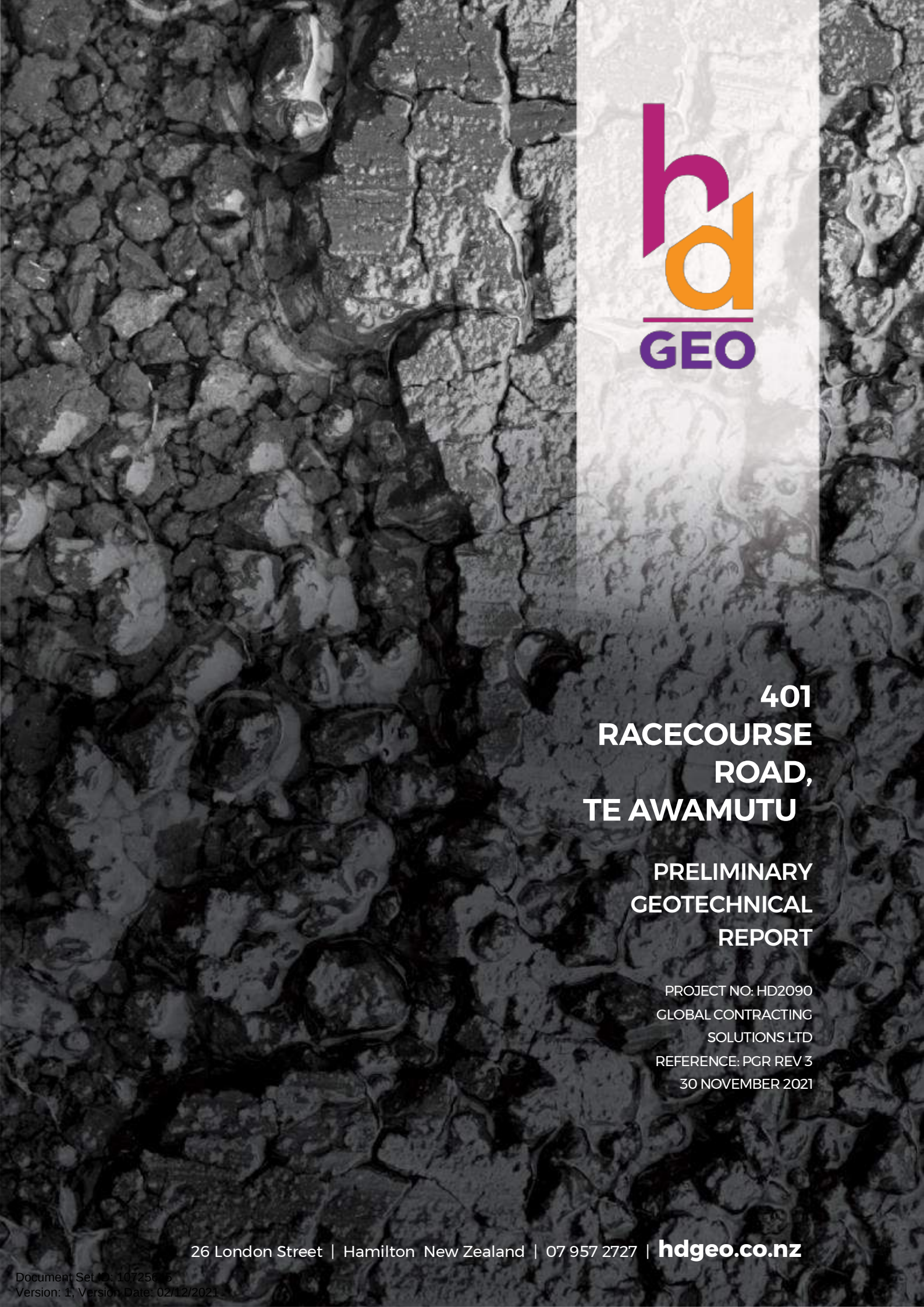
APPENDIX H

SITE SUITABILITY ASSESSMENT



401 RACECOURSE ROAD, TE AWAMUTU

PRELIMINARY GEOTECHNICAL REPORT

PROJECT NO: HD2090
GLOBAL CONTRACTING SOLUTIONS LTD
REFERENCE: PGR REV 3
30 NOVEMBER 2021

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Executive summary

Introduction

Global Contracting Solutions Ltd (GCS) have engaged us to undertake a preliminary geotechnical assessment for their site located at 401 Racecourse Road, Te Awamutu. They propose develop the site into a large industrial complex.

This report is intended to inform concept design for the site and to support a land use change application.

Our scope included:

- a desktop study of the site including a review of geology maps, aerial photography, contour maps, and the NZ Geotechnical Database
- a site walkover and investigation to broadly characterise the ground conditions at the site
- a natural hazards assessment, including a quantitative liquefaction assessment
- preliminary assessment and development of initial parameters to support concept design

Our key findings were:

- ground conditions were consistent with the mapped geology
- the near surface soils are generally loose or low strength up to 1.9 m below the ground level
- ground water was dipped at between 0.5 and 2.8 m below the ground level
- the Mangapiko Stream is about 3 m lower than the low lying areas of the site
- there are areas of uncontrolled fill on the site

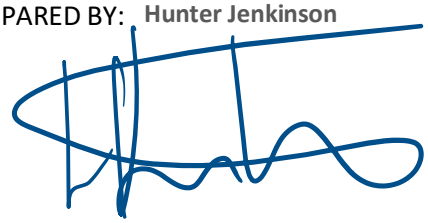
Our assessment is:

- the degree of liquefaction induced ground damage is likely to be 'minor to moderate expression of liquefaction in a large earthquake using the ground water conditions we encountered
- static settlement from between 50 to 200 mm is expected under large buildings with high loads
- preloading the site to induce settlement prior to construction should be considered and could require up to 4 m of additional fill (preload) to be placed
- an ultimate bearing capacity of at least 300 kPa is generally achievable over the site
- liquefied bearing capacity is low at between 30 and 40 kPa depending on the footing type
- the slopes are qualitatively assessed to be stable however some of the development will affect the slopes and mitigation will be needed to ensure stability is maintained
- further investigation and assessment will be required during the detailed design stage of the development

The site has several geotechnical hazards that will require mitigation through further investigation, assessment and design. We believe that these hazards are at a level that they can be effectively mitigated, allowing for the successful development and operation of the site as proposed by GMS.

Contents

PREPARED BY: **Hunter Jenkinson**



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Revision No.	Prepared by	Reviewed by	Description	Date issued
0	Hunter Jenkinson (MEngNZ)	Andrew Holland (CPEng)	PGR - initial	2021.10.11
1			PGR Rev 1 – updated to include preliminary preloading	2021.11.24
2			PGR Rev 2	2021.11.29
3			PGR Rev 3	2021.11.30

Introduction

Global Contracting Solutions Ltd (GCS) propose to develop the site at 401 Racecourse Road, Te Awamutu into a waste to energy plant. We have been engaged to undertake a preliminary geotechnical assessment for the site to assist in detailed design and consenting applications.

This report is intended to inform concept design of the site and to support a land use resource consent application. Further testing and assessment will be needed to inform more detailed design stages. The site has multiple geotechnical hazards that will require mitigation via further investigation, assessment and design.

Scope

The scope of our assessment included:

- a desktop study of the site to review existing information, including historical aerial images, geology maps, contour maps, and the NZ Geotechnical Database (NZGD)
- a site investigation including 12 x hand augers with strength testing and 6 x 20 m deep Cone Penetration Tests (CPT)
- a natural hazards assessment, with a quantitative liquefaction, qualitative slope and settlement screening assessments
- recommendations for developing the site including preliminary recommendations for foundations
- highlighting areas of risk that required further investigation, assessment and design

Site description

For context, we have supplied a site plan with annotations which is attached in Appendix C.

The site is located on the western side of Racecourse Road, Te Awamutu. The site is bounded by the Te Awamutu horse racecourse to the north east, an industrial building to the north, wastewater treatment ponds to the west and the Mangapiko Stream to the south. The ground levels on the eastern side of the site are at a reduced level (RL) of about 49 m (Area 1: higher elevated areas). A moderately steep river terrace with slope grades from between 15 and 30degrees dips to the west onto the lower lying areas of the site. The lower area of the site (Area 2: lower elevated areas) has RLs from 40 m to 43 m above the local datum.

Most of the site is currently in pastoral land with the low-lying areas typically wet. These wet areas flow via open channel drains towards a culvert which is located on the southern side of the paddocks and drains into the Mangapiko Stream.

The Mangapiko Stream is a large tributary to the Waipa and flows from the south east to north west. It is an approximately 10 m wide meandering River. The riverbanks are grassed, about 3 m high and relatively steep. The appear relatively stable with no signs of major regression or slumping.

A small stream runs around the base of the wastewater ponds to the west of the site, discharging into the Mangapiko Stream.

Desk study

We completed a desktop study prior to the site investigation to identify areas of interest. The desktop study consisted of a review of proposed development plans, recent[1] and historic[2] aerial imagery, relevant geological maps[3] and existing nearby geotechnical data[4].

Proposed development

The proposed development plans[5] indicate that an education and exhibition building will be built on Area 1, the higher elevated terrain, with a floor level at RL 50. Hard stand and parking will be located to the east of this building on a similar RL.

The furnace & boiler system, waste recycling plant, tipping and vehicle manoeuvring area, power generator and gas storage area are all to be located on Area 2, the lower elevated areas on the west and southern portion of the site, adjacent to the Mangapiko Stream. The plans show that there will be a GMS underground bunker and truck passage at an RL of 45 m.

There is a proposed bunker on the northern side of the furnace and boiler building with the floor level at an RL of about 42 m.

The plans supplied do not include any cut/fill plans, however, we expect that cut and fill operations will be required to achieve the design RLs

Geological setting

Geological mapping of the area[3] indicates the site is likely to be underlain by younger soils of the Piako Subgroup to the south west and older soils of the Hinuera Formation on the north east.

The Piako Subgroup is described as, *"alluvial and colluvial sand, silt, mud and clay with local gravel and peats beds.".*

The Hinuera Formation is described as, *"Cross-bedded pumice sand, silt and gravel with interbedded peat"*.

Other deposits that maybe present at the site and are typically not shown on relevant geological maps include fill type soils (human modification).

Aerial photography

We have assessed recent and historic aerial imagery of the site from 1944 to 2020 to review the recent evolution of the site. Images with annotations are attached in Appendix B. A summary of each image is presented in Table 1 below.

Table 1: Summary of information from historical and recent images.

Date	Observations
1944	• The site is currently in pasture with the development of Te Awamutu to the south

[1] Google Earth Pro

[2] Sourced from http://retrolens.nz and licensed by LINZ CC-BY. Accessed 1/04/2021

[3] 1:250 000 Geological Map 4 (Waikato) (QMAP). GNS Science, 2005. Accessed 1/04/2021

[4] New Zealand Geotechnical data base (NZGD). www.nzgd.org.nz.accessed 1/04/2021

[5] Paewira Recycle plant, Paewira - 401 Racecourse Road, Te Awamutu. By Terra Consultants, for Global Contracting solutions Limited. Ref200065, November 2021.

	• the Mangapiko Stream to the south of the site appears to have recently abandoned a channel (now seen as swampy area). • The stream has more 'meanders' than seen today. • the Te Awamutu racetrack is located to the north and there is an industrial site to the north west. • Modifications to some of the stream or river terraces is visible in the central portion of the site adjacent to the stream. This is appears to be a sand quarry or similar indicated by the steep cut face.
1958	• little change to the geomorphic environment. • residential dwellings have been developed on the northern side of the site.
1971	• The stream to the south has recently flooded with high water levels present. • Water/silt is visible in the low lying areas of the site to the north • The stream appears to have abandoned previous meanders along its path (unclear if this is natural or human intervention)
1976	• The stream course has straightened with meanders cut off. The old meanders have vegetation growing in them. • An additional industrial building has been built to the north.
2008	• The abandoned stream channels across the lower lying area of the site (area 2) and near the old sand quarry appear to have been infilled. • Abandoned stream channels on the southern side of the stream (outside of our site) have also been infilled. • Waste water ponds have been built on the western boundary of the site
2020	• No significant change to the site since 2008.

NZGD

We have reviewed the NZ Geotechnical Database (NZGD) in the area of the site. The database has a site 200 m to the south east and at a RL of 44 m, which is slightly higher than Area 2 of our site. The site has 4 hand augers and DCPs. The logs do not provide a geological unit for the soils, however the logs appear to show soils of the Hinuera Formation or Piako Subgroup. The results are like soils recovered on our site.

Groundwater was identified at between 1.5 and 1.8 m (Approx. RL 42.5 and 42.2 respectively) below the ground level in the NZGD augers.

Site investigation

Our site investigation included a site walkover, 12 hand augers with strength testing and 6 x 20 m deep Cone Penetration Tests (CPT) across the site.

The testing has been grouped by method and discussed below. Results are attached in Appendix C.

Site observations

We completed a site walkover during our investigation to investigate areas of interest highlighted in our desk study and to identify key geomorphic features that may affect the development. Key observations are presented below:

Area of uncontrolled fill

On the southern side of the access way from Racecourse Road is a large area of uncontrolled fill which is up to 3 m thick. This has been placed over a spring or small stream. This fill appears to include concrete, pipes and tree roots and debris. There were signs of erosion and tension cracks on

the outer edges of the platform. Discussion with the farmer[6] indicated that the fill was being placed by the contractors currently working at the wastewater plant and that Waipa District and Waikato Regional Councils were aware of the works. This material is outside of the main development areas but may affect linear infrastructure (access roads, underground power cables or services) if they are to go through this area.

Historic sand quarry

There is evidence in the historical images and from onsite observations that sand was quarried from the site just south of the entrance to the underground bunker on the southern side of the waste recycling plant (area 2). The area has near vertical cut faces which are marginally stable. The area is now used to dump farm rubbish and green waste. Rubbish induced green waste and piles of soil and gravels. It also appears that the local power network provider is storing large power poles here as well.

Paleochannels

The paleo channels highlighted in our historic aerial image assessment have mostly been filled and are no longer visible. We suspect these have been infilled to allow for better land utilisation for pastoral grazing.

Drain

An opendrain or possibly an old paleochannel is located in the southern side of the low lying paddock, collecting surface water run off from the area. This water is directed to the south where it travels through a farm culvert (pipe) and discharges into the stream.

Shallow ground conditions

We have broken the following section into the relevant mapped geological settings which correspond to “Area 1” and “Area 2”, the upper, and lower, areas of the site respectively.

Hinuera Formation – Area 1

HA01 and HA02 were completed on the higher elevated areas of the site (49 m) adjacent to the river terrace slope. The hand auger logs revealed:

- Typically, 0.1 to 0.2 m of topsoil overlying,
- Typically medium dense to dense sand and gravelly sand to at least 3.0 m below the ground level
- Thin layers of loose sand were logged in the upper 1.0 m

Groundwater was not identified in these tests (max 3m deep).

Piako Subgroup – Area 2

HA03 to HA12 were completed on the lower lying areas of the site, where most of the proposed developed will be located. The ground RL ranges from 40 to 43 m.

The hand auger logs revealed:

- Typically, 0.2 m of topsoil overlying,
- Sandy silt, silt or clayey silt (Piako Subgroup) to between 0.3 and 1.9 m
- The deeper soils were typically sand soils (Hinuera Formation) with occasional thin silt layers
- HA03, HA05, HA06, HA09 and HA12 revealed uncontrolled fill to between 0.3 and 1.1 m below the ground level

[6] Personal communication between the Farmer and Hunter (HD Geo Ltd) on the 11th August.

Groundwater was dipped at between 0.4 and 1.8 m bgl. Ground water was not identified in HA05, HA08 or HA10.

Deep ground conditions

We completed 6 CPT tests across the site. The soil behaviour type is summarised below:

- topsoil assumed to be up to 0.2 m below ground level (bgl)
- interbedded layers of sand and silt (Hinuera Formation) to at least 9 m bgl (cone tip resistance 3 – 15 MPa)
- low strength clay and silt layers were revealed to extend to between 12.5 and 18 m below the ground level (possible transition to Karapiro Formation) (cone tip resistance typically < 3 MPa)
- Higher strength sand and silty layers (possible Walton Subgroup cemented alluvium) extended to at least 20 m below the ground level. The CPTs generally refused in this layer due to it being too dense to penetrate. (cone tip resistance 5 - > 30 MPa)

Table 2: CPT summary table.

Inferred geology	Depth to bottom of unit (m bgl)	Soil behaviour type (SBT (Robertson, 2010)	Typical CPT qc (MPa)
Topsoil	Assumed to be 0.2	Silt/clay	<1
Hinuera Formation (Piako Subgroup)	Between 9 to 14	Interbedded sands and gravelly sands with occasionally silt layers	<1 to 20
Karapiro Formation (Walton Subgroup)	12.5 to 18	Alternating layers of clay and silt	<1.0
(Walton Subgroup alluvium)	>20.0	Alternating layers of silty clay and silt sand soils	>5 gradually increasing and typically refusing (>20)

[1]: m below ground level

Groundwater

We recorded groundwater at different levels over the site. We expect that the groundwater is controlled by the flowing level of the Mangapiko Stream to the south, tracking higher as distance from the stream increases. We have summarised the dipped water levels in Table 3 and provide an approximate RL for that level based on available contour data.

