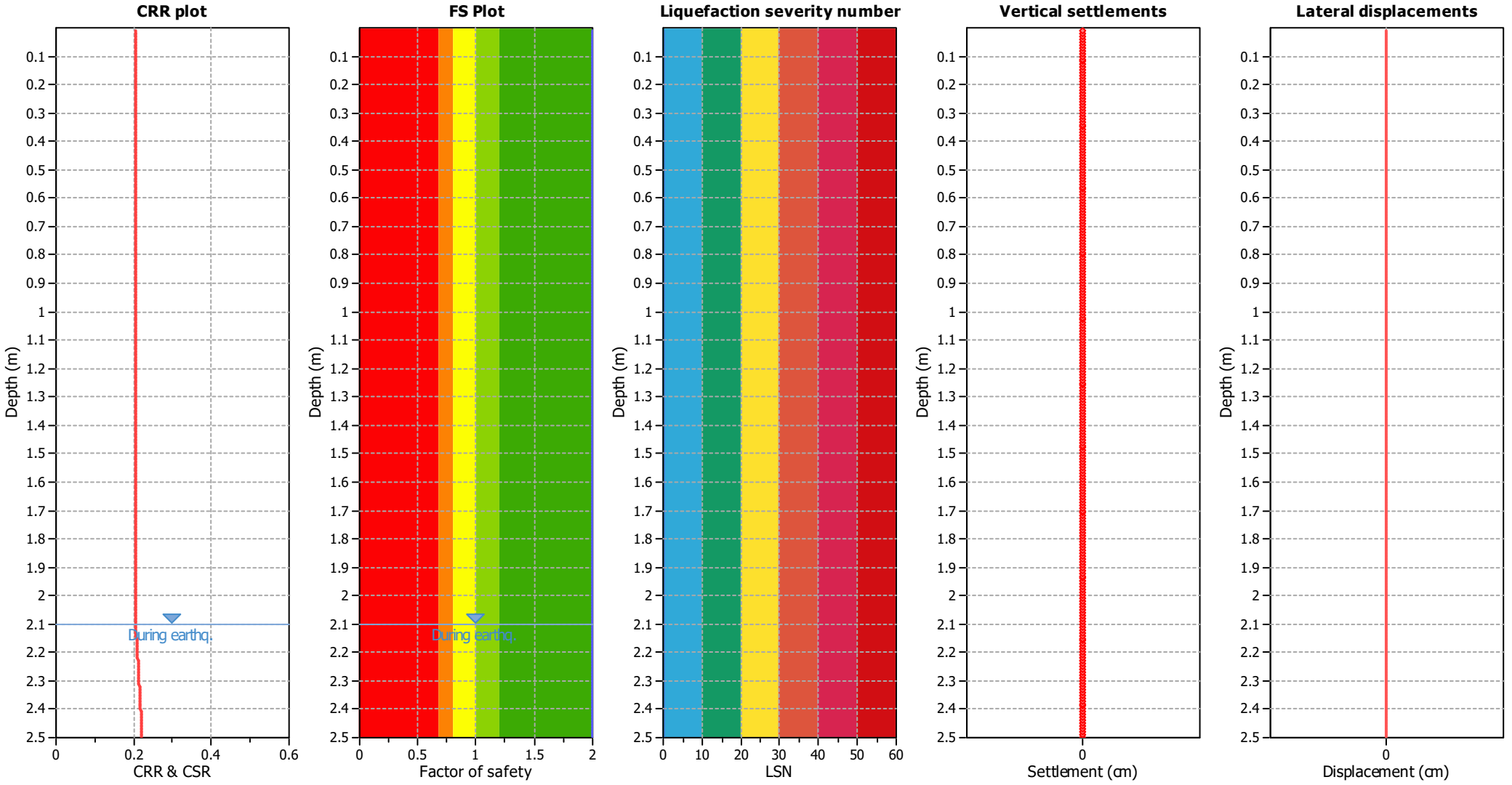

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.10 m	Fill height:	N/A	Limit depth:	10.00 m

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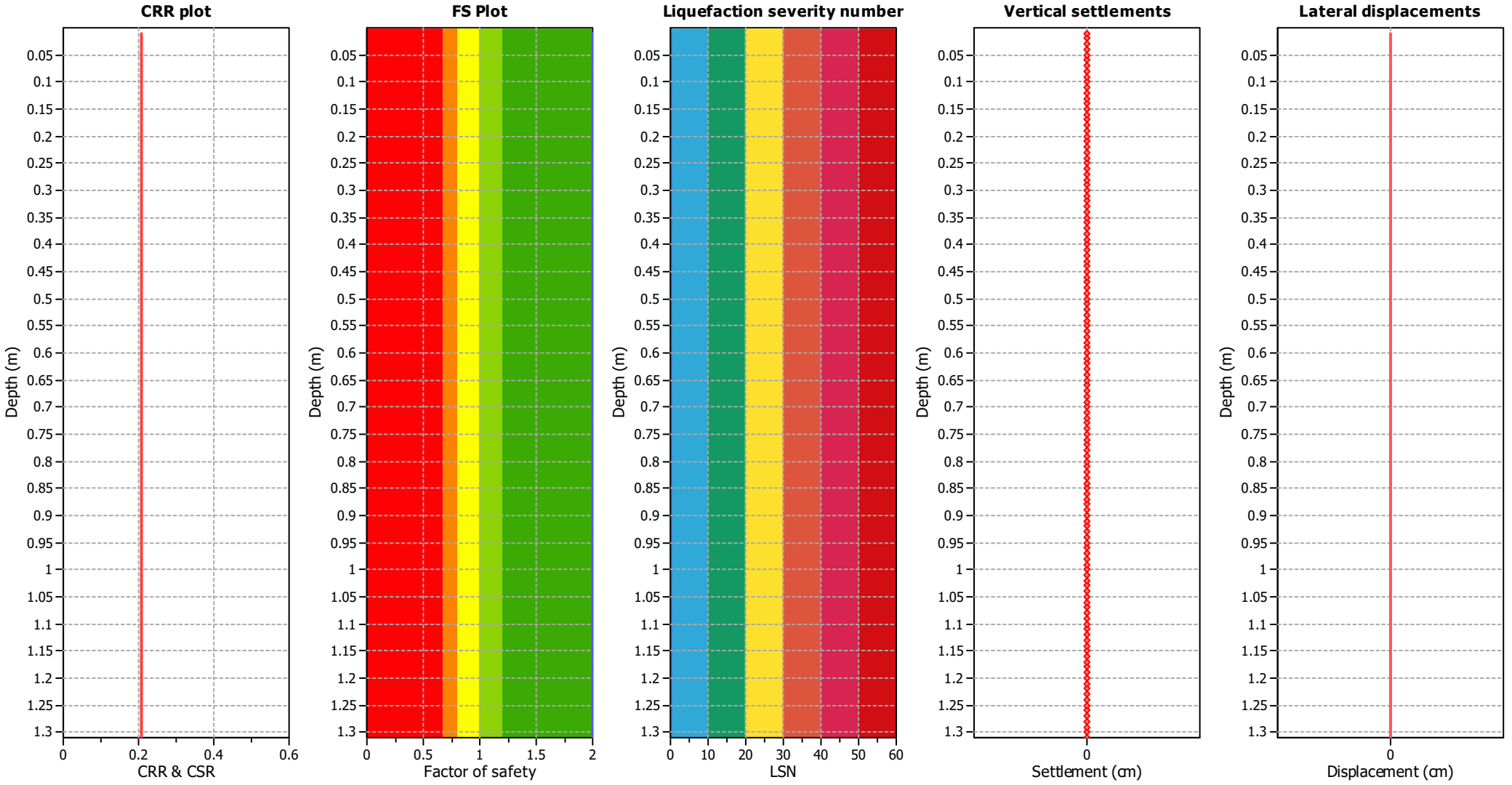

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.10 m	Fill height:	N/A	Limit depth:	10.00 m

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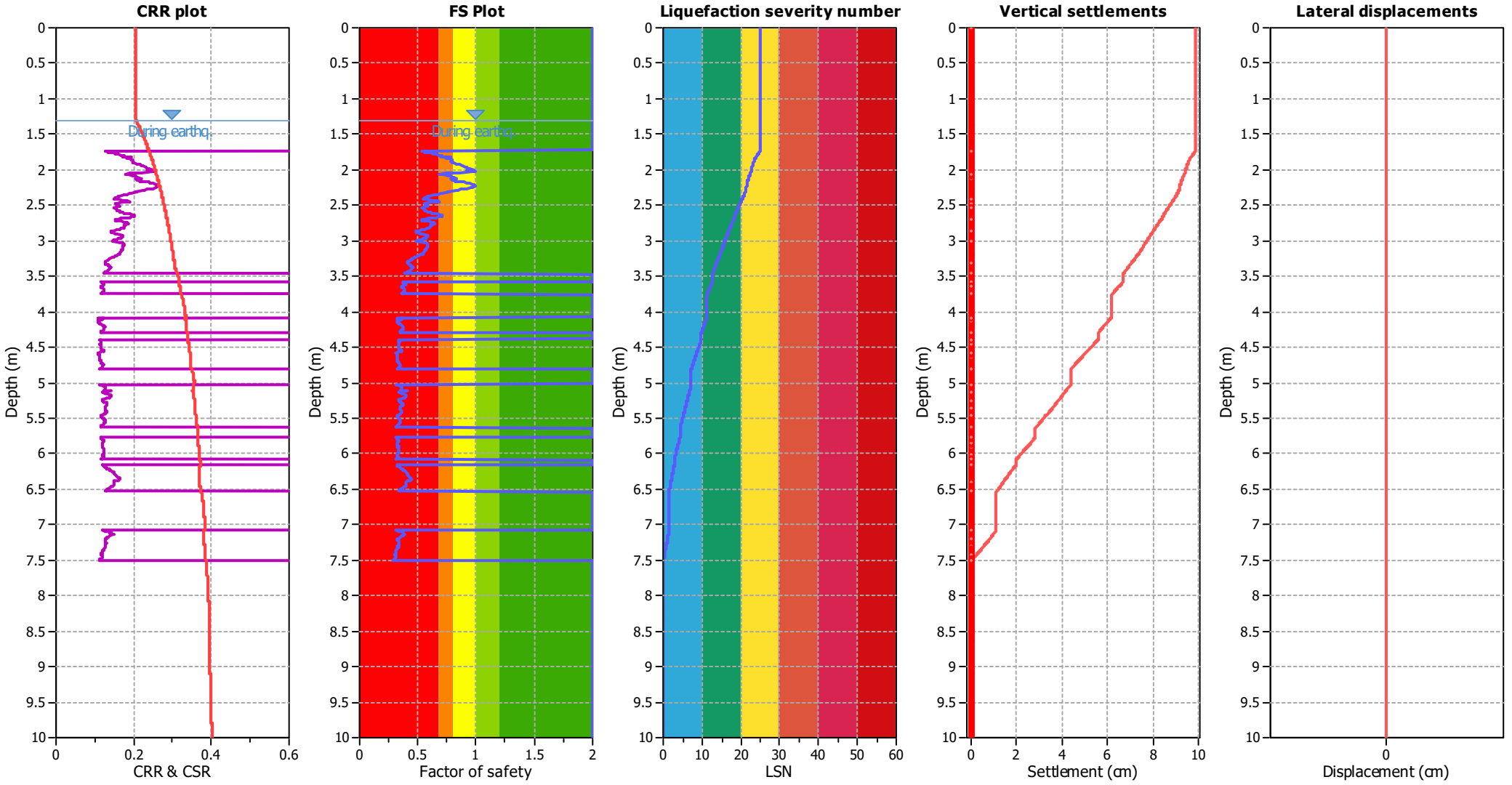
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.30 m	Fill height:	N/A	Limit depth:	10.00 m

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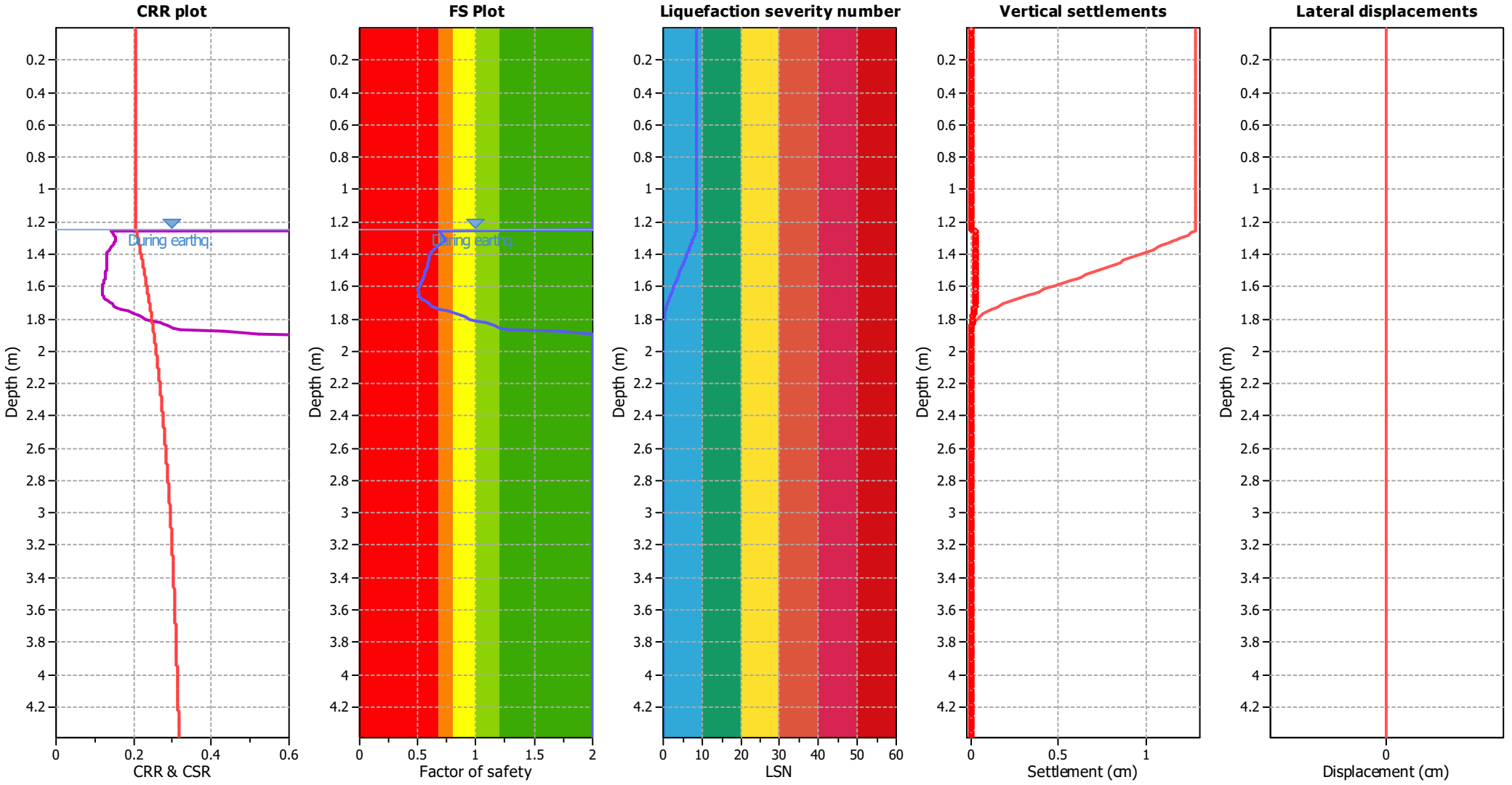
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.25 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.25 m	Fill height:	N/A	Limit depth:	10.00 m

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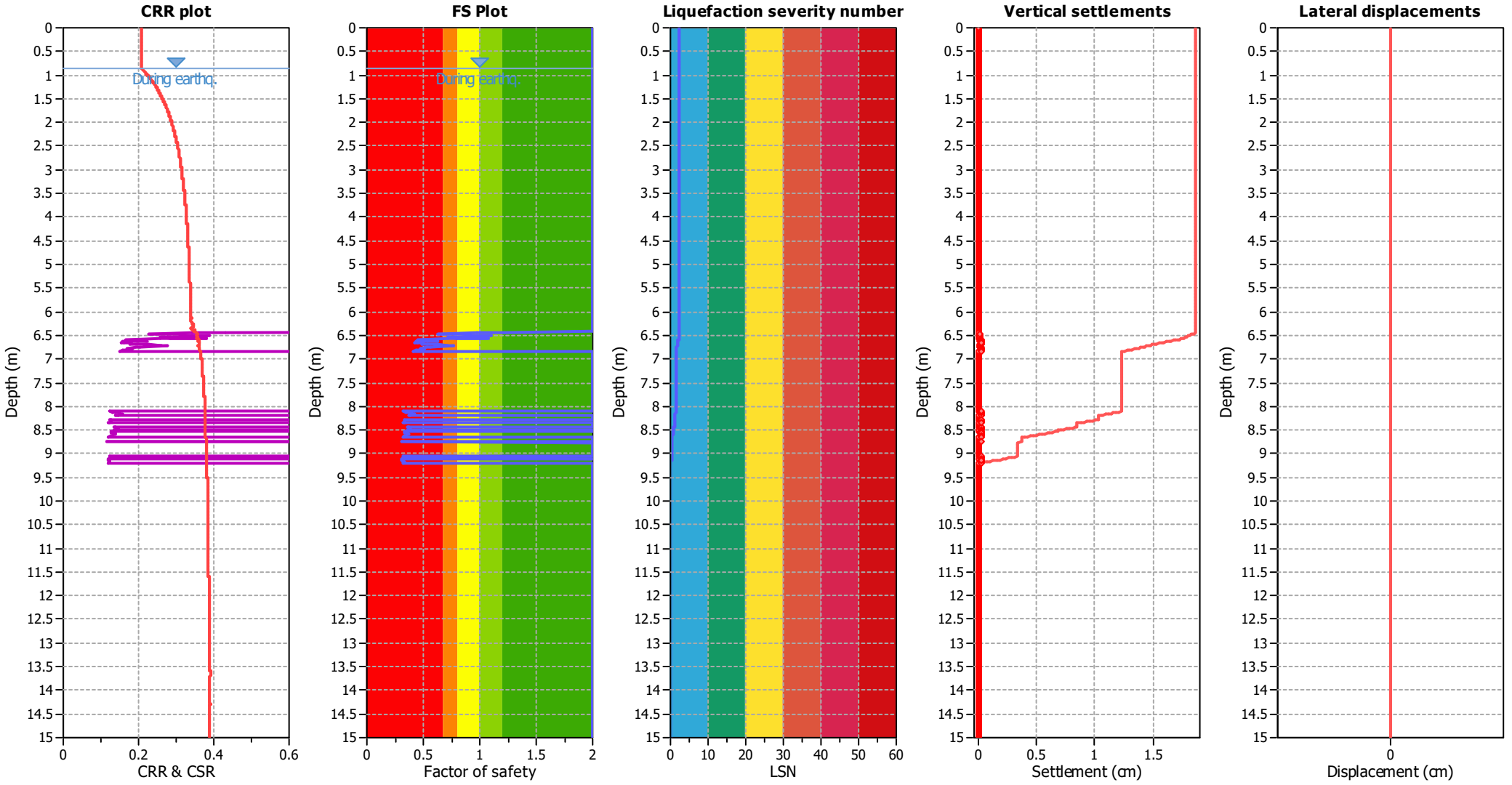
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.85 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.85 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
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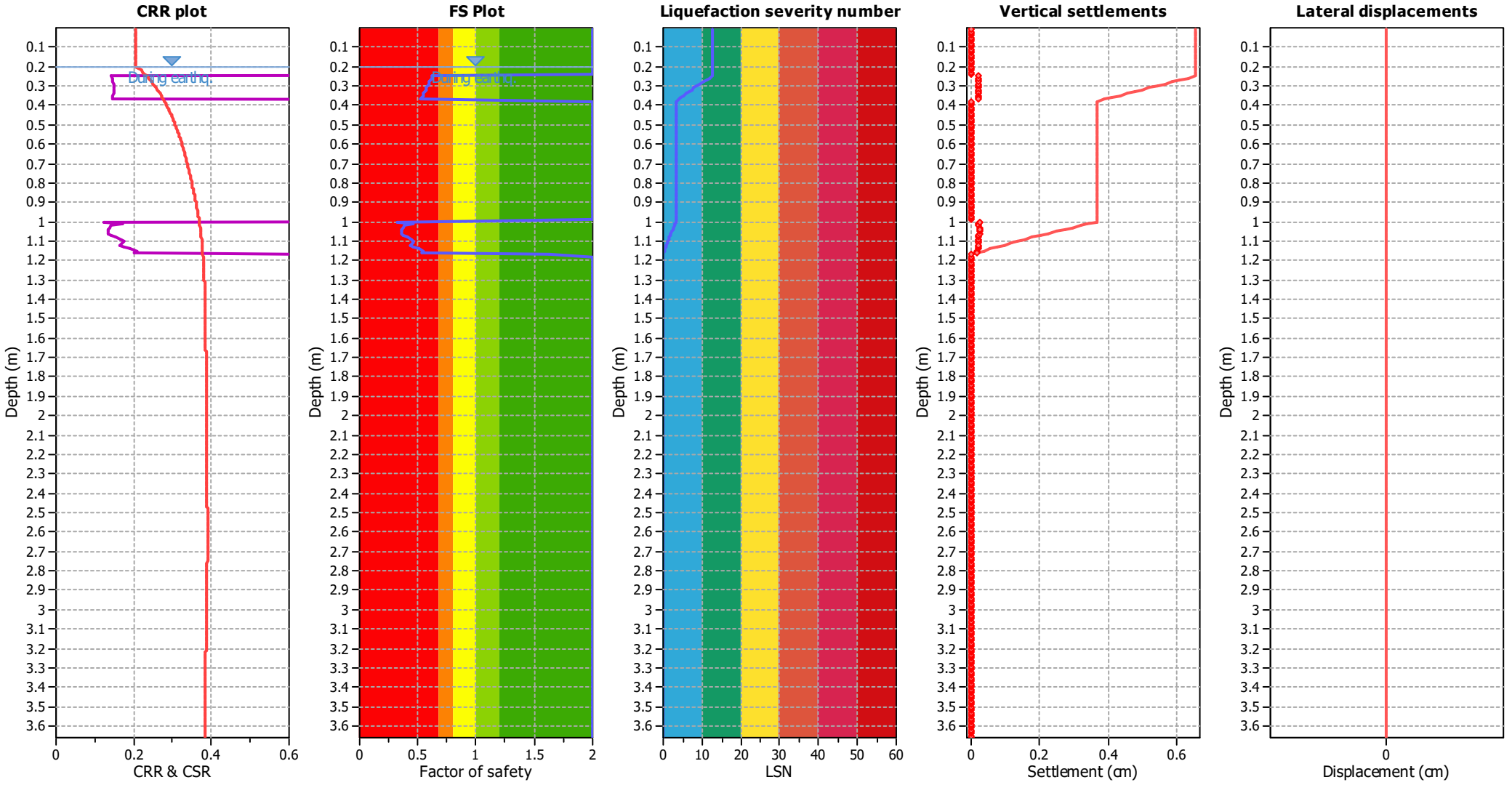
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.20 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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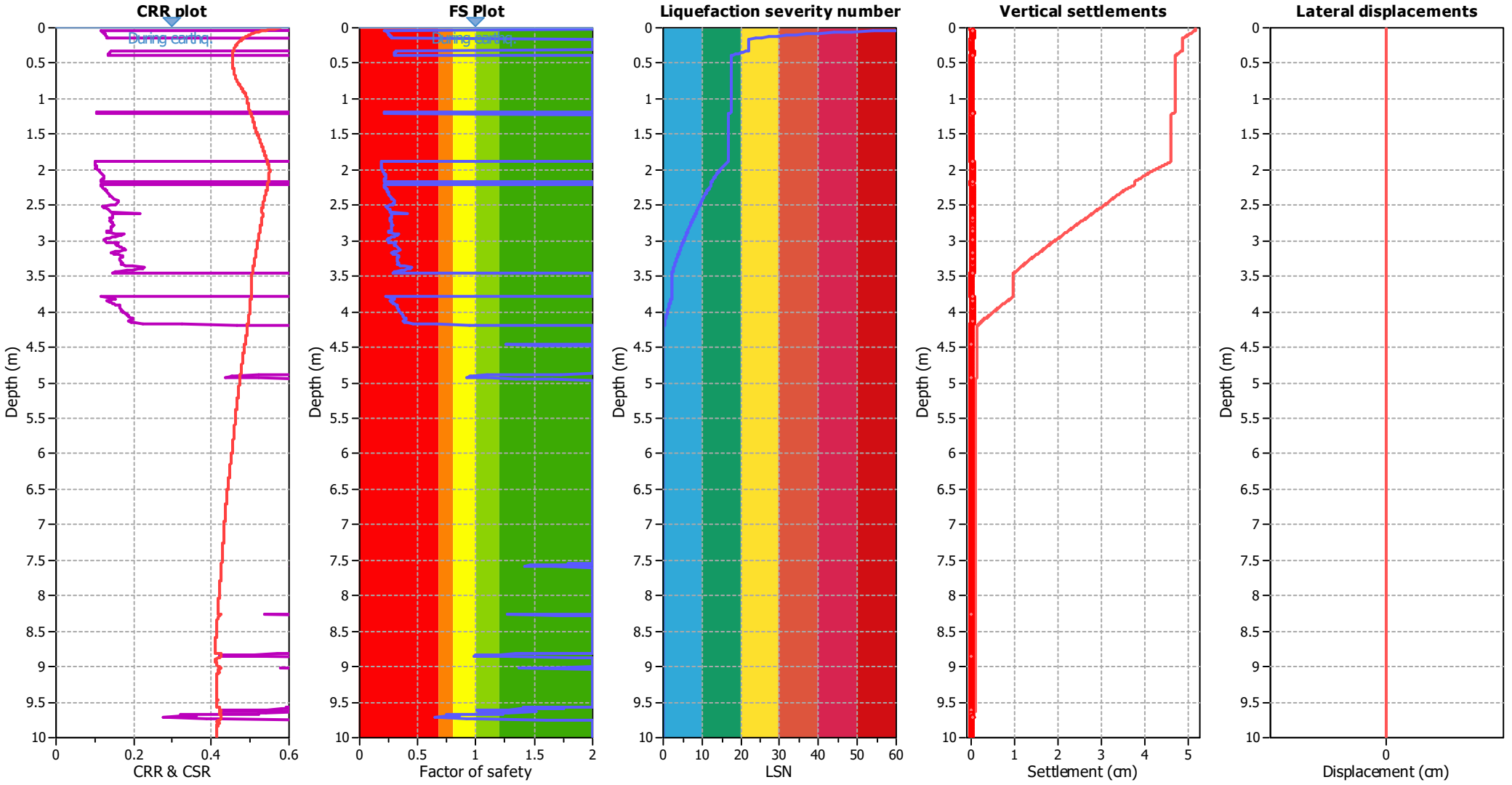
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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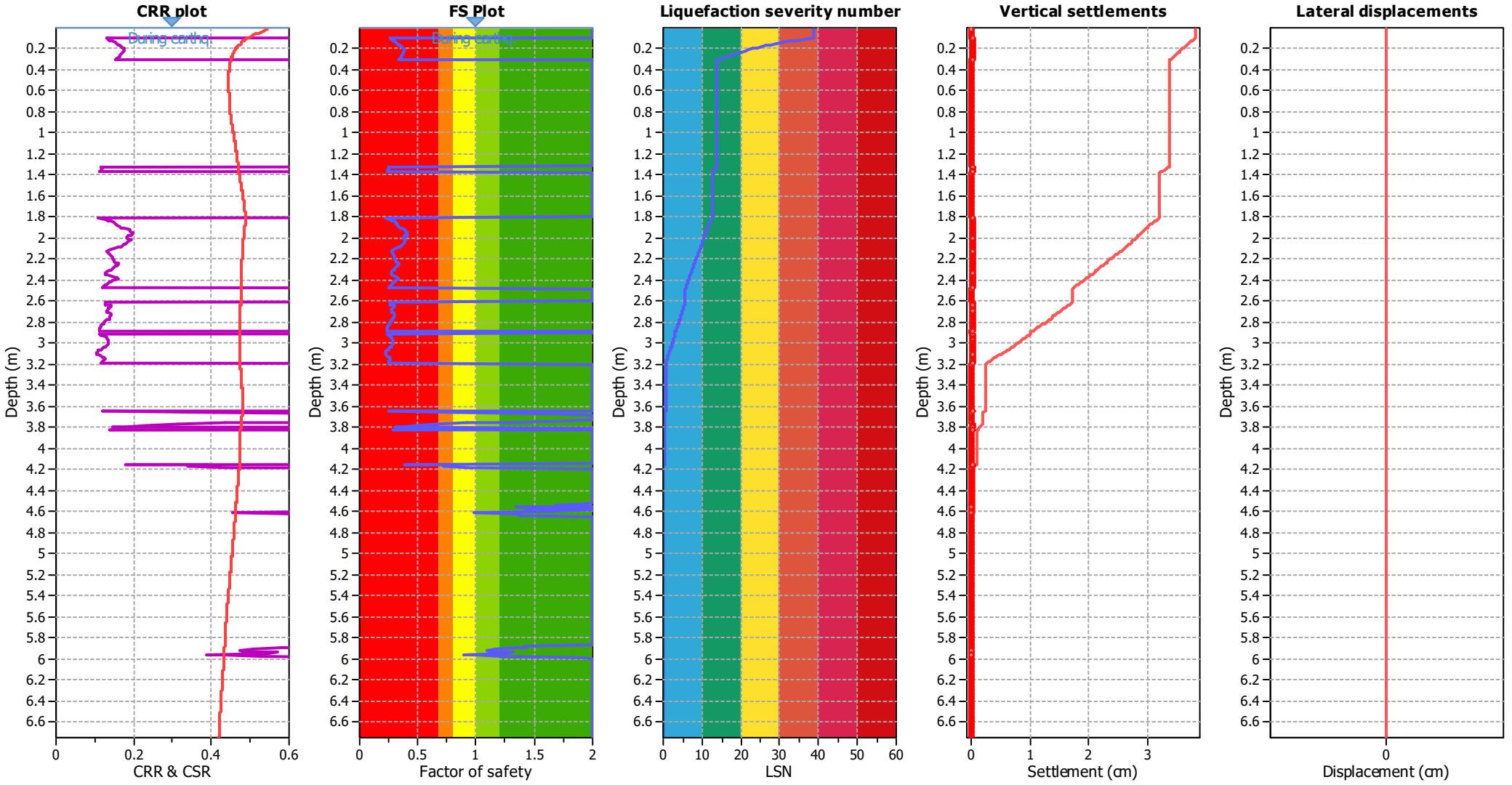

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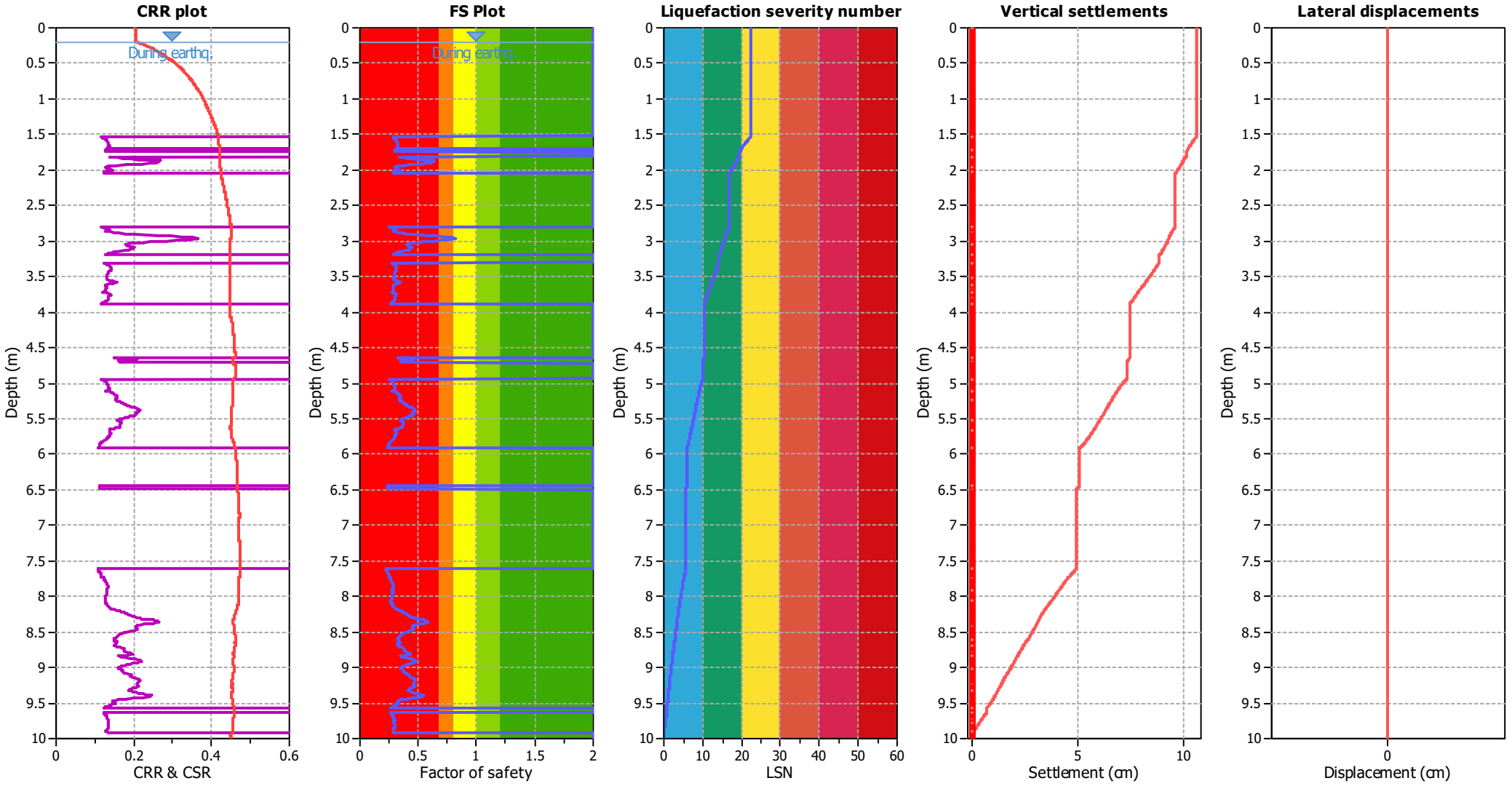

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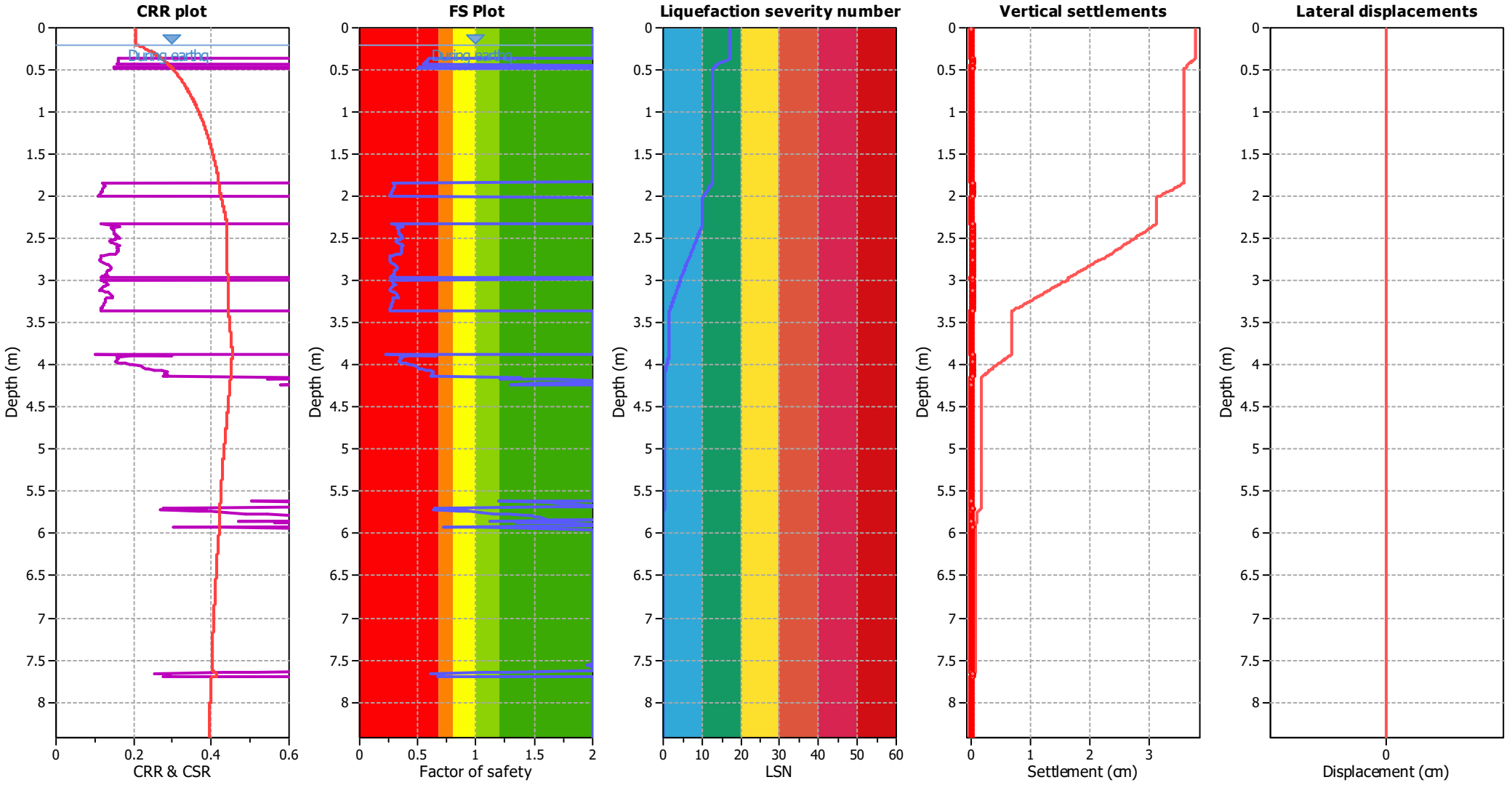

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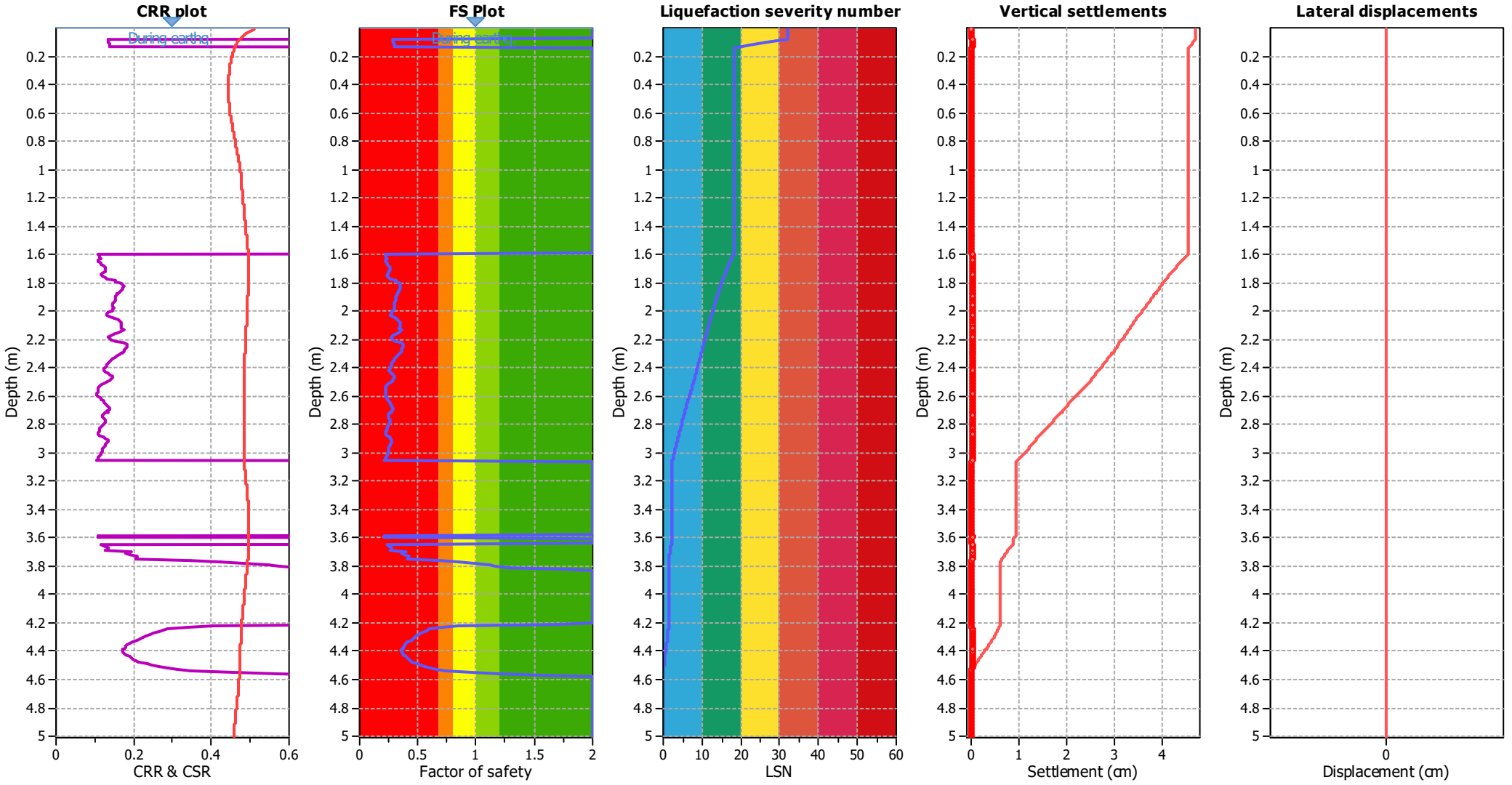

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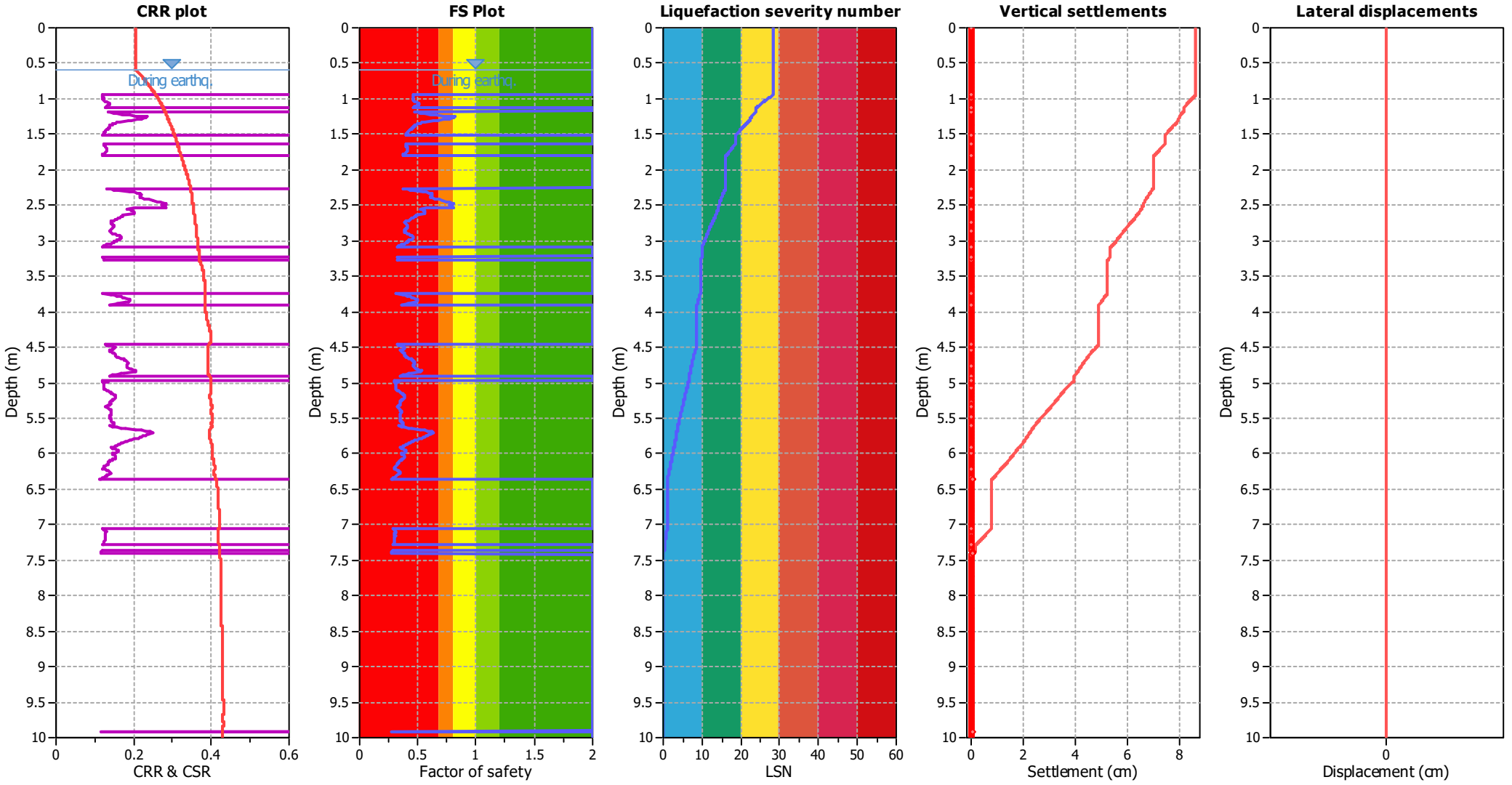

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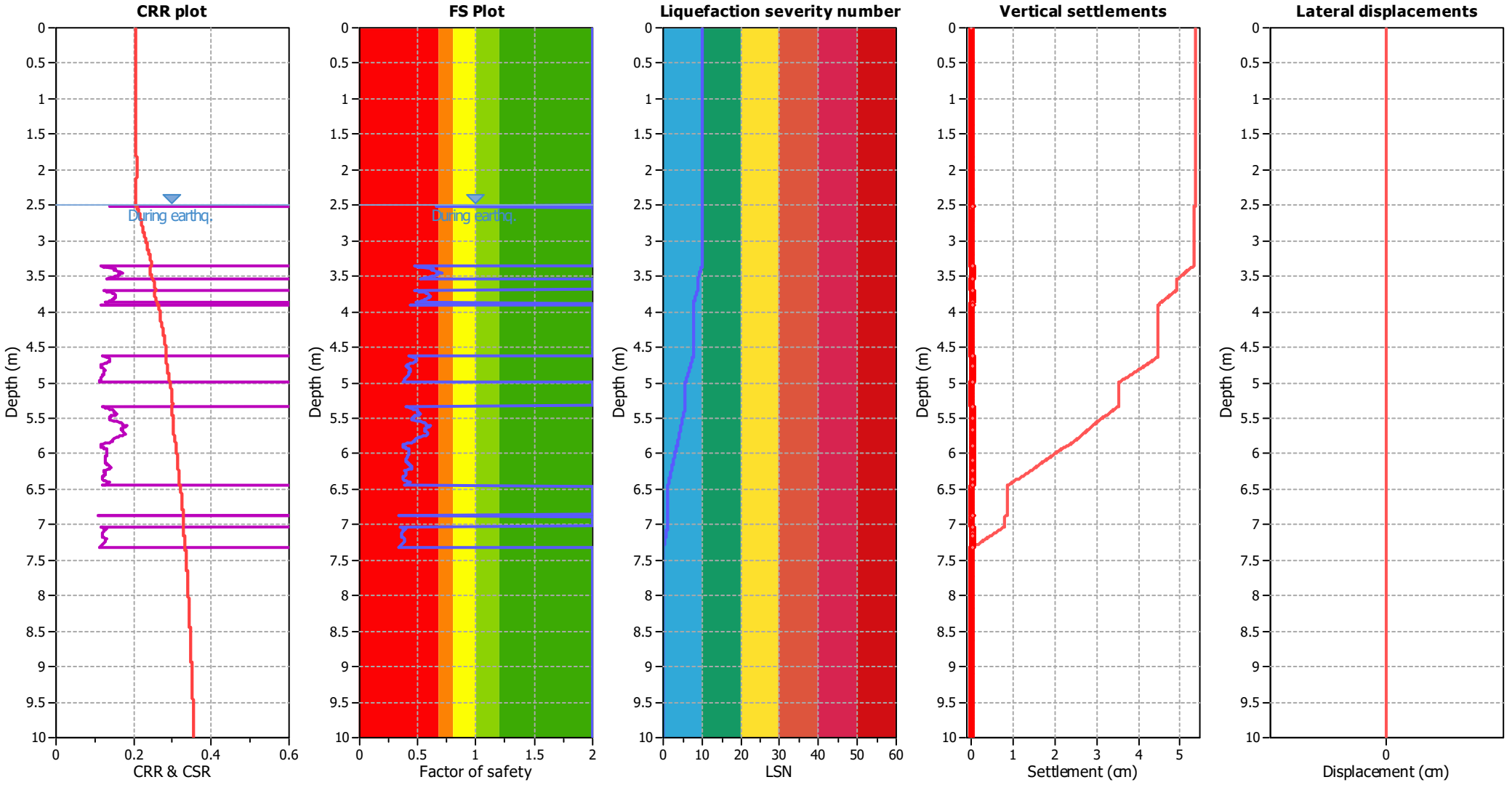

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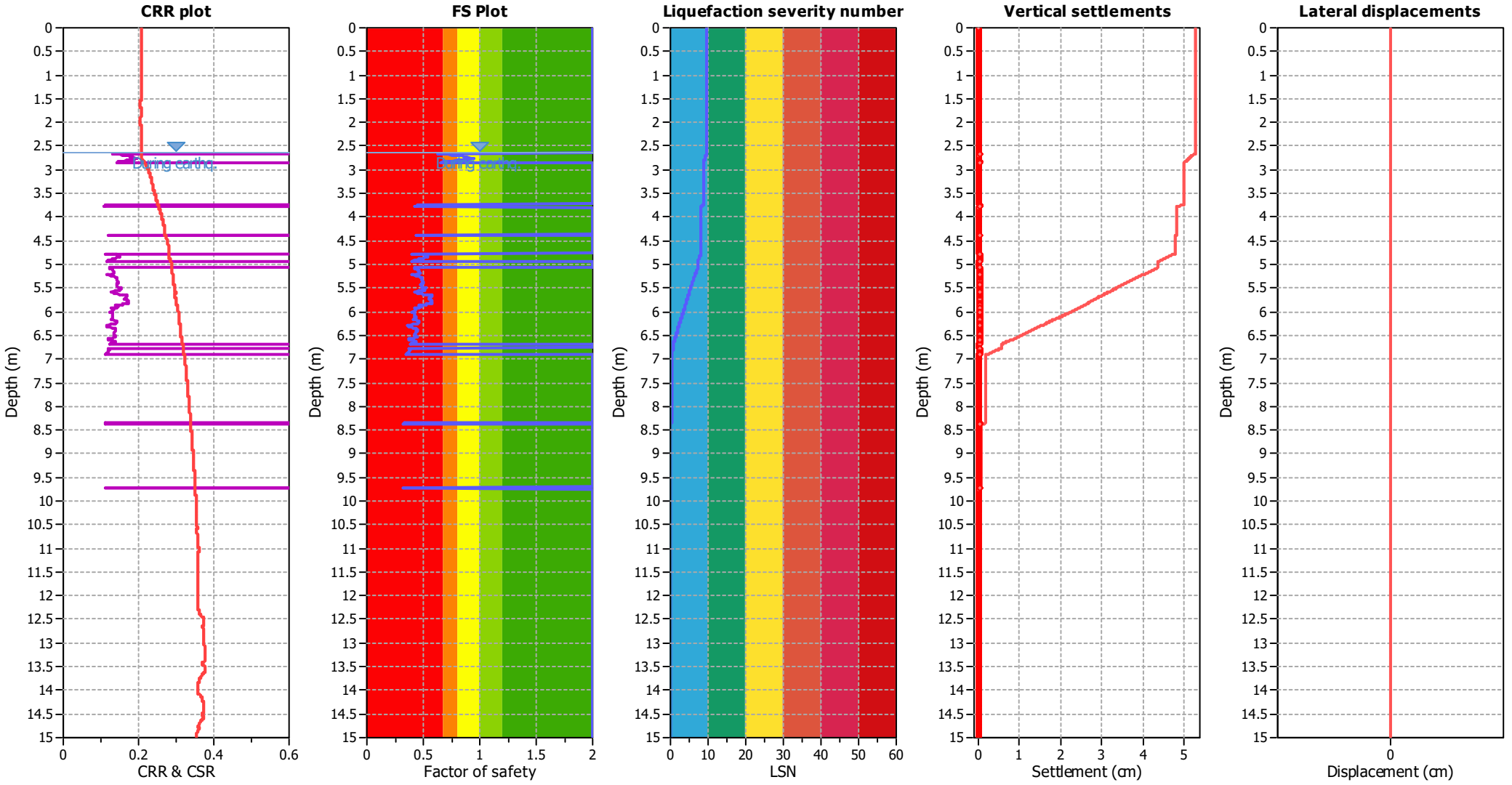
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.65 m	Fill height:	N/A	Limit depth:	10.00 m

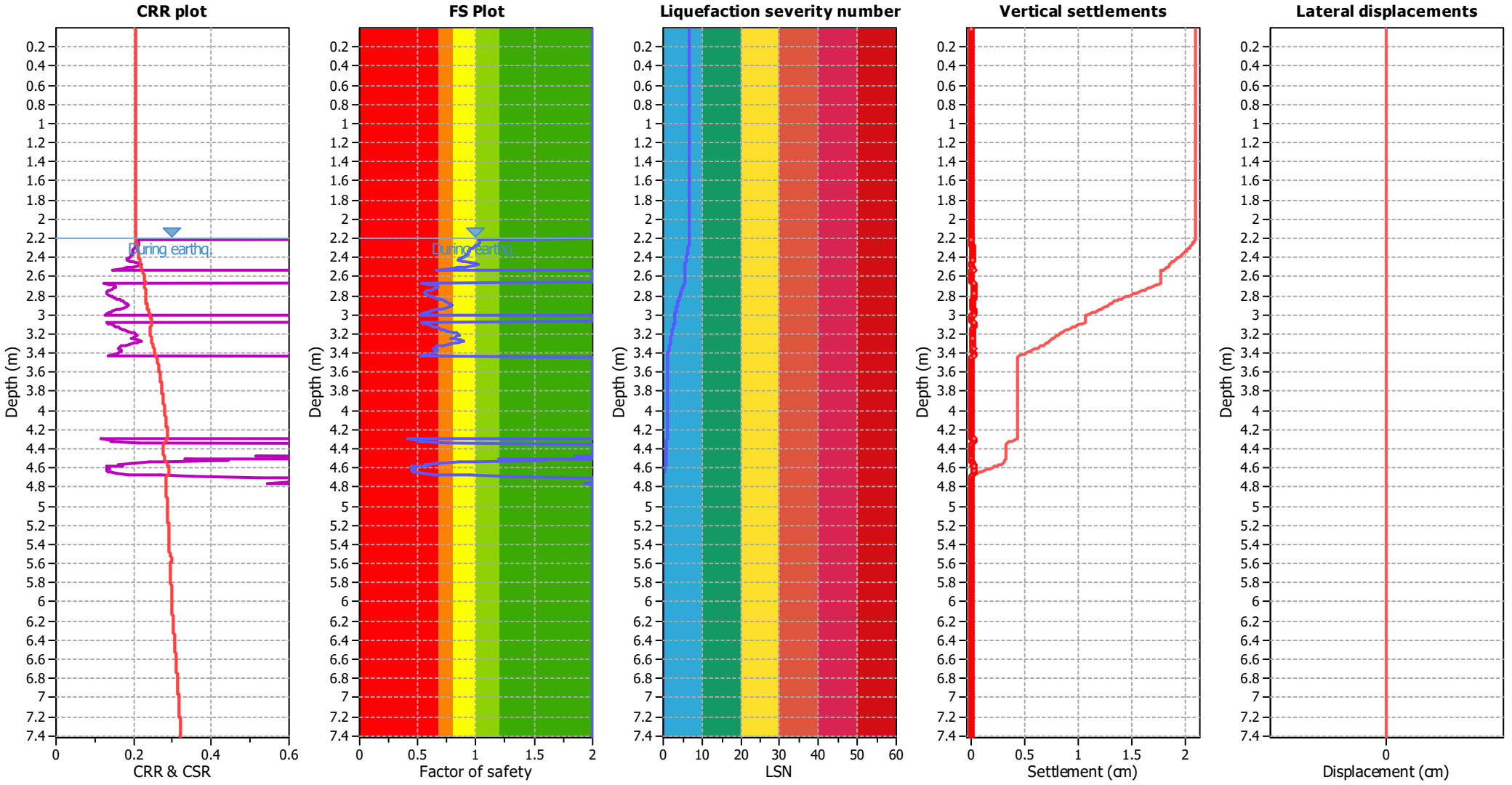
F.S. color scheme

- 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.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 m	Fill height:	N/A	Limit depth:	10.00 m

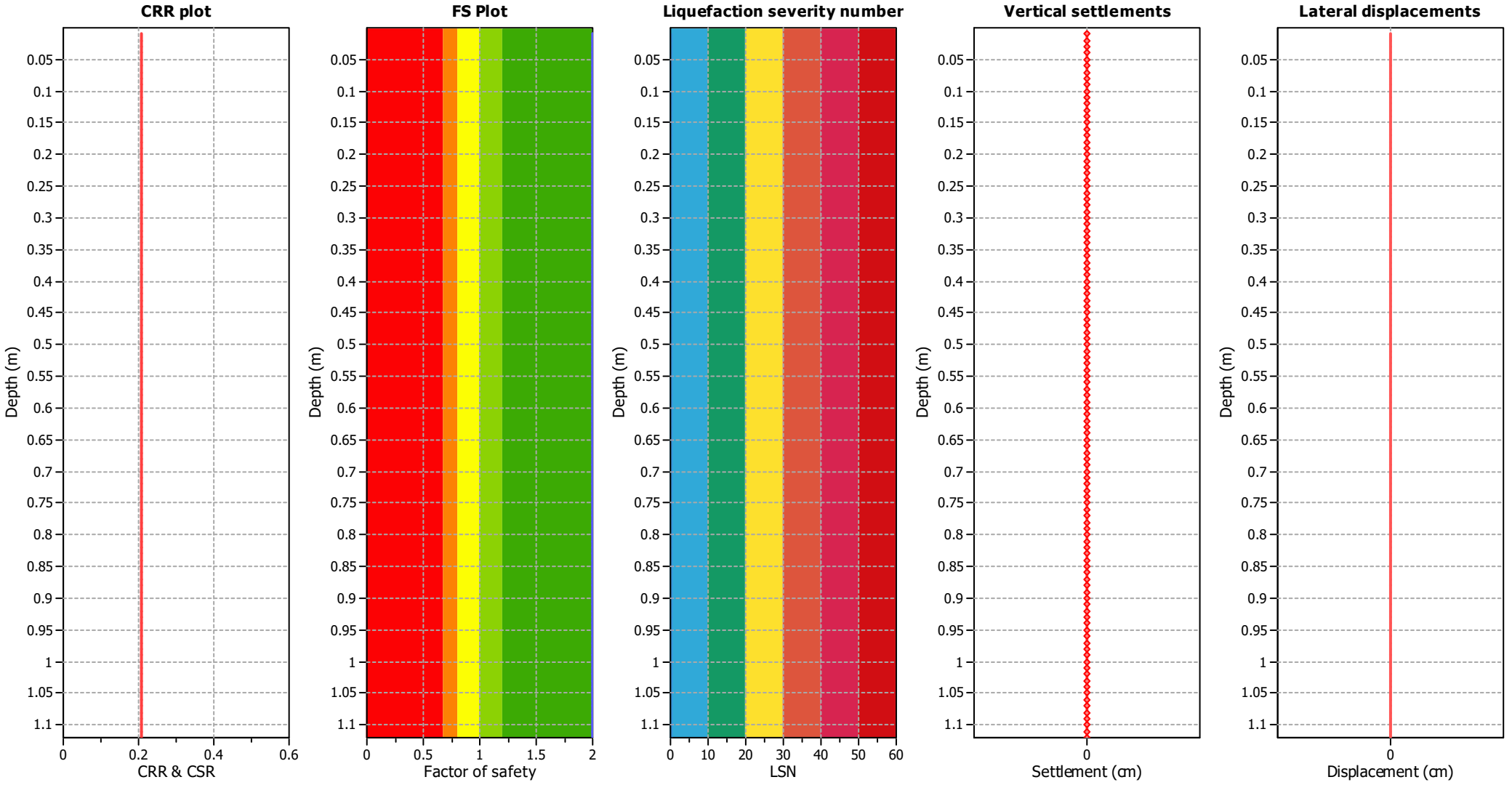
F.S. color scheme

- 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:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
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

