Babingtons
CIVIL AND ENVIRONMENTAL CONSULTANTS

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To	Joe Gray – Saddleback Planning
From	Malcolm Todd - Babingtons
Re:	**BUN6044955 395 Fitzgerald Rd – S92 Response**
Date	9 June 2025

Hi Joe,

Please see our response to the request for additional information below

Regional Earthworks Specialist – Steve Bryant

3. The Babington *Infrastructure Report, April 2025*, has a brief section relating to earthworks *(5. Earthworks)*. Whilst the supporting Engineering Drawings provide great detail, the earthworks sediment control methodology is rather brief.
Please update the section, *5. Earthworks,* to describe site specific detail such as how the two sub-catchments will be managed to ensure that both Sediment Retention Ponds (SRP) receive dirty flows from the correct area, whether chemical treatment is proposed for each SRP and clearly define any areas controlled by Silt Fences alone, noting that the combined area controlled by SRPs is ~2,250m2, whereas the total earthworked area is 26,255m^2.

Please see our updated infrastructure report attached with the required additional information.

Stormwater / Industrial Trade Activity Specialist – Dr. Arsini Hanna
4. Please clarify what will be stored within the second warehouse building (e.g. aggregate?)

This will be used to store car parts.

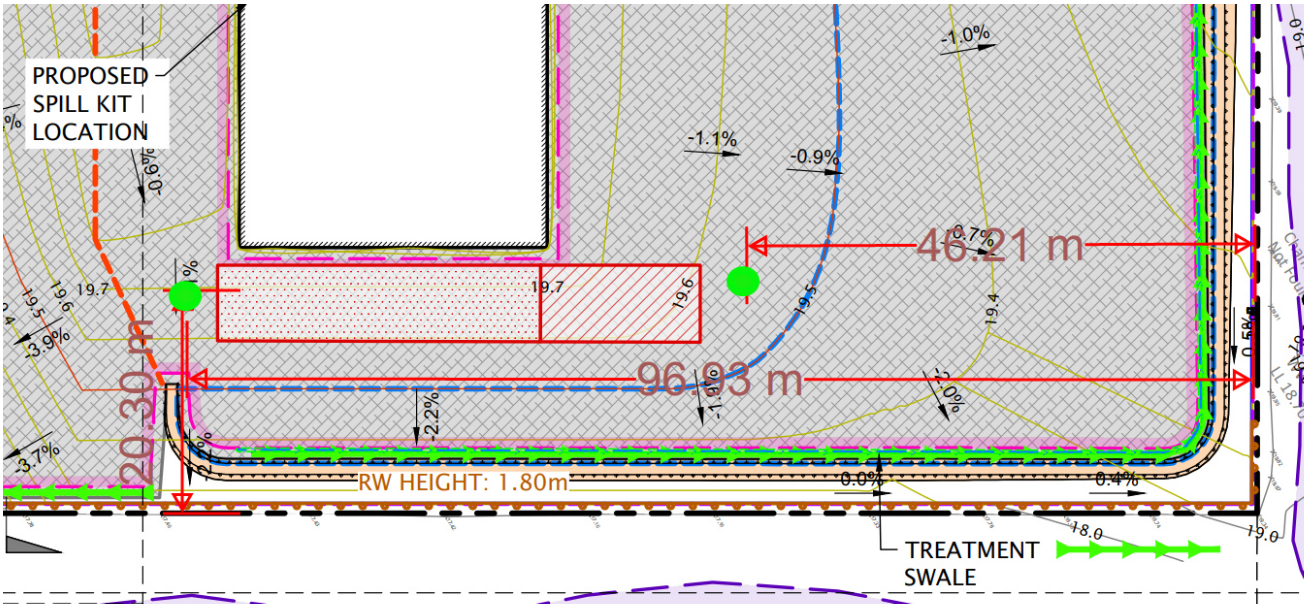
5. Please clarify where on site fuel will be transferred from the vehicles that are to be dismantled into small containers, then into staff vehicles, and where on site these activities will occur, and what mitigation measures are proposal to prevent adverse effects from spilling fuel?
What management procedures will be followed if for example, staff vehicles have a full tank or use different fuel to what has been syphoned from vehicles that are being dismantled?
Where will the fuel be stored on site? At what quantity before the fuel is disposed of?

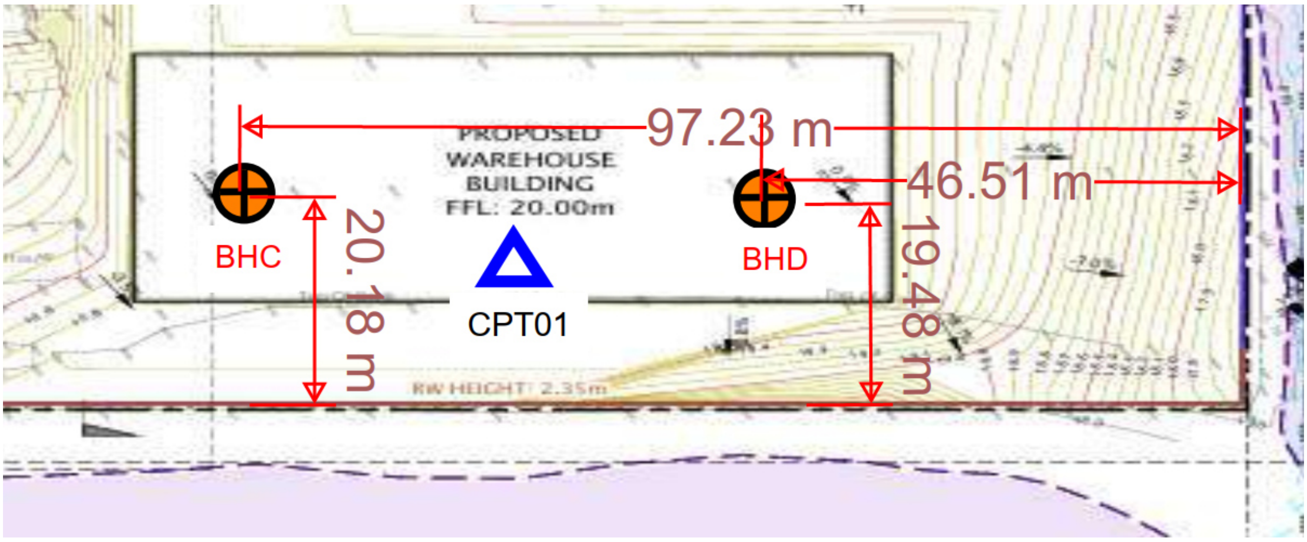
Petrol is removed from the vehicles within the workshop to a 20L jerry can and transferred to a staff vehicle within the workshop. No more than 50L of petrol is stored on site. This procedure means that if there is a spill it is within the workshop and can be quickly cleaned up with the spill kit without being discharge to the yard and stormwater system.

6. Oil and coolant are stored within one of two 1m3 containers in a dedicated storage area (within the warehouse). Correct.
a) Please clarify if parts will be washed within the dismantling building. No parts washing to be carried out on site. Parts are wiped with rags prior to dispatch if required.
b) Please clarify where the wash water will discharge. There will be no wash water generated.
c) Please clarify how the dismantling warehouse floor will be cleaned. It will be regularly swept.
d) Not sure if an oil and water separator will be at the site. There will be no separator on site.
e) Please confirm total site impervious area = 11,034m2. No, the impervious area is the activity area 22,710m^2 plus the two buildings (2 x 2,016m^2) = 26,742m^2.
f) Please clarify how the existing stream on site will be protected from adverse effects relating to the proposed use and development on the site.
The stream will be protected by the provision of full hydraulic neutrality for the new impervious area via the designed discharge control structures. Yard water quality will be addressed by carrying out all dismantling and handing of liquids within the workshop as well as draining all vehicles on arrival to avoid any leakage to the yard surface. Grassed treatment swales and extended detention sedimentation will be provided to remove any further yard contamination sources. This is considered a best practicable option for treatment. Ongoing discharge quality monitoring will be undertaken to ensure compliance with environmental standards is maintained.

Senior Specialist, Wastewater – Matt Richardson
The application was circulated to Matt Richardson to undertake a check of the proposal against the permitted wastewater discharge rules / standards of E5 of the AUP(OP). The following requests are being made to confirm that the proposed wastewater discharge / system can be undertaken as a permitted activity.
15. Please provide bore logs for boreholes drilled within the primary and reserve wastewater disposal areas.
Please note that section 5.2.2 of TP58 states: *"all site assessments are to include a detailed assessment of soils underlying the proposed land disposal area. A detailed description of soils encountered, depth to groundwater and relevant soil structure and soil textural features shall be recorded and the depth to each horizon and soil description within the soil profile submitted with the site assessment report."*

Please see the site geotechnical report attached that shows the locations and soil descriptions at borehole locations c and d. Below is snip of these locations relative to the disposal field (green dots). We feel these locations provide sufficient confidence for the soil classification. Please note the Geotech report describes the subgrade as clayey silt and silty clay. We have conservatively assumed a clay subgrade for the entire field.





16. The earthworks plan indicates that soil will be removed from the proposed wastewater disposal area. Please confirm whether the topsoil will be replaced.

We confirm the topsoil will be replaced.

17. Please specify what wastewater treatment system is proposed.

The treatment system will be and aerated unit (AWTS). The specific unit will be selected at building consent stage.

18. On the Sheet 1 civil engineering plan, please show the minimum separation distances of the primary and reserve wastewater disposal areas from buildings and overland flow paths including swales.

Please see attached our updated infrastructure report with updated layout plan that shows the amended field locations are greater than 10m from the proposed swale.

Additional request dated 5 June, 2025.

1. **Please provide cross-section and long-section plans for the proposed retaining walls and areas that have been marked and shown on the below diagram for the 2yr, 5yr and 100yr event.**
   The cross-section plan(s) shall include the swale and the bund in relation to the buildings and property boundaries.

This request has been satisfied via direct email with the development engineer Varusha Pandian.

Additional request received via email 19 June, 2025

Request:

The AEE shows that the dismantling process involves the draining of fluids, and removal of engines and popular items, fuel removed into small containers and immediately transferred into staff vehicles. Oil and coolant are stored within one of two 1m3 containers in a dedicated storage area (within the warehouse). Appendix 7 of the EMP shows that the quantities of hazardous substances involved in the operation include storage of less than 1000L diesel and petrol respectively in IBC in workshop. The AEE indicates that the proposed development of the site will also increase the level of stormwater runoff from the site. A bund around the platform is proposed to capture rainfall that will release the water at a controlled rate via a pipe outlet and weir arrangement.

The combined quantities of hazardous substances are likely to exceed the permitted activity thresholds in Table E31.4.3 for a Future Urban Zone. In addition, the Auckland Council GIS indicates that large parts of the site are within flood plains. Storage of hazardous substances on the site subject to the 1 per cent annual exceedance probability (AEP) floodplain (1% AEP floodplain) triggers a restricted discretionary activity under Rule E36.4.1(A29).

Please provide assessment of the proposed Hazardous Substances against Chapter E31 and Chapter E36 accordingly. This should include but is not limited to a full list of hazardous substances covered under Chapter E31 (including waste oil and coolants), their correspondent hazardous classifications relevant to E31 assessment, storage details, assessment against relevant storage thresholds specified in Table E31.4.3 for the zone (Future Urban Zone). Please also confirm the details of the outdoor chemical storage area mentioned in the EMP.

In terms of Chapter E36, the applicant is required to address the objectives, policies of E36 as well as the matters of discretion and assessment criteria in E36.8.1 and E36.8.2. Policies (22) requires the integrity of the storage method will not be compromised in a flood event. The EMP and the Emergency Management Plan have not fully addressed any flooding risks to the proposed storage of hazardous substances on the site. The matter of controls and assessment includes but is not limited to:

- location, design and management of the facility where hazardous substances are stored, used or disposed
- potential risk to public health and the extent of the risk
- potential contamination of water, the chance of groundwater contamination
- measures to ensure storage of hazardous substances be protected from flooding, spillage and leakage should a flood event occur
- mitigation measures to avoid the risk to public health and groundwater contamination
- sensitive of the environment and duration of the potential effect

Response:

Please see the below table for the substance classification in relation to permitted storage volumes. As is shown the storage of in excess of 0.3tonnes of materials classified 6.3-6.9 will require discretionary consent.

Hazardous Substance	**Volume**	**Location**	**Classification**	**AUP:OP Permitted Activity Threshold**
Diesel	<50L	IBC in workshop	3.1D , 6.1E, 6.3B, 6.7B, 9.1B	3.1D <1t 6.3/6.9<0.3t 9.1B <0.1t = 117L (SG 0.85)
Petrol	<50L	Small containers in cabinet	3.1A, 6.1E, 6.3B, 6.7B, 9.1B	3.1A<0.1t =133L (SG 0.75) 6.3/6.9<0.3t 9.1B <0.1t =133L (SG 0.75)
Used oils (engine, transmission, brake fluid)	<200L	Sealed drum within open IBC container	3.1D, 6.3B, 6.7B, 9.1C	3.1D <1t 6.3/6.9<0.3t=333L (SG 0.9) 9.1C < 30t or <10t if <30m to water course
Coolant	<200L	Sealed drum within open IBC container	6.1D (oral),6.4A, 6.9A. 9.3C	6.3/6.9<0.3t = 272L (SG 1.1) 9.3C < 30t or <10t if <30m to water course

Petrol and diesel will be stored in small containers within a cabinet in the workshop to a maximum total volume of 50L each before being transferred to vehicles.

Used oils and coolant will be each be stored in a 200L drum within an IBC with the top cut off within the workshop.

The EMP has been updated to reflect the above table and storage methodology.

Assessment against standards and assessment of effects

Request:

E31.6.1. Hazardous facilities site design

Any part of a hazardous facility involved in the manufacture, mixing, packaging, storage, loading, transfer, usage or handling of hazardous substances must be located designed, constructed and operated to ensure that:

(a) on-site facilities are set back from the more sensitive uses and watercourses to comply with the distances specified in the activity tables above; and

(b) hazardous substances are stored to:

(i) ensure that in the event of an unintended spill or release substances are contained within the intended areas of the site; and

(ii) prevent the accumulation of any solid, liquid, gas or vapour outside of the site area.

E31.6.2. Site drainage systems

The site drainage systems (including for washwater) must be designed, constructed and operated to prevent the entry or discharge of hazardous substances into:

(a) the stormwater or sewerage systems unless authorised by the relevant network utility operator; and
(b) air, land or water, including groundwater and potable water supplies, unless authorised by a resource consent or another rule in the Plan. Compliance can be achieved using precautionary methods, including clearly identified stormwater grates and access holes, roofing, sloped pavements, interceptor drains, containment and diversion valves, oil-water separators, sumps and similar systems.

E31.6.3. Hazardous facilities spill containment system Any part of the hazardous facility site where a hazardous substance spill may occur must be serviced by a suitable spill containment system that is: (a) constructed from impervious materials resistant to all hazardous substances on-site; and (b) for liquid hazardous substances: (i) able to contain the maximum volume of the largest tank present plus an allowance for stormwater or fire water; (ii) for drums or other smaller containers, able to contain half of the maximum volume of substances stored, plus an allowance for stormwater or fire water;

(iii) able to prevent any spill or other unintentional release of hazardous substances, and any stormwater and/or fire water that has become contaminated, from entering the stormwater drainage system, unless authorised by the relevant network utility; and

(iv) able to prevent any spill or other unintentional release of hazardous substances, and any stormwater and/or fire water that has become contaminated, from discharging into air, land or water, including groundwater and potable water supplies, unless authorised by a resource consent or another rule in the Plan.

E31.6.4. Hazardous facilities waste management Any hazardous facility generating waste containing hazardous substances must dispose of these wastes to lawfully operated facilities or be serviced by a Council approved waste disposal contractor.

Response:

Regarding the above standards, as set out in the EMP the hazardous substances will be stored in small containers and drums within a 1000L bund (cutoff IBC) within a concrete floored workshop. This bunding will mean that in the event of failure of any or all of the containers the substance will be contained. This will prevent the substance from entering groundwater, discharging to any watercourse or stormwater system and will prevent it from accumulating outside the site area.

The petrol and diesel will be used by site and staff vehicles (that will be refuelled in the workshop). Coolant and used oil will be removed by approved contractors.

With the above systems in place all standards will be met and in doing so it is concluded that any adverse effects will be less than minor.

The maximum ponding level adjacent to the workshop during a 100 year storm event floodplain level is at RL 19m. Any hazardous materials storage will be within the workshop building at an RL of 19.5m. There is no storage of hazardous materials in the floodplain and as such no assessment against E36 in relation to this has been undertaken.

I trust this provides sufficient information to continue processing the consent but for any further information or clarification please contact me.

Yours sincerely,

MJ Todd

Malcolm Todd

Civil and Environmental Engineer - Director

Babingtons

021 394 749

Attachment 1: Geotechnical Report

AKEL
CONSULTING ENGINEERS

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PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

ADDRESS: 395 FITZGERALD ROAD, DRURY, AUCKLAND 2113
(LOT 3 DP 194356).

CLIENT: TAHA AUTO GROUP

Project Number: AKE-G00745

Revision: 1

Dated: 11 April 2025

DOCUMENT CONTROL

REV:	DATE:	ISSUED FOR:	PREPARED BY:	PREPARED & CERTIFIED BY:
1	11 April 2025	Resource Consents	**Victor Okoko** *(BEng Tech Civil)* Geotechnical Engineer	**Aman Kumar** *(BEng Civil), MEngSt (Hons)* *CMEngNZ, CPEng, IntPE(NZ)* *CPEng No: 1010568, Auckland Council Producer Statement Author No: PSA123480* Geotechnical Engineer

This report presents the findings from the geotechnical investigation undertaken by AKEL Consulting Engineers (AKEL) and provides subsequent recommendations for the proposed development by our client (Taha Auto Group), which involves the construction of three stand-alone warehouses. For any queries or further clarification required while interpreting this report, please contact AKEL.

Disclaimer of Liability*- This Geotech Report has been prepared for the sole use of our client, Taha Auto Group for the particular brief and on the terms and conditions agreed with our client. It may not be used or relied on (in whole or part) by anyone else, or for any other purpose or in any other contexts, without our prior written agreement. This Geotech Report may not be read or reproduced except in its entirety. Geotechnical Construction monitoring during the construction phase of the project is a continuation of this Geotechnical Report. AKEL Consulting Engineers must be contacted to verify the ground parameters stipulated within this report before foundation construction is to proceed onsite. If AKEL is not provided the opportunity to complete the Construction observations onsite during the construction and earthworks phase of the project, no liability in part or aggregate is accepted by AKEL Consulting Engineers or its agents for the verification of ground parameters or foundation design recommendations.*

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1. PREAMBLE:

AK Engineers Ltd (AKEL) has been asked to provide a geotechnical report for the construction of three proposed warehouses at LOT 3 DP 194356 (395 Fitzgerald Road, Drury, Auckland 2113*),* herein referred to as the "*subject site*".

This report aims to assess the subsoil conditions and provide preliminary geotechnical recommendations for the detailed design of the proposed development at the subject site. Our investigations comprised of a desktop study, site inspection, and drilling hand auger boreholes to acquire subsoil information in the development site. Furthermore, GeoTest Ltd was engaged in completing two cone penetration tests (CPTs) on the subject site.

The development proposal is for the construction of three warehouses, requiring extensive earthworks for the proposed building platforms and ground retention systems consisting of Retaining walls up to 4.0m high. Based on the development scope, a Geotechnical Completion Report (GCR) and detailed plan review are mandatory to assess further and review the ground parameters and suitability of the underlying ground conditions during the earthworks phase of the project.

2. SITE DESCRIPTION & PROPOSED DEVELOPMENT:

The subject site is a large rural section that currently contains a single-level dwelling located in the middle of the site with two Greenhouses and a few Sheds. The site is partly used for horticulture, as vegetation and flowers are grown in the Greenhouses and the open fields located at the front portion of the site. The remaining ground surface is mainly covered by grass, gravel and areas of brick paving, with trees and shrubs scattered around the site. An existing watercourse is running along the southern site boundary. The subject site can be accessed directly from Fitzgerald Road, which runs adjacent to the northern boundary and is surrounded by other rural properties in all other directions.

The subject site is located in an area zoned under the Auckland Unitary Plan as both a Future Urban Zone and a Business Light Industry Zone.

The development proposal is to construct three single-level Warehouses. The Warehouses will be constructed as stand-alone buildings, with two of the Warehouses constructed at the front and the remaining Warehouse constructed at the rear. The Warehouses will be located over level building platforms formed by cutting/ filling.

Substantial earthworks are required for the proposed development; Engineered Fill or approved equivalent material is proposed to 4.0m in depth. Timber retaining walls up to 4.0m high (Maximum) are proposed along the site boundaries to support the Fill. Appendix F of this report presents copies of the proposed development plan.

The existing greenhouse and sheds at the rear will need to be demolished and removed from the site to enable the construction of the proposed dwellings.

3. DESKTOP STUDY:

We have reviewed the previous geotechnical report (Ref: 669, Dated 20 May 1998) by Geotek Services Ltd. This report was completed to subdivide the subject site from its parent title to facilitate the construction of the existing greenhouses.

Based on our review of the previous geotechnical report, we note that:

- Filling was encountered at the proposed Greenhouse location. The Fill was encountered up to a maximum depth of 1.8m.
- The natural soils comprised soft to firm alluvial soils of the Tauranga Group.
- A minimum embedment depth of 0.45m was proposed for shallow foundations.
- All foundations should be founded below the fill layer.
- Shallow bearing pressures, under live loads plus live load conditions, of 50kPa proposed for the greenhouse and 75kPa proposed for Lots 1 & 2 building platforms.

We are unaware of any other geotechnical investigations that have been undertaken on the proposed development area. Based on our review of the subject site and the New Zealand Geotechnical Database, the findings show that no other geotechnical investigations for the site, specifically in the proposed building areas, are available.

3.1. AERIAL PHOTO SURVEY

Historically, the subject site appears to have been a vacant section in a rural area with some properties located in the surrounding areas in the 1990s. Since then, a few additional properties and roading networks have been constructed in the surrounding area, including the subject site. Our review of the aerial photos extracted from the Auckland Council Geomaps shows no signs of recent mass ground movements or land instability at the subject site.

Figure 1 below shows aerial photos from 1996 (Left) and 2025 (Right) used in our desktop study.

Figure 1: Aerial Photos *(Source: 1996 & 2025 Auckland Council Geomaps, April 2025)*

3.2. FAULTS

Our review of the Institute of Geological and Nuclear Science (GNS) Active Fault Database shows that no active faults occur within the subject site; however, blind or unmapped faults may be present. The building shall be assessed and designed in accordance with NZS 1170.5:2004 *Structural design actions - Part 5: Earthquake actions.*

4. TOPOGRAPHY:

The site is a large rural section within LOT 3 DP 194356 (395 Fitzgerald Road, Drury, Auckland 2113*)*. The site is essentially trapezoidal, with a coverage area of 2.7679 Ha. The overall site topography generally varies from flat to moderately sloping. The two warehouses at the front are proposed on flat ground, while the remaining Warehouse at the rear is proposed on moderately sloping ground. The ground surfaces on the proposed development areas are covered by greenhouses, sheds and vegetation.

Figure 2 below shows the contour map of the site and surrounding area.

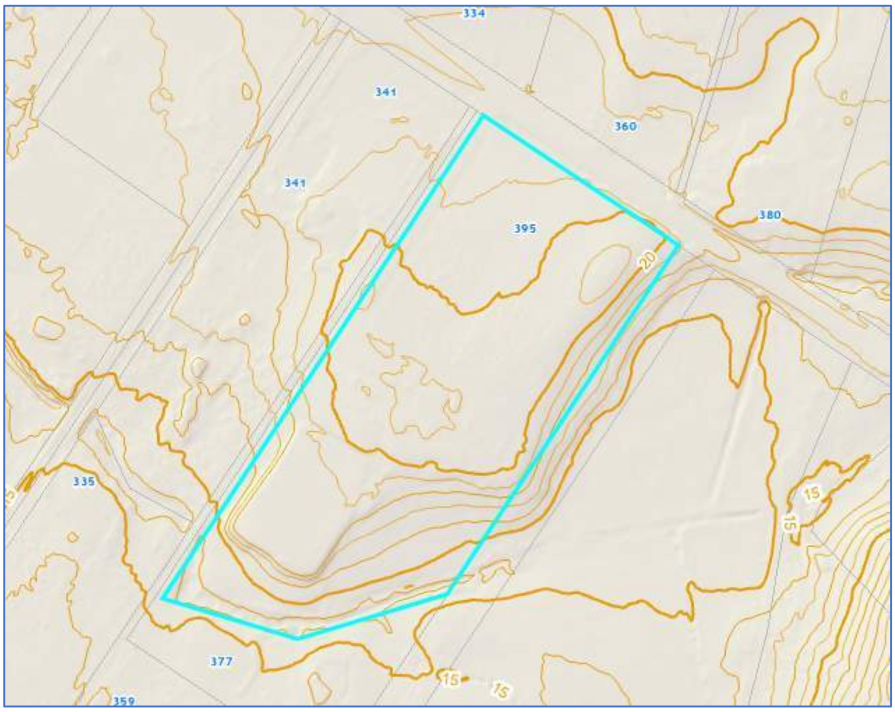


Figure 2: Contours Map of Subject Site (*Source: Auckland Council Geomaps Viewer, April 2025)*

5. SITE GEOLOGY:

The published geology, as indicated by the geological map IG & NA "Map 3 Auckland", shows two geological units at the subject site, namely, the undifferentiated Kerikeri Volcanic Group Basalt of South Auckland Volcanic Field and the Middle Pleistocene to Late Pleistocene River and Hill Slope Deposits of Tauranga Group. However, in our opinion, the soils encountered on site were more indicative of River and Hill Slope Deposits (Tauranga Group) soils.

According to the geological documentation from GNS Science Ltd, the Middle Pleistocene to Late Pleistocene River and Hill Slope Deposits consist of predominantly pumiceous sand, silt, mud, and clay, with interbedded gravel and peat. The geological is dated to be with a maximum age of 0.128 million years. We attribute the mapped geological variation to the complexities of large-scale geological mapping.

Figure 3 below shows an extract from the GNS Published Geological map, which coincides with the IG& NG Map 3, showing the geology of the subject site.

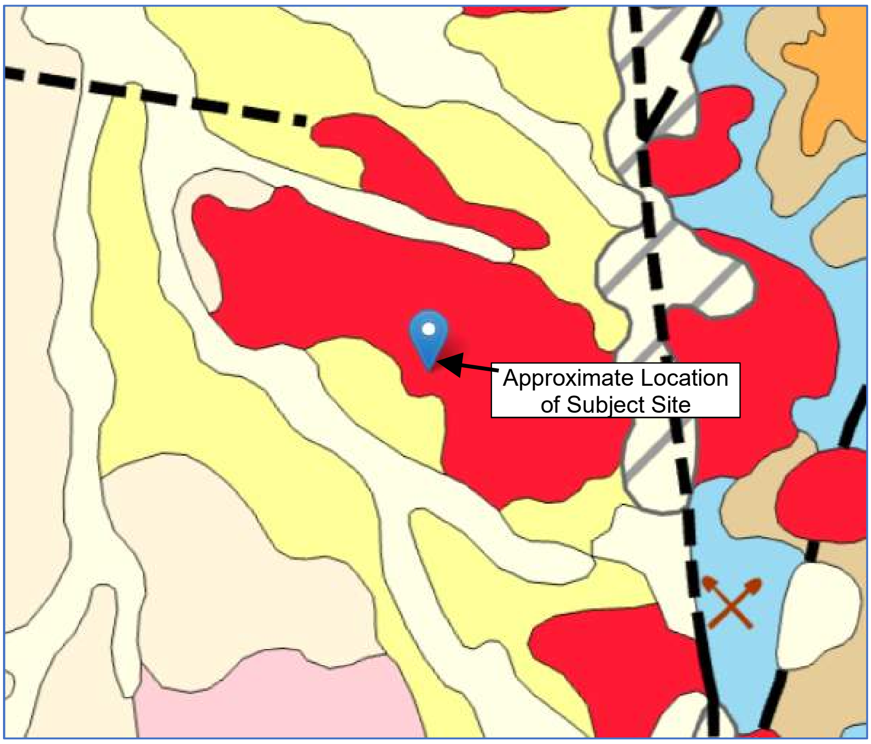


Figure 3: GNS Geological Map (Source: GNS – New Zealand Geology Web Map, April 2025)

6. NATURAL HAZARD & RISK ASSESSMENT

In accordance with Section 106 of the Resource Management Act and Auckland Earthworks and Geotechnical Council CoP (Version 2, May 2023), we have undertaken a qualitative site-specific natural hazards risk register for the proposed development site.

The risks were assessed by assigning likelihoods and consequences that have the potential to affect the proposed development in accordance with the Auckland Council Cop

The potential risks were classified as per the risk classification table below:

Likelihood	**Consequence**				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Extreme 5
Almost Certain **5** (>90%)	Medium	High	Very High	Extremely High	Extremely High
Likely **4** (50-90%)	Low	Medium	High	Very High	Extremely High
Moderate **3** (25-50%)	Low	Medium	Medium	High	Very High
Unlikely **2** (10-25%)	Very Low	Low	Medium	Medium	High
Rare 5 **1** (<10%)	Very Low	Very Low	Low	Low	Medium

The potential site risks associated with the proposed development site were assessed and are detailed in the risk register below:

Risk	**Potential consequences**	**Likelihood**	**Risk class**	**Comment**	**Mitigation measures**
SEISMIC/ LIQUEFACTION	Major	Unlikely	Medium	Auckland Council Geomaps Level A & Level B liquefaction assessments indicate that the site has very low vulnerability to liquefaction within the proposed area. Refer to Section 12 of the report.	N/A
SLOPE INSTABILITY	Major	Moderate	Medium	The topography of the development areas is flat to moderately sloping.	Warehouses will be founded on adequately retained level building platforms. No slope instability is anticipated.
SOIL EXPANSIVITY	Moderate	Moderate	Medium	The site soils have been assessed to be 'Moderately' & 'Highly' expansive. Refer to Section 10 of the report.	SED Foundations designed for expansive soils.
COLLAPSIBLE/ COMPRESSIBLE SOILS	Moderate	Rare	Low	No evidence of compressible/ collapsible soils was encountered during the site investigation.	N/A
ACID SULPHATE SOILS	Major	Rare	Low	There was no evidence of acid sulphate soils during the site soil investigation.	N/A
FLOODING	Moderate	Moderate	Medium	Auckland Council Geomaps shows that the site contains 100-year overland flow paths and 100-year flood plains.	A flood assessment will be required for the proposed development.
UNCONTROLLED FILLING	Moderate	Unlikely	Medium	No uncontrolled filling was encountered during the site investigation. However, non-engineered Fill was encountered in one borehole (BHF) up to 1.0m below ground level.	Any filling on building platforms is to be removed and replaced with compacted hardfill or piled foundations that extend below the filling proposed.
GROUND/ SOIL EROSION	Major	Rare	Low	The site topography is flat to moderately sloping, with no water courses nearby. Therefore, no erosion effects are anticipated.	N/A
COASTAL INSTABILITY AND EROSION	Major	Rare	Low	The subject site is located well away from any coastal areas.	N/A
VOLCANIC ERUPTION	Major	Rare	Low	The subject site is far from any known active volcanoes in the Auckland region.	N/A

7. SUBSURFACE SOIL INVESTIGATIONS:

The soil investigations were completed on 05 April 2025 by AKEL Consulting Engineers and consisted of six 50mm diameter hand auger boreholes (BHA to BHF). All the boreholes (BHA to BHF) were drilled up to 3.0m below ground level (bgl).

A Pilcon handheld shear vane apparatus was used to test and measure the undrained shear strength within the base of the boreholes at 0.5 m depth intervals in accordance with the New Zealand Geotechnical Society Guidelines for Handheld shear vane tests.

In addition to the hand auger boreholes, two cone penetration tests (CPT01 & CPT02) were completed by a specialist contractor (GeoTest Ltd) on 04 April 2025 to acquire additional subsoil information. The CPTs were completed on the proposed warehouse locations. CPT01 was penetrated to a depth of 13.62m, while CPT02 was penetrated to a depth of 12.24m.

Refer to Figure 4 & Figure 5, Appendix A, for the approximate locations of the boreholes and CPT tests.

7.1. RESULTS OF SUBSURFACE SOIL CONDITIONS

The results of the subsurface soil conditions encountered at the subject site are summarised below in Tables 1 & 2. The bore logs corresponding to the summary of the results are presented in Appendix B.