Table 3: Groundwater summary table.

Test ID	Test RL (m)	Ground water bgl (m)	Approx Ground water RL (m)
HA01	48.5	n/a	n/a
HA02	49	n/a	n/a

HA03	43	1.8	41.2
HA04	43.5	0.9	42.6
HA05	45	n/a	n/a
HA06	43.5	1.0	42.5
HA07	42.5	1.2	41.3
HA08	43.5	n/a	n/a
HA09	43	0.5	42.5
HA10	43	n/a	n/a
HA11	41	0.5	40.5
HA12	40	0.4	39.6
CPT01	48.5	7.6	40.9
CPT02	43.5	2.79	40.7
CPT03	43.5	1.57	41.9
CPT04	43	2.20	40.8
CPT05	43	2.75	40.25
CPT06	43.5	2.63	40.9

Due to the variability of the groundwater over the site, we have used the recorded ground water level at each location for the purpose of our assessment. These levels are subject to seasonal fluctuations and may vary from those recorded.

We have used the dipped ground water levels for the assessments below. These levels can be assumed to be the typical winter levels. We have also assumed worst case ground water levels of 6 m bgl for area 1 and 1 m bgl for area 2 in our sensitivity screening assessment for liquefaction.

Geotechnical assessment

This assessment is a collection of general information and advice for the site. Further geotechnical investigation, assessment and design will be required to mitigate the identified geotechnical hazards once the design details and structural requirements are confirmed.

Natural hazards

Earthquake: The site subsoil class is D 'Deep or soft soils'. Design peak ground acceleration for the 1 in 500-year average recurrence interval earthquake event is calculated to be 0.22g[7]. Earthquake induced liquefaction and lateral spread are assessed in the 'Liquefaction' section below.

Volcanic, geothermal, or sedimentation activity:

- the site is approximately 18 km east of Mount Pirongia an extinct stratovolcano.
    - the last eruption is assessed to be about 1.6 Ma[8]

[7] New Zealand Transport Agency (2018) Bridge Manual (SP/M/022), Third edition, Amendment 3.

[8] McLeod, O.E., Pittari, A. 2019. Mount Pirongia – North Island's largest basaltic volcano. In: Lowe, D.J., Pittari, A. (editors), Field Trip Guides. Geosciences 2019 Conference, Hamilton, New Zealand (24-29 November). Geoscience Society of New Zealand Miscellaneous Publication 155B, pp. 1–18.

- the risk from volcanic hazards is negligible as the volcano is extinct

- geothermal activity is not expected
- there is a low to moderate risk of sedimentation due to the close proximity of the Mangapiko Stream. Sedimentation could occur if the stream floods

Landslips: Most of the site is near level with no anticipated instability. The moderately sloping river terrace appears relatively stable. Slope stability is considered in the 'Slope stability' section below.

Erosion: overland flow paths and minor erosional features were identified during our site walkover. Any development would need to consider stormwater discharge to not cause any erosional issues in the future.

Subsidence: Risk of the site to general subsidence (from consolidation due to loading) is moderate to high as detailed in 'Soft soils and settlement' below.

Liquefaction

The following is a site-specific liquefaction assessment in accordance with the relevant guidance documents. Assessment printouts are included in Appendix E.

Assessment inputs

We have analysed the CPT data using the proprietary software CLIQ (Geologismiki) and engineering calculations under the most recent guidelines. We have used the groundwater levels at each CPT location for this assessment to understand the current risk over the site. Input parameters are listed in Table 3 below.

Table 4: Liquefaction assessment parameters.

Parameter	Input
Site seismic classification:	Class D (deep soil site)
1000-year return period PGA coefficient (C0,1000)	0.29
Structure Importance Level[9]:	Level 2 (Normal importance) and assuming a 50-year design life.
Peak ground acceleration (PGA)[10]:	• 0.06 g Serviceability Limit State (SLS); 1 in 25-year event; • 0.22 g Ultimate Limit State (ULS); 1 in 500-year event;
Earthquake magnitude	5.9 M
Analysis depth	Limited to 10
Ground water depth (m bgl)	Levels range from 1.6 to 7.6 m bgl
Aging correction	Not applied

Liquefaction susceptibility

We have assessed the site in the two areas as they have different hazards. Area 1 typically has better ground conditions and lower groundwater. Area 2 has lower strength soils and shallower

[9] NZS 1170.0:2002. *Structural Design Actions—General Principles. SANZ*

[10] New Zealand Transport Agency (2018) Bridge Manual (SP/M/022), Third edition, Amendment 3.

groundwater. CPT03 has not been included in the assessment below (Area 2) due to it not achieving the required testing depth. It refused on a very dense layer at 1.6 m bgl.

Area 1 – upper river terrace

Serviceability Limit State (SLS) conditions:

Under SLS conditions, no liquefaction was predicted for the site.

Ultimate limit state (ULS) conditions:
Under ULS conditions, our assessment showed potential liquefaction within the sand layers located typically below 7.5 m.

Our analysis predicted:

- about 25 mm of vertical settlement
- Liquefaction Severity Number (LSN) value of 3 (little to no expression of liquefaction)
- Liquefaction Potential Index (LPI) value of 0.2 (low risk)
- differential settlement has not been assessed

Site Performance Level (Area 1)

Our assessment indicates the site lies between performance levels L0 to L1 (Insignificant to mild) when the groundwater is at the dipped level of 7.6 m bgl

This performance level is defined as:

- limited excess pore water pressures
- negligible deformation of the ground and small settlements

Area 2 – low lying areas

SLS conditions:

Under SLS conditions, no liquefaction was predicted for the site.

ULS conditions:

Under ULS conditions, our assessment showed potential liquefaction within the sand layers located typically below 3.0 m.

Our analysis predicted:

- about 90 to 120mm of vertical settlement
- Liquefaction Severity Number (LSN) value of 16 to 22 (minor to moderate expression of liquefaction)
- Liquefaction Potential Index (LPI) value of 5 to 7.5 (low to high risk)
- differential settlement of up to 50 mm between the CPT test locations

Site Performance Level (Area 2)

Our assessment indicates the site lies between performance levels L2 and L3 (moderate to high) when the groundwater is at the dipped levels recorded.

This performance level is defined as:

- liquefaction occurs in a significant portion of the deposits
- moderate differential movements and settlement of the ground in the order of 100 to200 mm.

Sensitivity check

Groundwater

The liquefaction assessment is moderately sensitive to groundwater level due to the presence of the sand soils. The assessment detailed above is representative of dipped ground water conditions during our investigation.

Area 1 would have a 35 mm increase in vertical settlement with an elevated worst case ground water table of 6.0 m.

Area 2 would have about a 20 mm increase in total vertical settlement if the ground water level is located at a worst-case high level of 1 m bgl. The site performance level will remain at L3 (high).

Limit depth

To assess the potential for deeper liquefiable layers (important if piles are necessary) we ran the assessment with no limit depth. This unlimited assessment shows that the expected vertical settlement in CPT01 and 02 see the largest increase in vertical settlement. 50 mm at CPT01 and 30 mm at CPT02. This additional settlement is coming from layers below 10 m which extend to 19 and 17 m respectively. LSN and LPI categories remain similar.

The risk of deeper liquefaction (below 10 m) will need to be considered if deepened foundations such as driven or screw piles are required. This risk is accounted for in the 'foundation assessment' section below.

Building importance level

We have completed our assessment using inputs based on the development being Importance Level (IL) 2 buildings. However, we have completed a parametric assessment to understand how vertical settlements are expected to change with increasing PGA values (ie, a higher IL level). The assessment indicated that if the site is assessed as an IL3 development, the vertical settlements will increase by about 20 mm across the site. We have included the parametric assessment output in Appendix C and highlighted the PGA for both IL2 and IL3.

Lateral spreading risk

The site is located adjacent to the Mangapiko Stream which has banks that are about 3 m high at grades up to and over 45 degrees. Such banks create a 'free face' meaning that they can allow lateral spreading during a liquefaction event. The screening assessment indicates that lateral displacement following a ULS event could be significant. The displacements will increase the closer the location of interest is to the stream banks. The assessed displacements are large enough to cause slope failures along the gully banks and disruption well back from the stream edge. Our assessment shows potentially damaging lateral spreading can occur up to 100 m away from the stream bank[11].

We recommend that a detailed lateral spreading risk assessment is completed during further assessment and design. If lateral spreading is confirmed to affect the proposed buildings, mitigation measures such as shear piles or deepened footings will be required to mitigate the risk.

[11] Lateral spreading and its impacts in urban areas in the 2010 2011 Christchurch earthquakes. M Cubrinovski et al. Final version 10 April 2012

Soft soils and settlement

We have completed a settlement screening assessment to check the response of the subgrade soils below the proposed development. We have applied different loads and assumed two scenarios:

- pad footing dimensions of 2 m by 2m with a depth of 0.5 m
- widespread load of 25 m by 100 m.

Pad footings are typically affecting only the upper soils, which are generally more sandy. That means that pad footings are relatively stiff and settlement is low for loads up to 100 kPa. For wider spread loads, deeper, softer soils are affected and settlement is much higher. Widespread loads could be from earthworks (filling) or from widespread dead or live loads. The results of our assessment are shown in Figure 1 and Figure 2.

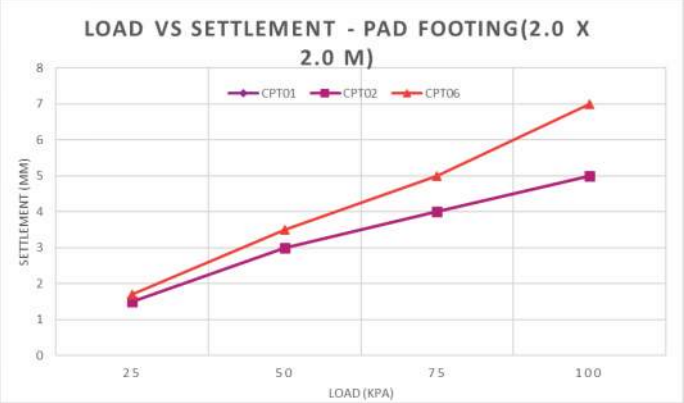

Figure 1: Settlement vs load for a small pad type foundation.

Figure 2: Settlement vs load for a wide-spread load.

The results indicate there is a high risk of static settlement for large and widespread loads from both foundations and the placement of bulk fill. Settlement is occurring in the clay and silt layers at depth with settlement expected to extend to 18 m below the ground level below 'area 1' and 12 to 13 m below 'area 2'.

The actual amount of settlement and depth of influence will be governed by the loaded dimensions and by the load. A detailed settlement assessment will be needed during the detailed design stage of the project. To refine the settlement assessment, we recommend further geotechnical investigation to obtain samples of the susceptible soils for laboratory testing.

Preliminary preloading assessment

The preliminary civil plans[12] for the development indicate that earth fill from <1 m up to 6 m will be required to create the levels for construction. This is equivalent to about 20 kPa up to 120 kPa which could cause widespread and large settlements over the site (as indicated above).

In order to reduce post-construction settlement to acceptable levels, a preload fill is considered a suitable mitigation measure. We expect the time to 95% consolidation will be approximately 6 to 12 months. However, due to the uncertainty in the ground model and other structural inputs required

[12] DRAFT Earthworks plan overall. Prepared by Terra Consultants for Global Contracting Solutions Ltd (GCS). Dated 1/12/2021, Ref: 200065, CD-020 Rev A

for an accurate assessment, we recommend a detailed settlement assessment. This will include additional subsurface testing including CPTs and boreholes, in situ samples of the compressible material, lab testing and quantitative assessment. The results of this additional assessment will provide better guidance on the expected settlement and timeframes.

There are two options to consider for establishing preload at the site:

1) complete a trial area on site and monitor the settlement with survey at regular intervals for approximately 3 months. This will provide more information on the rates and magnitudes of settlements expected on site and could be undertaken in parallel with the investigation and assessment. This will allow the preload design to be refined prior to preloading the remainder of the site. For preliminary purposes, this preload trial could be a 4 to 6 m high, 25 m by 25m embankment constructed centrally within the site.
2) Fill the site to design levels and add preload over the entire site that is to be developed. For preliminary purposes, the preload could be an 3 to 4 m high.

Settlement data will be assessed by HD Geo as it is collected. From the outputs of the preload monitoring, we will be able to assess and estimate the consolidation parameters and the timeframes for settlement stabilisation.

The final details for the preload design will be confirmed following the detailed design phase of the project. All information above is for planning purposes only for resource consent application.

Slope stability

We saw no signs of significant instability during our review of the recent and historic photography or the site walkover. Minor soil creep was observed on slopes greater than 20 degrees, particularly closer to the base of the slopes.

The plans indicate that the education and exhibition building is to be located on the edge of the old elevated river terrace (RL 49) and the Building and hard stand on the lower lying areas are to be at the toe of this slope with excavations likely to undercut the toe of the slope.

The risk of slope instability will be mitigated during the detailed design stage of the project. This will include quantitative slope stability modelling and assessment once the final plans are made available.

It is likely that the building near the top of the slope will required deepened footings and/or a barrier pole wall to mitigate any influence on the slopes. Any areas at are to require excavation at the toe of the slopes will need specific assessment which may indicate retaining walls are required.

We will need the following to complete a detailed assessment of the slopes:

- Final development plans including
    - Building loads from the structural engineer
    - Cut to fill plans
    - Building design plans (footing and walls with RLs)
    - Contour plan
    - Drainage (stormwater) plans/designs

Bearing capacity

We have completed a preliminary bearing capacity assessment for different foundation dimensions

The results of the assessment are detailed in Table 5.

Table 5: Bearing capacity screening assessment results.

Footing dimensions (m)	Drained – Ultimate bearing capacity (kPa)
30 x 0.3 x 0.5 (strip)	350
2.0 x 2.0 x 0.5 (pad)	600
100 x 25 x 0 (pad)	3000

We have also completed a layered bearing capacity assessment to assess the capacity achieved during a liquefaction event. The results are presented in Table 6.

Table 6: Liquefied bearing capacity assessment.

Footing dimensions (m)	Design bearing strength (kPa)*
2.0 x 2.0 x 0.5 (pad)	100
30 x 0.5 x 0.5 (strip)	200
25 x 100 x 0.5 (wide raft)	30

**note that liquefaction will also cause significant settlement and these bearing pressures may lead to foundation disruption. Detailed assessment is needed.*

These numbers are indicative only and a specific bearing capacity assessment will be required for the development once the foundation plans have been developed.

Foundation assessment

Industrial buildings

Due to the liquefaction risk, risk of static settlement under high loads, and low liquefied bearing capacity, we expect that parts or all the industrial development will require ground improvement or deepened foundations such as piles.

We have completed a pile screening assessment to provide preliminary results for the expected bearing that could be achieved for a single pile and the expected depth. Our preliminary assessment shows that deep piles are a suitable solution for mitigating the risk from liquefaction and static settlement for the site. The optimal details of the piles (sizes, type and spacings) will be determined during the detailed design of the project. We expect the founding depth of piles to be between 12 m to 19 m below the existing ground level.

A detailed foundation assessment will be required once the plans and loads have been developed and finalised.

Light weight buildings

Light weight timber frame buildings (possibly the exhibition and educational building in Area 1) are unlikely to cause the deep static settlement or be as vulnerable during a liquefaction event. However, the strength requirements of 'good ground' according to NZS 3604:2011 were not met across the site up to a depth of between 0.4 and 1.9 m as the near surface soils were generally loose or low strength. For a concrete floor, light timber framed building, we expect TC2 type raft foundations with ground improvements (to between 0.4 and 1.9 m bgl) to be suitable.

Ground improvements would include excavation to remove topsoil and any soft, loose or unsuitable material. Any excavation would be backfilled with compacted hardfill. Our preliminary testing indicates excavation depth would vary depending on the location.

A specific design for low strength soils and liquefaction risk may prove more economic than the ground improvement option with generic foundation solutions.

Earthworks

Only draft cut and fill plans were available at the time of this assessment. The plans indicate that some areas of the site will be cut down by up to 4 m while other areas will be filled by up to 6 m to create the building platforms.

All earthworks must be undertaken in accordance with a specification developed for the site. With the exception of topsoil, organic soils, softer soils or uncontrolled fill, cut material maybe suitable for re-use as hard fill across the site. Once more developed plans are available for the site, testing of the cut soils should be undertaken and a site-specific specification should be developed.

Summary

Based on our assessment, the site has geotechnical hazards that require mitigation for the development of the industrial buildings. We have summarised the key findings of this assessment below:

- The site is subject to a liquefaction hazard. The hazard varied across the site and detailed assessment will be needed to enable targeted mitigation.
- Slopes are generally stable however, due to the modification proposed, mitigation may be needed. If required, retaining or stabilisation will mitigate the hazard.
- There are soft soils at depth below the site. These soils are susceptible to consolidation settlement if loaded.
- Foundations will need to be designed for the potential liquefaction and static settlement risks expected at the site. It is likely that piled foundations will be needed.
- A specific foundation bearing capacity assessment will be required during detailed design.
- Piled foundations would likely be 12 to 19m below current ground level (depending on loads)

Recommendations

The site is suitable for the proposed development as long as the identified geotechnical hazards are mitigated. Further investigation, assessment and specific design of foundations will be required for structures proposed on the site. Given the geotechnical hazards, we recommend the geotechnical and structural assessment and design are undertaken with close collaboration.