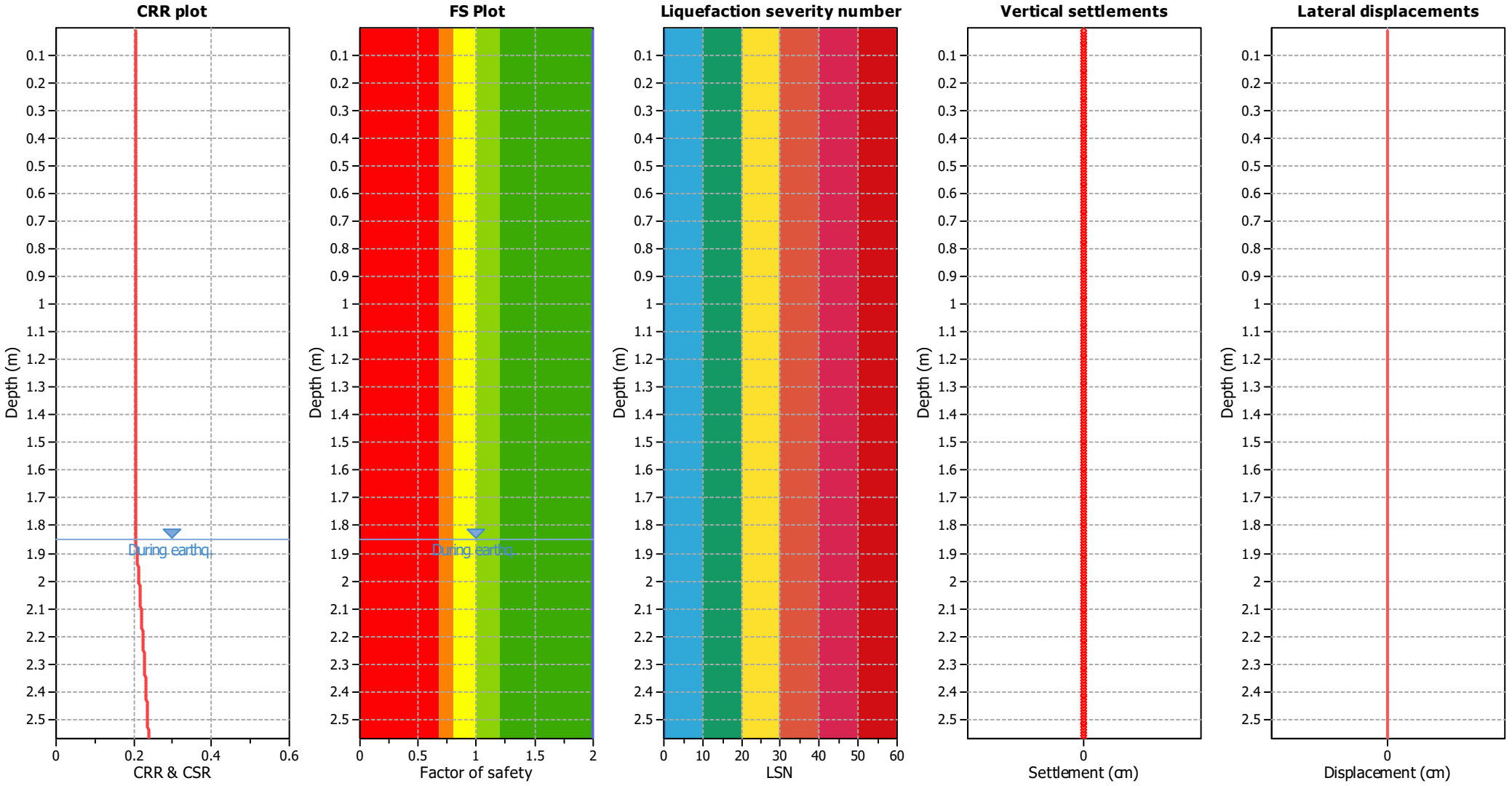
F.S. color scheme

- 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

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.85 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.85 m	Fill height:	N/A	Limit depth:	10.00 m

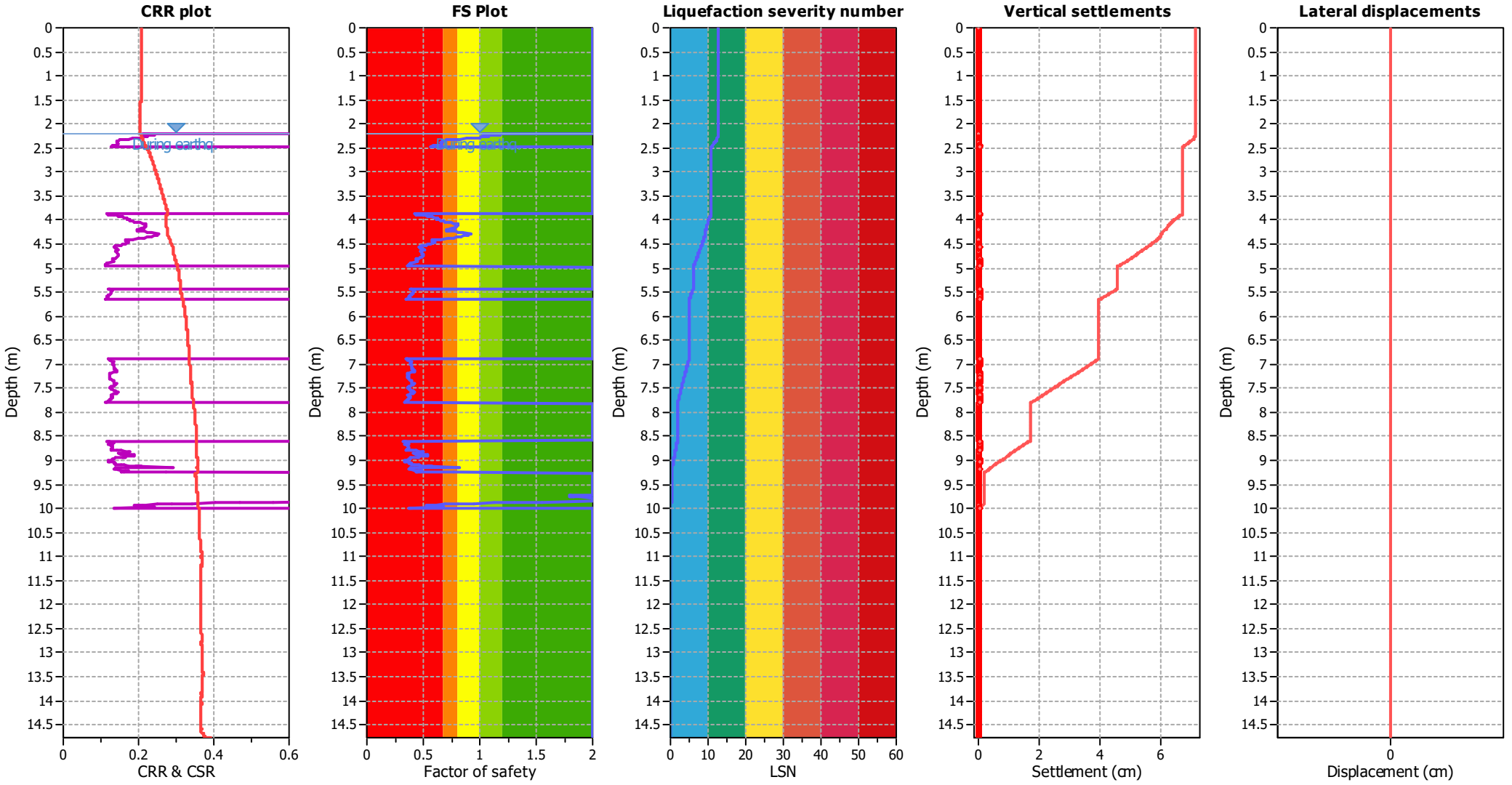
F.S. color scheme

- 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.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 m	Fill height:	N/A	Limit depth:	10.00 m

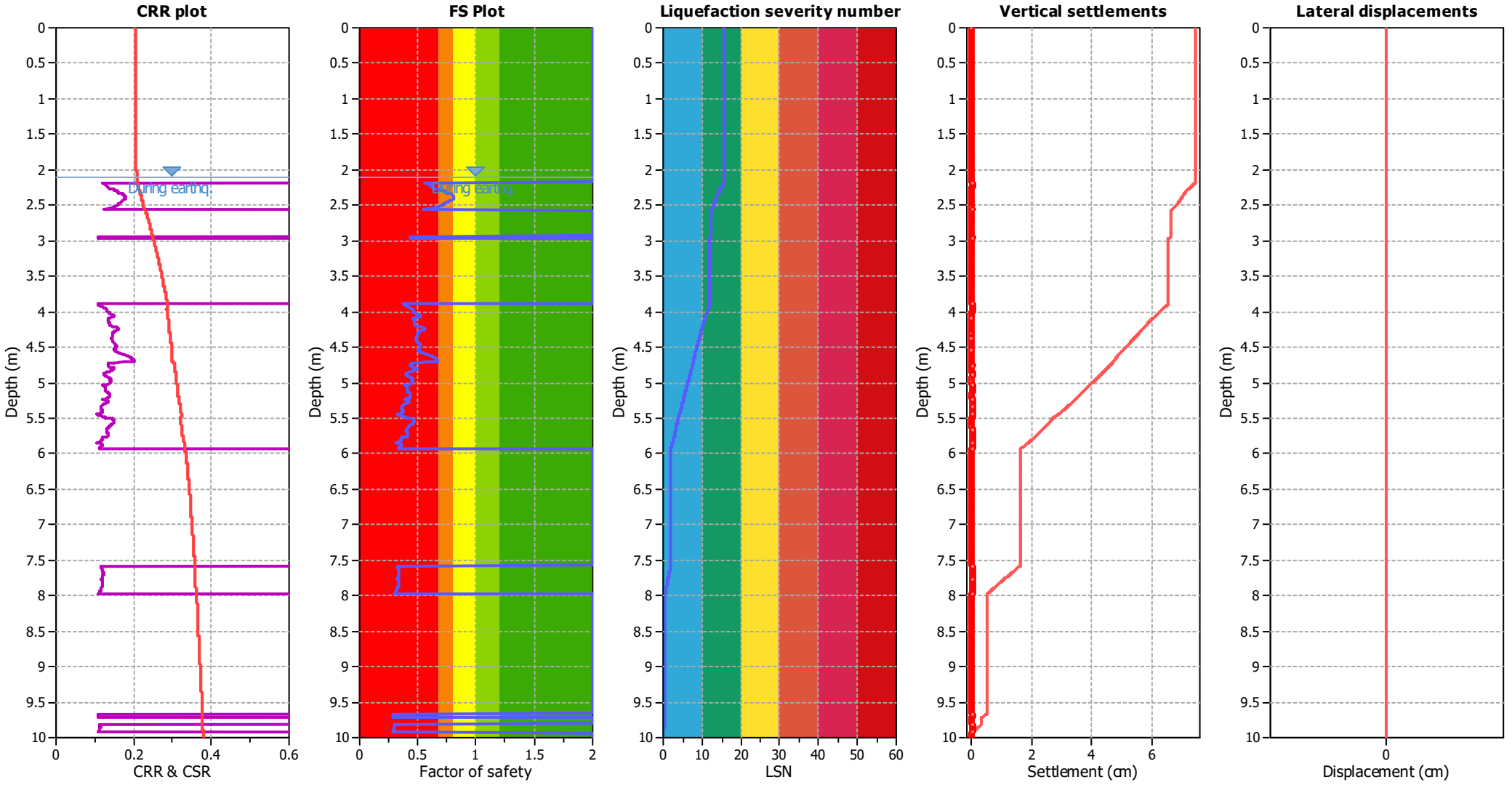
F.S. color scheme

- 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.):	2.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.10 m	Fill height:	N/A	Limit depth:	10.00 m

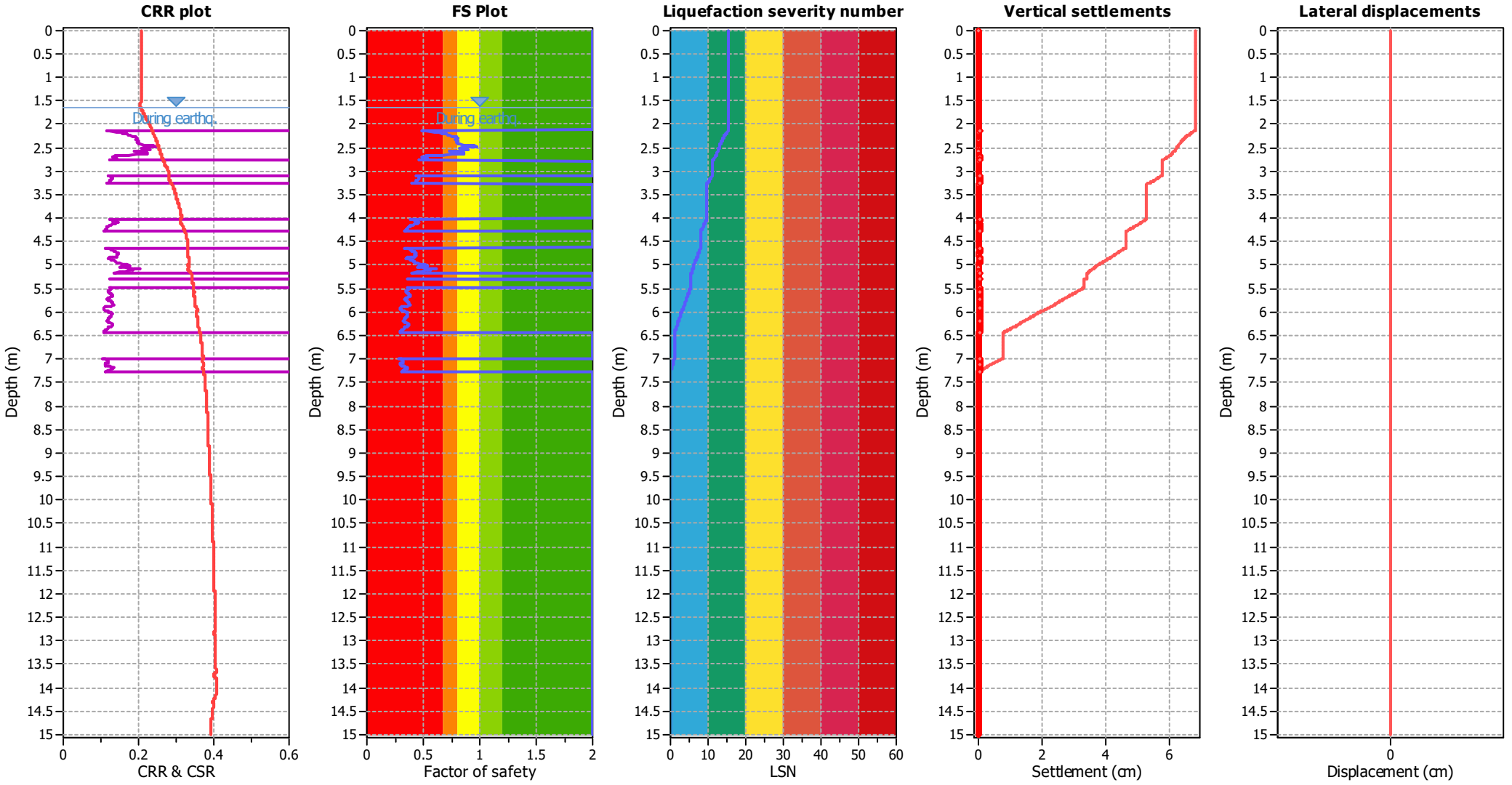
F.S. color scheme

- 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.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 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
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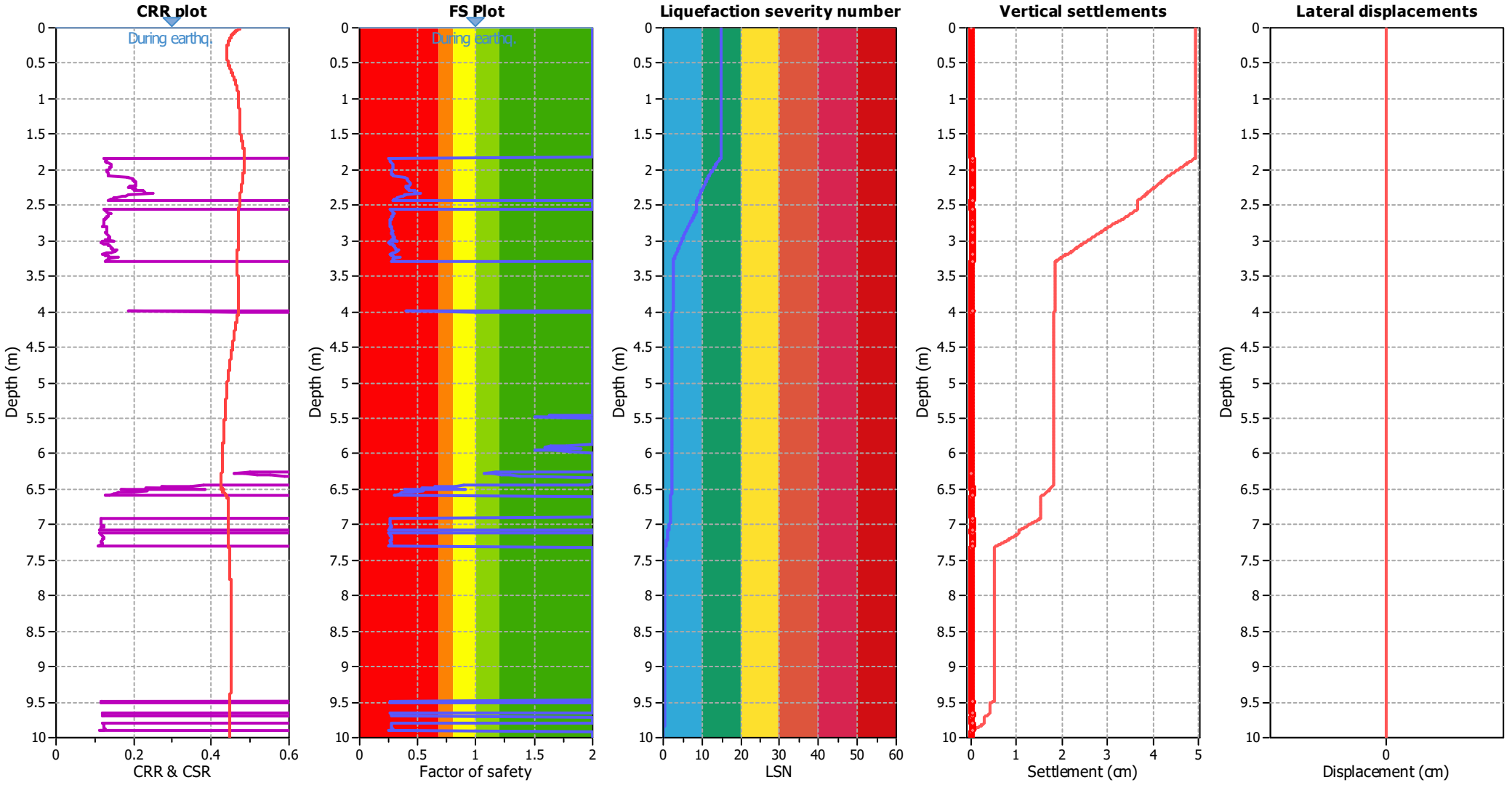
- Almost certain it will not liquefy

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.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

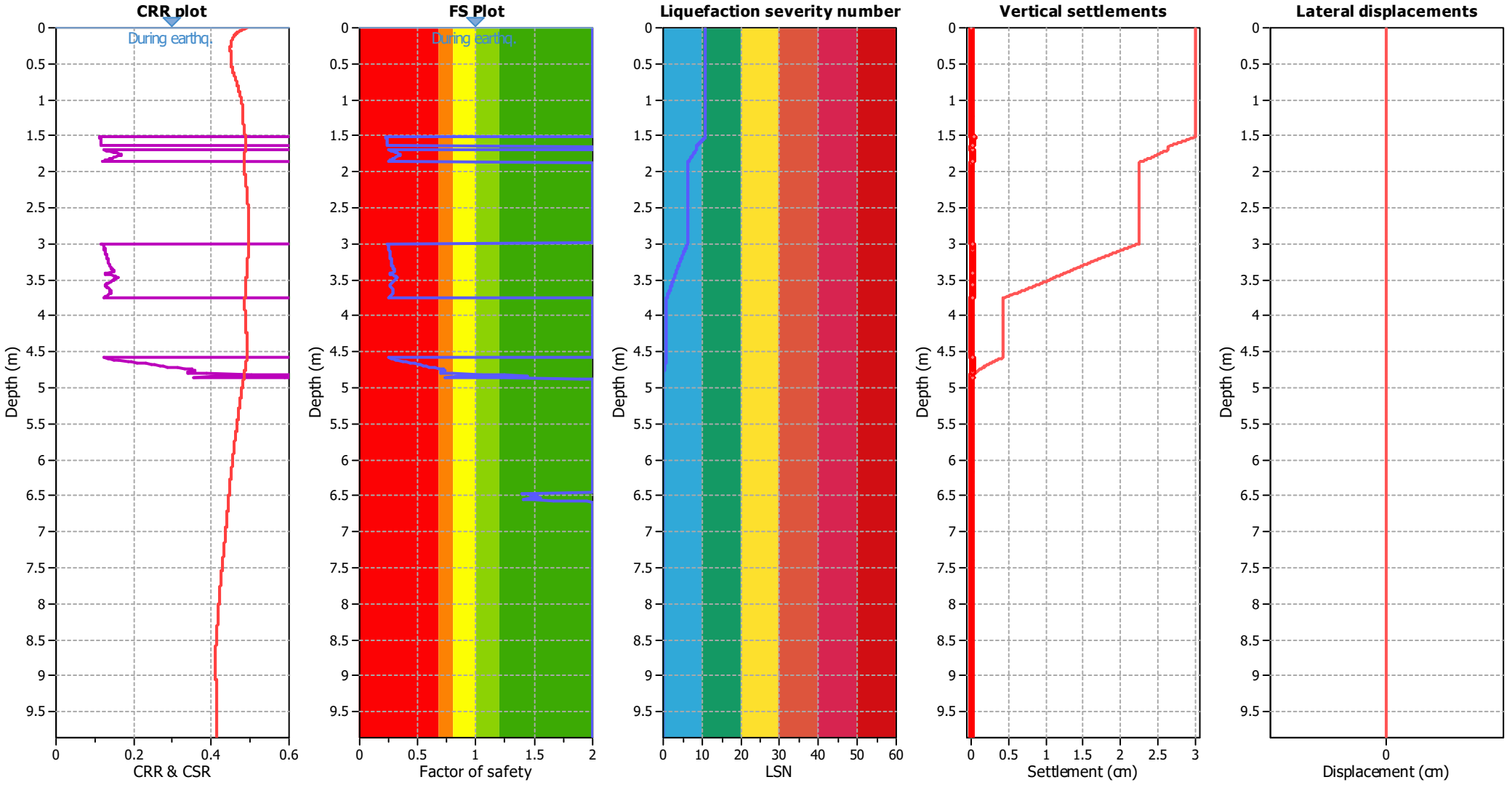
F.S. color scheme

- 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.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

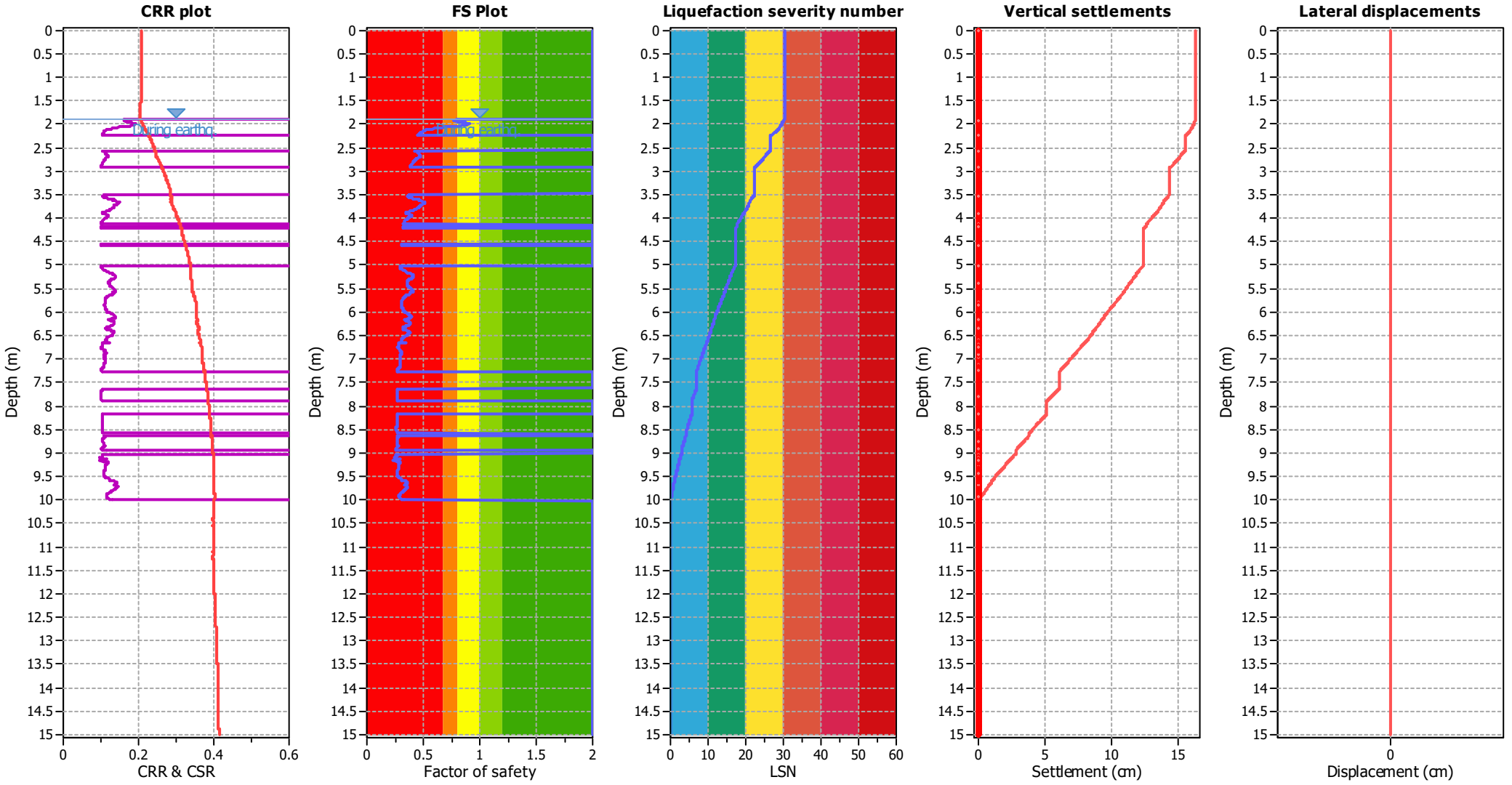
F.S. color scheme

- 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.):	1.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.90 m	Fill height:	N/A	Limit depth:	10.00 m

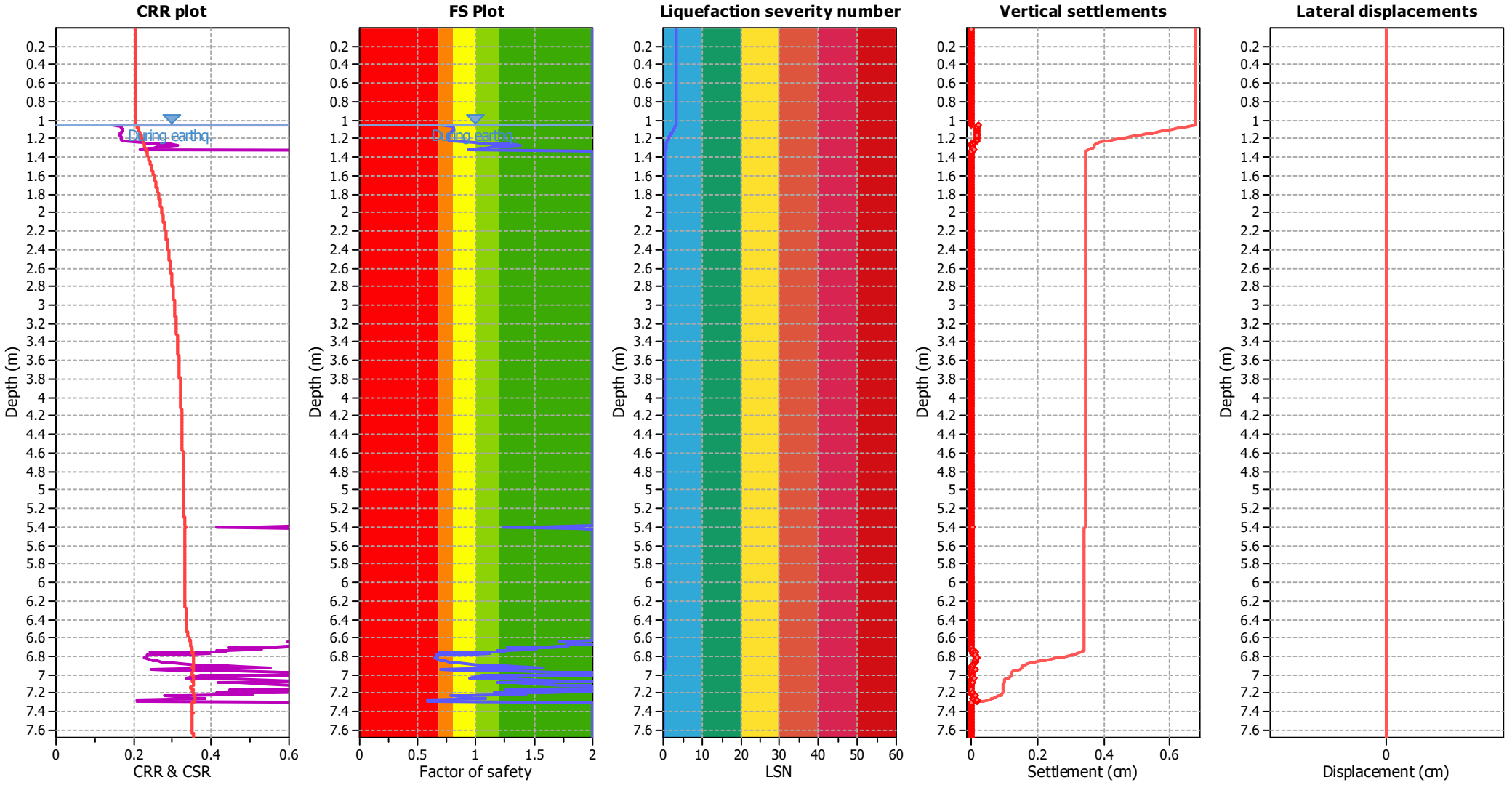
F.S. color scheme

- 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.):	1.05 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.05 m	Fill height:	N/A	Limit depth:	10.00 m

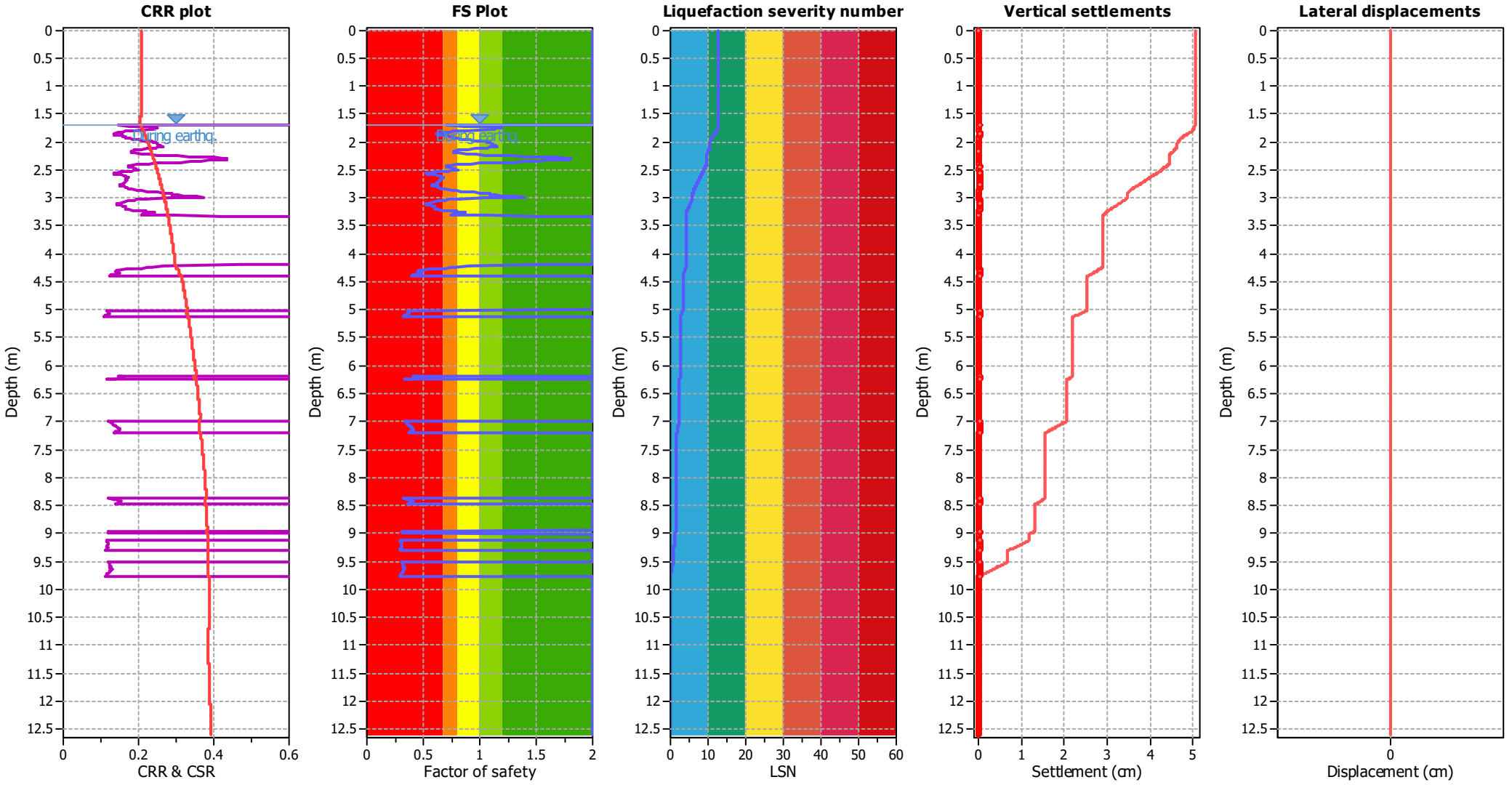
F.S. color scheme

- 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.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 m	Fill height:	N/A	Limit depth:	10.00 m

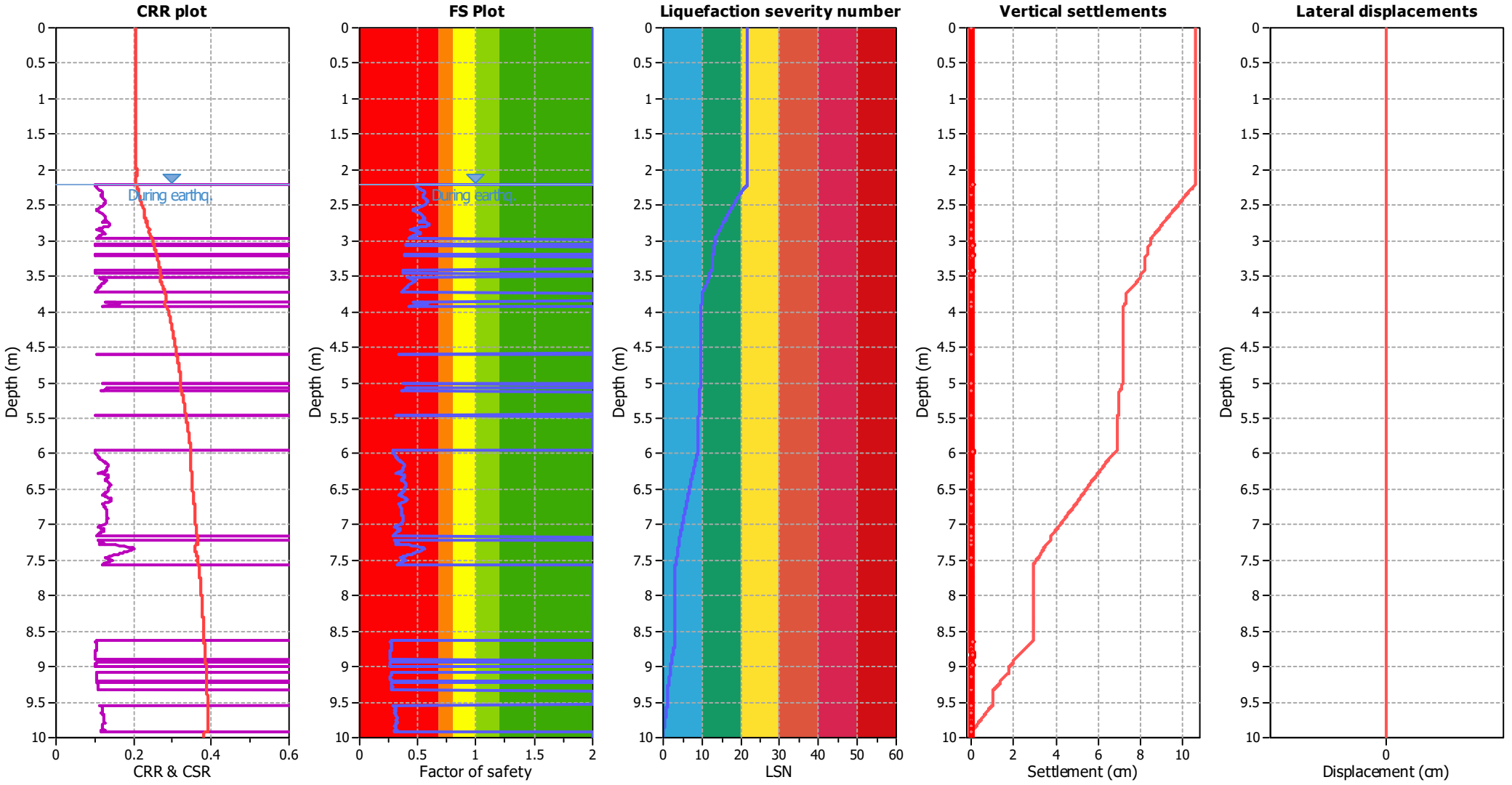
F.S. color scheme

- 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.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 m	Fill height:	N/A	Limit depth:	10.00 m

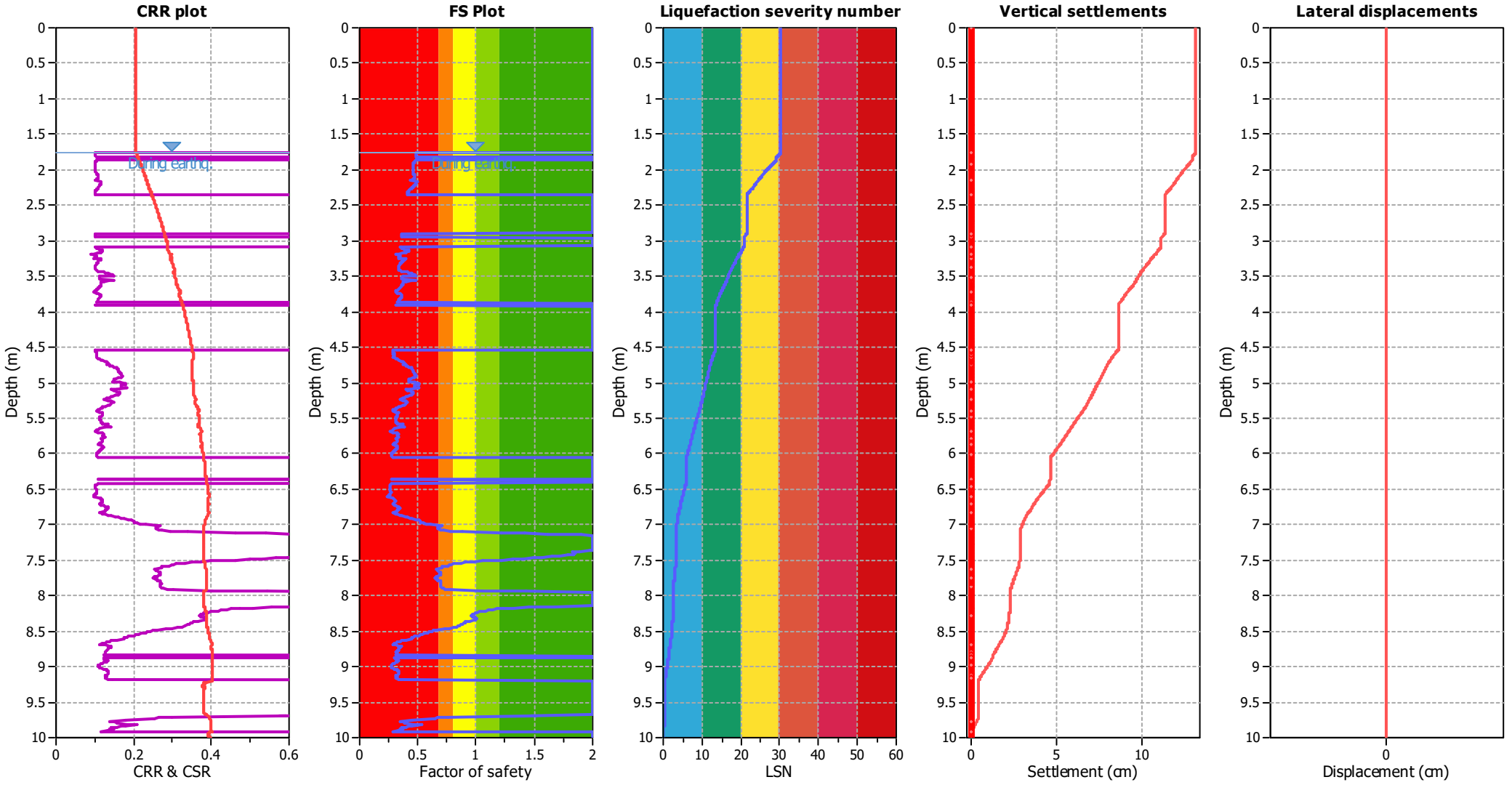
F.S. color scheme

- 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.):	1.75 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.75 m	Fill height:	N/A	Limit depth:	10.00 m

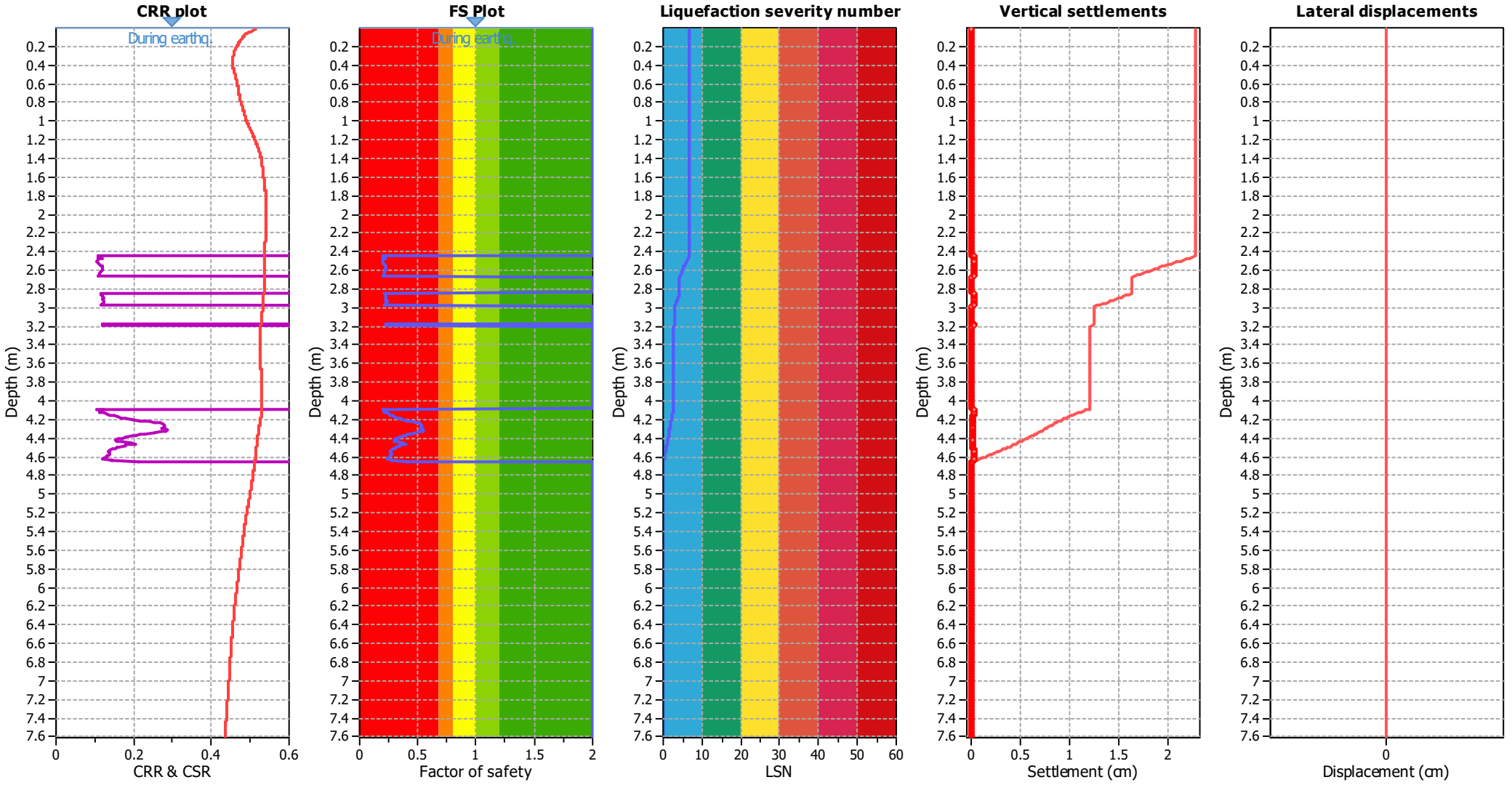
F.S. color scheme

- 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.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 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
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LSN color scheme

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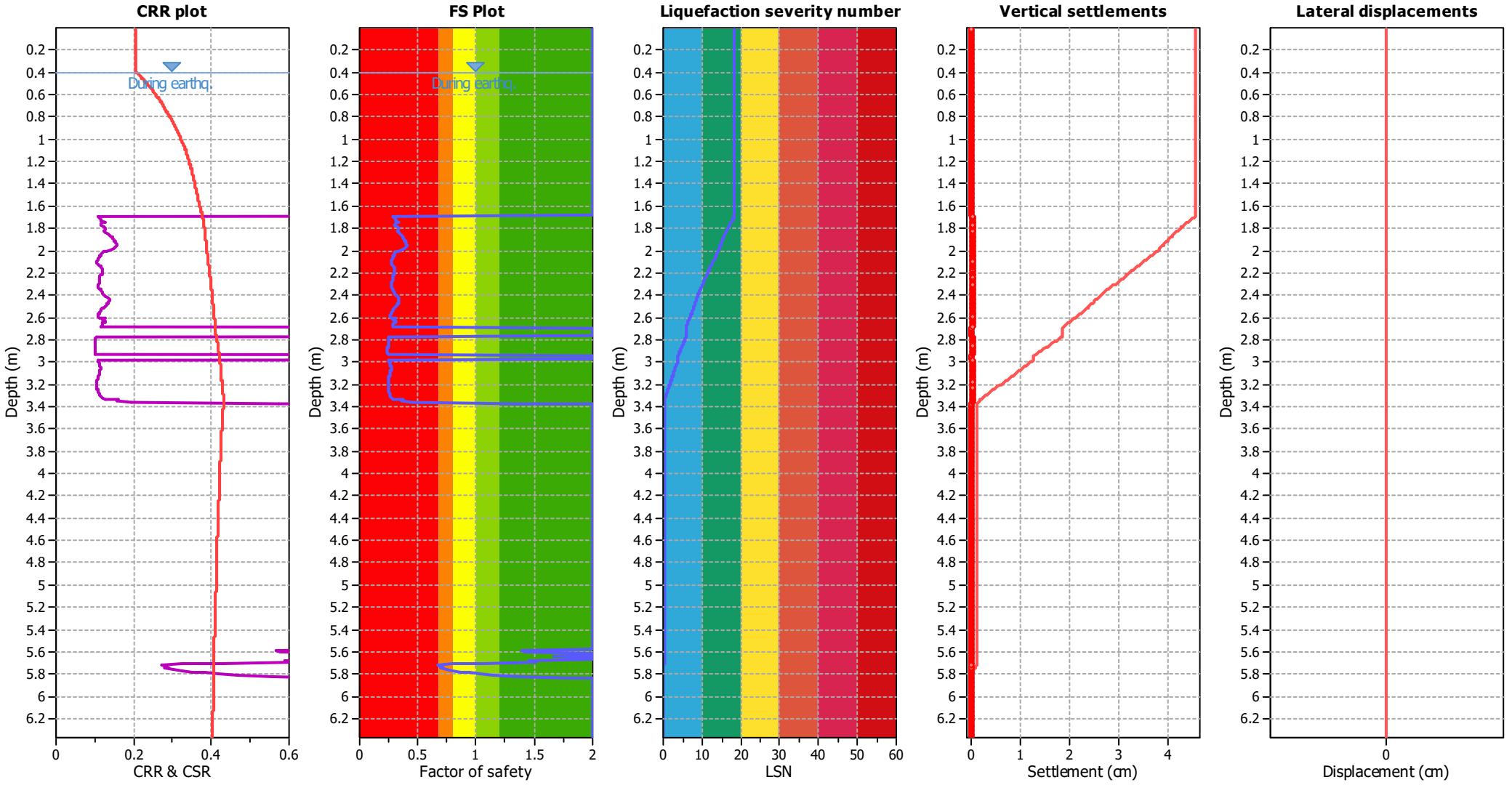
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.40 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
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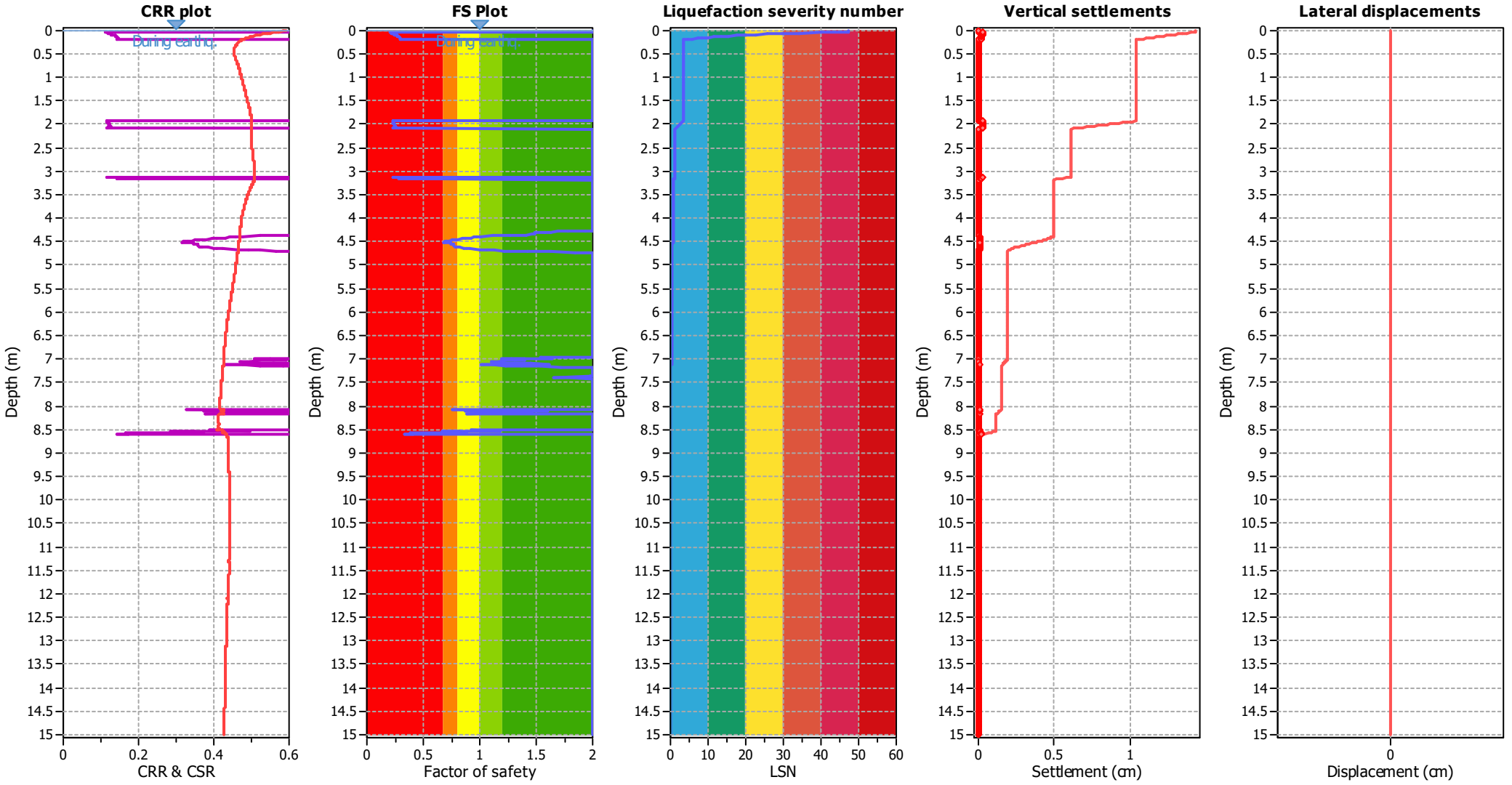
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

- Almost certain it will liquefy
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LSN color scheme

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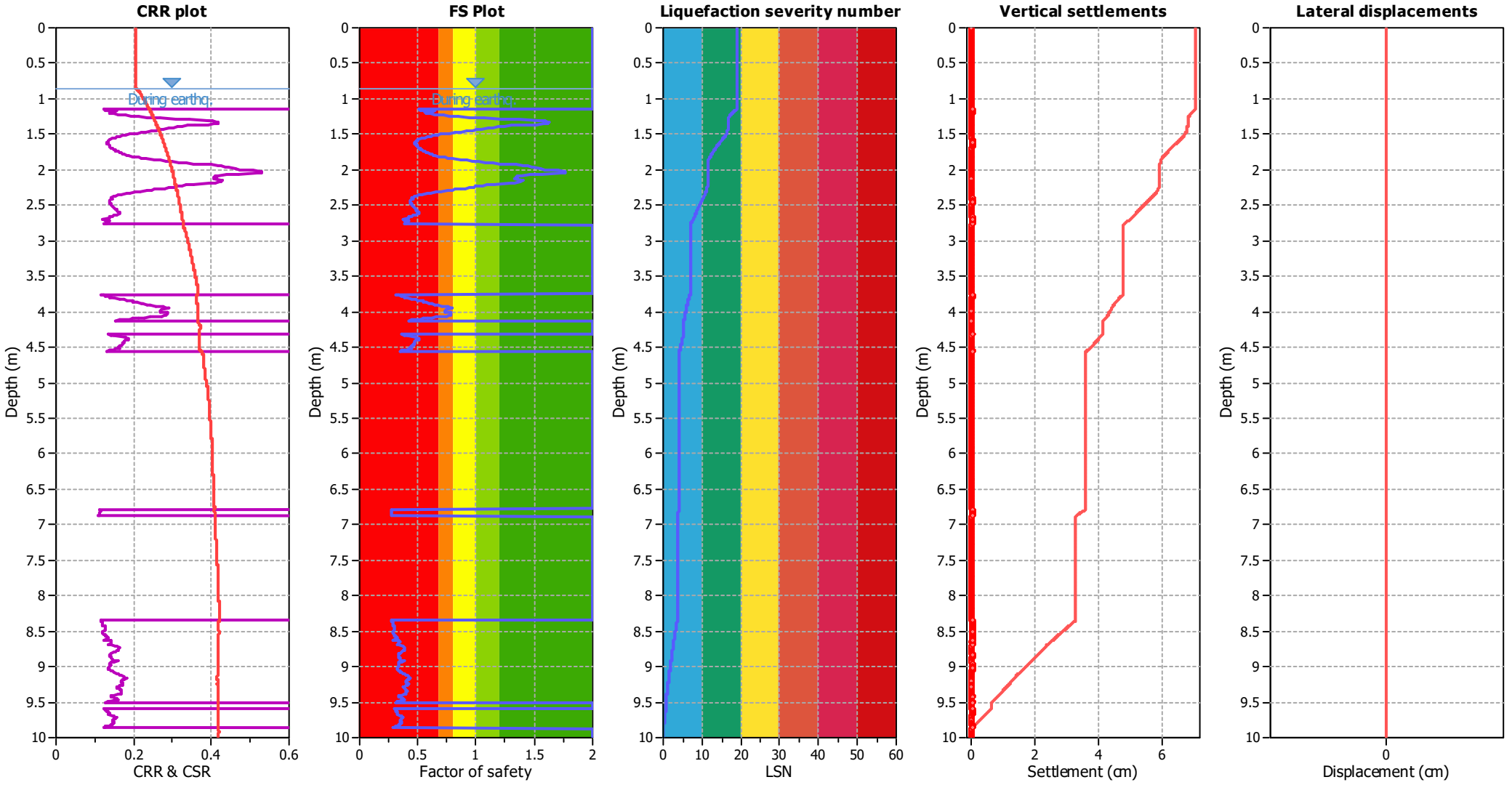
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.85 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.85 m	Fill height:	N/A	Limit depth:	10.00 m