Test Location	**Depth to End of Test (bgl)**	**Topsoil depth (bgl)**	**Ground Water Depth (bgl)**	**Peak Shear Strength (kPa)** Range (min-max)	**Residual Shear Strength Value (kPa)** Range (min-max)
BH-A	3.0m	0.3m	-	139 to 200+	39 to 72
BH-B	3.0m	0.3m	-	122 to 178	44 to 67
BH-C	3.0m	0.3m	-	72 to 111	14 to 56
BH-D	3.0m	0.3m	-	56 to 156	14 to 75
BH-E	3.0m	0.3m	-	114 to 200+	42 to 72
BH-F	3.0m	0.3m	-	103 to 200+	28 to 56

Table 1: Summary of Site Testing Results

Soil Horizon/ Material	**Depth (bgl)**	**Undrained Shear Strength Ave. (kPa)**	**Remoulded Shear Strength Ave. (kPa)**	**Soil Sensitivity/ Consistency**
TOPSOIL	0m - 0.3m	-	-	Moist
Non-Engineered Fill (Silty CLAY with some sand)	0.3m - 1.0m	108 (103 to 114)	35 (28 to 42)	3.1 (Very Stiff) **Moderately Sensitive**
RESIDUAL SOIL (Silty CLAY/Clayey SILT with some sand)	0.3m - 3.0m	123 (56 to 200+)	48 (14 to 75)	2.6 (Stiff – Very Stiff) **Moderately Sensitive**

Table 2: Summary of Soil Profile, Soil Sensitivity and Consistency

7.2. DESCRIPTION OF BORELOGS AND SOILS OBSERVED ONSITE

Topsoil

- Topsoil was encountered in all boreholes (BHA to BHF). The topsoil's thickness was approximately 0.3m on all boreholes.

Non-Engineered Fill

- Non-engineered Fill was encountered in one borehole (BHF) beneath the topsoil. The fill strength was very stiff and comprised of Silty CLAY with some sand. Non-engineered filling was encountered in BHF at up to 1.0m bgl.

River and Hill Slope Deposits (Tauranga Group)

- Alluvial soils comprising the Middle Pleistocene to Late Pleistocene River and Hill Slope Deposits (Tauranga Group) were encountered in all boreholes (BHA to BHF) below the topsoil/ non-engineered fill. The natural soil strengths ranged from stiff to very stiff and comprised Silty CLAY with some sand and Clayey SILT with some sand. The soils had a variety of colours, as specified in our bore logs, and were encountered up to the borehole termination depths.

CPTs (GeoTest Ltd)

- GeoTest Ltd completed two CPTs (CPT01 & CPT02) at the proposed warehouse locations. CPT01 was done to a depth of 13.62m, while CPT02 was completed to a depth of 12.24m.

Refer to our borehole logs in Appendix B for more detailed descriptions of the soils encountered during our investigation. The CPT logs by GeoTest Ltd are also presented in Appendix B.

8. GROUNDWATER:

No groundwater levels were observed in any of the six boreholes (BHA to BHF) during the site investigation.

Based on the information supplied by the client regarding the proposed development and our site investigation, we do not foresee the proposed development impeding any potential groundwater at the subject site.

9. SURFACE WATER:

Surface water from roofs and paved areas shall be collected and safely discharged via a piped network to the reticulated Public Stormwater network or an approved discharge point to prevent any increases in groundwater or surface water intrusion from the subject site entering neighbouring properties or the building foundations.

Furthermore, Auckland Council Geomaps shows that the subject site is affected by 100-year flow paths and flood plains. Therefore, a flood risk assessment is recommended for the proposed development. This assessment shall take all practicable measures to eliminate any potential groundwater from entering the proposed warehouse foundations.

10. GEOTECHNICAL FINDINGS & EXPANSIVE SOILS:

The boreholes encountered alluvial soils comprising the Middle Pleistocene to Late Pleistocene River and Hill Slope Deposits (Tauranga Group) beneath the topsoil/non-engineered fill. The subject site is generally covered by topsoil approximately 0.3m in thickness, followed by alluvial soils. The alluvial soils comprised stiff to very stiff Silty CLAY with some sand and Clayey SILT with some sand up to the boreholes' termination depths. It should be noted that engineered filling was encountered only in one borehole (BHF) up to 1.0m bgl.

10.1. EXPANSIVE SOILS

Expansive clay and silt soils are common for soils in the Auckland region. These soils tend to shrink and swell, particularly with seasonal fluctuations in moisture content. This behaviour has implications for foundation design and surface structures and should be incorporated during foundation design.

We collected two soil core samples to undertake a Shrink-Swell Index Test to determine the soil expansivity class on the subject site. The samples comprised natural soils taken from the areas designated as SS1 and SS2. Refer to Figure 4 & Figure 5, Appendix A for the soil sample locations (SS1 & SS2).

The Shrink-Swell Index test was carried out in accordance with AS1289:2003 – Test 7.1.1. The laboratory test results are attached in Appendix B of this report.

A summary of the Shrink-Swell Index Test is presented below:

Sample No.	**Depth Sample Taken (bgl)**	**Shrinkage Strain E_{sh} (%)**	**Swell Strain E_{sw} (%)**	**Shrink - Swell Index I_{ss} (%)**
SS1	0.8m – 1.2m	6.2%	-0.12%	3.4%
SS2	0.8m – 1.2m	9.6%	-0.07%	5.4%

The laboratory results indicate that the site soils have a Shrink–Swell Index (Iss) of 3.4% for SS1 and 5.4% for SS2.

The Shrink-Swell Index (I_{ss}) values indicate that SS1 has a soil expansivity Class' M' (Moderately) in accordance with NZBC B1/AS1 (Amendment 19) & AS 2870-2011: Residential Slabs and Footings. The surface movement characteristics associated with Expansive Soil Class 'M' are 22mm to 44mm.

The Shrink-Swell Index (I_{ss}) values indicate that SS2 has a soil expansivity Class 'H' (Highly) in accordance with NZBC B1/AS1 (Amendment 19) & AS 2870-2011: Residential Slabs and Footings. The surface movement characteristics associated with Expansive Soil Class 'H' are 44mm to 78mm, which is anticipated across the subject site. A minimum foundation depth of 850mm is recommended for the foundation elements of the proposed Warehouse at the rear of the site.

For Timber Framed buildings, NZS3604:2011 excluded soils from the definition of good ground where soils have a liquid limit (LL) greater than 50% (as tested by NZS 4402:2.2:1986) and a linear shrinkage (LS) greater than 15% (as tested by NZS 4402:2.6:1986). Note that this is the case of the soils at the subject site. Therefore, the soils at the subject site are not considered to lie within the definition of "good ground" as per NZS3604.

Specific engineering design shall be undertaken by a qualified engineer experienced in the design of footing systems, who may then utilize the provisions of section 4 of AS2870.

The soils at the subject site are not considered to lie within the definition of "good ground" as per NZS3604. A qualified engineer experienced in the design of footing systems shall undertake specific engineering design and may then utilize the provisions of section 4 of AS2870.

Respectively, the site subsoil category shall be taken as Class C – Shallow Soils in terms of NZS1170.5.2004.

The peak undrained shear strengths obtained indicate that an ultimate bearing strength of 200kPa may be used to design shallow foundations. However, the strength of the soils is variable, and this design is subject to an inspection of the foundation excavations by AKEL Ltd.

11. GROUND STABILITY:

The subject site's overall topography ranges from flat to moderately sloping. The two Warehouses at the front are proposed on flat ground, while the remaining Warehouse at the rear is proposed on moderately sloping ground. The proposed development will involve creating adequately retained-level building platforms for the Warehouses.

Based on our site observations, review of the proposed development, and site investigations, we do not consider the subject site prone to ground instability effects as a result of the proposed development. However, during the detailed design of the Building Structures, further assessment is recommended to verify building loads in relation to soil structure interaction.

12. GROUND SETTLEMENT AND LIQUEFACTION:

During the site desktop review, Auckland Council Geomap's basic and calibrated liquefaction assessments were checked for the proposed development areas at the subject site. Both assessments indicate that the proposed development area is anticipated to have very low vulnerability to liquefaction. Liquefaction has the potential to occur in silts, sands, and gravels, especially where groundwater tables are high and the soil is in a loose state. The soils encountered in our investigation were firm to very stiff cohesive clays and silts, which we anticipate will have low liquefaction potential.

Furthermore, we have undertaken a liquefaction analysis using the data obtained from two Cone Penetration Tests (CPT01 & CPT02) conducted by GeoTest Ltd. Refer to Figure 4 and Figure 5, Appendix A, for the approximate location of the CPTs.

Our liquefaction analysis was undertaken using Geologismiki Software "CLiq" and assesses earthquake-induced ground deformation under the Ultimate Limit State (ULS) and the Serviceability Limit State (SLS).

The liquefaction analysis has been carried out in accordance with the NZTA Bridge Manual (3rd Edition). The calculation method was based on Boulanger & Idriss (2014). We considered the site to be seismic Class C – Shallow Soil Site (NZS 1170.5.2004) based on the soils encountered and CPT results.

The liquefaction analysis has been carried out with reference to the NZTA Bridge Manual (3rd Edition), Auckland Council CoP for Land Development and Subdivision (Version 2) and the Earthquake Geotechnical Engineering Practice Module 1 (November 2021). The calculation method was based on Boulanger & Idriss (2014). The site is considered to be seismic Class C – Shallow Soil Site (NZS 1170.5.2004) based on the soils encountered during the site investigation and CPT results.

The site was assessed to be of importance level 2; the annual probability exceedance was 1/500 under the ULS and 1/50 under the SLS. (NZS 1170.5.2004).

ULS: Peak horizontal ground acceleration (PGA) of 0.19g and 1000-year effective magnitude earthquake of 6.5 were adopted for the liquefaction assessment analysis in accordance with the Earthquake Geotechnical Engineering Practice Module 1 (November 2021). The return period factor under the ULS case is 1.0 (Table 3.5 of NZS1170.5.2004).

SLS: Peak horizontal ground acceleration (PGA) of 0.06g and 1000-year effective magnitude earthquake of 5.9 were adopted for the liquefaction assessment analysis in accordance with Earthquake Geotechnical Engineering Practice Module 1 (November 2021). The return period factor under the ULS case is 0.35 (Table 3.5 of NZS1170.5.2004).

The following analysis and results were obtained from the liquefaction analysis:

Overall Probability of Liquefaction:

CPT Number	Overall Probability of Liquefaction (ULS)	Overall Probability of Liquefaction (SLS)
CPT01	6.207 % (Low)	4.344 % (Low)
CPT02	8.885 % (Low)	4.344 % (Low)

The results indicate that the site has a low overall probability of liquefaction under the ULS cases and SLS cases.

Overall Liquefaction Potential Index:

CPT Number	Overall Liquefaction Potential Index (ULS)	Overall Liquefaction Potential Index (SLS)
CPT01	1.728 (Low)	0 (Low)
CPT02	3.506 (Low)	0 (Low)

The results indicate that the site has low overall liquefaction potential under the ULS and SLS cases.

Overall Vertical Settlement:

CPT Number	Overall Vertical Settlement (ULS)	Overall Vertical Settlement (SLS)
CPT01	4.146 cm	0.001 cm
CPT02	8.487 cm	0 cm

The results indicate that the site's estimated vertical settlement for CPT01 is 4.146 cm under the ULS case and 0.001 cm under the SLS case. Under the ULS case, minor expressions of liquefaction are shown to occur at 3.0m bgl & 6.5m bgl, with a major expression of liquefaction shown at 11.5m bgl.

The results indicate that the site's estimated vertical settlement for CPT02 is 8.487cm under the ULS case and 0.00 cm under the SLS case. Under the ULS case, minor expressions of liquefaction are shown to occur at 3.5m bgl & 4.0m bgl, with a major expression of liquefaction shown at 7.0m bgl.

Overall Liquefaction Severity Number:

CPT Number	Overall Liquefaction Severity Number (ULS)	Overall Liquefaction Severity Number (SLS)
CPT01	5.508 (Little to no expression of liquefaction)	0.003 (Little to no expression of liquefaction)
CPT02	14.643 (Minor expression of liquefaction)	0 (Little to no expression of liquefaction)

The results indicate that the site has little to no expression of liquefaction under the ULS cases and SLS cases.

Summary:

The analysis results indicate that the proposed development site has a very low to negligible liquefaction potential and probability under the ULS case and SLS case. Therefore, the site has a low risk of damage to the proposed buildings as a result of ground settlement during the 50-year design life.

For CPT01, minor expressions of liquefaction are shown to occur at 3.0m bgl & 6.5m bgl, with a major expression of liquefaction shown at 11.5m bgl. For CPT02, minor expressions of liquefaction are shown to occur at 3.5m bgl & 4.0m bgl, with a major expression of liquefaction shown at 7.0m bgl. The potential vertical settlements are shown to occur at depths below 6.5m below ground level. Therefore, the risk of ejecta occurring on the surficial level and damaging the shallow foundations is deemed low based on the cohesive nature of the surficial soils.

The differential settlements that could affect future foundations should be within the tolerable differential settlement ranges of 1 in 240 (approximately 25 mm over a six-meter length of the building) as required by the New Zealand Building Code Handbook, Appendix B Section B1A/M4, clause B1.0.2, under the serviceability limit state load combinations of NZS 4203 or NZS 1170.0, unless the structure is specifically designed to limit damage under a greater settlement. Refer to Appendix C for the liquefaction analysis outputs.

13. EARTHWORKS RECOMMENDATIONS:

No bulk earthworks shall start during the winter months (1 June to 1 October) without prior approval of AKEL.

Compacted Hardfill either (AP40/GAP40 or equivalent) shall be placed within the building platform or to support car parking and driveway pavements with compaction confirmed with Clegg Impact Value (CIV) of 25 or higher.

It is recommended that the placement of the Compacted Hardfill layer is completed with urgency to ensure that work is completed efficiently to avoid the effects of wet weather on the exposed subgrade surface. The program for the hardfill placement is to be completed upon inspection of the subgrade surface, and AKEL Consulting Engineers issued approval to place the hardfill.

AKEL Earthworks specification shall be referenced for the proposed excavation and earthworks at the subject site. The Earthworks specifications are shown in Appendix D of this report.

14. FOUNDATION DESIGN:

14.1. PROPOSED WAREHOUSE FOUNDATIONS

Foundations for the proposed front two warehouses shall be specifically designed in accordance with AS2870-2011: Residential Slabs & Footings for Class "H" expansive soil movements. The proposed front two warehouses can be founded on shallow foundations. Ultimate bearing strength of 200 kPa may be assumed at the ground surface on the prepared level building platforms. Shallow foundations must be founded at a minimum depth of 0.85m below existing (or cleared) ground level or into the natural ground for any raft slab or slab on grade foundations.

During the preparation of the building platforms, any unsuitable materials encountered, such as tree roots & stumps, pre-existing foundations, and non-engineered filling, must be excavated and replaced with compacted hardfill.

The table below shows the parameters for shallow foundations:

Shallow/ Raft Slab Foundations design strength parameters *NB: As required by Section B1/VM4 of the NZBC. A strength reduction faction of 0.5 must be applied to all geotechnical ultimate soil capacities with reference to the relevant factored design load cases.*	
Ultimate Bearing Capacity (q_{ult})	200 kPa
Dependable Bearing Capacity (q_{dbc})	100 kPa
Allowable Bearing Capacity (q_{all})	67 kPa
Surface movement characteristics for Class' H' soils	ys ≤ 78mm.
Site subsoil Class as per NZS 1170.5:2004	Site Subsoil Class C – Shallow Soils Site

Foundations may also be specifically designed using an ultimate bearing strength of 200 kPa, which may be assumed for any shallow bored pile foundations to a depth of 0.9 m bgl and into natural soil, provided that bases are clean and dry.

The table below shows the parameters for shallow pile foundations:

Shallow Pile Foundations design strength parameters (Conventional Pile Foundations) *NB: As required by Section B1/VM4 of the NZBC. A strength reduction faction of 0.5 or 0.8 must be applied to all geotechnical ultimate soil capacities with reference to the relevant factored design load cases.*	
Ultimate Pile End Bearing Capacity (q_{ult}) –	200kPa **Geotechnical End bearing only to 0.9m bgl.**
Strength Reduction factor (ϕ)	0.5
Site subsoil Class as per NZS 1170.5:2004	Site Subsoil Class C – Shallow Soil Site

This is subject to an inspection of the foundation excavations by AK Engineers Ltd (AKEL) to ensure that the bearing strengths assumed in the design and required embedment depths are achieved on site.

15. RETAINING WALLS:

Substantial earthworks will be required as part of the proposed development to create level platforms. Timber retaining walls up to 4.0m high (Maximum) are proposed on parts of the site boundaries to support the level platforms. The proposed retaining walls may be specifically designed assuming the following soil parameters for residual soils as stated in the table below titled 'Retaining Wall Design Parameters.

Retaining Wall Design Parameters	
Bulk density	18 kN/m^3
Drained effective Cohesion, c'	2 kPa
Friction angle, φ'	28 degrees
Peak Undrained Shear strength, Su (kPa)	50 kPa

The detailed design of the retaining walls at the subject site is to be supported by a staged construction methodology and risk assessment to ensure safety in design principles are implemented with the focus of eliminating risks such as the following listed below;

(a) Erosion (including coastal erosion, bank erosion, and sheet erosion):
(b) Falling debris (including soil, rock, snow, and ice):
(c) Subsidence:
(d) Inundation (including flooding, overland flow, storm surge, tidal effects, and ponding):
(e) Slippage."

It should be noted that the risk assessment must consider all elements of the proposed development and the land surrounding the development site.

16. PAVEMENT/DRIVEWAY DESIGN:

Based on the soils encountered during our site investigations, we recommend a CBR value of 3 or greater for any pavement/driveway design. However, this must be verified on-site by the AKEL Geotech Engineer or a CPEng Geotechnical Engineer familiar with the findings of this report.

17. DEVELOPMENT & DESIGN RECOMMENDATIONS:

- The proposed development foundations shall be designed by a suitably qualified Chartered Professional Engineer who shall confirm that the foundations meet the required ultimate bearing capacity specified in **Section 14** of this report.
- Any Non-Engineered Fill shall be completely removed from the subject site and disposed of at an approved managed fill facility or piled through.
- A **Geotechnical Completion Report (GCR)** must be completed during the earthworks phase to assess further and review the ground parameters and suitability of the underlying ground conditions during the earthworks phase of the project.
- **The Certifying AKEL Geotechnical Engineer must complete a plan review upon completion of the Foundation Design and Drawing set prior to submission of the Building Consent.**
- The foundation excavation and methodology shall be reviewed by a suitably qualified Chartered Professional Engineer familiar with the subject site, who shall confirm the founding soil strength of the proposed foundations onsite.
- The subject site is assessed as Class' M' to 'H' for expansiveness, and the design of the foundations at the subject shall be completed with reference to AS2870-2011: Residential Slabs & Footings.
- The main contractor responsible for the earthworks at the site shall schedule a prestart meeting with the AKEL Geotechnical Engineer at least five days before any earthworks or pile construction commencement. This meeting will ensure that all parties involved in the earthworks phase understand the project requirements, the design, and the geotechnical conditions at the site. In addition, the main contractor/principal must provide copies of the approved building consent document set, H&S Plans, temporary works design, and Erosion and Sediment control plans for the physical works to the AKEL Geotech Engineer for review and approval before attendance onsite.
- If required, any Earthworks at the subject site shall be completed with reference to the AKEL Earthworks Specifications.
- The property owner is advised to follow the guidelines shown in Appendix E of this report by CSIRO Foundation Maintenance and Footing Performance for the new building upon completing the building structure at the subject site. Large trees near the building foundations must be designed with reference to the CSIRO foundation guide and AS2870-2011: Residential Slabs & Footings. A factor of 1.5 shall be multiplied by the tree's height to evaluate the proximity of any large trees near the proposed building foundations.

18. DESIGN CERTIFICATION:

The ground conditions at the subject site are suitable for the proposed three warehouses. The recommendations in **Section 14**, titled ***Foundation Design,*** ***and*** **Section 17**, ***Design & Development Recommendations*** of this report, are critical to the foundation stability for the proposed dwelling and extension at the subject site. It is noted that this is reviewed and assessed by the Structural Engineer during the design of the building foundations for the proposed development.

PLEASE NOTE THE LIMITATIONS OF THIS GEOTECHNICAL REPORT:

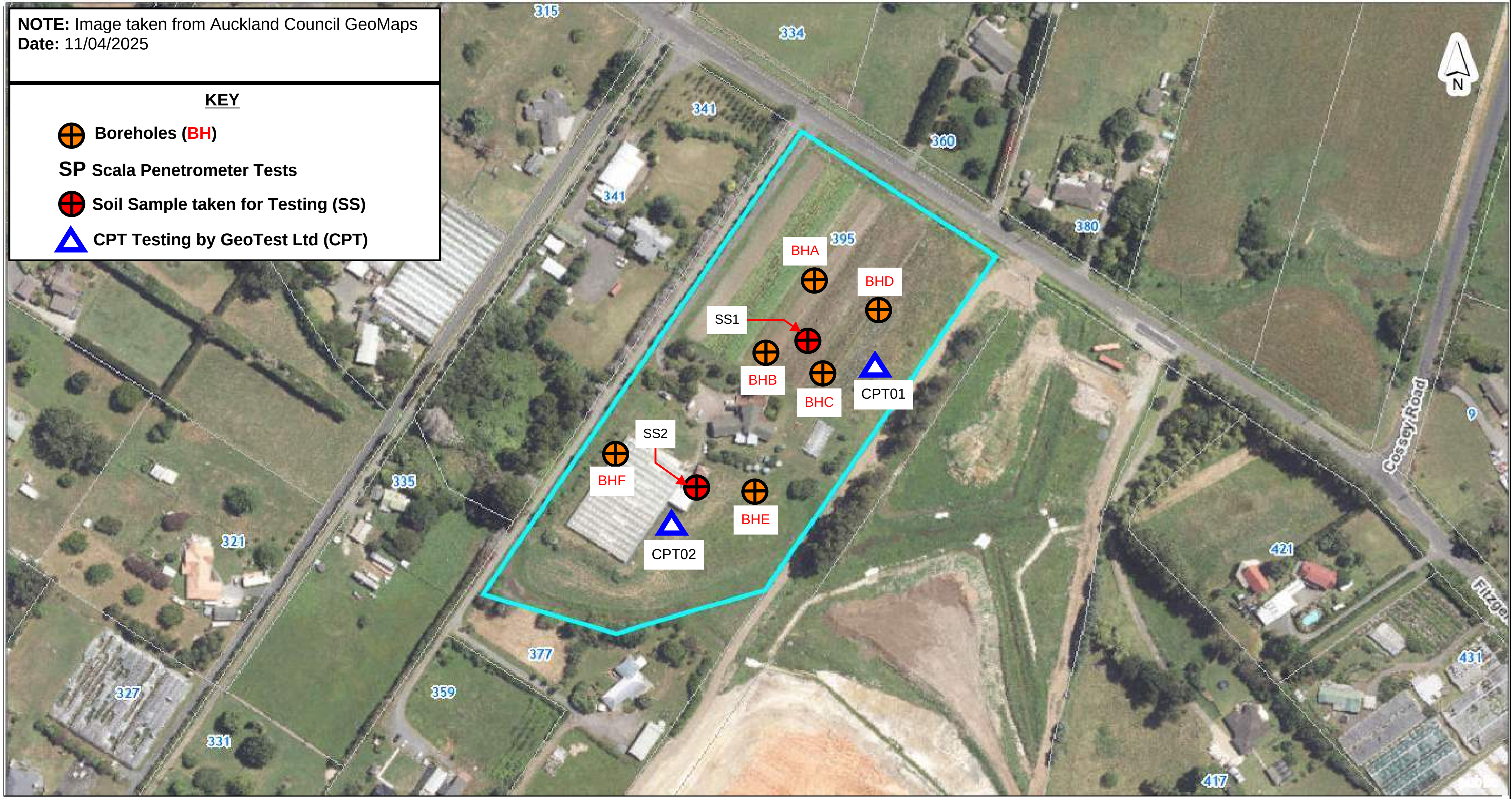
This report's findings and subsequent recommendations are based on investigations carried out at a limited number of locations. It must be understood that soil conditions may vary across the site from those encountered at the boreholes. Due to this, the site must be checked by a qualified geotechnical engineer/ geologist familiar with this report during construction, confirming that the subsoil conditions match those mentioned in the AKEL Geotech report. For continuity, we can provide this service if required. We also request that we be contacted if the subsoil conditions vary from those mentioned in this report.

ATTACHMENTS:

Appendix A:	Site Plans Showing Boreholes, CPT & Soil Core Sample Locations
Appendix B:	Borelogs, CPT logs, Shrink-Swell Index Test Results
Appendix C:	Liquefaction Analysis Outputs
Appendix D:	AKEL Earthworks Specifications.
Appendix E:	CSIRO Foundation Maintenance and Footing Performance Guide.
Appendix F:	Proposed Development Plan(s).

APPENDIX A

SITE PLAN(S) SHOWING BOREHOLES LOGS, CPT & SOIL CORE SAMPLE LOCATIONS



NOTE: Image taken from Auckland Council GeoMaps
Date: 11/04/2025

KEY

- ⊕ **Boreholes (BH)**
- **SP Scala Penetrometer Tests**
- ⊕ **Soil Sample taken for Testing (SS)**
- △ **CPT Testing by GeoTest Ltd (CPT)**

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No.	Amendment	Date

Figure No.: 04

Project No.: AKE-G00745

Date: 11/04/2025

Site: 395 Fitzgerald Road, Drury, Auckland 2113

Scale: NTS

Drawn: AN

Checked: VO

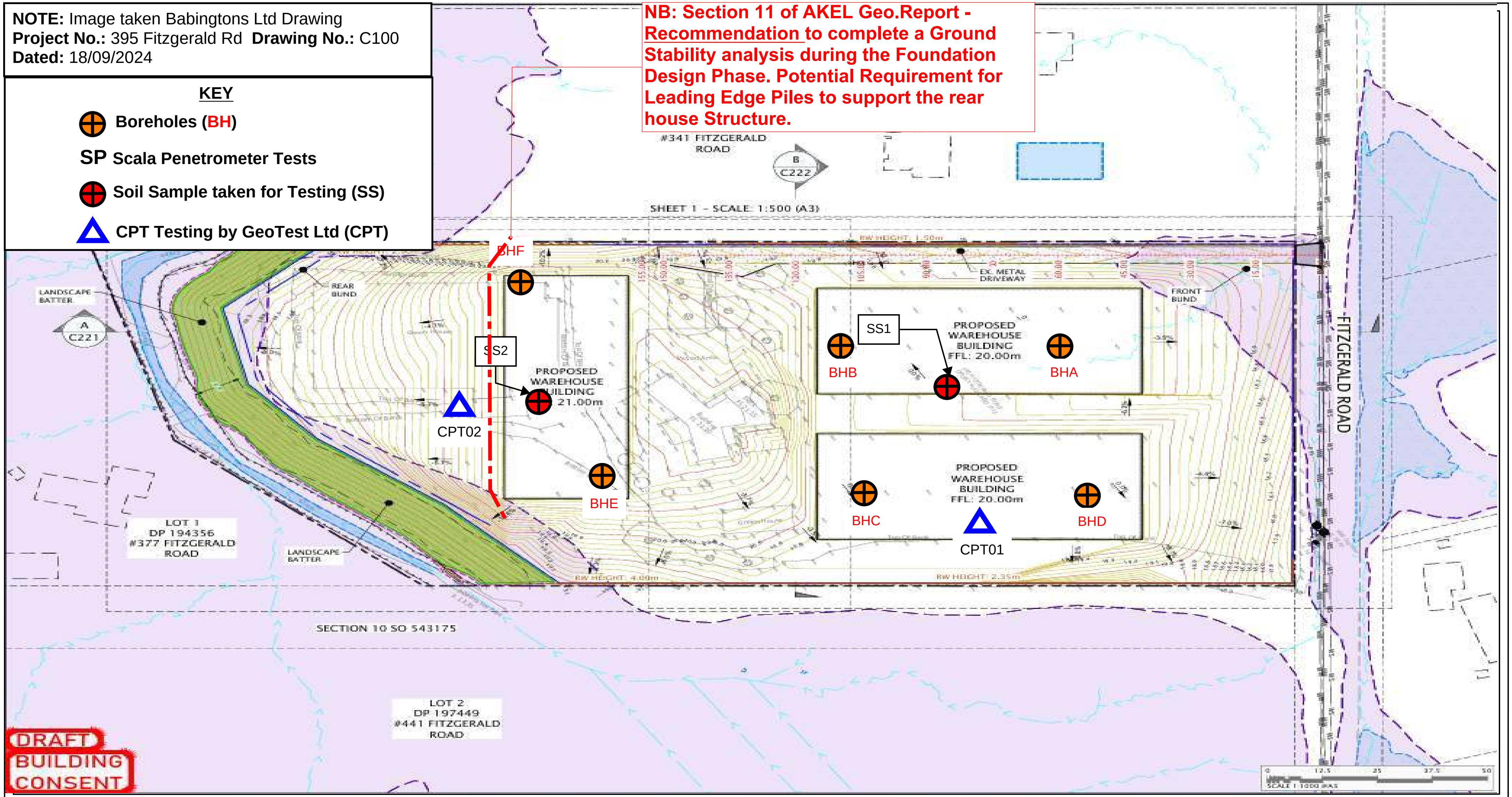
Revision: 01

Drawing Title: EXISTING SITE PLAN WITH BOREHOLES & CPT LOCATIONS

NOTE: Image taken Babingtons Ltd Drawing
Project No.: 395 Fitzgerald Rd **Drawing No.:** C100
Dated: 18/09/2024

KEY

- ⊕ Boreholes (BH)
- **SP** Scala Penetrometer Tests
- ⊕ Soil Sample taken for Testing (SS)
- △ CPT Testing by GeoTest Ltd (CPT)



NB: Section 11 of AKEL Geo.Report - Recommendation to complete a Ground Stability analysis during the Foundation Design Phase. Potential Requirement for Leading Edge Piles to support the rear house Structure.

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No.	Amendment	Date

Figure No.: 05
Project No.: AKE-G00745
Date: 11/04/2025
Site: 395 Fitzgerald Road, Drury, Auckland 2113
Scale: NTS
Drawn: AN
Checked: VO
Revision: 01
Drawing Title: PROPOSED SITE PLAN WITH BOREHOLES & CPT LOCATIONS

APPENDIX B

BORELOGS, CPT LOGS & SHRINK-SWELL INDEX TEST RESULTS

BOREHOLE A (BH A)

PROJECT NUMBER AKE-G00745
PROJECT NAME 395 Fitzgerald Road
CLIENT Taha Auto Group
ADDRESS 395 Fitzgerald Road,
Drury, Auckland 2113

DRILLING DATE 05 April 2025
TOTAL DEPTH 3 m
DIAMETER 50 mm

SU Corr. Factor 1.389
SURFACE ELEVATION RL 20.00 m

COMMENTS BH A Location shown on Figure 4 & Figure 5, Appendix A.

LOGGED BY VO/AN
CHECKED BY VO

Depth (m)	Material Description	Graphic Log	Moisture	NO Static Groundwater was encountered at BHA on 05/04/25	Peak Shear (kPa)	Residual Shear (kPa)
0.2	Topsoil	≀	Moist			
0.4 0.6	Silty CLAY with some fine sand; grey brown streaked orange and pale grey. Very stiff, moist, moderately plastic. (Tauranga Group - River and Hill Deposits)	▨			168	67
0.8 1 1.2 1.4	Becoming pale grey mottled orange.	▨			200+ 150	- 72
1.6 1.8 2 2.2	Becoming pale grey streaked orange.	▨			200+	-
2.4 2.6	Becoming pale grey mottled orange, with some fine to medium sand.	▨			167	58
2.8	Becoming white mottled orange, with fine sand.	▨			139	39
3	End of Borehole at 3.0 m bgl.				End of Borehole at 3.0 m bgl.	

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BOREHOLE B (BH B)

PROJECT NUMBER AKE-G00745
PROJECT NAME 395 Fitzgerald Road
CLIENT Taha Auto Group
ADDRESS 395 Fitzgerald Road,
Drury, Auckland 2113

DRILLING DATE 05 April 2025
TOTAL DEPTH 3 m
DIAMETER 50 mm

SU Corr. Factor 1.389
SURFACE ELEVATION RL 20.00 m

COMMENTS BH B Location shown on Figure 4 & Figure 5, Appendix A.