Limitation

This report has been prepared for our client, Global Contracting Solutions Ltd (GCS), their professional advisers, and the relevant local authority for the purposes detailed above and may not be relied on by any other party for any other purposes. This report contains a preliminary assessment to establish suitability for the proposed development based on a site walkover and testing in discrete locations. Further testing and assessment are required during the design of the development. Inferences about the conditions at the site have been made based on the testing undertaken and our understanding of the geological environment in which the site lies.

We recommend that HD Geo is engaged to undertake further testing and assessment for building design.

APPENDIX A – DEVELOPMENT PLANS

Site development plans

terra

A0 GENERAL NOTES

SHEET	SHEET NAME	REV
A00-00	COVER SHEET	
A00-10	3D VIEWS	
A01-01	SITE PLAN	

A1 PLANS

A01-01	SITE PLAN	
A10-01	UPPER LEVEL PLAN	A
A10-02	LOWER LEVEL PLAN	A

A2 ELEVATIONS

A3 SECTIONS

A30-01	SECTIONS	

A4 LARGE SCALE DRAWINGS

A40-01	CAFE/MUSEUM/OFFICE BUILDING LAYOUT	

FOR INFORMATION

PAEWIRA RECYCLE PLANT

PAEWIRA – 401 RACECOURCE ROAD, TE AWAMUTU

PROJECT NO. 200065

NOVEMBER 2021

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3D VIEW 01

3D VIEW 02

3D VIEW 03

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REV.	DESCRIPTION	DATE

terra consultants

79 GRAFTON ROAD,
GRAFTON, AUCKLAND 1010
09 357 3557
WWW.TERRAGROUP.CO.NZ

PROJECT STATUS:

PROJECT TITLE:
PAEWIRA RECYCLE PLANT

PROJECT ADDRESS:
PAEWIRA – 401 RACECOURCE ROAD, TE AWAMUTU

SHEET TITLE:
3D VIEWS

PROJECT ISSUE DATE:
NOVEMBER 2021

SCALES
1 : 1000 at A1

DESIGNER	DRAWN BY	CHECKER
Designer	Author	Checker

PROJECT NO.	SHEET NO.	REV NO.
200065	A00-10	

TE AWAMUTU RACECOURSE

TEMPORARY BUNKER FOR WET ASH
A20-01
POND
2 A30-01
A20-01
BUNKER
CHIMNEY
EDUCATION & EXHIBITION PROGRAMME + CAFETERIA
50000
VISITOR CARPARK
1 A30-01
FURNACE & BOILER SYSTEM
45000
50000
50000
TIPPING AND VEHICLE MANEUVERING AREA
WEIGH BRIDGE IN
WEIGH BRIDGE
POWER GENERATOR
WASTE AND RECYCLING PLANT
WEIGH BRIDGE OUT
RAMP DOWN TO LOWER LEVEL FOR GMS TRUCKS ONLY
WEIGH BRIDGE OUT
WEIGH BRIDGE IN
PICKING CRANE
BUNKER
45000
ENTRANCE TO UNDERGROUND BUNKER
1 A30-01
2 A30-01
A20-01
RACECOURSE ROAD
MANGAPIKO STREAM
RACECOURSE ROAD

80
10
50
80
97
100
27
50
11
97

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PROJECT STATUS:

PROJECT TITLE:
PAEWIRA RECYCLE PLANT

PROJECT ADDRESS:
PAEWIRA – 401 RACECOURCE ROAD, TE AWAMUTU

SHEET TITLE:
SITE PLAN

PROJECT ISSUE DATE:
NOVEMBER 2021

SCALES
1 : 1000 at A1

DESIGNER	DRAWN BY	CHECKER
Designer	Author	Checker

PROJECT NO.	SHEET NO.	REV NO.
200065	A01-01	

NORTH BOUNDARY
46° 38' 42" 182.30 m

WEST BOUNDARY
47° 47' 55" 134.57 m

POND

VISITOR CARPARK

BUS PARK

EDUCATION & EXHIBITION PROGRAMME + CAFETERIA

ACCESS TO VIEWING PLATFORMS

PASSING BAY

TIPPING AND VEHICLE MANEUVERING AREA

TUNNEL BELOW

TEMPORARY BUNKER FOR WET ASH

STAFF STAIR TO PLANT

VIEWING PLATFORM OVERHEAD

MOVEABLE TRAFFIC CONTROL BOLLARDS

PICKING CRANE

FURNACE & BOILER SYSTEM

WASTE AND RECYCLING PLANT

ENTRANCE TO UNDERGROUND BUNKER BELOW

BUNKER

PASSING BAY

EMERGENCY EXIT FOR VIEWING PLATFORM

BUNKER

VIEWING PLATFORM OVERHEAD

POWER GENERATOR

WEIGH BRIDGE OUT

WEIGH BRIDGE IN

OFFICE

RAMP DOWN

WEIGH BRIDGE OUT

WEIGH BRIDGE IN

MANGAPIKO STREAM

A20-01 2

A40-01 1

A20-01 4

A30-01 2

A20-01 1

A30-01 1

A20-01 3

A20-01 1

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REV	DESCRIPTION	DATE
-		
A	REMOVAL OF GAS STORAGE	21.11.15

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PROJECT STATUS:

PROJECT TITLE:
PAEWIRA RECYCLE PLANT

PROJECT ADDRESS:
PAEWIRA – 401 RACECOURCE ROAD, TE AWAMUTU

SHEET TITLE:
UPPER LEVEL PLAN

PROJECT ISSUE DATE:
NOVEMBER 2021

SCALES
1 : 500 at A1

DESIGNER	DRAWN BY	CHECKER
Designer	Author	Checker

PROJECT NO.	SHEET NO.	REV NO.
200065	A10-01	A

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NORTH BOUNDARY
46° 38' 42" 182.30 m

A20-01
2

WEIGH BRIDGE ABOVE
WEIGH BRIDGE ABOVE
WEIGH BRIDGE OUT
WEIGH BRIDGE IN

VISITOR CARPARK ABOVE

EDUCATION & EXHIBITION PROGRAMME + CAFETERIA ABOVE

WATER TANKS STORAGE

PASSING BAY

A

50

TEMPORARY BUNKER FOR WET ASH

10

1

STAFF LIFT TO OFFICES

STAFF STAIR TO OFFICES

WATER TANKS STORAGE

89

97

55

42

A20-01
4

A20-01
1

10

2
A30-01

BUNKER

40

PASSING BAY

80

FURNACE & BOILER SYSTEM

45000

45000

GMS SPARE BUNKER

GMS UNDERGROUND BUNKER

ENTRANCE TO UNDERGROUND BUNKER BELOW

EMERGENCY EXIT FOR VIEWING PLATFORM

45000

BUNKER

11

50

MANGAPIKO STREAM

27

POWER GENERATOR

100

1
A10-10

3
A20-01

1
A30-01

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-		
A	REMOVAL OF GAS STORAGE	21.11.15

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PROJECT STATUS:

PROJECT
PAEWIRA RECYCLE PLANT

PROJECT ADDRESS:
PAEWIRA – 401 RACECOURCE ROAD, TE AWAMUTU

SHEET
LOWER LEVEL PLAN

PROJECT ISSUE
NOVEMBER 2021

SCALES
1 : 500 at A1

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200065	A10-02	A

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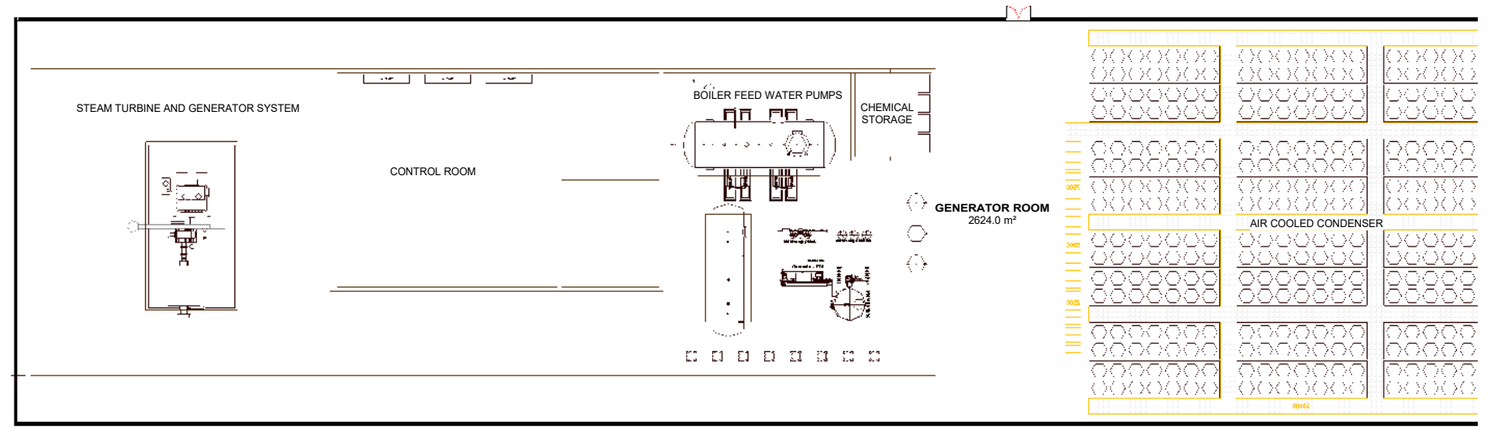


1 **STEAM TURBINE**
1 : 200

PROJECT STATUS:

PROJECT TITLE:
PAEWIRA RECYCLE PLANT

PROJECT ADDRESS:
PAEWIRA – 401 RACECOURCE ROAD, TE AWAMUTU

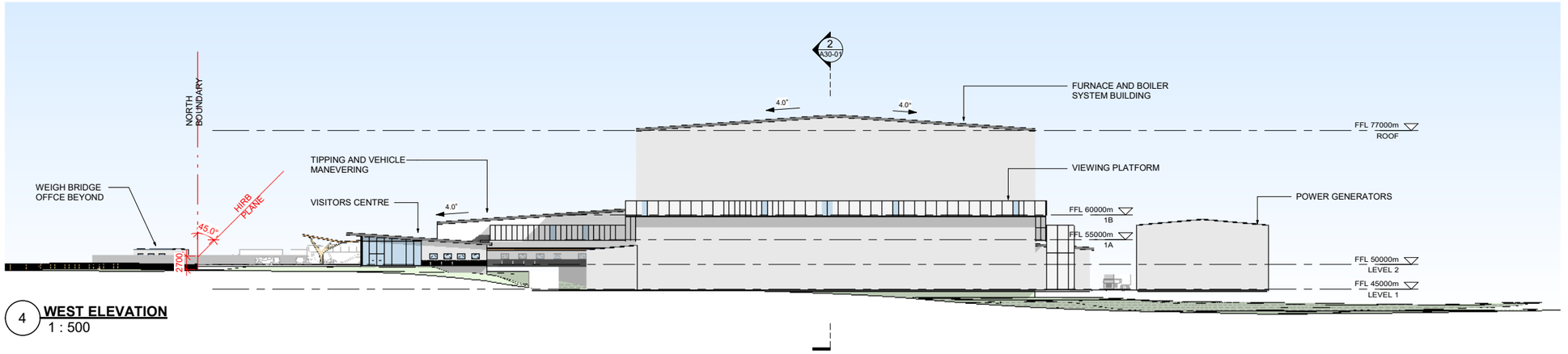
SHEET TITLE:
POWER GENERATOR PLAN

PROJECT ISSUE DATE:
NOVEMBER 2021

SCALES:
1 : 200 at A1

DESIGNER	DRAWN BY	CHECKER
Designer	Author	Checker

PROJECT NO.	SHEET NO.	REV NO.
200065	A10-10	



4 **WEST ELEVATION**
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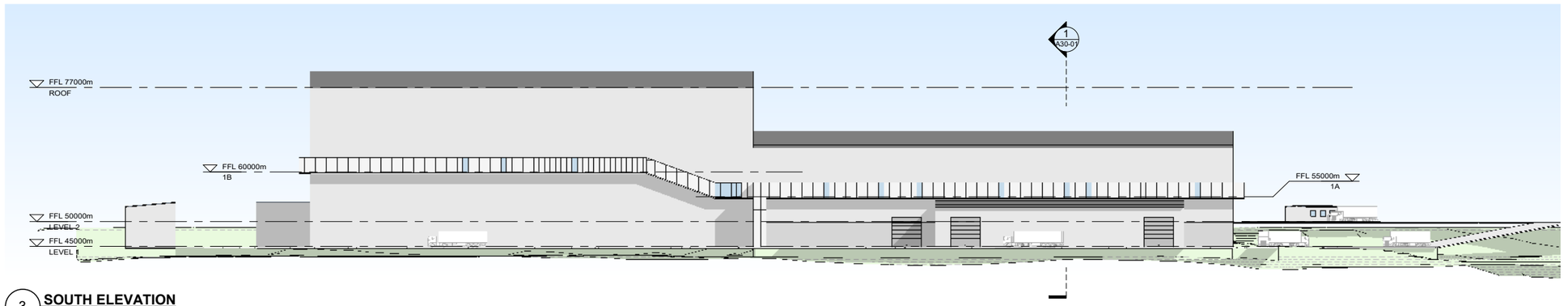

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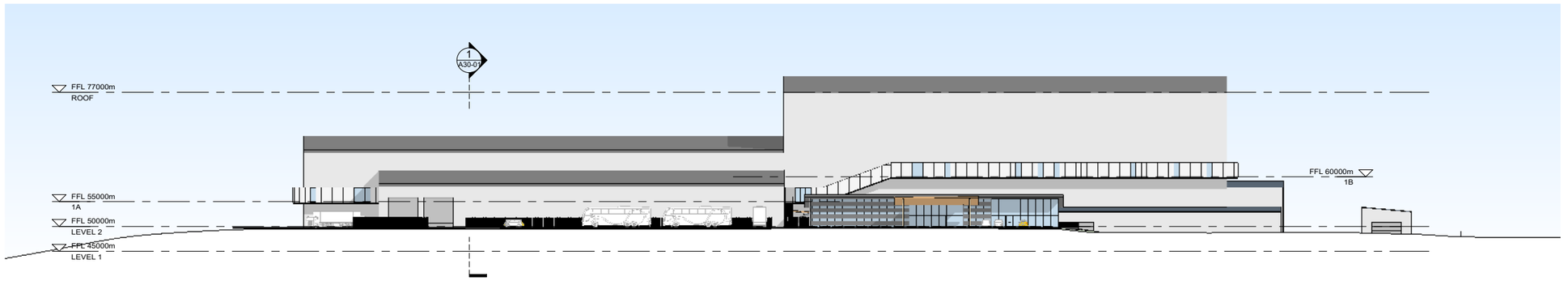
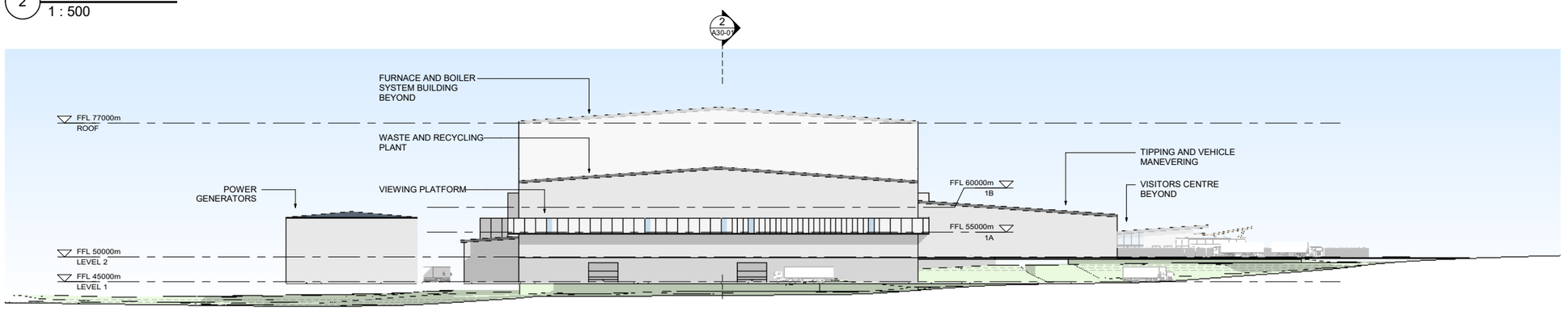


2 **NORTH ELEVATION**
1 : 500



1 **EAST ELEVATION**
1 : 500

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PROJECT STATUS:

PROJECT TITLE:
PAEWIRA RECYCLE PLANT

PROJECT ADDRESS:
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SHEET TITLE:
ELEVATIONS