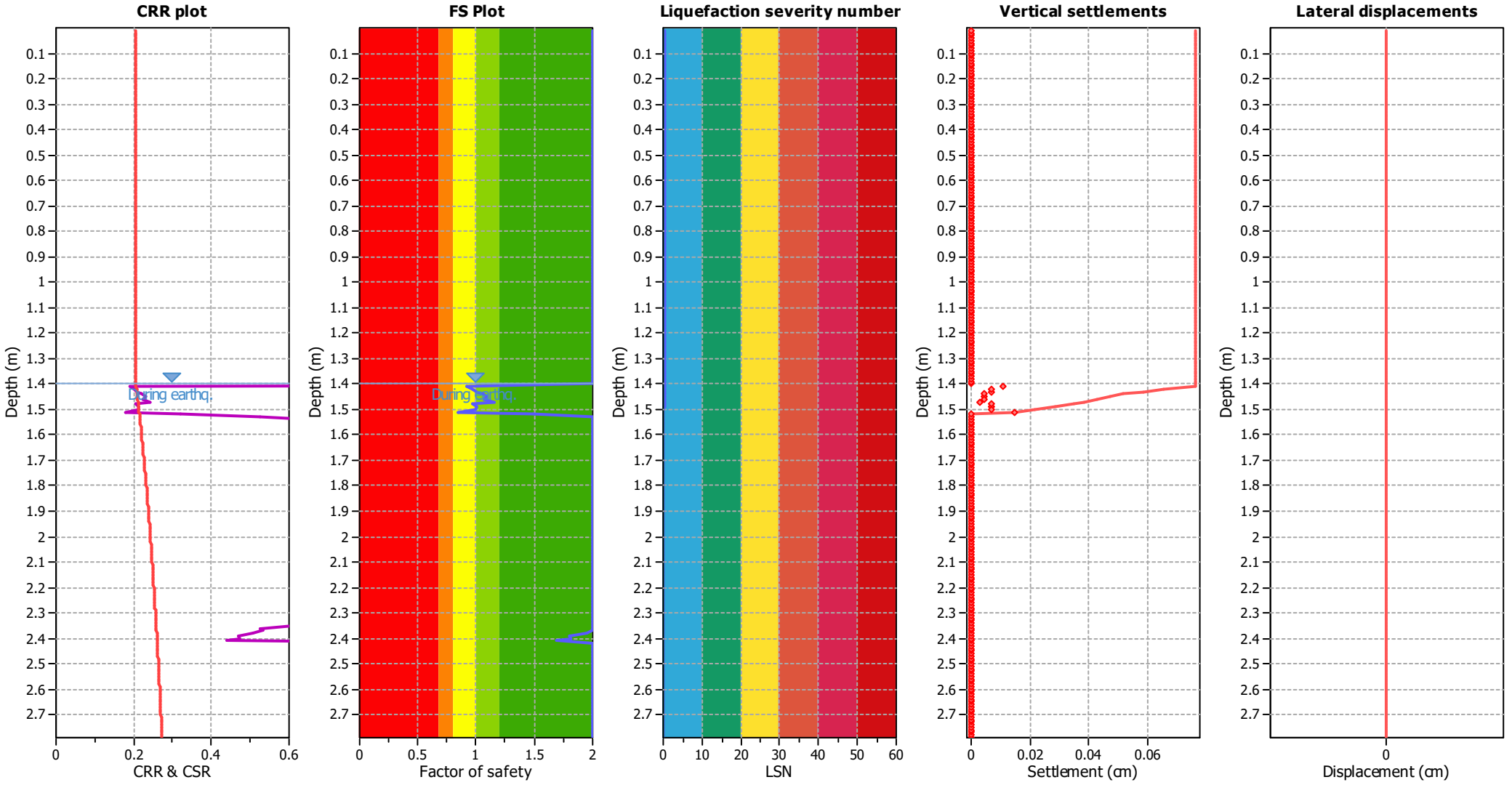
F.S. color scheme

- 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.):	1.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.40 m	Fill height:	N/A	Limit depth:	10.00 m

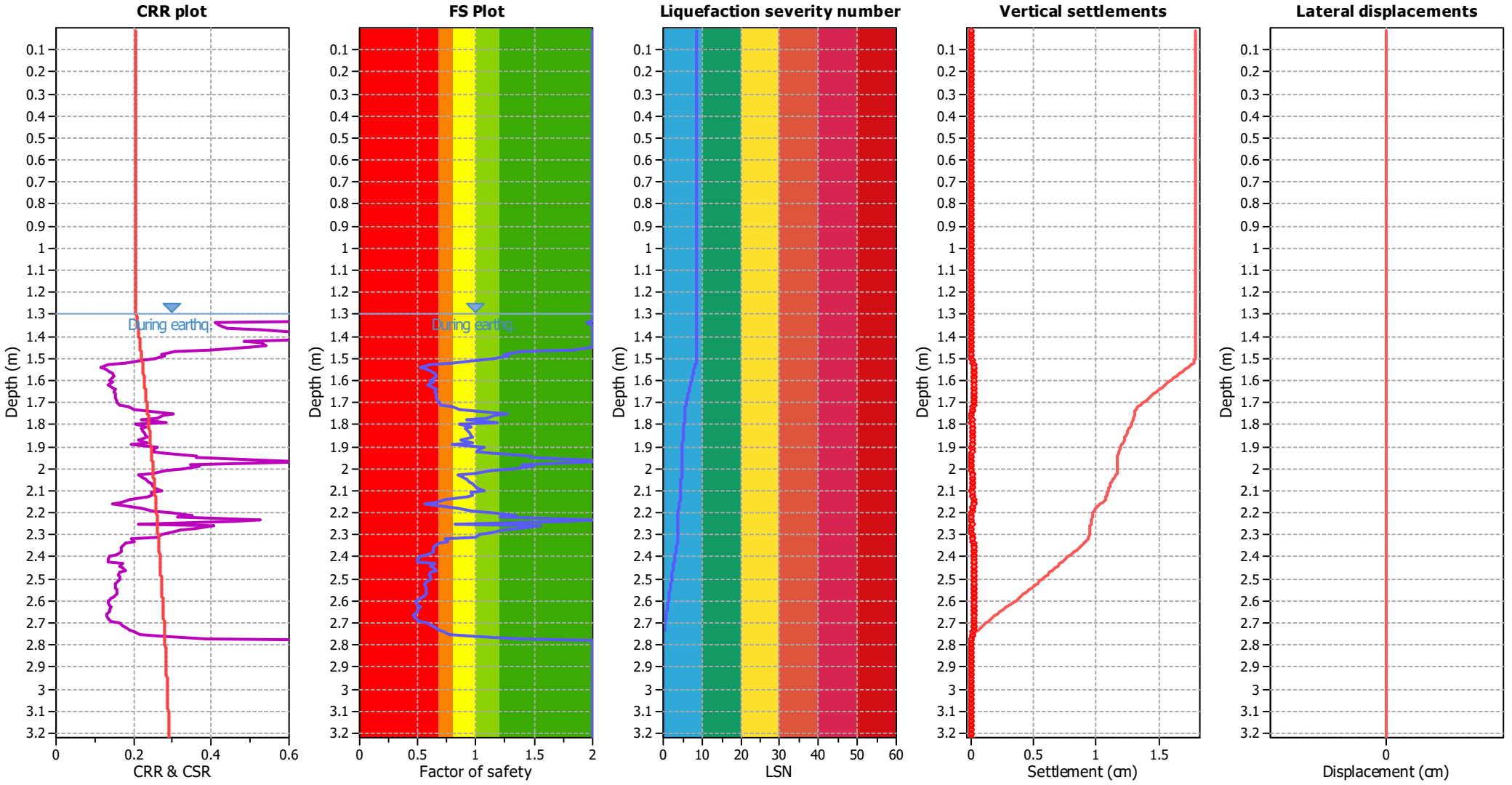
F.S. color scheme

- 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.):	1.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.30 m	Fill height:	N/A	Limit depth:	10.00 m

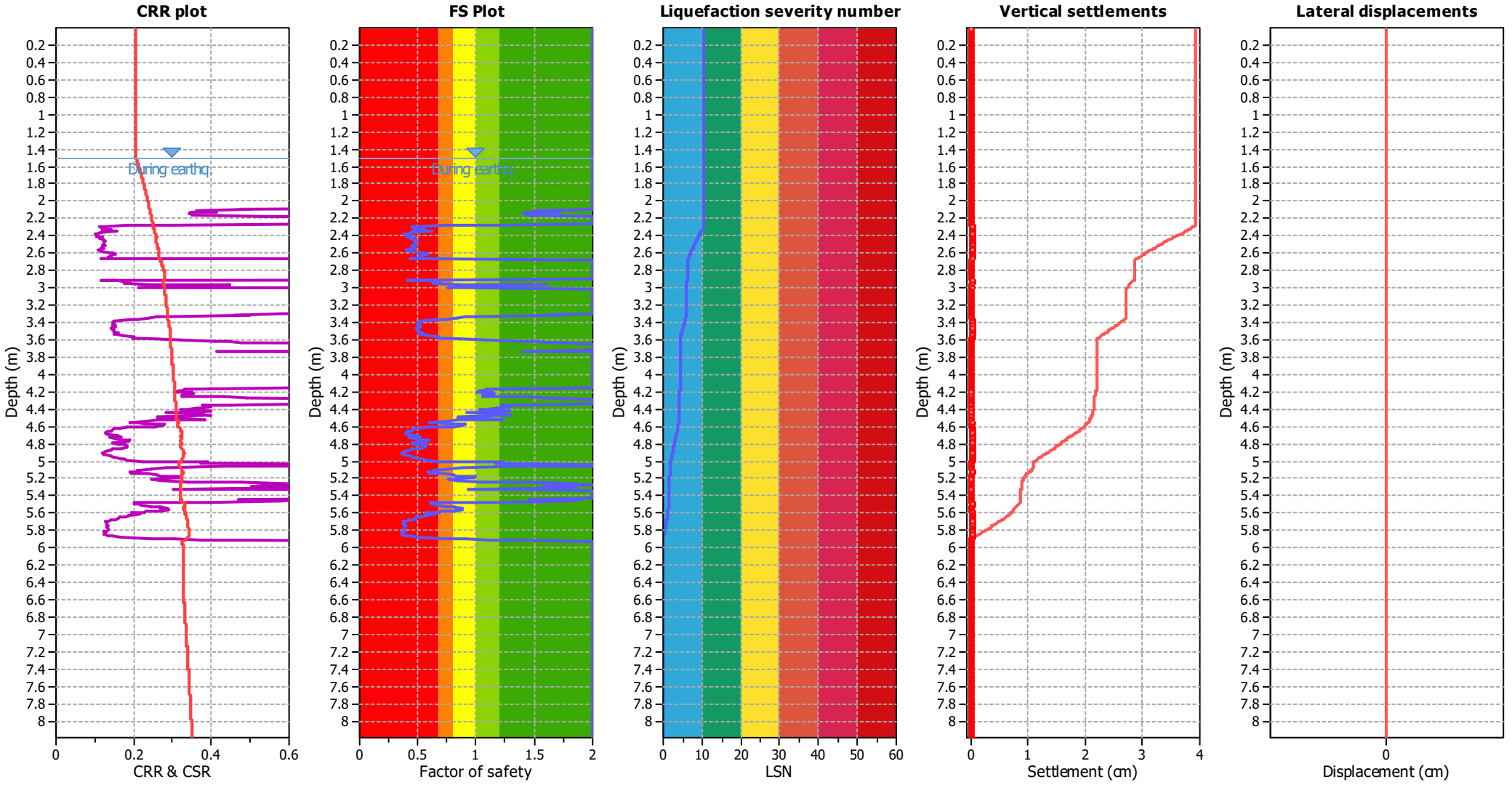
F.S. color scheme

- 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.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

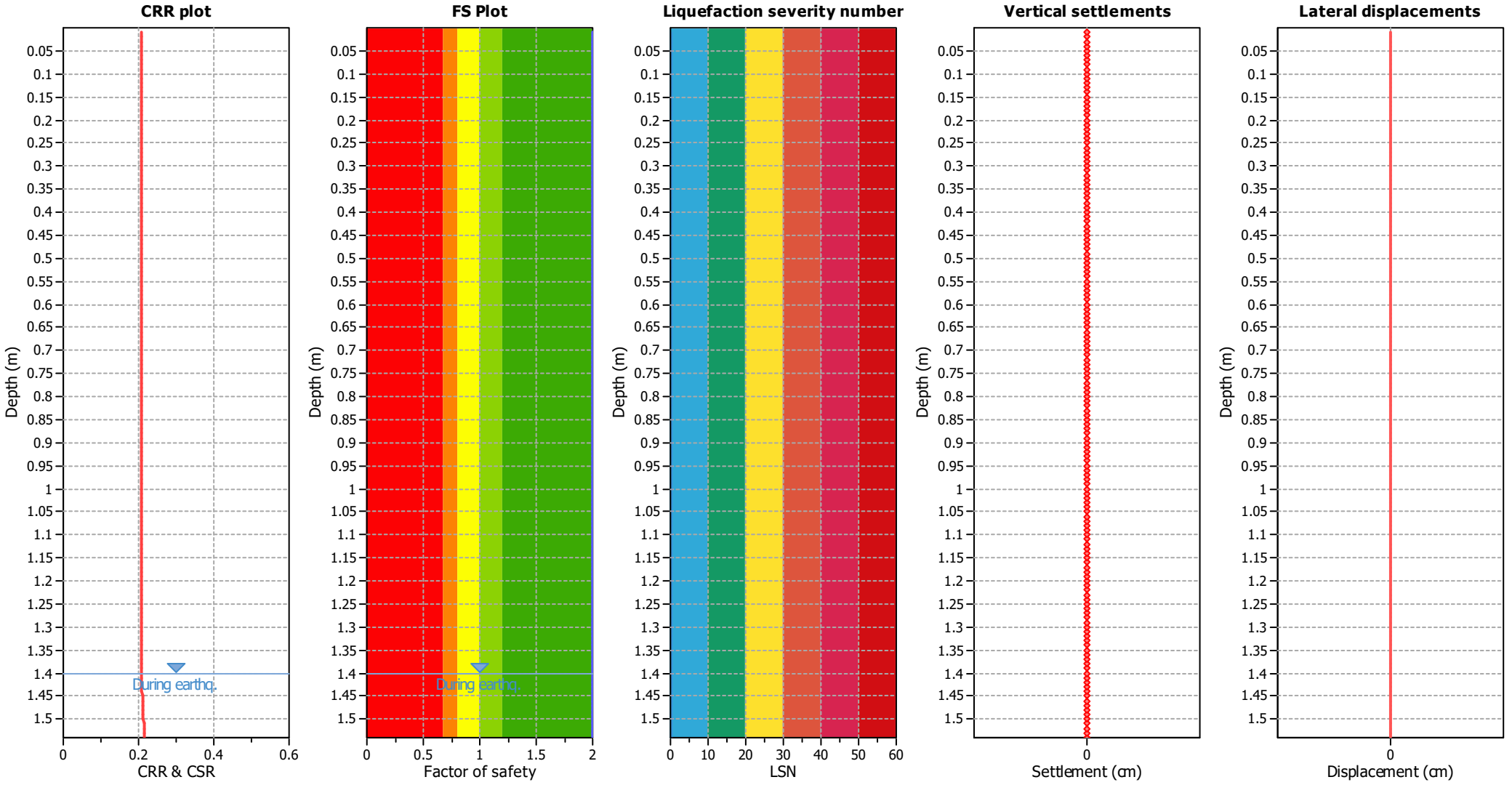
F.S. color scheme

- 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.):	1.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.40 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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

LSN color scheme

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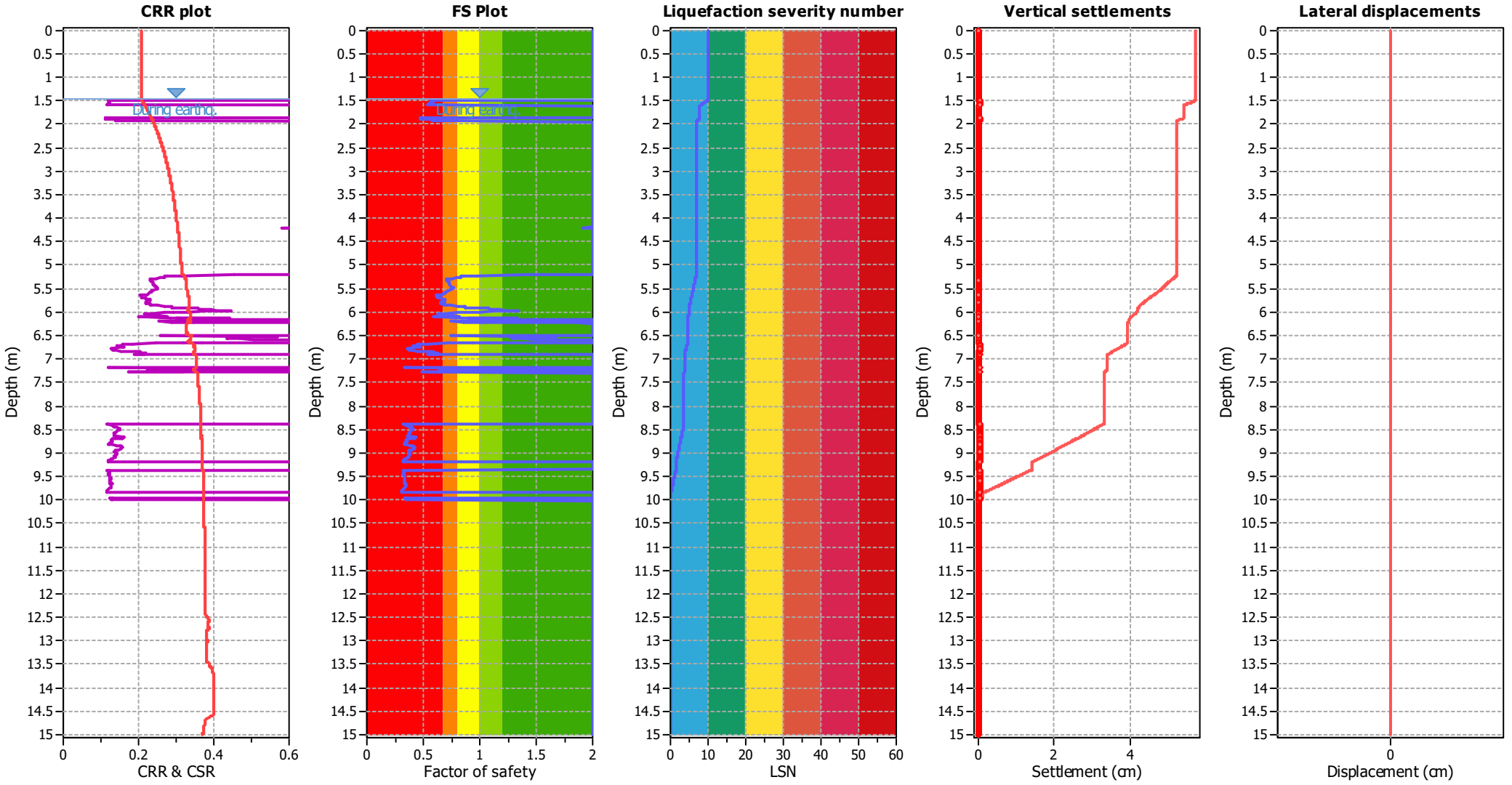
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.45 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.45 m	Fill height:	N/A	Limit depth:	10.00 m

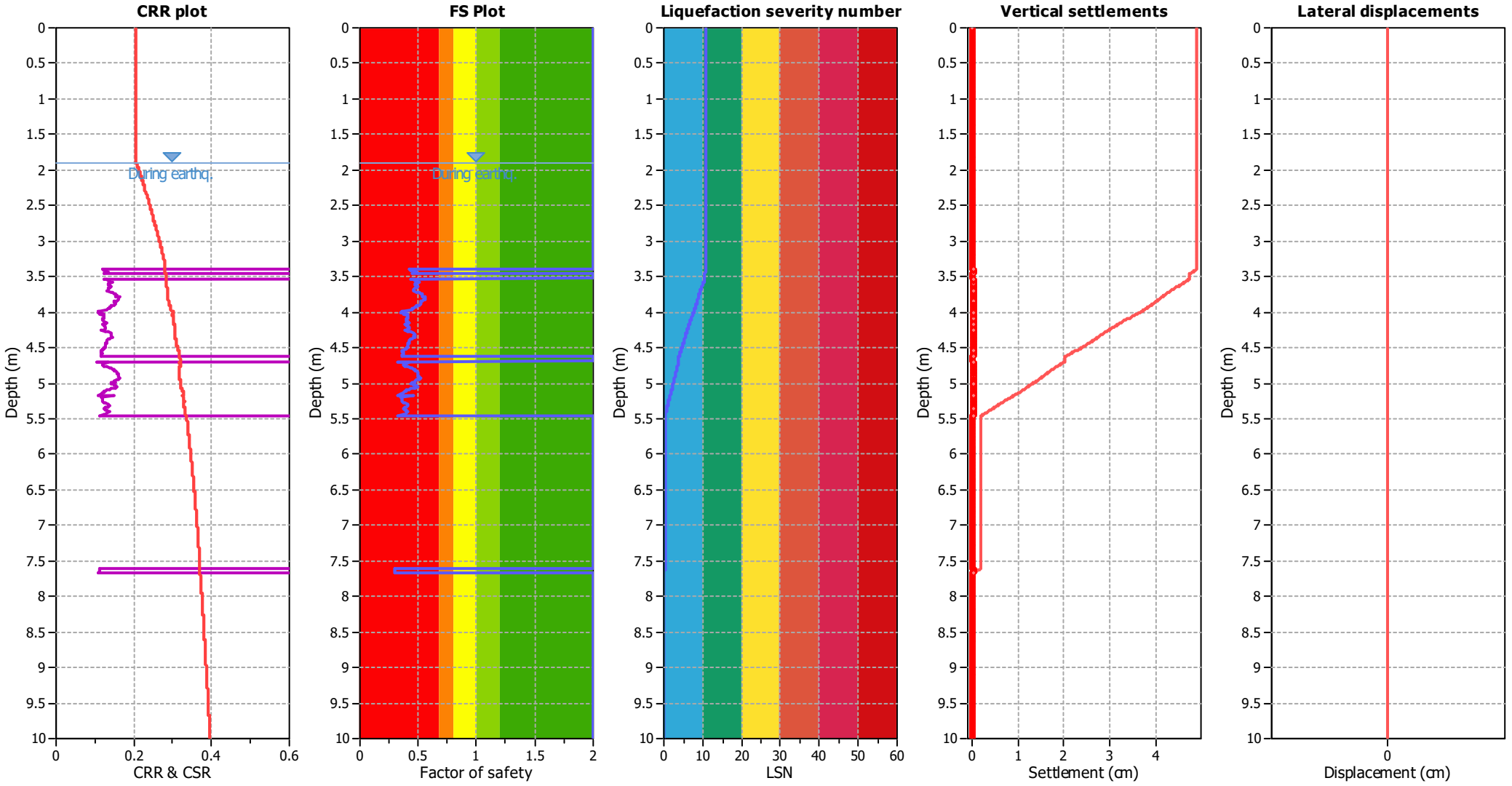
F.S. color scheme

- 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.):	1.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.90 m	Fill height:	N/A	Limit depth:	10.00 m

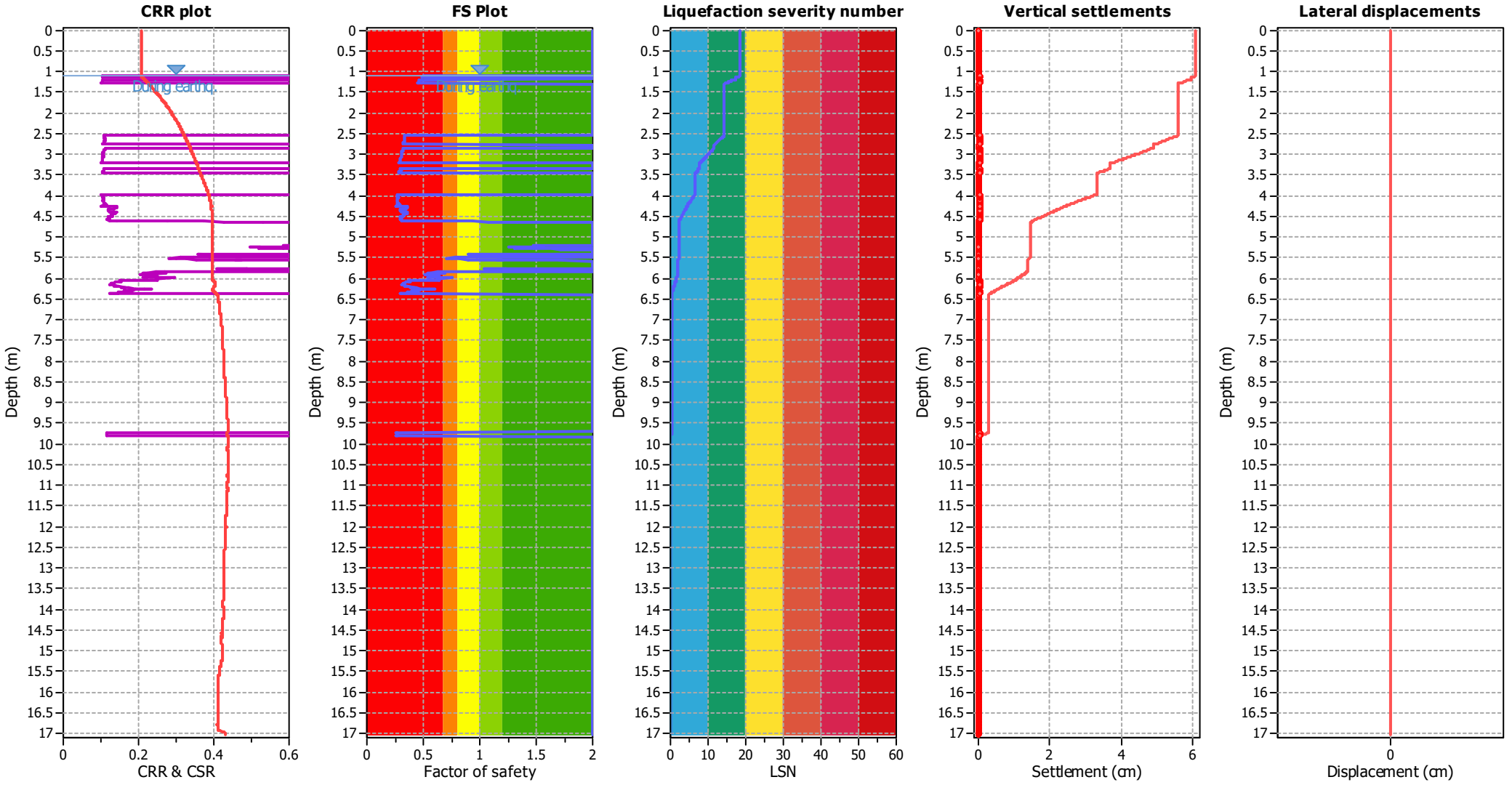
F.S. color scheme

- 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.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

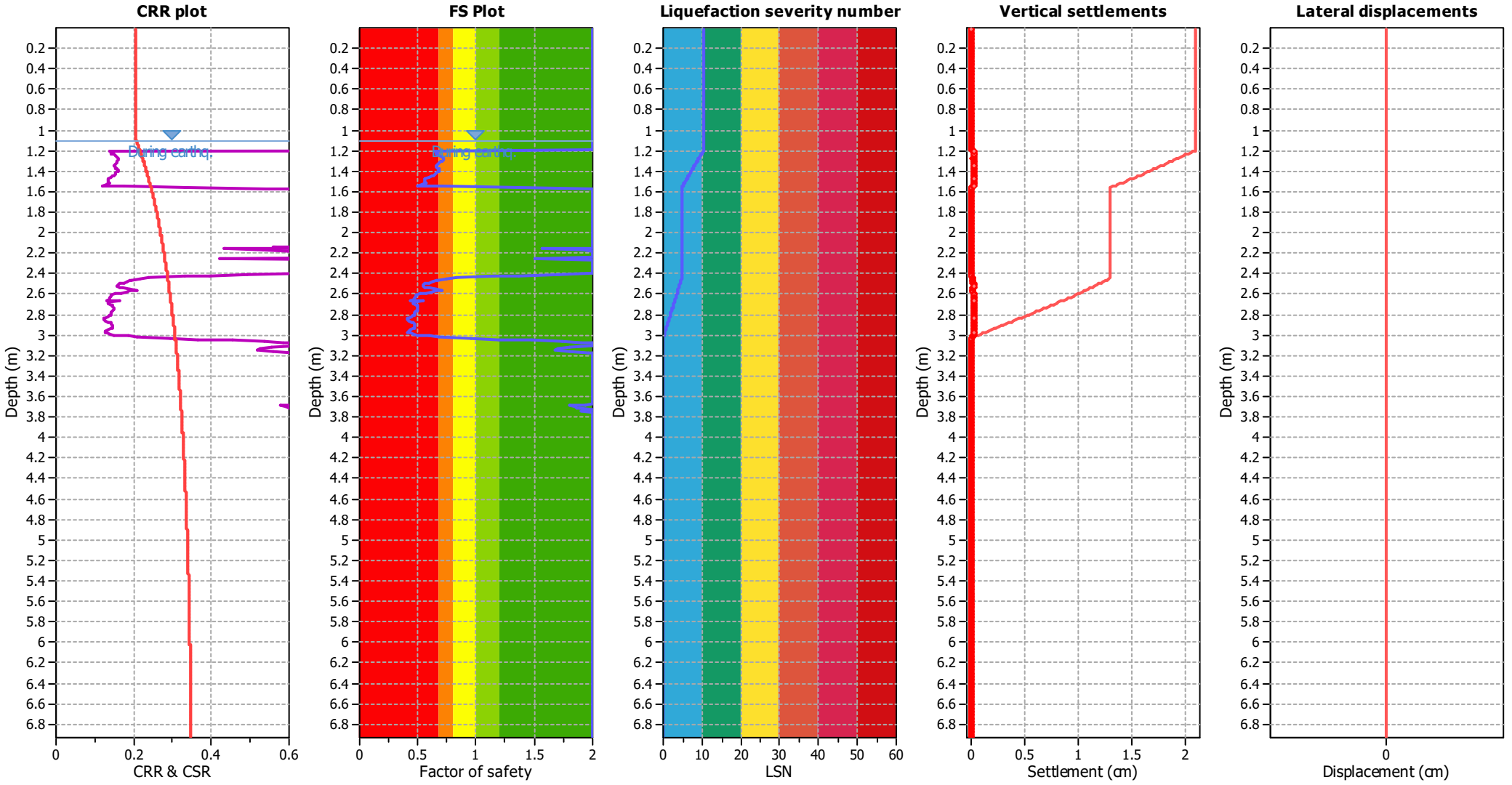
F.S. color scheme

- 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.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

- Almost certain it will liquefy
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LSN color scheme

- Severe damage
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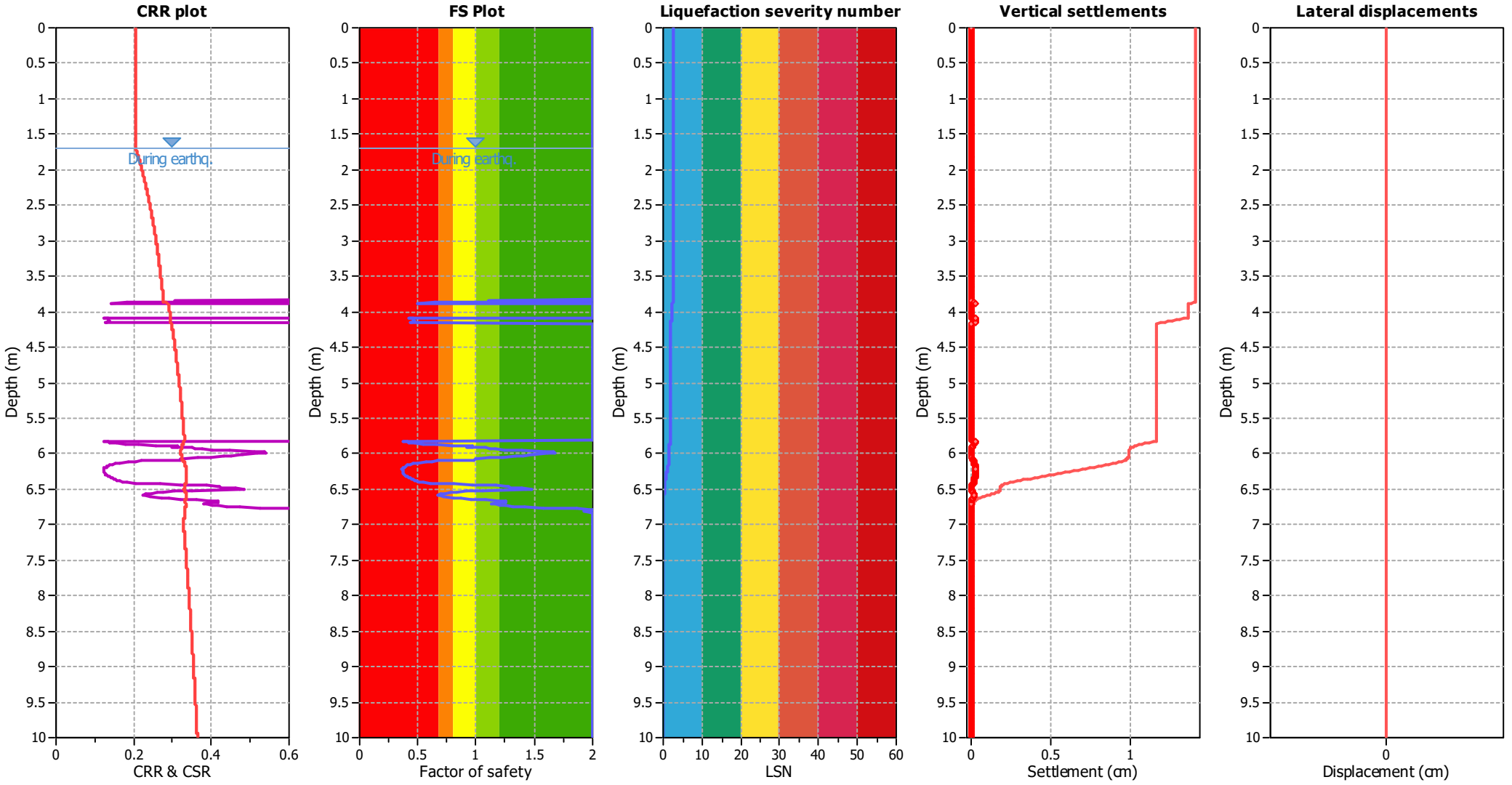
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 m	Fill height:	N/A	Limit depth:	10.00 m

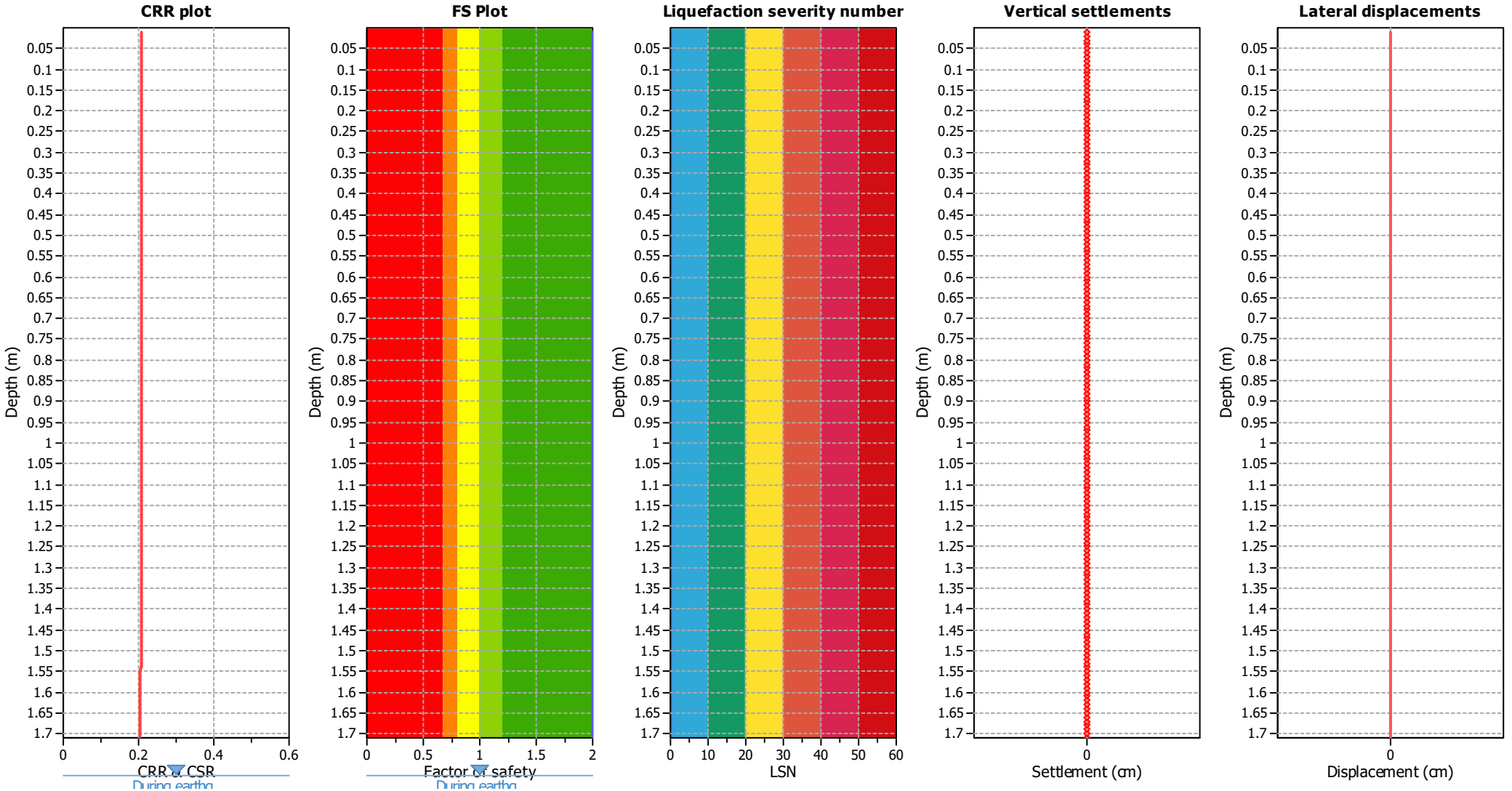
F.S. color scheme

- 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.):	1.80 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.80 m	Fill height:	N/A	Limit depth:	10.00 m

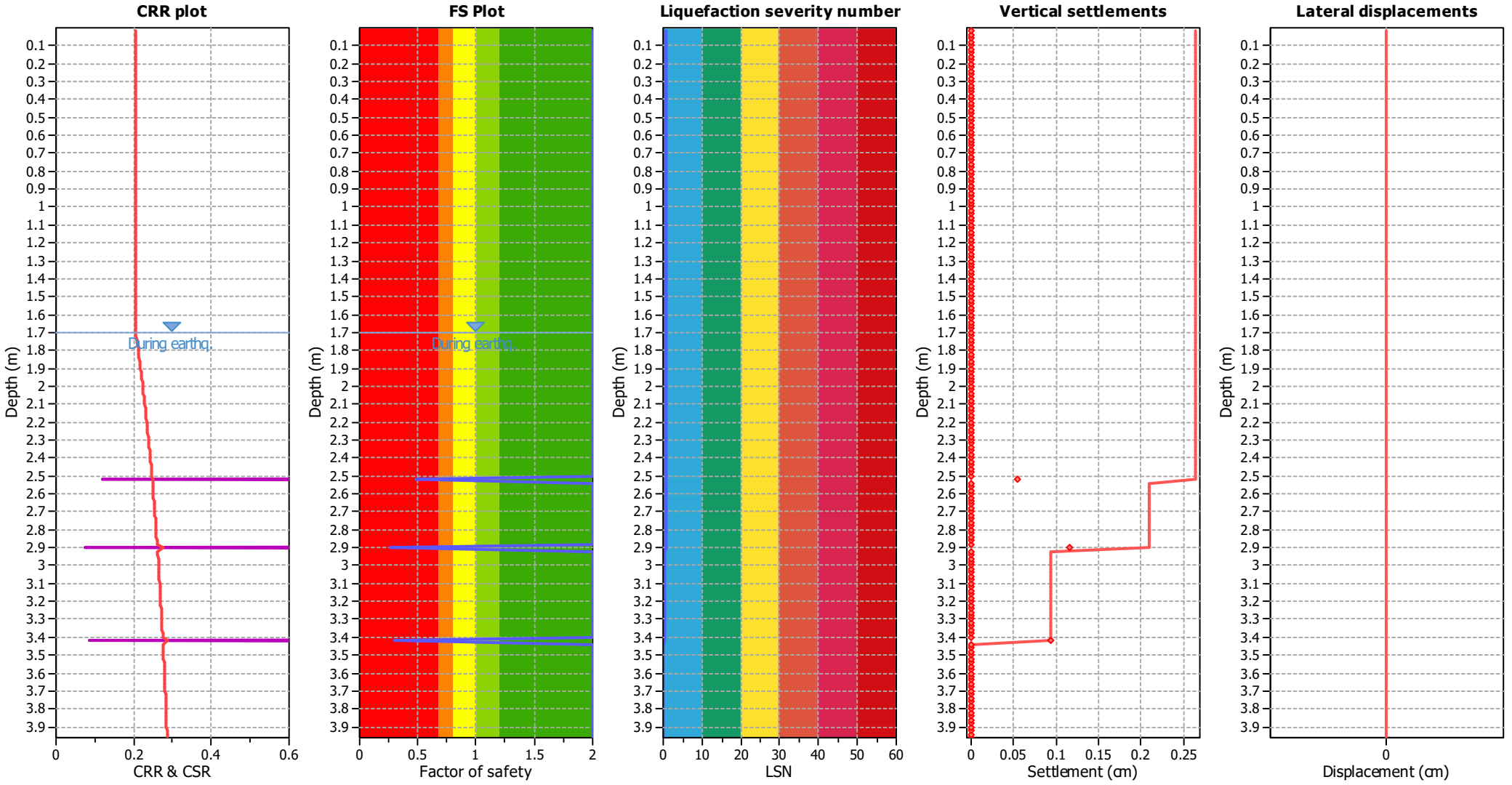
F.S. color scheme

- 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.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LSN color scheme

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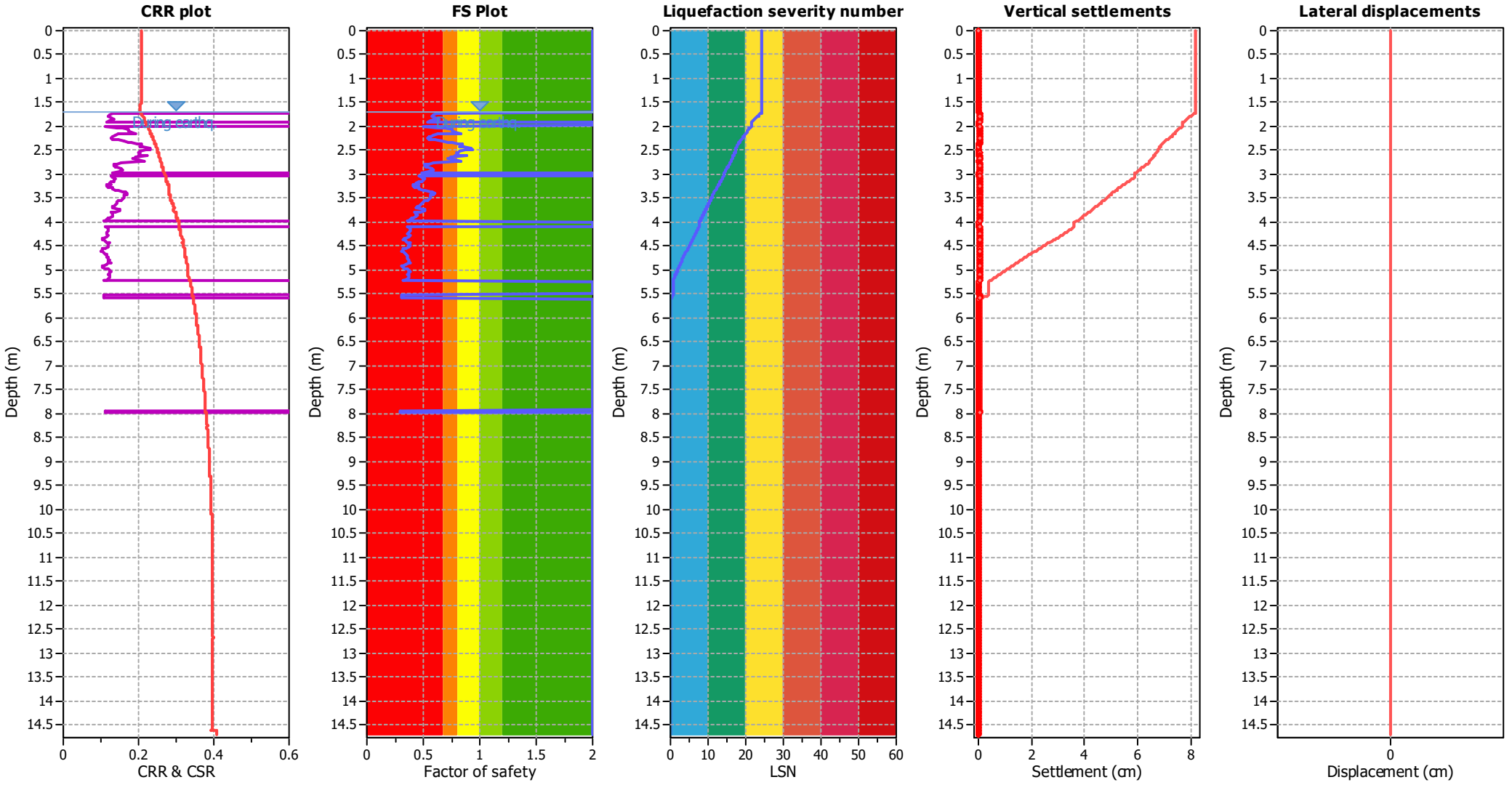
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.70 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LSN color scheme

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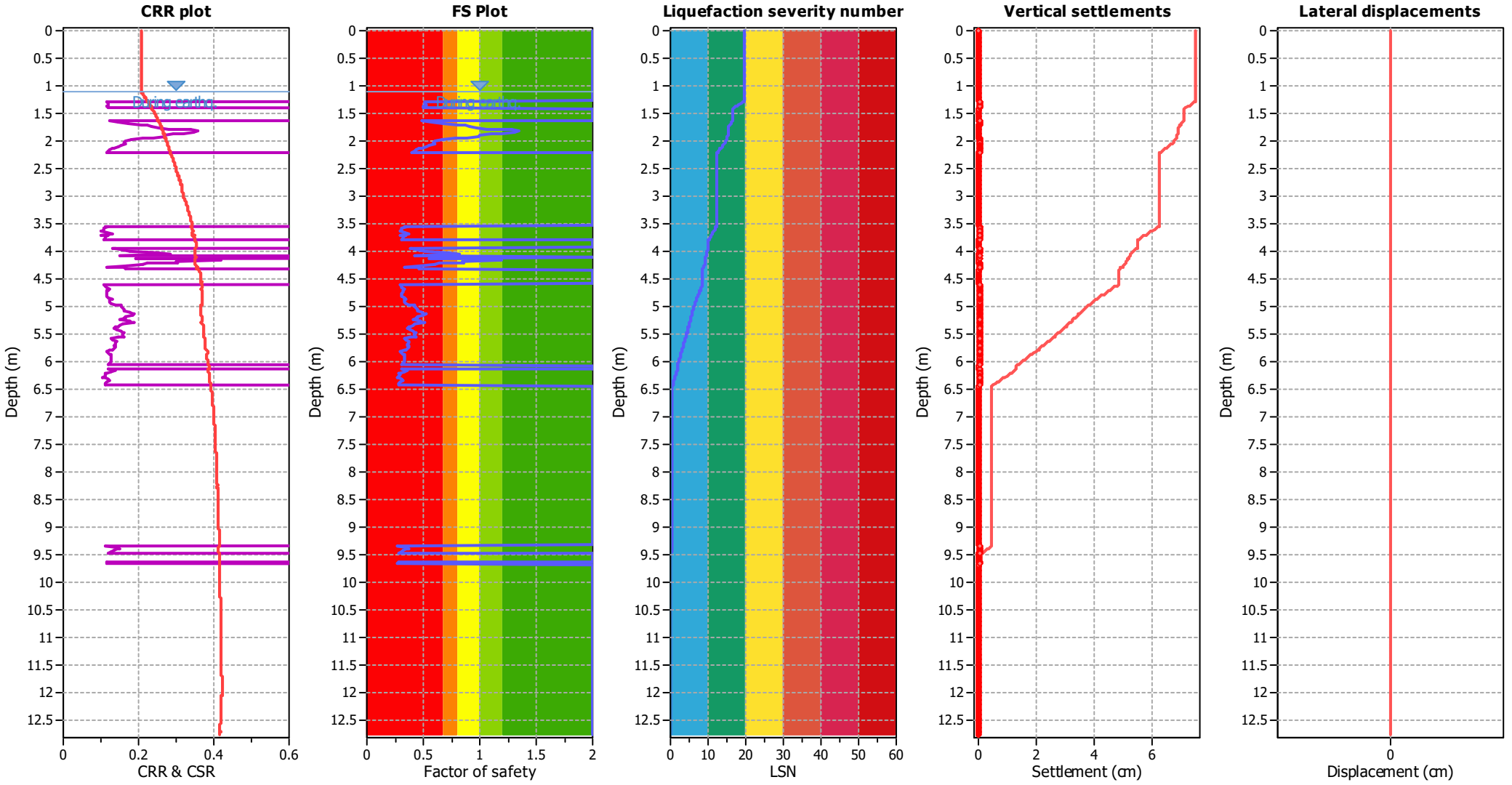
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

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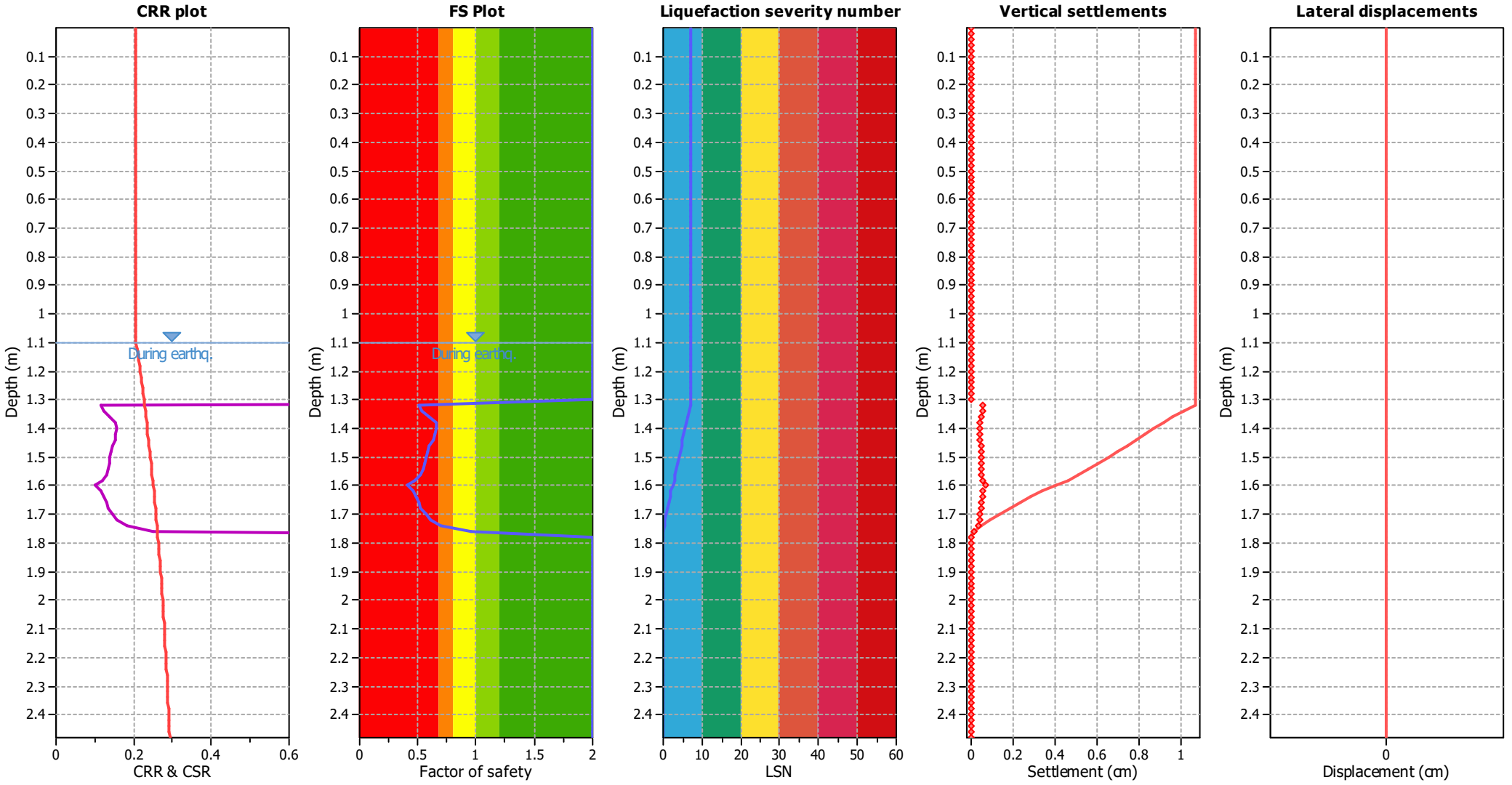
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

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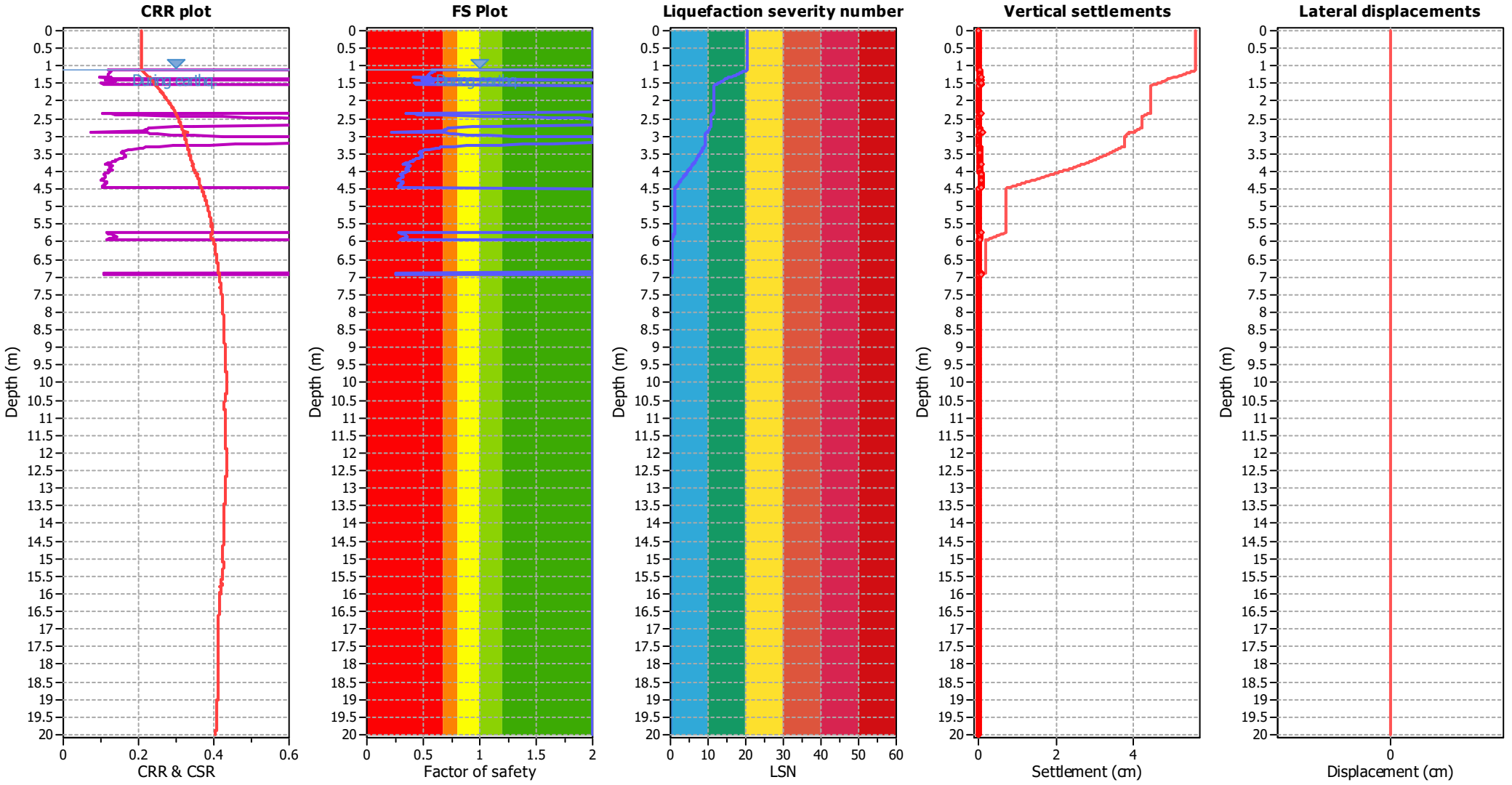
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	10.00 m