LOGGED BY VO/AN
CHECKED BY VO

Depth (m)	Material Description	Graphic Log	Moisture	NO Static Groundwater was encountered at BHB on 05/04/25	Peak Shear (kPa)	Residual Shear (kPa)
0.2	Topsoil	〰	Moist			
0.4 0.6 0.8	Silty CLAY with some fine sand; greyish brown mottled orange. Very stiff, moist, moderately plastic. (Tauranga Group - River and Hill Deposits)	▨			122 139	50 67
1 1.2 1.4 1.6	Becoming orange mottled pale grey.	▨			178	53
1.8 2	Clayey SILT with fine to medium; orange. Very stiff, moist, slightly plastic.	▥			169	44
2.2 2.4	Becoming orange streaked pale grey.	▥			139	64
2.6 2.8	Silty CLAY with fine sand; orange mottled white. Very stiff, moist, moderately plastic.	▨			139	61
3	End of Borehole at 3.0 m bgl.				End of Borehole at 3.0 m bgl.	

BOREHOLE C (BH C)

PROJECT NUMBER AKE-G00745
PROJECT NAME 395 Fitzgerald Road
CLIENT Taha Auto Group
ADDRESS 395 Fitzgerald Road,
Drury, Auckland 2113

DRILLING DATE 05 April 2025
TOTAL DEPTH 3 m
DIAMETER 50 mm

SU Corr. Factor 1.389
SURFACE ELEVATION RL 20.00 m

COMMENTS BH C Location shown on Figure 4 & Figure 5, Appendix A.

LOGGED BY VO/AN
CHECKED BY VO

Depth (m)	Material Description	Graphic Log	Moisture	NO Static Groundwater was encountered at BHC on 05/04/25	Peak Shear (kPa)	Residual Shear (kPa)
	Topsoil	▨	Moist			
0.2	Clayey SILT with some fine to medium sand; orange brown. Very stiff, moist, slightly plastic. (Tauranga Group - River and Hill Deposits)	▨				
0.4					78	28
0.6						
0.8						
1	Silty CLAY with fine sand; grey streaked orange brown. Stiff, moist, moderately plastic.	▨			94	47
1.2						
1.4	Clayey SILT with fine to medium sand; pale grey streaked orange and pink. Very stiff, moist, slightly plastic.	▨			111	56
1.6						
1.8						
2					72	14
2.2						
2.4	Becoming orange.				94	19
2.6	Becoming pink mottled white and red.					
2.8						
3	End of Borehole at 3.0 m bgl.				92 End of Borehole at 3.0 m bgl.	19

BOREHOLE D (BH D)

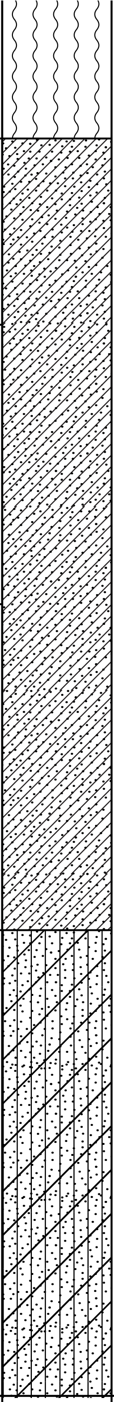
PROJECT NUMBER AKE-G00745
PROJECT NAME 395 Fitzgerald Road
CLIENT Taha Auto Group
ADDRESS 395 Fitzgerald Road,
Drury, Auckland 2113

DRILLING DATE 05 April 2025
TOTAL DEPTH 3 m
DIAMETER 50 mm

SU Corr. Factor 1.389
SURFACE ELEVATION RL 20.00 m

COMMENTS BH D Location shown on Figure 4 & Figure 5, Appendix A.

LOGGED BY VO/AN
CHECKED BY VO

Depth (m)	Material Description	Graphic Log	Moisture	NO Static Groundwater was encountered at BHD on 05/04/25	Peak Shear (kPa)	Residual Shear (kPa)
0.2	Topsoil		Moist			
0.4 0.6	Silty CLAY with some fine sand; orange brown mottled grey. Very stiff, moist, moderately plastic. (Tauranga Group - River and Hill Deposits)				153	75
0.8 1 1.2	Becoming orange mottled pale grey streaked red.				156	72
1.4 1.6 1.8	Becoming white mottled orange streaked pink, with some fine to medium sand.				131 97	44 25
2 2.2 2.4 2.6 2.8	Clayey SILT with some fine to medium sand; pinkish red streaked orange and white. Stiff, moist, slightly to moderately plastic.				56 61	17 14
3	End of Borehole at 3.0 m bgl.				End of Borehole at 3.0 m bgl.	

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BOREHOLE E (BH E)

PROJECT NUMBER AKE-G00745
PROJECT NAME 395 Fitzgerald Road
CLIENT Taha Auto Group
ADDRESS 395 Fitzgerald Road,
Drury, Auckland 2113

DRILLING DATE 05 April 2025
TOTAL DEPTH 3 m
DIAMETER 50 mm

SU Corr. Factor 1.389
SURFACE ELEVATION RL 18.50 m

COMMENTS BH E Location shown on Figure 4 & Figure 5, Appendix A.

LOGGED BY VO/AN
CHECKED BY VO

Depth (m)	Material Description	Graphic Log	Moisture	NO Static Groundwater was encountered at BHE on 05/04/25	Peak Shear (kPa)	Residual Shear (kPa)
	Topsoil		Moist			
0.2						
	Silty CLAY with some fine sand; greyish brown streaked orange. Very stiff, moist, moderately plastic. (Tauranga Group - River and Hill Deposits)					
0.4						
					183	72
0.6	Becoming light brown streaked orange and pale grey.					
0.8						
1					200+	-
1.2						
	Becoming orange streaked pale grey, with some fine to medium sand.					
1.4						
					117	44
1.6						
1.8						
2					114	58
2.2						
	Becoming white streaked orange and pink, with some fine sand.					
2.4						
					128	58
2.6						
2.8						
3					114	42
	End of Borehole at 3.0 m bgl.				End of Borehole at 3.0 m bgl.	

BOREHOLE F (BH F)

PROJECT NUMBER AKE-G00745
PROJECT NAME 395 Fitzgerald Road
CLIENT Taha Auto Group
ADDRESS 395 Fitzgerald Road,
Drury, Auckland 2113

DRILLING DATE 05 April 2025
TOTAL DEPTH 3 m
DIAMETER 50 mm

SU Corr. Factor 1.389
SURFACE ELEVATION RL 18.75 m

COMMENTS BH F Location shown on Figure 4 & Figure 5, Appendix A.

LOGGED BY VO/AN
CHECKED BY VO

Depth (m)	Material Description	Graphic Log	Moisture	NO Static Groundwater was encountered at BHF on 05/04/25	Peak Shear (kPa)	Residual Shear (kPa)
0.2	Topsoil		Moist			
0.4 0.6 0.8	Silty CLAY with some fine to medium sand; orange mottled white and pink. Very stiff, moist, moderately plastic. (Non-Engineered Fill)				114 103	28 42
1 1.2 1.4 1.6	Clayey SILT with some fine to medium sand; orange brown streaked grey. Very stiff, moist, slightly plastic. (Tauranga Group - River and Hill Deposits)				200+	-
1.8 2 2.2 2.4 2.6	Silty CLAY with some fine sand; grey brown streaked orange and pale grey, Very stiff, moist, moderately plastic.				200+ 131	- 56
2.8	Becoming orange mottled pale grey.				103	47
3	End of Borehole at 3.0 m bgl.				End of Borehole at 3.0 m bgl.	

CONE PENETRATION TEST (CPT) LOG

HOLE NO.: CPT01

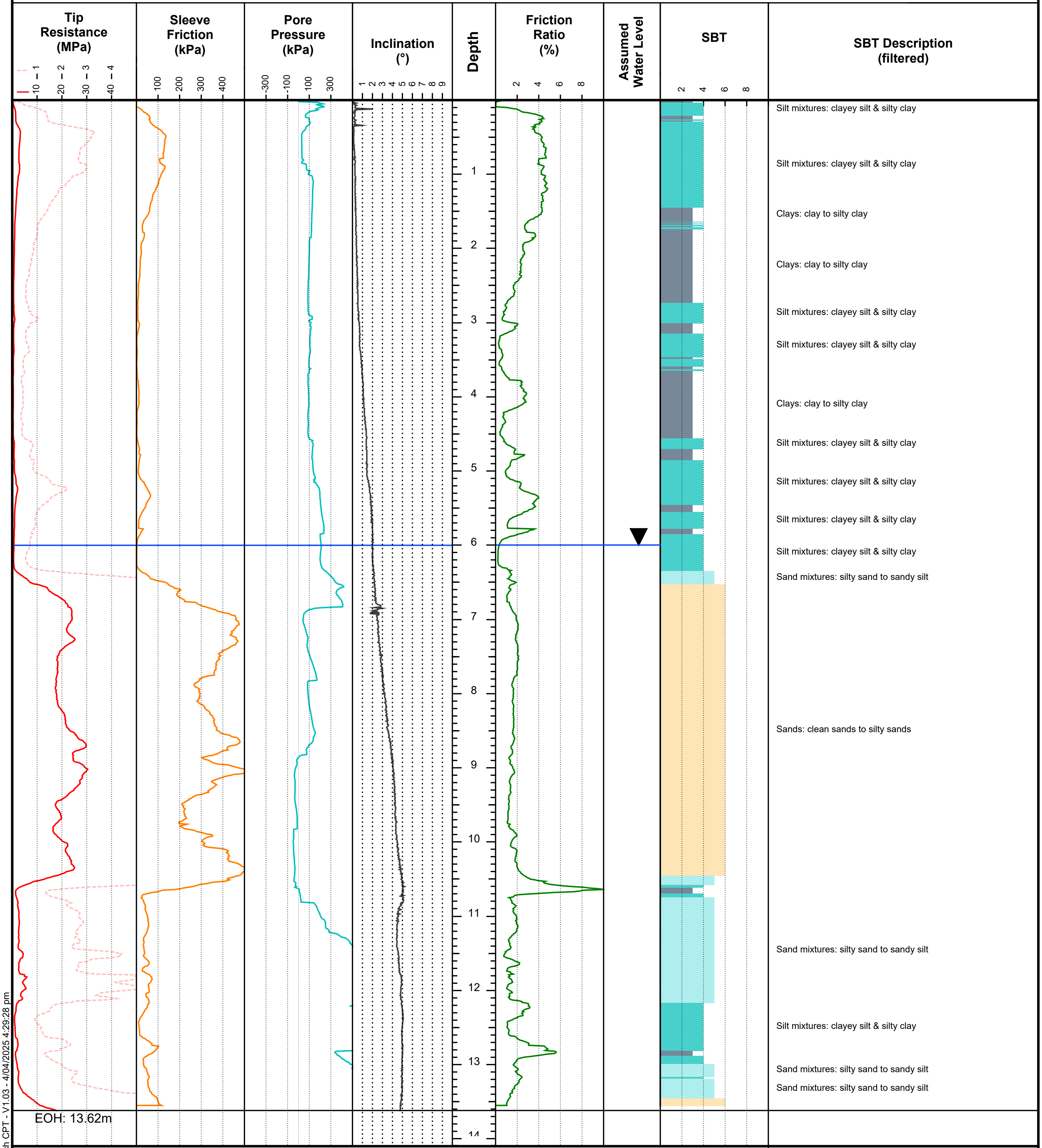
CLIENT: AKEL Consulting Engineers
PROJECT: CPT Testing

JOB NO.: QU-0140

SITE LOCATION: 395 Fitzgerald Road, Drury, Auckland
CO-ORDINATES: 1774733.00mE, 5890263.00mN (NZTM)

OPERATOR: CW
ELEVATION: 22m (NZVD2016)

START DATE: 04/04/2025
END DATE: 04/04/2025



REMARKS:

Groundwater measured at 6.0m (Dipmeter)
Coordinates from handheld GPS accurate to +/-4m
Pagani TG63-150 Rig. Cone specs: Lenght: 290 mm, Diameter: 35.8 mm, Cone Base Area: 10 cm². Side sleeve surfaces: 150 cm²

NOTES:

TEST DETAILS:

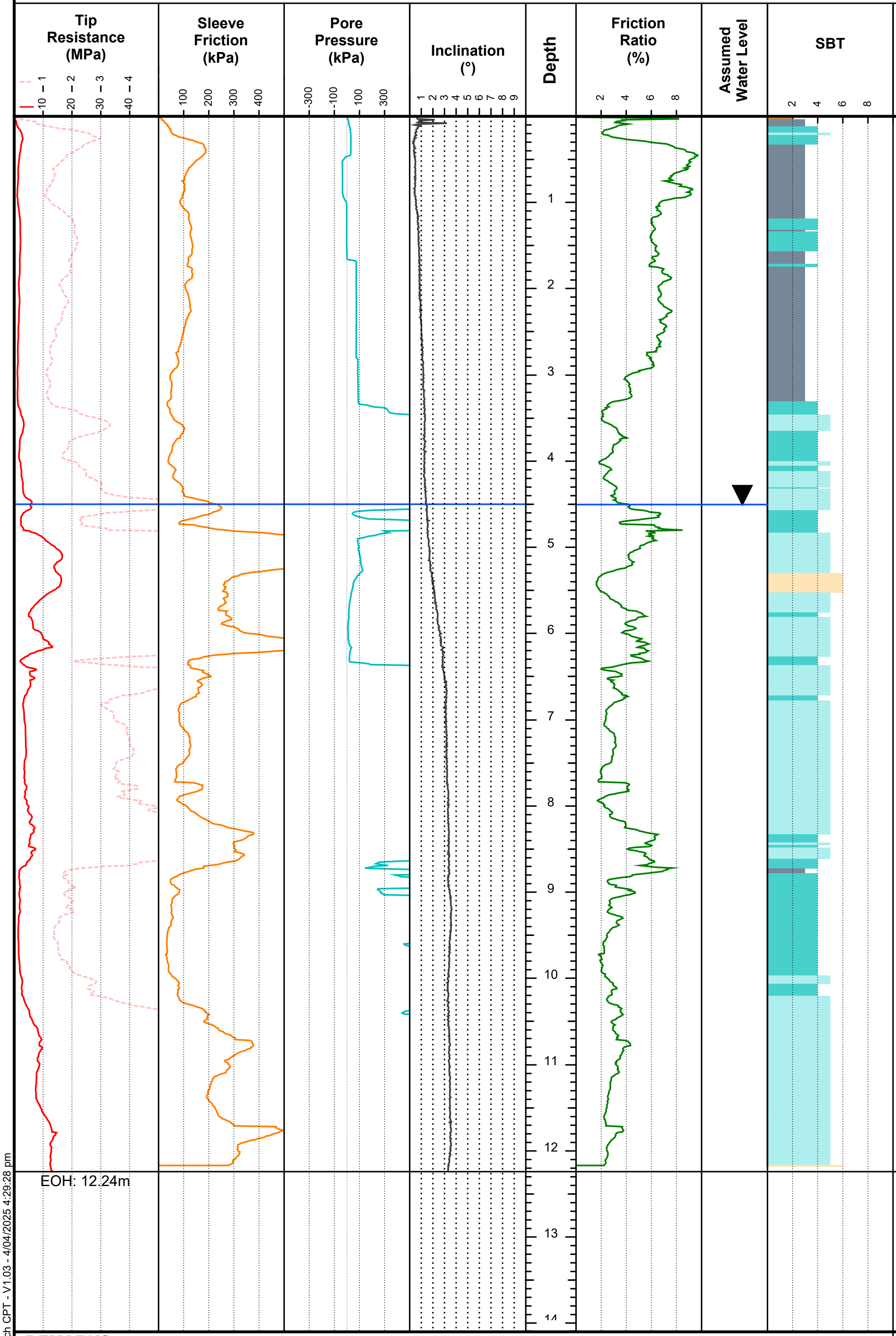
Cone Number	000954
Cone Type	PC
Area Ratio	0.80
Filter Location	u2
Termination Reason	u2 refusal

CONE PENETRATION TEST (CPT) LOG

HOLE NO.: CPT02

CLIENT: AKEL Consulting Engineers
PROJECT: CPT Testing
JOB NO.: QU-0140

SITE LOCATION: 395 Fitzgerald Road, Drury, Auckland
OPERATOR: CW
START DATE: 04/04/2025
CO-ORDINATES: 1774627.00mE, 5890166.00mN (NZTM)
ELEVATION: 20m (NZVD2016)
END DATE: 04/04/2025



SBT Description (filtered)

Clays: clay to silty clay

Silt mixtures: clayey silt & silty clay

Clays: clay to silty clay

Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt

Silt mixtures: clayey silt & silty clay

Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

Silt mixtures: clayey silt & silty clay

Sand mixtures: silty sand to sandy silt

Sands: clean sands to silty sands
Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

Silt mixtures: clayey silt & silty clay

Sand mixtures: silty sand to sandy silt

REMARKS:

Groundwater measured at 4.5m (Dipmeter)
Coordinates from handheld GPS accurate to +/-4m
Pagani TG63-150 Rig. Cone specs: Lenght: 290 mm, Diameter: 35.8 mm, Cone Base Area: 10 cm². Side sleeve surfaces: 150 cm²

NOTES:

TEST DETAILS:

Cone Number	000954
Cone Type	PC
Area Ratio	0.80
Filter Location	u2
Termination Reason	u2 refusal

AKEL
CONSULTING ENGINEERS
1 - 7 BRICK STREET HENDERSON
AUCKLAND 0610
PH: 0508 425 364
EMAIL:ADMIN@AKENG.CO.NZ

Client:	Taha Auto Group	**Tested by:**	AN
Project name:	395 Fitzgerald Road	**Checked by:**	VO/AK
Project No:	AKE-G00745	**Start date:**	7/04/2025
Sample depth (m):	0.80m - 1.2m	**End date:**	9/04/2025
Sample ID:	SS1	**Collected date:**	5/04/2025

SHRINK SWELL INDEX REPORT

Soil Description:

Silty CLAY with some fine sand; pale grey mottled orange and pink. Very stiff, moist, moderately plastic.
(Tauranga Group - River and Hill Deposits)

Shrink Test - AS1289:2003 Test 7.1.1

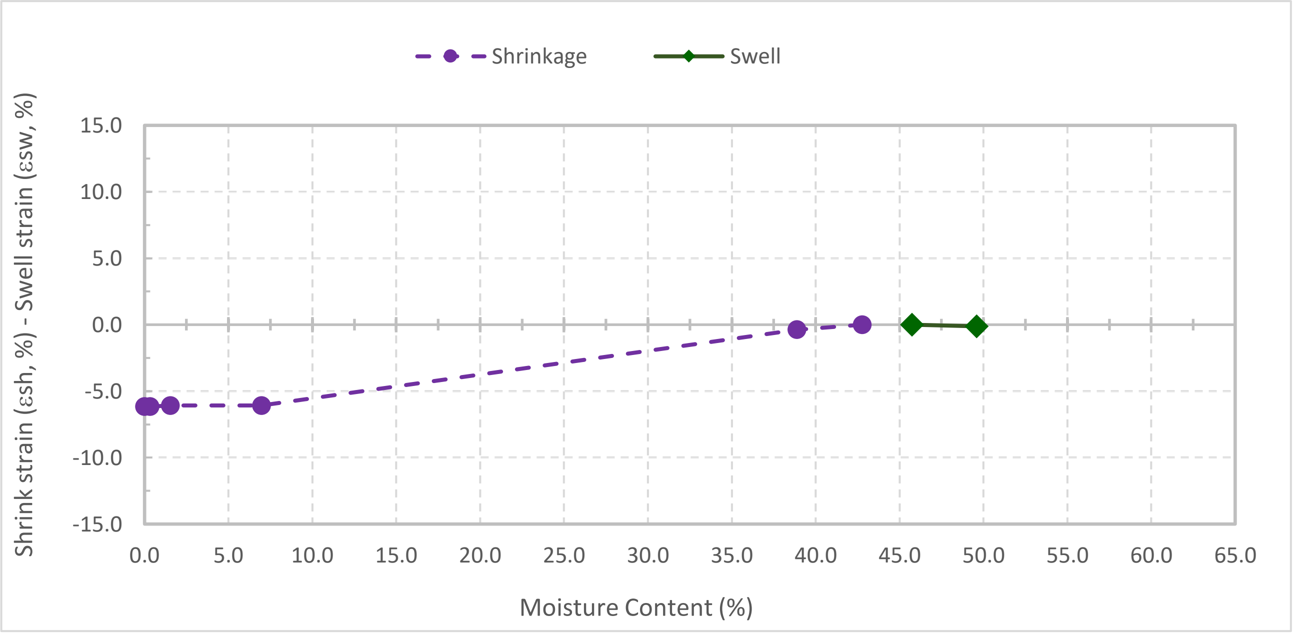
Shrink on Drying (%):	6.2
Shrinkage Moisture Content (%):	42.8
Est. inert Material (%):	0
Est. Crumbling during Shrinkage (%):	30
Est. Cracking during Shrinkage (%):	0

Swell Test - AS1289:2003 Test 7.1.1

Swell on Saturation (%):	-0.12
Moisture Content before (%):	45.7
Moisture Content after (%):	49.6

Shrink Swell Index - I_{ss} (%): **3.4**

Shrink Swell Strain - Moisture Content



Comments

AKEL
CONSULTING ENGINEERS
1 - 7 BRICK STREET HENDERSON
AUCKLAND 0610
PH 0508 425 364
EMAIL ADMIN@AKENG.CO.NZ

Client:	Taha Auto Group	**Tested by:**	AN
Project name:	395 Fitzgerald Road	**Checked by:**	VO/AK
Project No:	AKE-G00745	**Start date:**	7/04/2025
Sample depth (m):	0.80m - 1.2m	**End date:**	9/04/2025
Sample ID:	SS1	**Collected date:**	5/04/2025

SHRINK SWELL INDEX REPORT

Soil Description:

Silty CLAY with some fine sand; pale grey mottled orange and pink. Very stiff, moist, moderately plastic.
(Tauranga Group - River and Hill Deposits)

Shrink Test - AS1289:2003 Test 7.1.1

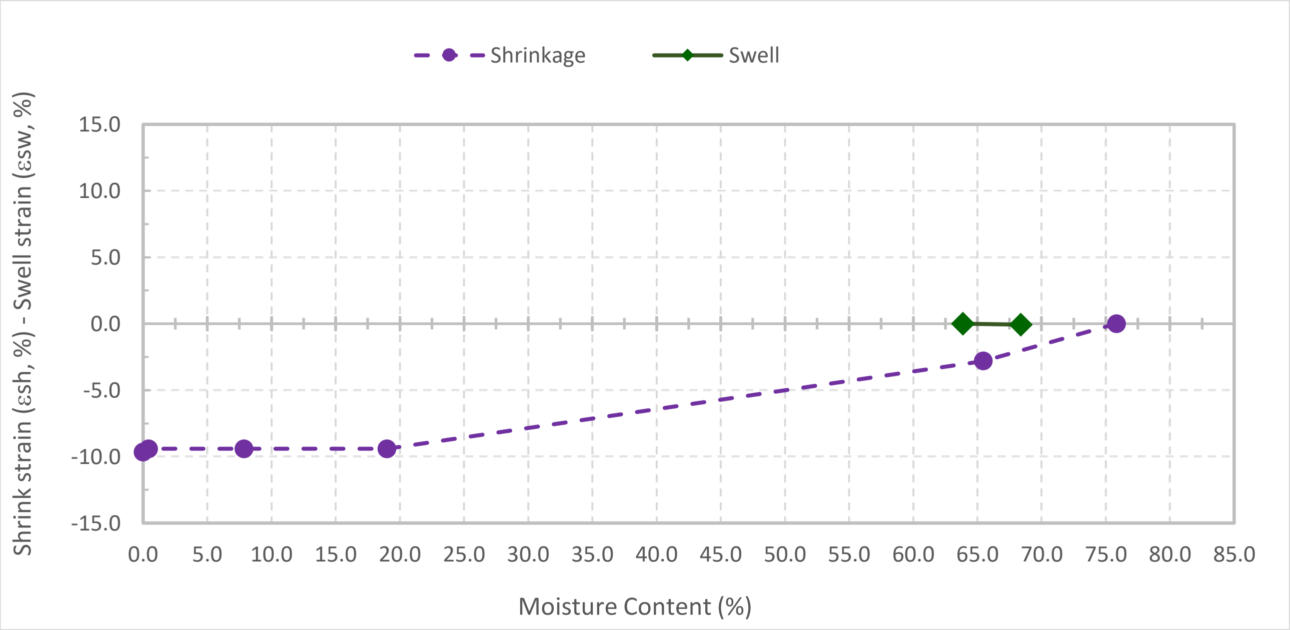
Shrink on Drying (%):	9.6
Shrinkage Moisture Content (%):	75.8
Est. inert Material (%):	0
Est. Crumbling during Shrinkage (%):	10
Est. Cracking during Shrinkage (%):	0

Swell Test - AS1289:2003 Test 7.1.1

Swell on Saturation (%):	-0.07
Moisture Content before (%):	63.9
Moisture Content after (%):	68.4

Shrink Swell Index - I_{ss} (%): **5.4**

Shrink Swell Strain - Moisture Content



Comments

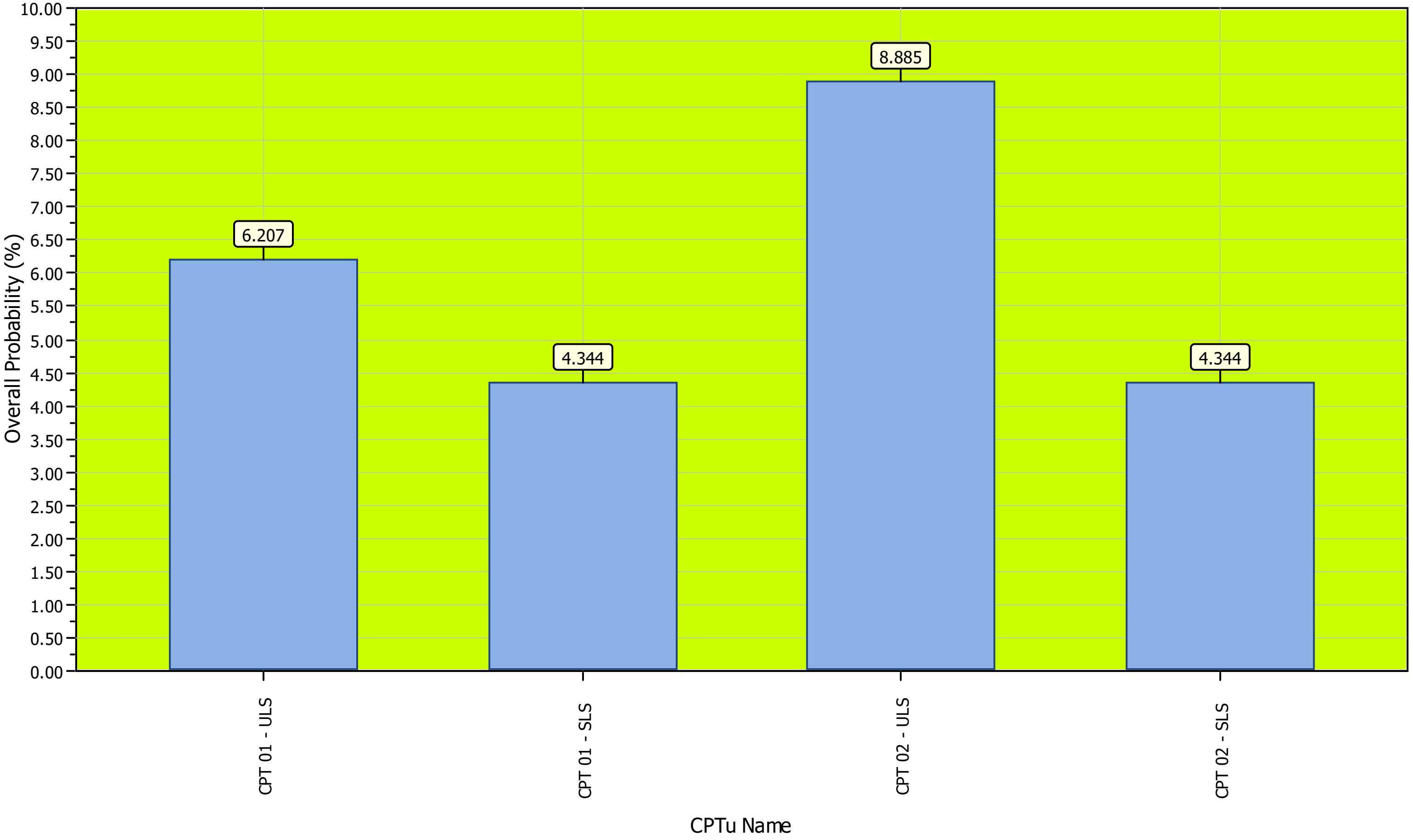
APPENDIX C

LIQUEFACTION ANALYSIS
OUTPUTS

Project title : AKE- G00745

Location : 395 Fitzgerald Road, Drury

Overall Probability for Liquefaction report



Probability color scheme

🟥 Very High Probability
🟧 High Probability
🟩 Low Probability

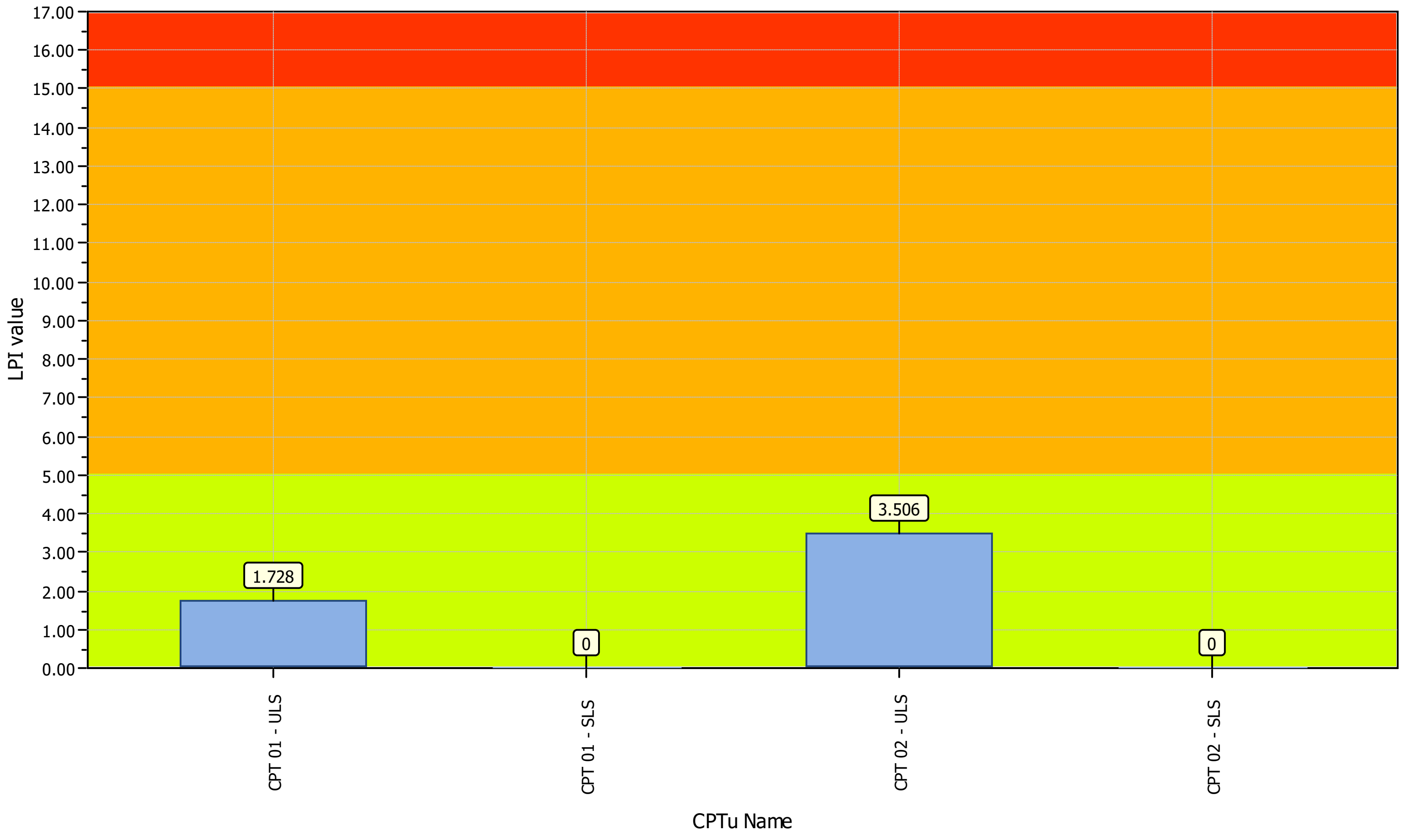
Basic statistics

Total CPT number: 4
100% low probability
0% high probability
0% very high probability