PROJECT ISSUE DATE:
NOVEMBER 2021

SCALES @:
1 : 500 at A1

DESIGNER	DRAWN BY	CHECKER
Designer	Author	Checker

PROJECT NO.	SHEET NO.	REV NO.
200065	A20-01	

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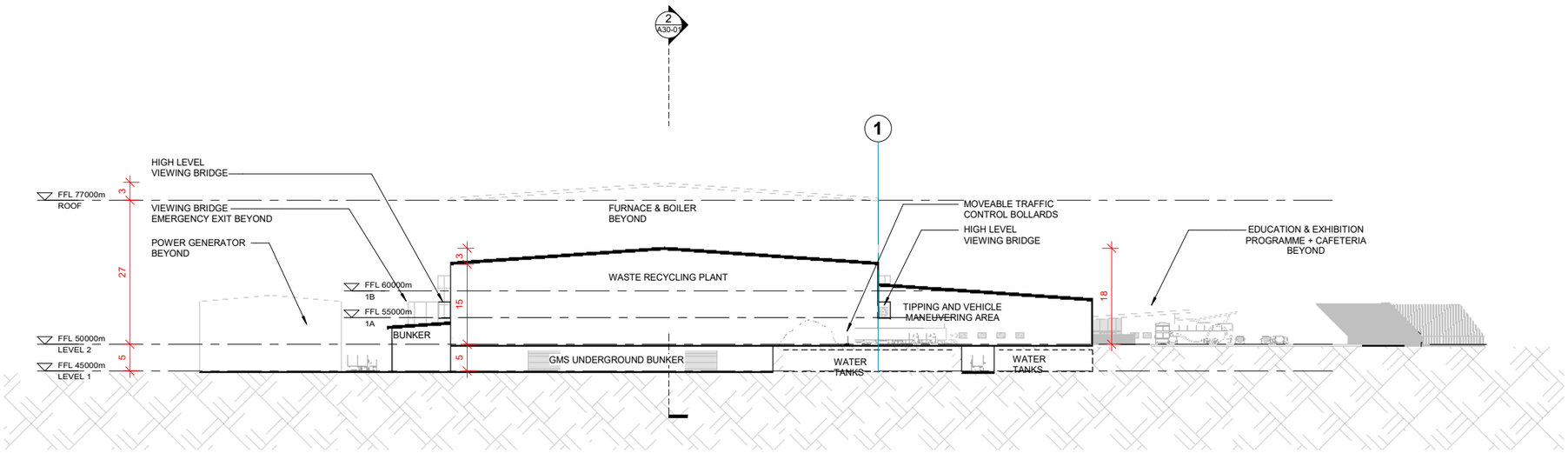

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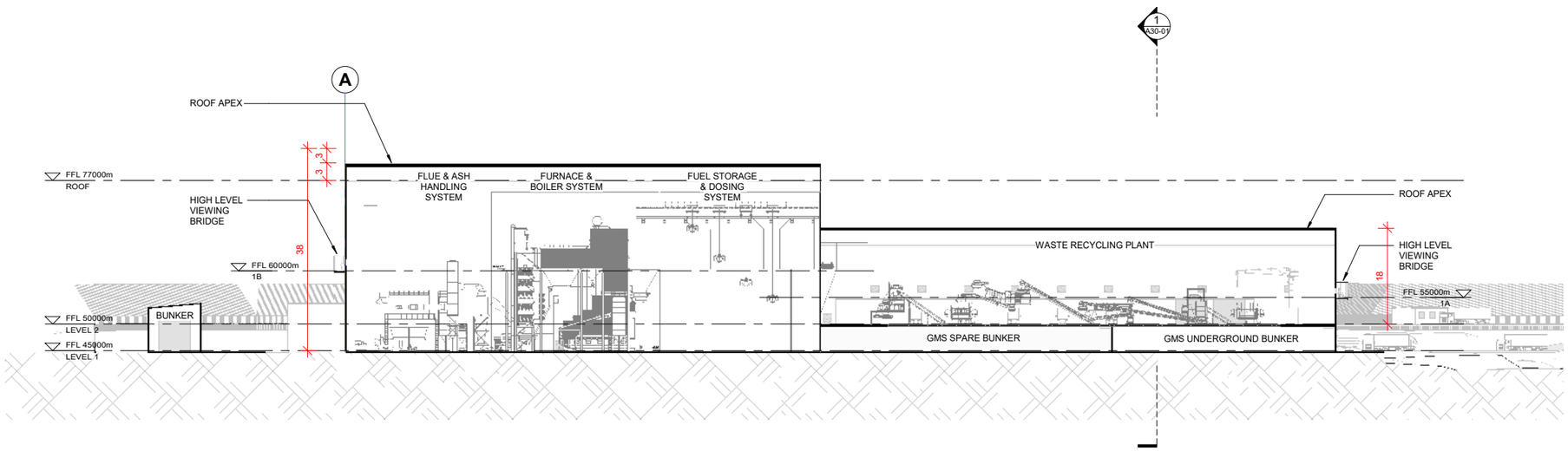

2 **SECTION 1**
1 : 500

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PROJECT STATUS:

PROJECT
PAEWIRA RECYCLE PLANT

PROJECT ADDRESS:
PAEWIRA – 401 RACECOURCE ROAD, TE AWAMUTU

SHEET TITLE:
SECTIONS

PROJECT ISSUE DATE
NOVEMBER 2021

SCALES
1 : 500 at A1

DESIGNER	DRAWN BY	CHECKER
Designer	Author	Checker

PROJECT NO.	SHEET NO.	REV NO.
200065	A30-01	

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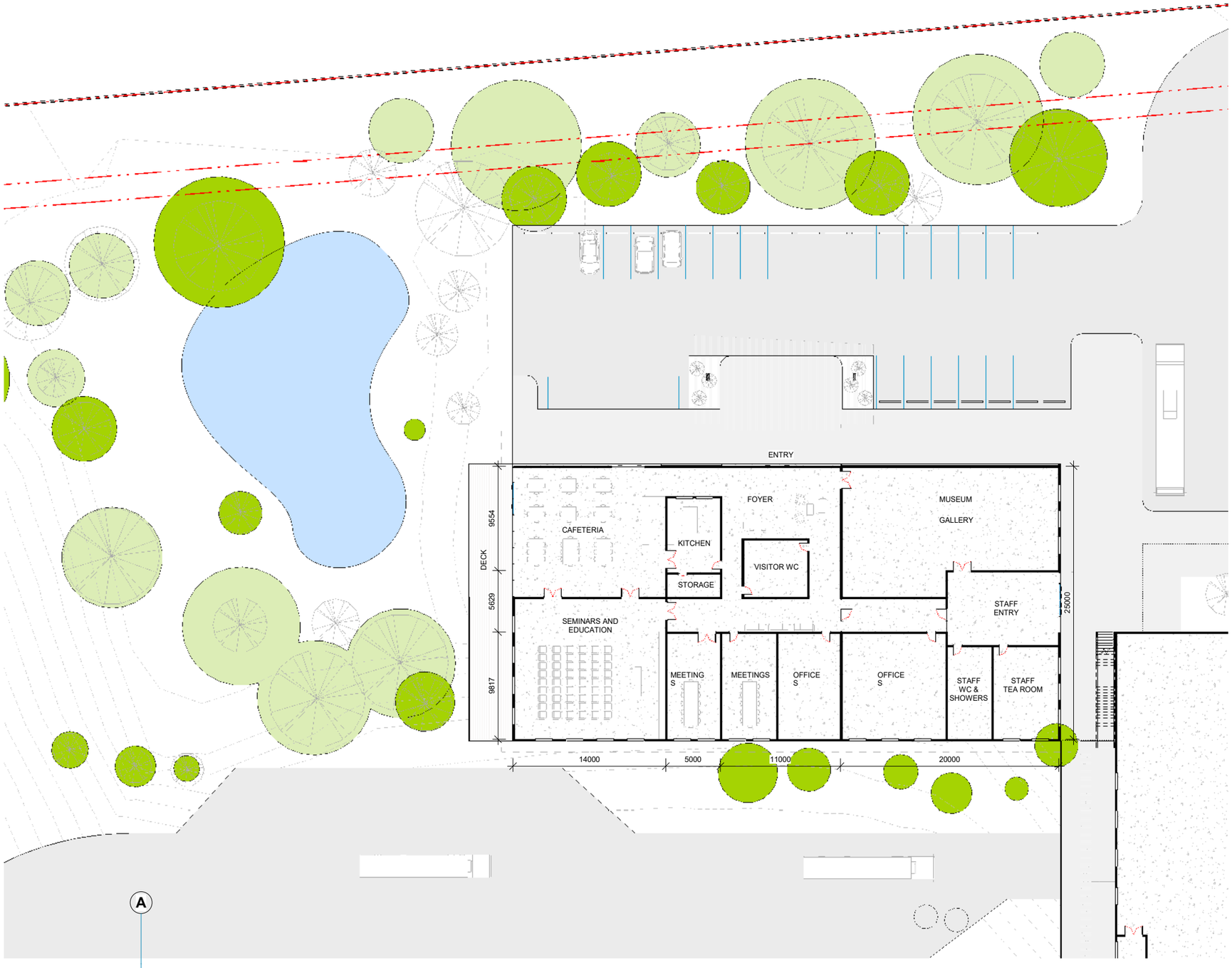

1 **LEVEL 2(1) - Callout 1**
1 : 200

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REV.	DESCRIPTION	DATE

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PROJECT STATUS:

PROJECT
PAEWIRA RECYCLE PLANT

PROJECT ADDRESS:
PAEWIRA – 401 RACECOURCE ROAD, TE AWAMUTU

SHEET TITLE:
CAFE/MUSEUM/OFFICE BUILDING LAYOUT

PROJECT ISSUE DATE:
NOVEMBER 2021

SCALES
1 : 200 at A1

DESIGNER	DRAWN BY	CHECKER
Designer	Author	Checker

PROJECT NO.	SHEET NO.	REV NO.
200065	A40-01	

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CUT & FILL ISOPACHS

MINIMUM ELEVATION	MAXIMUM ELEVATION	RANGE AREA	VOLUME	COLOUR
-4.03m	-3.00m	90	37	
-3.00m	-2.00m	241	191	
-2.00m	-1.00m	530	569	
-1.00m	0.00m	5,034	1,752	
0.00m	1.00m	20,651	53,286	
+1.00m	2.00m	22,724	27,890	
+2.00m	3.00m	7,604	15,912	
+3.00m	4.00m	7,186	8,147	
+4.00m	5.00m	1,438	4,076	
+5.00m	6.00m	816	3,100	
+6.00m	7.00m	2,663	983	

CUT AND FILL HEIGHTS SHOWN
BASE = SURVEYED GROUND LEVLS (NOT STRIPPED)
NEW = PROPOSED SUBGRADE (0.5m BELOW FFL)

TBC WITH DETAILED DESIGN

CONCEPTUAL CUT AND FILL EXTENTS
AREA = 70,000m2
TOPSOIL / UNSUITABLE STRIP = 21,000m3
CUT TO FILL 2,000m3
IMPORTED FILL 130,000m3

TBC WITH DETAILED DESIGN

100 YEAR FLOOD EXTENTS FROM GOLOVIN VERTICAL DATUM ADJUSTED +0.2m FROM NZVD TO MOTURIKI

EXTENT OF WORKS ASSUMED

TBC WITH DETAILED DESIGN

ACCESS
CARPARK
BUILDINGS
GENERATOR
STORAGE
TUNNEL
RAMP DOWN
SUBGRADE 44.50mRL
SUBGRADE 49.50mRL
MANGAPIKO STREAM
RACECOURSE ROAD
10.83m
22.09m
17.70m

DRAFT

1:1000 @ A1
1:2000 @ A3
0 10 20 30 40 50 60 70 80 90 100 m

REVISION				
ISSUE	DATE	DETAIL	CHKD	DRWN
A	01/12/21	FOR RESOURCE CONSENT	GC	AC

STAGE
RESOURCE CONSENT

PROJECT CONSULTANTS

terra CONSULTANTS
PO BOX 12858, Penrose, New Zealand
Auckland: (09) 357 3557
Northland: (09) 431 4444
Christchurch: (03) 379 5055
Email: terra@terragroup.co.nz | Web: www.terragroup.co.nz

CLIENT
GLOBAL METAL SOLUTIONS

PROJECT
PAEWIRA RECYCLE PLANT

LOCATION
401 RACECOURSE PARADE,
TE AWAMUTU

DRAWING TITLE
EARTHWORKS PLAN
OVERALL

ORIENTATION

SCALE	A1	1:1,000
	A3	1:2,000
DATE		01/12/2021
SURVEYED		TERRA
DESIGNED		VARIOUS
DRAWN		A.COOK
CHECKED		G.CLARKE

PROJECT NUMBER	DWG NUMBER	REVISION
200065	CD-020	A

C:\Users\anthov\ARC Civil Dropbox\Projects\Terra\Racecourse Road 401\CAD\RC020-025_EARTHWORK.dwg, 020, 10/25/2021 2:15 pm

APPENDIX B – HISTORICAL IMAGES

Retro lens

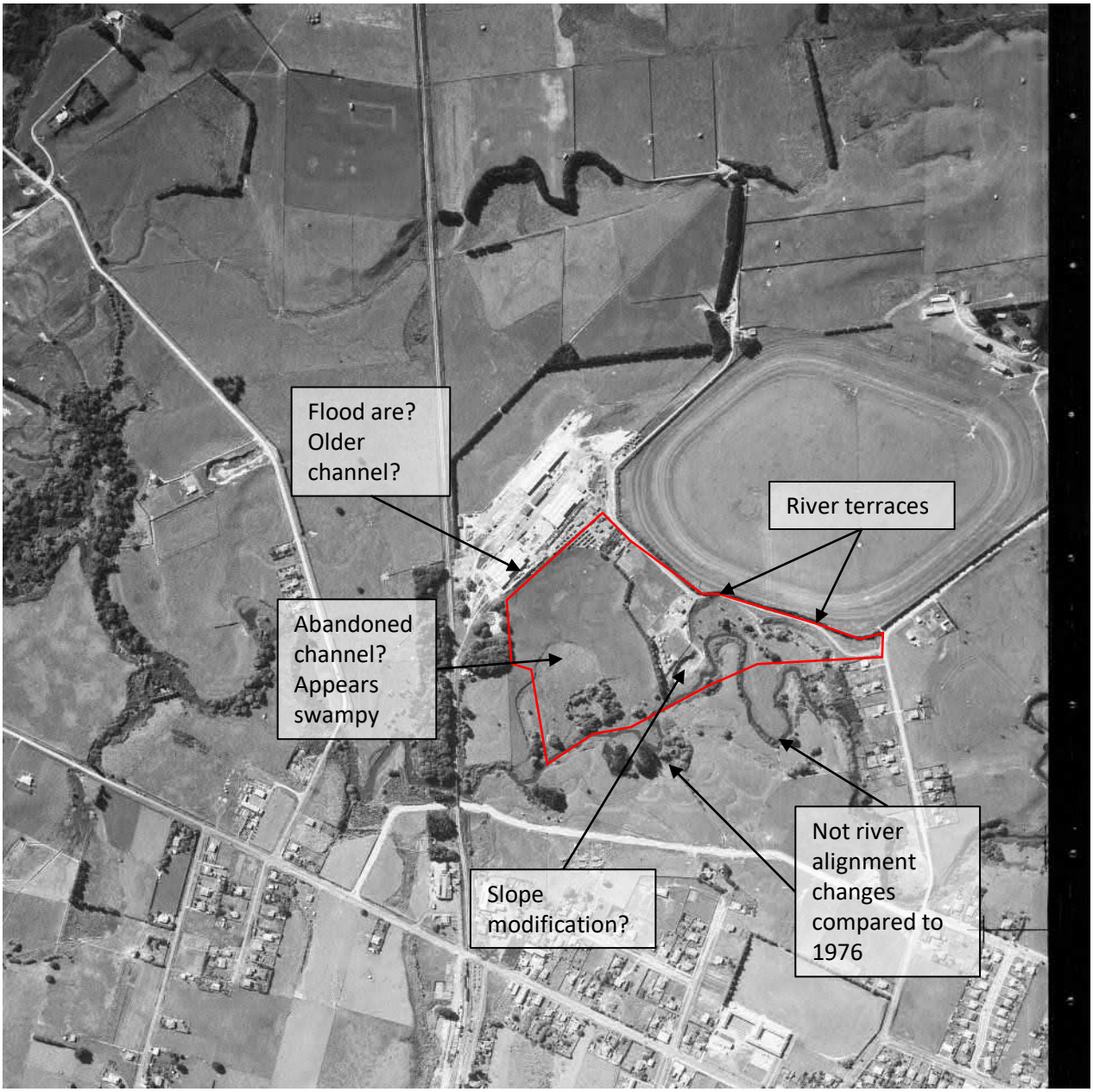


Figure 1. Historical Imagery from 1944. Approximate site location marked by red square. (Image sourced from https://retrolens.co.nz/map/)

Figure 2. Historical Imagery from 1958. Approximate site location marked by red square. (Image sourced from https://retrolens.co.nz/map/)