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LSN color scheme

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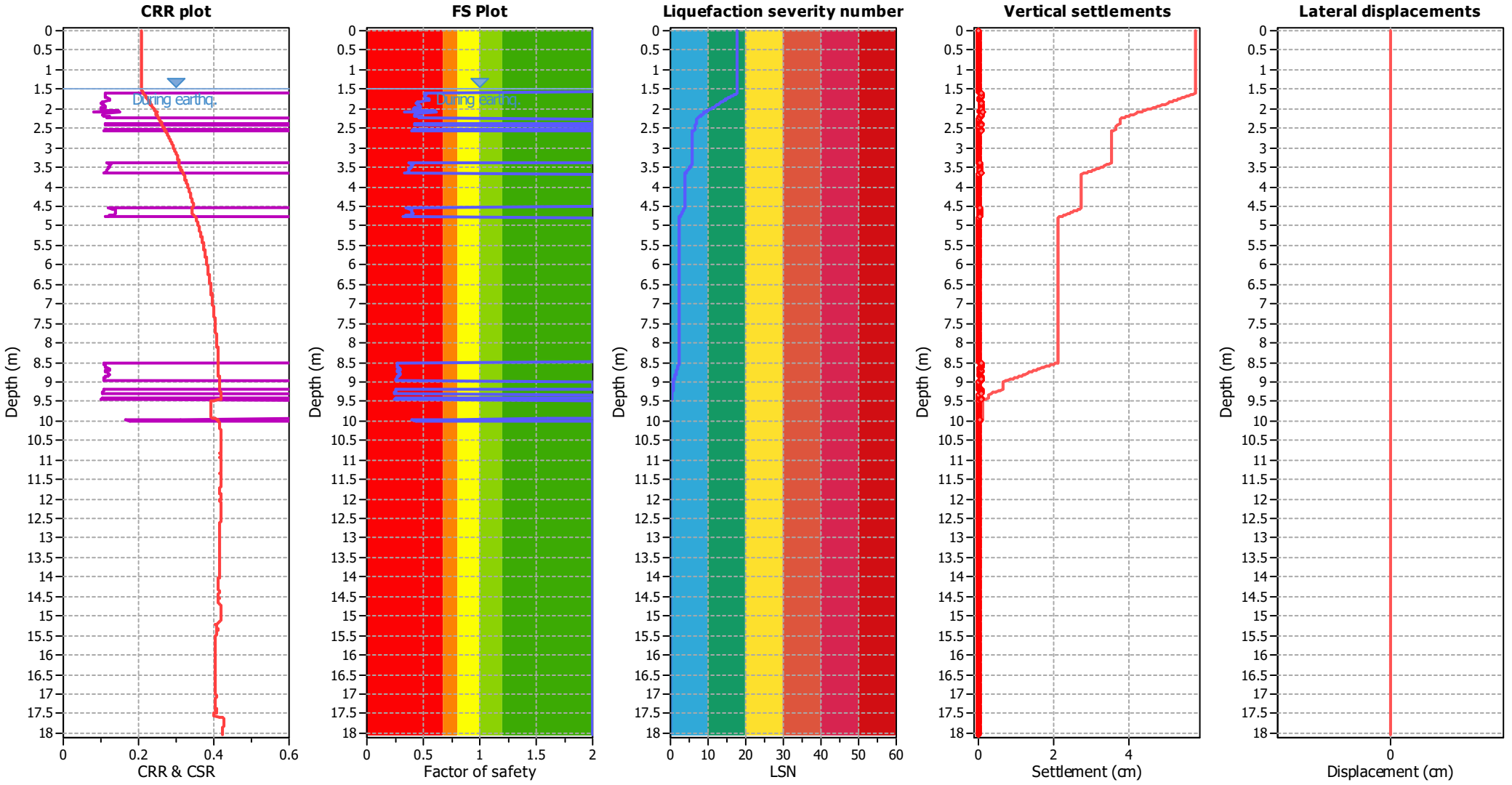
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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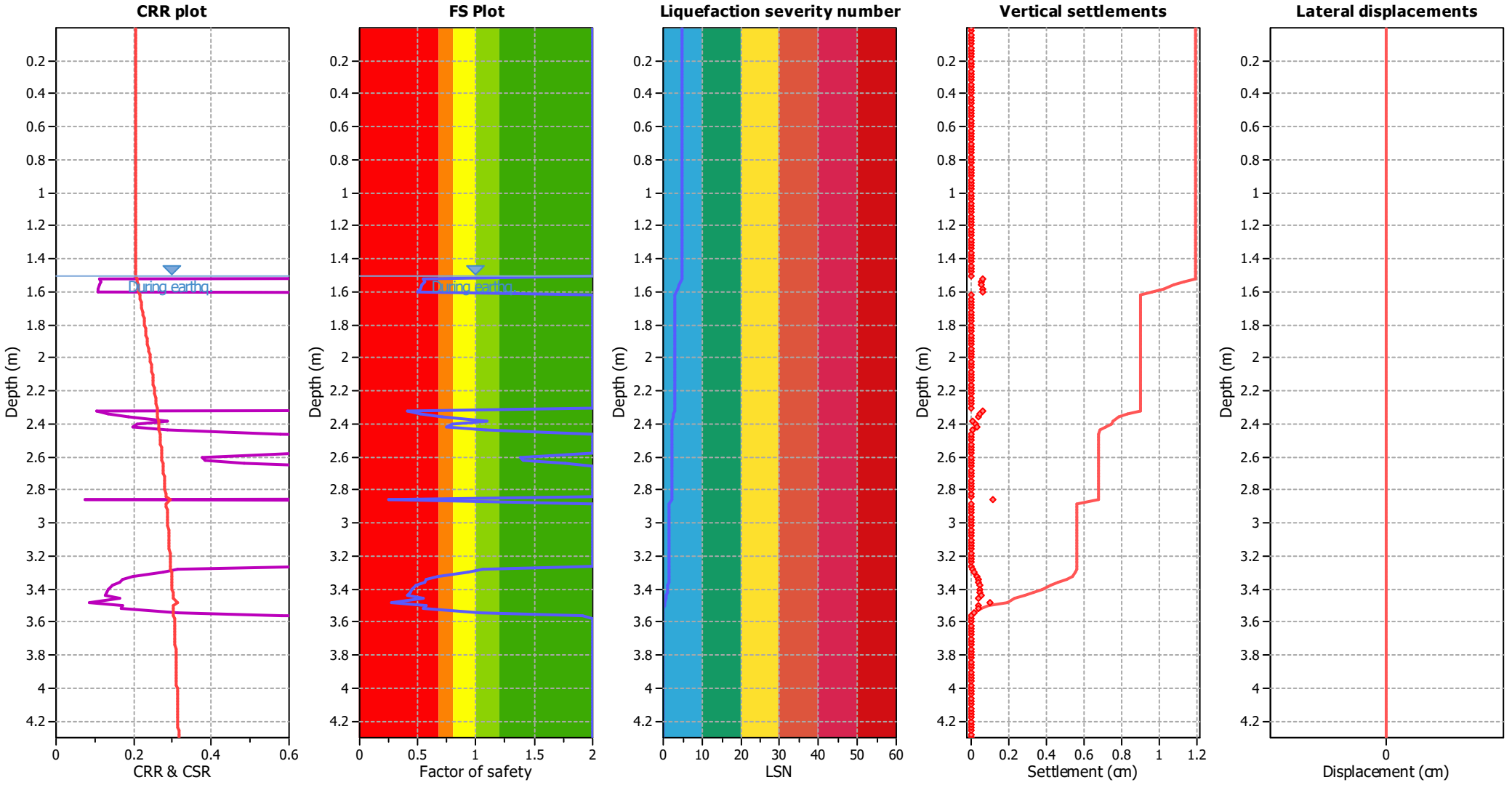
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

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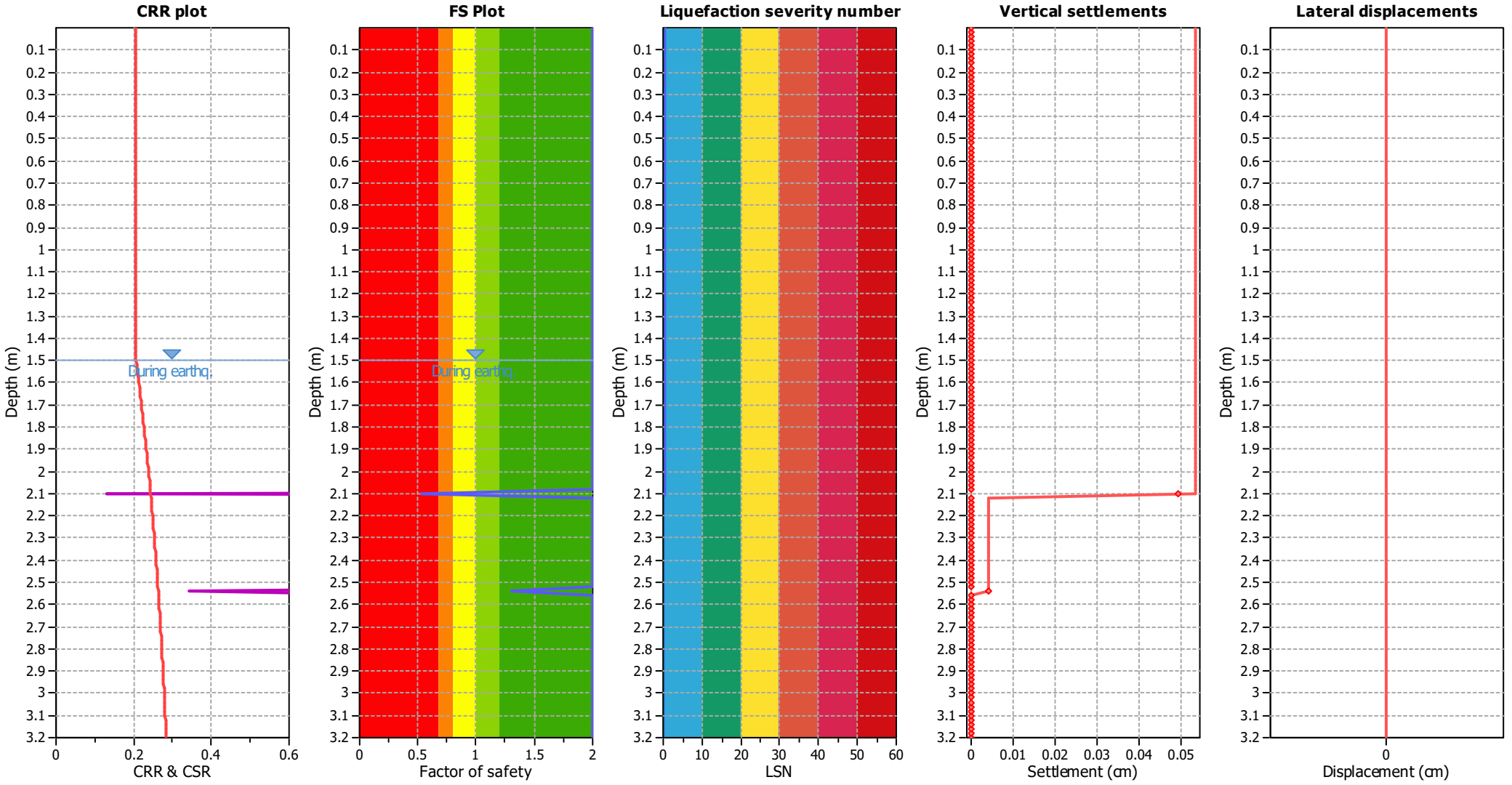
LSN color scheme

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

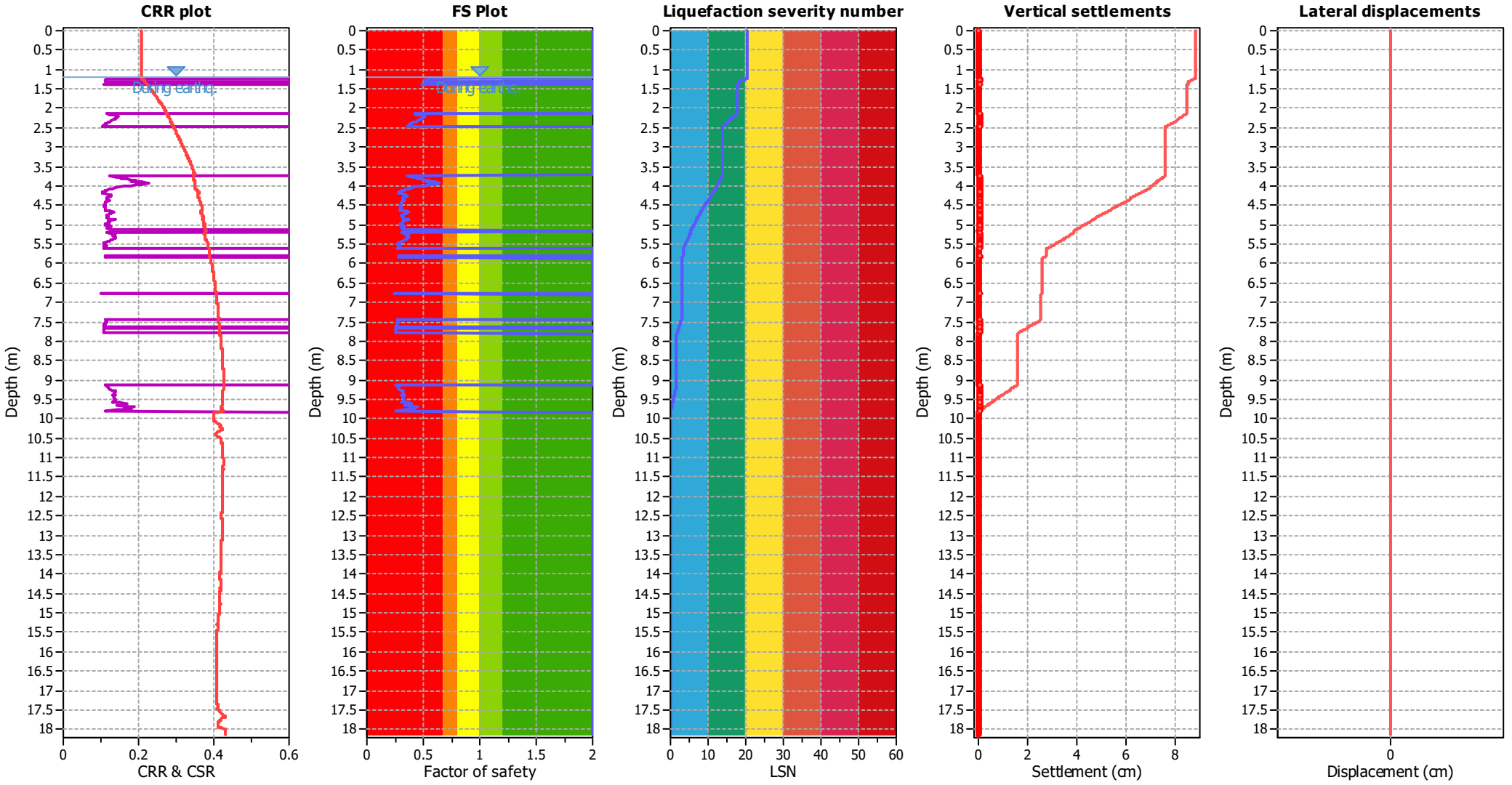
F.S. color scheme

- 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.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 m	Fill height:	N/A	Limit depth:	10.00 m

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LSN color scheme

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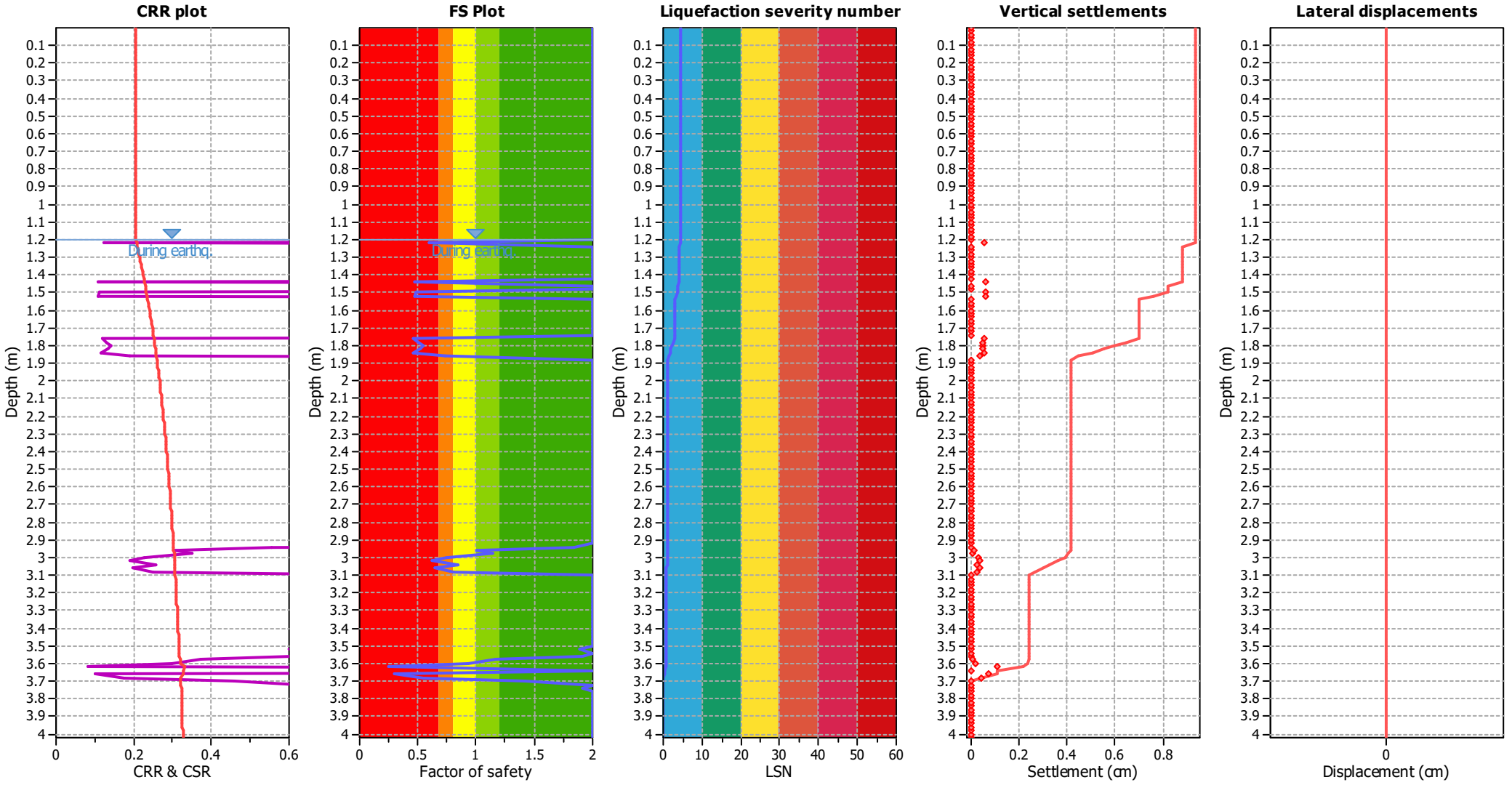
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.20 m	Fill weight:	N/A
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LSN color scheme

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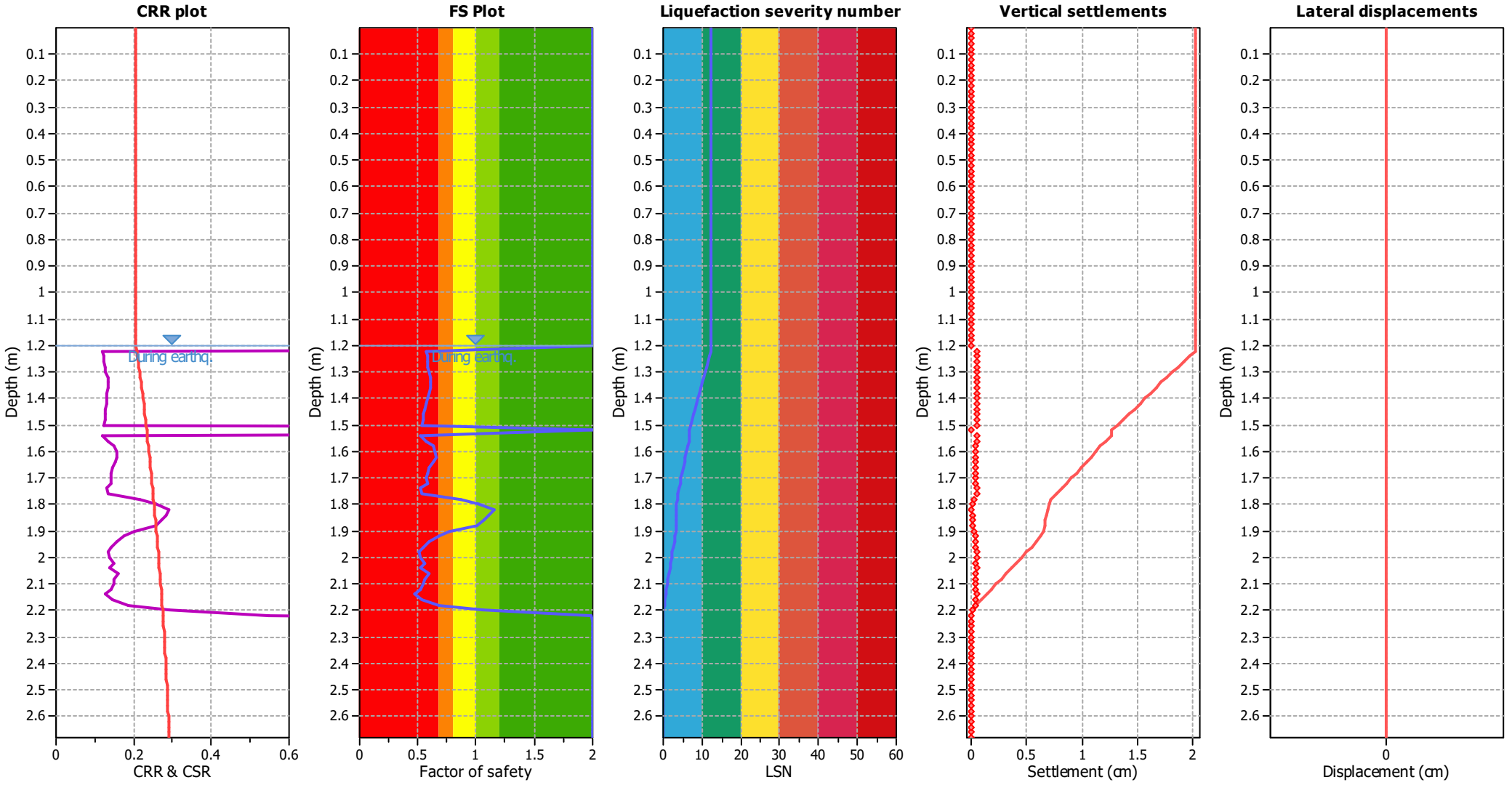
Liquefaction analysis overall plots



Input parameters and analysis data

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LSN color scheme

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APPENDIX 6:

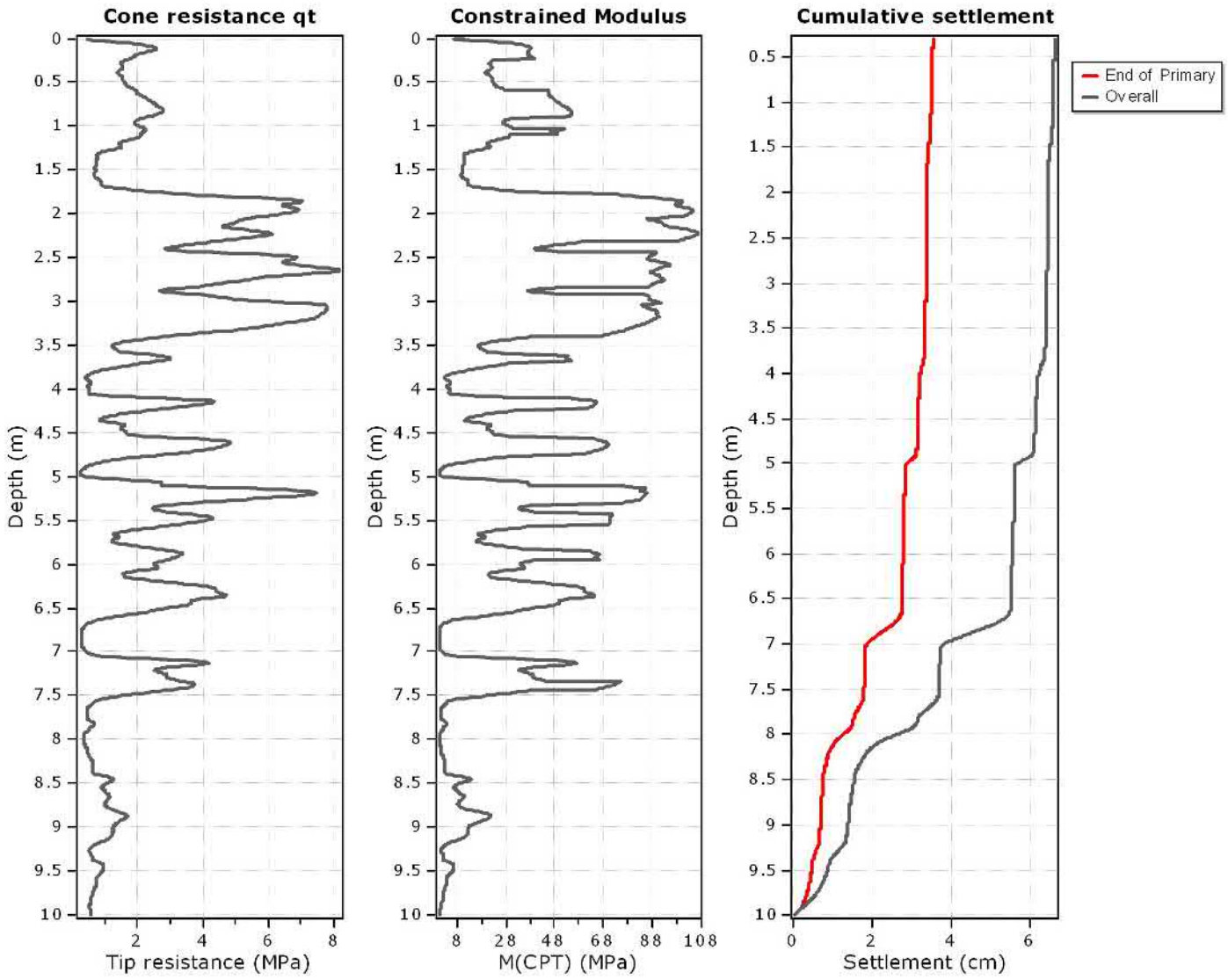
Consolidation Analysis Outputs

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

CPT: CPT-03
Total depth: 10.00 m, Date: 23/11/2021
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project:
Location:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 20.00 (m)
L/B: 1.0
Footing pressure: 20.00 (kPa)
Embedment depth: 0.30 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

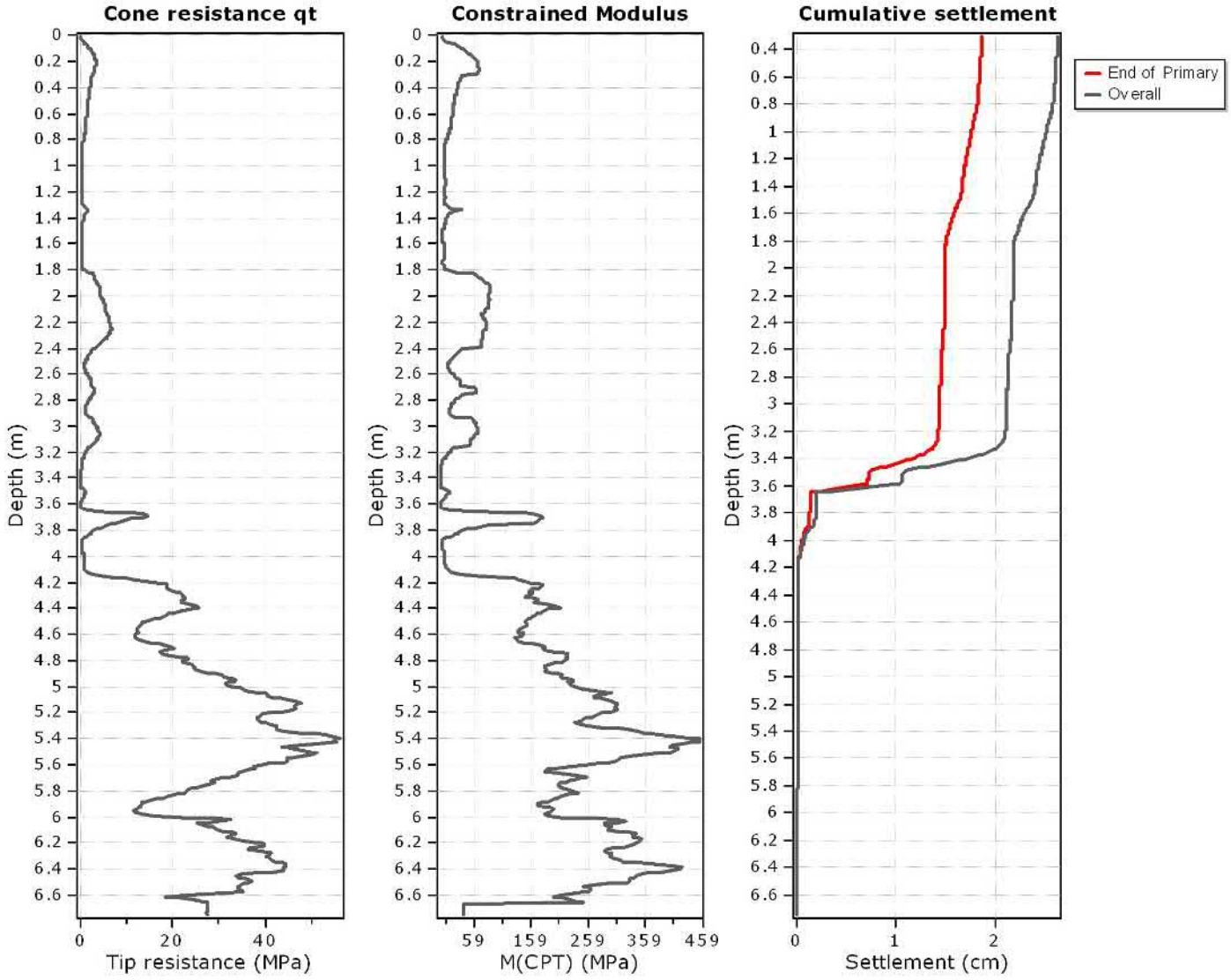
* Primary settlements calculation is performed according to the following formula:

$$S = \sum \frac{\Delta \sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlements calculation is performed according to the following formula:

$$S = C_a \cdot \Delta z \cdot \log(t)$$

Settlements calculation according to theory of elasticity*



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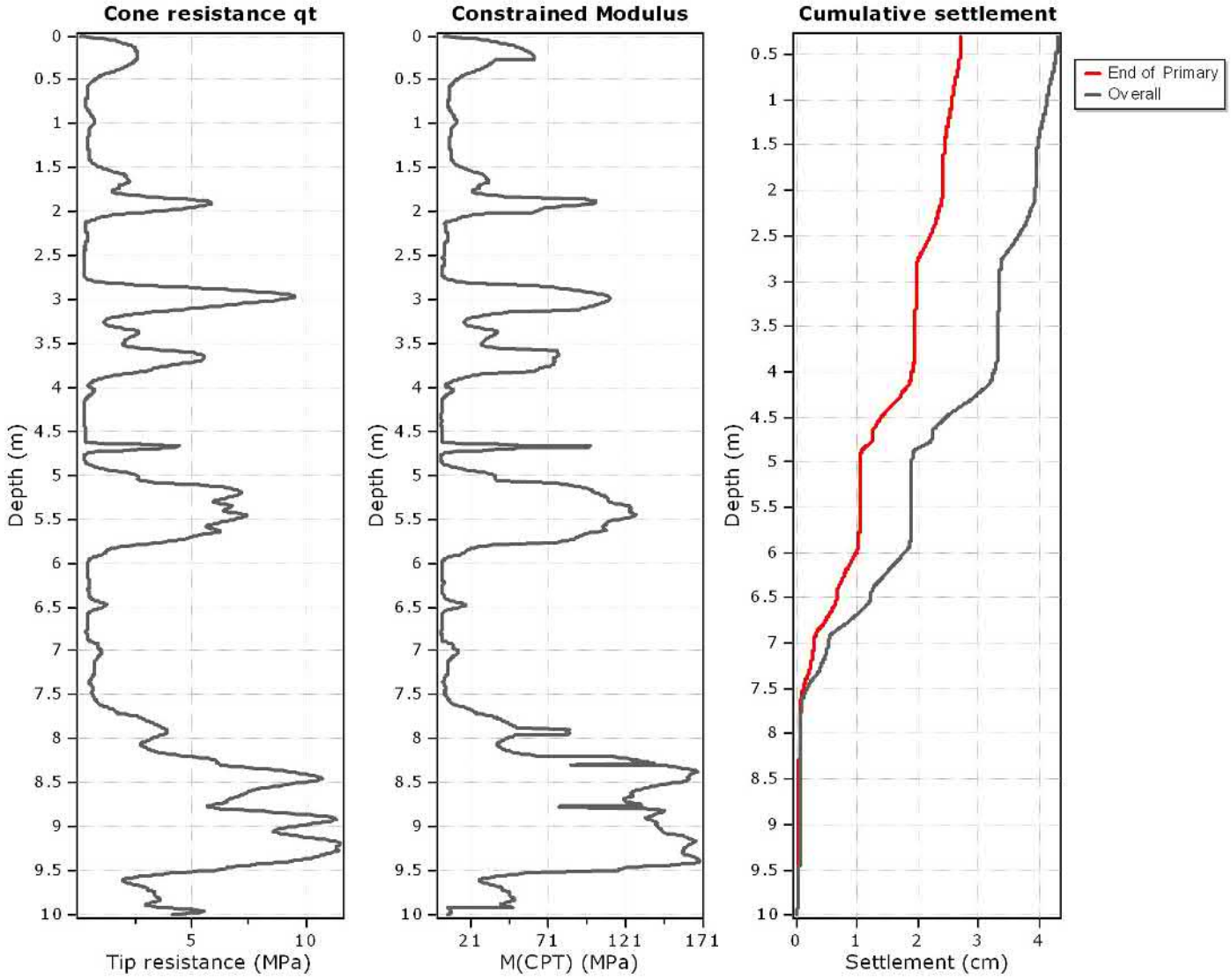

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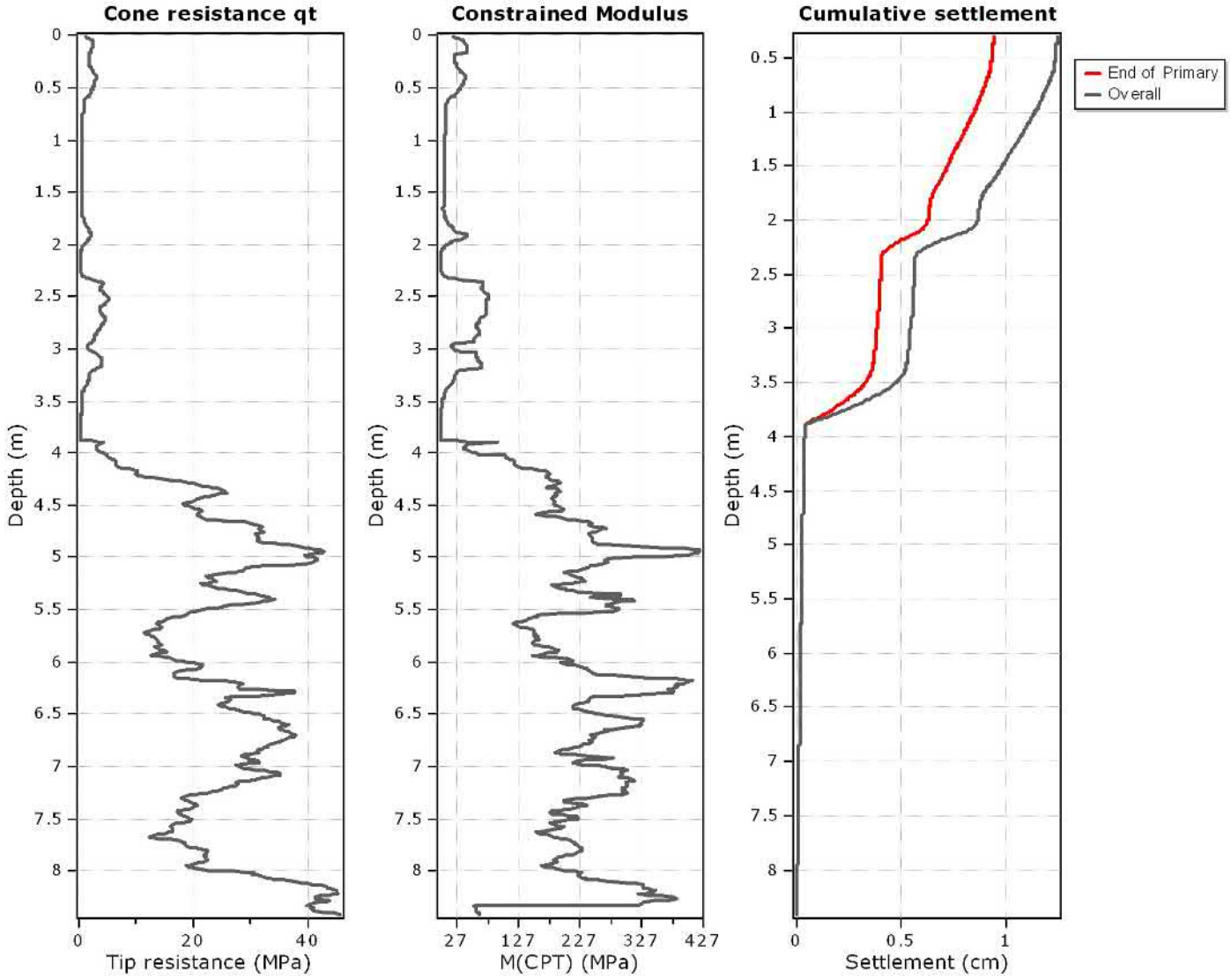

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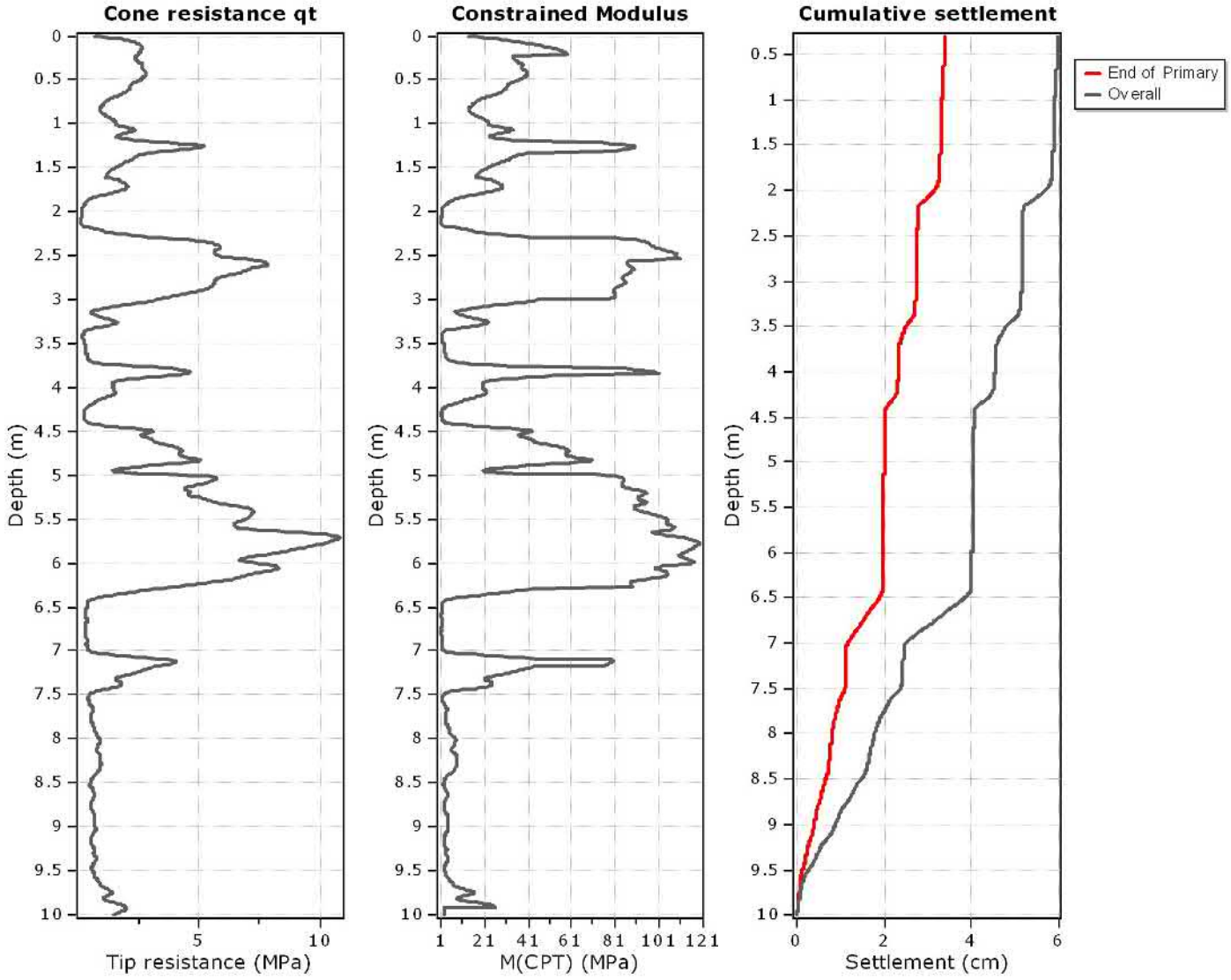

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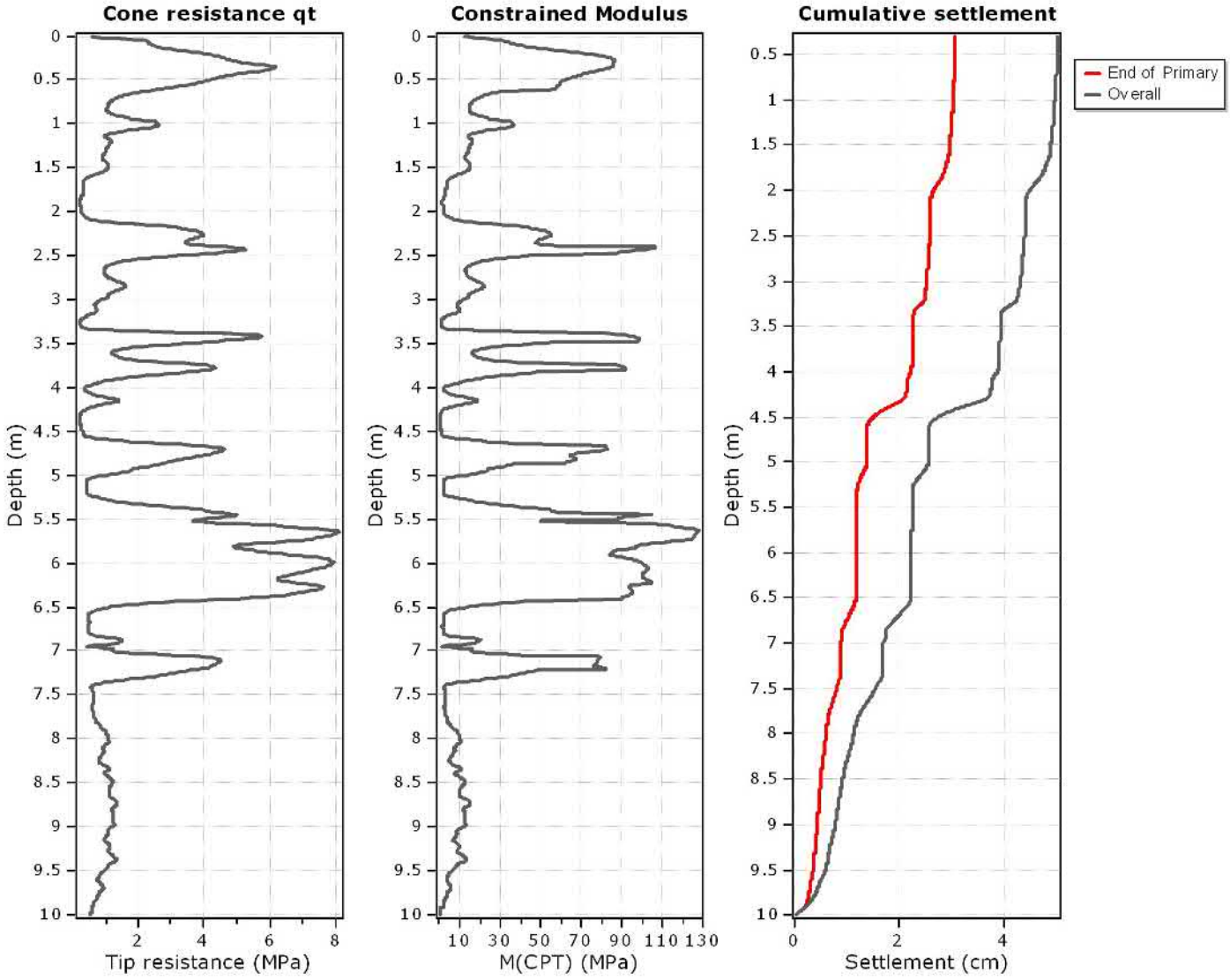

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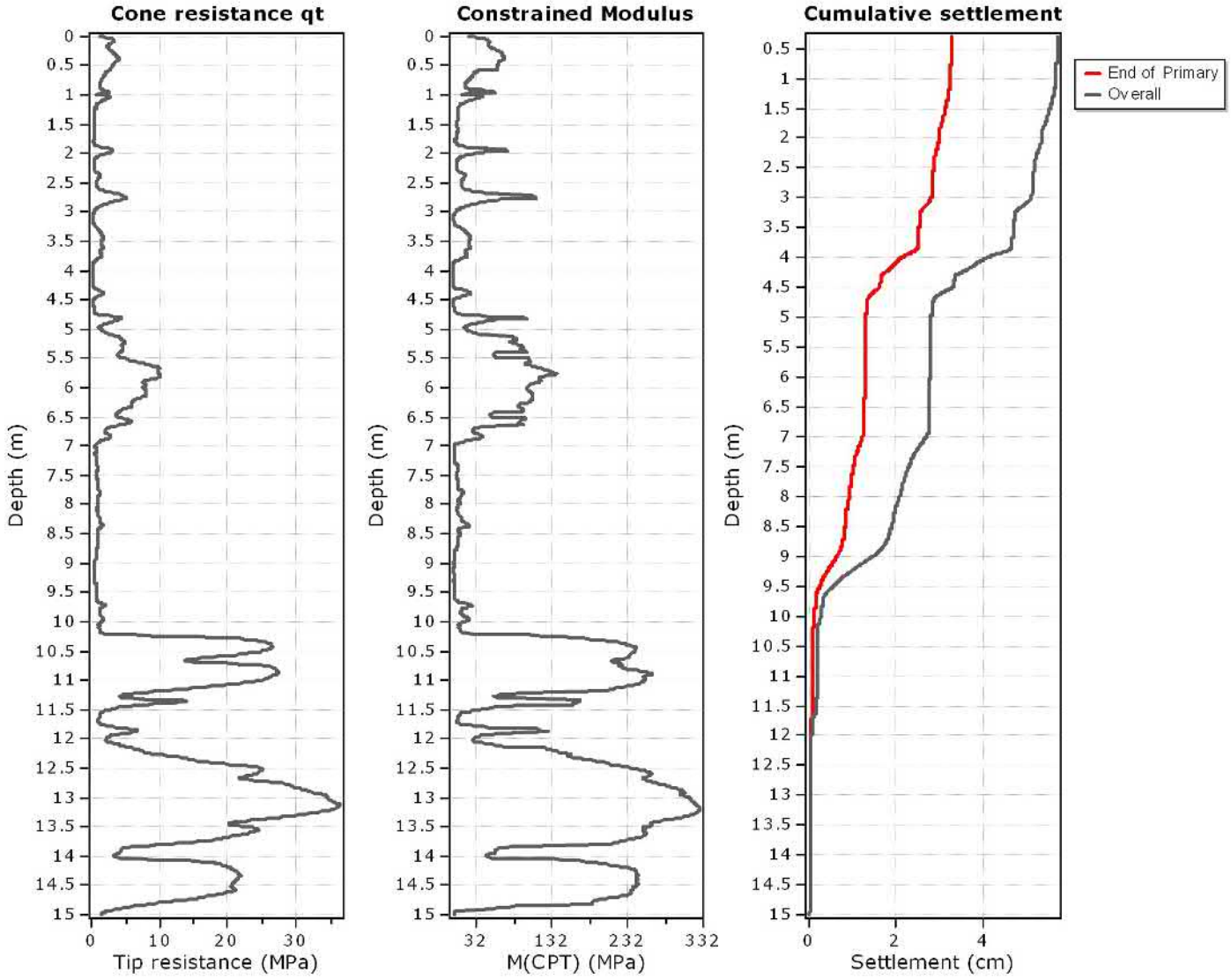

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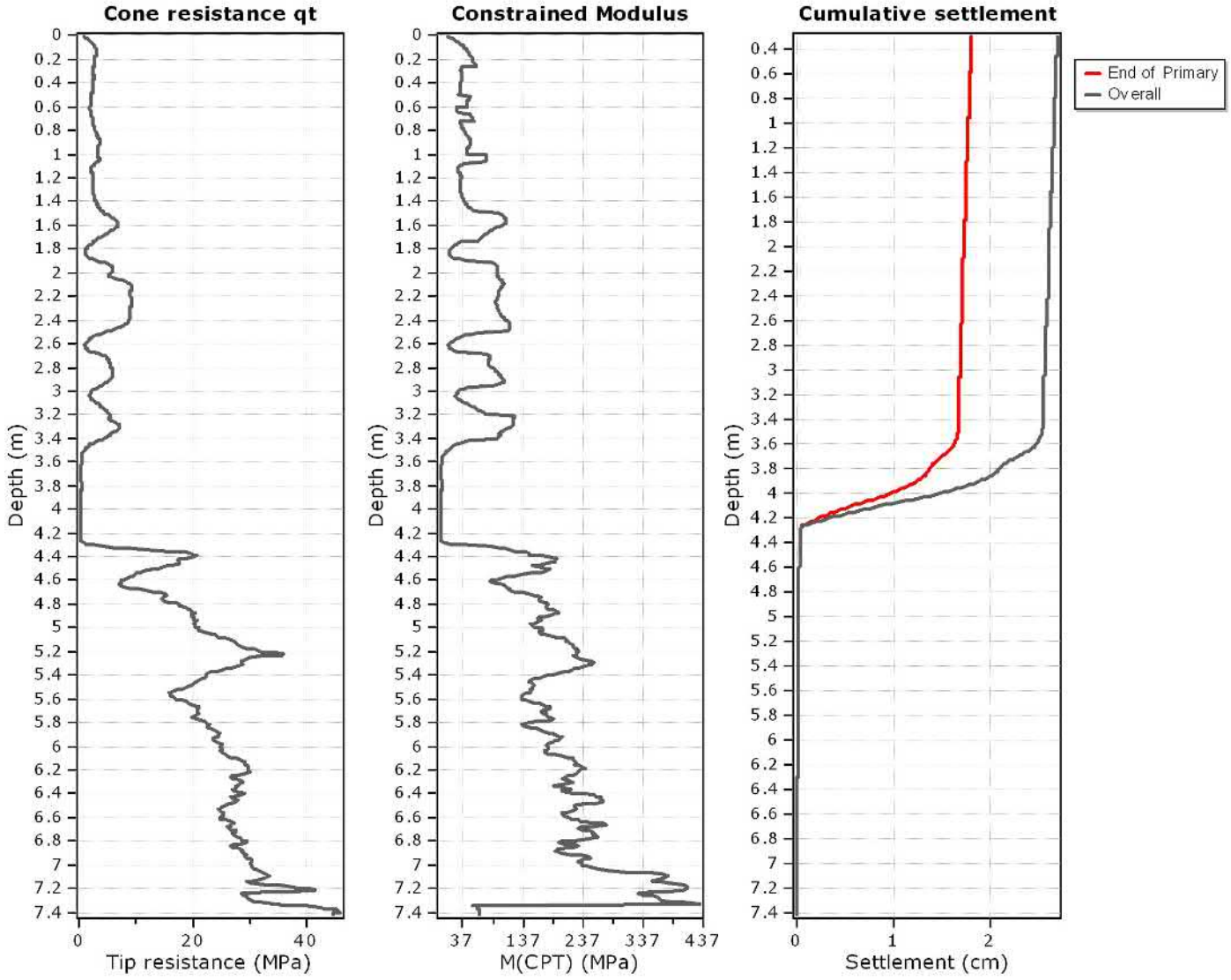

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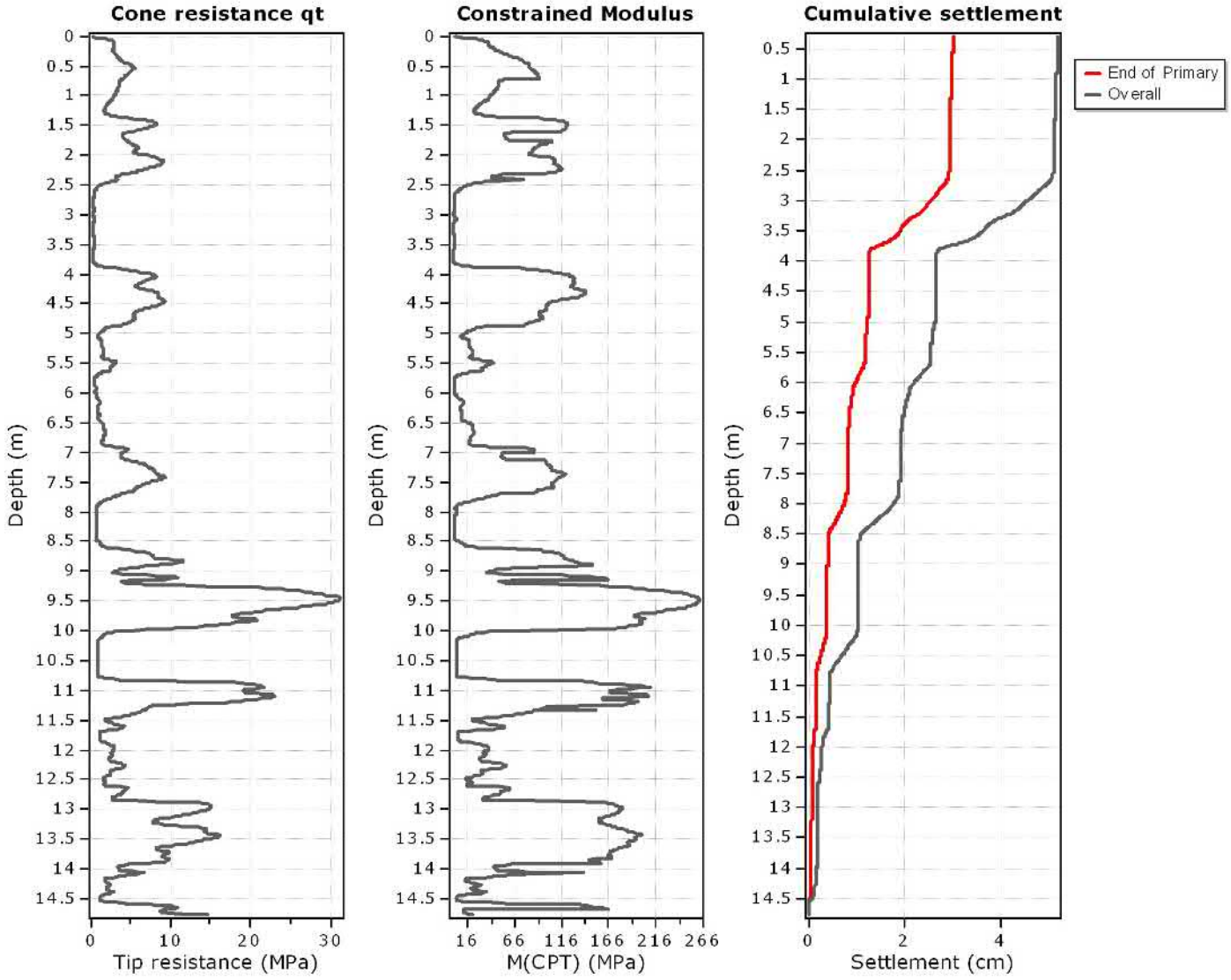

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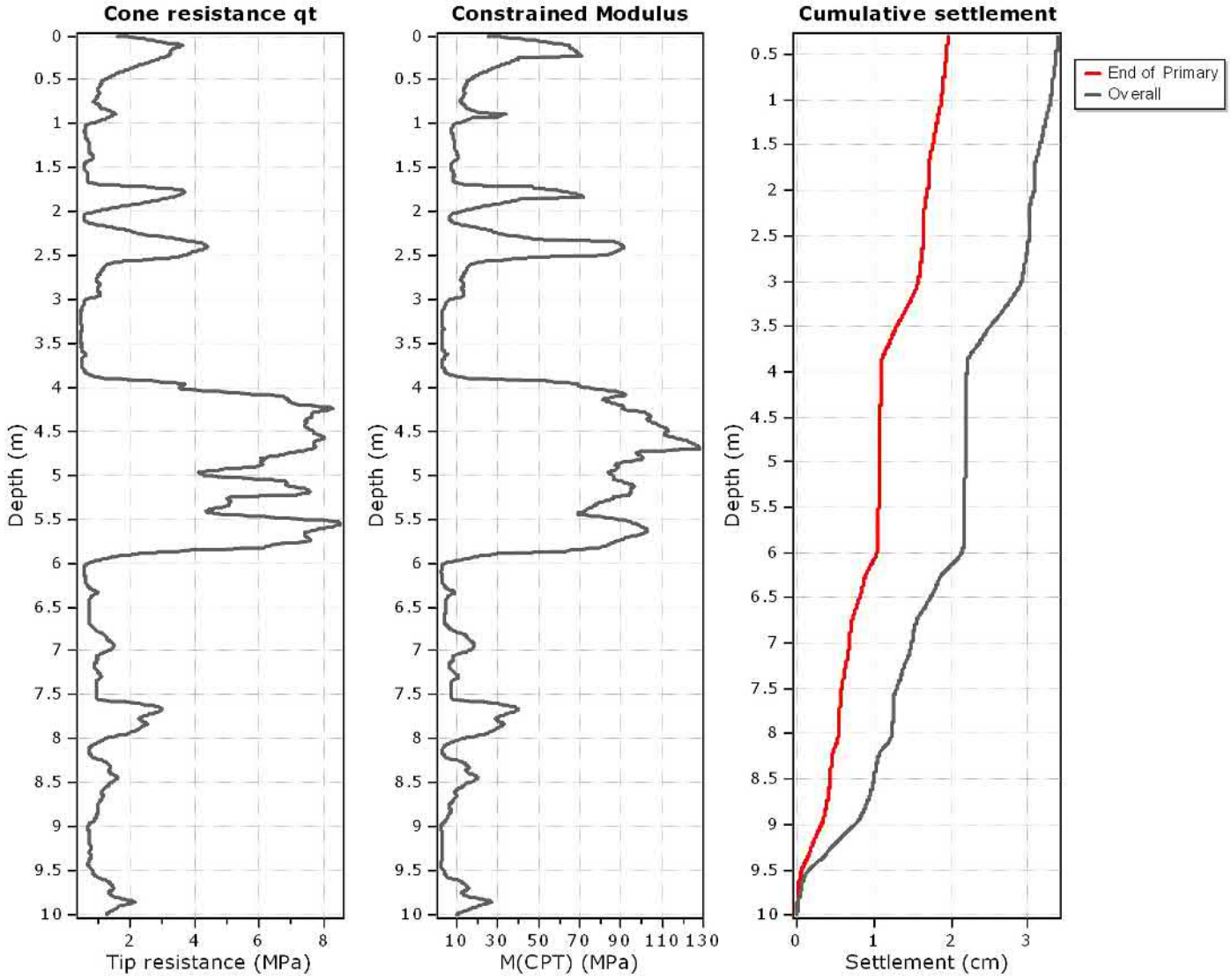

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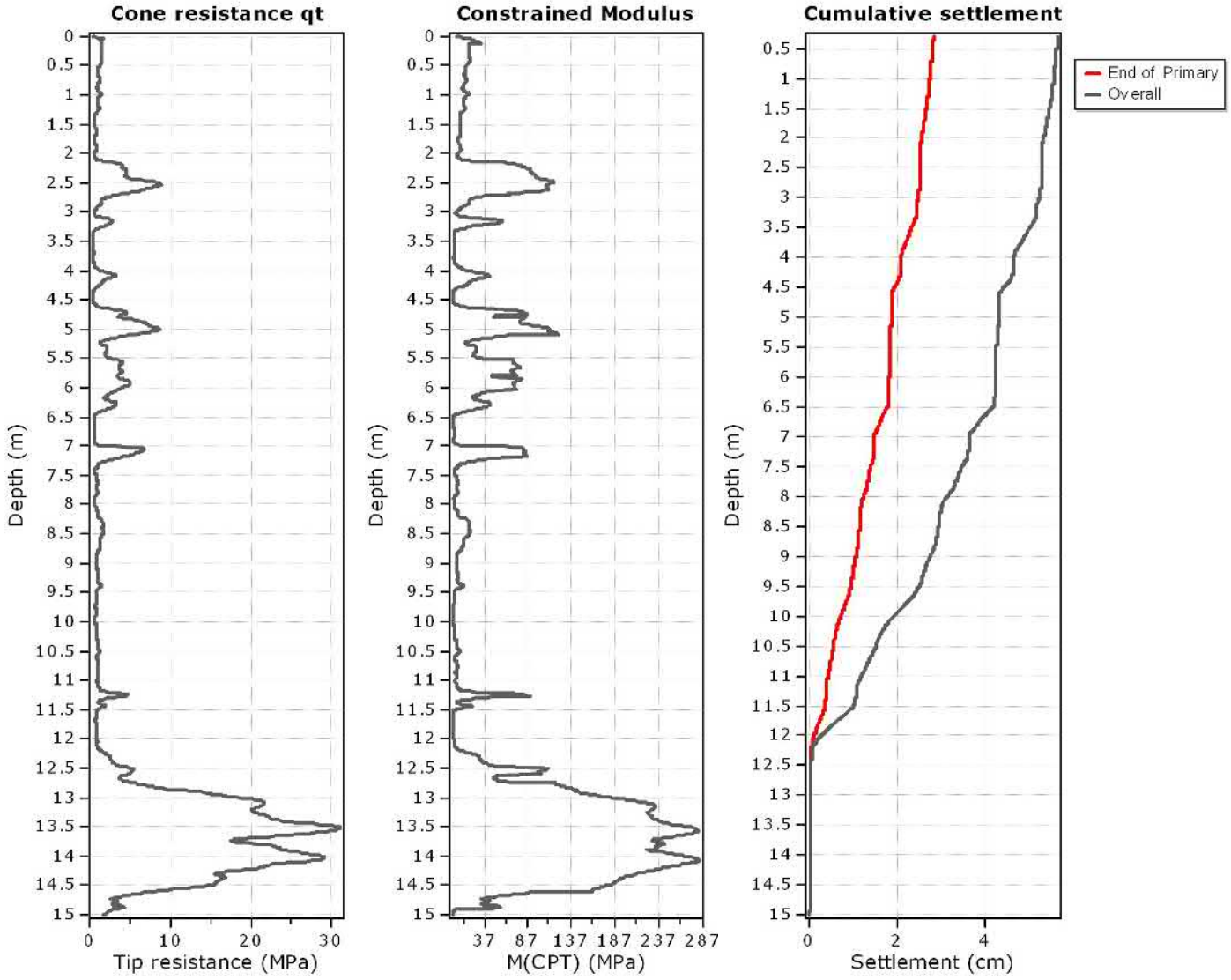