Project title : AKE- G00745

Location : 395 Fitzgerald Road, Drury

Overall Liquefaction Potential Index report



LPI color scheme

- 🟥 Very high risk
- 🟧 High risk
- 🟩 Low risk

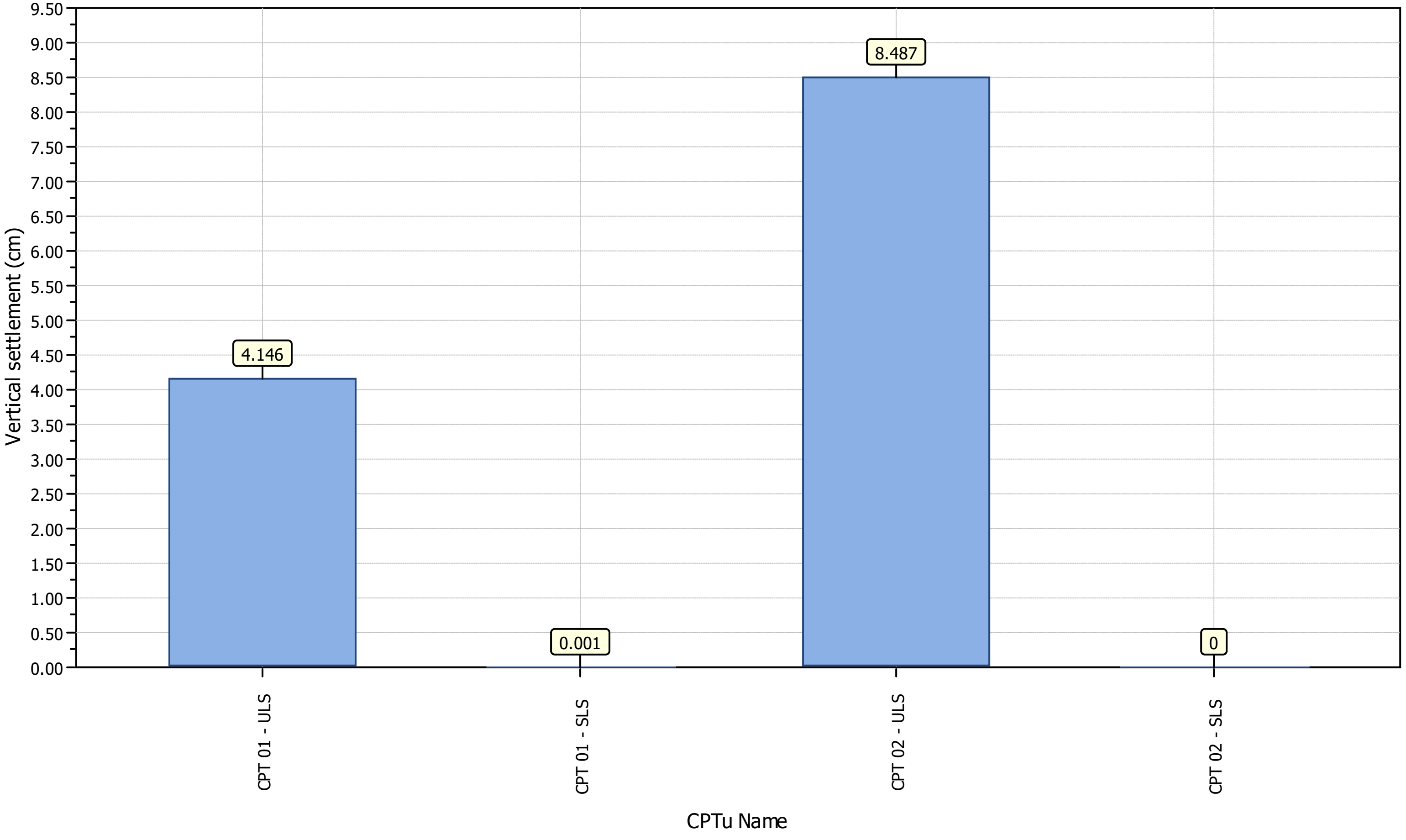
Basic statistics

Total CPT number: 4
100% low risk
0% high risk
0% very high risk

Project title : AKE- G00745

Location : 395 Fitzgerald Road, Drury

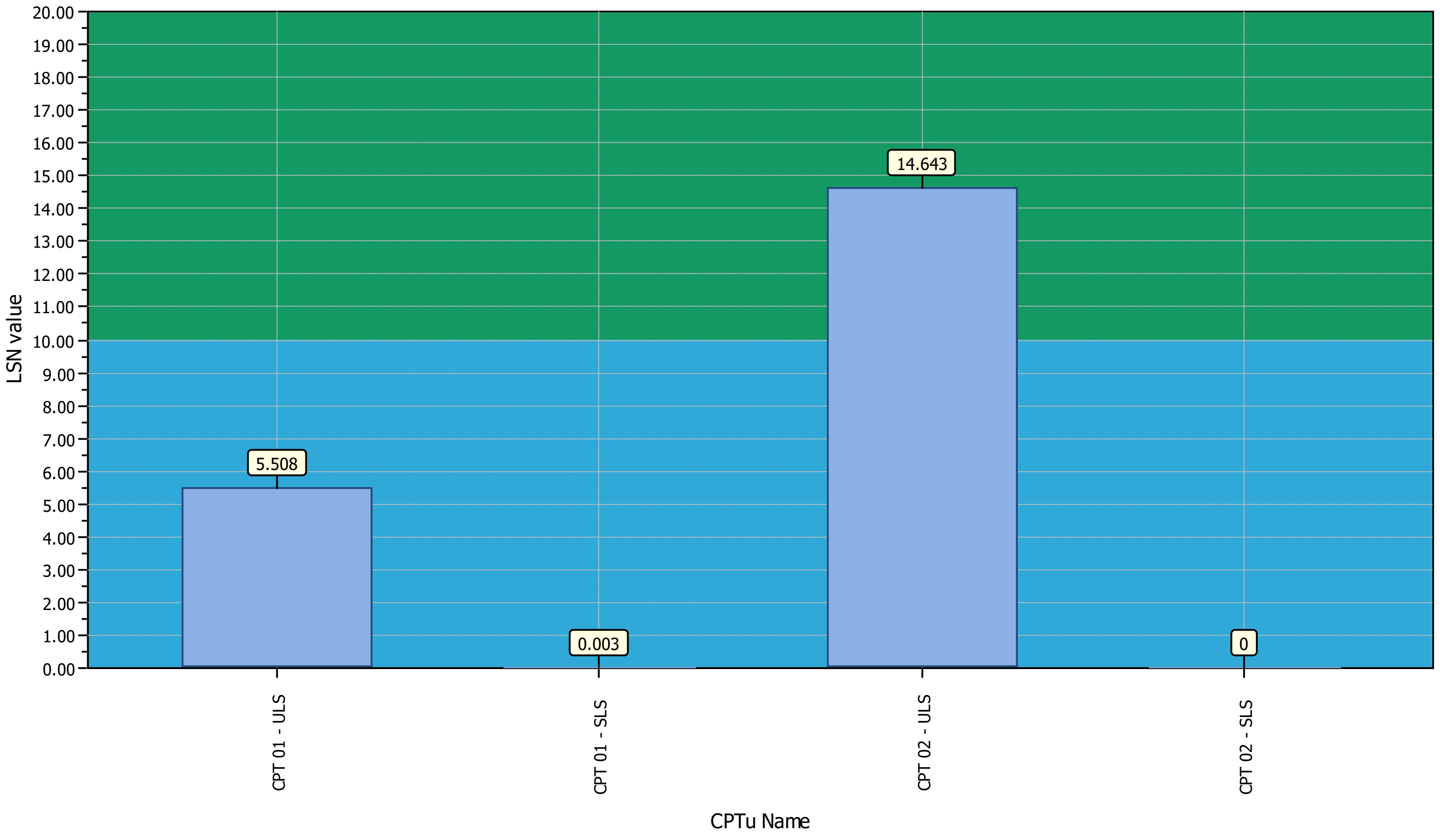
Overall vertical settlements report



Project title : AKE- G00745

Location : 395 Fitzgerald Road, Drury

Overall Liquefaction Severity Number report



LSN color scheme
- 🟥 Severe damage
- 🟥 Major expression of liquefaction
- 🟧 Moderate to severe exp. of liquefaction
- 🟨 Moderate expression of liquefaction
- 🟩 Minor expression of liquefaction
- 🟦 Little to no expression of liquefaction

Basic statistics

Total CPT number: 4

75% little liquefaction

25% minor liquefaction

0% moderate liquefaction

0% moderate to major liquefaction

0% major liquefaction

0% severe liquefaction

TABLE OF CONTENTS

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Geotechnical Engineers
1-7 Brick Street, Henderson, Auckland 0610
www.akeng.co.nz

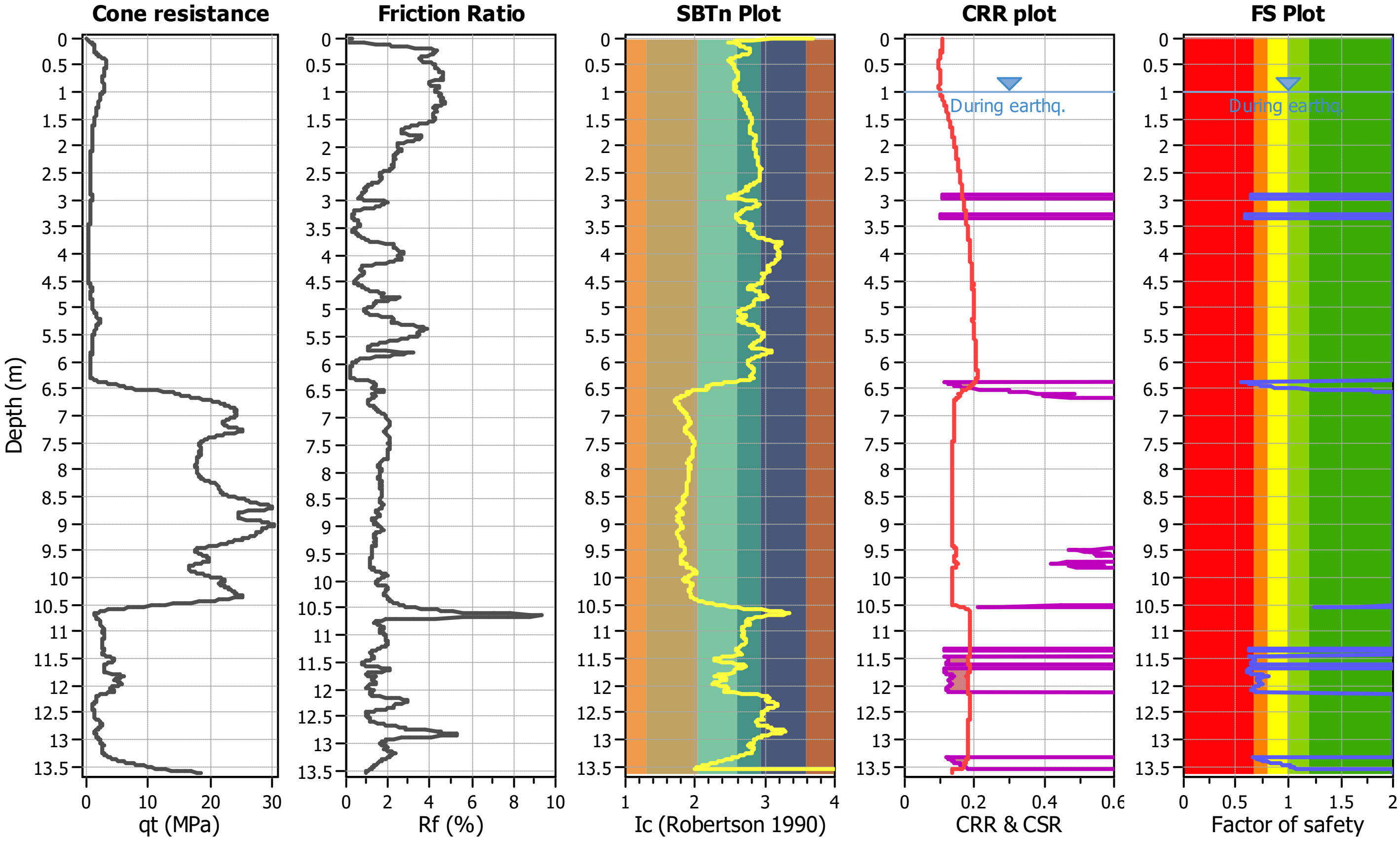
LIQUEFACTION ANALYSIS REPORT

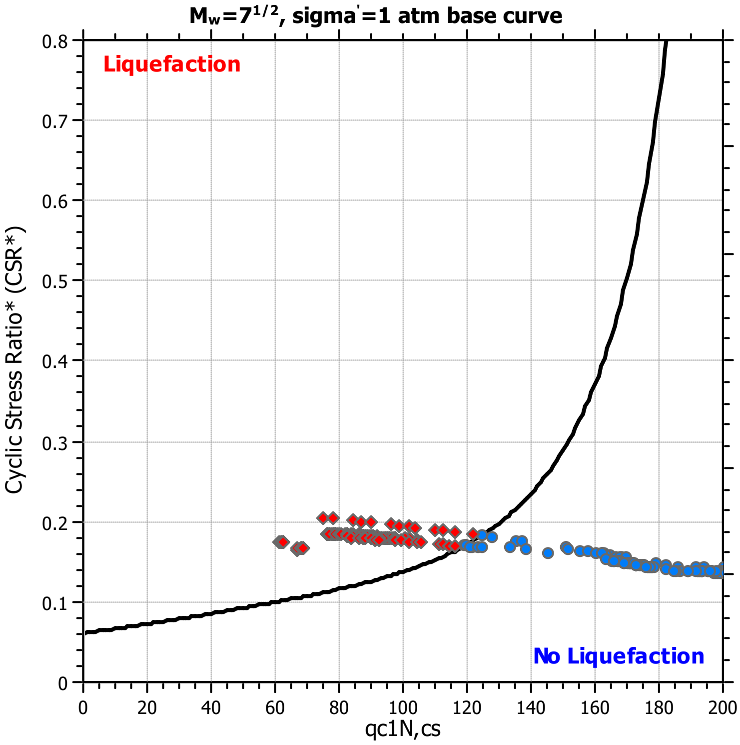
Project title : AKE- G00745 **Location : 395 Fitzgerald Road, Drury**

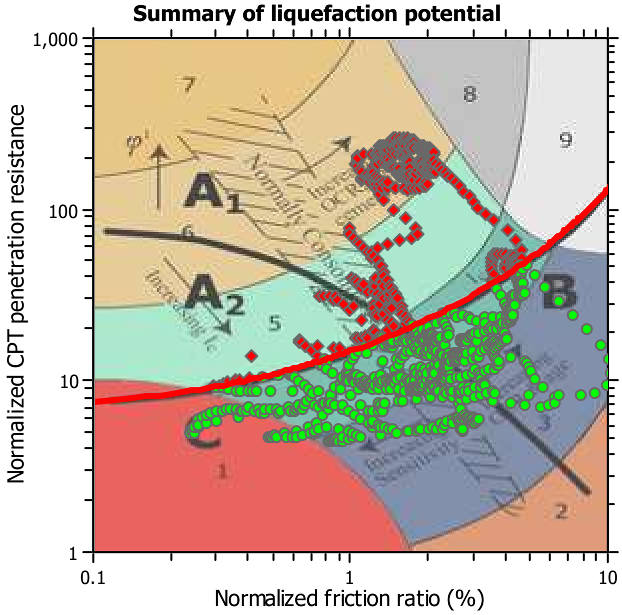
CPT file : CPT 01 - ULS

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

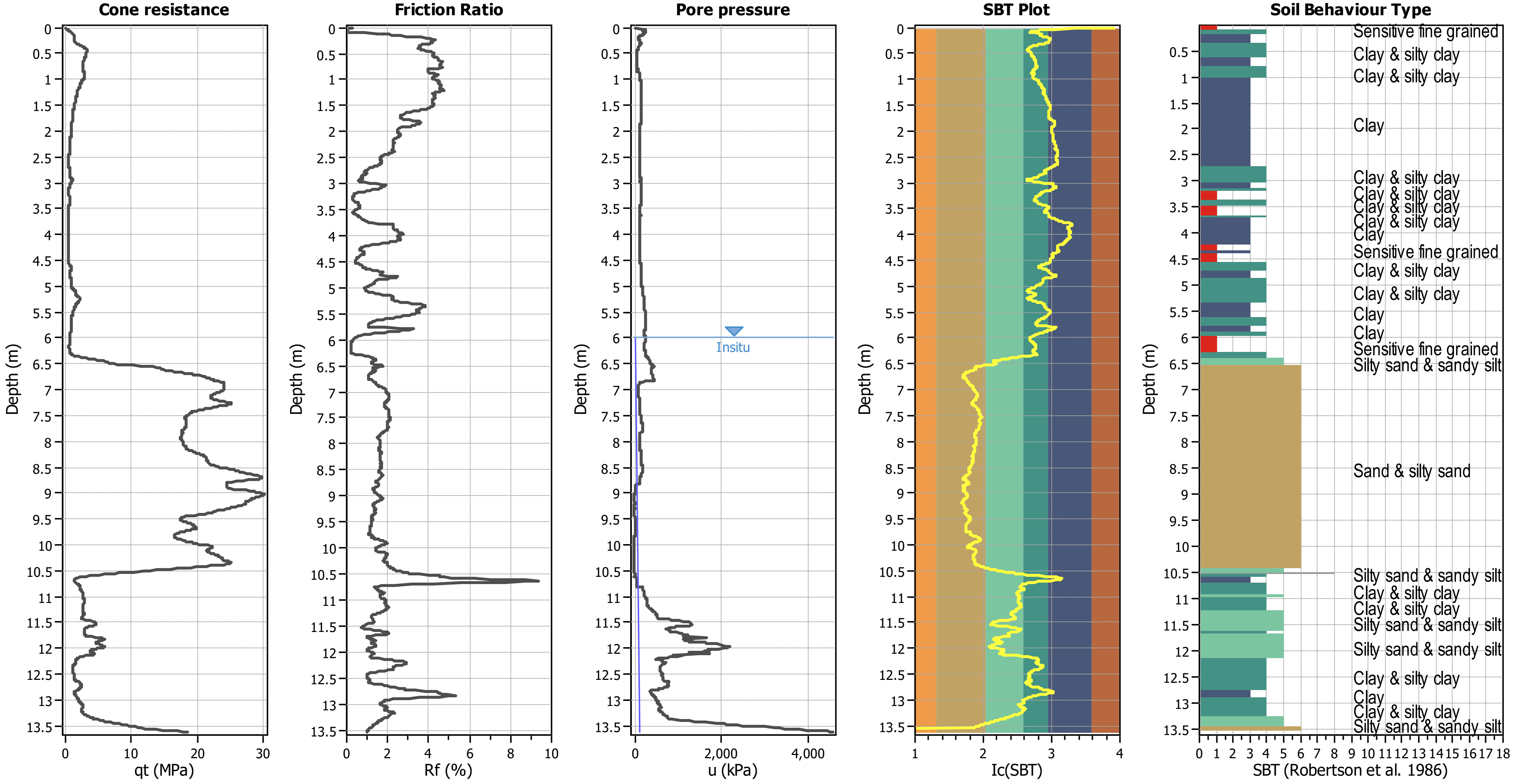






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



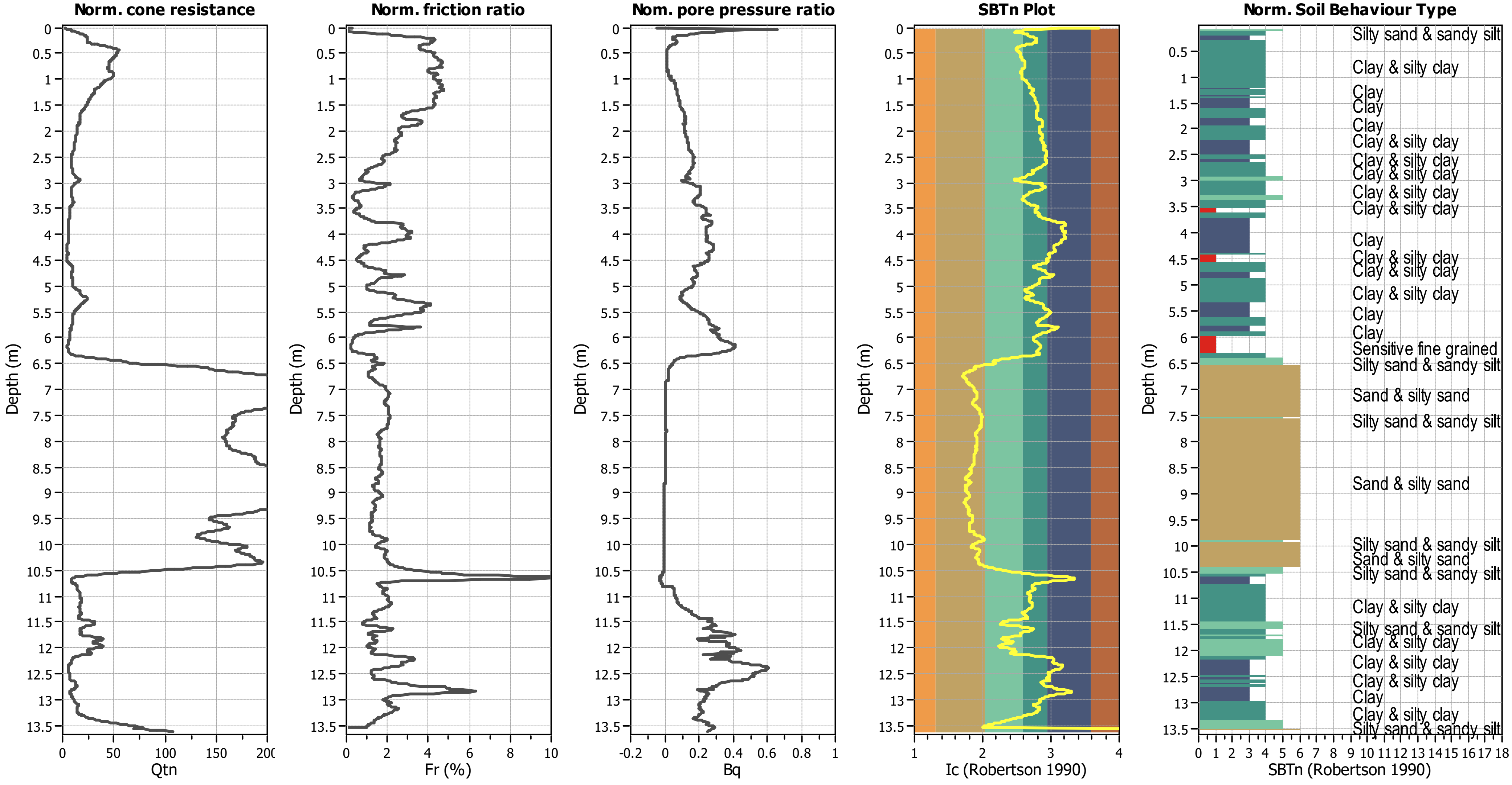
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

🟥 1. Sensitive fine grained	🟩 4. Clayey silt to silty	🟧 7. Gravely sand to sand
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬛ 8. Very stiff sand to
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

CPT basic interpretation plots (normalized)



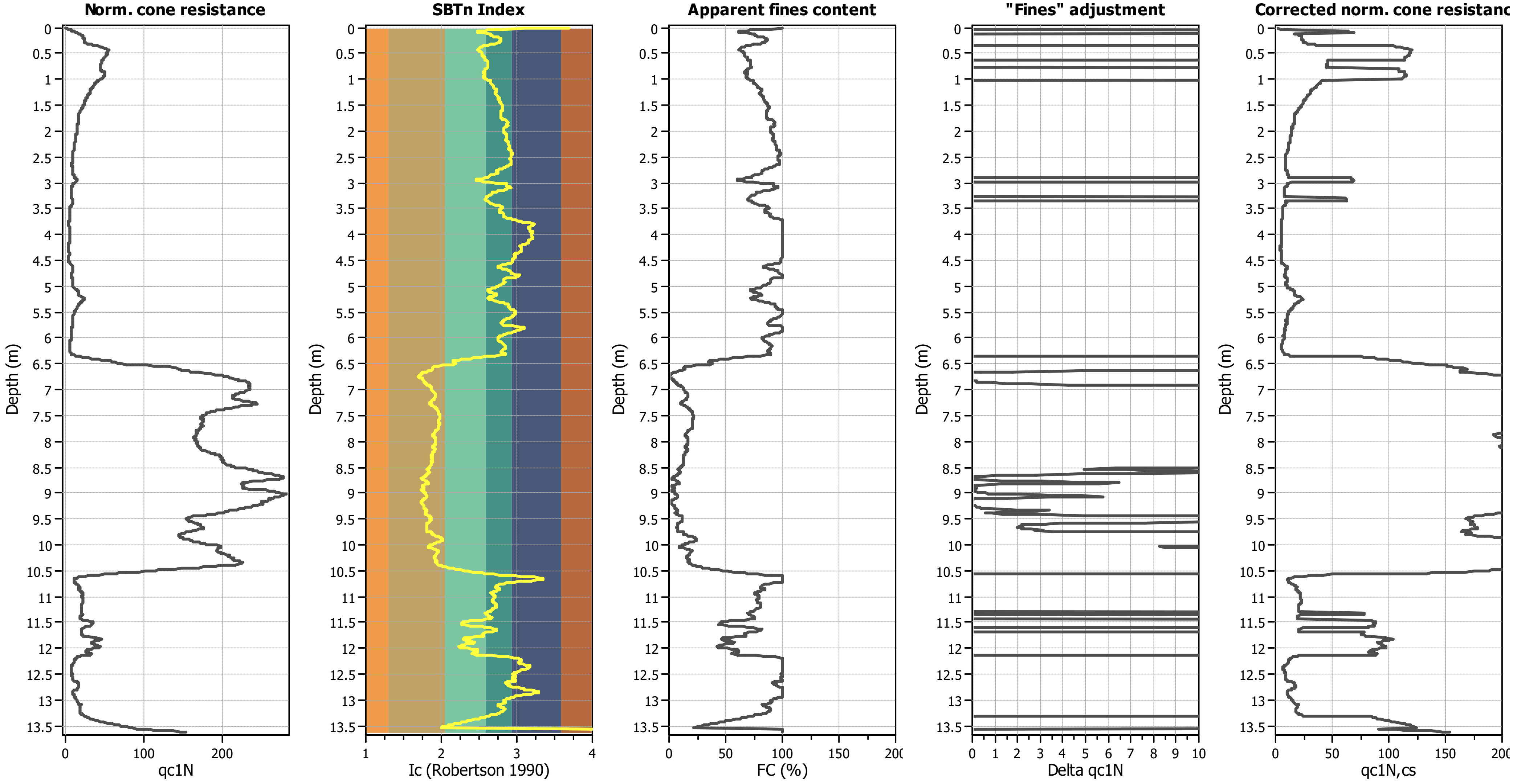
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟫 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

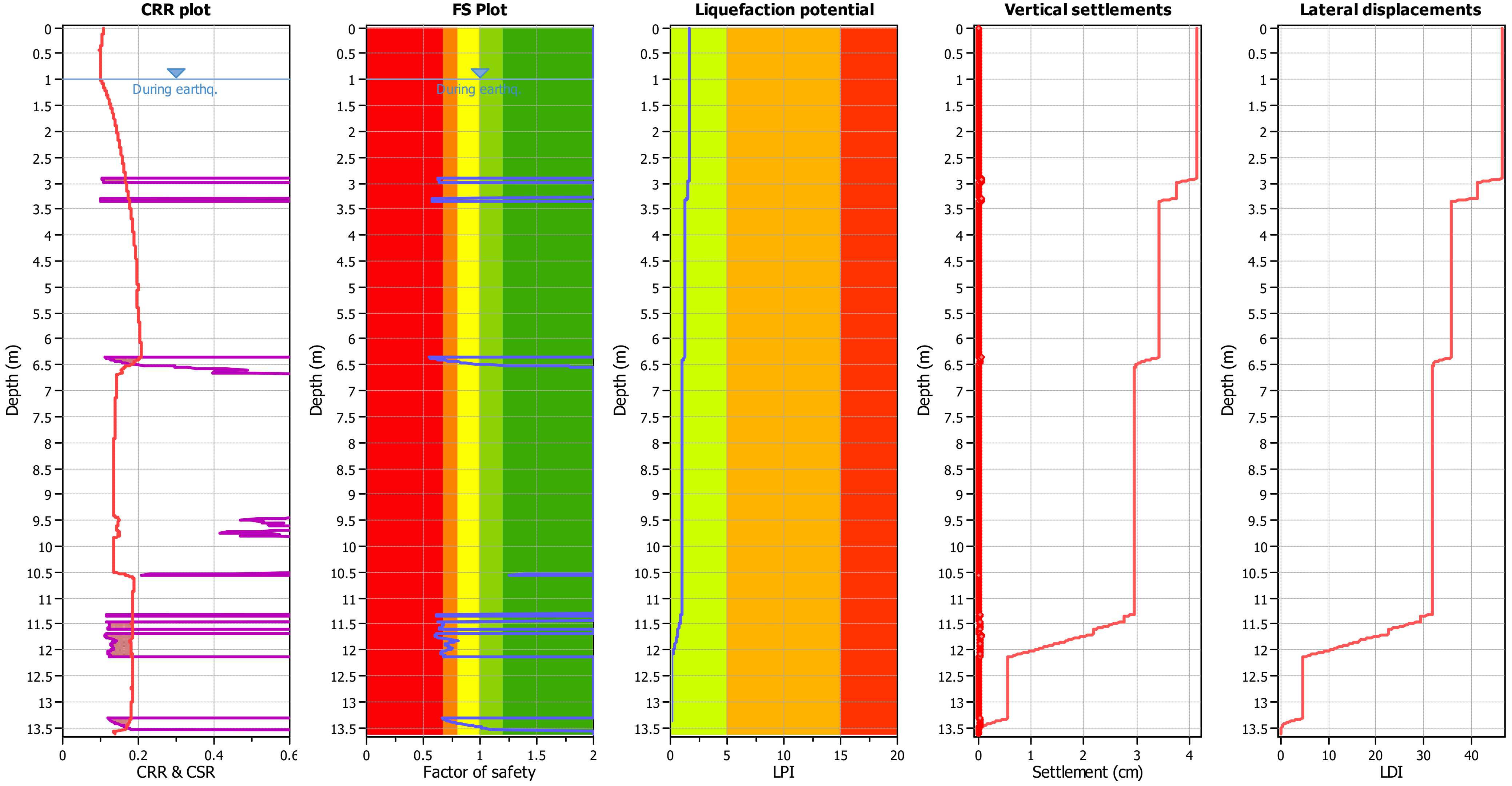
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	N/A	Limit depth:	N/A