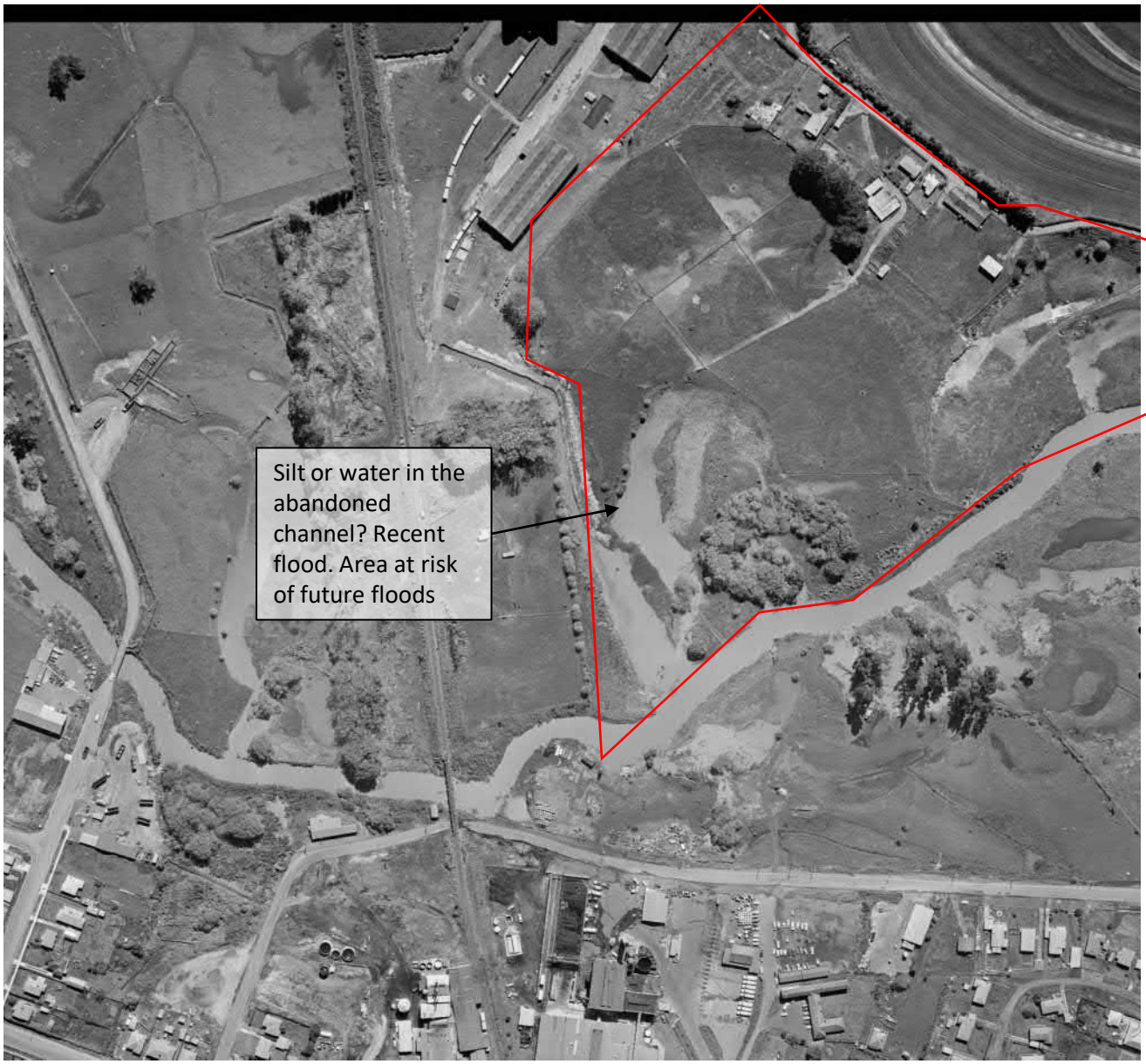


Figure 3. Historical Imagery from 1971. Approximate site location marked by red square. (Image sourced from https://retrolens.co.nz/map/)

Figure 4. Historical Imagery from 1976. Approximate site location marked by red square. (Image sourced from https://retrolens.co.nz/map/)

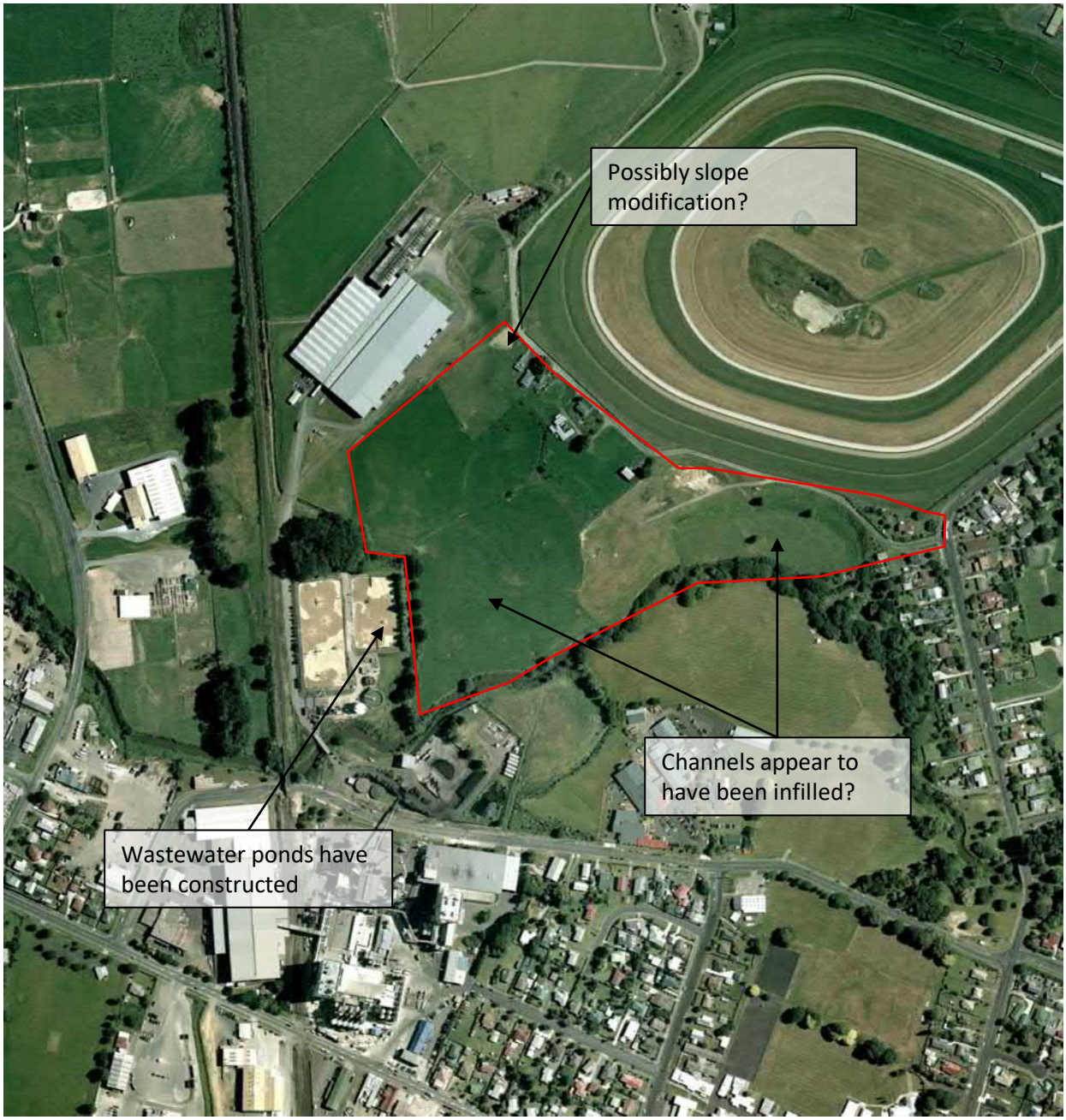


Figure 5. Historical Imagery from 2008. Approximate site location marked by red square. (Image sourced from Google Earth Pro)

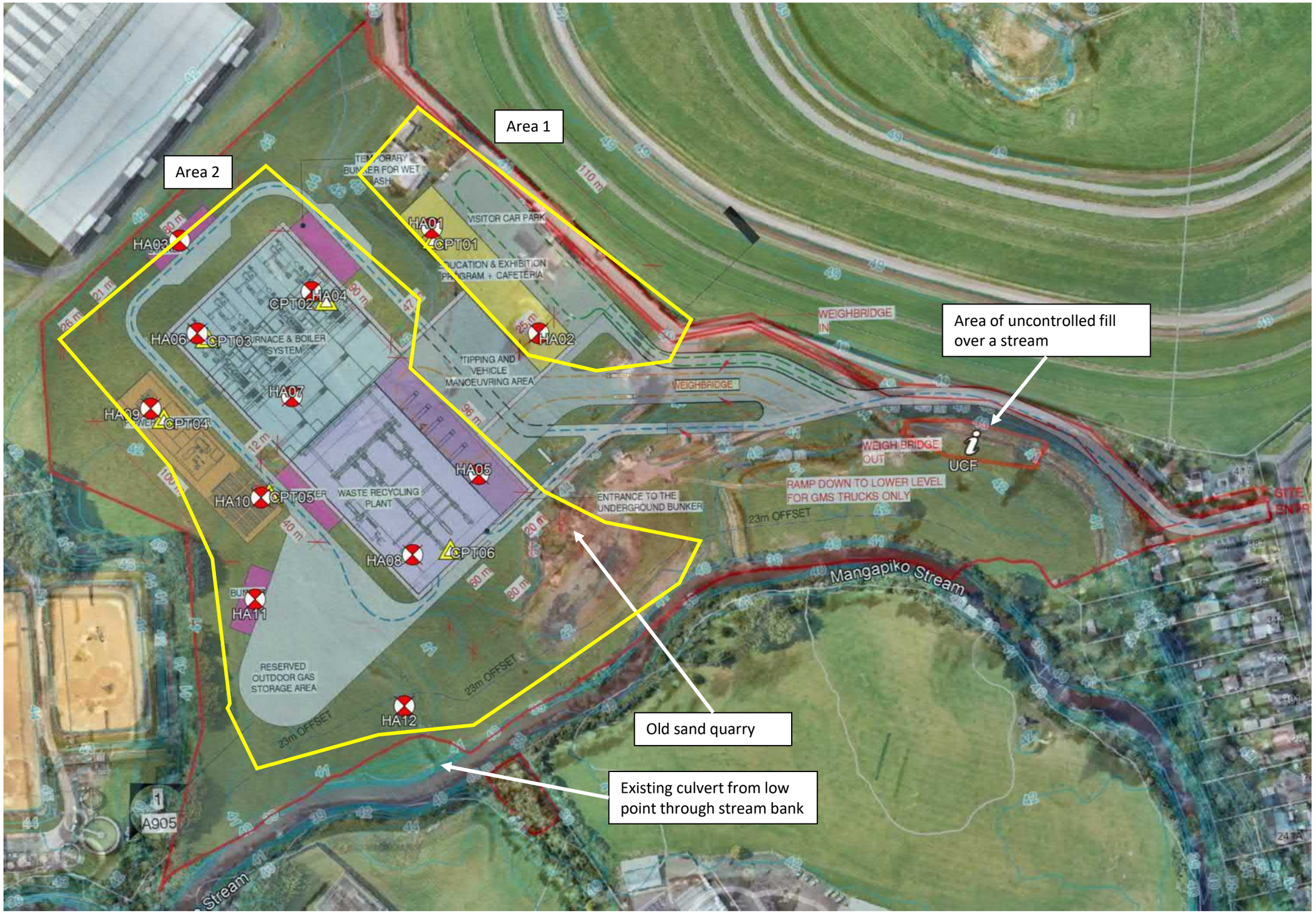
Figure 6. Historical Imagery from 2020. Approximate site location marked by red square. (Image sourced from Google Earth Pro)

APPENDIX C – GEOTECHNICAL DATA

Site plan

Hand augers (HAs)

Cone Penetrometer Tests (CPTs)



LEGEND

Hand Auger (HA)

Cone Penetrometer Test (CPT)

PROJECT: 401 Racecourse Road, Te Awamutu	
PROJECT No: HD2090	
CLIENT: Global Contracting Solutions Ltd	
TITLE: Site investigation plan	
SCALE: N/A	
Drawing No: 01	
Drawing By: HJ	
Rev no:	
1	Initial – 07.09.2021

INVESTIGATION LOG

Job No.:	HD2090
Client:	Global Contracting Solutions Ltd
Project:	401 Racecourse Road, Te Awamutu
No.:	HA01
Location:	4.0 m from top of slope. Western side of the proposed education building.
Co-ordinates:	-
Elevation:	Ground
Date:	11.08.21
Logged By:	SW
Checked By:	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)	Legend	Scala Penetrometer (Blows / 100 mm)	Vane Shear Strength (kPa)	Water
Topsoil	TOPSOIL; darlk brown. Moist.	0.2		2, 2		Groundwater Not Encountered
Hinuera Formation	Silty SAND; orange brown. Medium dense; moist; sand, fine to coarse, pumiceous, siliceous.	0.4		4, 5, 6		
	0.5 m: Becomes grey with minor fine gravel, sub angular to subrounded, no silt.	0.6		1		
	0.5 m - 0.6 m: Very Loose	0.8		2, 3, 4		
		1.0		3, 3		
		1.2		4, 4		
	1.4 m - 1.9 m: very loose	1.4		6, 1		
		1.6		1, 1		
		1.8		1, 1, 1		
	2.0 m: Gravel, fine to coarse, subangular to subrounded.	2.0		2, 3		
		2.2		3, 4		
		2.4		5, 5		
		2.6		9, 10		
	2.8 m - 2.9 m: Loose	2.8		6, 2		
	EOH: 3.00 m	3.0		10, 10		
		3.2		8, 6		
		3.4		13, 10		
		3.6		4, 7		
		3.8		5, 6		
		4.0		4, 10		
		4.2		9, 4		
		4.4		6, 6		
		4.6		5, 7		
		4.8		10, 13		
		5.0		12, 5		
		5.2				
		5.4				

Photo

Remarks

End of auger @ 3.0 m - Target depth achieved.

Shear Vanes
- Peak
- Remoulded

Water
- Standing Water Level
- Out flow
- In flow

Investigation Type
- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

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INVESTIGATION LOG

Job No.:	HD2090
Client:	Global Contracting Solutions Ltd
Project:	401 Racecourse Road, Te Awamutu
No.:	HA02
Location:	Eastern end of the proposed education building.
Co-ordinates:	-
Elevation:	Ground
Date:	11.08.21
Logged By:	SW
Checked By:	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)	Legend	Scala Penetrometer (Blows / 100 mm)	Vane Shear Strength (kPa)	Water
Topsoil	TOPSOIL , with minor sand, with trace gravel; dark brown. Moist; , rootlets; sand, fine; gravel, fine to medium, subangular to subround.	0.0		6		
		0.2		9		
		0.4		7		
	SAND, with some gravel, with trace silt; brownish . Medium dense; moist; sand, fine to medium; gravel, medium, subangular to subround.	0.6		6		
		0.8		4		
	SAND, with trace gravel; orange brown . Medium dense; uniformly graded; sand, fine to medium; gravel, fine to medium, subround, Pumice.	1.0		1		
		1.2		3		
		1.4		5		
Piako Subgroup	SAND, with minor gravel; greyish brown. Medium dense to dense; moist; uniformly graded; sand, fine to medium; gravel, fine to coarse, subangular to subround, Pumice.	1.6		7		
		1.8		7		
		2.0		10		
	2.2 m - 2.3 m: Loose	2.2		11		
		2.4		10		
		2.6		5		
		2.8		4		
		3.0		6		
	EOH: 3.00 m			9		
	3.0 m - 5.0 m: Very loose to Very Dense			10		
		3.2		9		
		3.4		4		
		3.6		2		
		3.8		4		
		4.0		5		
		4.2		6		
		4.4		7		
		4.6		6		
		4.8		5		
		5.0		6		
		5.2		7		
				9		
				10		
				12		
				11		
				3		
				2		
				9		
				4		
				1		
				8		
				15		
				9		
				8		
				4		
				1		
				6		
				5		
				22 >>		
				12		

Groundwater Not Encountered

Photo

Remarks

End of borehole @ 3m - target depth

Shear Vanes
- Peak
- Remoulded

Water
- Standing Water Level
- Out flow
- In flow

Investigation Type
- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

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Document Set ID: 10725645
Version: 1, Version Date: 02/12/2021

INVESTIGATION LOG

Job No.:	HD2090
Client:	Global Contracting Solutions Ltd
No.:	HA03
Project:	401 Racecourse Road, Te Awamutu
Location:	Middle of the western bunker.
Date:	11.08.21
Co-ordinates:	-
Logged By:	SW
Elevation:	Ground
Checked By:	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Topsoil	TOPSOIL; dark brown. Moist.	0.2
Uncontrolled Fill	Silty CLAY; brown speckled black. Loose to dense; moist; low plasticity.	0.6
Uncontrolled Fill	SAND, with minor gravel; dark grey brown. Medium dense to loose; moist; sand, fine to coarse; gravel, fine to medium, subangular to subround.	1.0
Piako Subgroup	SAND; slight grey. Loose to dense; moist; sand, fine; slightly iron stained. 1.0 m - 1.1 m: Heavy iron staining - pan 1.1 m: Contains sand, fine to coarse. 1.2 m: Sand becomes fine. 1.2 m - 1.3 m: Moderately iron stained. 1.5 m: Dense 1.6 m - 1.7 m: Heavy iron staining, sand becomes fine to coarse. 1.8 m: Becomes wet. 2.0 m: Becomes wet.	2.2
Piako Subgroup	SAND, with minor gravel; reddish brown. Dense; saturated; sand, fine to medium; gravel, fine to coarse, subangular to subround.	2.4
	EOH: 2.50 m	2.6

Legend

Scala Penetrometer (Blows / 100 mm)

Depth (m)	Blows / 100 mm
0.2	2, 2
0.4	3, 1, 6
0.6	20
0.8	7, 4, 2
1.0	1, 1, 1
1.2	2, 3, 14
1.4	14, 11
1.6	7, 7, 10
1.8	5, 7, 10
2.0	9, 2, 3
2.2	2, 6, 7
2.4	3, 5, 2
2.6	2, 2, 2
2.8	7, 6, 5
3.0	5, 12, 5
3.2	11, 10, 6
3.4	14, 15, 15
3.6	10, 1, 10
3.8	11, 9, 13
4.0	15, 9, 5
4.2	
4.4	
4.6	
4.8	
5.0	
5.2	
5.4	

Vane Shear Strength (kPa) — Vane:

Water: 1.8 m

Photo

Remarks

End of auger @ 2.5 m - auger stopped due to no sample retrieval due to high ground water.