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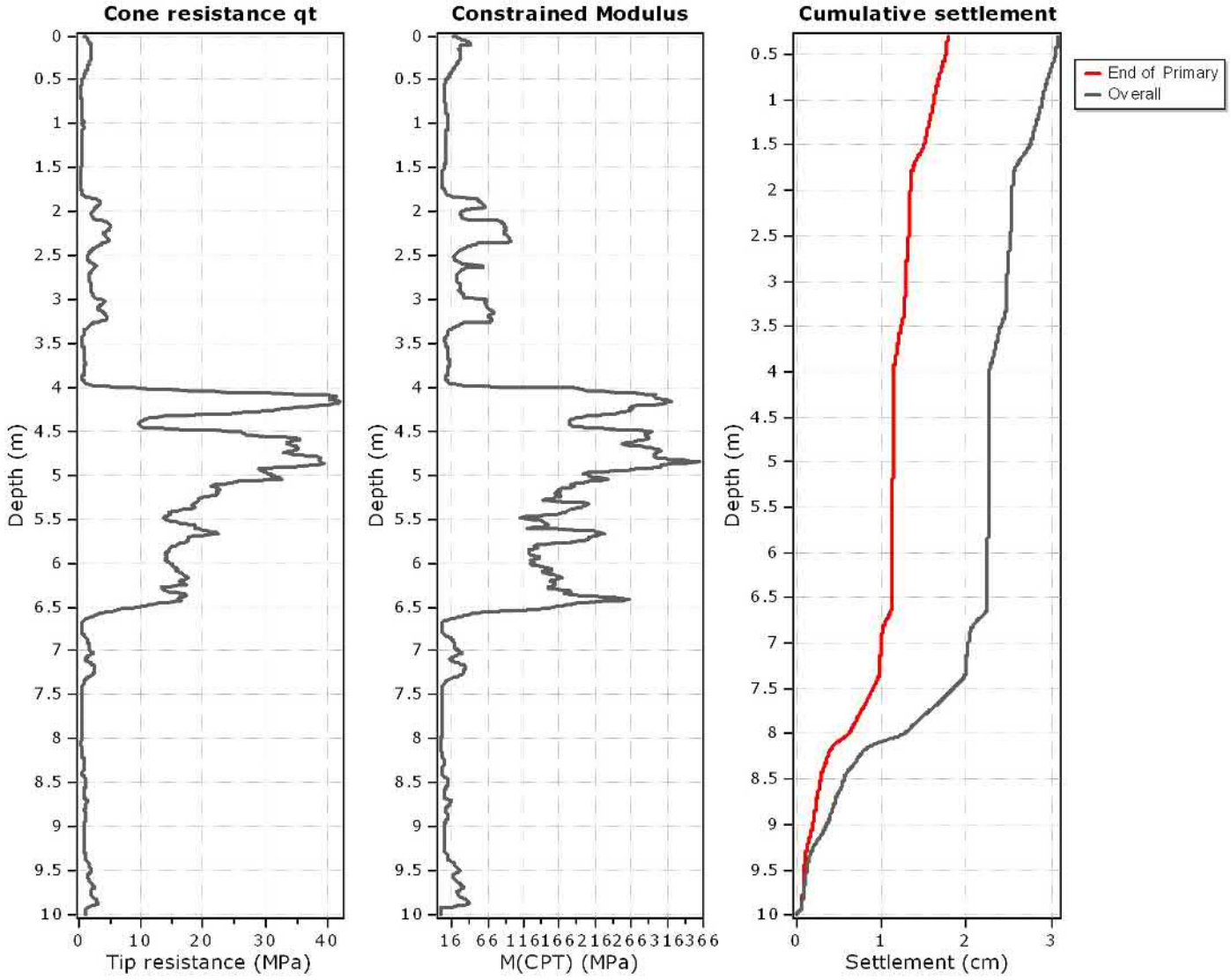

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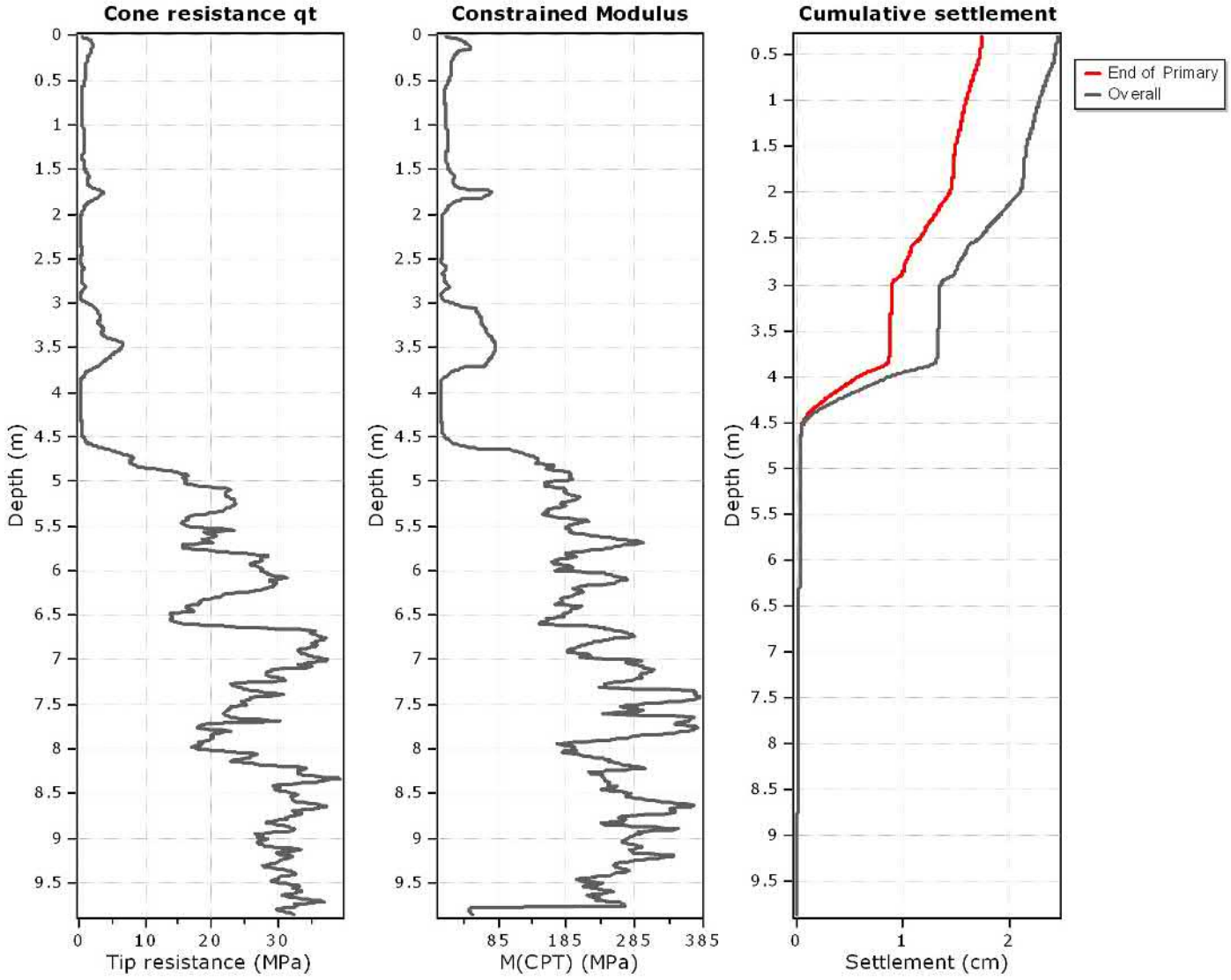

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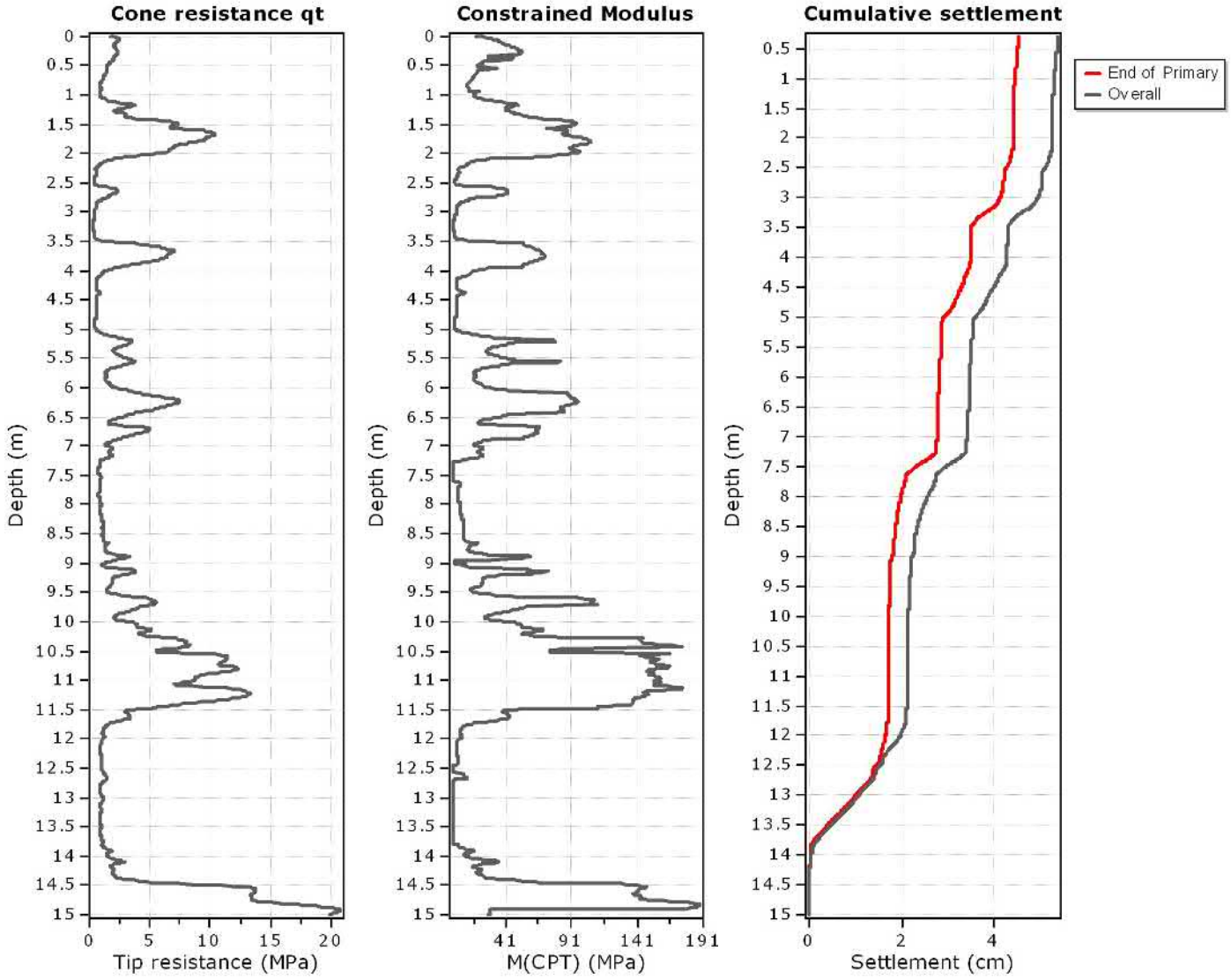

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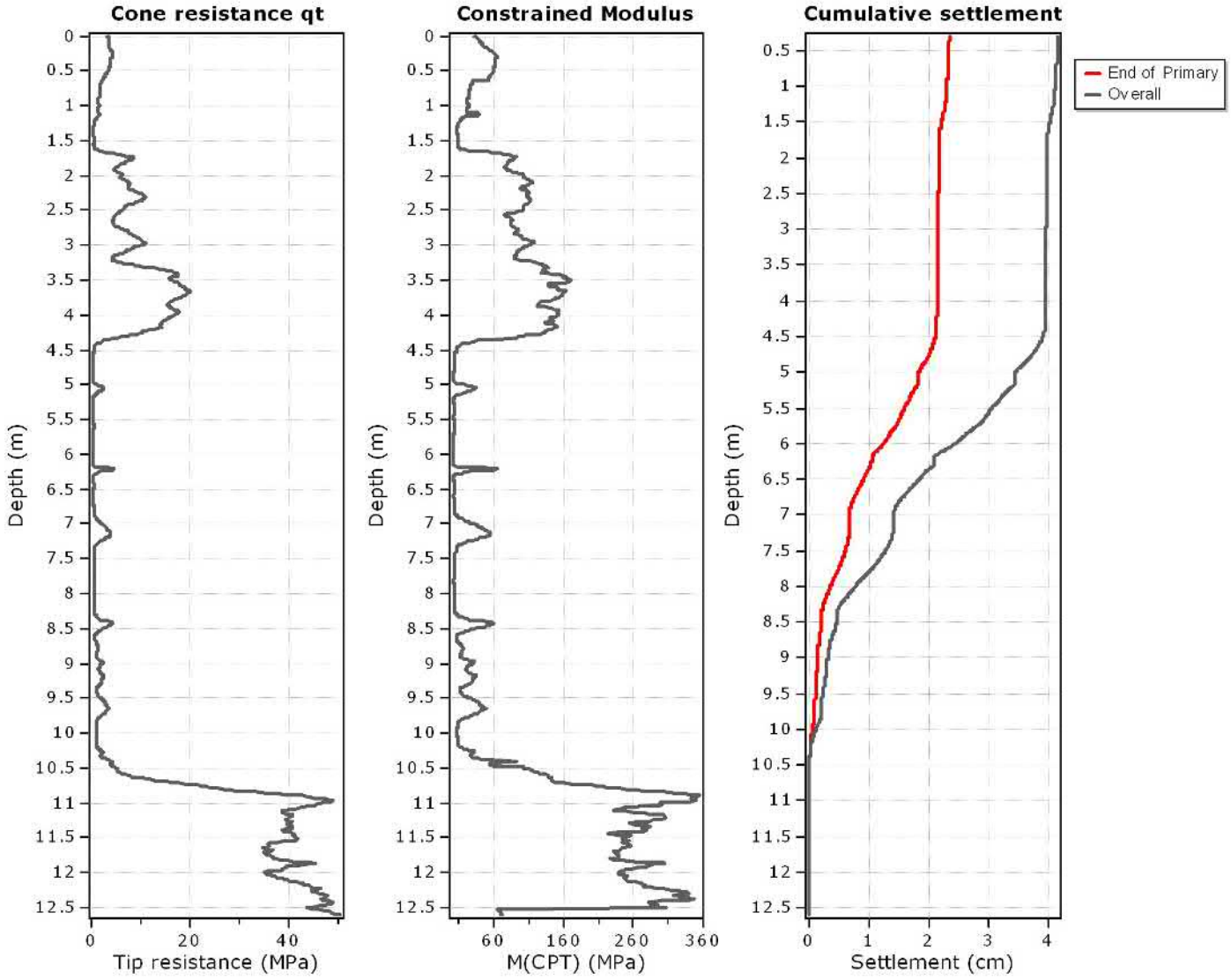

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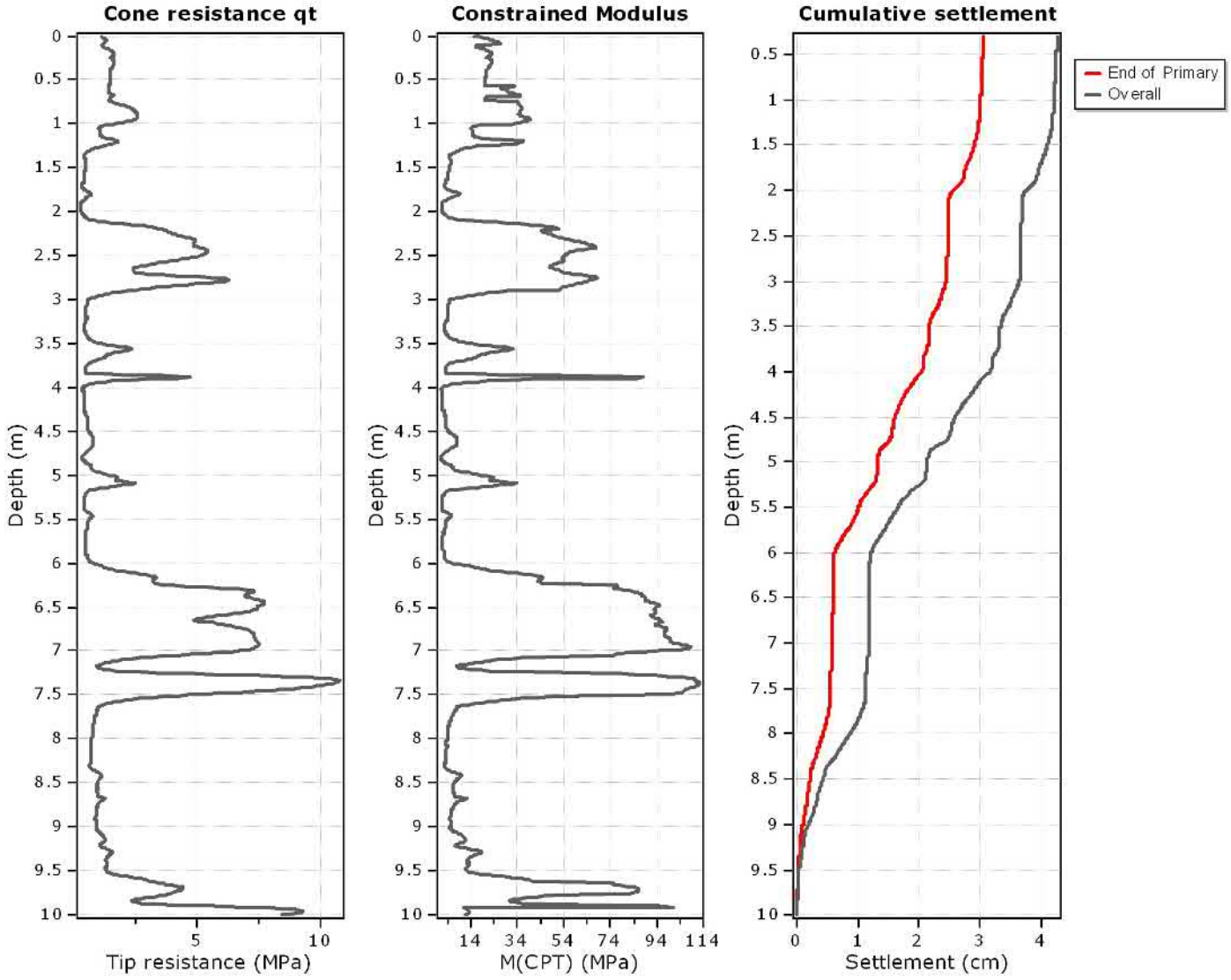

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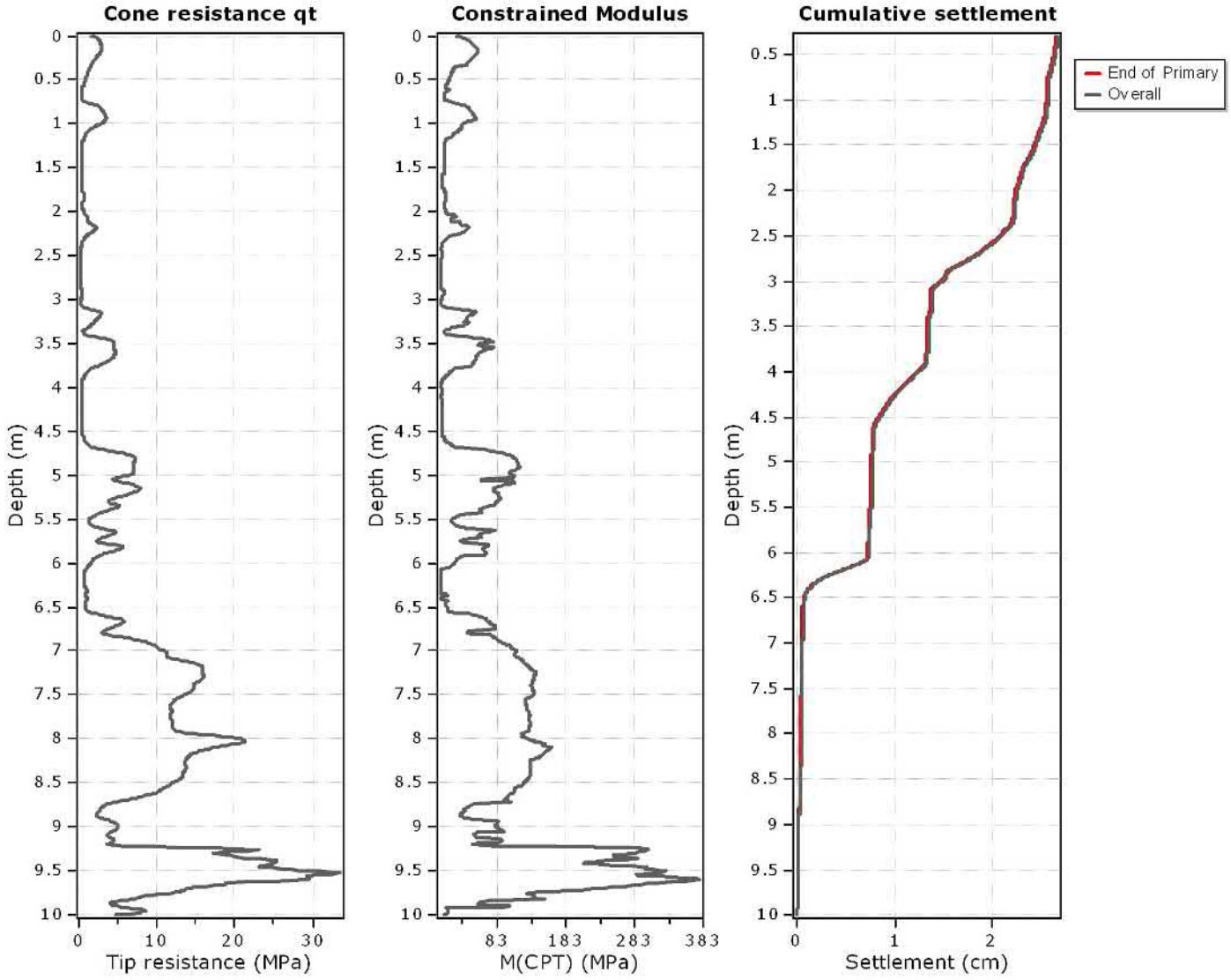

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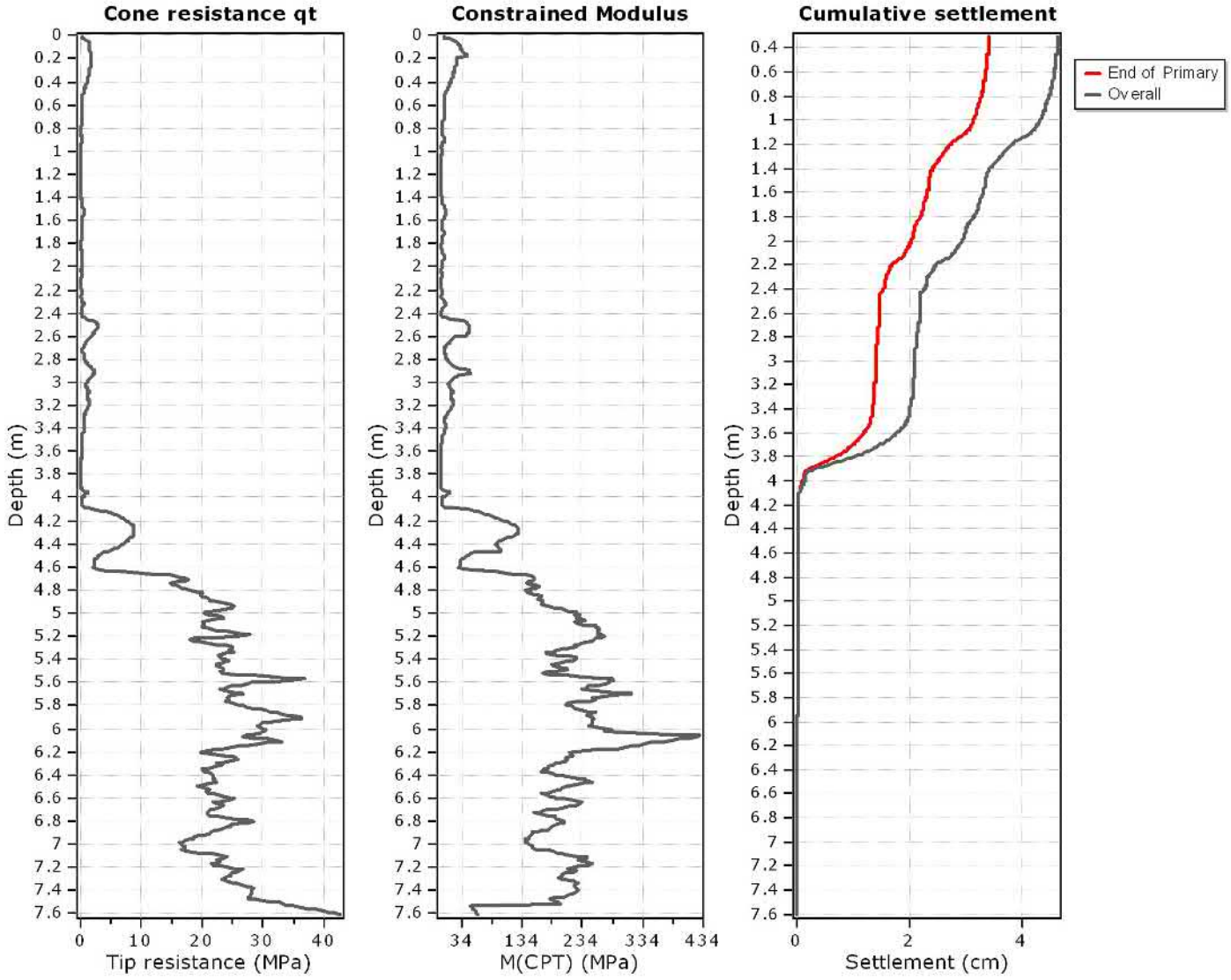

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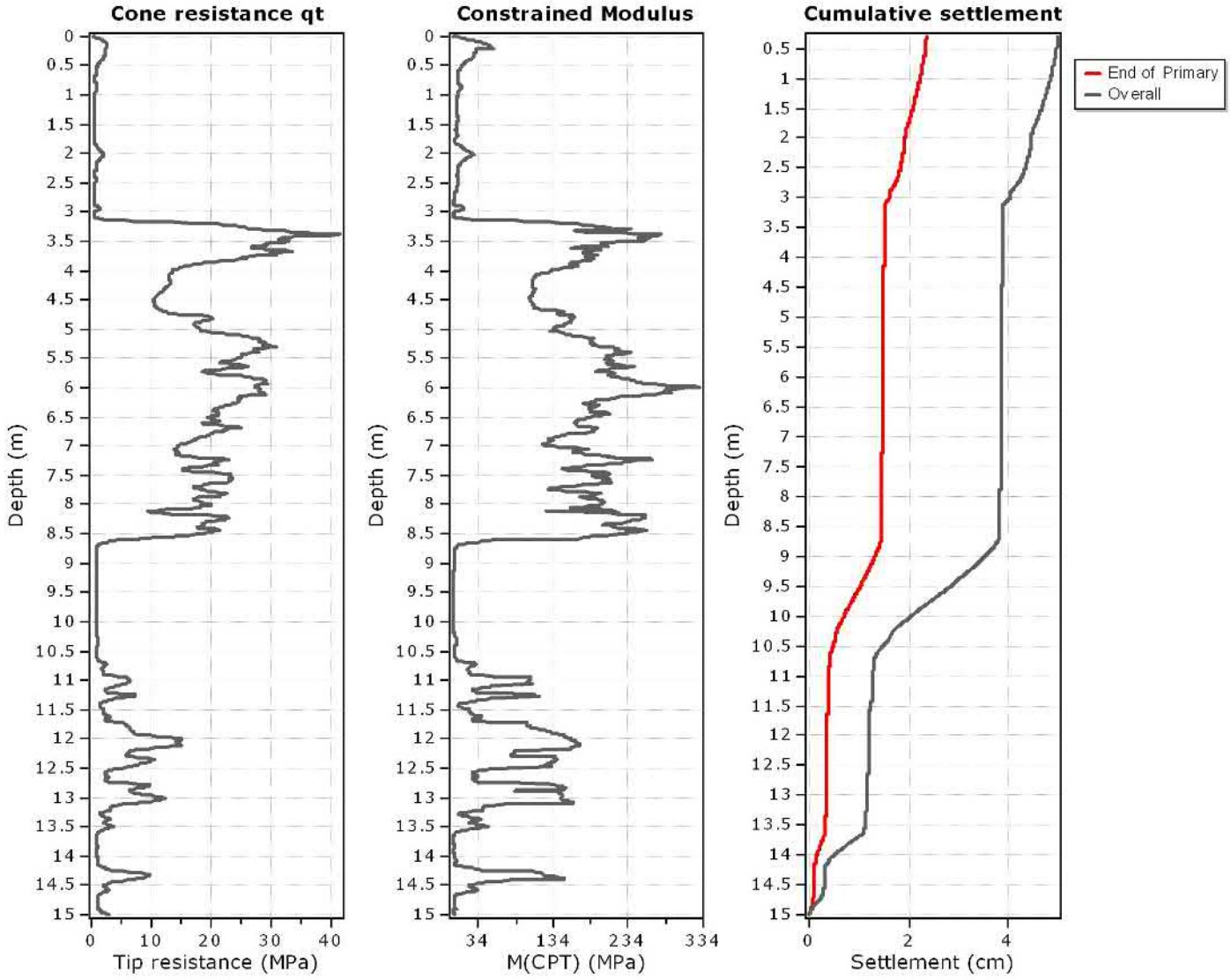
Settlements calculation according to theory of elasticity*



Calculation properties

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Footing pressure: 20.00 (kPa)
Embedment depth: 0.30 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

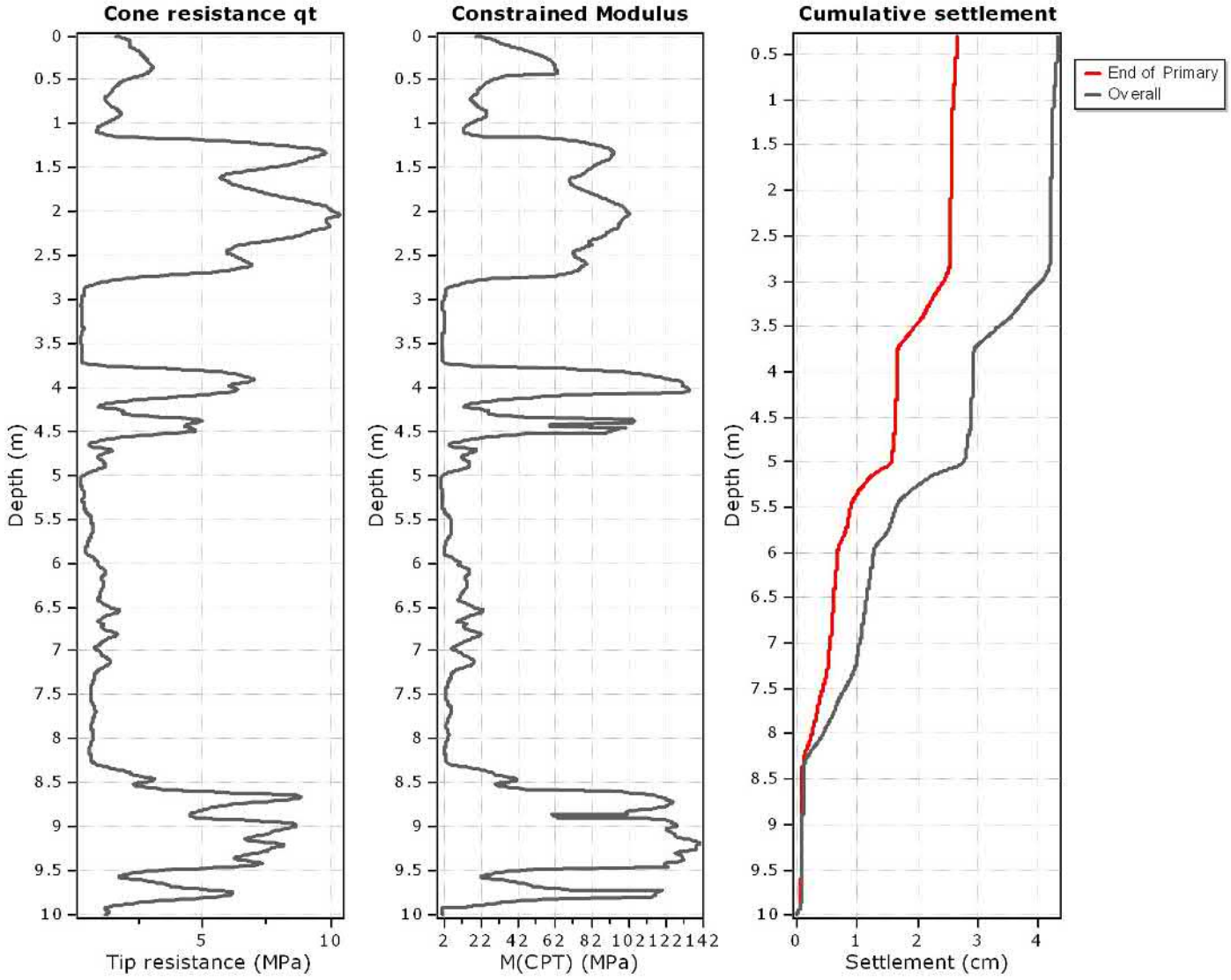
* Primary settlements calculation is performed according to the following formula:

$$S = \sum \frac{\Delta \sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlements calculation is performed according to the following formula:

$$S = C_a \cdot \Delta z \cdot \log(t)$$

Settlements calculation according to theory of elasticity*



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Embedment depth: 0.30 (m)
Footing is rigid: No
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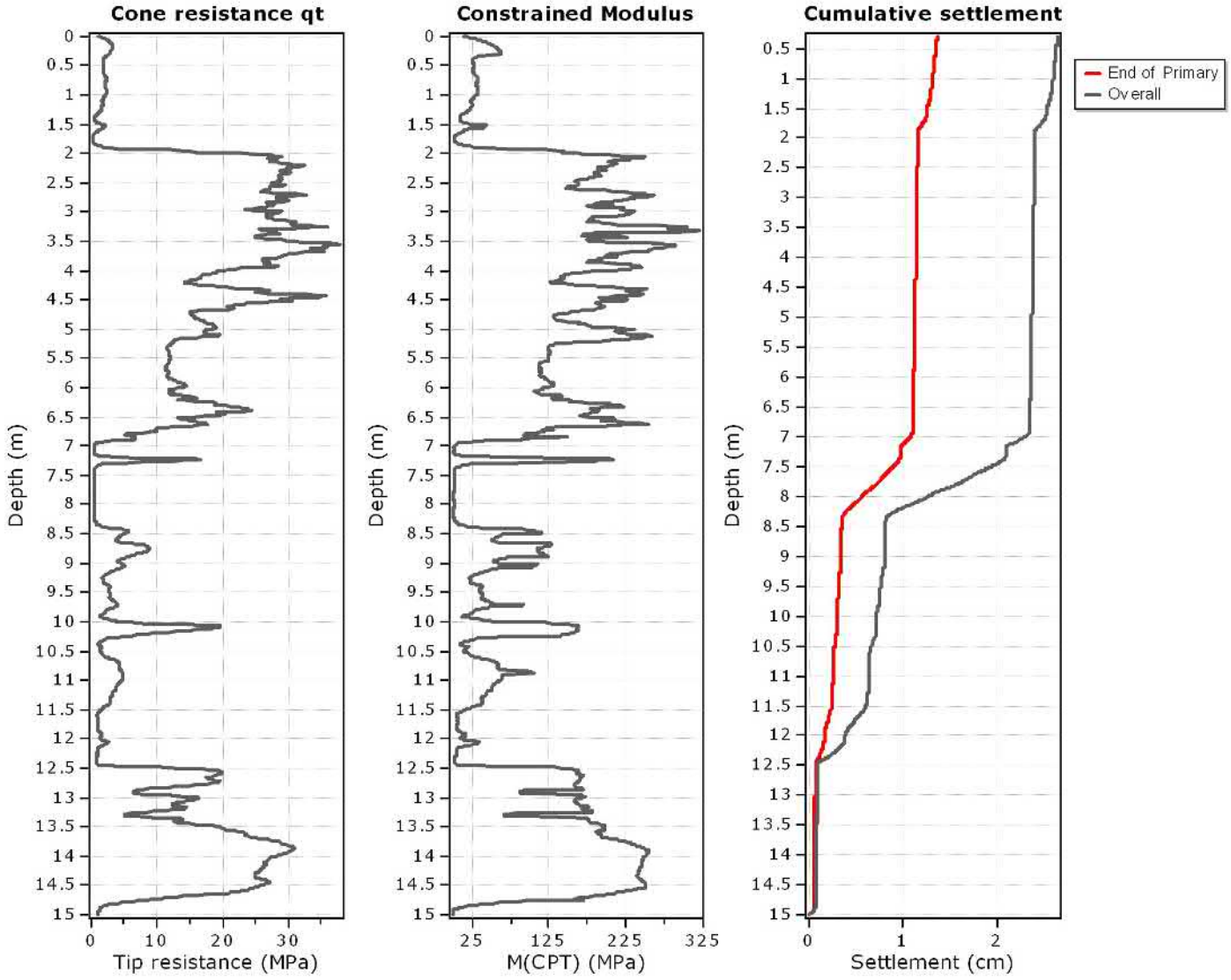

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$$S = C_a \cdot \Delta z \cdot \log(t)$$

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CPT: CPT-37
Total depth: 10.00 m, Date: 23/11/2021
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Cone Type: Uknown
Cone Operator: Uknown

Project:
Location:

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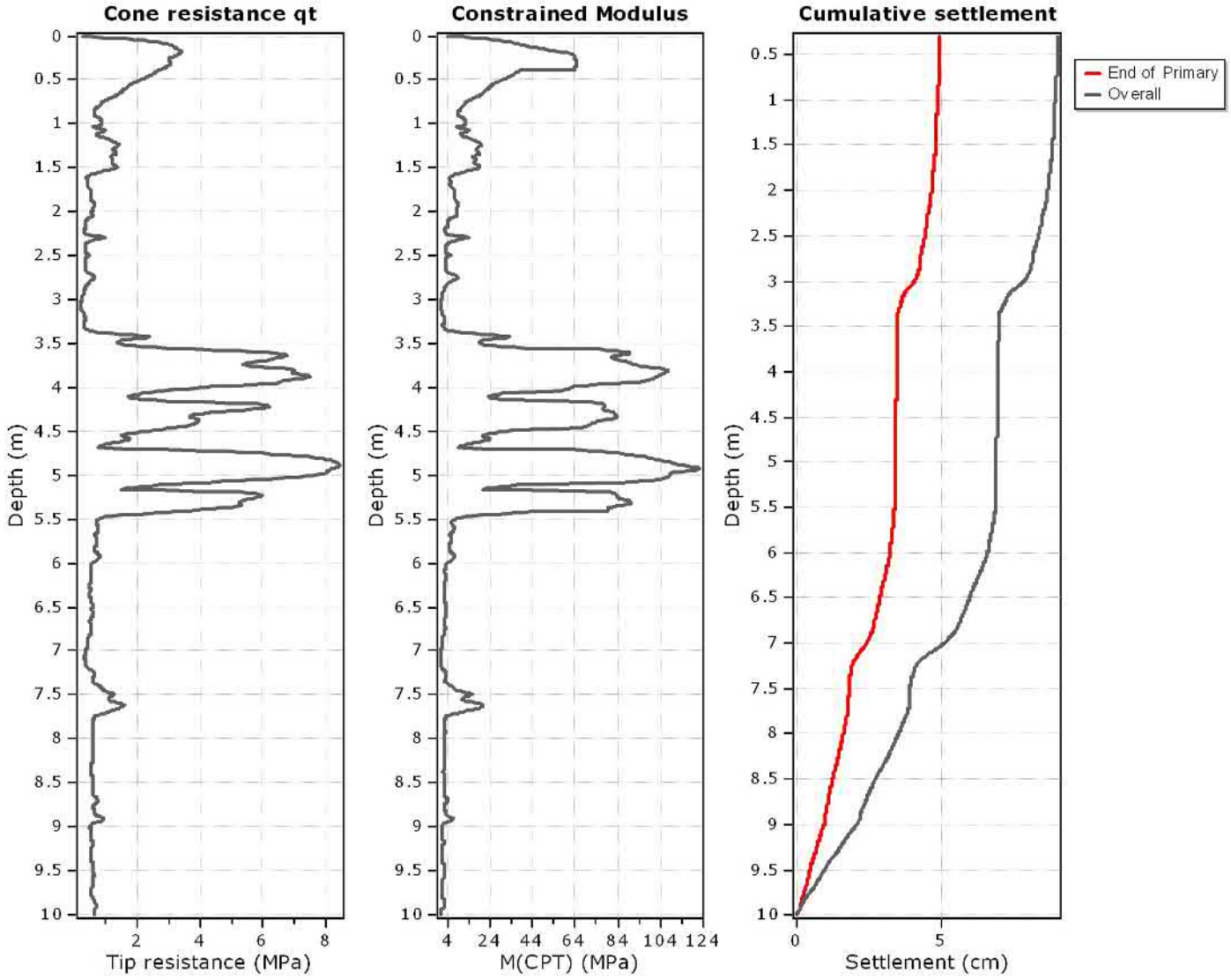

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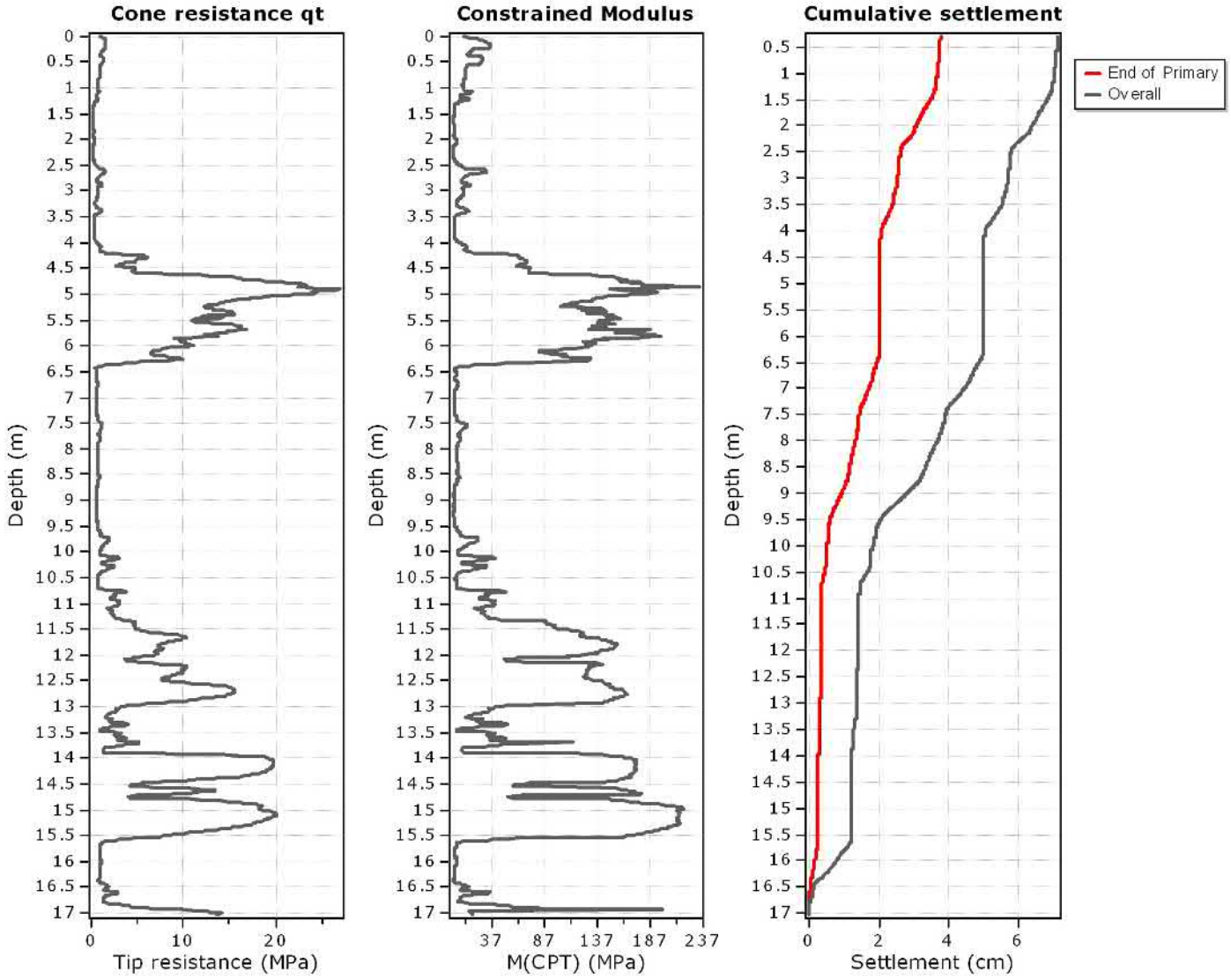

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Footing is rigid: No
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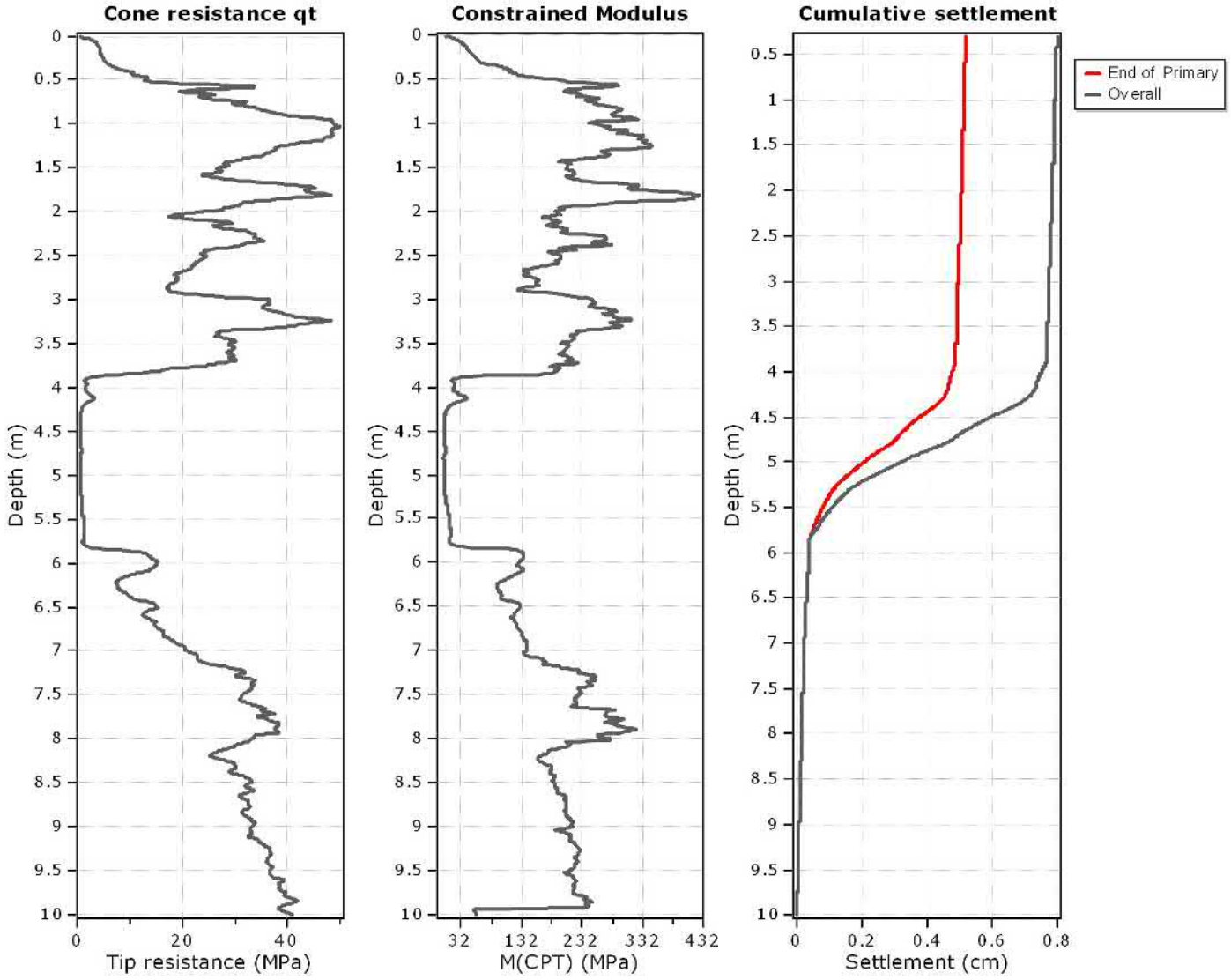

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Embedment depth: 0.30 (m)
Footing is rigid: No
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Apply 20% rule: No
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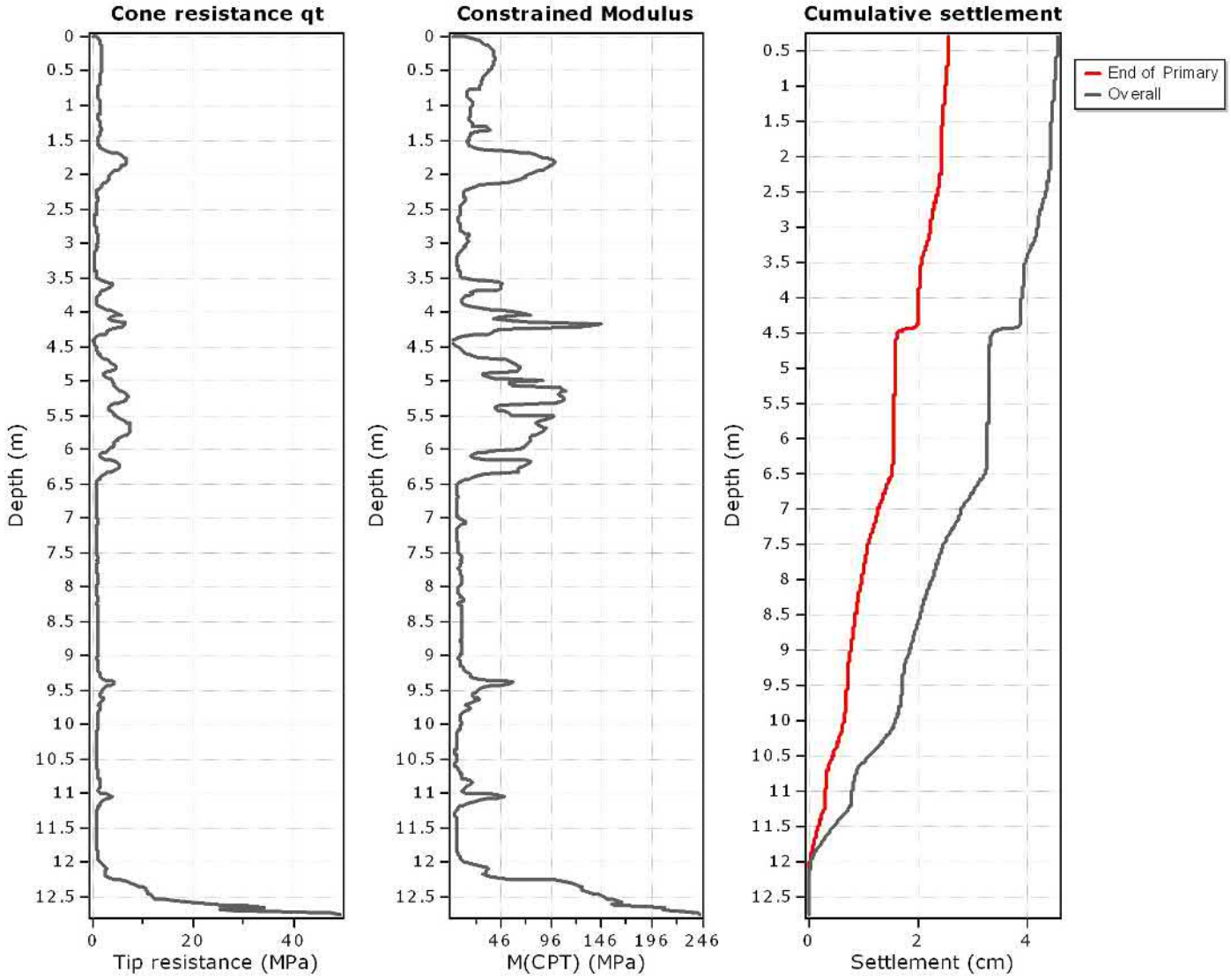
$$S = C_a \cdot \Delta z \cdot \log(t)$$

Settlements calculation according to theory of elasticity*



Calculation properties

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$$S = C_a \cdot \Delta z \cdot \log(t)$$

GeoLogismiki
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CPT: ES-CPT-05
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Surface Elevation: 0.00 m
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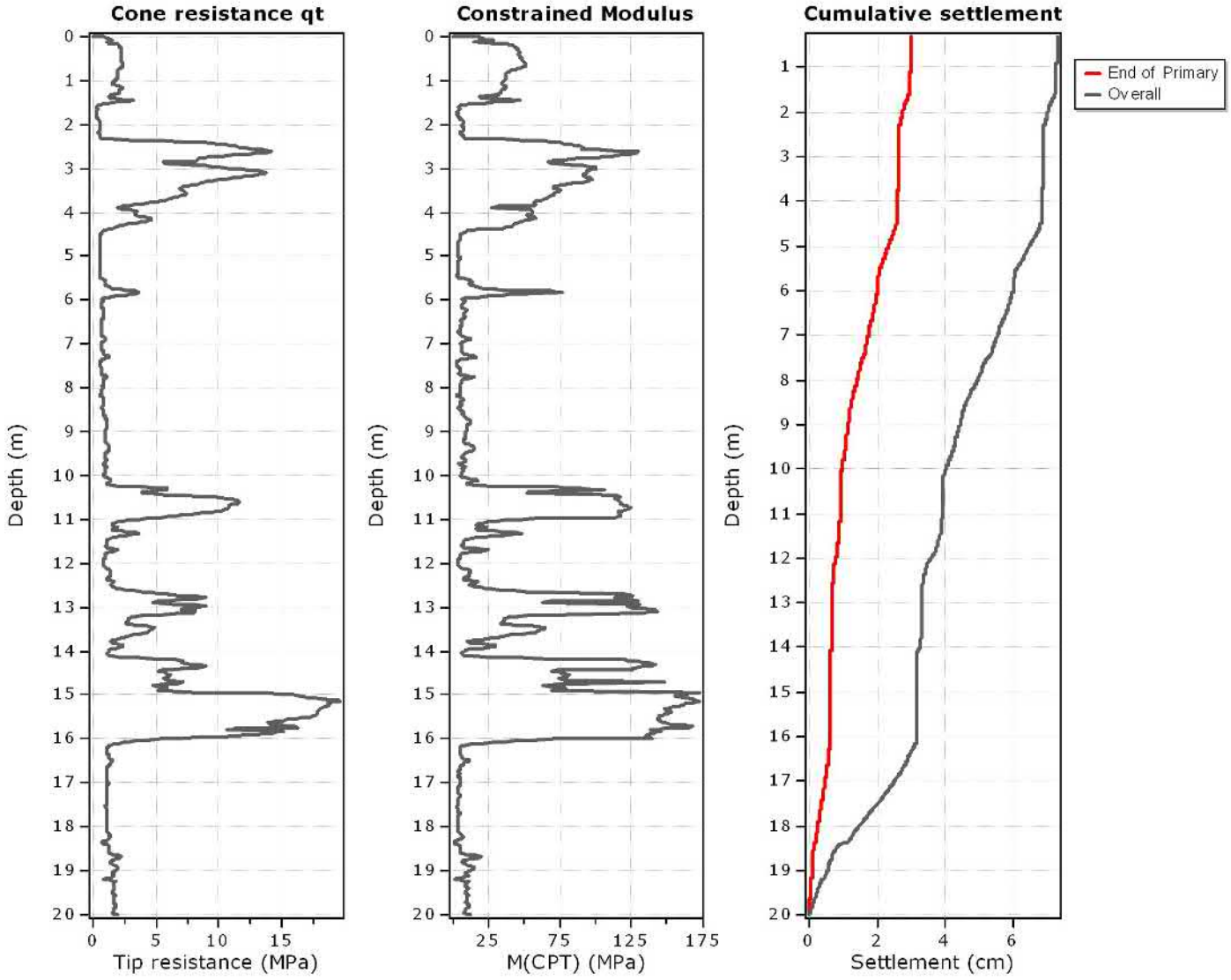
Cone Operator: Uknown

Project:
Location:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
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Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlements calculation is performed according to the following formula:

$$S = \sum \frac{\Delta \sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlements calculation is performed according to the following formula:

$$S = C_a \cdot \Delta z \cdot \log(t)$$

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Cone Operator: Uknown

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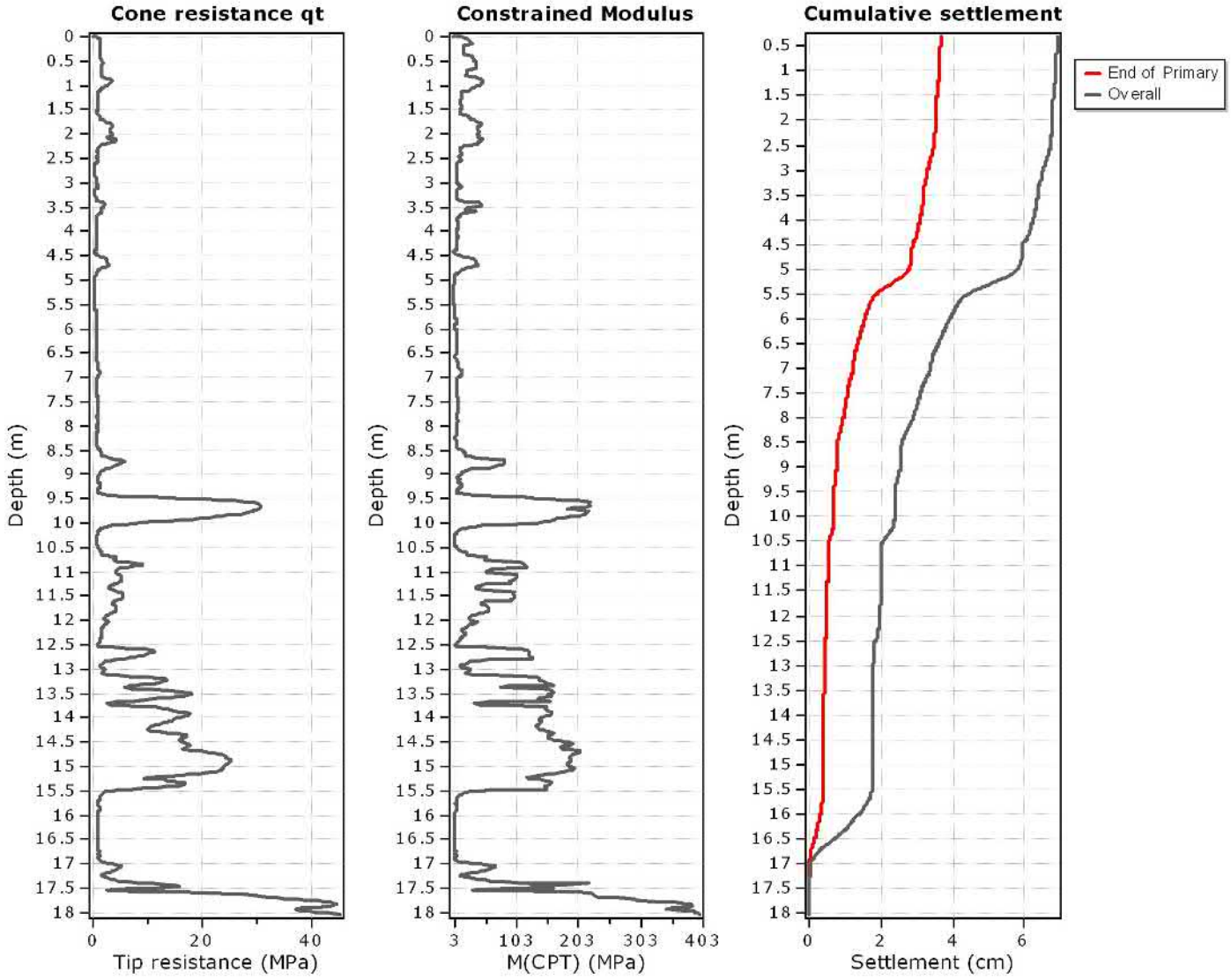
Location:

Settlements calculation according to theory of elasticity*



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Embedment depth: 0.30 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
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APPENDIX 7

ENGEO – CONTAMINATION ASESSMENT (2021)

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Project Number #19640.000.001

Preliminary Environmental Site Investigation

Gressons and Main North Road, Woodend, Waikuku

Submitted to:
Westside Country Limited
250 Oxford Terrace
Christchurch Central
Christchurch 8011

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1.3 Scope of Works 2
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Appendix 1: LLUR Enquiry

ENGEO Document Control:

Report Title	Preliminary Environmental Site Investigation - Gressons and Main North Road, Woodend			
Project No.	19640.000.000	Doc ID	01	
Client	Westside Country Limited	Client Contact	Brian Stokes	
Distribution (PDF)	Westside Country Limited			
Date	Revision Details / Status	Author	Reviewer	WP
23/11/2021	Issued to Client	HE	DR	DF

1 Introduction

ENGEO Ltd was commissioned by Westside Country Limited to conduct a preliminary environmental site investigation (PSI) of the property at Gressons and Main North Road, Woodend, Waikuku (herein referred to as 'the site'). It is proposed to apply for a plan change from rural to residential for the area. This work has been carried out in accordance with our signed agreement reference P2021.005.919_01 dated 2 November 2021.