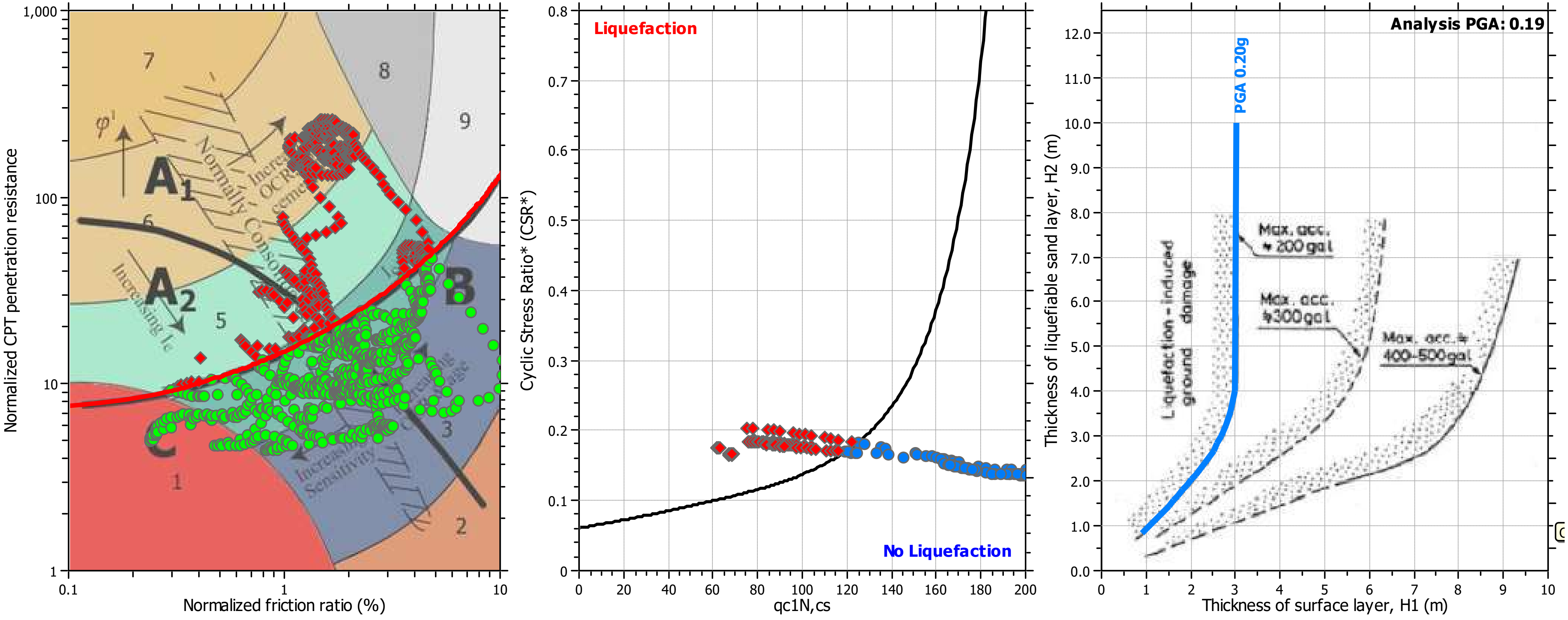
F.S. color scheme

- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

LPI color scheme

- 🟥 Very high risk
- 🟧 High risk
- 🟩 Low risk

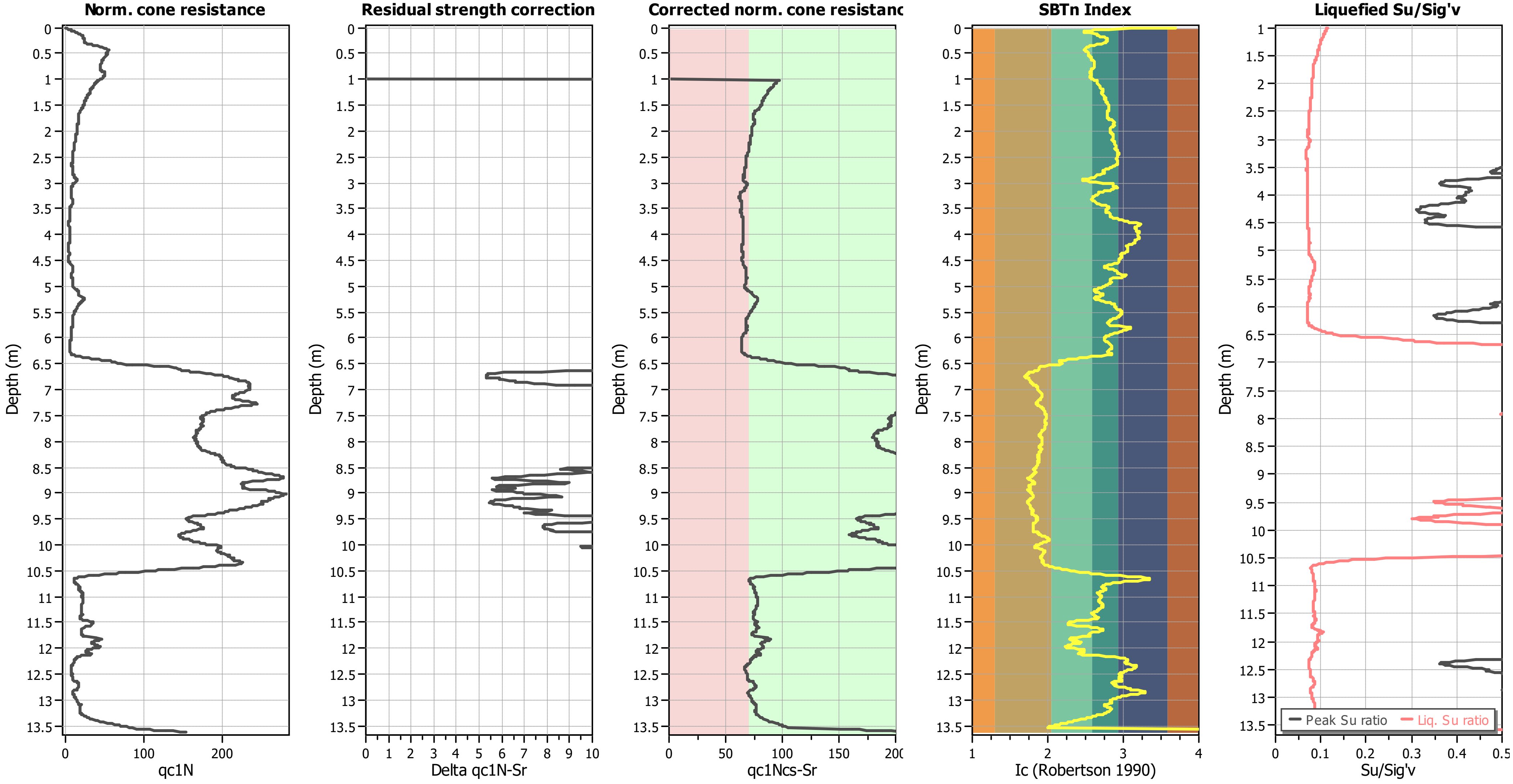
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	N/A	Limit depth:	N/A

AKEL Consulting Engineers
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www.akeng.co.nz

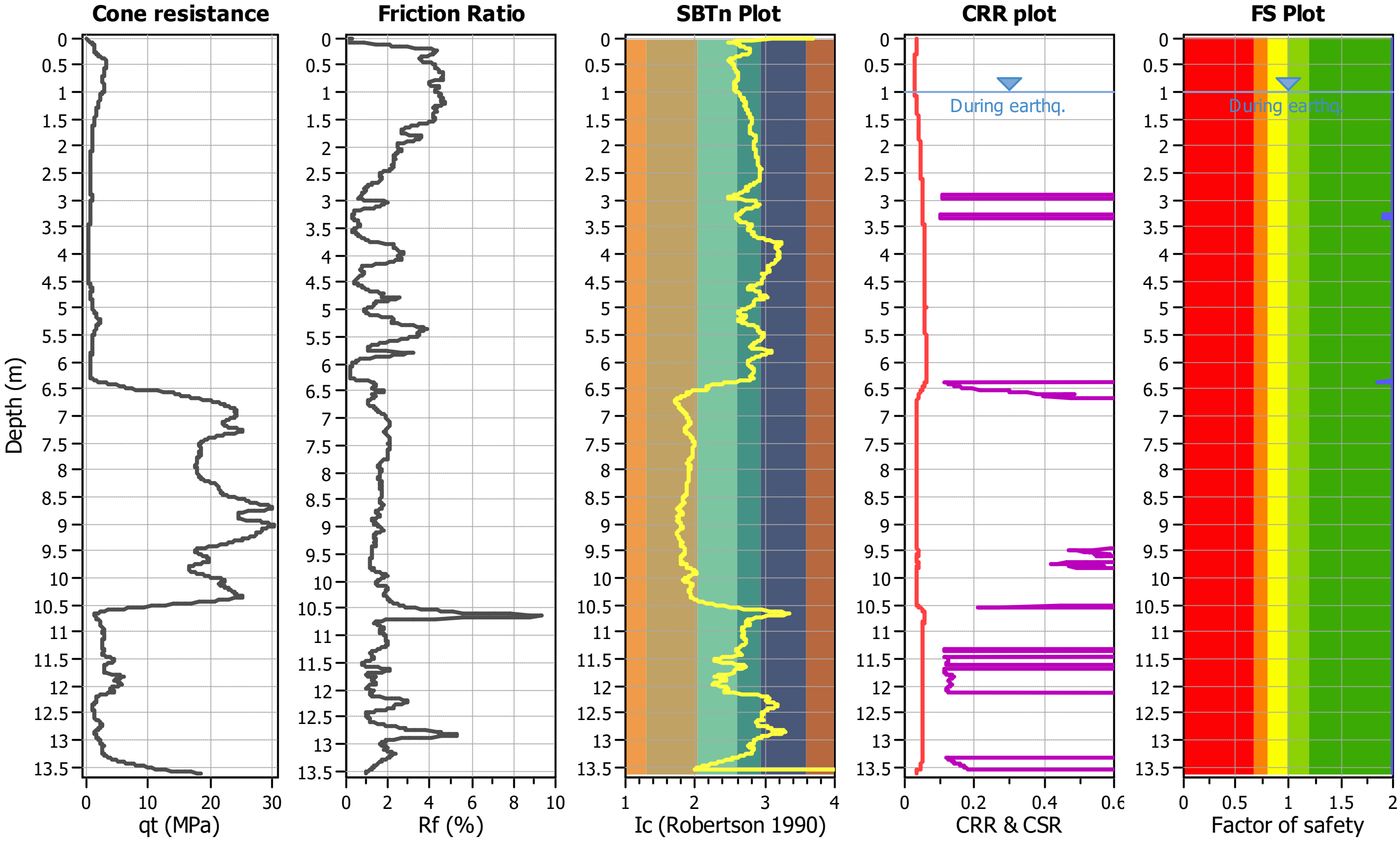
LIQUEFACTION ANALYSIS REPORT

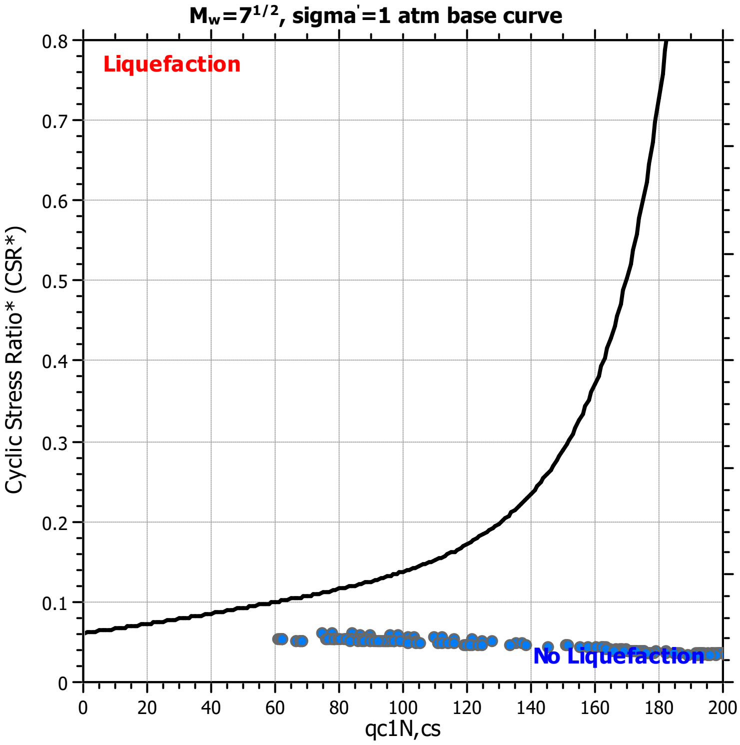
Project title : AKE- G00745 **Location : 395 Fitzgerald Road, Drury**

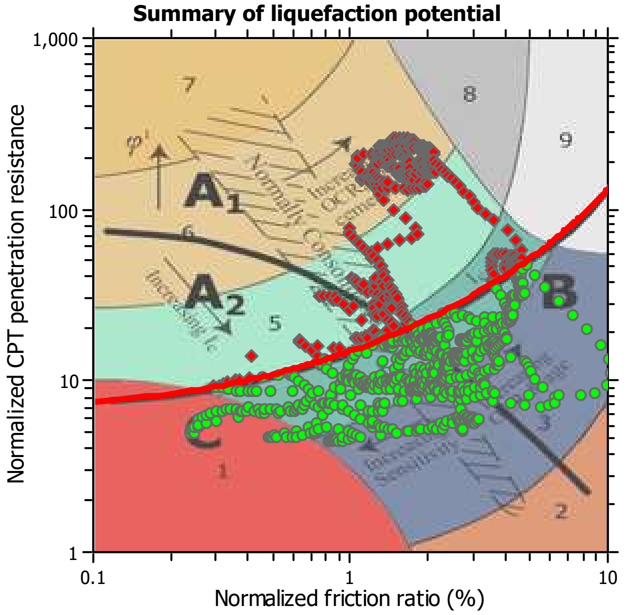
CPT file : CPT 01 - SLS

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.06	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

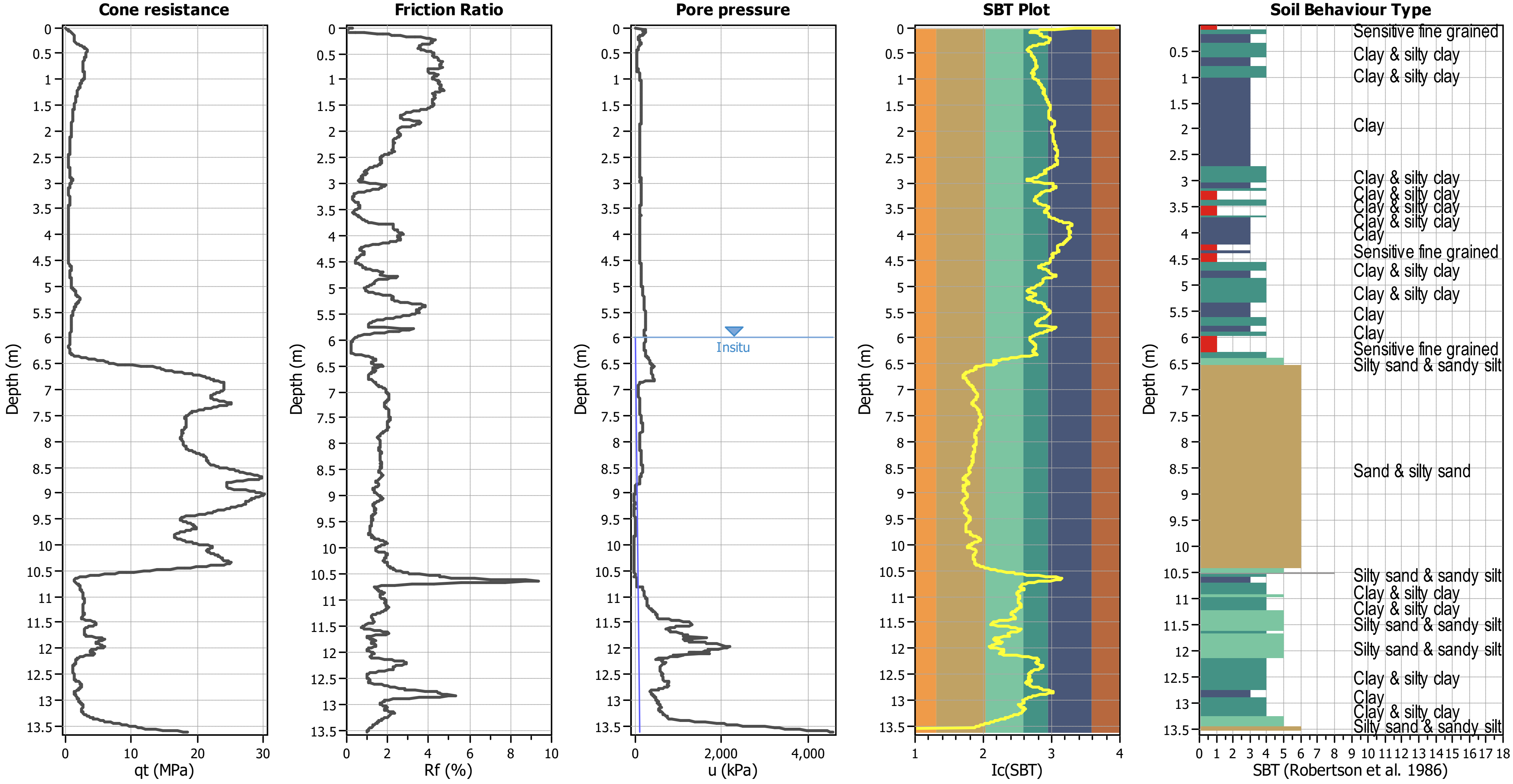






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 5.90
Peak ground acceleration: 0.06
Depth to water table (insitu): 6.00 m

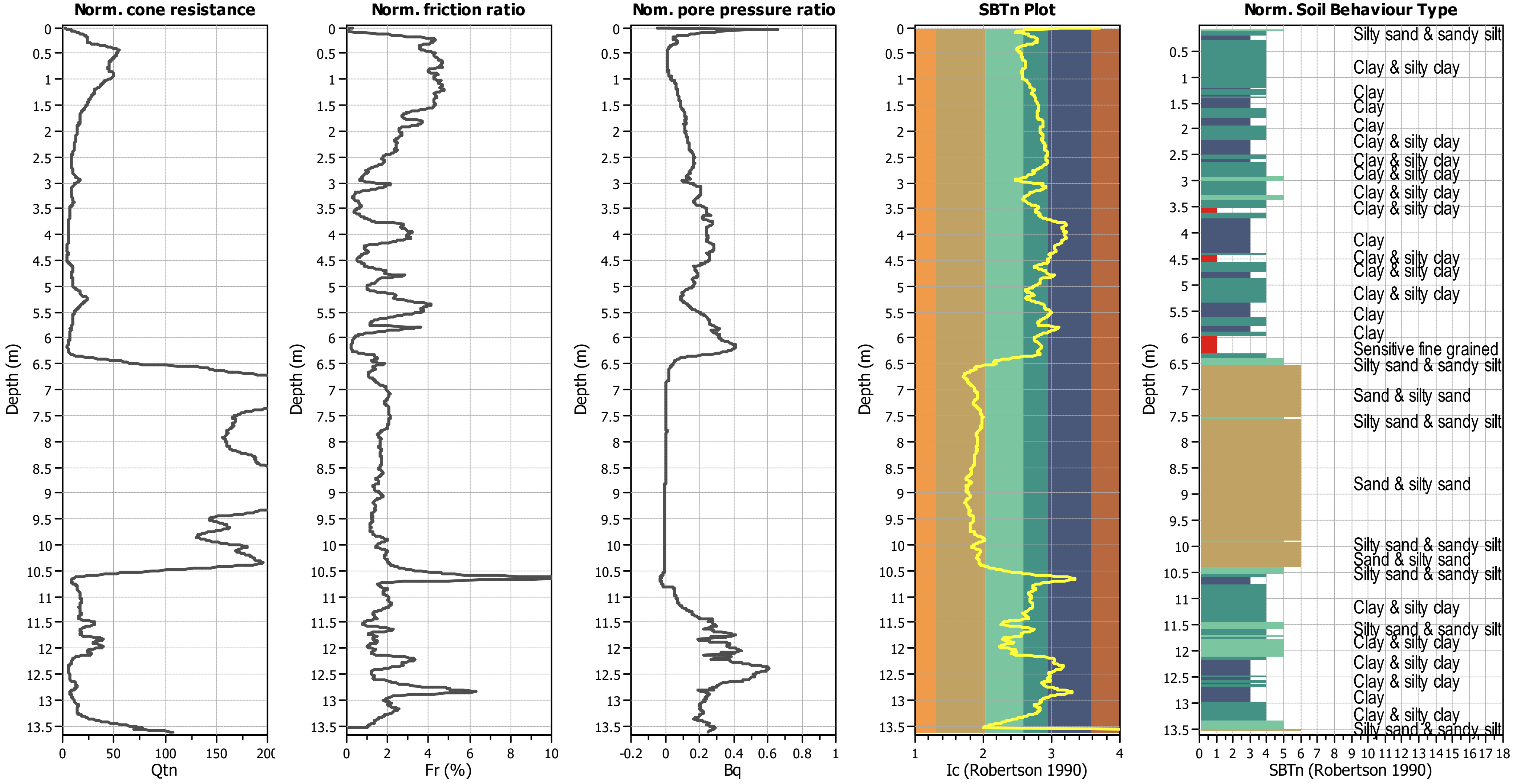
Depth to GWT (erthq.): 1.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
Limit depth: N/A

SBT legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟨 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

CPT basic interpretation plots (normalized)



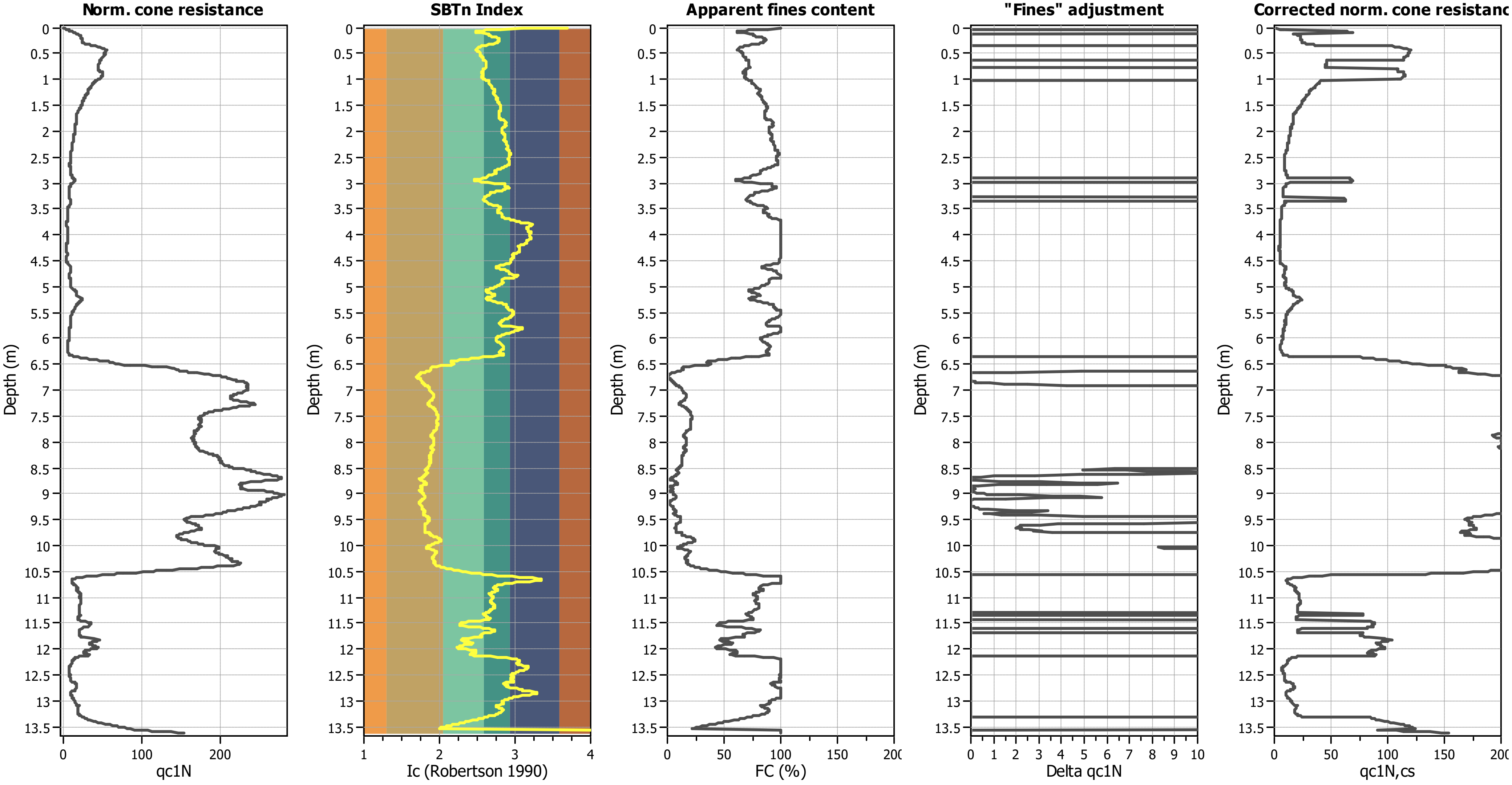
Input parameters and analysis data

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:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

🟥 1. Sensitive fine grained
🟫 2. Organic material
🟦 3. Clay to silty clay
🟩 4. Clayey silt to silty
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬛ 8. Very stiff sand to
⬜ 9. Very stiff fine grained

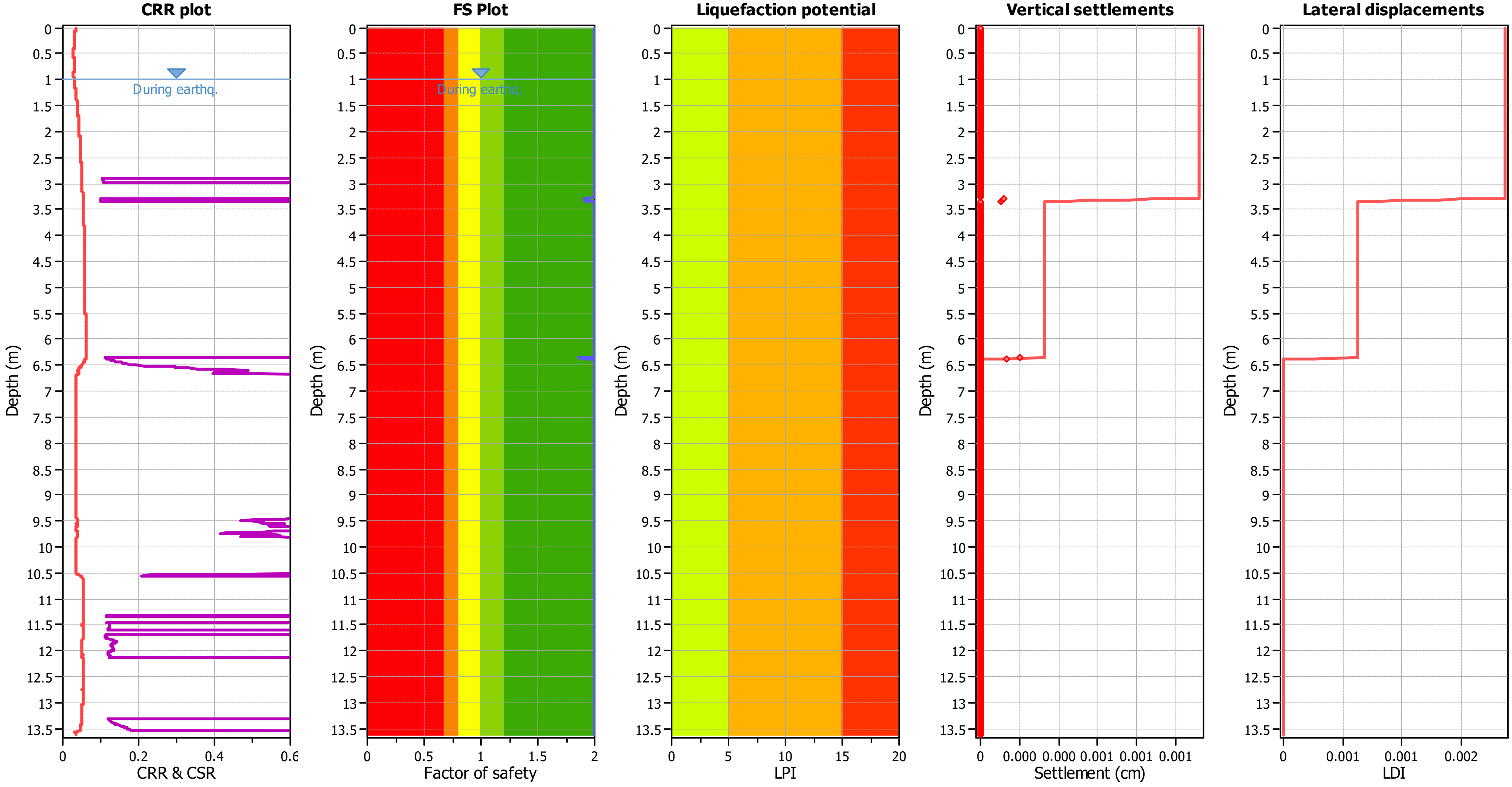
Liquefaction analysis overall plots (intermediate results)



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:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	N/A	Limit depth:	N/A

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:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	N/A	Limit depth:	N/A

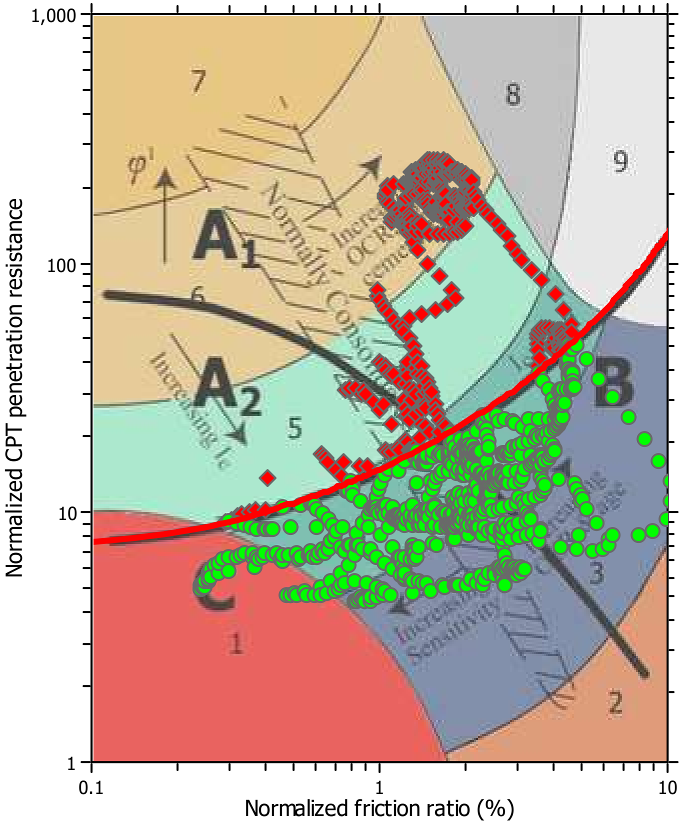
F.S. color scheme

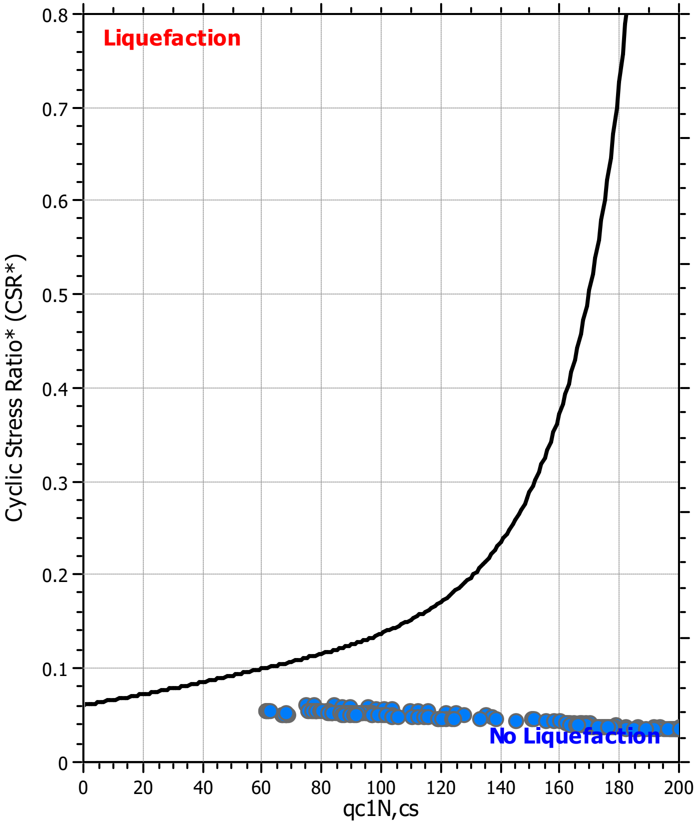
- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