Shear Vanes
- Peak
- Remoulded

Water
- Standing Water Level
- Out flow
- In flow

Investigation Type
- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

Document Set ID: 10725645
Version: 1, Version Date: 02/12/2021

INVESTIGATION LOG

Job No.:	HD2090
Client:	Global Contracting Solutions Ltd
Project:	401 Racecourse Road, Te Awamutu
No.:	HA04
Location:	North western side of the proposed furnace and boiler building.
Co-ordinates:	-
Elevation:	Ground
Date:	11.08.21
Logged By:	SW
Checked By:	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Topsoil	TOPSOIL; dark brown. Moist.	0.2
Plako Subgroup	Clayey SILT; orange brown speckled black. Moist; moderate plasticity; manganese nodules.	0.4
	0.5 m: Becomes grey streaked orange, moderately iron stained.	0.6
	SAND; light grey. Medium dense to very dense; wet; sand, fine; slightly iron stained.	0.8
	1.2 m: Becomes saturated.	1.0
	1.4 m: Becomes grey, sand, fine to coarse, gravel, fine, subangular.	1.2
	EOH: 1.50 m	1.4
		1.6
		1.8
		2.0

Legend

Scala Penetrometer (Blows / 100 mm): 2, 2, 2, 2, 3, 8, 5, 4, 5, 11, 10, 40 >>

Vane Shear Strength (kPa) — Vane: 50, 100, 150, 200, 250

Water: 0.9 m

Photo

Remarks

End of auger @ 1.5 m - auger stopped due to no sample retrieval due to high ground water.

Shear Vanes
- Peak
- Remoulded

Water
- Standing Water Level
- Out flow
- In flow

Investigation Type
- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

INVESTIGATION LOG

Job No.:	HD2090
Client:	Global Contracting Solutions Ltd
No.:	HA05
Project:	401 Racecourse Road, Te Awamutu
Location:	South of Farmhouse half way down a slope
Date:	11.08.21
Co-ordinates:	-
Logged By:	SW
Elevation:	Ground
Checked By:	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Uncontrolled Fill	SAND, with trace topsoil and silt and gravel; light brown. Loose to medium dense; moist; uniformly graded; sand, fine to medium; gravel, fine to medium, subround, Pumice.	0.2, 0.4, 0.6, 0.8, 1.0
Plako Subgroup	SILT, with trace clay and sand; orangey brown , black mottle. Very stiff; moist; low dilatency, moderately sensitive; sand, fine.	1.2, 1.4, 1.6, 1.8
	Clayey SILT, with trace sand; brownish. Moist; moderate dilatency; sand, fine.	2.0, 2.2
	SAND, with minor gravel, with trace clay and silt; brownish grey. Moist; sand, fine to coarse; gravel, fine to medium, subround.	2.4, 2.6, 2.8
	EOH: 3.00 m	3.0

Legend

Scala Penetrometer (Blows / 100 mm)

2 2 3 4 3 4 3 3 3 3 2 6 3 1 8 21 >> 30 >>

Vane Shear Strength (kPa) Vane: 534

146 / 65 126 / 49

Water

Groundwater Not Encountered

Photo

Remarks

End of borehole @ 3m - Target depth

Shear Vanes

- Peak
- Remoulded

Water

- Standing Water Level
- Out flow
- In flow

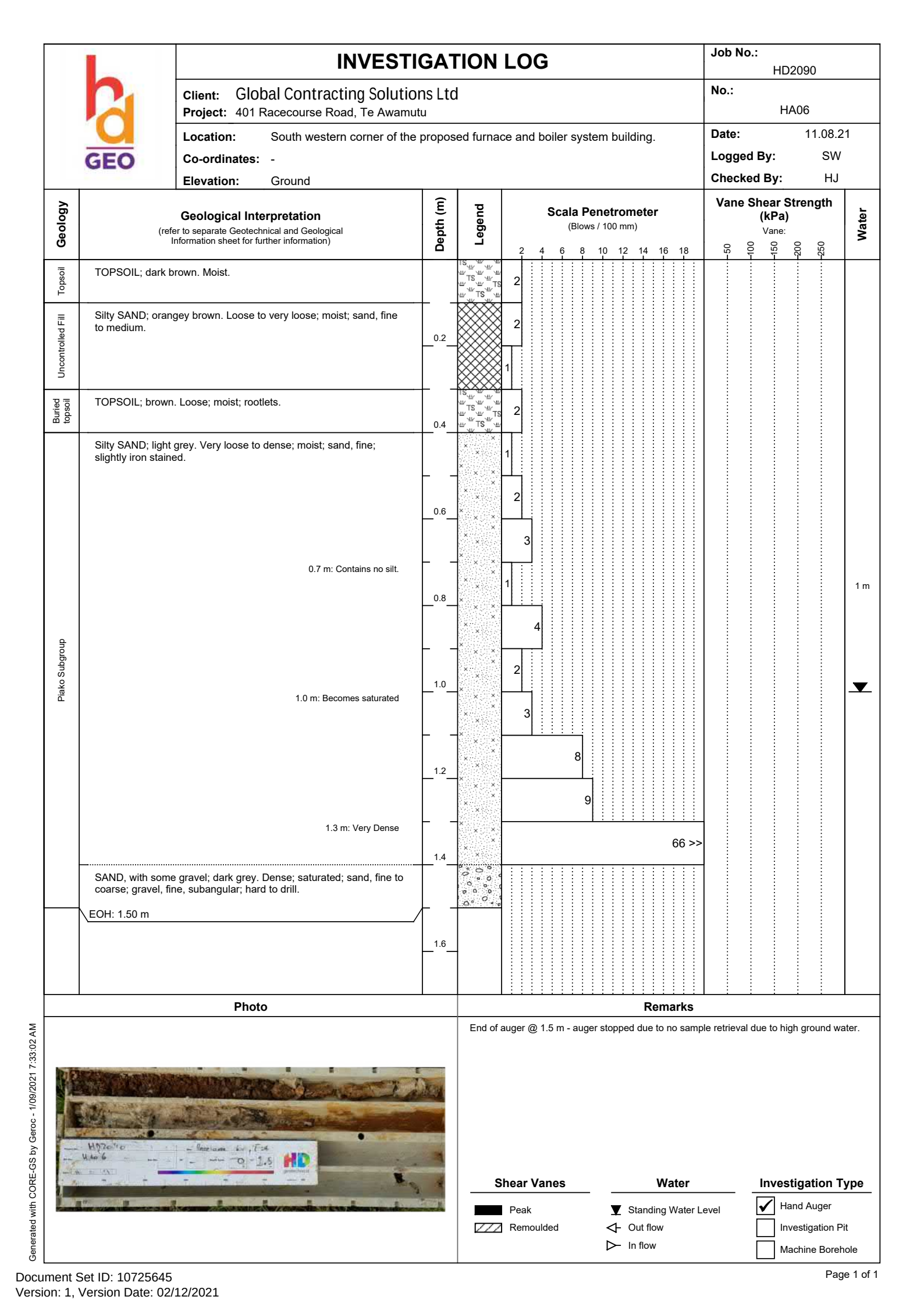
Investigation Type

- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

INVESTIGATION LOG

Job No.:	HD2090
Client:	Global Contracting Solutions Ltd
Project:	401 Racecourse Road, Te Awamutu
No.:	HA06
Location:	South western corner of the proposed furnace and boiler system building.
Co-ordinates:	-
Elevation:	Ground
Date:	11.08.21
Logged By:	SW
Checked By:	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Topsoil	TOPSOIL; dark brown. Moist.	
Uncontrolled Fill	Silty SAND; orangey brown. Loose to very loose; moist; sand, fine to medium.	0.2
Buried topsoil	TOPSOIL; brown. Loose; moist; rootlets.	0.4
Piako Subgroup	Silty SAND; light grey. Very loose to dense; moist; sand, fine; slightly iron stained.	0.6
	0.7 m: Contains no silt.	0.8
	1.0 m: Becomes saturated	1.0
	1.3 m: Very Dense	1.2
		1.4
	SAND, with some gravel; dark grey. Dense; saturated; sand, fine to coarse; gravel, fine, subangular; hard to drill.	
	EOH: 1.50 m	1.6



Photo

Remarks

End of auger @ 1.5 m - auger stopped due to no sample retrieval due to high ground water.

Shear Vanes
- Peak
- Remoulded

Water
- Standing Water Level
- Out flow
- In flow

Investigation Type
- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

INVESTIGATION LOG

Client:	Global Contracting Solutions Ltd
Project:	401 Racecourse Road, Te Awamutu
Location:	South eastern side of the furnace and boiler building.
Co-ordinates:	-
Elevation:	Ground

Job No.: HD2090
No.: HA07
Date: 11.08.21
Logged By: SW
Checked By: HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Topsoil	TOPSOIL; dark brown. Moist.	0.2
Piako Subgroup	Silty CLAY, with trace sand; grey brown. Very stiff; moist; moderate plasticity; sand, fine.	0.4
	Silty SAND; light grey. Medium dense; moist; sand, fine; manganese nodules.	0.6
		0.8
	Silty CLAY; light grey scpeckled black. Moist; manganese nodules.	1.0
	SAND; light grey. Medium dense to dense; wet; sand, fine; slightly iron stained.	1.2
	1.4 m - 1.5 m: Heavy iron staining - pan.	1.4
	SAND, with minor gravel; brownish grey. Medium dense to dense; saturated; sand, fine to coarse; gravel, fine, subround; slightly iron stained.	1.6
		1.8
	EOH: 2.00 m	2.0
	2.1 m - 5.0 m: Medium Dense to Dense	2.2
		2.4
		2.6
		2.8
		3.0
		3.2
		3.4
		3.6
		3.8
		4.0
		4.2
		4.4
		4.6
		4.8
		5.0

Legend: TS

Scala Penetrometer (Blows / 100 mm)

Depth (m)	Blows / 100 mm
0.2	1, 1
0.4	3, 3, 3
0.6	5, 3
0.8	5, 7
1.0	6, 6
1.2	11, 4
1.4	8, 8
1.6	8, 8
1.8	6, 8
2.0	5, 8
2.2	5, 4
2.4	6, 4
2.6	6, 6
2.8	9, 3
3.0	8, 7
3.2	7, 7
3.4	6, 6
3.6	4, 5
3.8	10, 5
4.0	10, 10
4.2	8, 10
4.4	6, 8
4.6	6, 9
4.8	9, 9
5.0	8, 9

Vane Shear Strength (kPa) Vane: 1710

Depth (m)	Peak	Remoulded
0.4	112	19
0.6	124	16

Water: 1.2 m

Photo

Remarks

End of auger @ 2.0 m - auger stopped due to no sample retrieval due to high ground water.

Shear Vanes
- Peak
- Remoulded

Water
- Standing Water Level
- Out flow
- In flow

Investigation Type
- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

INVESTIGATION LOG

Job No.:	HD2090
Client:	Global Contracting Solutions Ltd
No.:	HA08
Project:	401 Racecourse Road, Te Awamutu
Location:	Southeast of HA05 , same paddock ,By the South enterance
Date:	11.08.21
Co-ordinates:	-
Logged By:	SW
Elevation:	Ground
Checked By:	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)	Legend	Scala Penetrometer (Blows / 100 mm)	Vane Shear Strength (kPa)	Water
Topsoil	SILT, with some sand; dark brown. Moist; sand, fine.	0.2		1, 2		
Plako Subgroup	SILT, with some sand; brown speckled black. Moist.			2		
	SAND. Loose to medium dense; moist to wet, sensitive; sand, fine, slightly iron stained.	0.4		2, 5		
	0.6 m - 0.7 m: Black (some silt)	0.6		3, 3		
		0.8		2, 4		
		1.0		4, 2		
		1.2		6, 5		
		1.4		3, 5		
		1.6		4, 4		
	1.7 m: Dark grey 1.8 m - 1.9 m: Heavy Fe+ 1.9 m: Dense	1.8		5, 6		
		2.0		8, 8		
		2.2		7, 19		
		2.4		22 >>, 15		
		2.6		12, 10		
		2.8				
	EOH: 3.00 m	3.0				Groundwater Not Encountered

Photo

Remarks

End of borehole @ 1 m - Auger stopped at hole collapse

Shear Vanes
- Peak
- Remoulded

Water
- Standing Water Level
- Out flow
- In flow

Investigation Type
- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

INVESTIGATION LOG

Job No.:	HD2090
Client:	Global Contracting Solutions Ltd
Project:	401 Racecourse Road, Te Awamutu
No.:	HA09
Location:	North western side of the power generator building.
Co-ordinates:	-
Elevation:	Ground
Date:	11.08.21
Logged By:	SW
Checked By:	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Topsoil	TOPSOIL; dark brown. Moist.	0.2
Piako Subgroup	Silty SAND, with minor gravel; brown. Medium dense; moist; sand, fine to medium; gravel, fine, subangular. 0.3 m: Heavy iron staining.	0.4
	Gravelly SAND; grey brown. Dense; wet; sand, fine to coarse; gravel, fine to medium, subangular. 0.5 m: Becomes saturated	0.6
	0.9 m: Medium dense	1.0
	EOH: 1.20 m	1.2
		1.4
		1.6
		1.8
		2.0
		2.2
		2.4
		2.6
		2.8
		3.0
		3.2
		3.4
		3.6
		3.8
		4.0
		4.2
		4.4
		4.6

Legend

Scala Penetrometer (Blows / 100 mm)

Depth (m)	Blows / 100 mm
0.2	2
0.4	4, 4, 4
0.6	12, 17
0.8	17, 19
1.0	16, 3
1.2	8, 7
1.4	19, 4
1.6	15, 12
1.8	14, 11
2.0	7, 11
2.2	3, 3
2.4	11, 9
2.6	8, 15
2.8	11, 9
3.0	6, 5
3.2	8, 5
3.4	6, 8
3.6	6, 10
3.8	12, 6
4.0	7, 11
4.2	13, 13
4.4	12, 5
4.6	12, 10

Vane Shear Strength (kPa)

Vane:

Water: 0.5 m

Photo

Remarks

End of auger @ 1.2 m - auger stopped due to no sample retrieval due to high ground water.