This PSI was completed to identify potential land contamination hazards associated with the former uses of the site and to satisfy the Waimakariri District Council (WDC) requirements under the *Resource Management (National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health)* Regulations 2011 (NES).

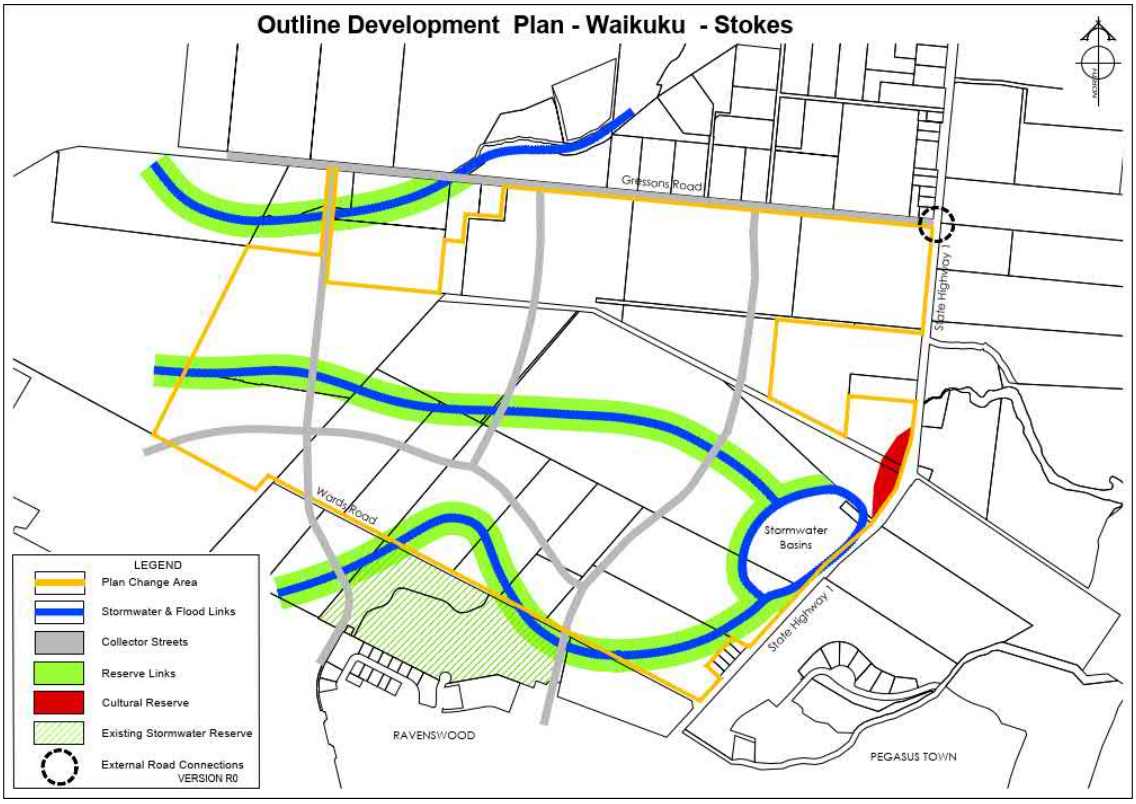
This PSI was undertaken in general accordance with the MfE 2021, *Guidelines for Site Investigation and Analysis of Soils* (CLMG No. 5) and reported in-line with the MfE 2021 *Guidelines for Reporting on Contaminated Sites in New Zealand* (CLMG No.1).

The fieldwork and reporting has been managed and reviewed by a Suitably Qualified and Experienced Practitioner (SQEP), as required by the NES.

1.1 Background

It is understood that a change of zoning for the land to the north of Ravenswood up to Gressons Road from rural to residential is to be applied for. Information is therefore required on the environmental conditions of the area. The current development plan is shown in Exhibit A.

Exhibit A - Development Plan



1.2 Objectives of the Assessment

To satisfy requirements of the Waimakariri District Council (WDC), this PSI aimed to:

- Evaluate and identify conditions indicative of releases and threatened releases of hazardous substances on, at, in or to the 'piece of land';
- Evaluate the presence and extent of identified contaminants of potential concern at the site; and
- Assess whether the contaminants of potential concern (if any) pose an unacceptable risk to human health or the environment for the proposed end land use.

1.3 Scope of Works

To fulfil the above objectives, the following scope of works was undertaken by ENGEO:

- Review and assess relevant reports on file for the site; including the properties adjoining or located near the subject property, certificates of title and previous investigations (if any);
- Review historical and current aerial photographs for information related to activities at the site;
- Review Environment Canterbury's (ECan) Listed Land Use Register (LLUR) Statement for the site and Waimakariri District Council's property files to determine significant potentially contaminating activities and relevant resource consents (if any);
- Conduct a site walkover to view current activities, structures and ground conditions;
- Review publicly available information on the geology and hydrogeology of the site, including sensitive water bodies;
- Develop a conceptual site model (CSM) to assess potential exposure pathways of hazardous activities (if identified) to site users during redevelopment; and
- Provide recommendations for further intrusive Detailed Site Investigation (DSI) (if required).

2 Environmental Setting

The site location is presented in Figure 1. The site identification, history, conditions and surrounding environment information are presented in Section 2.1 below:

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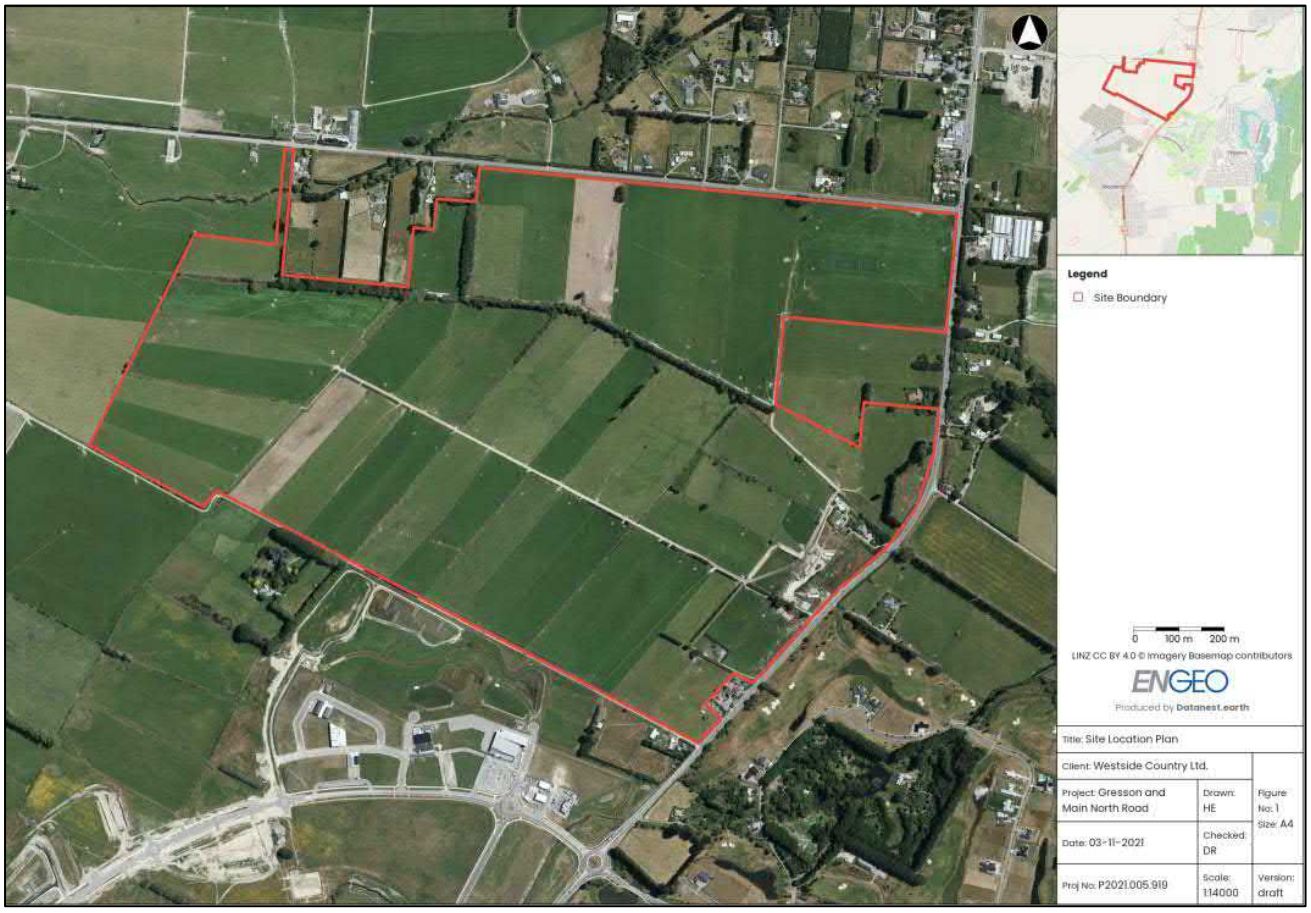
Figure 1: Site Location Plan



2.1 Site and Surrounding Land Uses

Site information is summarised in Table 1.

Table 1 - Site Information

Item	Description
Location	Gresson and Main North Road, Woodend
Legal Descriptions	Lots 2-3 DP 62186, Lot 2 DP 303387, Lots 1-2 DP 428676, Lot 1 DP 455971, Lot 6 DP 923, Part RS 3101, 3093, 3129, 3141-3144, 3169, 3170, Section 1 16798, Part Lot 4 DP 923, Lot 1 DP 46765, Lot 1 DP 43146, Lot 8 DP 923, Part RS 3919, 4719, Lot 1 DP 470921, Lot 2 DP 46765, Lot 5 DP 923.
Records of Title	Mr & Mrs B J & A L Stokes
Current Land Use	Rural / Pastoral
Proposed Land Use	Residential Development

Item	Description
Parcel Area	Approximately 135 hectares across all parcels within the site boundary.
Recent Resource Consents	• CRC090885: To discharge contaminants onto land and to air (dairy shed) (Active, 15 July 2009 to 15 July 2044). Address: 1332 Main North Road, Waikuku • CRC084939: To discharge contaminants to land (domestic wastewater from single dwelling) (Active 29 August 2008 to 17 August 2043). Address: 1295 Main North Road, Waikuku • CRC091594: To store contaminants (dairy shed effluent) (Active 15 July 2009 to 15 July 2044). Address: 1332 Main North Road, Waikuku
Territorial Authority	Waimakariri District Council

The site setting is summarised in Table 2.

Table 2: Site Setting

Item	Description
Topography	Relatively flat with minor marshland features.
Local Setting	Rural and rural residential, with generally flat land leading to the surrounding hills to the west and reclaimed swampland to the east.
Nearest Surface Water & Use	Waikuku Stream to north approximately 100 meters and Stokes Drain catchment – used for irrigation purposes.
Geology	Flaxton *f* deep silt loam, poorly drained on Canterbury alluvium deposits and sandy gravels.
Hydrogeology	Ground water zones related to site area: Ashley Estuary (Te Aka Aka) and Coastal Protection Zone, and Cust. Groundwater flow is expected to be in a general easterly direction but may be locally influenced.
Groundwater Abstractions	• CRC143176: To take and use surface water (for irrigation at Stokes Drain) (Active 20 February 2014 to 24 September 2032). Address: Main North Road, Waikuku • CRC143175: To take groundwater (for irrigation) (Active 20 February 2014 to 11 November 2033). Address: Main North Road, Waikuku

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2.2 Groundwater Sensitivity

As assessment to establish whether the groundwater below the site is a 'sensitive aquifer' as defined by the Ministry for the Environment (MfE) Guidelines (2011) has been undertaken. It is noted that the aquifer is considered sensitive when either all of the first three criteria set out below are met, or the fourth criterion is met in accordance with the Module 5.2.3 of the MfE Guidelines.

The assessment is provided in Table 3 below.

Table 3: Groundwater Sensitivity

Criteria	Assessment
1. The aquifer is not artesian or confined;	**Yes**. The coastal confined gravel aquifer system predominantly sits along the south-east of the site, whereas the northwest is primarily characterised by an unconfined or semiconfined aquifer.
2. The aquifer is expected to be less than 10 m below the potential suspected source of impact;	**Yes**. Groundwater has been recorded up to 2 meters below ground surface (m bgs).
3. The aquifer is of quality appropriate for use, can yield water at a useful rate, and is an area where abstraction and use of groundwater may be reasonably foreseen; OR	**Yes**. Several ground water and surface water abstractions are on-going for this site.
4. The source is less than 100 m of a sensitive surface water body (i.e. a surface water body where limited dilution is available to mitigate the impact of contaminated groundwater discharging into the surface water body).	**Yes**. Several small streams feed the area from the Ashley River to the North.
Sensitivity Assessment	**Yes**. The groundwater for the site is considered to be SENSITIVE.

Groundwater for the site is considered to be sensitive in relation to the MfE sensitive aquifer assessment.

3 Site History

A number of sources were used to investigate the past uses of the site. The findings of these information searches have been summarised in this section.

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3.1 Listed Land Use Register (LLUR)

Potentially hazardous activities are defined on the Hazardous Activities and Industries List (HAIL). Canterbury Regional Council (CRC) maintains a Listed Land Use Register (LLUR) of past and current land uses within the Canterbury region which have potentially had an activity included on the HAIL undertaken on them. The CRC LLUR property statement was requested by ENGEO on 15 November 2021 for the site and is presented in Appendix 1. According to the LLUR, no sites of interest were identified.

3.2 Waimakariri District Council Property Files

Property files were requested from the Waimakariri District Council on 18 November 2021. Most of the files associated within the site boundaries include consent application documents, building consents (for dairy sheds, milk rooms, etc.) inspection reports for buildings, approvals granted by Christchurch City Council, resource consents for effluent discharge associated with dairy farming (currently active: CRC091594) and a report from a groundwater testing programme undertaken by Environment Canterbury from 19 December 2000 for five wells across the site.

ECan's testing results for four out of five wells showed that arsenic was detected in the groundwater samples for wells M35/8110, M35/1160, M35/4227, and M35/8759 that exceeded the Drinking-Water Standards for New Zealand (1996) and was therefore not considered suitable as a drinking water supply (for humans). However, the guideline value for arsenic in livestock water was 0.5 mg/L at the time of testing and was therefore not an issue as water use on the property was for livestock and irrigation only.

3.3 Previous Environmental Investigations

In November 2020, Elliott Sinclair undertook a ground contamination assessment for the site at 81 Gressons and 1375 Main North Road in Waikuku for a land-use change of rural to residential. Their investigation concluded that the site was "highly unlikely" to contain ground contamination that exceeds NES soil contaminant standards for residential land use. Apart from 3 burn pads recommended to be removed after site-walkover observations and portable XRF testing, no historical or current HAIL activities were identified.

3.4 Historical Aerial Photographs Review

Aerial photographs dating from 1940 to 2019 have been reviewed. Historical use of the land includes cattle raising, sheep grazing and barley cropping. The relevant visible features are summarised in Table 4, with a red box indicating the location of the site.

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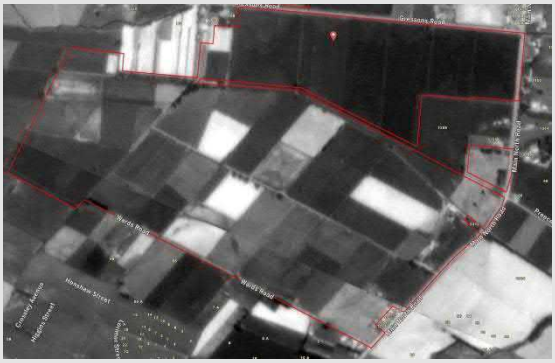
Table 4 - Historical Aerials Review

Date	Source	Description	Photo
1940-1944	Canterbury Maps Waimakariri District Council	The site is bound by Main North road to the east, Wards road to the south and Gressons road to the north. Land parcels contain fields with livestock, potential hay bales and several small structures along the eastern boundary. A single family residence exists towards the south.	
1960-1964	Canterbury Maps Waimakariri District Council	Surrounding land has remained similar, but the addition of what appears to be an irrigation system / catchment along Main North Road has been widened. Fields and potential agricultural activity appear more predominant across the site.	
1965-1969	Canterbury Maps Waimakariri District Council	The land appears to remain largely unchanged from the previous photo. Resolution is poor.	
1970-1974	Canterbury Maps Waimakariri District Council	The land appears to remain largely unchanged, however, the addition of more structures are observed along the southeast corner boundary near the family residence. Diverted streams are more predominant for irrigation purposes.	

Date	Source	Description	Photo
1975-1979	Canterbury Maps Waimakariri District Council	The land appears to remain largely unchanged. Potential crop farming along the northwest boundary at the adjacent property has taken place.	
1980-1984	Canterbury Maps Waimakariri District Council	The land appears to remain largely unchanged within and outside the site boundary. Residences adjacent to the south are more predominant.	
1985-1989	Canterbury Maps Waimakariri District Council	Resolution is poor, but it looks like crops has been rotated through different parcels.	
1990-1994	Canterbury Maps Waimakariri District Council	Land appears to be largely unchanged from previous photos. The potential irrigation catchment has been slightly altered along the north-east boundary.	

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Date	Source	Description	Photo
1995-1999	Canterbury Maps Waimakariri District Council	Additional buildings appear along the eastern boundary adjacent to Main North Road.	
2000-2004	Canterbury Maps Waimakariri District Council	Land appears to remain largely unchanged from previous photo. Irrigation streams are more predominant. What appear to be watering troughs are visible throughout the fields. Residential properties adjacent to the east of the site are more developed.	
2010-2014	Canterbury Maps Waimakariri District Council	Additional structures have been added along the eastern Main North Road boundary. As well as a residential dwelling. Surrounding land has become more developed with residential properties.	
2015-2019	Canterbury Maps Waimakariri District Council	Similar land-use as previous photo, with slightly more activity along the eastern Main North Road boundary.	

4 Current Site Conditions

4.1 Site Walkover

An ENEGO representative visited the site on Friday 12 November 2021 to undertake a site walkover.

Site walkover observations are presented in Figures 2, 2.1, 2.2 and 2.3.

Figure 2: Site Walkover Overview

The information gathered from the site walkover is summarised in Table 5.

Table 5 - Current Site Conditions

Current Site Conditions	Comments
Visible signs of significant land contamination at the subject site	Above ground fuel tanks, bulk chemical storage, treated timber, asbestos on buildings in a degraded condition on the milking shed along the eastern side of the site.
Surface water appearance	None observed.
Local sensitive environments	Irrigation streams throughout the site are considered sensitive environments.
Current surrounding land use	Rural residential
Visible signs of plant stress	None observed.
Potential for on or off-site migrations of contaminants (if any)	The potential for on or off-site migration of contaminants is considered to be possible, due to the proximity of the water irrigation channels.
Ground cover	Mostly vegetated with livestock grazing.
Buildings Present	Outbuildings, storage sheds, dairy sheds, chemical and fertiliser storage, residential dwellings.
Potential HAIL IDs	A1, A6, A10, A17, A18, E1, F8 indicated in the figures below

Potential areas of concern are highlighted by yellow, identified activities included on the HAIL are portrayed by red in the figures below:

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Figure 2.1: Areas of Concern South-East

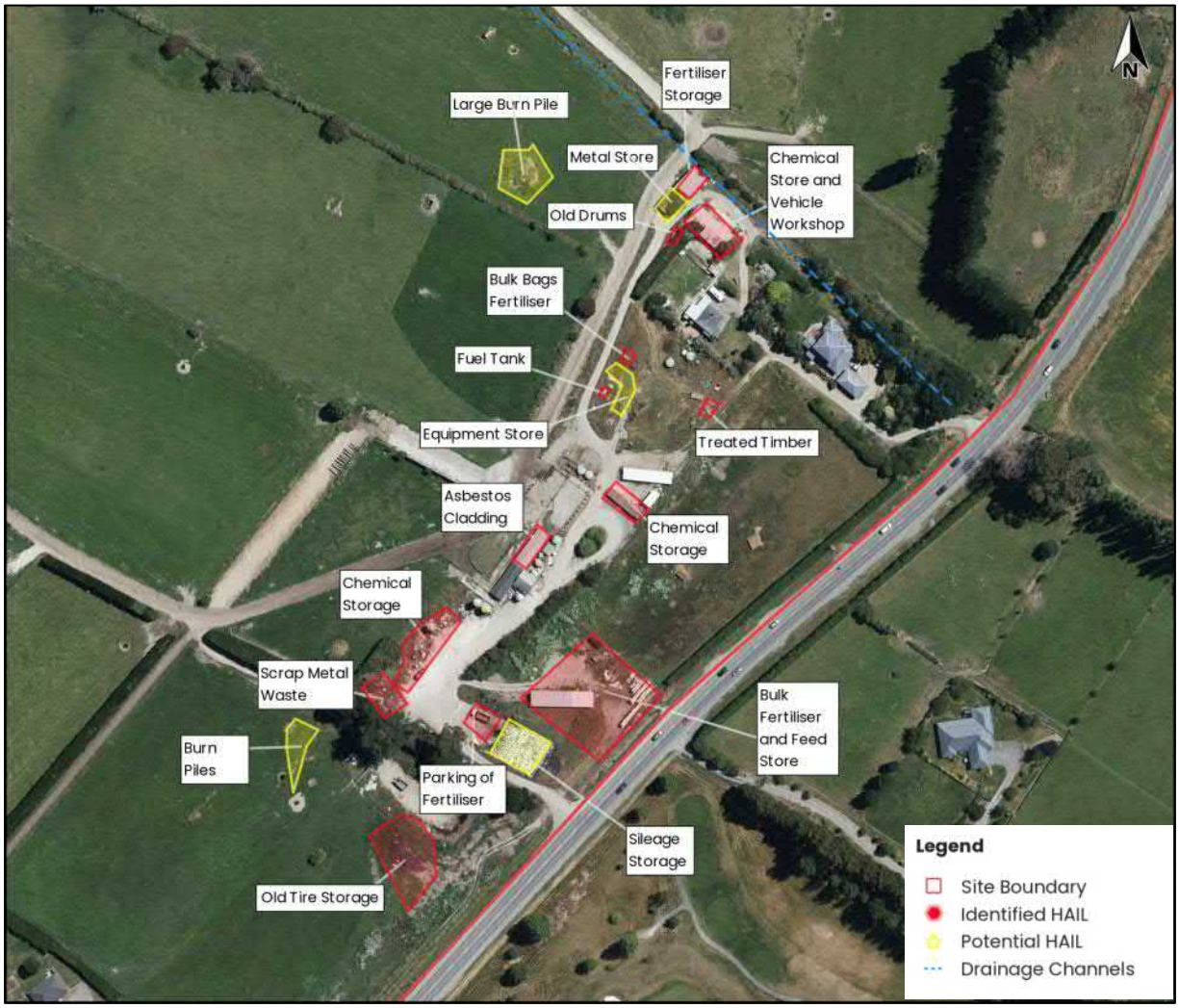

Figure 2.2 identifies potential areas of concern in the northwest portion of the site, shown below.

Figure 2.2: Areas of Concern Northwest

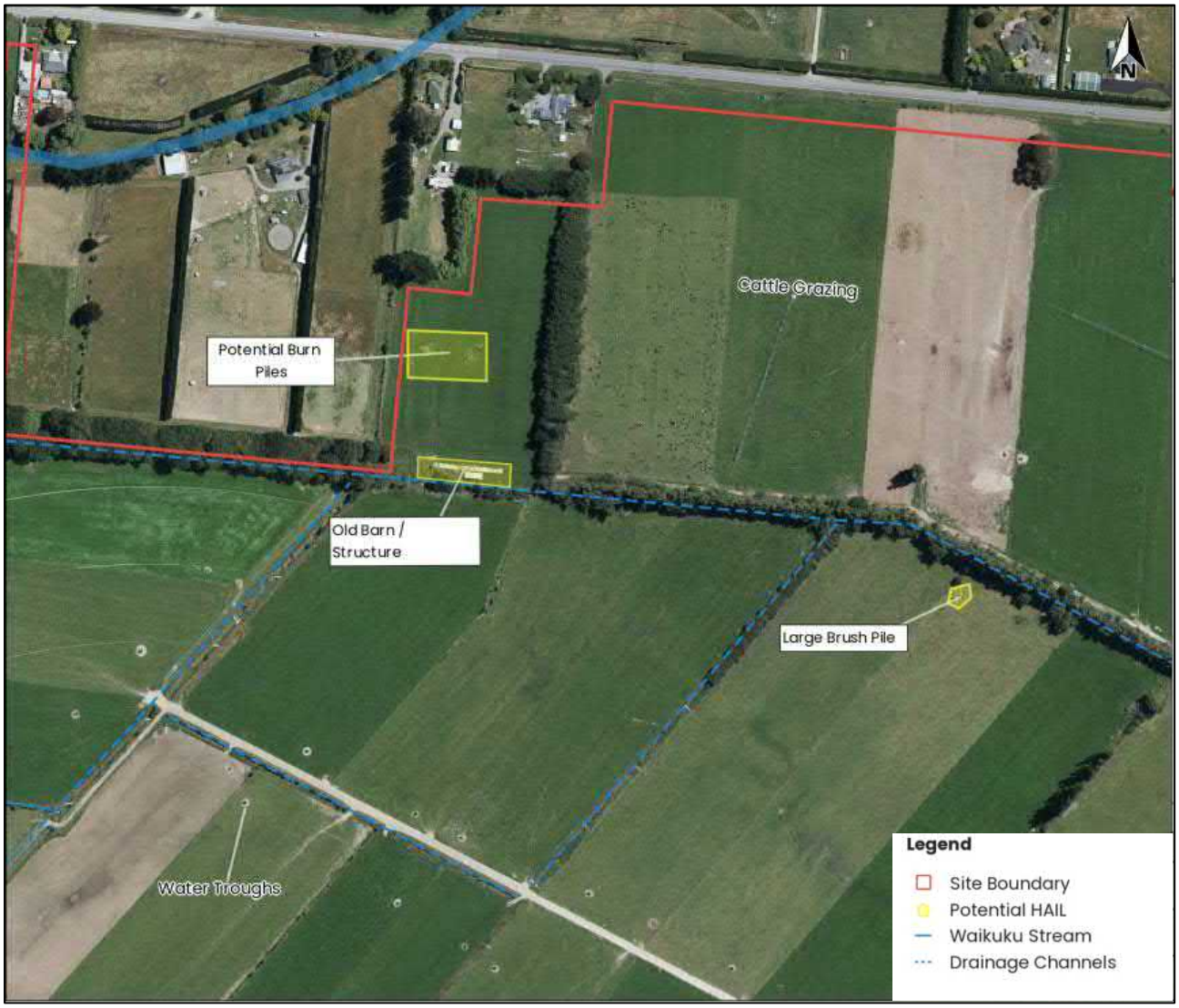

Figure 2.3 identifies potential areas of concern in the southern portion of the site, shown below.

Figure 3: Areas of Concern South

4.2 Site Walkover Photographs

During the site walkover, an ENGEO representative took photographs of these observations. They are presented below.

Photo 1: Bulk chemical storage at the eastern boundary of site.

Photo 2: Bulk fertiliser, agrichemical and equipment storage at the eastern boundary of site. Chemicals noted included: Nitro humus 323, Teat X Humic acid, NPK 8.3.6 liquid fish fertilizer, and Castrol antifreeze.

Photo 3: Bulk fertiliser storage, motor vehicle storage and agrichemical storage at eastern boundary of site. Chemicals noted were: Calcium supplements, Rock phosphate Magnesium oxide, and Vitophos for fertiliser.

Photo 4: Used drum storage along shed at eastern boundary of site. Chemical labels included: Acid Teat spray, and Roundup Organophosphates.

Photo 5: Bulk fertiliser storage along eastern side of site.

Photo 6: Above ground fuel tank towards along eastern side of site.

Photo 7: Farm equipment and machinery stored, drums also observed.

Photo 8: Old fertiliser bulk storage outside along eastern side of site.

Photo 9: Outside tire storage along eastern side of site.

Photo 10: Potentially treated timber on open grass along eastern side of site.

Photo 11: Asbestos in a degraded condition was observed on a milking shed along the eastern boundary of the site.

Photo 12: Two brush burn piles along the north-western side of the site.

Photo 13: Marshland runs east-west along the centre of the site.

Photo 14: Remnants of an old barn / structure along the north-western side of the site.

Photo 15: Scrap metal storage along the eastern side of the site.

Photo 16: Storage on concrete block along eastern side of the site.

This report may not be read or reproduced except in its entirety.

5 Potential HAIL Activities

If an activity on the Ministry for the Environment (MfE) Hazardous Activities and Industries List (HAIL) has occurred on the site, this triggers the requirement for a contaminated land investigation prior to site disturbance or redevelopment.

The majority of the site was open paddocks used for grazing and are not considered to have had an activity included on the HAIL undertaken on them. During the on-site walkover the following activities included on the HAIL were noted:

- A1: Agrichemicals including commercial premises used by spray contractors for filling, storing or washing out tanks for agrichemical application;
- A6: Fertiliser manufacture or bulk storage;
- A10: Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glass houses or spray sheds;
- A17: Storage tanks or drums for fuel, chemicals or liquid waste;
- A18: Wood treatment or preservation including the commercial use of anti-sapstain chemicals during milling, or bulk storage of treated timber outside;
- E1: Asbestos products manufacture or disposal including sites with buildings containing asbestos products known to be in a deteriorated condition; and
- F8: Transport depots or yards including areas used for refuelling or the bulk storage of hazardous substances.

6 Conceptual Site Model

A conceptual site model consists of four primary components. For a contaminant to present a risk to human health or an environmental receptor, all four components are required to be present and connected. The four components of a conceptual site model are:

- Source of contamination;
- Pathway(s) in which contamination could potentially mobilise along (e.g. vapour or groundwater migration);
- Sensitive receptor(s) which may be exposed to the contaminants; and
- An exposure route, where the sensitive receptors and contaminants come into contact (e.g. ingestion, inhalation, dermal contact, etc).

The potential source, pathway, and receptor linkages at this subject site are provided in Table 6.

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Table 6 - Conceptual Site Model

Potential Sources	Contaminants of Concern	Potential Exposure Route or Pathways	Receptors	Acceptable Risk?
Treated timber, historical pesticide use, bulk storage of pesticides	Heavy Metals and boron.	Dermal contact with impacted soil, inhalation of dust and incidental ingestion during earthworks and long-term use of the site.	On-site redevelopment workers, surrounding environment and long-term users of the site.	**Unknown.** Further intrusive investigation is required.
Historical pesticide use and bulk storage of pesticides	Heavy metals, Organochlorine Pesticides (OCPs)			
Farm equipment storage, vehicle depot, above ground fuel tanks, burn pits for waste, tyre storage	Heavy metals, Total Petroleum Hydrocarbons (TPHs), Polycyclic Aromatic Hydrocarbons (PAHs), Asbestos			
Bulk fertiliser storage	Nitrates in soil and groundwater			
Building materials in a degraded condition	Asbestos	Inhalation of fibres		

7 Conclusions

Our review of the available desktop information indicates that while the site is not flagged on the Listed Land Use Register, site walkover observations have indicated that further investigation may be required in isolated areas prior to residential land development along the eastern, north-western and southern boundaries of the site.

Property files were requested from the Waimakariri District Council on 18 November 2021. A report from a groundwater testing programme undertaken by Environment Canterbury from 19 December 2000 for five wells across the site showed that arsenic was detected in the groundwater samples for wells exceeding the Drinking-Water Standards for New Zealand (1996) and was therefore not considered suitable as a drinking water supply (for humans). However, the guideline value for arsenic in livestock water was 0.5 mg/L at the time of testing and was therefore not an issue as water use on the property was for livestock and irrigation purposes only.

Aerial photographs were assessed to see general land-use and any major changes undertaken (if any) from the 1940s to present. All photos portrayed historical pastoral and agricultural activities over time, with irrigation and the addition of residential dwellings in the 1990s. No other significant activities were identified.

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During the site walkover, it was noted that various storage containers of agrichemicals, fuel tanks, burn pits, empty drums, vehicle parts, old farm equipment, treated timber and scrap metal existed primarily along the eastern boundary of the site as denoted in Figure 2.1. Additionally, two burn pits and a demolished structure exist in the north-western area of the as shown in Figure 2.2. There is also a potential burn pit at the residential dwelling towards the southern end of the site as shown in Figure 2.3.

A number of chemicals identified on-site are considered unlikely to be persistent in the environment and large scale impacts are also considered unlikely. A number of the fertiliser products assessed were nitrogen based. Impact from nitrates has not been identified in groundwater in the area as highlighted in the Environment Canterbury publication “Risk maps of nitrates in Canterbury Groundwater, ECan June 2015”.

Based on the information reviewed and our site walkover observations, it is highly unlikely that the majority of the site has been used for an activity included on the HAIL. Therefore these areas are considered suitable for residential development and / or continued used for agriculture. As the soils in these areas are considered unlikely to have been impacted, the potential presence of contaminated soils is not likely to have an effect on the proposed plan change.

However, a number of activities and potential activities included on the HAIL were identified during the site walk along the eastern, north-western and southern boundaries. These areas have the potential to have caused localised impact and further investigation is therefore required. This can be managed via the Resource Management (*National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health)* Regulations 2011 and should also not have an impact on the proposed zone change.

8 Sustainability

We encourage you to consider sustainability when assessing the options available for your project. Where suitable for the project, we recommend prioritising the sustainable use of resources, using locally sourced materials where available, and installing in an environmentally friendly way (e.g., reduced carbon emissions and minimal contamination). If you would like to discuss these options further, ENGEO staff are available to offer suggestions.

9 References

MfE. (2011b). Contaminated Land Management Guidelines No. 1: Reporting on Contaminated Sites in New Zealand. Wellington: Ministry for the Environment.

MfE. (2011c). Contaminated Land Management Guidelines No. 2: Hierarchy and Application in New Zealand of Environmental Guideline Values (Revised 2011). Wellington: Ministry for the Environment.

MfE. (2012). Users' Guide: National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health. Wellington: Ministry for the Environment

MfE Oct (2011a) Ministry for the Environment Hazardous Activities and Industries List. Wellington, Ministry for the Environment.

MfE (2011d). Contaminated Land Management Guidelines No.5: Site Investigation and Analysis of Soils.

ECan (2015). Risk Maps of Nitrate in Canterbury Groundwater.

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10 Limitations

i. We have prepared this report in accordance with the brief as provided. This report has been prepared for the use of our client, Westside Country Limited, their professional advisers and the relevant Territorial Authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.

ii. The recommendations in this report are based on the ground conditions indicated from published sources, site assessments and subsurface investigations described in this report based on accepted normal methods of site investigations. Only a limited amount of information has been collected to meet the specific financial and technical requirements of the client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgement and it should be appreciated that actual conditions could vary from the assumed model.

iii. Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

iv. This Limitation should be read in conjunction with the Engineering NZ/ACENZ Standard Terms of Engagement.

v. This report is not to be reproduced either wholly or in part without our prior written permission.

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned on (03) 328 9012 if you require any further information.

Report prepared by

Holly Eeg

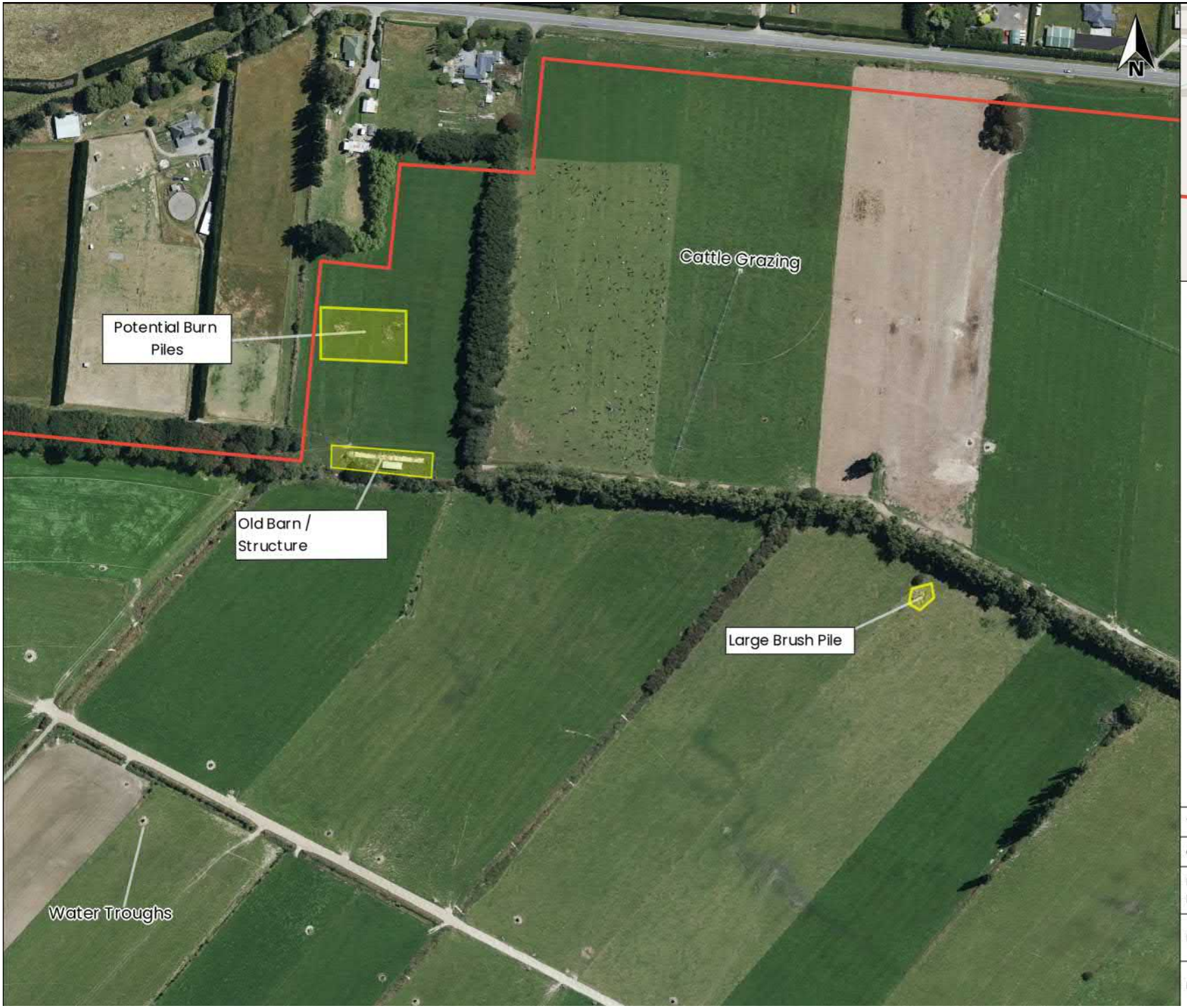
Environmental Scientist

Report reviewed by

Dave Robotham, CEnvP SC

Principal Environmental Consultant

FIGURES



Legend

- Site Boundary
- Potential HAIL

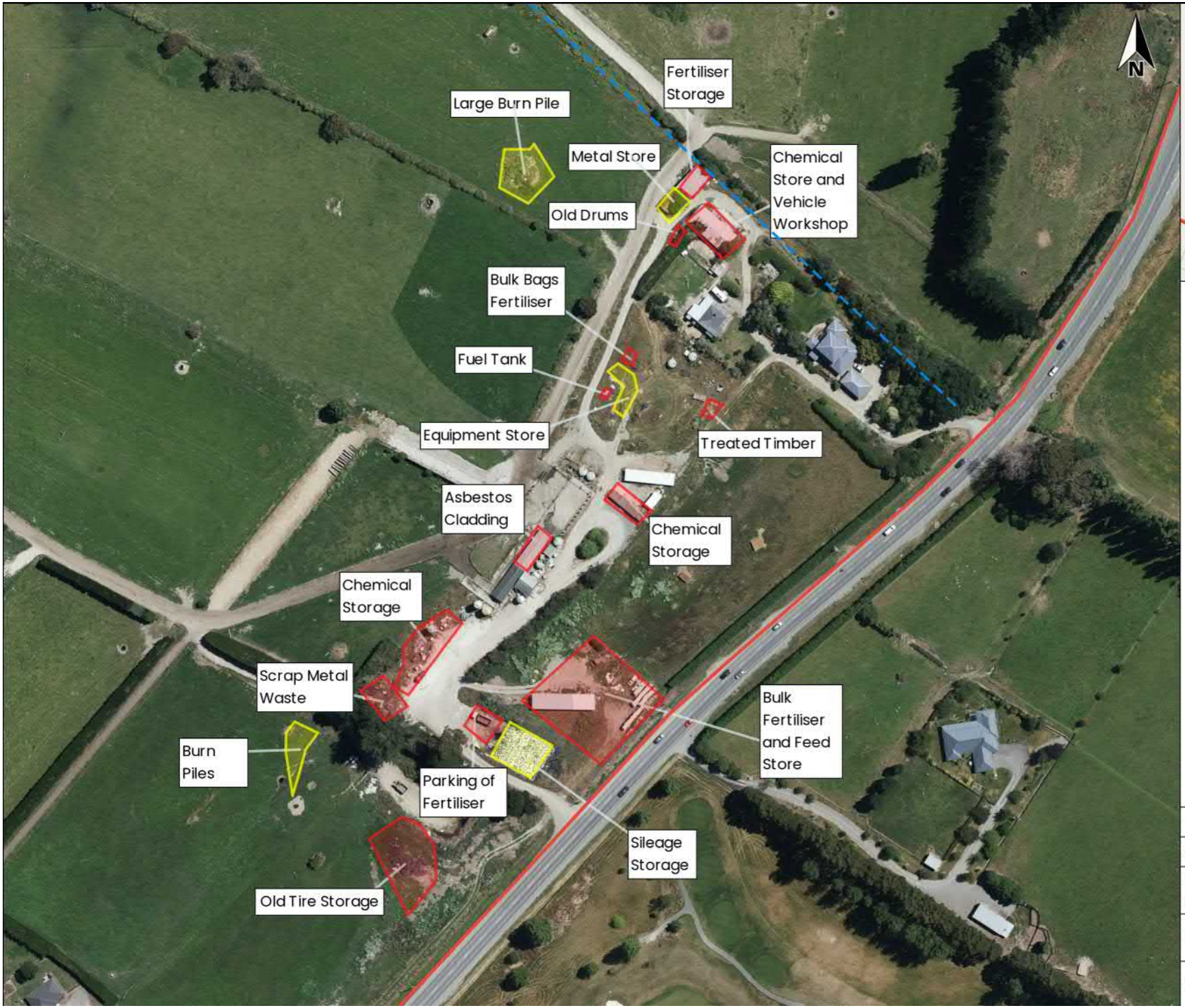
0 50 m 100 m

LINZ CC BY 4.0 © Imagery Basemap contributors

ENGEO

Produced by **Datanest.earth**

Title: Areas of Concern		
Client: Westside Country Ltd.		
Project: Gresson and Main North Road	Drawn: HE	Figure No: 2.2 Size: A4
Date: 03-11-2021	Checked: DR	
Proj No: P2021.005.919	Scale: 1:4637	Version: draft



Legend

- Site Boundary
- Identified HAIL
- Potential HAIL
- Drainage Channels

0 25 m 50 m

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ENGEO

Produced by **Datanest.earth**

Title: Areas of Concern		
Client: Westside Country Ltd.		
Project: Gresson and Main North Road	Drawn: HE	Figure No: 2.2 Size: A4
Date: 03-11-2021	Checked: DR	
Proj No: P2021.005.919	Scale: 1:2913	Version: draft

Legend

- Site Boundary
- Potential HAIL

0 10 m 20 m

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ENGEO

Produced by **Datanest.earth**

Title: Areas of Concern		
Client: Westside Country Ltd.		
Project: Gresson and Main North Road	Drawn: HE	Figure No: 2.2 Size: A4
Date: 03-11-2021	Checked: DR	
Proj No: P2021.005.919	Scale: 1:1456	Version: draft

APPENDIX 1:

LLUR Enquiry

Environment Canterbury
Regional Council
Kaunihera Taiao ki Waitaha

Customer Services
P. 03 353 9007 or 0800 324 636

PO Box 345
Christchurch 8140

P. 03 365 3828
F. 03 365 3194
E. ecinfo@ecan.govt.nz

www.ecan.govt.nz

Dear Sir/Madam

Thank you for submitting your property enquiry from our Listed Land Use Register (LLUR). The LLUR holds information about sites that have been used or are currently used for activities which have the potential to cause contamination.

The LLUR statement shows the land parcel(s) you enquired about and provides information regarding any potential LLUR sites within a specified radius.

Please note that if a property is not currently registered on the LLUR, it does not mean that an activity with the potential to cause contamination has never occurred, or is not currently occurring there. The LLUR database is not complete, and new sites are regularly being added as we receive information and conduct our own investigations into current and historic land uses.

The LLUR only contains information held by Environment Canterbury in relation to contaminated or potentially contaminated land; additional relevant information may be held in other files (for example consent and enforcement files).

Please contact Environment Canterbury if you wish to discuss the contents of this property statement.

Yours sincerely

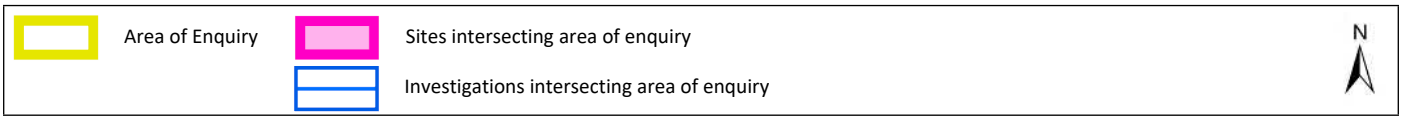
Contaminated Sites Team

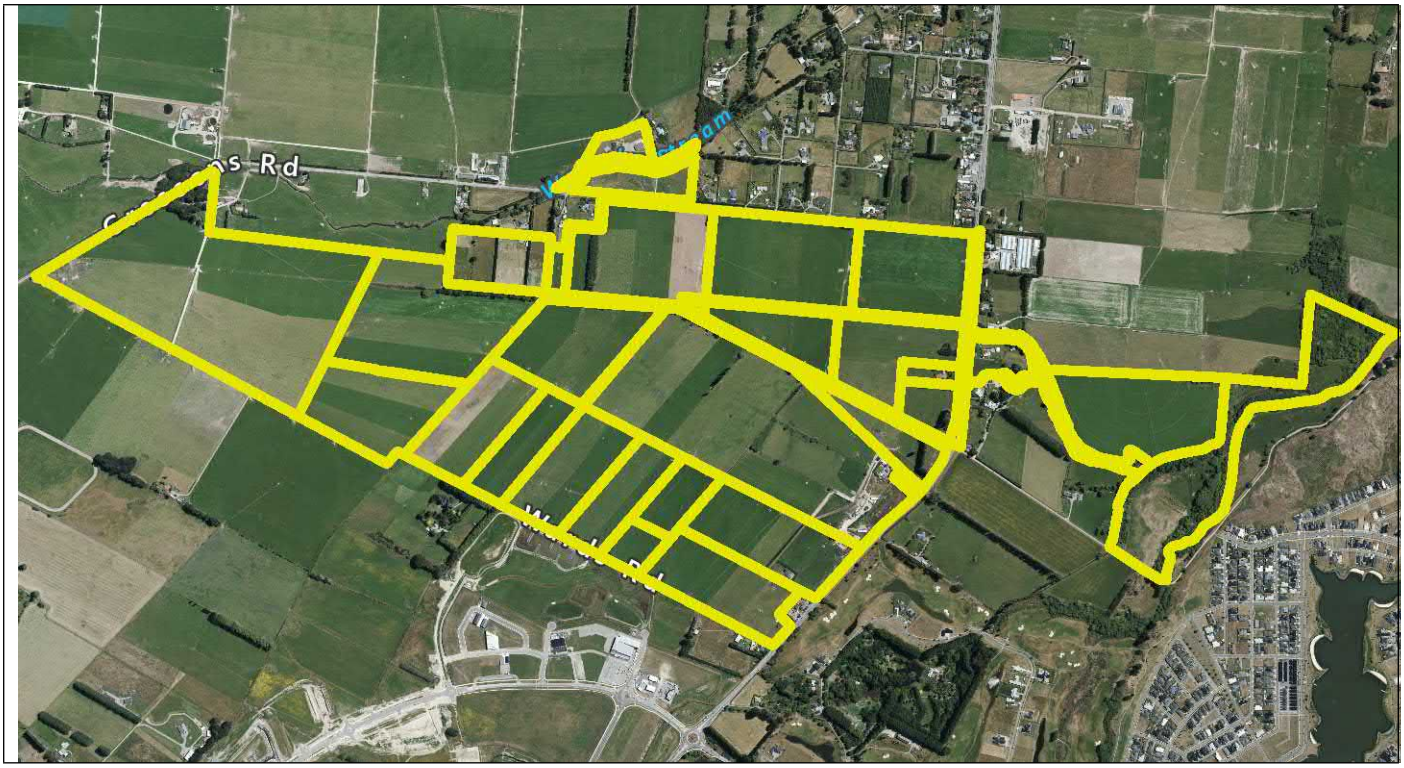
Property Statement
from the Listed Land Use Register

Visit ecan.govt.nz/HAIL for more information or
contact Customer Services at ecan.govt.nz/contact/ and quote ENQ300527

Date generated: 15 November 2021

Land parcels:
Lot 1 DP 455971
Lot 2 DP 428676
Part RS 3101
Lot 1 DP 46765
Lot 2 DP 303387
Lot 2 DP 61069
Part RS 3093,3129,3141-3144,3169,3170
Part RS 3093,3129,3141-3144,3169,3170
Part RS 3946
Lot 1 DP 428676
Lot 5 DP 923
Lot 2 DP 46765
CL SO 17137
Lot 6 DP 923
Part RS 3101
Part Lot 4 DP 923
Part RS 3919,4719
Part RS 3101
Lot 1 DP 470921
Part Lot 1 DP 18739
Part RS 3093,3129,3141-3144,3169,3170
Part Lot 4 DP 923
Section 1 SO 16798
RS 41401
Lot 1 DP 9769
Part RS 1485
Part RS 3093,3129,3141-3144,3169,3170
Lot 2 DP 62186
Part RS 3093,3129,3141-3144,3169,3170
Lot 1 DP 43146
Lot 8 DP 923
Lot 3 DP 62186
Part RS 3093,3129,3141-3144,3169,3170





The information presented in this map is specific to the property you have selected. Information on nearby properties may not be shown on this map, even if the property is visible.

Sites at a glance

Sites within enquiry area

There are no sites associated with the area of enquiry.

More detail about the sites

There are no sites associated with the area of enquiry.

Disclaimer

The enclosed information is derived from Environment Canterbury's Listed Land Use Register and is made available to you under the Local Government Official Information and Meetings Act 1987.

The information contained in this report reflects the current records held by Environment Canterbury regarding the activities undertaken on the site, its possible contamination and based on that information, the categorisation of the site. Environment Canterbury has not verified the accuracy or completeness of this information. It is released only as a copy of Environment Canterbury's records and is not intended to provide a full, complete or totally accurate assessment of the site. It is provided on the basis that Environment Canterbury makes no warranty or representation regarding the reliability, accuracy or completeness of the information provided or the level of contamination (if any) at the relevant site or that the site is suitable or otherwise for any particular purpose. Environment Canterbury accepts no responsibility for any loss, cost, damage or expense any person may incur as a result of the use, reference to or reliance on the information contained in this report.

Any person receiving and using this information is bound by the provisions of the Privacy Act 1993.

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Listed Land Use Register

What you need to know

Everything is connected

What is the Listed Land Use Register (LLUR)?

The LLUR is a database that Environment Canterbury uses to manage information about land that is, or has been, associated with the use, storage or disposal of hazardous substances.

Why do we need the LLUR?

Some activities and industries are hazardous and can potentially contaminate land or water. We need the LLUR to help us manage information about land which could pose a risk to your health and the environment because of its current or former land use.

Section 30 of the Resource Management Act (RMA, 1991) requires Environment Canterbury to investigate, identify and monitor contaminated land. To do this we follow national guidelines and use the LLUR to help us manage the information.

The information we collect also helps your local district or city council to fulfil its functions under the RMA. One of these is implementing the National Environmental Standard (NES) for Assessing and Managing Contaminants in Soil, which came into effect on 1 January 2012.

For information on the NES, contact your city or district council.

How does Environment Canterbury identify sites to be included on the LLUR?

We identify sites to be included on the LLUR based on a list of land uses produced by the Ministry for the Environment (MfE). This is called the Hazardous Activities and Industries List (HAIL)[1]. The HAIL has 53 different activities, and includes land uses such as fuel storage sites, orchards, timber treatment yards, landfills, sheep dips and any other activities where hazardous substances could cause land and water contamination.

We have two main ways of identifying HAIL sites:

- We are actively identifying sites in each district using historic records and aerial photographs. This project started in 2008 and is ongoing.
- We also receive information from other sources, such as environmental site investigation reports submitted to us as a requirement of the Regional Plan, and in resource consent applications.

[1] The Hazardous Activities and Industries List (HAIL) can be downloaded from MfE's website www.mfe.govt.nz, keyword search HAIL

How does Environment Canterbury classify sites on the LLUR?

Where we have identified a HAIL land use, we review all the available information, which may include investigation reports if we have them. We then assign the site a category on the LLUR. The category is intended to best describe what we know about the land use and potential contamination at the site and is signed off by a senior staff member.

Please refer to the Site Categories and Definitions factsheet for further information.

What does Environment Canterbury do with the information on the LLUR?

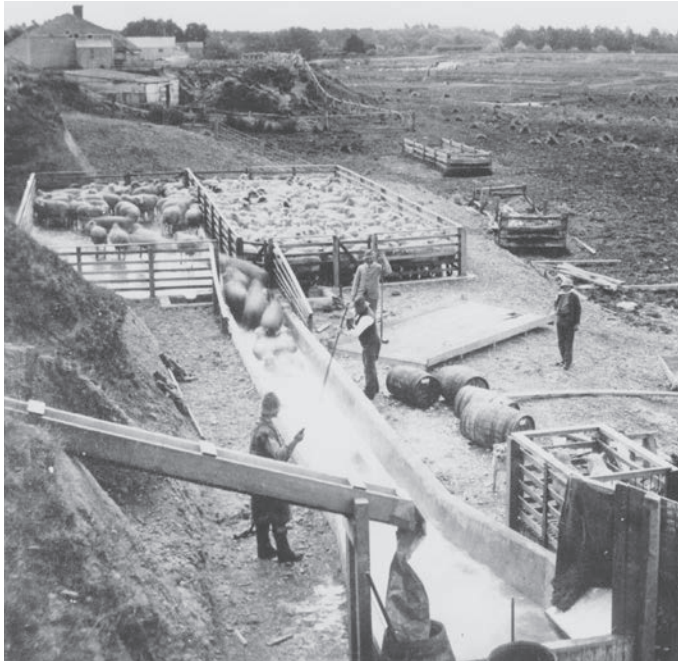
The LLUR is available online at www.llur.ecan.govt.nz. We mainly receive enquiries from potential property buyers and environmental consultants or engineers working on sites. An inquirer would typically receive a summary of any information we hold, including the category assigned to the site and a list of any investigation reports.

We may also use the information to prioritise sites for further investigation, remediation and management, to aid with planning, and to help assess resource consent applications. These are some of our other responsibilities under the RMA.

If you are conducting an environmental investigation or removing an underground storage tank at your property, you will need to comply with the rules in the Regional Plan and send us a copy of the report. This means we can keep our records accurate and up-to-date, and we can assign your property an appropriate category on the LLUR. To find out more, visit www.ecan.govt.nz/HAIL.

IMPORTANT!

The LLUR is an online database which we are continually updating. A property may not currently be registered on the LLUR, but this does not necessarily mean that it hasn't had a HAIL use in the past.



Sheep dipping (ABOVE) and gas works (TOP) are among the former land uses that have been identified as potentially hazardous. (Photo above by Wheeler & Son in 1987, courtesy of Canterbury Museum.)

My land is on the LLUR – what should I do now?

IMPORTANT! Just because your property has a land use that is deemed hazardous or is on the LLUR, it doesn't necessarily mean it's contaminated. The only way to know if land is contaminated is by carrying out a detailed site investigation, which involves collecting and testing soil samples.

You do not need to do anything if your land is on the LLUR and you have no plans to alter it in any way. It is important that you let a tenant or buyer know your land is on the Listed Land Use Register if you intend to rent or sell your property. If you are not sure what you need to tell the other party, you should seek legal advice.

You may choose to have your property further investigated for your own peace of mind, or because you want to do one of the activities covered by the National Environmental Standard for Assessing and Managing Contaminants in Soil. Your district or city council will provide further information.

If you wish to engage a suitably qualified experienced practitioner to undertake a detailed site investigation, there are criteria for choosing a practitioner on www.ecan.govt.nz/HAIL.

I think my site category is incorrect – how can I change it?

If you have an environmental investigation undertaken at your site, you must send us the report and we will review the LLUR category based on the information you provide. Similarly, if you have information that clearly shows your site has not been associated with HAIL activities (eg. a preliminary site investigation), or if other HAIL activities have occurred which we have not listed, we need to know about it so that our records are accurate.