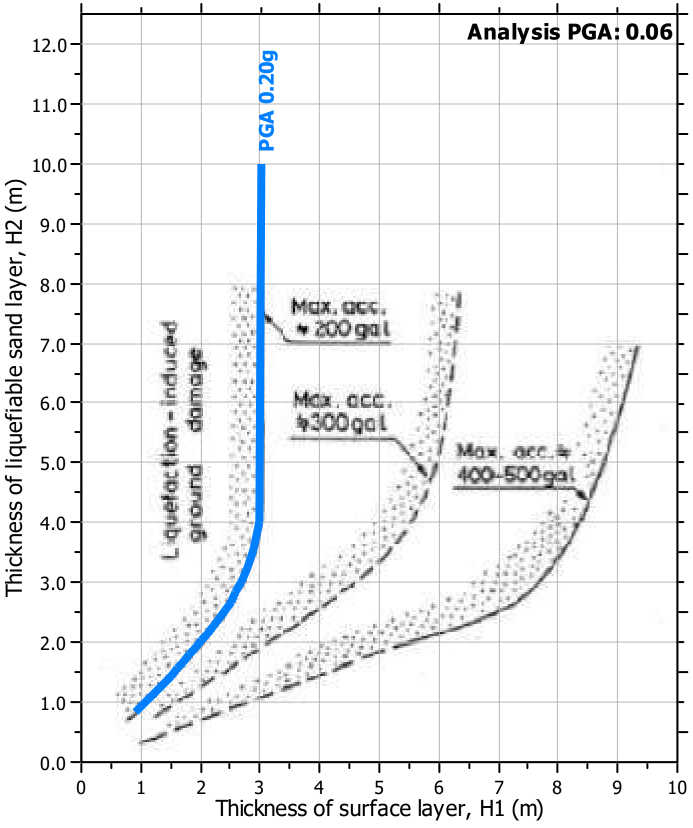
LPI color scheme

- 🟥 Very high risk
- 🟧 High risk
- 🟨 Low risk

Liquefaction analysis summary plots



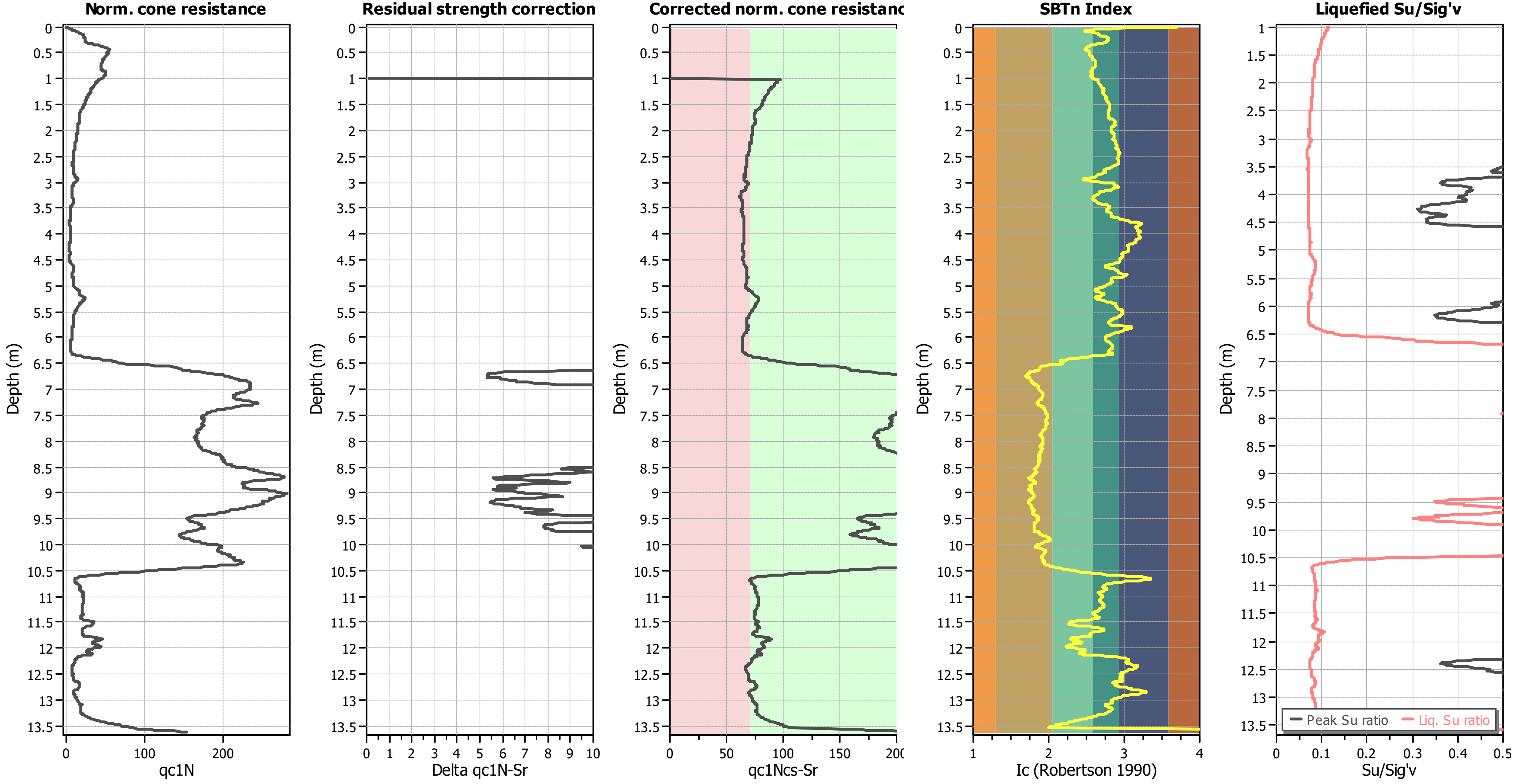




Input parameters and analysis data

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:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



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:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	N/A	Limit depth:	N/A

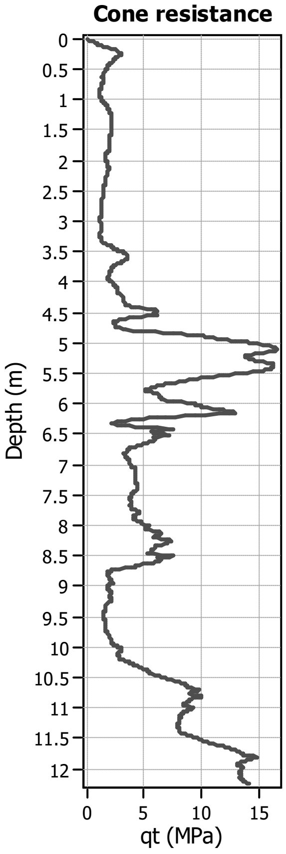
LIQUEFACTION ANALYSIS REPORT

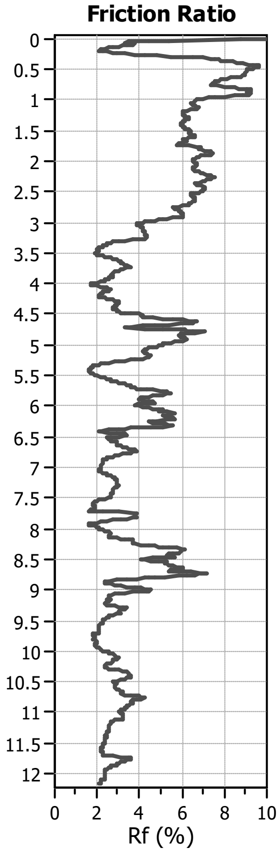
Project title : AKE- G00745 **Location : 395 Fitzgerald Road, Drury**

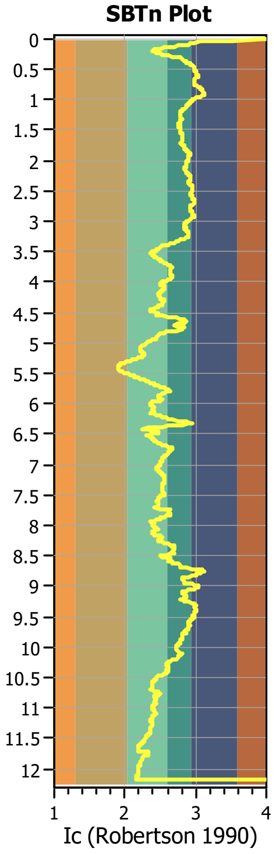
CPT file : CPT 02 - ULS

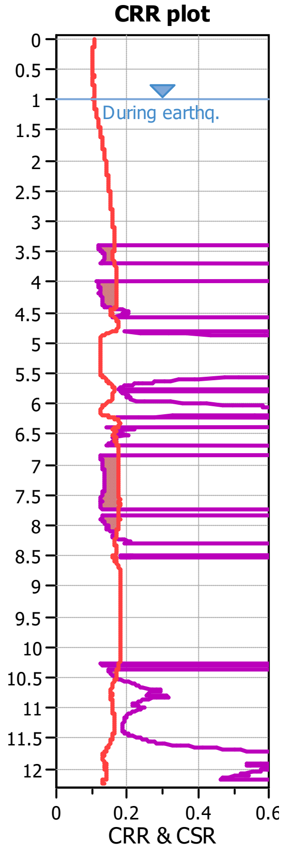
Input parameters and analysis data

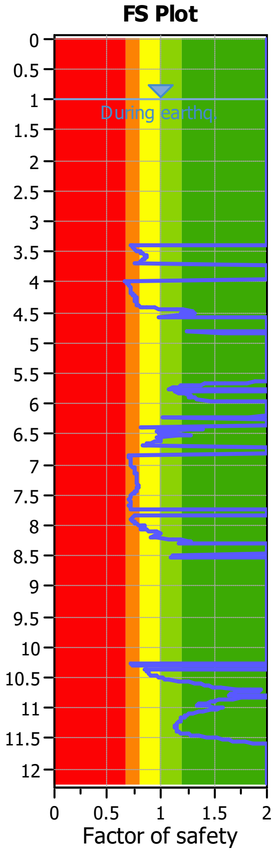
Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

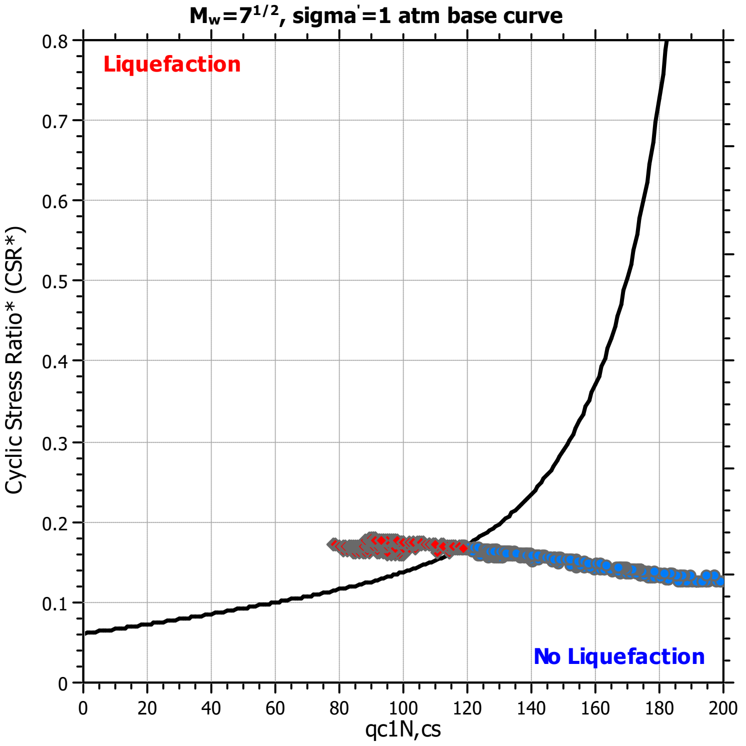

Cone resistance

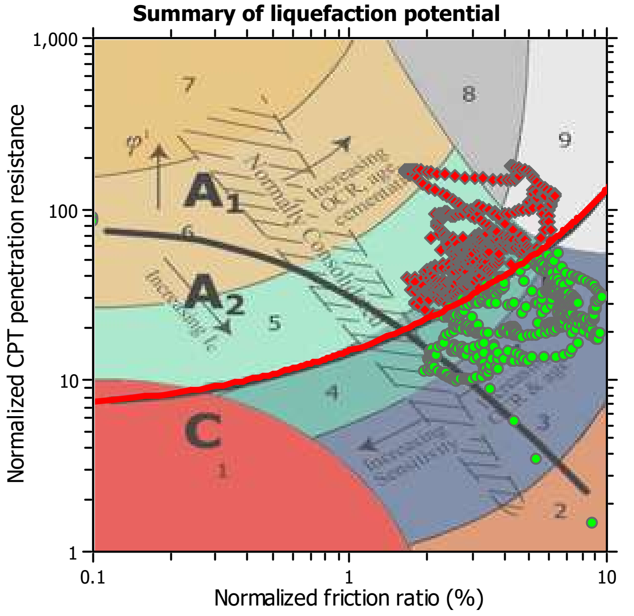

Friction Ratio


SBTn Plot


CRR plot

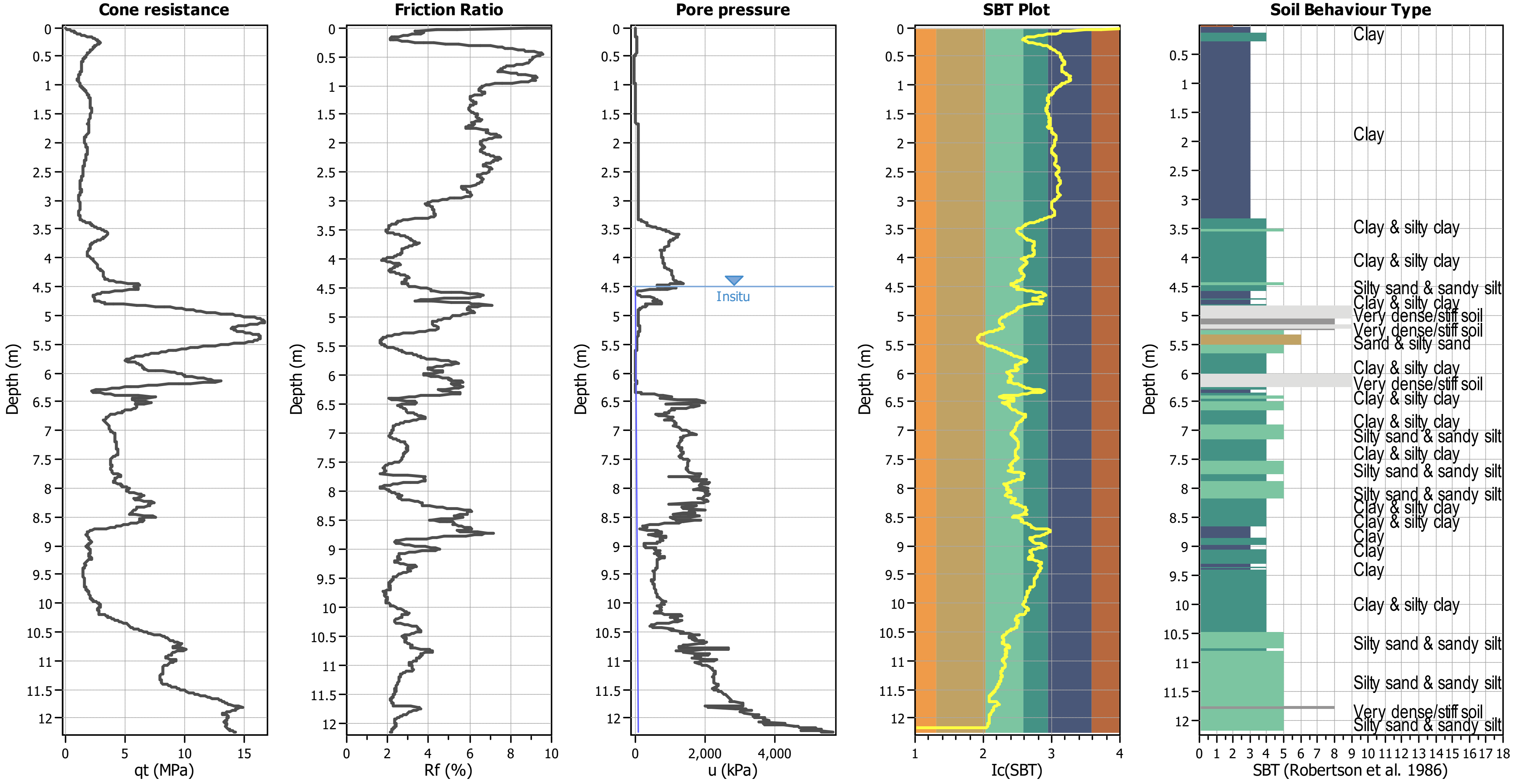

FS Plot


$M_w=7^{1/2}$, sigma'=1 atm base curve


Summary of liquefaction potential

Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



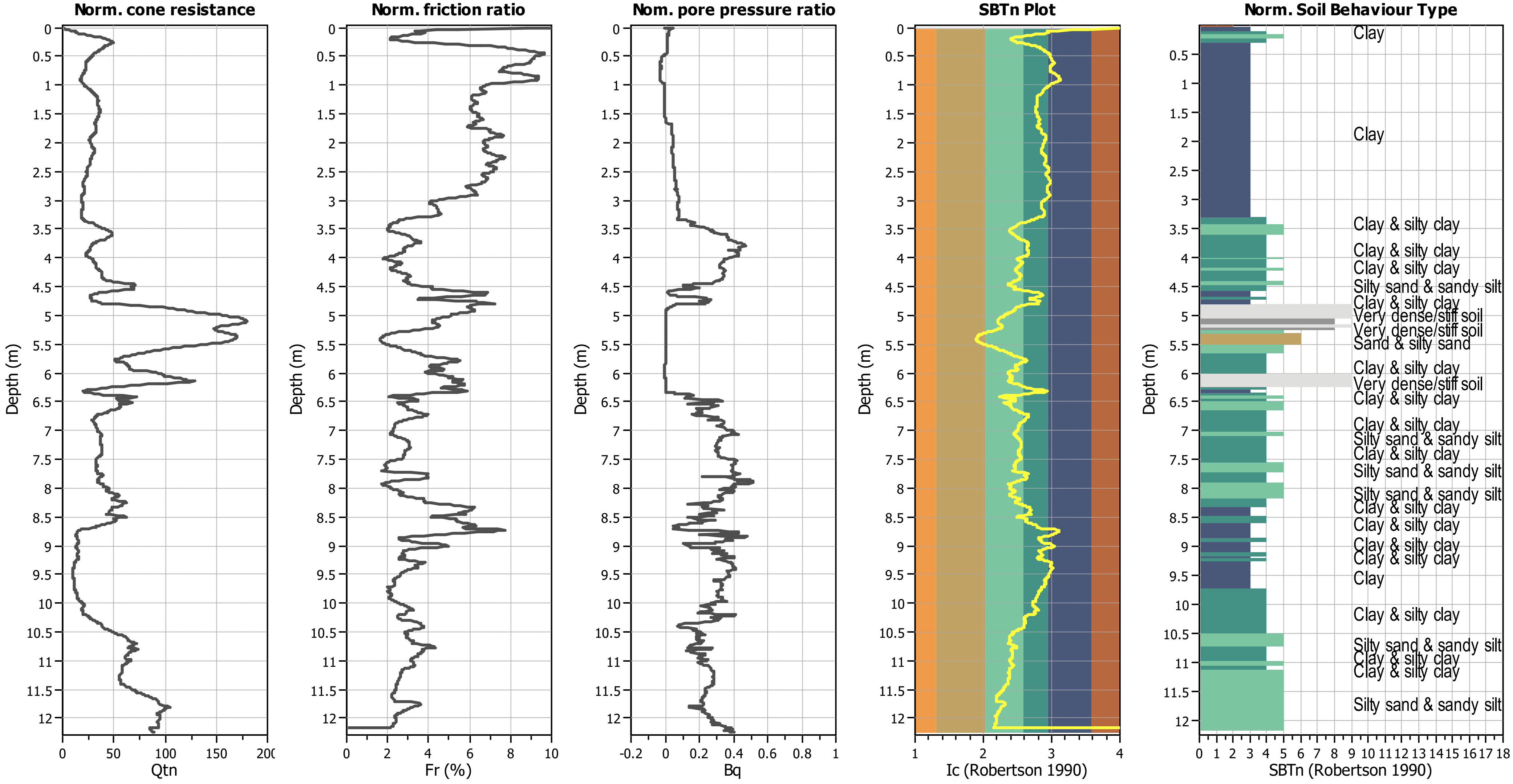
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normalized)



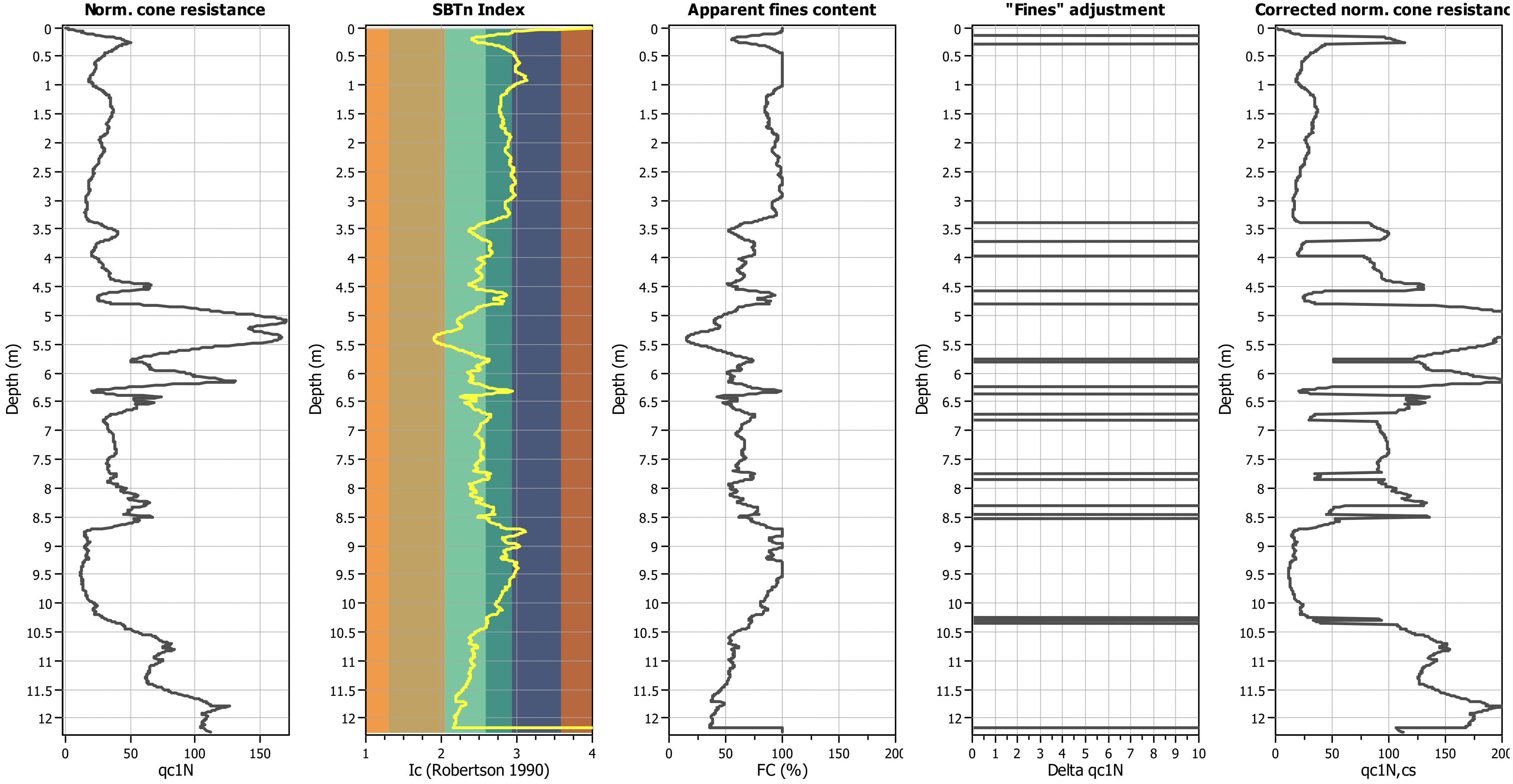
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟨 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots (intermediate results)



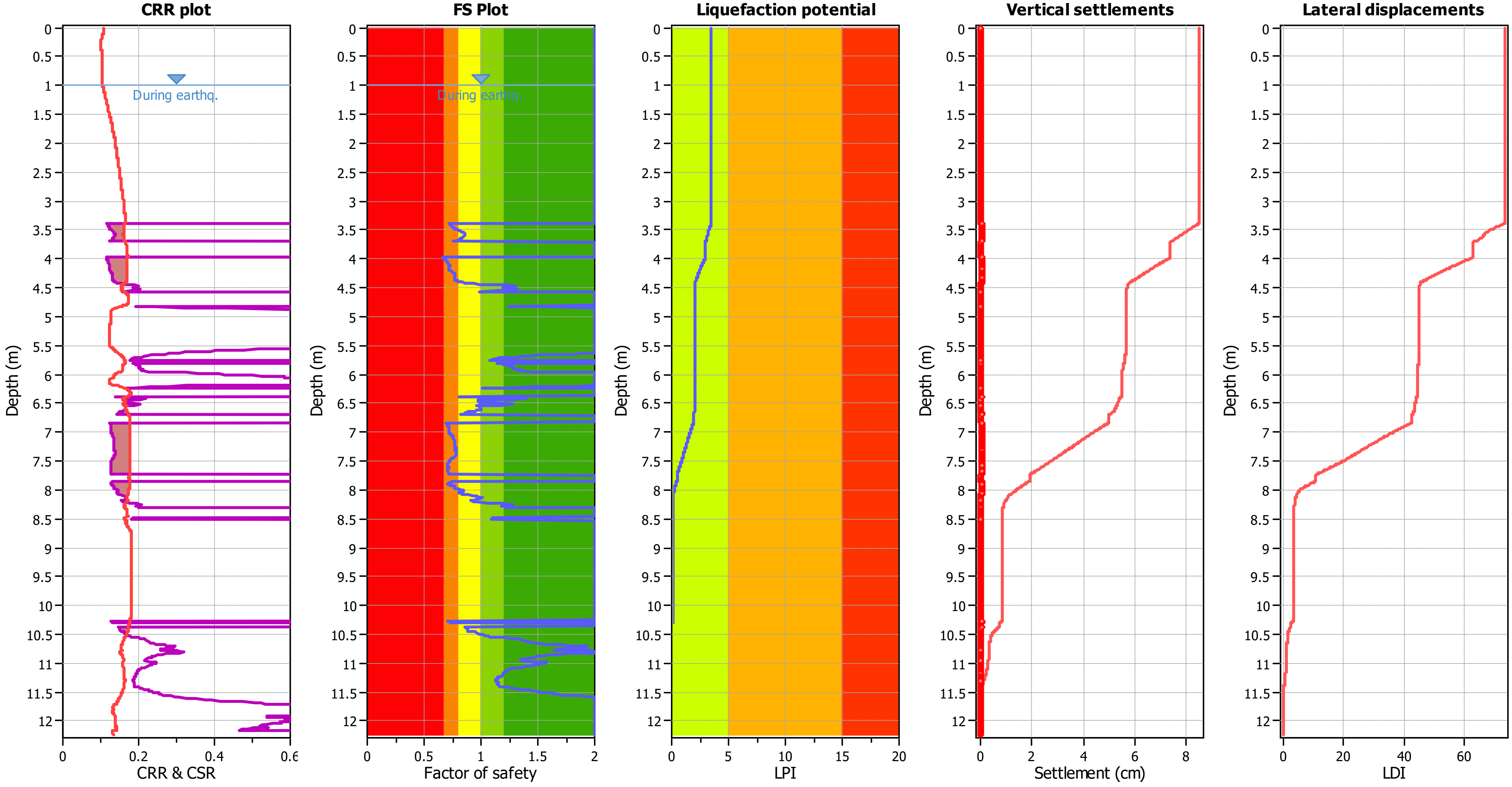
Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.50
Peak ground acceleration: 0.19
Depth to water table (insitu): 4.50 m

Depth to GWT (erthq.): 1.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_{σ} applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
Limit depth: N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.50
Peak ground acceleration: 0.19
Depth to water table (insitu): 4.50 m

Depth to GWT (erthq.): 1.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
Limit depth: N/A

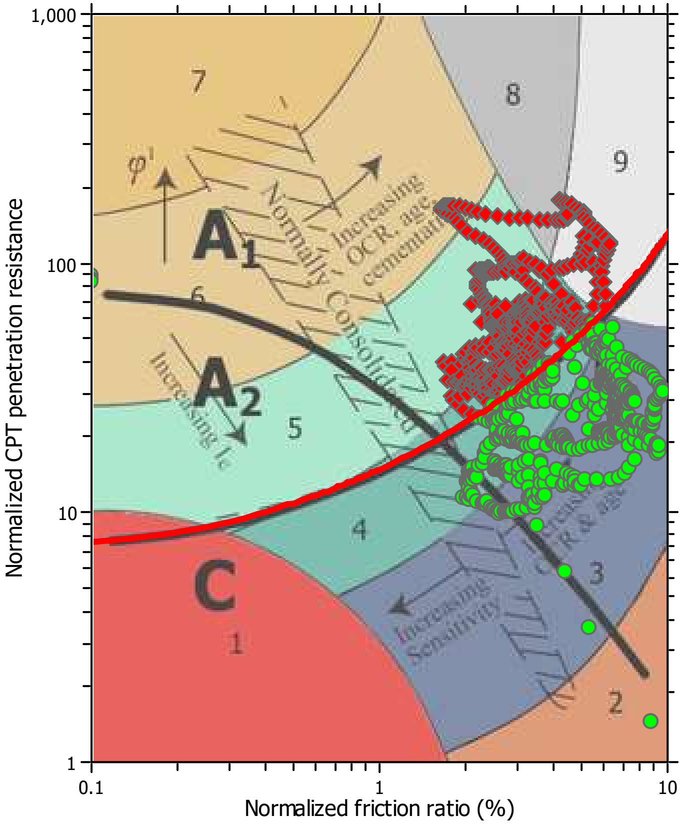
F.S. color scheme

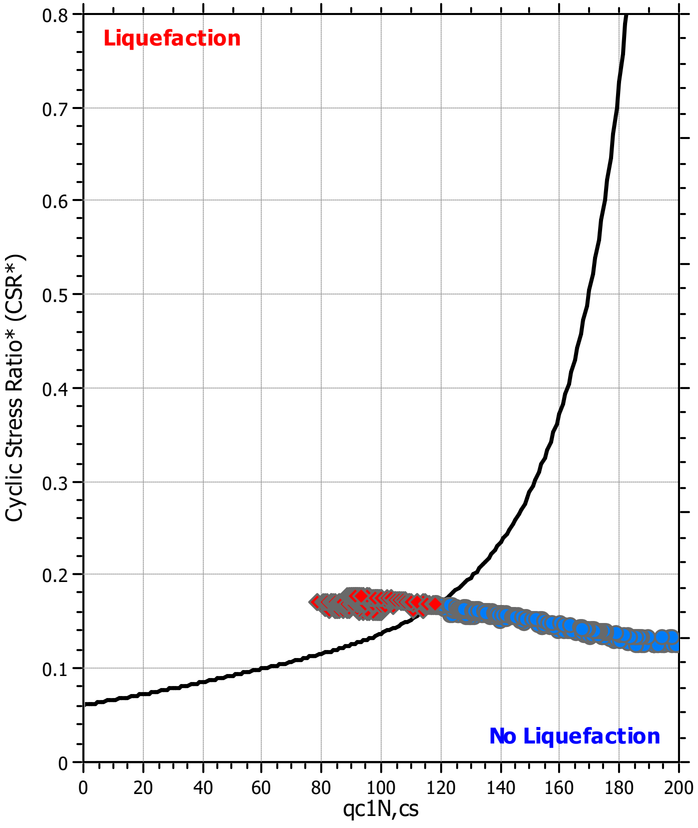
- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