Shear Vanes

- Peak
- Remoulded

Water

- Standing Water Level
- Out flow
- In flow

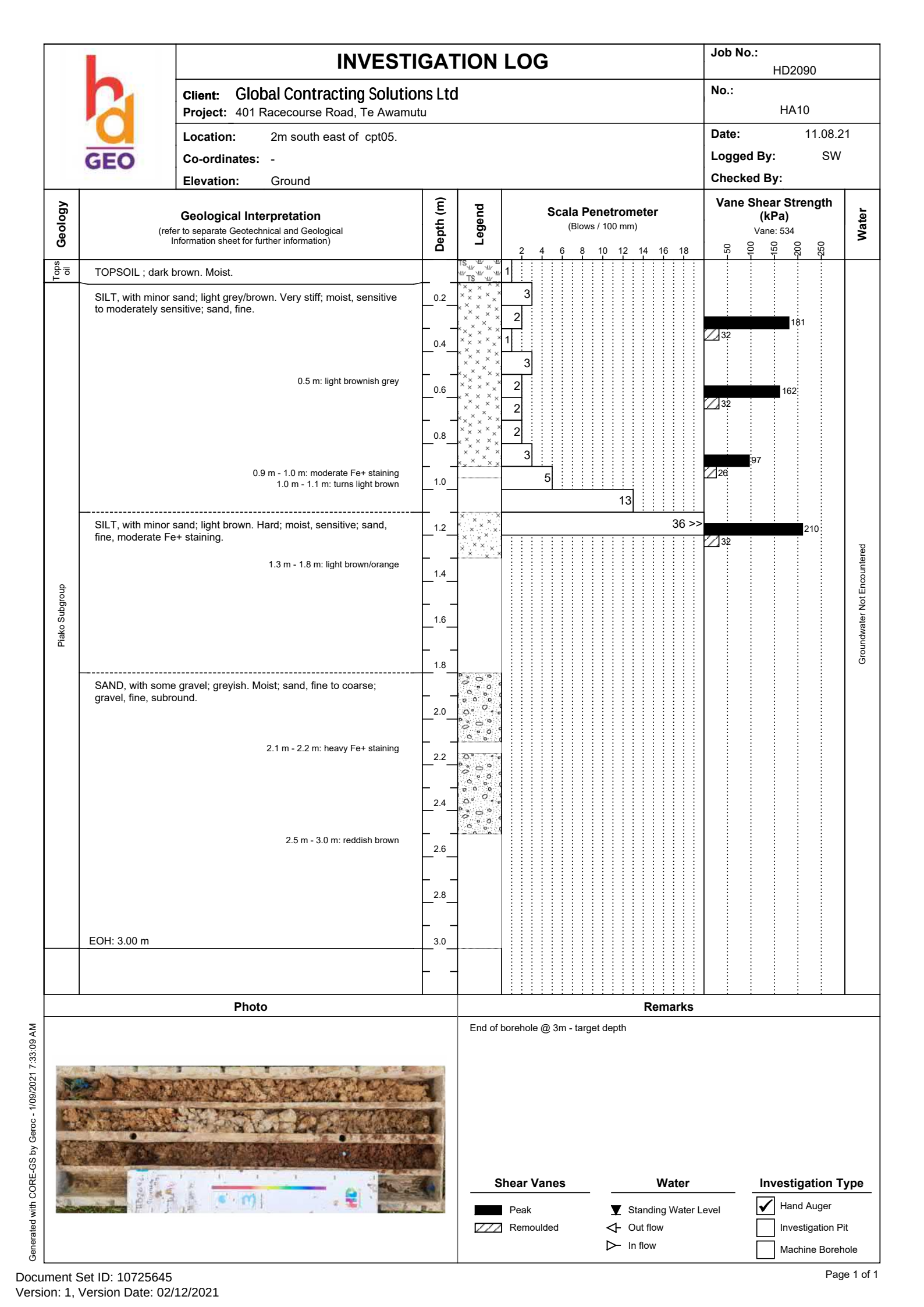
Investigation Type

- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

INVESTIGATION LOG

Client: Global Contracting Solutions Ltd	**Job No.:** HD2090
Project: 401 Racecourse Road, Te Awamutu	**No.:** HA10
Location: 2m south east of cpt05.	**Date:** 11.08.21
Co-ordinates: -	**Logged By:** SW
Elevation: Ground	**Checked By:**

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Topsoil	TOPSOIL ; dark brown. Moist.	
Plako Subgroup	SILT, with minor sand; light grey/brown. Very stiff; moist, sensitive to moderately sensitive; sand, fine.	0.2
	0.5 m: light brownish grey	0.4
	0.9 m - 1.0 m: moderate Fe+ staining 1.0 m - 1.1 m: turns light brown	0.6 0.8 1.0
	SILT, with minor sand; light brown. Hard; moist, sensitive; sand, fine, moderate Fe+ staining.	1.2
	1.3 m - 1.8 m: light brown/orange	1.4 1.6 1.8
	SAND, with some gravel; greyish. Moist; sand, fine to coarse; gravel, fine, subround.	2.0
	2.1 m - 2.2 m: heavy Fe+ staining	2.2
	2.5 m - 3.0 m: reddish brown	2.4 2.6 2.8
	EOH: 3.00 m	3.0



Photo

Remarks

End of borehole @ 3m - target depth

Shear Vanes
- Peak
- Remoulded

Water
- Standing Water Level
- Out flow
- In flow

Investigation Type
- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

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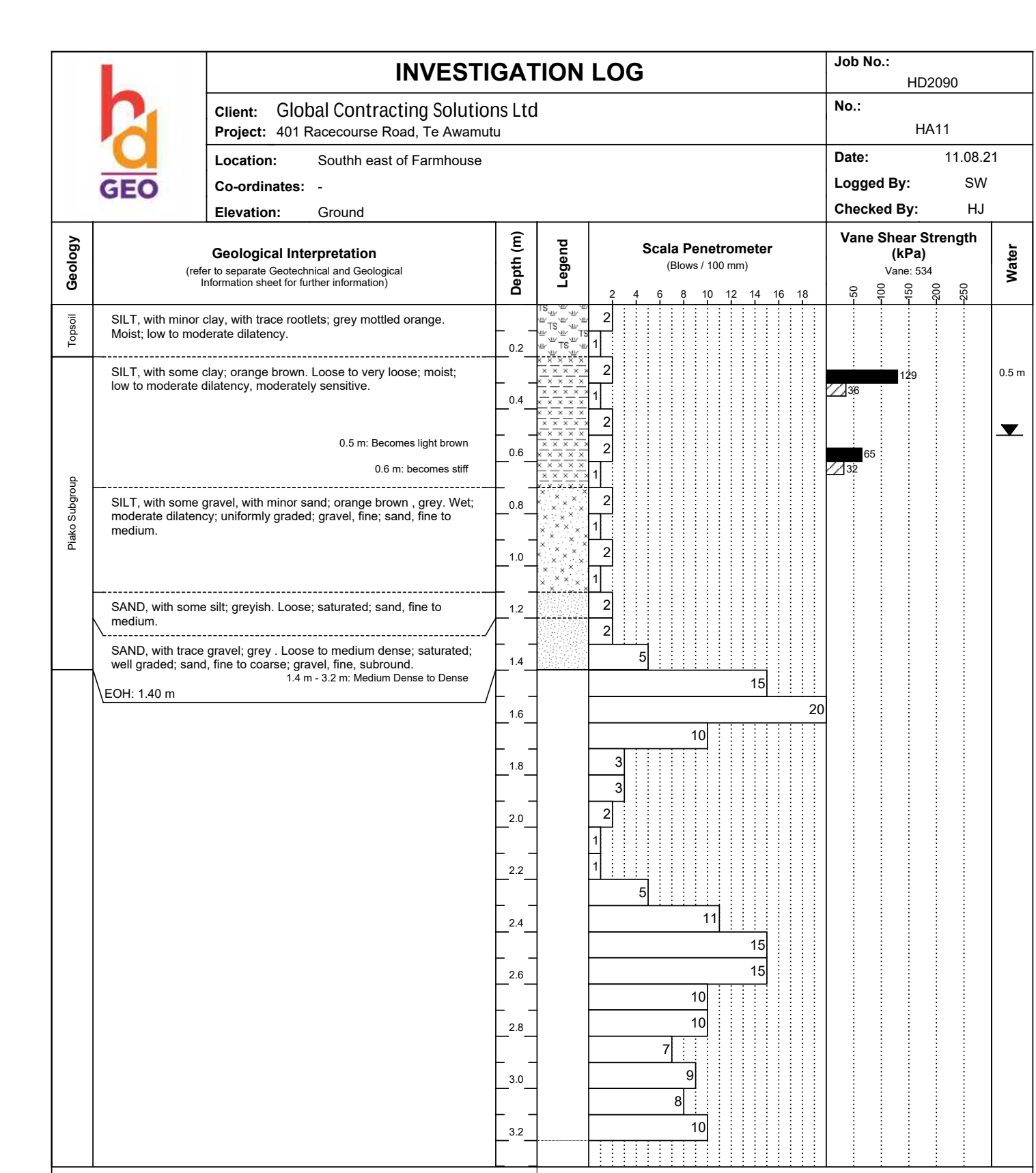
INVESTIGATION LOG

Client: Global Contracting Solutions Ltd
Project: 401 Racecourse Road, Te Awamutu

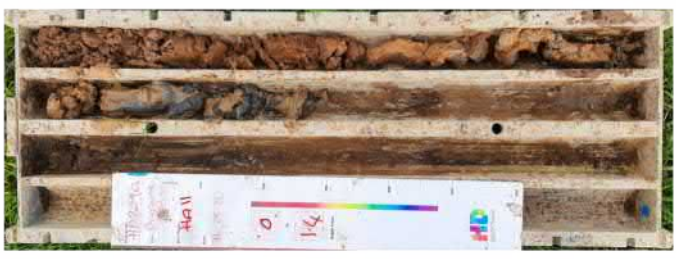
Location: Southh east of Farmhouse
Co-ordinates: -
Elevation: Ground

Job No.: HD2090
No.: HA11
Date: 11.08.21
Logged By: SW
Checked By: HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Topsoil	SILT, with minor clay, with trace rootlets; grey mottled orange. Moist; low to moderate dilatency.	0.2
Plako Subgroup	SILT, with some clay; orange brown. Loose to very loose; moist; low to moderate dilatency, moderately sensitive.	0.4
	0.5 m: Becomes light brown	0.6
	0.6 m: becomes stiff	
	SILT, with some gravel, with minor sand; orange brown , grey. Wet; moderate dilatency; uniformly graded; gravel, fine; sand, fine to medium.	0.8
		1.0
	SAND, with some silt; greyish. Loose; saturated; sand, fine to medium.	1.2
	SAND, with trace gravel; grey . Loose to medium dense; saturated; well graded; sand, fine to coarse; gravel, fine, subround. 1.4 m - 3.2 m: Medium Dense to Dense	1.4
	EOH: 1.40 m	1.6
		1.8
		2.0
		2.2
		2.4
		2.6
		2.8
		3.0
		3.2



Photo



Remarks

End of borehole at 1.4m - Auger stopped

Shear Vanes
- Peak
- Remoulded

Water
- Standing Water Level
- Out flow
- In flow

Investigation Type
- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

INVESTIGATION LOG

Client:	Global Contracting Solutions Ltd
Project:	401 Racecourse Road, Te Awamutu
Location:	South south east of treatment plant
Co-ordinates:	-
Elevation:	Ground

Job No.: HD2090
No.: HA12
Date: 11.08.21
Logged By: SW
Checked By: HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Topsoil	SILT, with minor sand, with trace gravel; brown . Moist; sand, fine; gravel, fine, subround.	0.2
Piako Subgroup	SILT, with trace sand and gravel; light brown. Firm; moist; sand, fine, gravel, fine, subround.	0.4
	SILT, with trace sand; light brown / orange. Firm; moist; low dilatency, moderately sensitive; sand, fine.	0.6
	SILT, with trace sand; light brown , black. Wet; high dilatency; sand, fine.	0.8
Buried topsoil	BURIED TOPSOIL; black. Very loose; saturated, moderately sensitive; , roolets ,. 1.0 m - 1.3 m: Auger dropped with no collection	1.0
Piako Subgroup	SAND, with some silt. Very loose to medium dense; wet; sand, fine to coarse.	1.2
	GRAVEL, with some sand; grey . Medium dense to dense; moist; uniformly graded; gravel, fine to coarse, subround, Pumice; sand, fine to coarse. 1.6 m - 1.9 m: loose	1.6
	1.9 m - 4.2 m: Medium Dense to Dense	2.0
	EOH: 2.30 m	4.2

Legend: TS (Topsoil)

Scala Penetrometer (Blows / 100 mm)

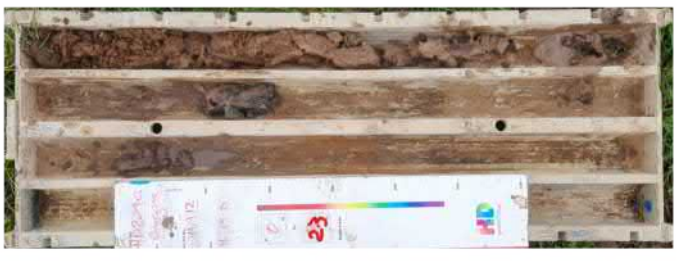
Depth (m)	Blows / 100 mm
0.0	1
0.2	2
0.4	2, 2, 2
0.6	1, 2
0.8	2
1.0	1, 1, 1
1.2	4, 2
1.4	4, 4
1.6	5, 2
1.8	2, 1
2.0	4, 8
2.2	7, 4
2.4	3, 3
2.6	3, 2
2.8	6, 5
3.0	3, 3
3.2	8, 6
3.4	8, 11
3.6	7, 7
3.8	7, 8
4.0	10, 10
4.2	10

Vane Shear Strength (kPa) Vane: 534

Depth (m)	Peak	Remoulded
0.4	32	13
0.6	32	16

Water: 0.4 m

Photo



Remarks

End of borehole @ 2.3m - target was 3m. Auger stopped

Shear Vanes: Peak, Remoulded

Water: Standing Water Level, Out flow, In flow

Investigation Type: ☑ Hand Auger, ☐ Investigation Pit, ☐ Machine Borehole

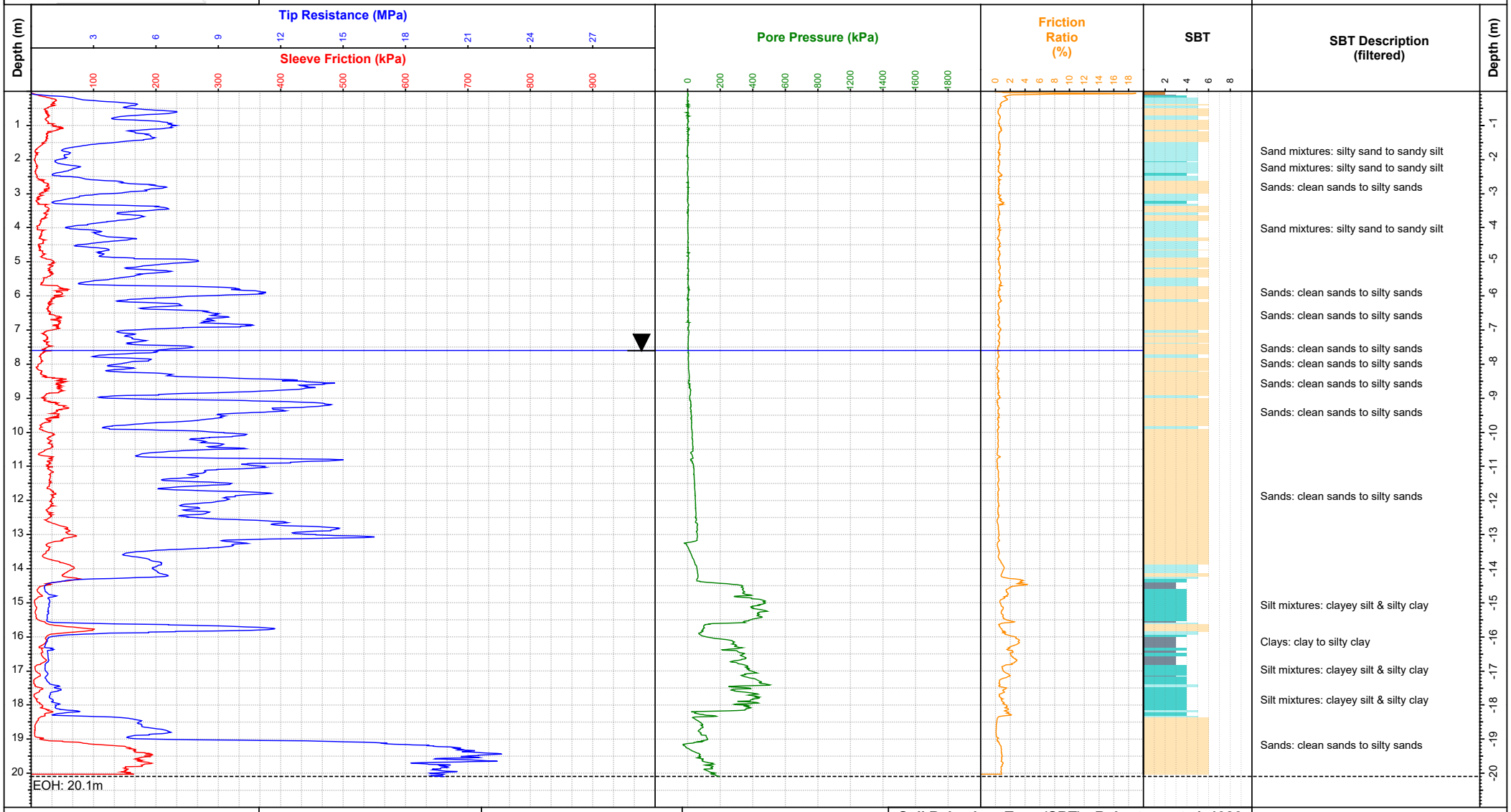
Generated with CORE-GS by Geroc - 1/09/2021 7:33:13 AM

CONE PENETRATION TEST LOG

Topdrill Geotech

Test No: CPT01

Client Ref.: HD2090



SBT Description (filtered)