If we have incorrectly identified that a HAIL activity has occurred at a site, it will be not be removed from the LLUR but categorised as Verified Non-HAIL. This helps us to ensure that the same site is not re-identified in the future.

Contact us

Property owners have the right to look at all the information Environment Canterbury holds about their properties.

It is free to check the information on the LLUR, online at www.llur.ecan.govt.nz.

If you don't have access to the internet, you can enquire about a specific site by phoning us on (03) 353 9007 or toll free on 0800 EC INFO (32 4636) during business hours.

Contact Environment Canterbury:

Email: ecinfo@ecan.govt.nz

Phone:
Calling from Christchurch: (03) 353 9007
Calling from any other area: 0800 EC INFO (32 4636)

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Everything is connected

Promoting quality of life through balanced resource management.

www.ecan.govt.nz E13/101

Listed Land Use Register

Site categories and definitions

When Environment Canterbury identifies a Hazardous Activities and Industries List (HAIL) land use, we review the available information and assign the site a category on the Listed Land Use Register. The category is intended to best describe what we know about the land use.

If a site is categorised as **Unverified** it means it has been reported or identified as one that appears on the HAIL, but the land use has not been confirmed with the property owner.

If the land use has been confirmed but analytical information from the collection of samples is not available, and the presence or absence of contamination has therefore not been determined, the site is registered as:

Not investigated:

- A site whose past or present use has been reported and verified as one that appears on the HAIL.
- The site has not been investigated, which might typically include sampling and analysis of site soil, water and/or ambient air, and assessment of the associated analytical data.
- There is insufficient information to characterise any risks to human health or the environment from those activities undertaken on the site. Contamination may have occurred, but should not be assumed to have occurred.

If analytical information from the collection of samples is available, the site can be registered in one of six ways:

At or below background concentrations:

The site has been investigated or remediated. The investigation or post remediation validation results confirm there are no hazardous substances above local background concentrations other than those that occur naturally in the area. The investigation or validation sampling has been sufficiently detailed to characterise the site.

Below guideline values for:

The site has been investigated. Results show that there are hazardous substances present at the site but indicate that any adverse effects or risks to people and/or the environment are considered to be so low as to be acceptable. The site may have been remediated to reduce contamination to this level, and samples taken after remediation confirm this.

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Managed for:

The site has been investigated. Results show that there are hazardous substances present at the site in concentrations that have the potential to cause adverse effects or risks to people and/or the environment. However, those risks are considered managed because:

- the nature of the use of the site prevents human and/or ecological exposure to the risks; and/or
- the land has been altered in some way and/or restrictions have been placed on the way it is used which prevent human and/or ecological exposure to the risks.

Partially investigated:

The site has been partially investigated. Results:

- demonstrate there are hazardous substances present at the site; however, there is insufficient information to quantify any adverse effects or risks to people or the environment; or
- do not adequately verify the presence or absence of contamination associated with all HAIL activities that are and/or have been undertaken on the site.

Significant adverse environmental effects:

The site has been investigated. Results show that sediment, groundwater or surface water contains hazardous substances that:

- have significant adverse effects on the environment; or
- are reasonably likely to have significant adverse effects on the environment.

Contaminated:

The site has been investigated. Results show that the land has a hazardous substance in or on it that:

- has significant adverse effects on human health and/or the environment; and/or
- is reasonably likely to have significant adverse effects on human health and/or the environment.

If a site has been included incorrectly on the Listed Land Use Register as having a HAIL, it will not be removed but will be registered as:

Verified non-HAIL:

Information shows that this site has never been associated with any of the specific activities or industries on the HAIL.

Please contact Environment Canterbury for further information:

(03) 353 9007 or toll free
on 0800 EC INFO (32 4636)
email ecinfo@ecan.govt.nz

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

E13/102

APPENDIX 8

DAVIE LOVELL-SMITH – INFRASTRUCTURE ASSESSMENT

Infrastructure Options Report

Stokes Farm – Westside Country Ltd

Gressons Road, Waikuku

Proposed Plan Change Submission

20605

November 2021

DAVIE LOVELL-SMITH

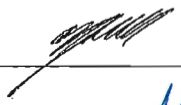
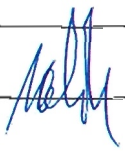
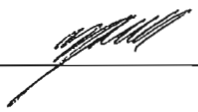
PLANNING SURVEYING ENGINEERING

Shaping the future since 1880

Revision History

Rev Number:	Prepared By:	Description:	Date:

Document Control

Action:	Name:	Signed:	Date:
Prepared By	Andy Hall		12/11/2021
Reviewed By	Mike Walsh		12/11/2021
Approved By	Andy Hall		12/11/2021

This report has been prepared by Davie Lovell-Smith Ltd on the specific instructions of our client. It is solely for our clients use for the purpose for which it is intended and in accordance with the agreed scope of work. Any use or reliance by any person contrary to the above, to which Davie Lovell-Smith Ltd has not given prior written consent, is at that persons own risk.

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1. Executive Summery

This report assesses servicing of the proposed Stokes Farm development area north of Ravenswood in Woodend. The site requires a full Plan Change Assessment but for the purposes of a submission for potential development, this report investigates the most likely and realistic options for Water Supply, Wastewater, Stormwater, Power and Telecommunications for 1500 lots.

Water Supply – Best Option is to follow the Councils Strategy investigation and connect to the Woodend Pegasus Facility but further investigation is required into pipe sizing and bore yields.

Wastewater – Best option is to connect to the Woodend Treatment Facility and carry out upgrades to suit and as prescribed by the WDC Activity Management Plan.

Stormwater – Design a facility on site to attend to the treatment and attenuation of stormwater, connect to existing WDC facilities and consider other areas of potential catchment.

Power – Able to be provided by Mainpower.

Telecommunications – Able to be provided by Chorus

2. General

2.1. Introduction

This infrastructure report addresses the servicing of the proposed residential development at 33, 33A, 81, 107 & 149 Gressons Road, and 1263, 1281, 1301, 1319, 1323, 1323B, 1341 & 1375 State Highway 1, between Woodend and Waikuku. It is proposed to divide the approximate 144ha hectare property into 1500 residential lots. Primarily this report will address viable options for Water Supply, Stormwater, Wastewater, Power and Telecommunications.

This area has been identified in the Waimakariri District Development Strategy (DDS) 'Our District, Our Future – Waimakariri 2048', which guides the District's anticipated residential and business growth over the next 30 years.

A pre-submission meeting was held between Davie Lovell-Smith (DLS) and Waimakariri District Council (WDC) Strategic Planners and Infrastructure Engineers to discuss the servicing requirements and design of the proposed development. These options described in this report will form the basis for further investigation that will be compiled as part of a Plan Change Application.

A geotechnical assessment report has shown that the site is suitable for residential development but with some areas of Technical Category 3(TC3) land requiring remediation. A copy of the report is included with the submission.

A Preliminary Site Investigation for Contamination has been completed and is attached to the submission. There appears to be some areas that require testing. A Detailed Site Investigation will be completed as part of a future application.

The design and construction of the proposed sub-division infrastructure will comply with the requirements the WDC standards or the Building Code.

It is anticipated that the density of the development will be affected by a general expectation that houses should be more dense in the future. Whilst the actual density will be fully considered as part of a plan change, a density of 15 homes per hectare has been adopted here.

2.2. Site

Please refer to the attached Aerial Photograph in Appendix A.

The site is predominantly level pasture and is utilised as a Dairy Unit. There are two centre pivot irrigators in the north east corner of the property. Stok races feed to a number of paddocks. Access to the Dairy operation is off State Highway 1.

There are a number of treed wind breaks over the site but no trees of significance.

Some years ago, the applicant, in collaboration with local Iwi, retired an area of land from production opposite the intersection of Preeces Road and State Highway 1. It is expected that this area holds archaeological features of importance.

There are existing houses and sheds on the site that are not considered significant in terms of heritage. All buildings will be removed during development.

The site undulates to form three distinct stormwater features on the site. Please refer to the attached topographical plan in Appendix B and the Outline Development Plan in Appendix C for the location of these features. It is proposed that these will be naturalised and utilised within the development for the passage of flood flows. Please also refer to the Flood Assessment attached to the overall submission.

There are bores registered on the site. All bores will be capped and abandoned in compliance with Environment Canterbury regulations. The bores may be utilised during construction as a water supply for dust suppression and irrigation of new grass areas. The water permits will most probably be transferred to WDC.

There are a number of drainage channels on the property that will be abandoned.

The property is bounded by State Highway 1 to the East, Gressons Road to the North and Wards Road to the South. The property shares a boundary to the south with the Ravenswood development and road connections will be made between the two areas.

The land abuts a number of rural, rural-residential and residential sites.

3. Water Supply

WDC have a water supply strategy for the next 50 years that includes for the land proposed in this submission. Please refer to the attached WDC Water Strategy Plan in Appendix D.

The Strategy stipulates a connection be made from the Pegasus Town water supply, along Pegasus Boulevard and then north along the State Highway to the site. The intended pipe size is 250mm(ID). Attached also find a plan connecting to the site via two alternative routes. Connection through the golf course will cause significantly less disruption but will require the clubs approval.

As a check on the proposed pipe sizing, a peak hourly flow of 0.1l/s/dwelling is adopted from the WDC Code of Practice. Working backwards from the 250mm pipe with a roughness coefficient of 0.15mm and a maximum velocity of 1.5m/s we get the following calculation from the Colebrook-White equation.

Pipe diameter	250mm	
Headloss - 1 in	117	
Pipe Roughness - ks		0.15mm
Velocities	1.499	m/s
Discharge	73.61	litres/sec

At 0.1l/s/dwelling, this equates to 736 lots.
1500 lots would be 150l/s and a 340mm ID pipe

While this simplistic assessment needs to be properly modelled, it demonstrates that perhaps a far greater flow may be required for the area.

With reference to the Activity Management Plan 2021 - Woodend-Pegasus Water Supply Scheme, demand on the Woodend-Pegasus water supply scheme is expected to increase by 60% between the July 2019 rates strike base year, and year ten of the 2021-31 Long Term Plan (LTP). This projection is based on:

1. 822 new connections from Ravenswood during the 2021-31 LTP period as identified as part of the 2020 WDC 50 Year Water and Sewer Connection Growth Forecast Work
2. 282 new connections from in Pegasus township during the 2021-31 LTP period as identified as part of the 2020 WDC 50 Year Water and Sewer Connection Growth Forecast Work
3. 438 new connections from East Woodend and Woodend Beach during the 2021-31 LTP period as identified as part of the 2020 WDC 50 Year Water and Sewer Connection Growth
4. 400 new connections in the Tuahiwi area, developing over the next 50 year period as identified as part of planning development work.

This 10 year projection does not include for the proposed development area in this submission.

Whilst the applicant is very happy to coordinate the water supply to the development land in accordance with the Water Supply Strategy, it appears that neither the proposed capacity of the pipework or 10 year projection fully address the potential demand for a denser form of development. That said, if the denser form were to be adopted then the strategy may easily be augmented with additional water take from the Pegasus bore or an additional new bore on site.

Feasible Options for Future Water Supply

A. Expansion of the existing Pegasus-Woodend Water Supply

B. New On-site Bore

4. Sewer

The options for the disposal of wastewater consist of:

1. Pumping to the Waikuku Treatment Plant
2. Pumping to the Woodend Treatment Plan

Neither of these Treatment Plants have sufficient capacity for the proposal. Neither option has connecting pipework to the site. Disposal on site is not an option due to ground conditions and the preference of Council to expand on existing systems.

Using the Waimakariri Code of practice, 1500 lots would create approximately 62l/s Peak Wet Weather Flow.

Please refer to the attached plans in Appendix F for potential pipe routes from the site to the two treatment plants.

4.1. Waikuku Treatment Plant

The Waikuku Beach Wastewater Scheme is part of the Eastern Districts Wastewater Scheme. It is generally an urban gravity reticulation scheme. The sewage is conveyed via a network of gravity pipes to the Reserve Road Pump Station where it is transferred to the Waikuku Beach Treatment Plant via a rising main.

The treatment plant consists of an automatic step screen to remove large solid particles and two oxidation ponds with a mechanical aerator that discharges via a pump station to the Woodend Wastewater Treatment Plant for further treatment and disposal via the ocean outfall. No provision has been made for future expansion. The oxidation ponds have sufficient capacity to treat the flow from all likely growth in the Waikuku Beach area.

Whilst there appears to be a very simple route for a pipe between the development site and the Waikuku Treatment Plant, and the land for the most part is owned by the applicant, the Plant itself may prove difficult to upgrade and the system relies on the transfer of the flows to the Woodend Plant for final treatment. The addition of the flows from this proposal would most probably necessitate the upgrading of the pipe between the two plants.

4.2. Woodend Treatment Plant

The Woodend Wastewater Scheme is part of the Eastern Districts Sewer Scheme. It is generally an urban gravity reticulation scheme, except for four small pump stations that discharge into the reticulation. There are 3 terminal pump stations that convey wastewater to the Woodend WWTP. The Tuahiwi wastewater scheme discharges directly into a manhole at the northern end of the Woodend wastewater reticulation and the Pegasus wastewater scheme pumps directly to the Woodend wastewater treatment plant. The Waikuku WWTP discharges directly into the Woodend WWTP inlet structure.

The Treatment Plant consists of an automatic step screen to remove large solid particles and three aeration basins followed by two facultative ponds and 2.5 ha planted wetland. UV treatment is used to ensure the final effluent meets the consent conditions. Following UV treatment, the flows are discharged to the sea.

The Activity Management Plan for the Woodend Treatment Plant details an expectation that any development north of Woodend would be pumped to the Plant. The Plan also details the future expansion of the Plant to accommodate future flow.

There is potential that the Plant may require upgrading prior to the projected growth rates. This is not expected to be a concern as long as the details of the works required is attended to in a timely fashion.

In terms of the wastewater, there are two options but the direct pumping from the site to the Woodend Treatment Plant appears to be the most obvious solution.

5. Stormwater

The existing gradient of the site is from west to east. As described previously, there are three distinct stormwater drainage features running through the site. The stormwater design will include for the naturalisation of these existing streams but it is noted that for the most part, the streams will not act as conduits for the untreated stormwater flows. The streams will flow through the site, bypassing any treatment. They will also act as safe secondary flow routes for floodwaters from upstream.

All stormwater emanating from roads, berms and lots will be collected by sumps and pipes and directed to the proposed stormwater facility at the eastern end of the site or the existing WDC stormwater facility in Ravenswood. The untreated flows will drain through the site via pipework to a storage and treatment facility including for a first flush basin, Storage basin and wetland. The treated and attenuated flows will be released to the streams

A stormwater facility is to be designed for the proposed ODP area but other areas could be included with additional funding from WDC. It is recognised that single large integrated facilities are better long-term assets for the Council rather than a number of small localised basins.

Once the designs are agreed with WDC, Discharge Consents will need to be sought from Ecan by the developer. The conditions of consent will be agreed with WDC and the consents will be transferred to WDC at the end of any prescribed maintenance period.

All cut material from the construction process is to remain on site for the filling of lots, elevating them above the roads. Roads will provide the secondary overflow path for storm events greater than 2% AEP. Secondary flow paths within the site will follow the road network and reserves towards the proposed stormwater facility.

In terms of stormwater infrastructure, there really is only the one option and that is to deal with it on site. This will not be an inhibitor to development.

8. Power, Telecommunications, and Street Lights

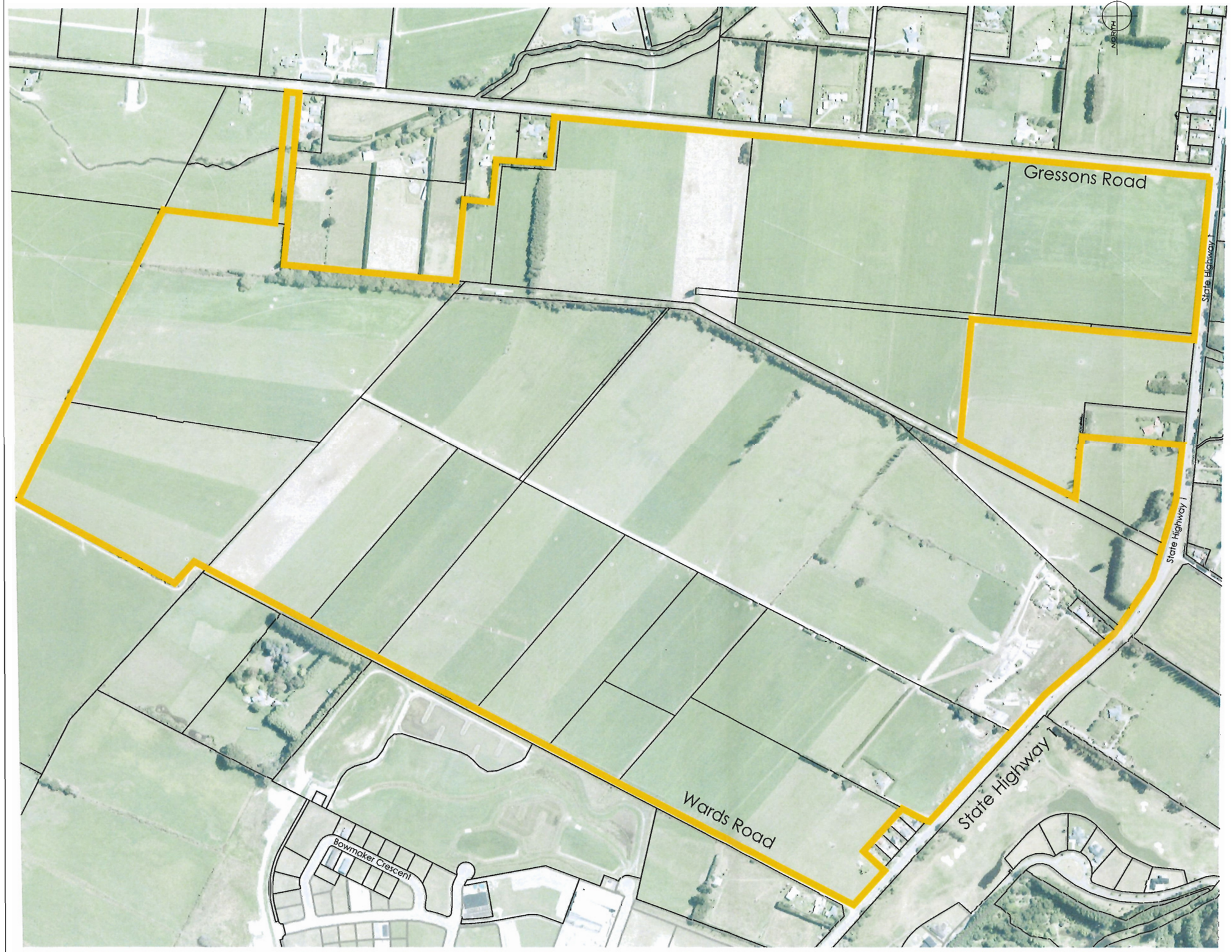
Power in this area will be provided by Mainpower. Mainpower have been contacted and asked to confirm that they will be able to service 1500 new lots in this area. Whilst there does not appear to be a formal design or strategy in place, they have confirmed that services will be able to be provided for this proposal.

Similarly, Chorus have been contacted and were also able to confirm that services would be available.

Power and Telecommunications will be provided to all residential lots to utility company and industry standards. All cables will be placed underground and all kiosks will be constructed on separate individual lots. The kiosk sites will be forwarded to Council for approval following the power design.

Street lights will be provided to the roading and reserves to Council standards. The applicant will also provide a street light style to Council for approval.

Appendix A – Aerial Photograph



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AMENDMENTS :

AMENDMENT	DATE	DESCRIPTION

NOTES :

1. Areas and dimensions are approximate only and are subject to final survey and deposit of plans.
2. Service easements to be created as required.
3. This plan has been prepared for subdivision concept & discussion purposes only. No liability is accepted if the plan is used for any other purposes.
4. Contours shown are from Christchurch City Council Lidar Data at 0.25m Contour Intervals and Interms of LINZ Vertical Datum 2016.

Total Area :

Comprised in:

DAVIE LOVELL-SMITH
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Telephone: 03 379-0793 Website: www.dls.co.nz E-mail: office@dls.co.nz

JOB TITLE:

Stokes - Waikuku

SHEET TITLE:

BASE PLAN

DRAWING STATUS

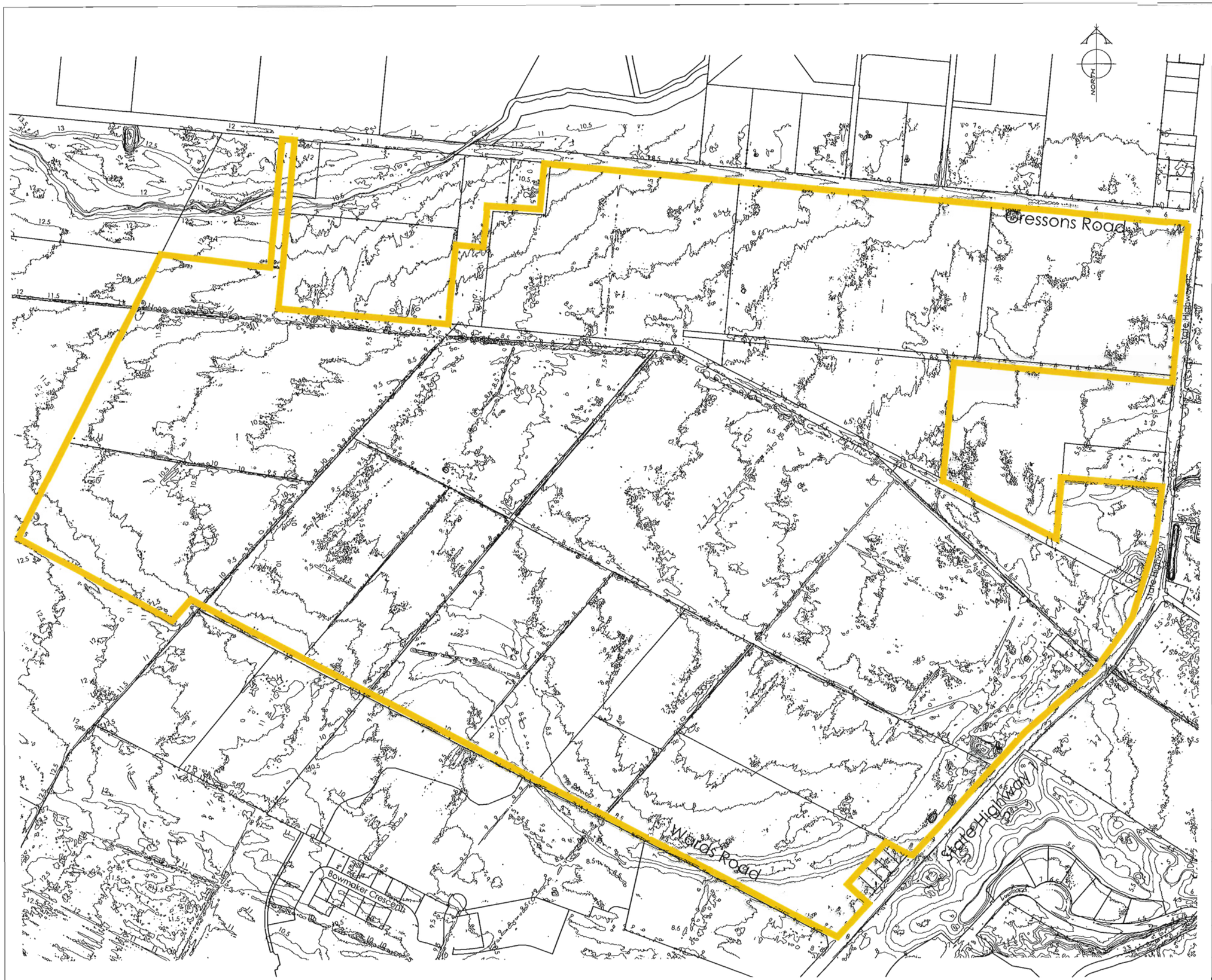
For Discussion Purposes

SCALE : 1:3000@A1 1:6000@A3 DATE : November 2021

CAD FILE : J:\20605\Wa3uku.dwg REVISION :

DRAWING No : **E20605** SHEET No: 1 OF 1 **R0**

Appendix B – Topographical Plan (LiDAR)



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SCALE : 1:3000@A1
1:6000@A3

DATE : November 2021

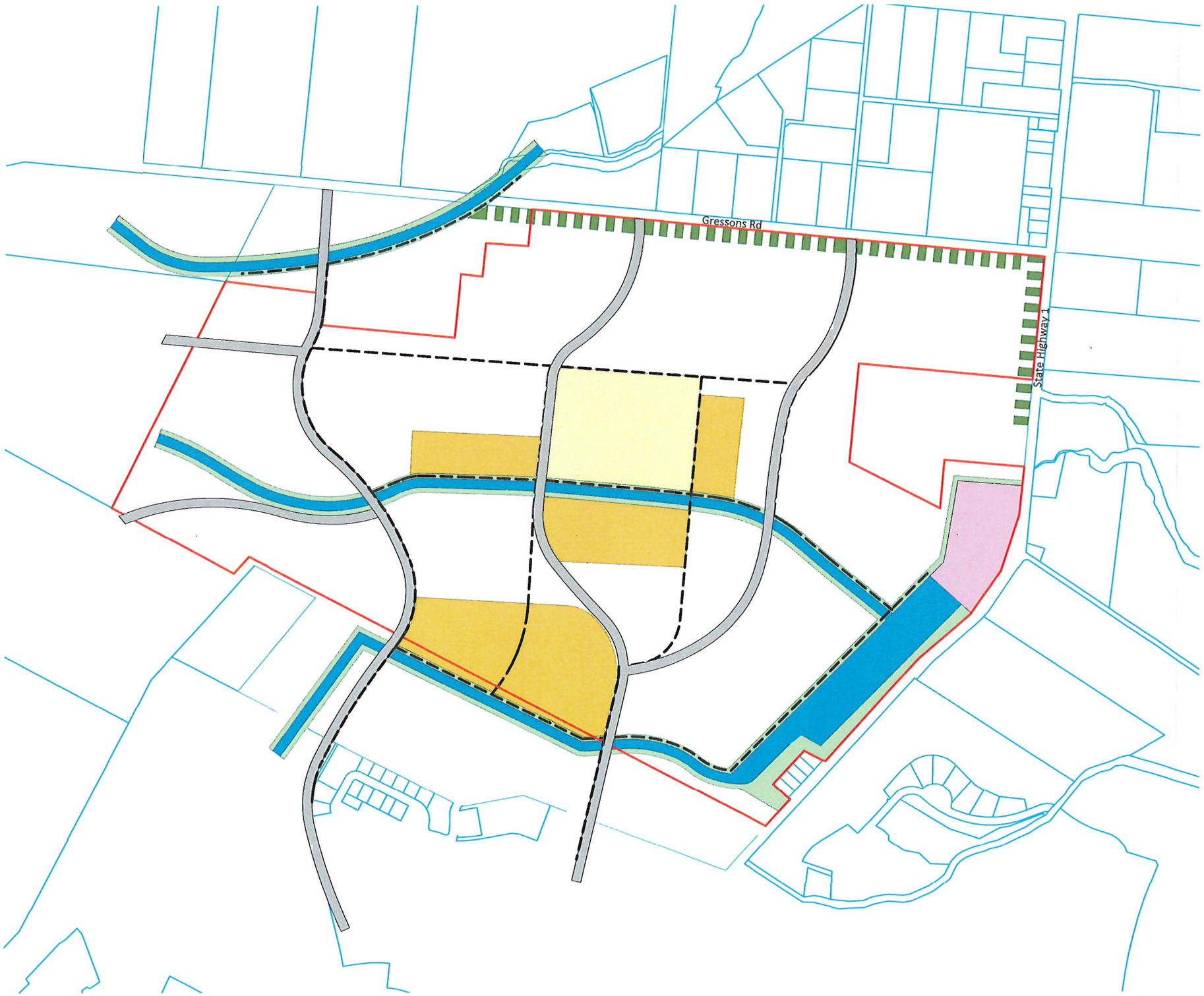
CAD FILE : J:\20605\Waikuku.dwg

REVISION :
R0

DRAWING No :
E20605

SHEET No
1 OF 1

Appendix C – Outline Development Plan



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REV DATE NOTES

Legend

- Proposed Plan Change Area
- Proposed Cycleway
- Proposed Road
- Proposed Reserve Link
- Proposed Stormwater & Flood Link
- Proposed Ngāi Tahu Reserve
- Proposed Recreation Reserve
- Proposed High Density Residential
- Proposed Open sapce buffer
- Existing Land Parcels

NORTH

Draft

RMM
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STOKES

JOB No.	21346
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DATE	24/11/2021
DESIGNED	
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CHECKED	CHECKED BY
STATUS	
DRAWING No.	REVISION

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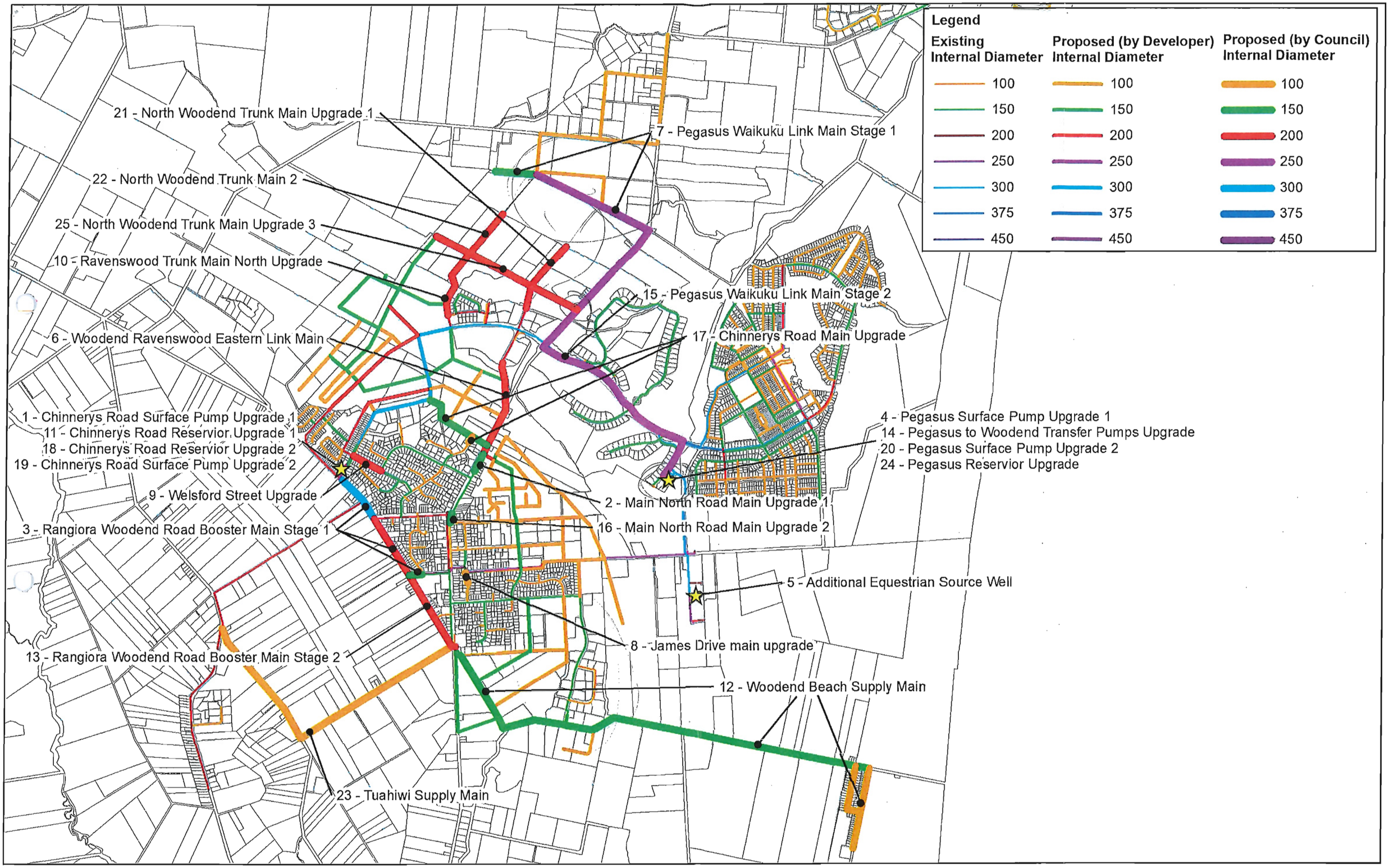
1 of 1

Appendix D – WDC Water Supply Strategy



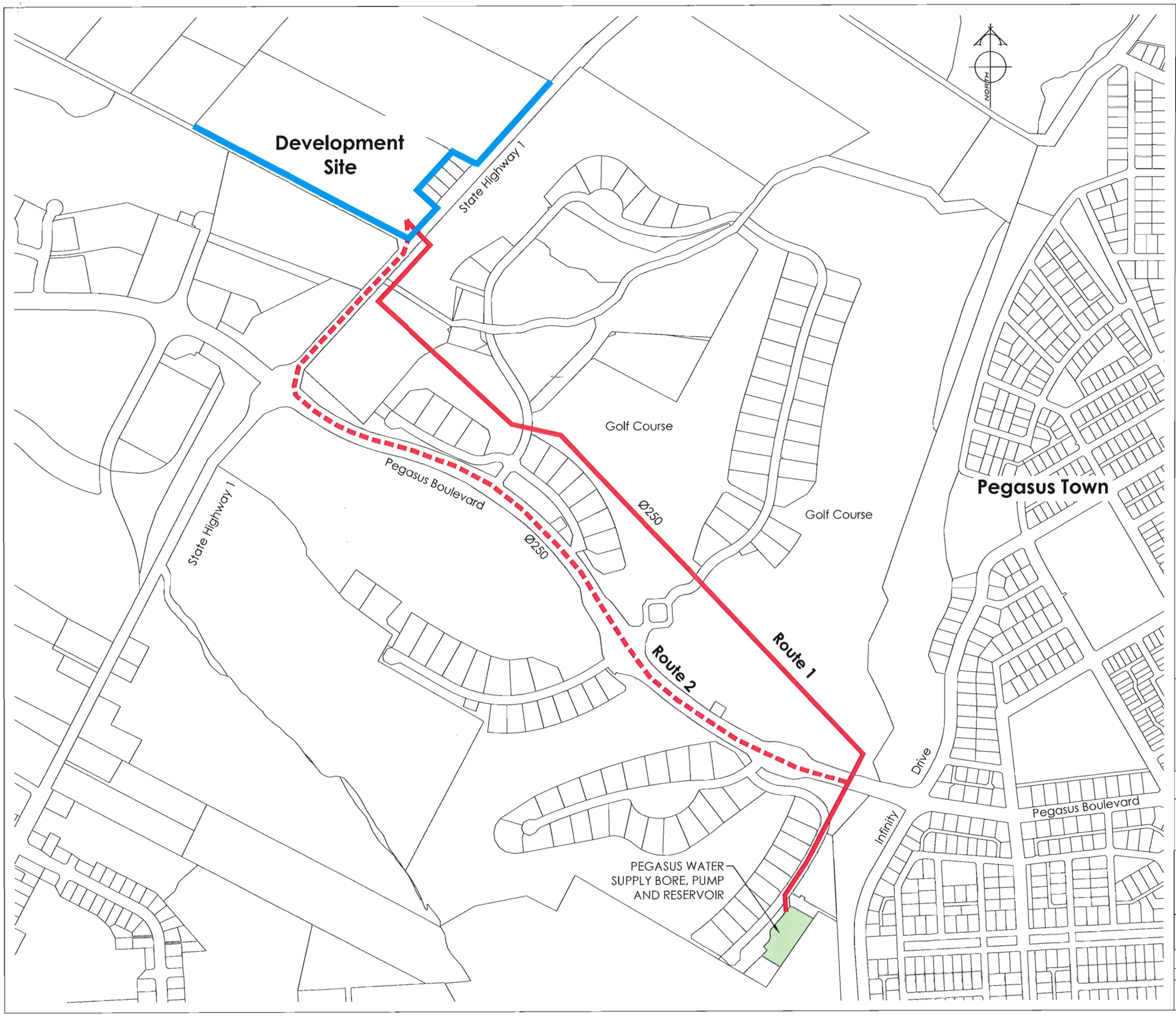
WAIMAKARIRI DISTRICT COUNCIL

Woodend Pegasus Water Supply
50 YEAR GROWTH PROJECTS
ALL WORKS

SCALE (A4)
1:35,000

DATE
29/09/2020

Appendix E – Potential Water Supply Routes



AMENDMENTS :

AMENDMENT	DATE	DESCRIPTION

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SHEET TITLE :
Potential Water Supply

DRAWING STATUS
For Discussion Purposes

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CAD FILE : J:\20605\Eng\E20605 Route B.dwg	DRAWN : GC
DRAWING No : E20605	SHEET No : 1
	REVISION:

Appendix F – Potential Wastewater Pumping Routes

AMENDMENTS :		
AMENDMENT	DATE	DESCRIPTION

Waikuku

NORTH

State Highway 1

Gressons Road

Stokes Road

Waikuku Treatment Plant

Route A1

Development site

Route A2

Kaiapoi Pa Road

Route A3

Pegasus Town

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JOB TITLE :

Westside Country
Waikuku Development

SHEET TITLE :

Potential Sewer
Route A

DRAWING STATUS

For Discussion Purposes

SCALE : 1:7500@A3	DATE : October 2021
CAD FILE : J:\20605\Eng\E20605 Route A.dwg	DRAWN : GC
DRAWING No : E20605	SHEET No : 1
	REVISION:

Development Site

State Highway T

Golf Course

Golf Course

Pegasus Boulevard

Route B1

Route B2

Drive

Infinity

Pegasus Boulevard

Pegasus Town

Gladstone Road

Woodend Waste Water Treatment Plant

Gladstone Road

AMENDMENTS :

AMENDMENT	DATE	DESCRIPTION

DAVIE LOVELL-SMITH

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JOB TITLE :

Westside Country
Waikuku Development

SHEET TITLE :

Potential Sewer
Route B

DRAWING STATUS

For Discussion Purposes

SCALE : 1:7500@A3	DATE : October 2021	
CAD FILE : J:\20605\Eng\E20605 Route B.dwg		DRAWN : GC
DRAWING No : E20605	SHEET No : 1	REVISION :

APPENDIX 9

MARKET ECONOMICS – ECONOMIC ASSESSMENT

Proposed Stokes-Waikuku Residential Growth Area

Preliminary Assessment

22 November 2021

m.e consulting

Proposed Stokes-Waikuku Residential Growth Area

Preliminary Assessment

Prepared for:

Westside Country Limited

Document reference: Waikuku Futures – Preliminary View Draft Final.docs

Report author: Douglas Fairgray

www.me.co.nz

Disclaimer: Although every effort has been made to ensure accuracy and reliability of the information contained in this report, neither Market Economics Limited nor any of its employees shall be held liable for the information, opinions and forecasts expressed in this report.

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3. GROWTH CONTEXT 2

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1. Objective

This Paper examines the development prospects for the Stokes-Waikuku land north of Ravenswood in Waimakariri District.

2. Development Potential

The area for potential urbanisation is approximately 144 ha, north of Ravenswood. Figure 2.1 shows the draft outline development plan and context, while Figure 2.2 shows the overall holding and boundaries.

Figure 2-1: Draft Outline Development Plan

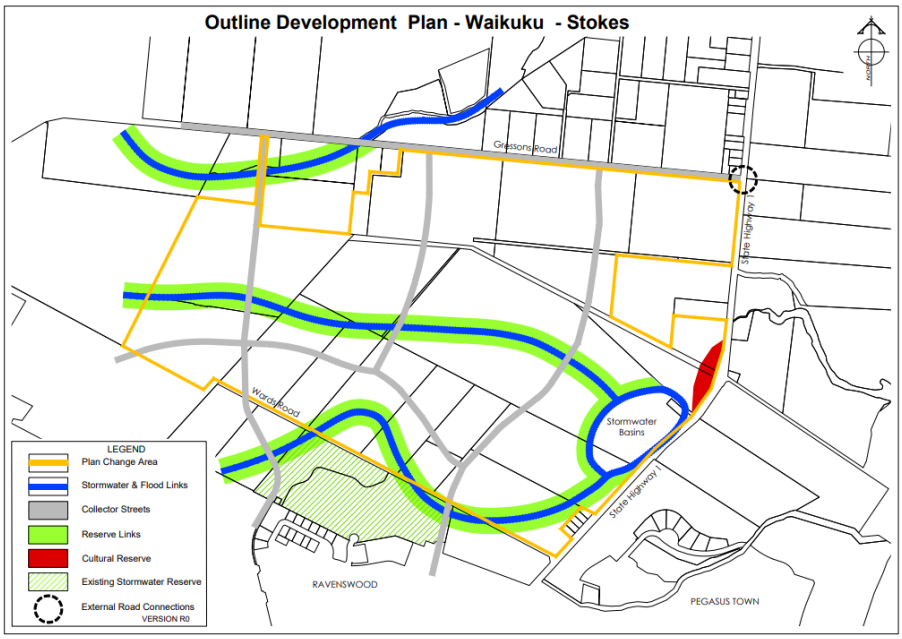


Figure 2-2: Westside Country Limited Holding and Layout

This is a substantial land area. Taking into account requirement for roading and open space and community facilities, which commonly account for 30% of total "raw" land area, that would leave about 100ha of housing land (that is 144 ha x 70% = c100 ha useable land).

Indicatively, this area could yield between 1,200 dwellings (@ 12 dwellings/ha) and 1,500 dwellings (@ 15 dwellings/ha).

3. Growth Context

This scale and implied residential capacity mean this is a quite substantial proposal in the District context.

Household Growth

Substantial population and business growth is anticipated in Waimakariri District over the next 3 decades, continuing the strong gains observed over the last 20 years. Since 2001, the District population has increased by 28,400 persons (75%), to its current 66,300 in 2021 (StatisticsNZ), at a rate of 2.8%pa. Importantly, that growth has been consistent, with growth at 2.9%pa in the 2011-21 period.

The Waimakariri 2048 District Development Strategy (Our District, Our Future) prepared in July 2018 identifies substantial growth prospects for the District over the next 30 years. The medium growth future would see an additional 6,060 households over the next decade (600 pa), while the high growth future would see 6,900 households (690 pa). Longer term to 2050, the outlook is for 10,600 households in the medium growth future (350 pa) and 17,200 more households in the high growth future (570 pa). The projected growth indicates ongoing substantial increases beyond 2030, with 290 pa under the medium growth future, and 520 pa under the high.

Adopting the NPSUD assumption of one dwelling per resident household, these projections indicate demand for 6,000 to 6,900 additional dwellings over the next decade, and 10,600 to 17,200 additional dwellings into the longer term.

While there is some potential for additional housing capacity through infill and re-development of established sites, a substantial share of the future growth – potentially more than 75% - will need to be accommodated through development of greenfield land. The strategy[1] notes that "*intensification opportunities will be explored within areas of Rangiora, Kaiapoi, and Woodend/Pegasus.*"

Growth Strategy

Much of the household and housing growth is expected in and around Rangiora town, the District's main population centre. While growth is likely to occur across many areas of the District, including through rural-residential development, there is clear focus on the existing urban network, including to the east of Rangiora in the Ravenswood-Woodend-Pegasus Bay area. This sees the growth strategy focused on expansion of established towns and settlements, with new urban growth areas to be integrated into the Council's existing reticulated infrastructure networks. The overall pattern is indicated in Figure 3.1 (Figure 5 from the strategy), reproduced below.

[1] Waimakariri 2048 District Growth Strategy, WDC, 2020.

The main town centres of Rangiora and Kaiapoi will be enhanced and expanded, a main centre for Woodend/Pegasus is proposed at North Woodend (Ravenswood KAC) and other centres will continue to be supported. This strategy will have a number of key elements, including that it will provide for anticipated growth, will achieve a sustainable urban growth pattern, it will support existing towns, support the efficient provision of infrastructure, provide for community facilities to match community needs, and protect and enhance the District economy.

Figure 3-1: Waimakariri District Greenfield Priority Areas and Infrastructure Boundary

Figure 3.2 offers closer focus, showing the indicative growth strategy for Woodend-Pegasus.

Figure 3-2: Indicative Growth Strategy Woodend - Pegasus

The subject land is firmly in the proposed growth path for Woodend and is therefore considered appropriately located. Figure 3-3 shows the draft outline development plan (Figure 2-1) overlain on the Indicative Growth Strategy (Figure 3-2). With the Ravenswood centre zoned at the northern edge of current residential zoning, development of the subject land will place the KAC in the centre of a residential catchment.

Figure 3-3: Development Context (Approximate)

Issues

It is important to understand the development potential in this context. Figure 3-4 shows the indicative demand for additional dwellings in the District, in relation to the capacity on the development area, at 1,200 dwellings and 1,500 dwellings.

Figure 3-4: Proposed Development Context (Approximate)

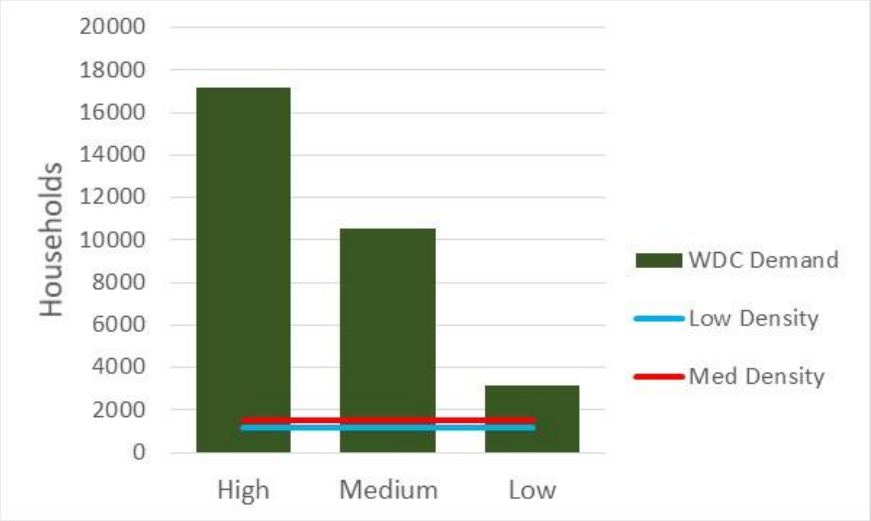


Table 3-1 shows the indicative capacity as a share of projected growth over the period. In the high growth future, the 1,200 to 1,500 dwelling capacity would provide for 7% to 9% of future demand. In the medium growth future, the development would accommodate a larger share, at 11% to 14% of the District total.

Table 3-1: Development Capacity as a Share of Projected Growth

WDC Growth Scenario	Low Density	Med Density
High	7%	9%
Medium	11%	14%
Low	38%	48%

The development would accommodate a material share of the District's total demand. Important trade-offs relate to the enabled scale of growth and the timing of that enablement. If enablement is significantly earlier than anticipated demand, then key trade-offs are between the higher development costs which arise from funding and financing infrastructure in advance of its take-up, compared with any effect on housing prices from potential competitive effects of providing wider choice to the market, and potentially greater supply relative to demand. These matters need to be addressed in that wider context.

Context and relativity are important considerations. Simply put, assuming there is sufficient capacity for housing development in the short-medium term without the subject land being released to the market,

that indicates the market would already be relatively competitive. If there is otherwise a shortfall, then the subject land would be expected to have some effect on prices. That said, the main share of growth, including greenfield, is expected to be around Rangiora, and Kaiapoi. This land would represent a limited share of the District market, which suggests it would have limited ability to affect land prices.

With the location being generally suitable for urban expansion and anticipated by the growth strategy, that would indicate the timing of its enablement and release might be guided more by the effects on infrastructure and infrastructure costs, as distinct from its ability to have a material "supply-side" downward effect on prices. That said, it would depend on the total capacity available, including this land, relative to supply.

Further work is recommended to understand the notified changes proposed to the District Plan and how these changes are likely to impact the capacity of existing zoned areas. Such changes may also be relevant for the future dwelling yield of the proposed development area and may influence the relative contribution of the proposed land in the wider context. Given the proximity to the Ravenswood centre, benefits of the proposed development area in supporting the viability and vibrancy of that centre could also be explored.

APPENDIX 10

STANTEC – TRANSPORT ASSESSMENT

Waikuku Residential Rezoning

Transport Assessment Report

PREPARED FOR WESTSIDE COUNTRY LTD | NOVEMBER 2021

We design with community in mind

Stantec

Revision Schedule

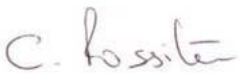
Rev No	Date	Description	Signature or Typed Name (documentation on file)		
			Prepared by	**Reviewed by**	**Approved by**
A	23/11/21	For WDC Plan Submission	C Rossiter	A Metherell	A Metherell

This Transport Assessment Report was prepared by Stantec New Zealand ("Stantec") for the account of Westside Country Limited (the "Client"). The material in it reflects Stantec's professional judgment in light of the scope, the Client's brief (if any) and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published. In preparing the document, Stantec may have relied on information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. No liability is accepted by Stantec or any employee or sub-consultant of Stantec with respect to its use by a third party.

Quality Statement

Project Manager	Project Technical Lead
Kyle Martin	Chris Rossiter

PREPARED BY

Chris Rossiter  25 / 11/ 2021

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Abbreviations

Abbreviation	Full Name
AADT	Annual Average Daily Traffic Volume
CTM	Christchurch Transport Model
LOS	Level of Service
ODP	Operative District Plan
PDP	Proposed District Plan
SH1	State Highway 1
Vpd	Vehicle movements per day
Vph	Vehicle movements per hour
Waka Kotahi	Waka Kotahi New Zealand Transport Agency
WDC	Waimakariri District Council

Glossary

Term	Definition
Level of Service	Level of Service is a qualitative stratification of numerical performance measures to provide a simplified system to present road users' perceptions of the quality of service of a road or intersection.
LOS A	A condition of free-flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.
LOS B	In the zone of stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is a little less than with level of service A.
LOS C	In the zone of stable flow but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.
LOS D	Close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.
LOS E	Traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause breakdown.
LOS F	In the zone of forced flow, where the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result.

1 Introduction

Waimakariri District Council (WDC) has recently notified its Proposed District Plan (PDP). Westside Country Limited is seeking rezoning of approximately 140ha of land between Gressons Road south of Waikuku and Ravenswood from rural to residential to enable construction of 1,000-1,500 new houses. This report provides an assessment of the potential transport effects of residential development of this scale on the surrounding transport network.

Figure 1-1 shows the location of the proposed residential zoned land within the wider context of the Waimakariri district. Rangiora is located about 7 km to the west by road with Kaiapoi about 9 km to the south. Christchurch is about 26 km to the south.

Figure 1-1: Site Context (Source: Canterbury Maps)

Figure 1-2 shows the site location on the western side of State Highway 1 (SH1). The site is bounded by Gressons Road to the north, the Ravenswood subdivision to the south and rural land to the west. Pegasus township is located to the southeast, and Woodend is to the south of Ravenswood.

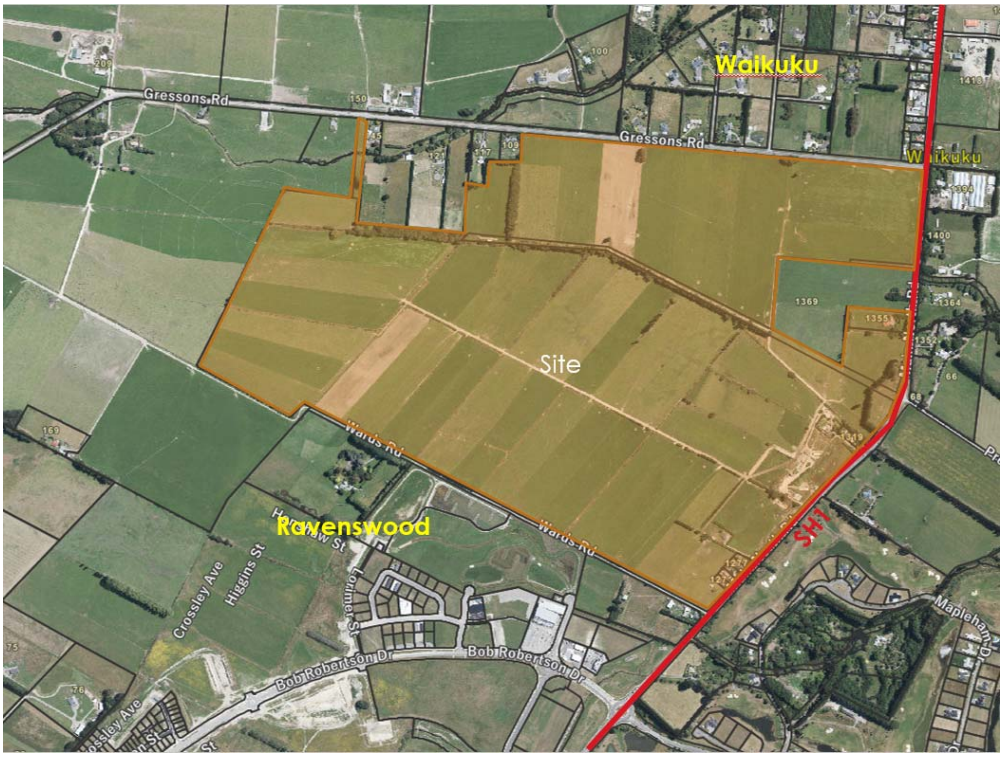

Figure 1-2: Site Location (Source: Canterbury Maps)

2 Transport Environment

2.1 Road Hierarchy

Figure 2-1 shows the WDC road hierarchy within the PDP. SH1 is classified as a strategic road and forms the main north-south link connecting towns along the east coast of the South Island. State Highway 71 (SH71) which links Kaiapoi and Rangiora is also classified as a Strategic Road

Rangiora Woodend Road links Woodend with Rangiora and is classified as an Arterial Road. Gressons Road and Bob Robertson Drive are classified as Collector roads.

Bob Robertson Drive meets SH1 at a roundabout intersection with Pegasus Boulevard which forms the primary road connection to Pegasus to the east.

Figure 2-1: WDC Road Hierarchy (Source: Waimakariri District Council)

2.2 Transport Infrastructure

2.2.1 Existing Roads and Intersections

SH1 has been constructed as a two-lane, rural highway north of the Ravenswood roundabout. The sealed carriageway comprises two 3.5 m wide traffic lanes and 1-1.5 m wide shoulders as shown Figure 2-2. The speed limit on SH1 is 80 km/h between Woodend and Waikuku and is 60 km/h within Waikuku.

Gressons Road which forms the southern boundary to the Waikuku residential area meets SH1 at a Stop sign controlled intersection. SH1 has been widened at the intersection to include a right turn bay as shown in Figure 2-3. Gressons Road has a 6.9 m wide sealed carriageway with marked centre line and edge lines. The speed limit on Gressons Road is 80 km/h.

Figure 2-2: SH1 South of Waikuku - View South

Figure 2-3: SH1 - Gressons Road intersection (Source: Google Earth)

Bob Robertson Drive forms the primary road through the Ravenswood development and connects SH1 with Rangiora-Woodend Road. It has been constructed as a median divided road and meets SH1 at a two-lane roundabout intersection with Pegasus Boulevard to the east.

2.2.2 Woodend Bypass

Figure 2-4 shows the designation of the Woodend bypass. At its northern limit, it will link with SH1 at the Pegasus / Ravenswood roundabout. It rejoins the current SH1 alignment at the SH1 / Williams Street

intersection at the northern end of Kaiapoi. The bypass will reduce traffic volumes travelling through Woodend.

Gladstone Road and Woodend Beach Road provide connections from SH1 to land to the east of SH1 and Woodend. The designation plans indicate that both roads will cross the bypass at bridges and have no connections to the bypass.

Figure 2-4: Woodend Bypass Designation (Source: Waimakariri District Council)

While the designation for the bypass has been agreed, funding for construction has not been approved and Waka Kotahi have previously indicated it is unlikely that it would be constructed before 2031.

2.3 Development Areas

Figure 2-5 shows the anticipated roads within the Ravenswood area and also a large lot development area south of Gressons Road.

The Ravenswood development largely comprises residential development on both sides of Bob Robertson Drive. A commercial zone is located at the northern end of Ravenswood north of Bob Robertson Drive and west of SH1. The existing development within the zone includes a supermarket, service station, fast food outlet which are accessed from a roundabout about 200m west of the SH1 roundabout.

The large lot residential area would allow for about 65 lots to be formed with an average lot size of 5,000 m^2.

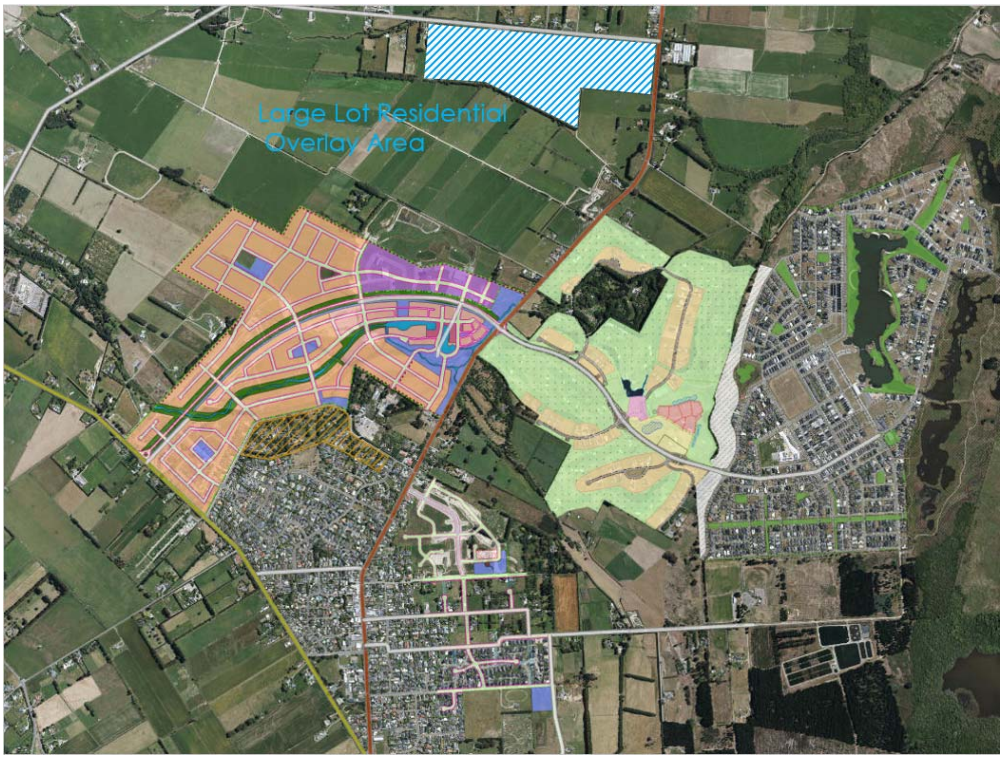

Figure 2-5: PDP Development Areas (Source: Waimakariri District Council)

An Operative Plan Change seeking a Key Activity Centre and expanded business zone in Ravenswood has recently been considered by Council. The commissioner decision raised some concerns with retail distribution effects and the detail of the ODP provisions, which led to a recommendation to decline. The Plan Change is within the appeal period at the time of preparing this report and has not been allowed for in the assessments that follow.

3 Proposed Residential Zone

3.1 Outline Development Plan

Figure 3-1 shows the Outline Development Plan (ODP) for the site. The ODP indicates that four new Collector roads would be constructed. Two of the new roads will provide north-south connections between Gressons Road and Ravenswood while the other two roads would provide a framework for internal movement. It is proposed that the western collector road connects with Lorimer Street and that the eastern collector road connects with Kesteven Place. Both of these roads within Ravenswood meet Bob Robertson Drive at roundabout intersections.