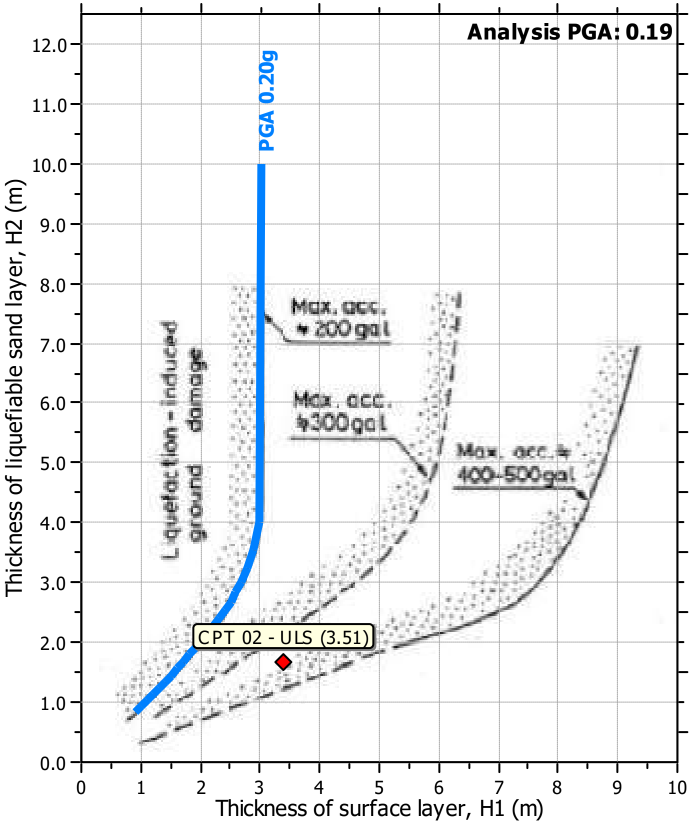
LPI color scheme

- 🟥 Very high risk
- 🟧 High risk
- 🟩 Low risk

Liquefaction analysis summary plots



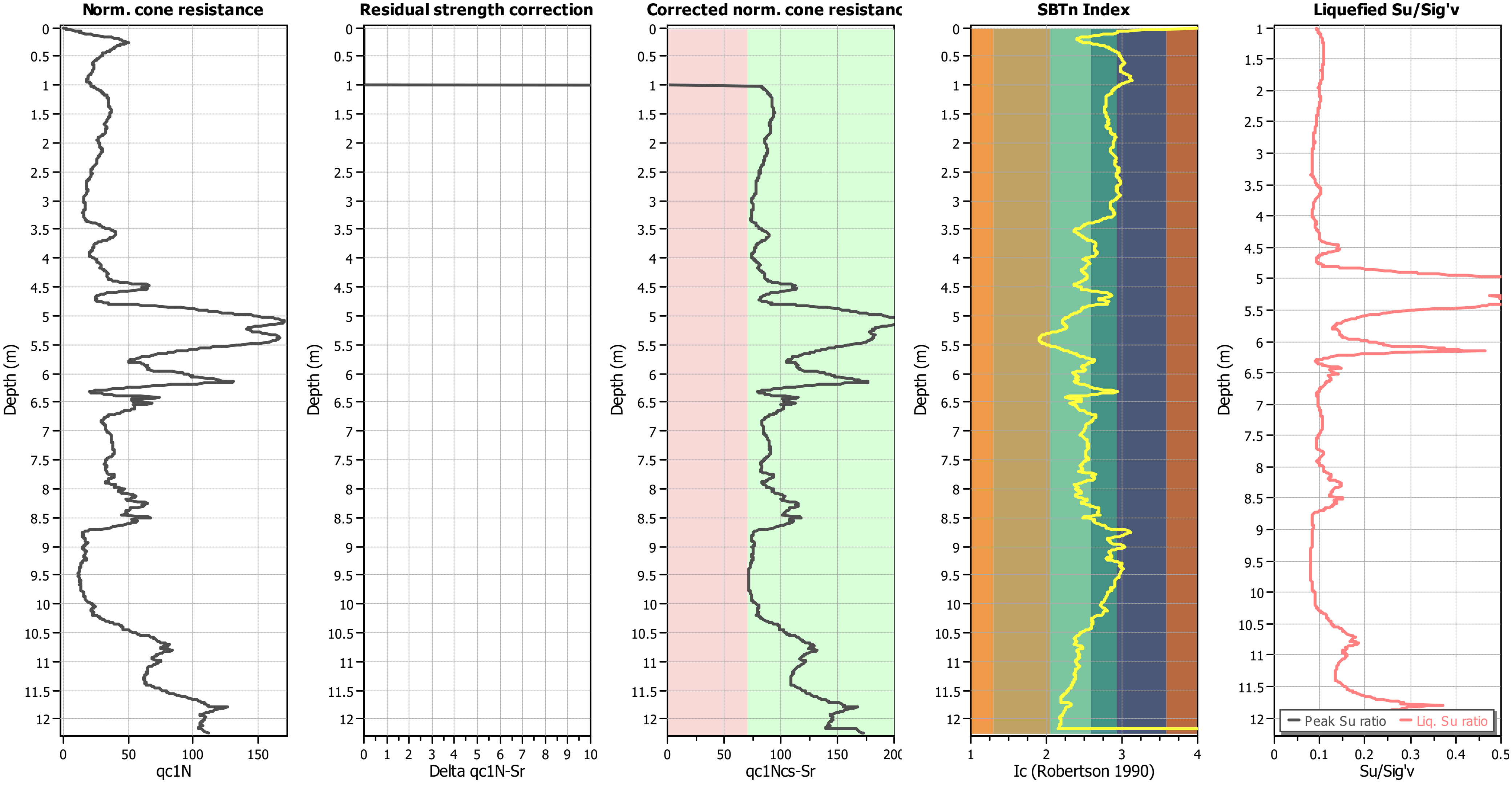




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

LIQUEFACTION ANALYSIS REPORT

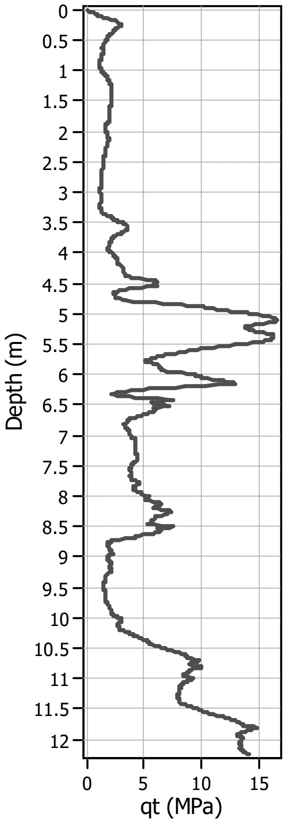
Project title : AKE- G00745 **Location : 395 Fitzgerald Road, Drury**

CPT file : CPT 02 - SLS

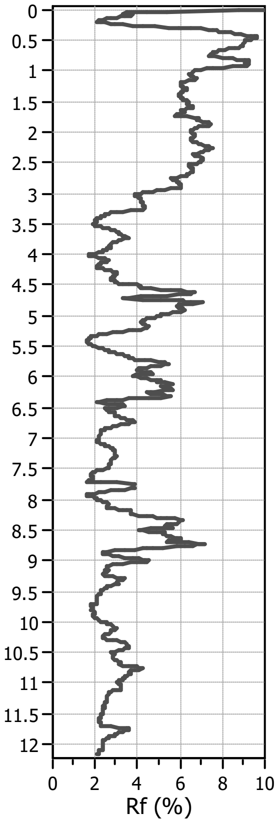
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.06	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

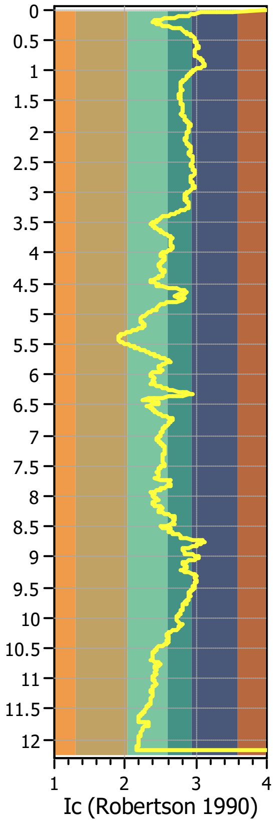
Cone resistance



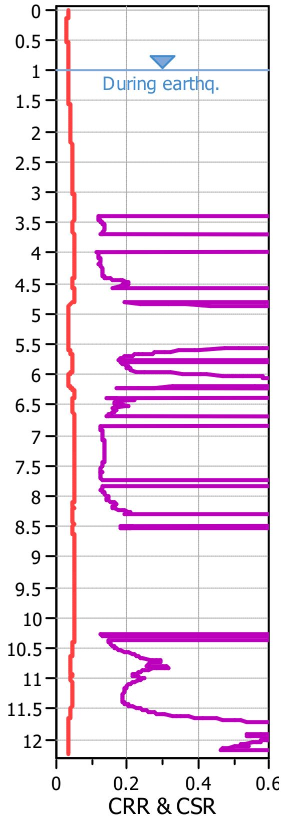
Friction Ratio



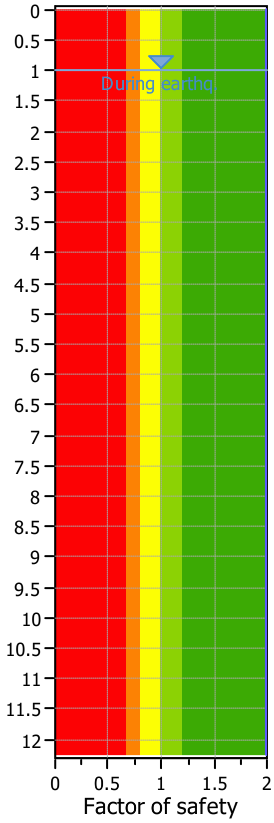
SBTn Plot



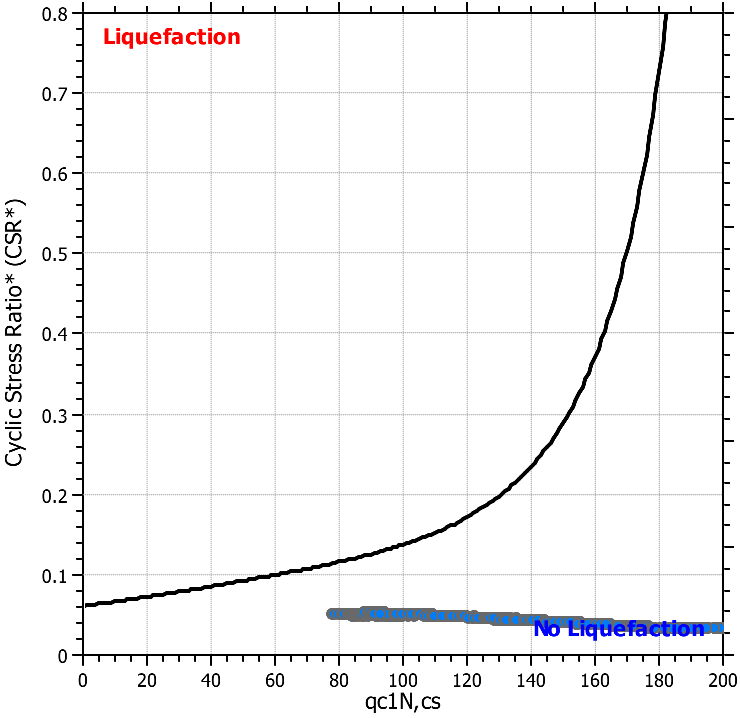
CRR plot



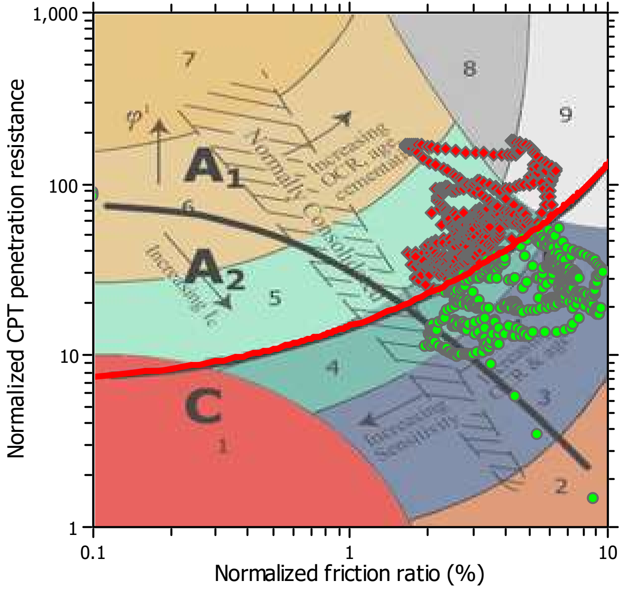
FS Plot



$M_w=7^{1/2}$, sigma'=1 atm base curve

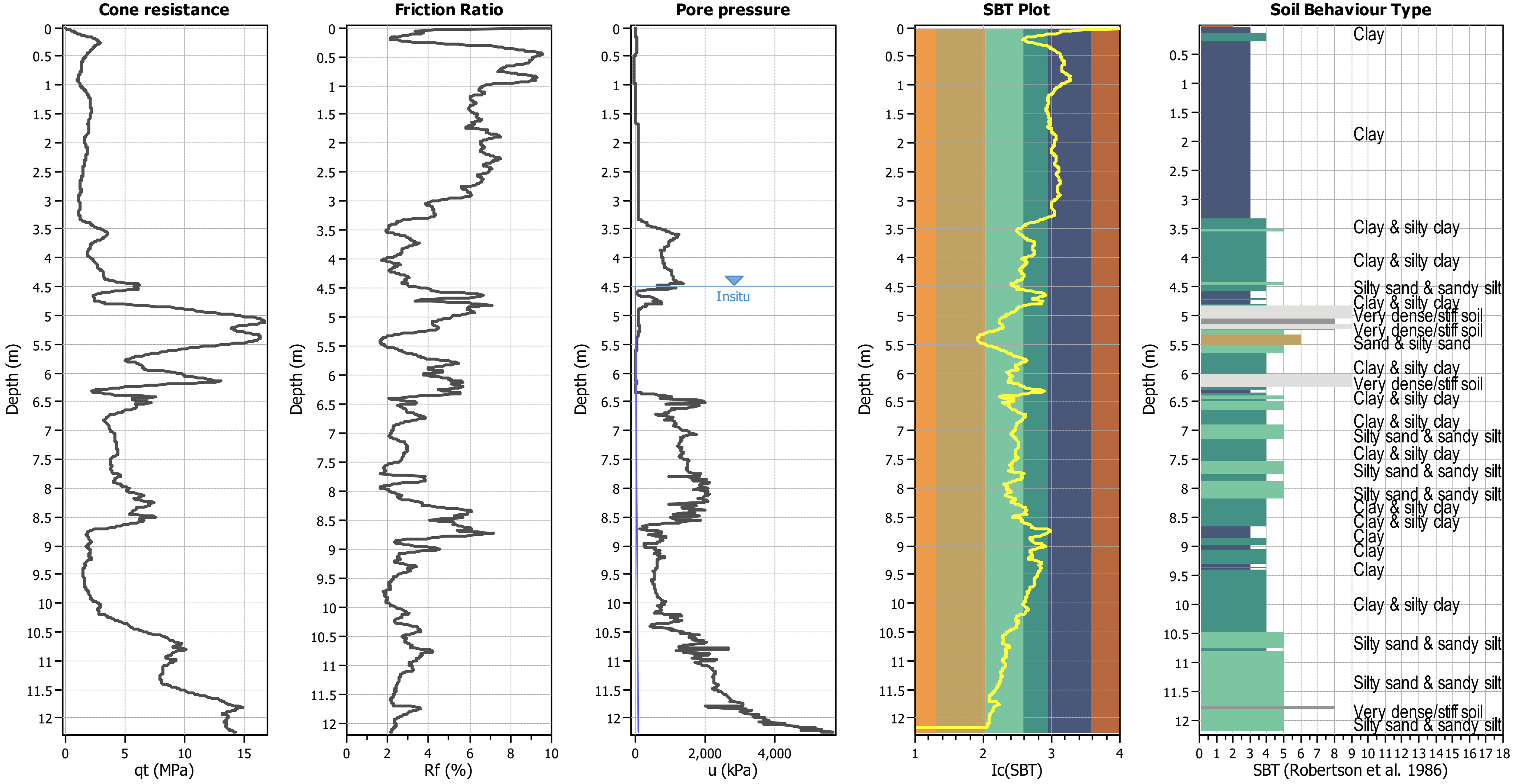


Summary of liquefaction potential



Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



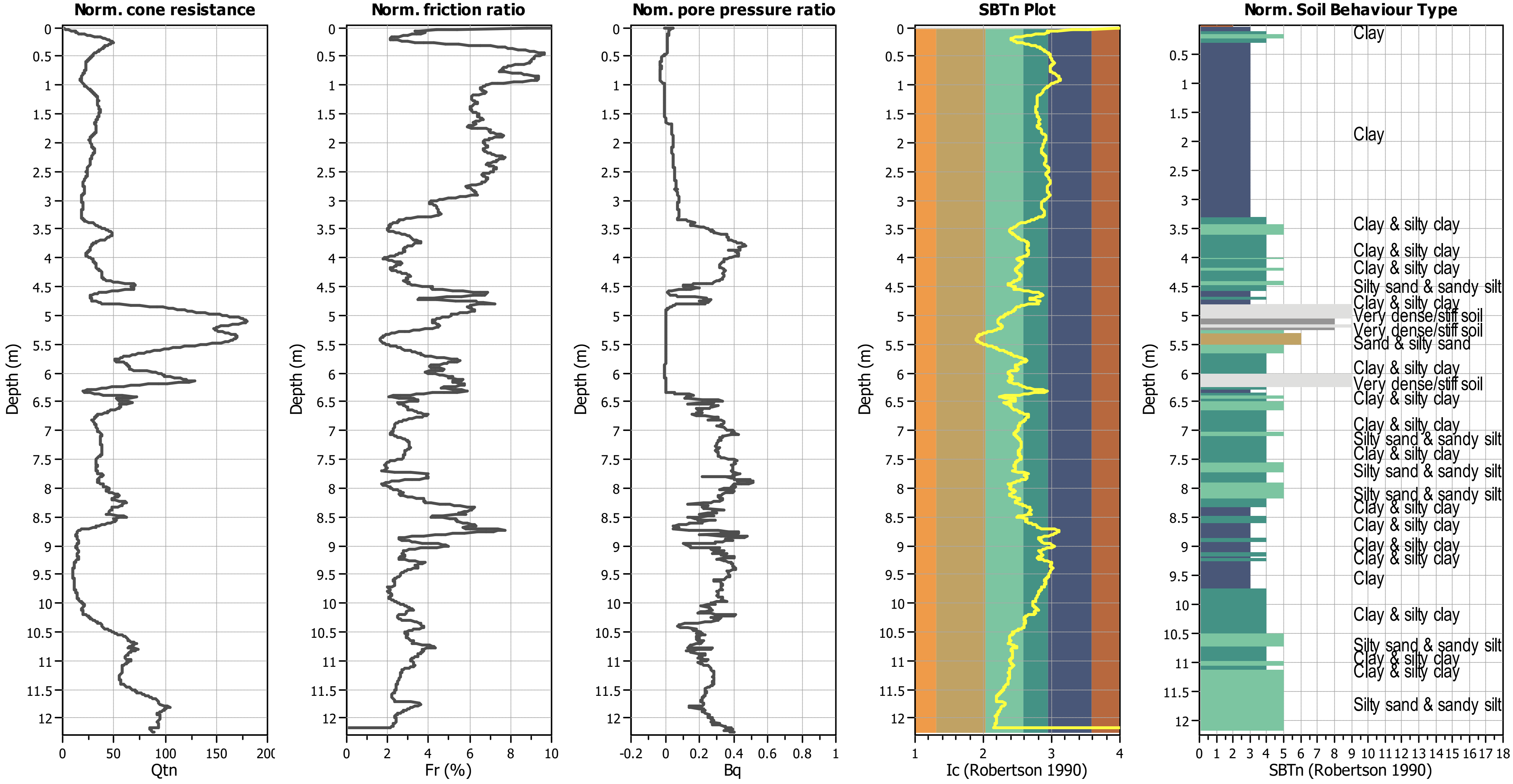
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normalized)



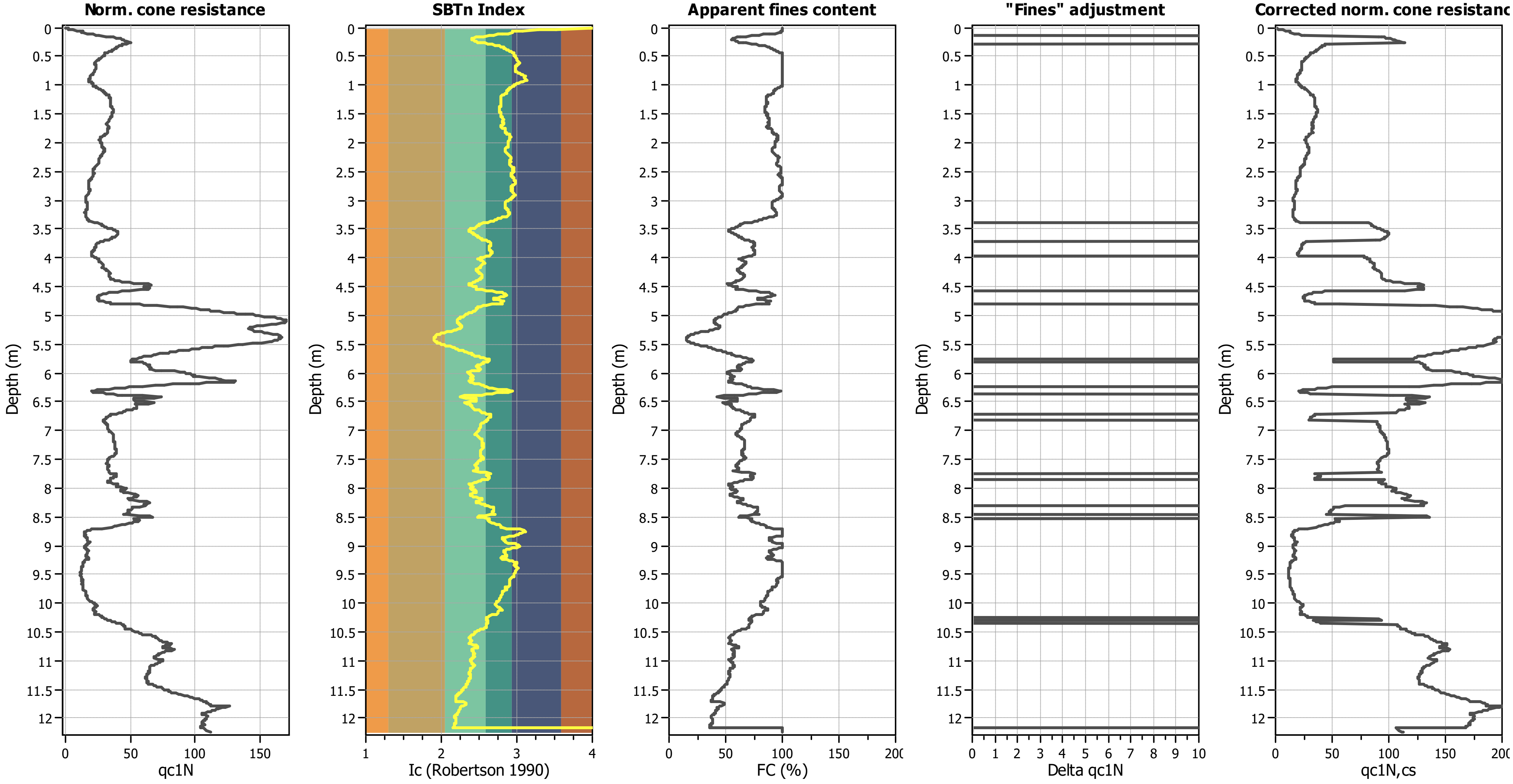
Input parameters and analysis data

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:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

Liquefaction analysis overall plots (intermediate results)



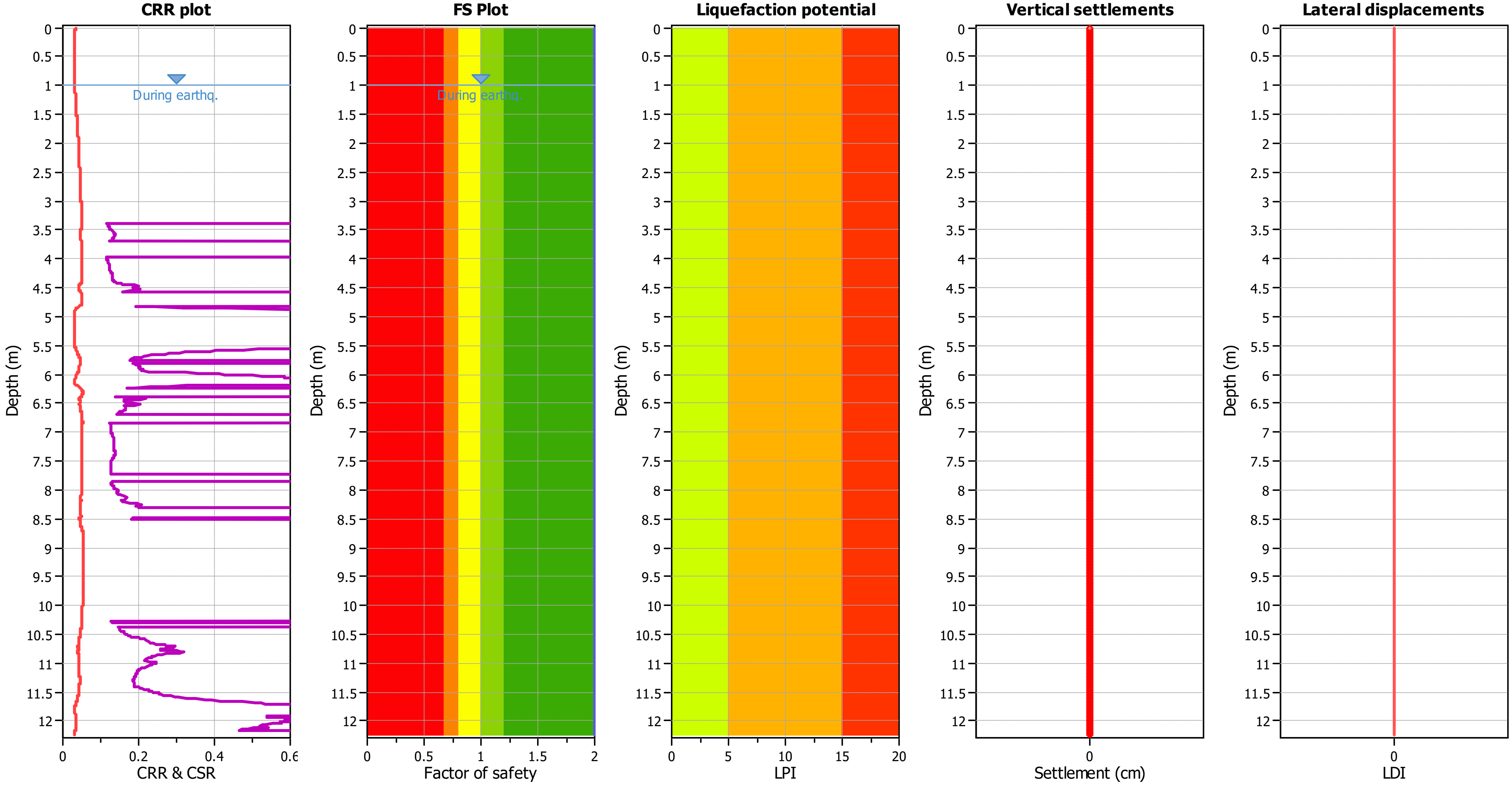
Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 5.90
Peak ground acceleration: 0.06
Depth to water table (insitu): 4.50 m

Depth to GWT (erthq.): 1.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
Limit depth: N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 5.90
Peak ground acceleration: 0.06
Depth to water table (insitu): 4.50 m

Depth to GWT (erthq.): 1.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
Limit depth: N/A

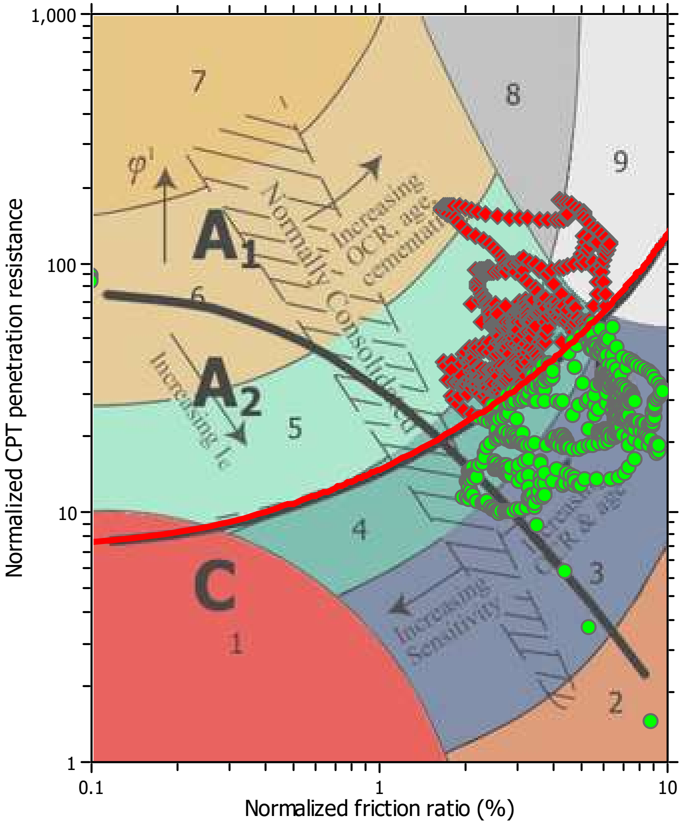
F.S. color scheme

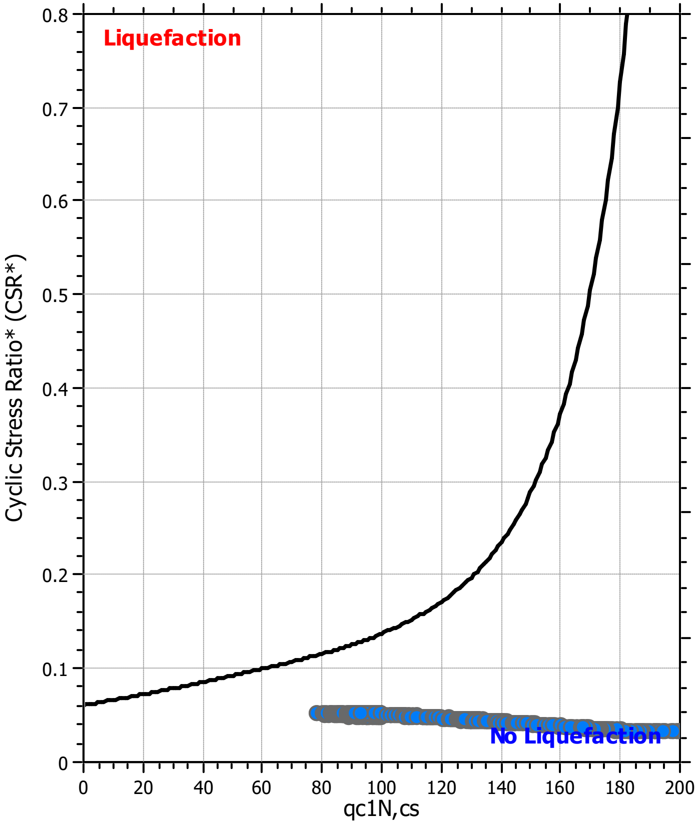
🟥 Almost certain it will liquefy
🟧 Very likely to liquefy
🟨 Liquefaction and no liq. are equally likely
🟩 Unlike to liquefy
🟩 Almost certain it will not liquefy

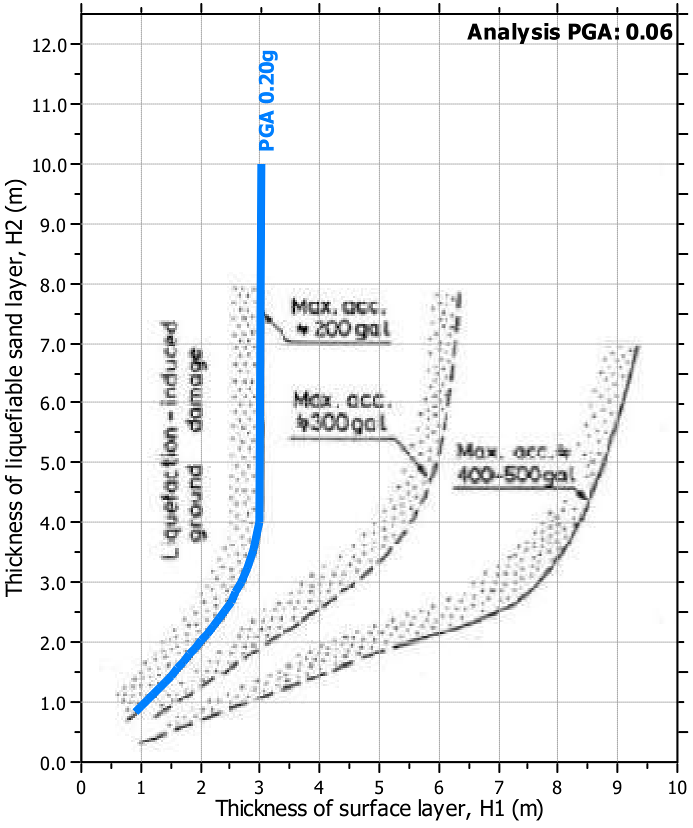
LPI color scheme

🟥 Very high risk
🟧 High risk
🟨 Low risk

Liquefaction analysis summary plots



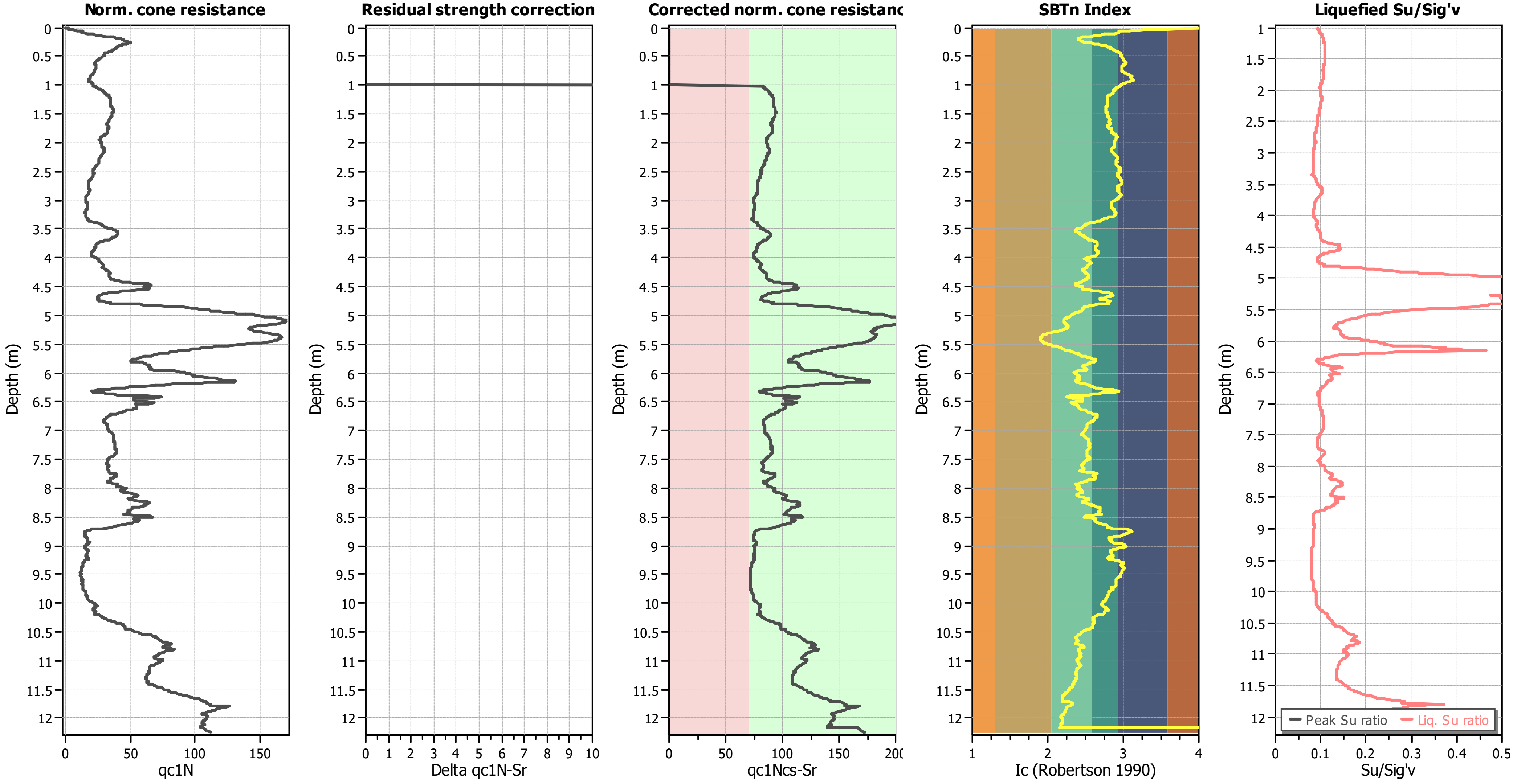




Input parameters and analysis data

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:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



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:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

APPENDIX D

AKEL EARTHWORKS

SPECIFICATIONS

AKEL EARTHWORKS SPECIFICATION

SITE ADDRESS: 395 FITZGERALD ROAD, DRURY, AUCKLAND 2113

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AKEL Earthworks specifications are to be reviewed and referenced for all the areas on the subject site, which require excavation of the natural ground and the removal and disposal of excavated soil material from the subject site.