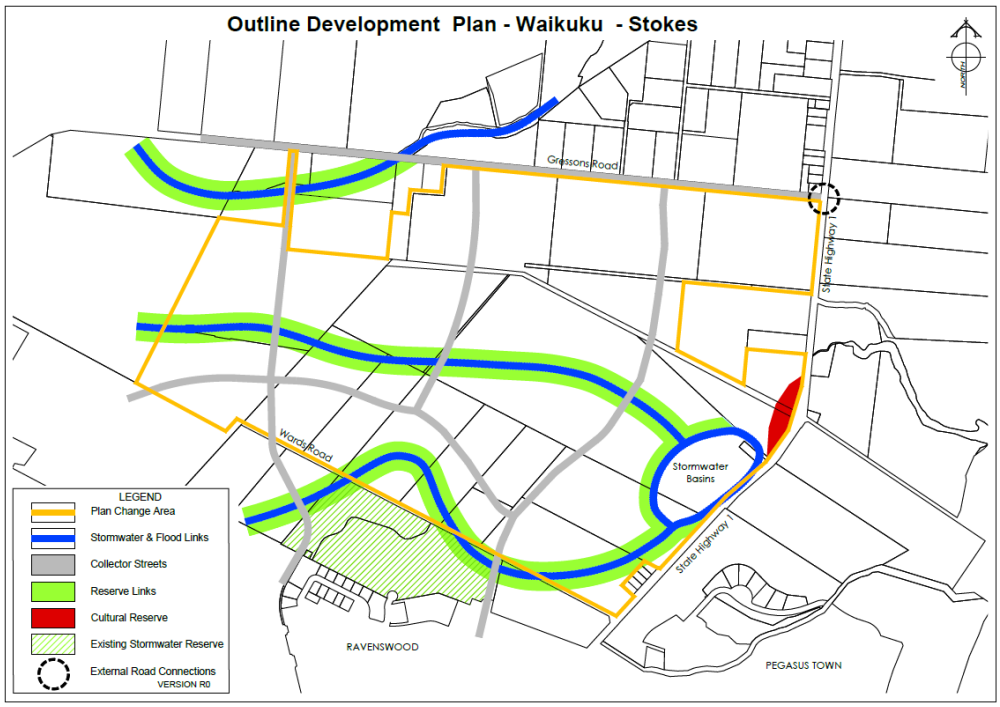

Figure 3-1: Outline Development Plan

It is understood that there is sufficient land after allowing for roads and reserves to develop 1,000-1,500 households depending upon the density of housing. For the purposes of this initial transport assessment, a development potential of 1,500 households has been adopted.

The proposed zone represents an expansion to the Large Lot Residential Area included within the PDP and allows for a higher density of housing than was anticipated by the Large Lot Residential Area.

4 Expected Transport Effects

4.1 Road Network

4.1.1 Assessment Methodology

This assessment of potential transport related effects of the proposed rezoning has been completed using the Christchurch Transportation Model (CTM) v18a which represents the latest available, calibrated model in November 2021. The CTM is a four stage transport model that uses forecast landuse information to estimate travel demands and transport network information to estimate how the travel demands will be distributed on the network.

For this assessment, a variation to the model has been developed that includes two of the proposed new roads within the residential zone, the western collector road linking Gressons Road with Lorimer Street in Ravenswood and the eastern collector road linking Gressons Road with Kesteven Place. Two new zones have been introduced to represent the land use and to distribute the forecast travel demands across the new roads.

This initial assessment has been based on residential development only occurring within the zone with no provision for new employment opportunities or schools. Table 4-1 provides a summary of the 2048 forecast households, population, school capacity and employment in terms of jobs for Ravenswood, Pegasus and the proposed zone, which would reflect full development.

Table 4-1: CTM v18a 2048 Landuse Forecast for 2048

Zone	Households	Population	Primary Schools (Students)	Secondary School (Students)	Employment (Jobs)
Ravenswood	2,000	5,100	0	0	400
Pegasus	1,400	3,900	740	0	120
Proposed Zone	1,500	4,200	0	0	0

4.1.2 Modelling Results

An assessment year of 2048 has been adopted to provide a realistic timeframe for full development of the proposed land and because this model forecast year includes the Woodend Bypass. This assessment year sits well beyond the timeframe of the District Plan but enables consideration of long term transport network infrastructure that could be necessary to support development.

It is understood that the CTM landuse file includes development of all zoned land-use development up to 2018. The landuse does not include any new land zoning proposed within the PDP, such that more refined transport modelling would be warranted to understand the time specific network effects.

The use of the model is intended to indicate the long term changes in transport patterns and transport network performance based on a continuation of existing trip making characteristics. As such it is a broad assessment only to understand potential effects of a large residential development south of Waikuku.

Analysis of the 2048 forecast traffic volumes and intersection performance indicates that the road network with the District will broadly be operating with good level of service (LOS), typically LOS B or better. This represents a transport environment with stable flows where drivers have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream.

Table 4-2 shows the change in two hour volumes for the morning and evening peak periods for selected parts of the road network. The largest changes in traffic volumes are expected to occur on Gressons Road to the east of the subdivision, on Bob Robertson Drive north of Rangiora-Woodend Road and on the Woodend bypass. The travel demands on routes to and from Rangiora, Gressons Road and Rangiora-Woodend Road show moderate growth in both the morning and evening peak periods which is likely to reflect the employment opportunities that are available in Rangiora. There are larger increases in the traffic volumes on the Woodend bypass which reflects the high demands for travel to and from Christchurch to the south. Appendix A includes figures showing two hour traffic volumes on all roads within the Woodend / Ravenswood area.

Table 4-2: Two-hour volumes – with and without zone in 2048

Location	AM Peak			PM Peak		
	Without Zone	With Zone	Change	Without Zone	With Zone	Change
Gressons Road East of site	350	550	57%	360	810	125%
SH1 North of Gressons Road	2,700	2,720	1%	3,300	3,060	-7%
SH1 North of Pegasus Rdbt	2,430	2,310	-5%	2,760	2,630	-5%
Woodend Bypass	3,570	4,200	18%	4,120	4,450	8%
Bob Robertson Drive north RW Rd	1,050	1,240	18%	1,670	2,680	60%
Rangiora Woodend Rd west of BR Dr	1,530	1,630	7%	2,830	2,820	0%
Rangiora Woodend Rd east of BR Dr	720	690	-4%	1,550	1,660	7%

Figure 4-1 shows the turning volumes at the Pegasus roundabout in the morning peak in the 2048 base scenario and with the residential zone. The most significant change is the increased demand for the right turn movement from Bob Robertson Drive onto the Woodend Bypass which grows from less than 800 vehicles over the two hour peak period to 1,400 vehicles.

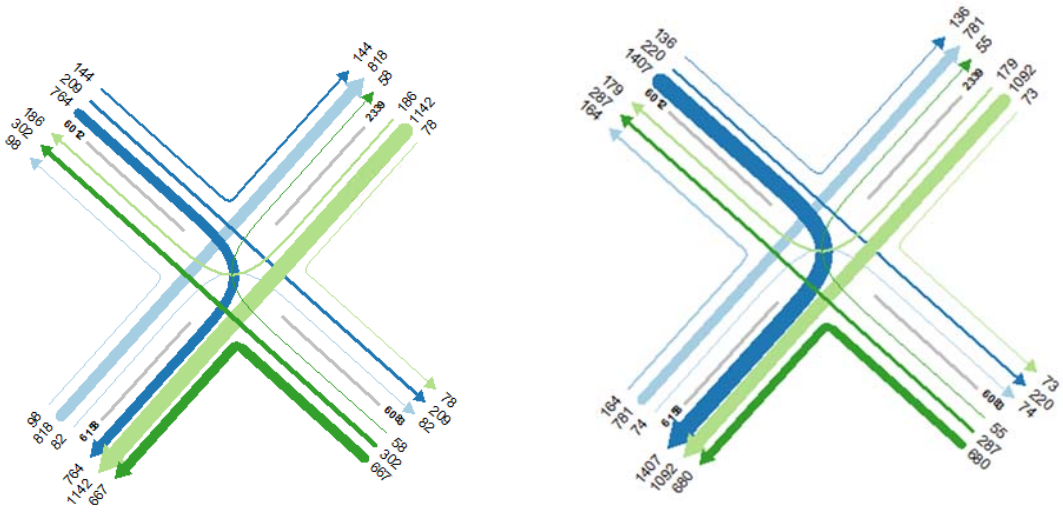

Figure 4-1: AM Peak Turning Volumes at Pegasus Roundabout – base (left) and with zone (right)

Figure 4-2 shows that the increased demand for travel to the south via the Woodend bypass has a large effect on the operational performance of the SH1 / Pegasus roundabout, particularly in the morning peak period. In the morning peak, the additional high demand for the right turn movement from Bob Robertson Drive onto the Woodend Bypass creates forecast delays of several minutes for vehicles departing from Pegasus. All other intersections within the network are expected to continue operating with LOS B or better (see Appendix A for network LOS plots).

Figure 4-3 shows the forecast delays for the evening peak period. In the base scenario, there are delays of 0.6 minutes on Bob Robertson Drive. These increase to 0.8 minutes with the development and also increase the delays on the Woodend Bypass to over one minute.

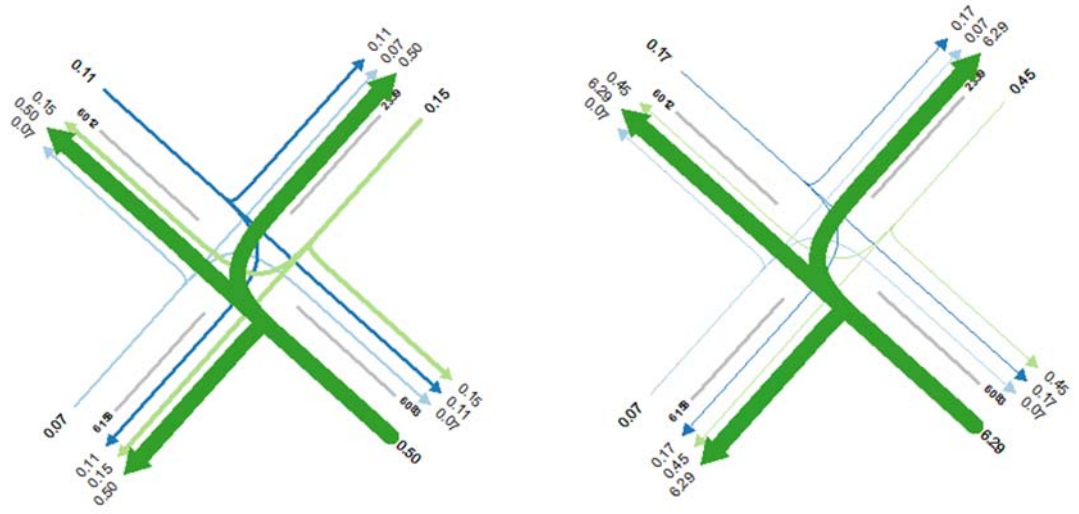

Figure 4-2: 2048 AM Peak Period Delays - Base and Development

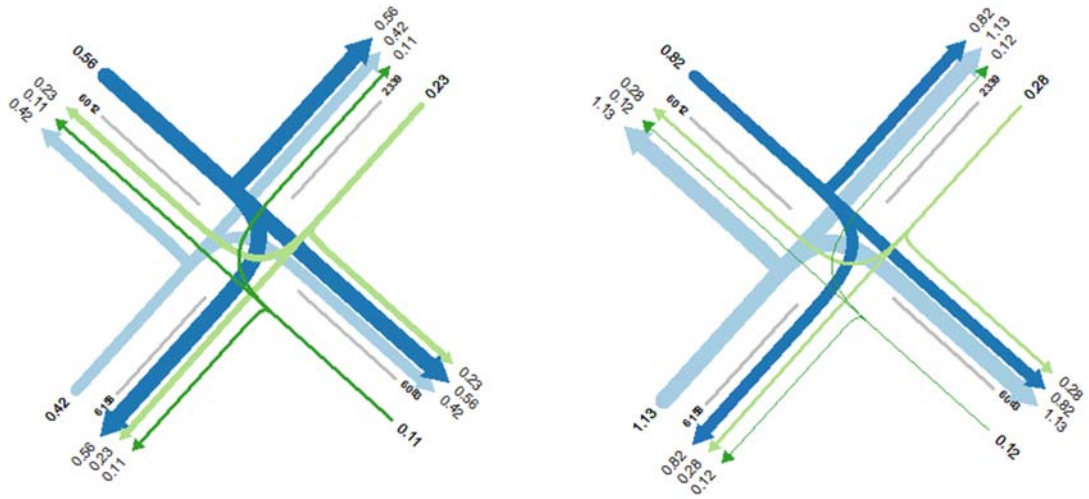

Figure 4-3: 2048 PM Peak Period Delays - Base and Development

The peak hour flows at the roundabout will typically represent about 60% of the two hourly flows. In the morning peak, this means that in the 2048 base scenario, the outbound flows from Pegasus will be opposed by about 1,200 movements and delays will be very sensitive to increases in turning volumes. This is reflected in the forecast growth in delays on that approach from 30 seconds to several minutes. It is noted that this reflects long term growth, and continuation of current trip making characteristics.

Some potential mitigation methods for reducing the forecast increase in delays at the Pegasus roundabout include:

- Reduced density of development in the residential zone;
- Inclusion of employment opportunities or schools with the proposed zone;
- Intersection improvements such as high capacity traffic signals, or roundabout metering;
- Improved access from Pegasus to Woodend Bypass at the intersection, or further south onto the bypass.

Table 4-3 shows the forecast approach delays for the worst approach for four scenarios: the 2048 base with no residential zone, 2048 with 1,500 households in the zone, 2048 with 1,000 households and 2048 with a

connection from Pegasus to the bypass at Gladstone Road. In the morning peak period, the longest delays are on the Pegasus Boulevard Approach while in the evening, the longest delays on the Woodend Bypass. The reduced development scenario indicates that this will reduce the right turn demands from Bob Robertson Drive in the morning which will reduce delays on Pegasus Boulevard. The option of providing a more direct connection to the Woodend Bypass for Pegasus residents shows significant reductions in delays at the roundabout even with the full development of the proposed zone.

Table 4-3: Forecast Approach Delays – Worst Approach

Peak Period	2048 Base	1,500 HH	1,000 HH	1,500 HH and Additional Bypass Link
AM	0.5 min	6.3 min	2.8 min	0.2 min
PM	0.6 min	1.1 min	1.0 min	0.2 min

4.2 Public Transport

Figure 4-4 shows the current public transport routes in the Waimakariri District. There are two regional services that provide connections to Christchurch, Route 1 Rangiora to Cashmere and Route 95 Waikuku to City. Route 97 is a local service that connects Pegusus with Rangiora.

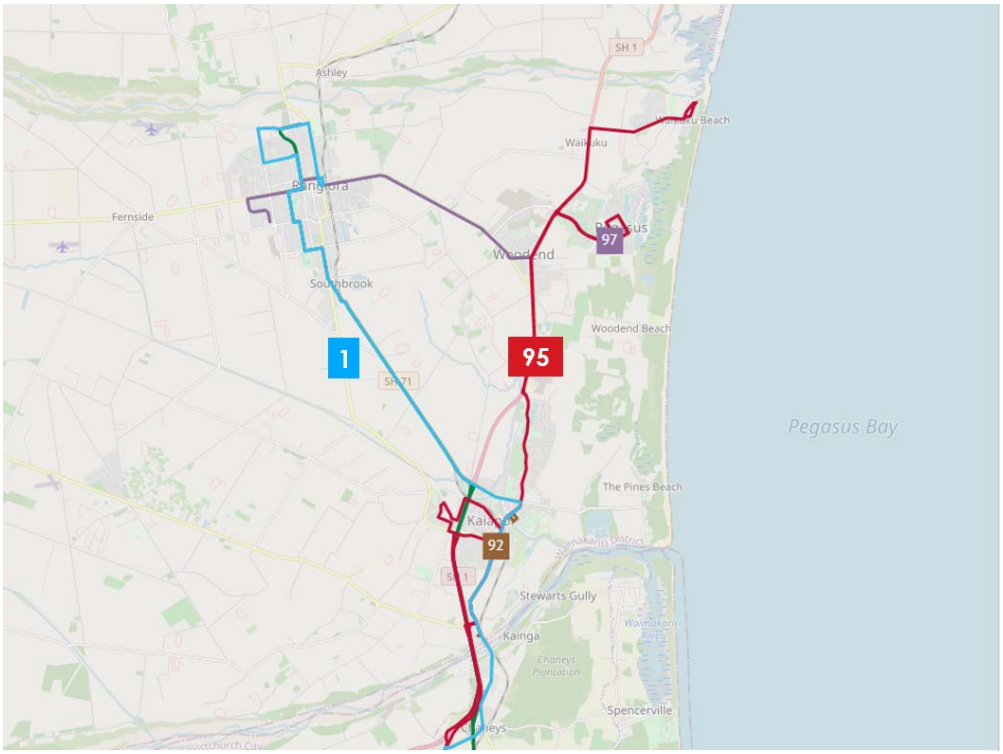

Figure 4-4: Public Transport Routes – 2021

Significant funding has been provided to enhance public transport route provision and frequency in greater Christchurch to increase ridership. Recent developments for the Waimakariri include Park and Ride sites, and a High Occupancy Vehicle lane across the Waimakariri River and into Christchurch.

While there are no published plans for new public transport routes within the Woodend / Waikuku / Pegusus area that would provide connections with Ravenswood or the proposed zone, both Ravenswood and the proposed zone are based on Collector road networks that would enable public transport routes to be developed that would ensure that over 90% of households are located within 400 m of a bus route.

4.3 Active Modes

Figure 4-5 shows the Cycle Route Network set out in the WDC Walking and Cycling Strategy 2017-22. This includes a new cycleway parallel to Rangiora-Woodend Road, which has been constructed. Although the network map does not show on-road facilities, it is understood that the PDP requirements for new Collector roads will provide sufficient width for cycle lanes and off-road cycle paths on designated routes. On that basis, it is expected that the proposed collector road network for the zone will provide safe cycle route connections to the wider cycle network to allow travel to Rangiora or Kaiapoi.

Figure 4-5: WDC Cycle Route Network

5 Proposed District Plan

5.1 Subdivision

5.1.1 SUB-01 Subdivision Design

The proposed residential zone is located between the existing residential areas of Waikuku and Ravenswood. Development of the proposed zone will contribute to linking the two areas in an integrated manner.

It is understood that the large size and generally level nature of the proposed zone does not generate any specific constraints on lot sizes and there are no reasons why a range of housing densities could not be achieved.

Overall, it is considered that the ODP is consistent with this objective.

5.1.2 SUB-02 Infrastructure and Transport

The ODP for the proposed residential zone includes a Collector Road network that will allow local roads to be constructed in a manner that ensures all new dwellings are located within 400 m of the Collector Road network. This will enable more efficient travel through the new network and connection to existing transport infrastructure.

The Collector road network will provide a good basis for developing cycle routes that can connect to the District wide facilities such as the cycle paths to Rangiora and to Kaiapoi.

Gresson Road forms one of the primary connections between SH1 and Rangiora. While the proposed subdivision does not affect the operational performance of the intersection, it has been noted that if an upgrade to the intersection was required in the future, it would not be possible to construct a roundabout on the SH1 centreline without purchasing land to the east of SH1 or on the northwest corner of the intersection. Any new roundabout would need to be constructed with an offset into the residential zone. An initial concept design based on a 30 m diameter island and single circulating lane is shown in Figure 5-1. It is recommended that the ODP for the zone includes some building restrictions so that a roundabout could be constructed in the future if required.

Figure 5-1: SH1 / Gressons Road Roundabout Concept

6 Conclusions

The ODP for the proposed residential zone will provide good connections to the existing classified road network which will enable efficient access to the state highway network and to the surrounding towns. The new roads will enable the development to be integrated with Ravenswood and provide an opportunity to increase links with Waikuku.

The CTM has been used to evaluate at an initial level the likely effects on the road network if the subdivision was developed with 1,500 households with no new employment opportunities or schools in the zone. This represents a worst case scenario as all residents would need to travel outside the zone for work or education. The assessment of the road network in 2048, which includes the Woodend Bypass, shows that while the development has no noticeable effects on the majority of the road network, it will affect the operation of the Pegasus roundabout.

In the morning peak period, the development will increase right turn demands from Bob Robertson Drive onto the Woodend Bypass which will increase the delays for vehicles departing from Pegasus by several minutes. While there are also forecast increased delays in the evening peak, these are of a much smaller scale.

The large demand for southbound travel from the zone is also reflected in the demands from Ravenswood and Pegasus. Mitigation of this demand could be achieved by enabling changes to the landuse in the area to increase local employment and education opportunities.

At a wide area level, the reliance on the Pegasus roundabout as the primary access to Pegasus represents an underlying, contributing factor to the forecast delays. A range of localised improvement options could be contemplated to reduce delays. An additional, more direct connection to the Woodend Bypass has been modelled which indicates that this could provide significant benefits at the roundabout, regardless of whether the proposed zone was approved.

Overall, it is considered that the proposed zone can generally be supported from a transport perspective but that there is a need to investigate further some transport network effects mitigation, possibly in combination with a refinement of the landuse with the zone to include some employment and education opportunity, or through a lower density of development.

Appendices

We design with community in mind

Appendix A Model Results

A.1 Morning Peak Period Traffic Volumes

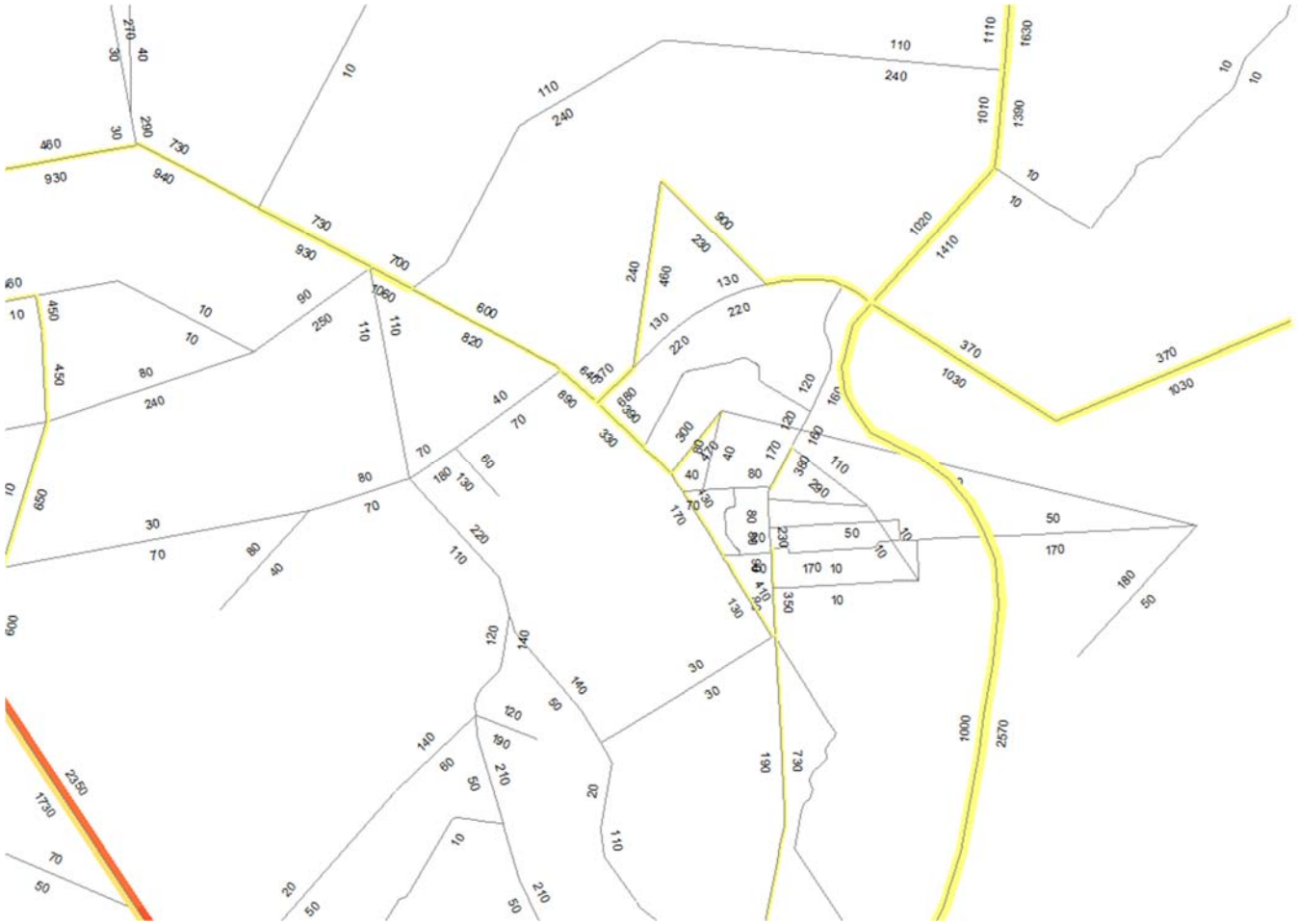

Figure A-1: 2048 AM Base – 2 hour Peak Period Volumes

Figure A-2: 2048 AM Base plus 1,500 Household – Two hour traffic volumes

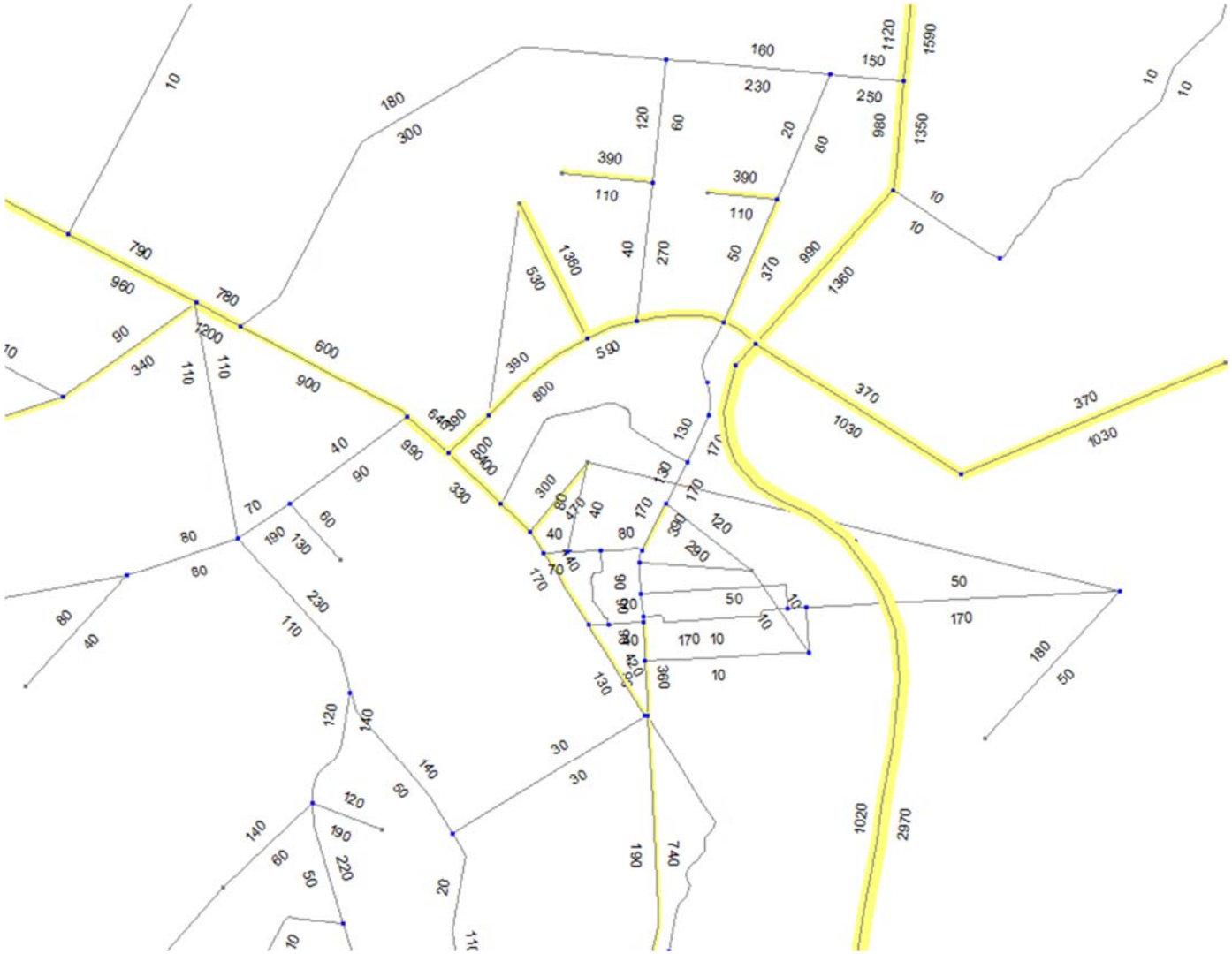

Figure A-3: 2048 AM Base plus 1,000 Household – Two hour traffic volumes

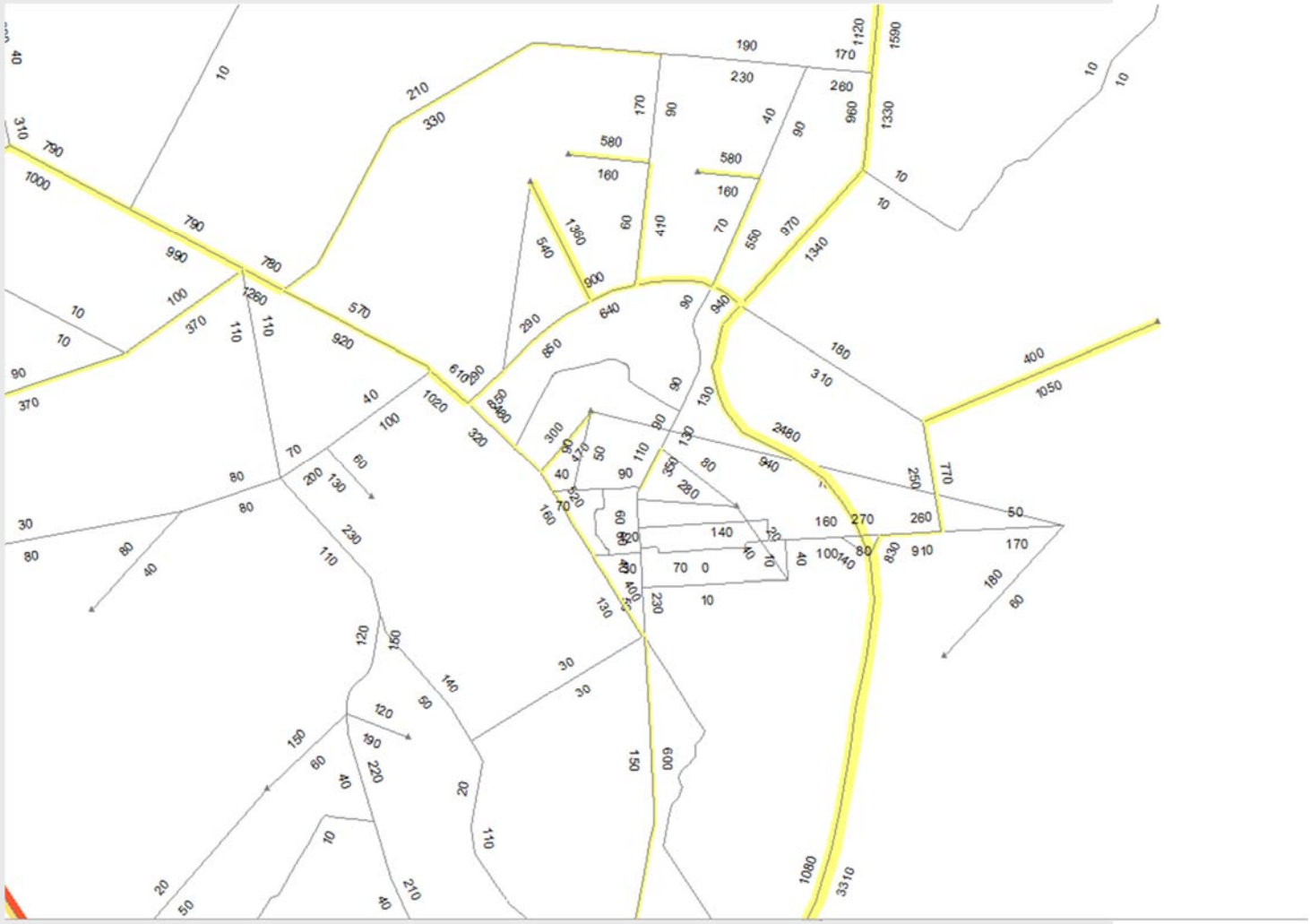

Figure A-4: 2048 AM Base plus 1,500 Household and Gladstone Road connection – Two hour traffic volumes

A.2 Evening Peak Traffic Volumes

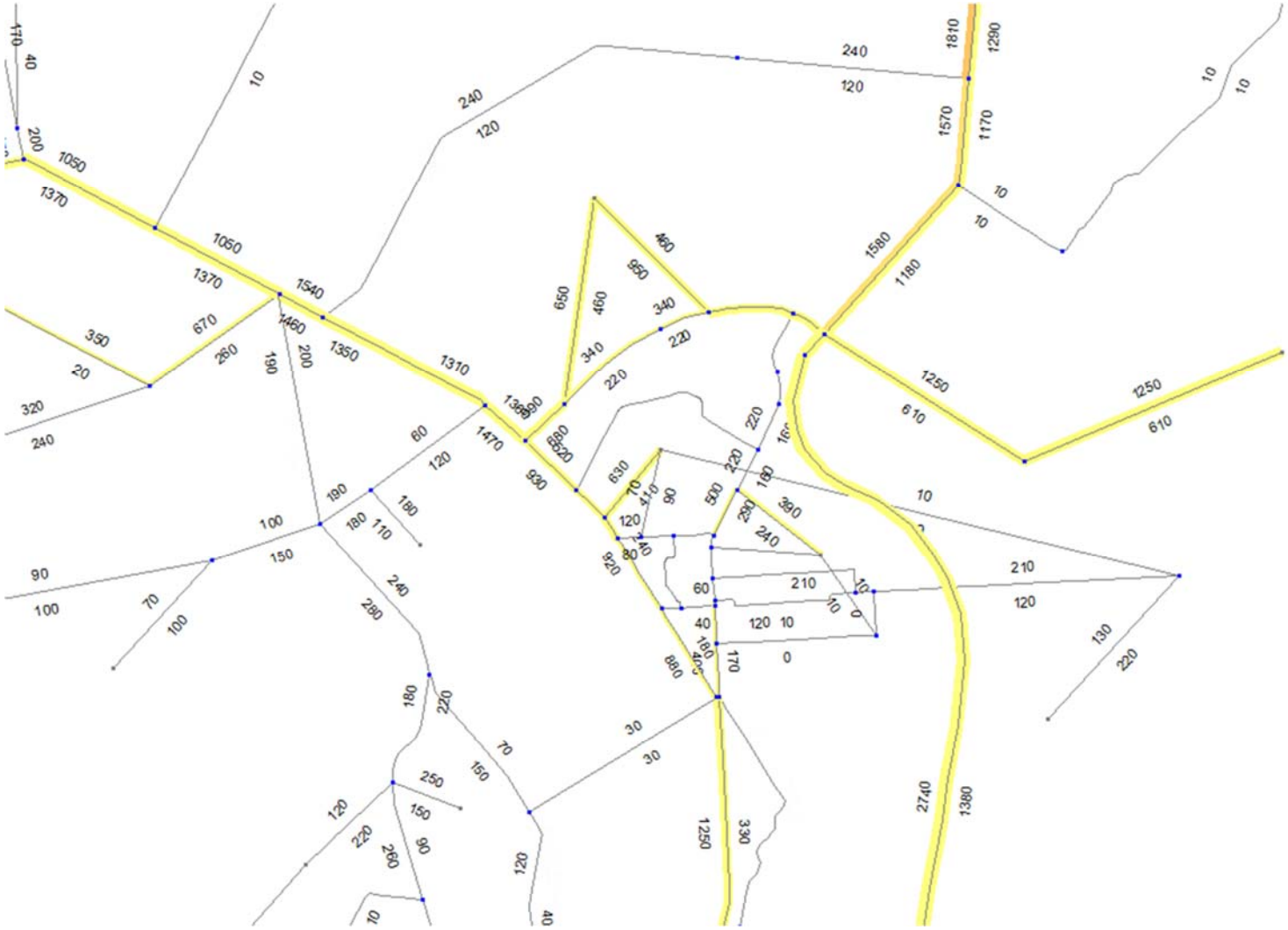

Figure A-5: 2048 PM Base – 2 hour Peak Period Volumes

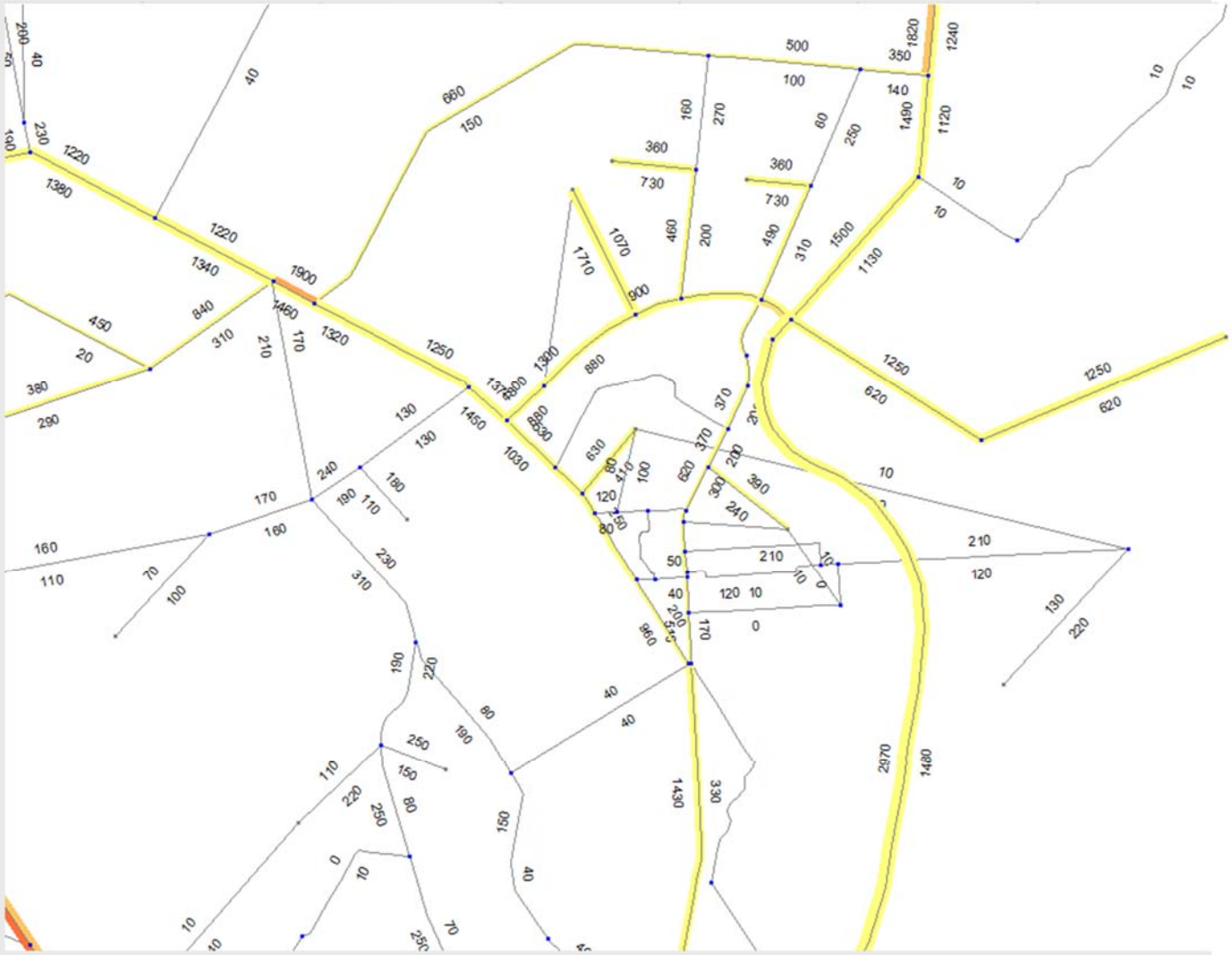

Figure A-6: 2048 PM Base plus 1,500 Household – Two hour traffic volumes

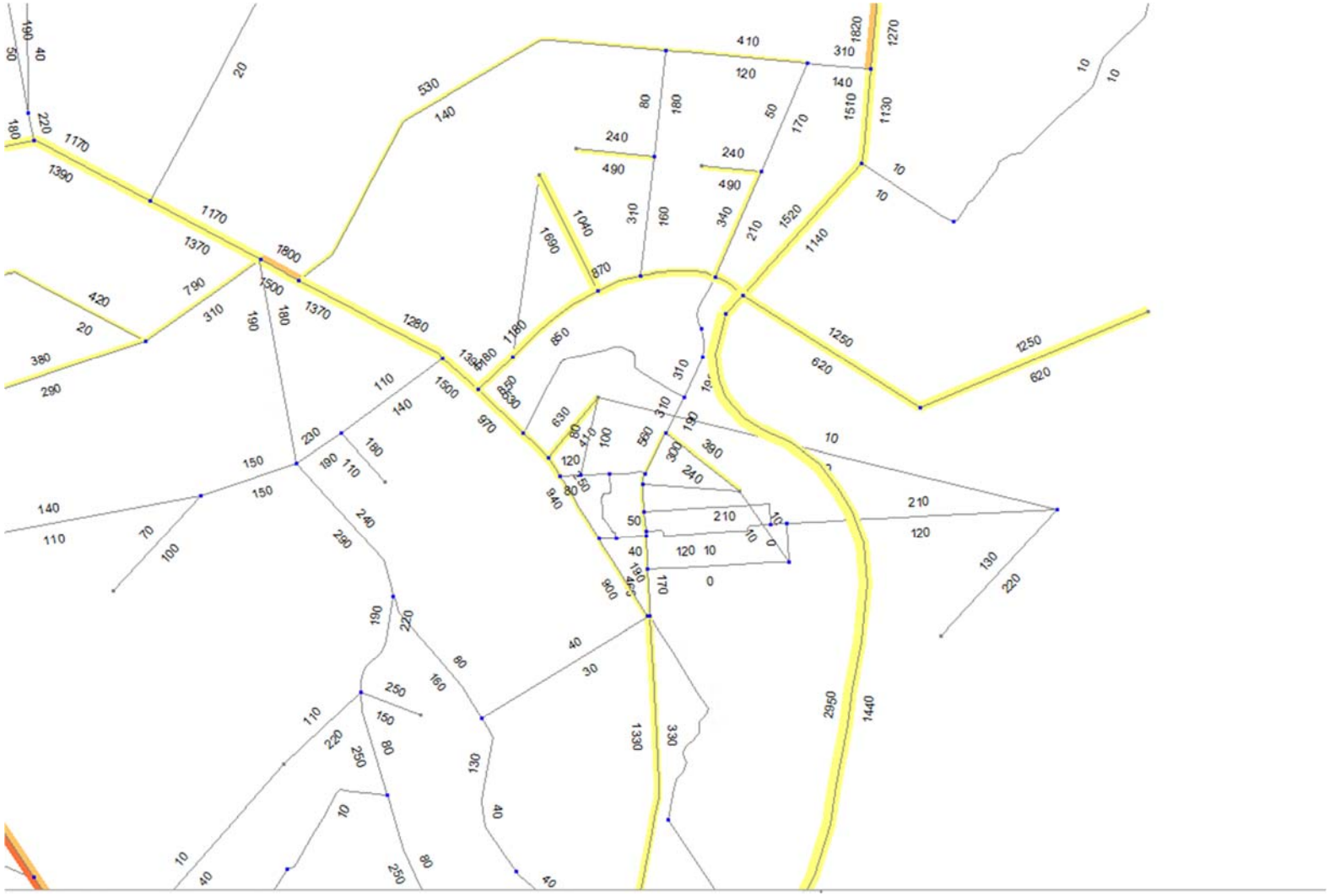

Figure A-7: 2048 PM Base plus 1,000 Household – Two hour traffic volumes

Figure A-8: 2048 PM Base plus 1,500 Household and Gladstone Road connection – Two hour traffic volumes

A.3 Level of Service Plots

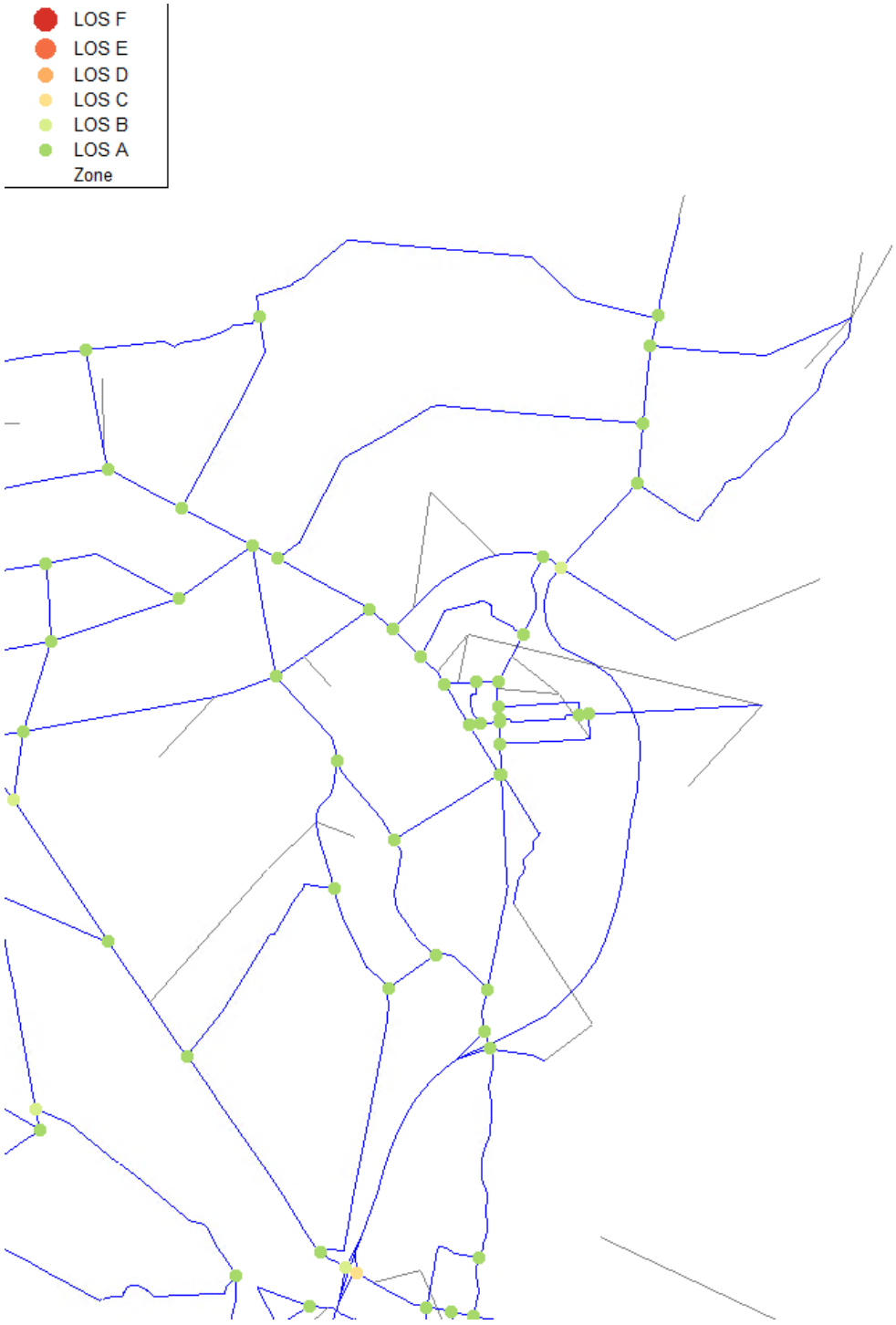

Figure A-9: 2048 AM Base - Levels of Service

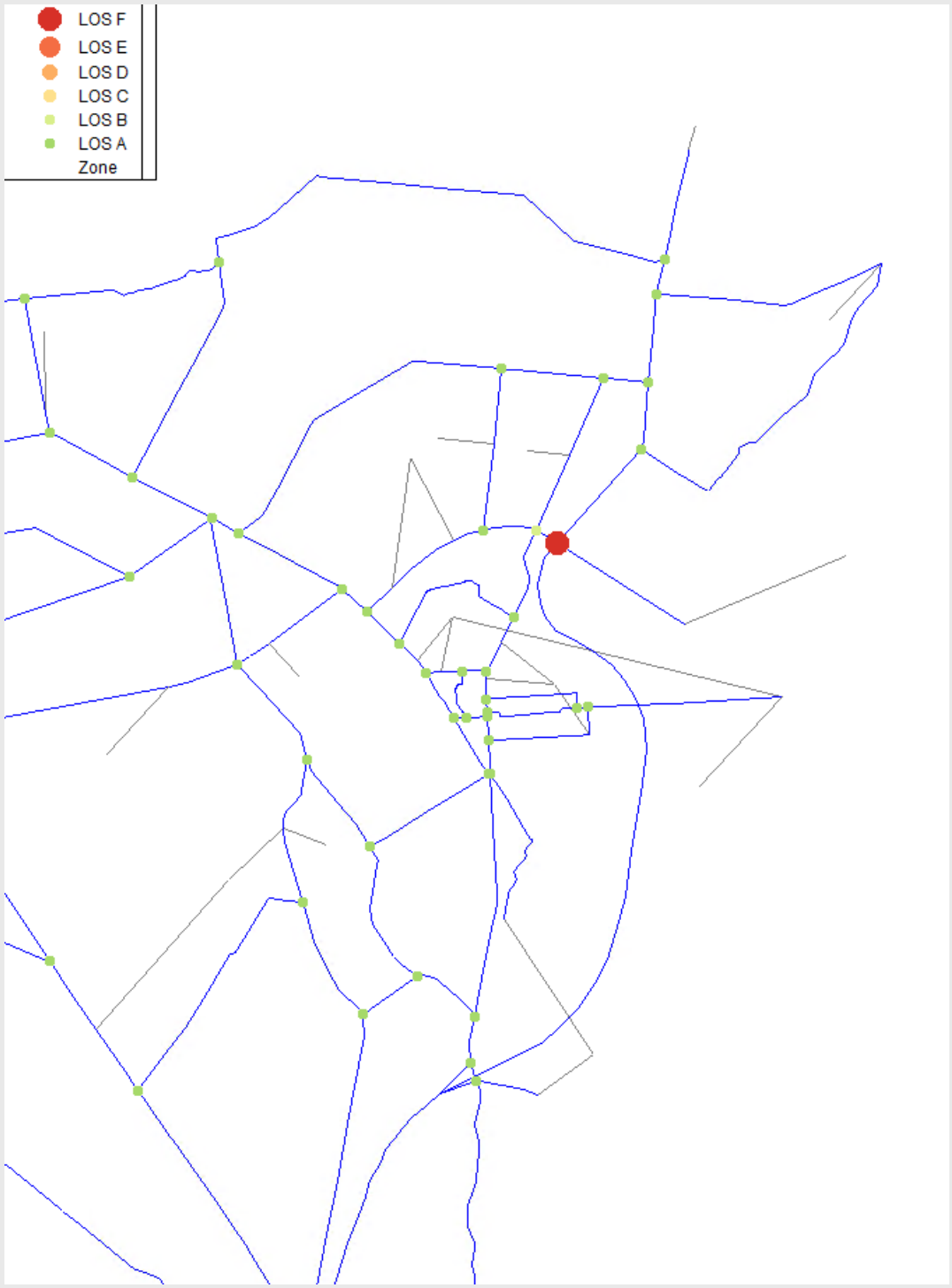

Figure A-10: 2048 AM Base plus 1,500 Households - Levels of Service

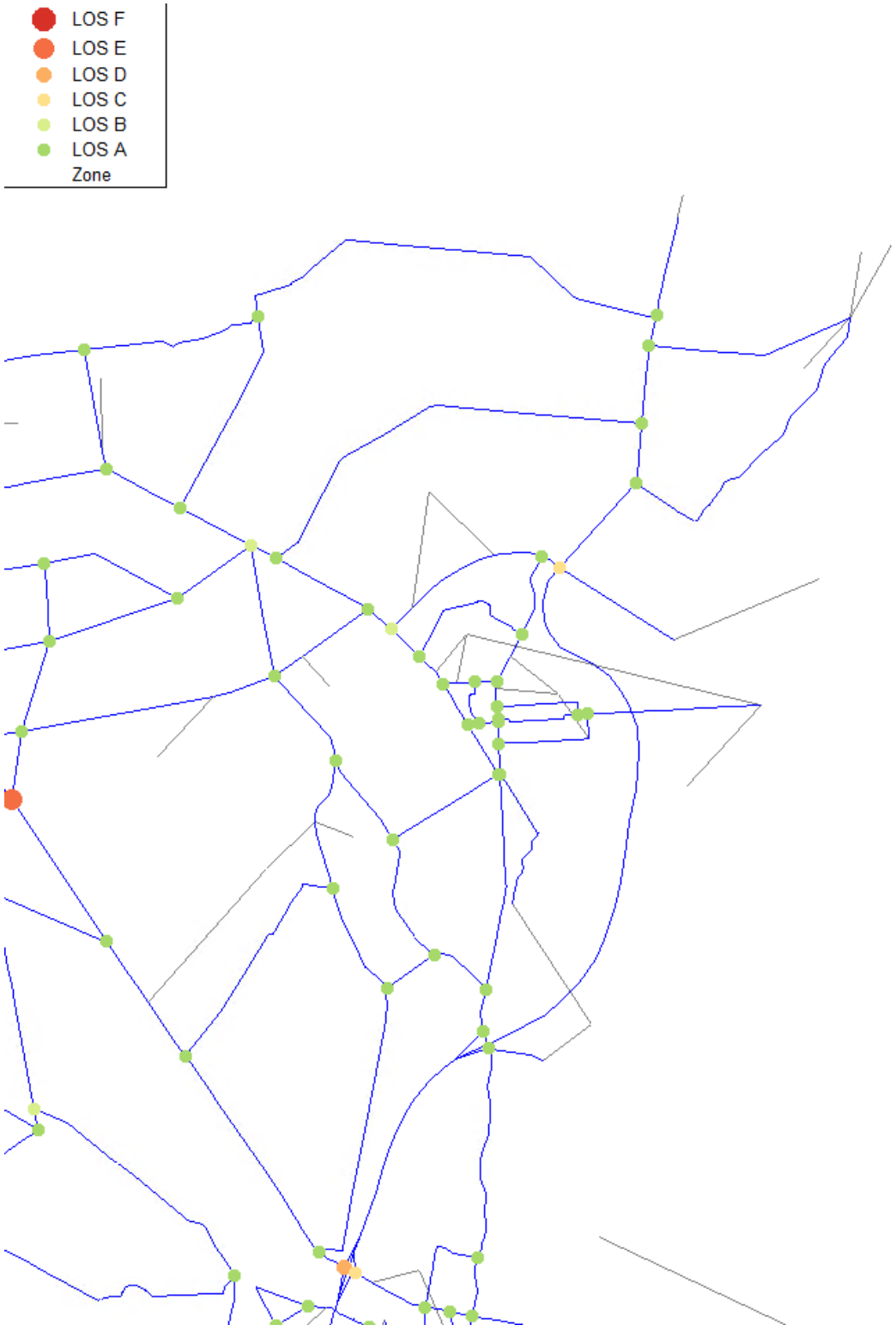

Figure A-11: 2048 PM Base - Level of Service

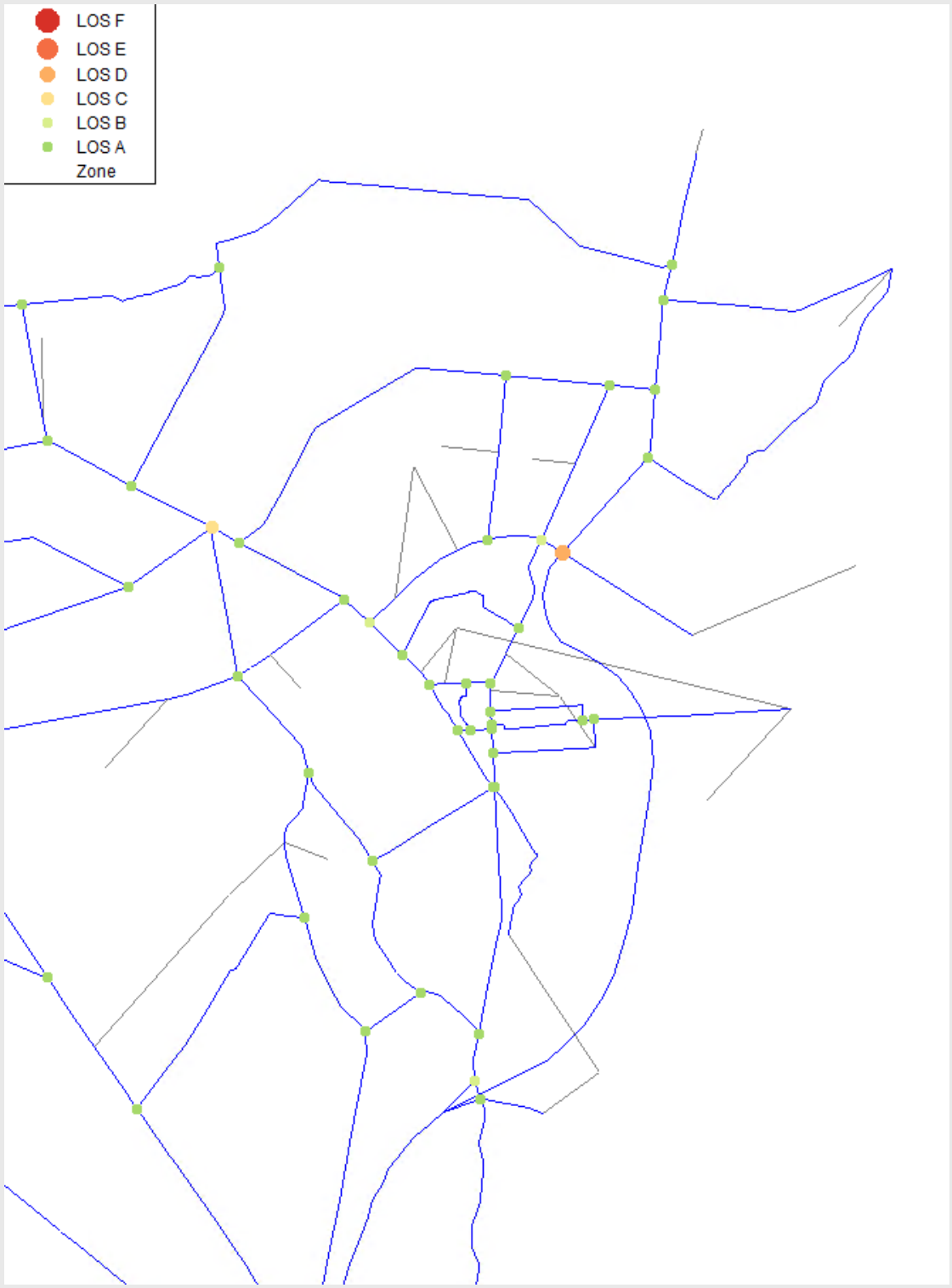

Figure A-12: 2048 PM base plus 1,500 Households - Level of Service

CREATING COMMUNITIES

Communities are fundamental. Whether around the corner or across the globe, they provide a foundation, a sense of belonging. That's why at Stantec, we always **design with community in mind**.

We care about the communities we serve—because they're our communities too. We're designers, engineers, scientists, and project managers, innovating together at the intersection of community, creativity, and client relationships. Balancing these priorities results in projects that advance the quality of life in communities across the globe.

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APPENDIX 11

REEFTIDE – FLOODING ASSESSMENT