Unless otherwise stated, all earthworks operations shall be constructed under the drawings and project specification for the subject site.

1.0 Governing Documents for Earthworks activities.

Earthworks at the subject site shall be completed in accordance with the documents referred to in items 1.1 to 1.4 for the subject site.

1.1) Auckland Council – GD05 Erosion& Sediment Control.

1.2) NZS 4402 - Methods of Testing Soils for Civil Engineering Purposes TNZ F/1 Specification for Earthwork Construction.

1.3) NZS 4431:2022 - Code of Practice for Engineered Fill Construction for Lightweight Structures.

1.4) Worksafe: Excavation Safety Part 1 to Part 7.

2.0 Natural Ground

Shallow investigations have been completed at the subject site. AKEL has provided a geotechnical report for the subject site with recommendations for earthworks activities. It must be understood that the Earthworks Contractor is responsible for interpreting the information to complete all of the Earthworks activities in accordance with Governing Documents referenced in *1.0 Governing Documents for Earthworks activities*.

The Earthworks Contractor is responsible for the site-specific risk assessment, the implementation of safe working conditions at the subject site, and the site erosion and sediment protection requirements for the subject site.

3.0 Earthworks Consents

The Contractor shall implement with reference to Auckland Council GD05-Erosion and Sediment Control Plan for erosion and sediment control methods, site access, manoeuvrability stockpile location, and how the clean fill sites will be maintained upon the completion of construction activities to ensure that no silt contamination of the surrounding areas and waterways, roads do not occur.

Access to adjacent properties shall be maintained at all times. This needs to be a priority for the site access and manoeuvrability for the subject site.

A copy of any approved Earthworks Consent obtained by the Principal shall be forwarded to the Contractor before the commencement of any clearing or earthworks.

It shall be the Earthworks Contractor's responsibility to ensure all work and physical work practices are in accordance with the requirements of all resource consents to the subject site.

4.0 Site Clearance & Preparation

Clearing trees, stumps, rubbish and perishable matter from the area covered by the earthworks and establishment areas shall be carried out as part of the clearing operations before commencing topsoil stripping. The material, including tree roots, shall be removed from the site to the Contractor's dump area. In addition, the proposed building footprint is to be cleared of any organic material and inspected by the AKEL Geotechnical Engineer before the commencement of foundation works.

Any old foundations, drainage infrastructure, floor slabs and wastewater tanks must be made redundant and sealed before the commencement of Earthworks activities and the removal of any contaminated soils.

Grub out roots above 75 mm diameter to a minimum of 500 mm below the bottom level of footings or paving. Backfill to be carried out with selected excavated material, well rammed in layers.

All cavities resulting from removing tree stumps, roots and debris outside the subgrade layer shall be backfilled to the standard required by this bulk fill specification. In addition, all cavities within the final subgrade layer shall be backfilled to the standard required by this specification for subgrade fill.

Take special care when working close to retained trees and shrubs.

5.0 Topsoil

Topsoil should be stripped from all cut and fill areas, stripping operations being planned to extend beyond cut and fill lines to avoid peripheral topsoil fill contamination. In addition, temporary stockpiles of topsoil and unsuitable organic materials should be sited well clear of the works on suitable areas of natural ground to avoid stockpile loading causing land slippage.

Generally, the topsoil should be stripped over the whole site to form a general subgrade, at least 300 mm below the original ground level. Leave the subgrade level clear of all loose material without impediment to the excavation work.

The Earthworks Contractor is responsible for temporarily diverting, as necessary of all ditches, field drains, and other waterways encountered during the excavations and reinstating them for approval on completion.

Remove unwanted stripped soil from the site continually as the work proceeds. Clean up continually any soil if dropped on footpaths or roads.

Do not excavate or remove topsoil within the drip line of retained trees unless specifically directed. If excavation is directed, use hand methods to avoid damage to roots. Do not cut roots greater than 50 mm in diameter. Do not stockpile spoil against tree trunks or beneath the drip line of retained trees. Report any damage to tree boles or branches with necessary remedial work by an approved tree surgeon.

6.0 Excavation

Before commencement on-site, the Earthworks Contractor must check all levels and conditions and report any discrepancies that affect further work.

The Contractor shall excavate and dispose of surplus and unsuitable materials to a disposal site proposed by the Contractor.

If not spread on-site, all identifiable deposits of unsuitable organic cut-to-waste materials should be removed from earthwork areas and disposed of into topsoil stockpiles.

Locate underground services and foundations before work is started. Any information provided regarding the location of these services and foundations is given from available records but with no guarantee of accuracy regarding alignment or depth. Furthermore, no guarantee is provided or implied that the information provided covers all existing services and foundations. Make good at no extra cost damage to existing services to the satisfaction of the appropriate network utility operator. Protect existing roads, footpaths, gutters, crossings etc., from damage during work.

It is the Earthworks Contractor's responsibility to protect all batters with a change of level between crest and toe of more than 1.5 metres from weather erosion with a waterproof covering of either Hessian or heavy-duty black polythene sheet. Seal at joints and securely fix down at crest and toe. Maintain coverings in good condition until the ground is secured by permanent construction.

Earthworks Contractor shall be responsible for cutting all batters at no steeper than 1V:2H to the horizontal.

Excavated soils are to be incorporated in Fill as specified in this specification or may be placed in unsupervised fills provided these are clear of building areas, to minimal depths and on the ground, which slopes no steeper than 1V:6H.

If the excavations vary from the drawings and calculated quantities, those affected areas shall be measured as a solid volume and the quantity recorded and agreed to in writing as the excavation proceeds.

Keep excavations free from water and keep water from excavations clear of other construction work.

Any over-excavation makes good with well-compacted approved backfill to a minimum depth of 200mm.

7.0 Fill Material

Earthwork fillings/ Controlled Fill shall be constructed from approved materials available on-site or an approved off-site source.

Fill material to be selected clay and silt material cut from on-site.

Filled areas are to be entirely stripped of all topsoil and soft surficial soils and benched where the existing ground slope exceeds 1V in 8H.

Fill to be placed in layers of no greater than 200mm (loose) thickness and compacted by at least six (6) passes of a Sheepsfoot or Vibrating Padfoot roller. The compaction equipment is to be to the Engineer's satisfaction.

The fill platform must be compacted to at least 1.5m outside the foundation line. Fill batters are to be finished and compacted to no steeper than 1V:3H.

The Geotech Engineer has the authority to halt the earthworks operation and call for compaction tests on site. Any under-compacted areas shall be excavated and dried or re-compacted as necessary.

Shear vane readings are to be taken at random locations over the Fill. Every single reading to exceed 150kPa.

Inspections by an AKEL Geotechnical Engineer are required at the following stages for the subject site:

- Completion of all stripping and bench excavation.
- At 75 per cent completion of fill compaction.
- After excavation and earthworks on the development site.

<u>AKEL requires a minimum of 48 hours of written notice to confirm attendance for site inspections for the Earthworks at the subject site.</u>

APPENDIX E

CSIRO FOUNDATION MAINTENANCE AND FOOTING PERFORMANCE GUIDE

Foundation Maintenance and Footing Performance:
A Homeowner's Guide

BTF 18
replaces
Information
Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

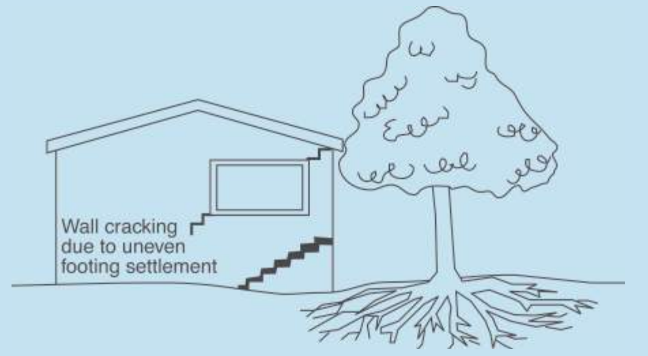
Seasonal swelling/shrinkage in clay

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

Trees can cause shrinkage and damage



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.
Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

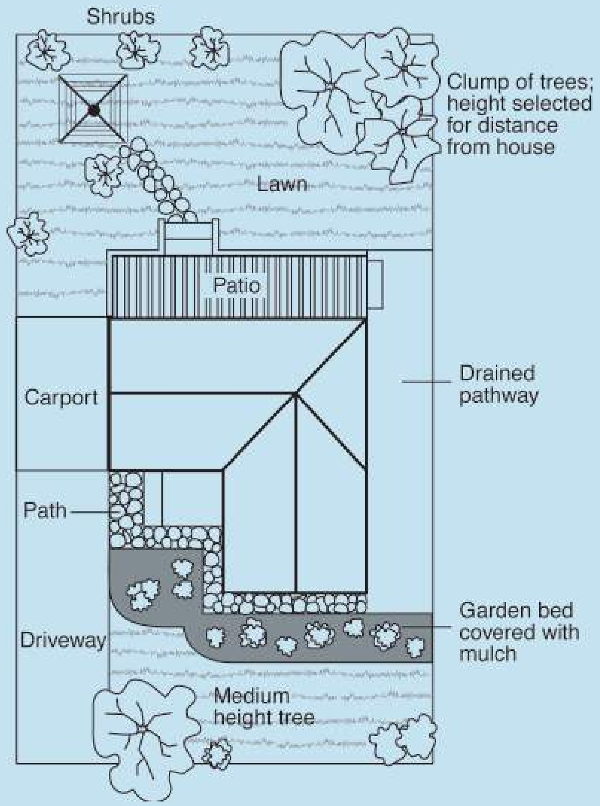
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4

Gardens for a reactive site



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

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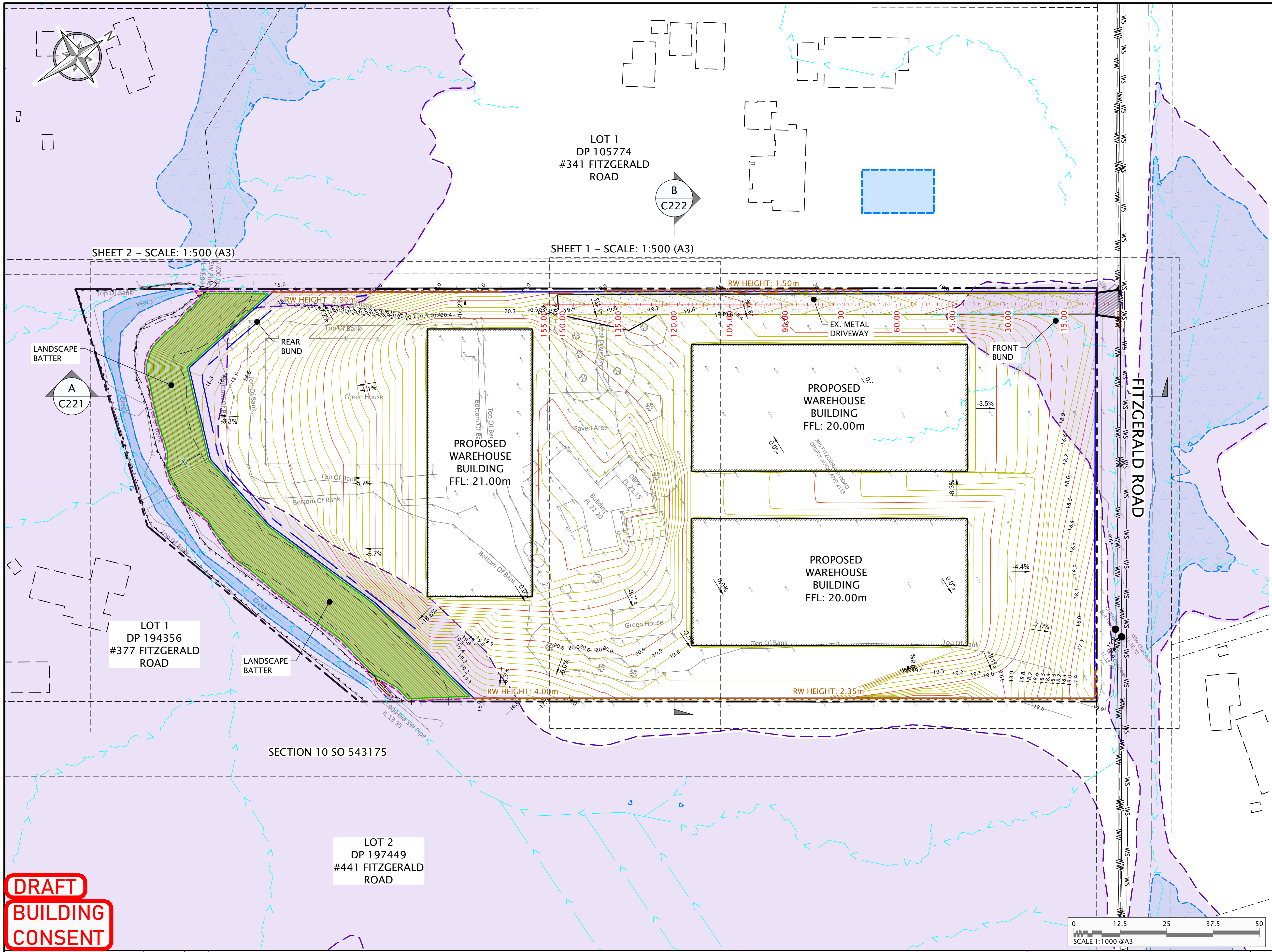
APPENDIX F

DEVELOPMENT PLAN(S)



DRAFT
BUILDING
CONSENT

REV	REVISION DETAILS	DATE	BY
A	INITIAL ISSUE	18/09/24	JDT

CLIENT:
TAHA
AUTO
LIMITED

PROJECT / ADDRESS:
395 FITZGERALD ROAD, DRURY,
AUCKLAND

DRAWING TITLE:
PROPOSED CIVIL ENGINEERING
OVERALL PLAN

Babingtons
CIVIL AND ENVIRONMENTAL CONSULTANTS

DESIGNED BY: MT
CHECKED BY: LH
DRAWN BY: JDT
APPROVED BY: MT
ORIGIN: 18 SEPTEMBER 2024
PROJECT NUMBER: 395 FITZGERALD RD
SCALE (@A3): 1:1000
DRAWING NO.: C200
REVISION: A

PRINTED ON: 16/10/2023

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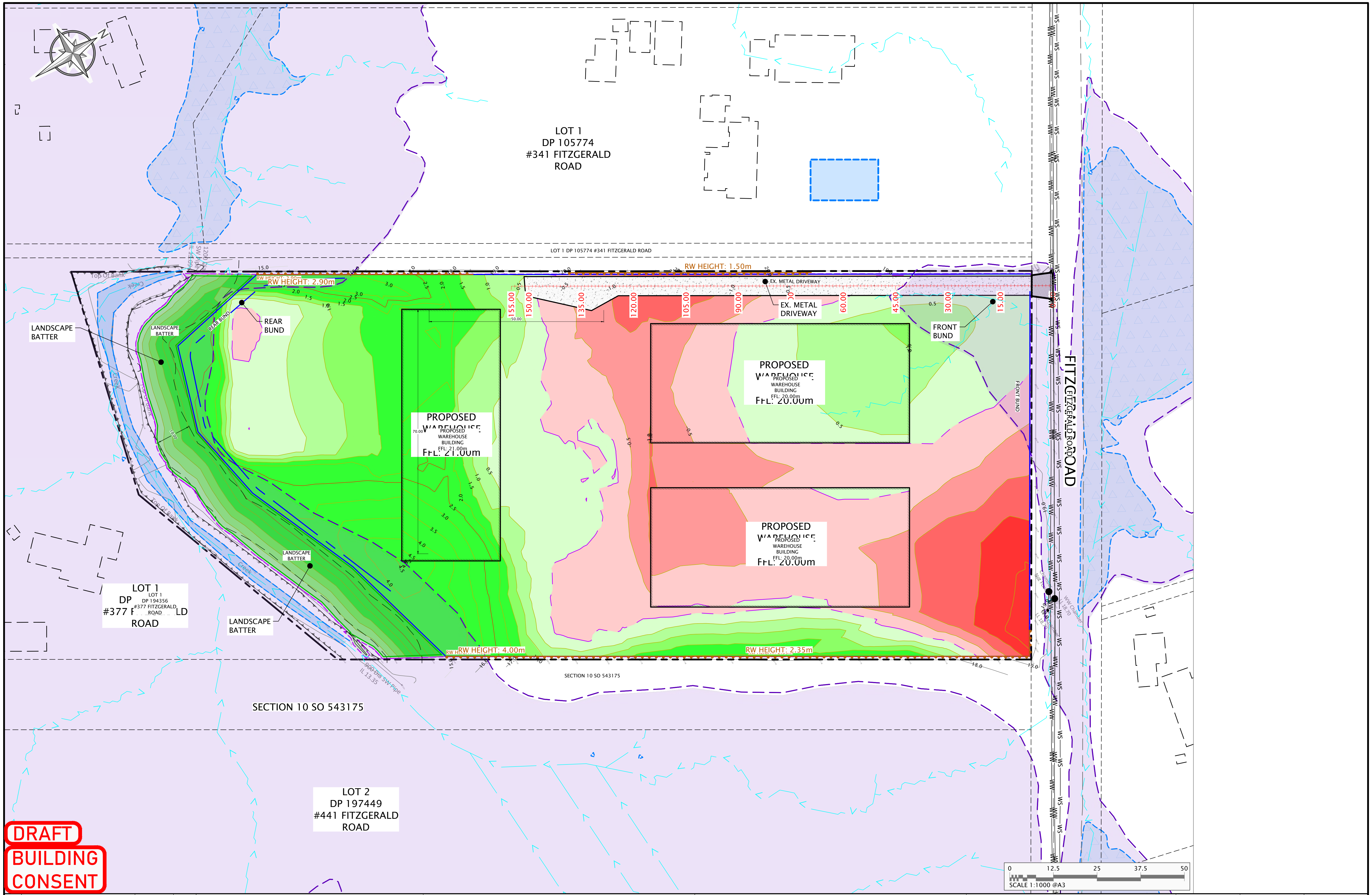


DRAFT
BUILDING
CONSENT

FILE LOCATION: Y:\01 LAND DEVELOPMENT\395 FITZGERALD ROAD, DRURY\CAD\WORKING FOLDER\395 FITZGERALD RD-A.DWG

REV	REVISION DETAILS	DATE	BY
A	INITIAL ISSUE	18/09/24	JDT

CLIENT:
TAHA
AUTO
LIMITED

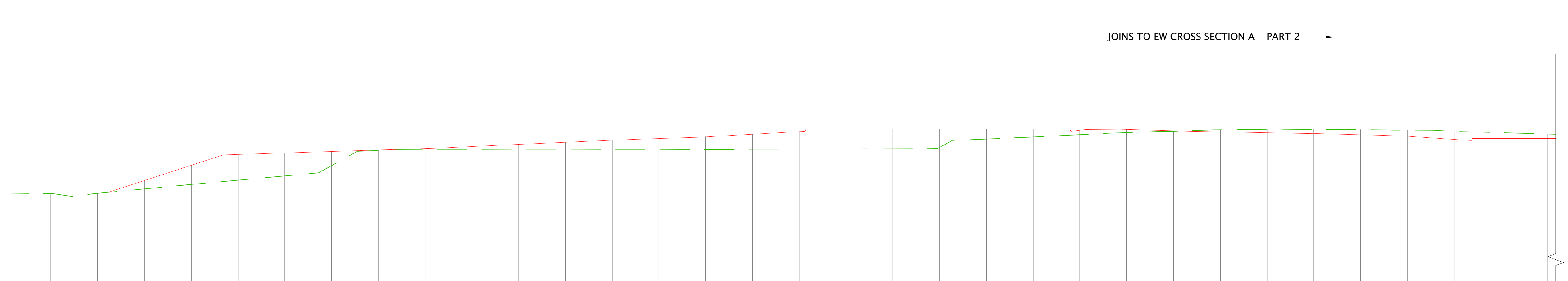
PROJECT / ADDRESS:
395 FITZGERALD ROAD, DRURY,
AUCKLAND

DRAWING TITLE:
CUT AND FILL AND EROSION
AND SEDIMENT CONTROL PLAN

Babingtons
CIVIL AND ENVIRONMENTAL CONSULTANTS

DESIGNED BY: MT	CHECKED BY: LH	DRAWN BY: JDT
APPROVED BY: MT	ORIGIN: 18 SEPTEMBER 2024	
PROJECT NUMBER: 395 FITZGERALD RD		
SCALE (@A3): 1:1000	DRAWING NO. C210	REVISION: A

PRINTED ON: 16/10/2023



VERT EXAG 1:1
Datum 5.000

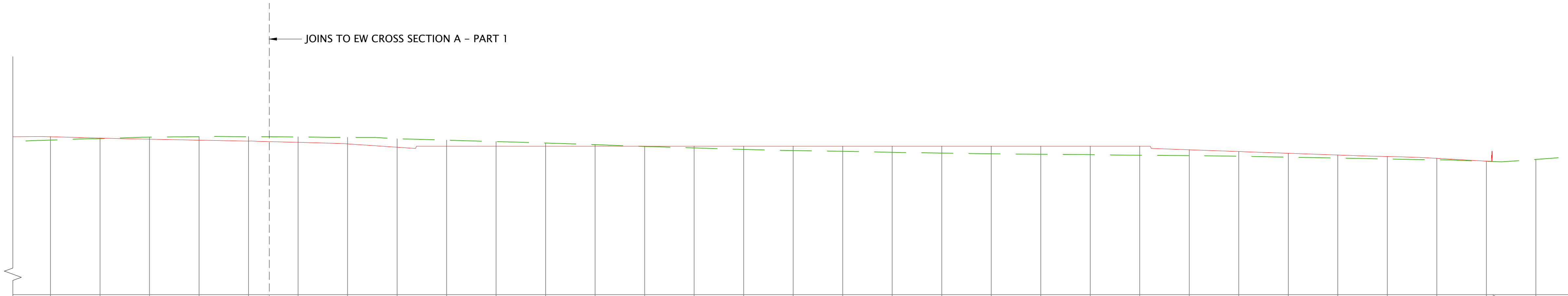
DESIGN LEVELS						15.5	17.1	18.3	18.5	18.6	18.77	18.9	19.1	19.4	19.6	19.8	20.0	20.2
EXISTING LEVELS				14.11	14.14	14.61	15.09	15.54	16.00	17.09	18.72	18.78	18.78	18.77	18.77	18.78	18.78	18.80
DEPTH						0.89	2.05	2.75	2.45	1.52	0.05	0.15	0.36	0.60	0.82	1.02	1.21	1.38
CHAINAGE	0.000	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.000	55.00	60.00	65.00	70.00	75.00	80.00	85.00

DESIGN LEVELS	20.5	20.7	21.00	21.0	21.0	21.0	21.0	20.9	21.0	20.8	20.7	20.6	20.52	20.4	20.2	19.9	20.0	20.0
EXISTING LEVELS	18.85	18.87	18.88	18.90	19.06	19.94	20.16	20.41	20.63	20.77	20.92	20.98	20.97	20.94	20.89	20.76	20.62	20.47
DEPTH	1.61	1.87	2.12	2.10	1.94	1.06	0.84	0.48	0.34	0.06	-0.21	-0.36	-0.45	-0.54	-0.66	-0.86	-0.62	-0.47
CHAINAGE	90.00	95.00	100.000	105.00	110.00	115.00	120.00	125.00	130.00	135.00	140.00	145.00	150.000	155.00	160.00	165.00	170.00	175.00

JOINS TO EW CROSS SECTION A - PART 2

A / C200 EARTHWORKS CROSS SECTION A - PART 1

SCALE: 1:500 @ A3



21.0	20.8	20.7	20.6	20.52	20.4	20.2	19.9	20.0	20.0	20.0	20.0	20.0	20.0	20.00	20.0	20.0
20.63	20.77	20.92	20.98	20.97	20.94	20.89	20.76	20.62	20.47	20.33	20.17	19.99	19.83	19.68	19.57	19.49
0.34	0.06	-0.21	-0.36	-0.45	-0.54	-0.66	-0.86	-0.62	-0.47	-0.33	-0.17	0.01	0.17	0.32	0.43	0.51
130.00	135.00	140.00	145.00	150.000	155.00	160.00	165.00	170.00	175.00	180.00	185.00	190.00	195.00	200.000	205.00	210.00

20.0	20.0	20.0	20.0	20.0	20.0	19.6	19.46	19.3	19.1	19.0	18.8	18.5	18.461			
19.39	19.31	19.24	19.19	19.15	19.09	19.05	18.99	18.90	18.81	18.72	18.63	18.48	18.461	18.67		
0.61	0.69	0.76	0.81	0.85	0.91	0.58	0.47	0.38	0.31	0.25	0.15	0.01	0.000			
215.00	220.00	225.00	230.00	235.00	240.00	245.00	250.000	255.00	260.00	265.00	270.00	275.00	275.606	280.00	285.00	285.766

JOINS TO EW CROSS SECTION A - PART 1

A / C200 EARTHWORKS CROSS SECTION A - PART 2

SCALE: 1:500 @ A3

DRAFT
BUILDING CONSENT

FILE LOCATION: Y:\01 LAND DEVELOPMENT\395 FITZGERALD ROAD, DRURY\CAD\WORKING FOLDER\395 FITZGERALD RD-A.DWG

REV	REVISION DETAILS	DATE	BY
A	INITIAL ISSUE	18/09/24	JDT

CLIENT:
TAHA
AUTO
LIMITED

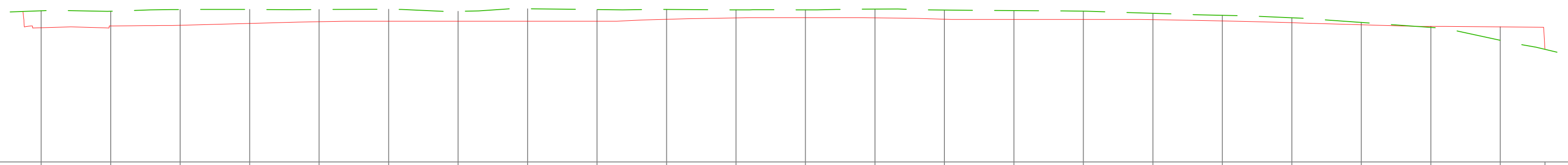
PROJECT / ADDRESS:
395 FITZGERALD ROAD, DRURY,
AUCKLAND

DRAWING TITLE:
PROPOSED EARTHWORKS
CROSS SECTIONS - PART 1

Babingtons
CIVIL AND ENVIRONMENTAL CONSULTANTS

DESIGNED BY: MT
CHECKED BY: LH
DRAWN BY: JDT
APPROVED BY: MT
ORIGIN: 18 SEPTEMBER 2024
PROJECT NUMBER: 395 FITZGERALD RD
SCALE (@A3): AS SHOWN
DRAWING NO. C221
REVISION: A

PRINTED ON: 16/10/2023



VERT EXAG 1:1
Datum 10.000

DESIGN LEVELS		19.6	19.8	19.8	19.9	20.1	20.1	20.1	20.1	20.1	20.23	20.3
EXISTING LEVELS		20.84	20.81	20.93	20.93	20.93	20.94	20.80	20.98	20.93	20.93	20.91
DEPTH		-1.22	-1.06	-1.13	-1.00	-0.88	-0.86	-0.72	-0.90	-0.84	-0.70	-0.58
CHAINAGE	0.000	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.000	55.00

DESIGN LEVELS	20.3	20.3	20.2	20.2	20.2	20.2	20.1	20.0	19.84	19.7	19.7	18.079		
EXISTING LEVELS	20.91	20.96	20.89	20.85	20.81	20.66	20.52	20.34	20.01	19.65	18.73	18.079		
DEPTH	-0.56	-0.63	-0.66	-0.64	-0.60	-0.46	-0.40	-0.35	-0.17	0.07	0.96	0.000		
CHAINAGE	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.000	105.00	110.00	113.220	115.00	117.601

B
C200
EARTHWORKS CROSS SECTION B
SCALE: 1:500 @ A3

FILE LOCATION: Y:\01 LAND DEVELOPMENT\395 FITZGERALD ROAD, DRURY\CAD\WORKING FOLDER\395 FITZGERALD RD-A.DWG

DRAFT
BUILDING
CONSENT

REV	REVISION DETAILS	DATE	BY
A	INITIAL ISSUE	18/09/24	JDT

CLIENT:
TAHA
AUTO
LIMITED

PROJECT / ADDRESS:
395 FITZGERALD ROAD, DRURY,
AUCKLAND

DRAWING TITLE:
PROPOSED EARTHWORKS
CROSS SECTIONS - PART 2

Babingtons
CIVIL AND ENVIRONMENTAL CONSULTANTS

DESIGNED BY: MT	CHECKED BY: LH	DRAWN BY: JDT
APPROVED BY: MT	ORIGIN: 18 SEPTEMBER 2024	
PROJECT NUMBER: 395 FITZGERALD RD		
SCALE (@A3): AS SHOWN	DRAWING NO. C222	REVISION: A

PRINTED ON: 16/10/2023