Sand mixtures: silty sand to sandy silt
Sand mixtures: silty sand to sandy silt
Sands: clean sands to silty sands
Sand mixtures: silty sand to sandy silt
Sands: clean sands to silty sands
Sands: clean sands to silty sands
Sands: clean sands to silty sands
Sands: clean sands to silty sands
Sands: clean sands to silty sands
Sands: clean sands to silty sands
Sands: clean sands to silty sands
Silt mixtures: clayey silt & silty clay
Clays: clay to silty clay
Silt mixtures: clayey silt & silty clay
Silt mixtures: clayey silt & silty clay
Sands: clean sands to silty sands

Client: HD Geo

Project: CPT Investigations

Location: 401 Racecourse Road, Te Awamutu

Contractor: Topdrill Ltd

Remarks:
GWL dipped at 7.60m

Termination Reason:
Target Depth

Northing:	5791770.0
Easting:	1803087.0
System:	NZTM
Elevation:	Ground
Datum:	N/A
Method:	Garmin GPS

Rig:	Pagani TG63 - 150
Cone ID:	MKs633
Cone Area:	10mm²
Sleeve Area:	150mm²
Area Ratio:	0.80
Predrill:	0.00

Soil Behaviour Type (SBT) - Robertson et al. 1986

0 Undefined	5 Sand mixtures: silty sand to sandy silt
1 Sensitive fine-grained	6 Sands: clean sands to silty sands
2 Clay - organic soil	7 Dense sand to gravelly sand
3 Clays: clay to silty clay	8 Stiff sand to clayey sand
4 Silt mixtures: clayey silt & silty clay	9 Stiff fine-grained

Test No:	CPT01
Topdrill Ref.:	TD202204
Client Ref.:	HD2090
Depth (m):	20.1
Date:	03/09/2021

SHEET 1 OF 1

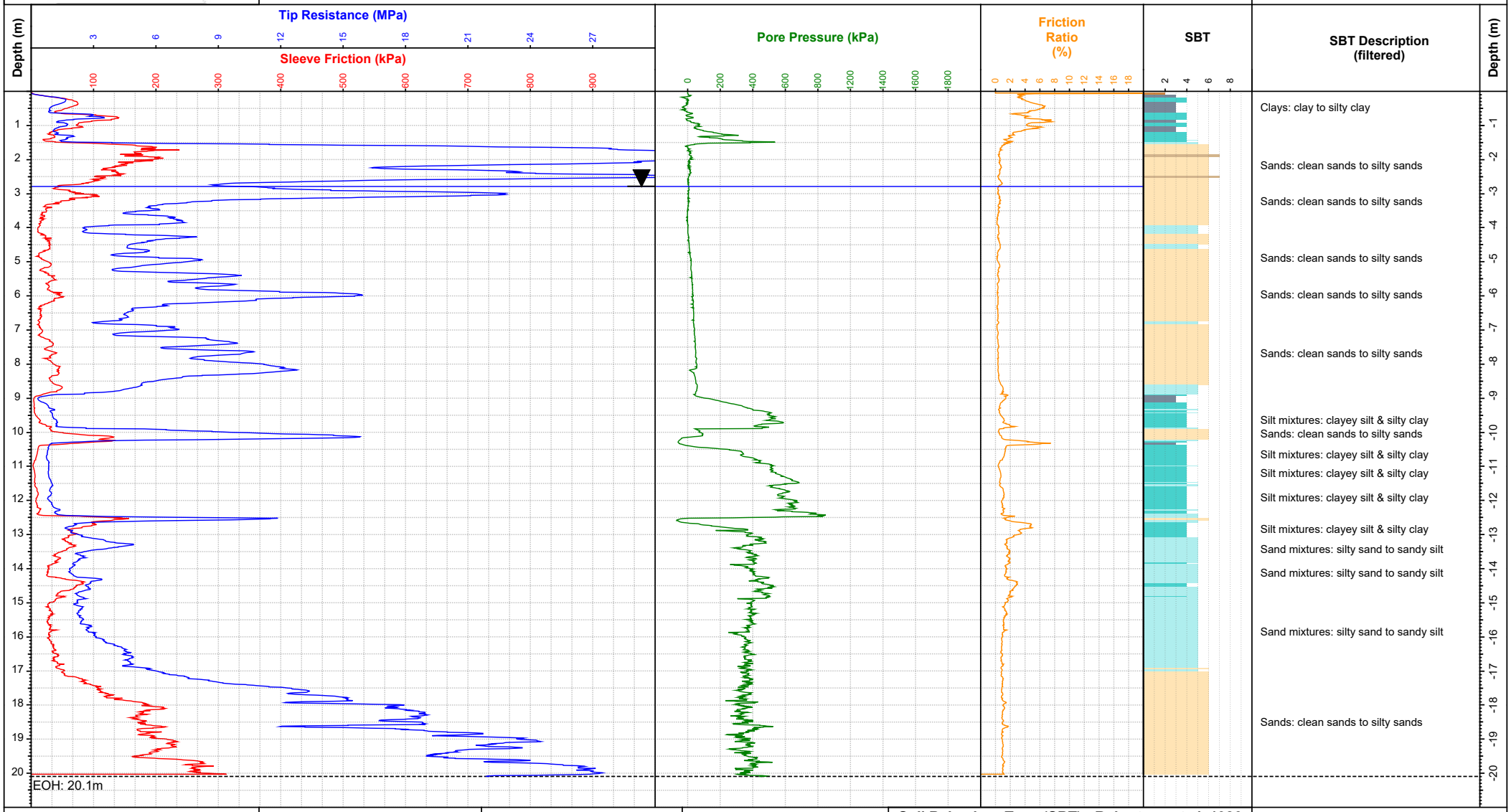
Generated with CORE-GS by Geroc - CPT - TopDrill 30 MPa - 4/09/2021 3:38:48 PM

CONE PENETRATION TEST LOG

Topdrill Geotech

Test No: CPT02

Client Ref.: HD2090



Client: HD Geo

Project: CPT Investigations

Location: 401 Racecourse Road, Te Awamutu

Contractor: Topdrill Ltd

Remarks:
GWL dipped at 2.79m

Termination Reason:
Target Depth

Northing:	5791746.0
Easting:	1803027.0
System:	NZTM
Elevation:	Ground
Datum:	N/A
Method:	Garmin GPS

Rig:	Pagani TG63 - 150
Cone ID:	MKs633
Cone Area:	10mm²
Sleeve Area:	150mm²
Area Ratio:	0.80
Predrill:	0.00

Soil Behaviour Type (SBT) - Robertson et al. 1986

0	Undefined
1	Sensitive fine-grained
2	Clay - organic soil
3	Clays: clay to silty clay
4	Silt mixtures: clayey silt & silty clay
5	Sand mixtures: silty sand to sandy silt
6	Sands: clean sands to silty sands
7	Dense sand to gravelly sand
8	Stiff sand to clayey sand
9	Stiff fine-grained

Test No:	CPT02
Topdrill Ref.:	TD202204
Client Ref.:	HD2090
Depth (m):	20.1
Date:	03/09/2021

SHEET 1 OF 1

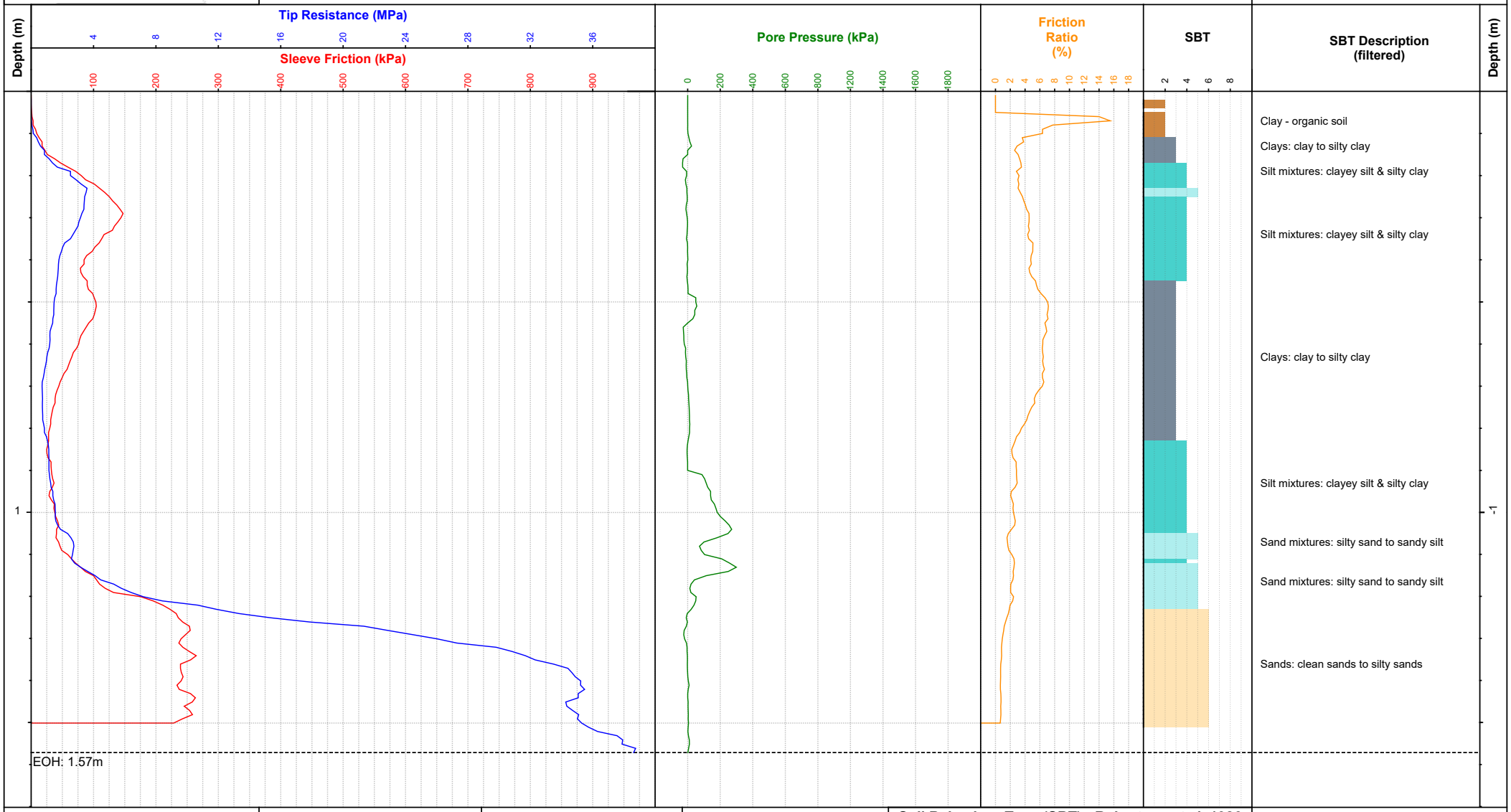
Generated with CORE-GS by Geroc - CPT - TopDrill 30 MPa - 4/09/2021 3:39:40 PM

CONE PENETRATION TEST LOG

Topdrill Geotech

Test No: CPT03

Client Ref.: HD2090



Client: HD Geo

Project: CPT Investigations

Location: 401 Racecourse Road, Te Awamutu

Contractor: Topdrill Ltd

Remarks:
Hole dipped dry to 1.57m

Termination Reason:
Refusal on anchor uplift

Northing:	5791724.0
Easting:	1802973.0
System:	NZTM
Elevation:	Ground
Datum:	N/A
Method:	Garmin GPS

Rig:	Pagani TG63 - 150
Cone ID:	MKs633
Cone Area:	10mm²
Sleeve Area:	150mm²
Area Ratio:	0.80
Predrill:	0.00

Soil Behaviour Type (SBT) - Robertson et al. 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test No:	CPT03
Topdrill Ref.:	TD202204
Client Ref.:	HD2090
Depth (m):	1.57
Date:	03/09/2021

SHEET 1 OF 1

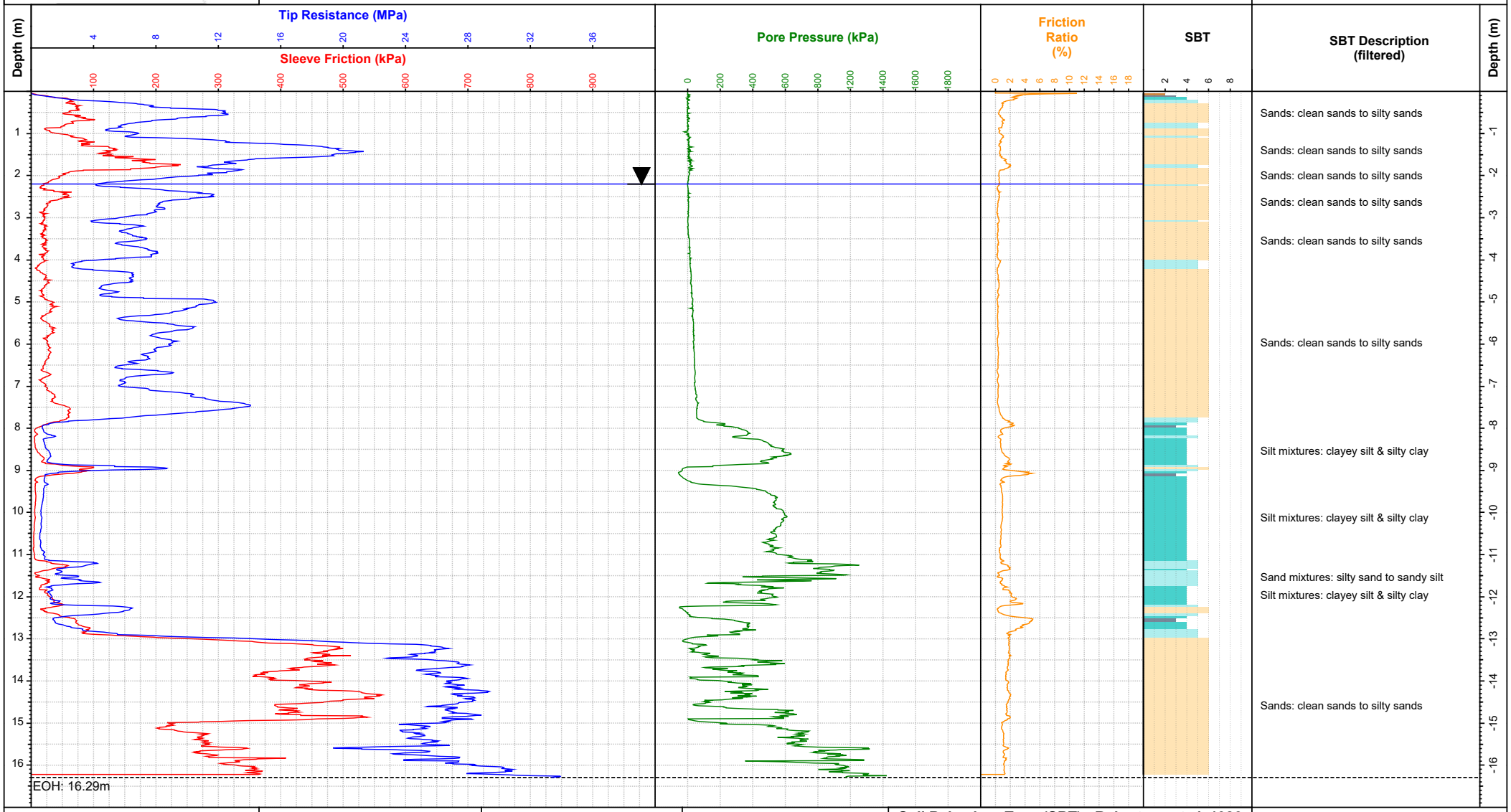
Generated with CORE-GS by Geroc - CPT - TopDrill 40 MPa - 4/09/2021 3:40:06 PM

CONE PENETRATION TEST LOG

Topdrill Geotech

Test No: CPT04

Client Ref.: HD2090



Client: HD Geo

Project: CPT Investigations

Location: 401 Racecourse Road, Te Awamutu

Contractor: Topdrill Ltd

Remarks:
GWL dipped at 2.20m

Termination Reason:
Refusal on anchor uplift

Northing:	5791686.0
Easting:	1802946.0
System:	NZTM
Elevation:	Ground
Datum:	N/A
Method:	Garmin GPS

Rig:	Pagani TG63 - 150
Cone ID:	MKs633
Cone Area:	10mm²
Sleeve Area:	150mm²
Area Ratio:	0.80
Predrill:	0.00

Soil Behaviour Type (SBT) - Robertson et al. 1986

0	Undefined
1	Sensitive fine-grained
2	Clay - organic soil
3	Clays: clay to silty clay
4	Silt mixtures: clayey silt & silty clay
5	Sand mixtures: silty sand to sandy silt
6	Sands: clean sands to silty sands
7	Dense sand to gravelly sand
8	Stiff sand to clayey sand
9	Stiff fine-grained

Test No:	CPT04
Topdrill Ref.:	TD202204
Client Ref.:	HD2090
Depth (m):	16.29
Date:	03/09/2021

SHEET 1 OF 1

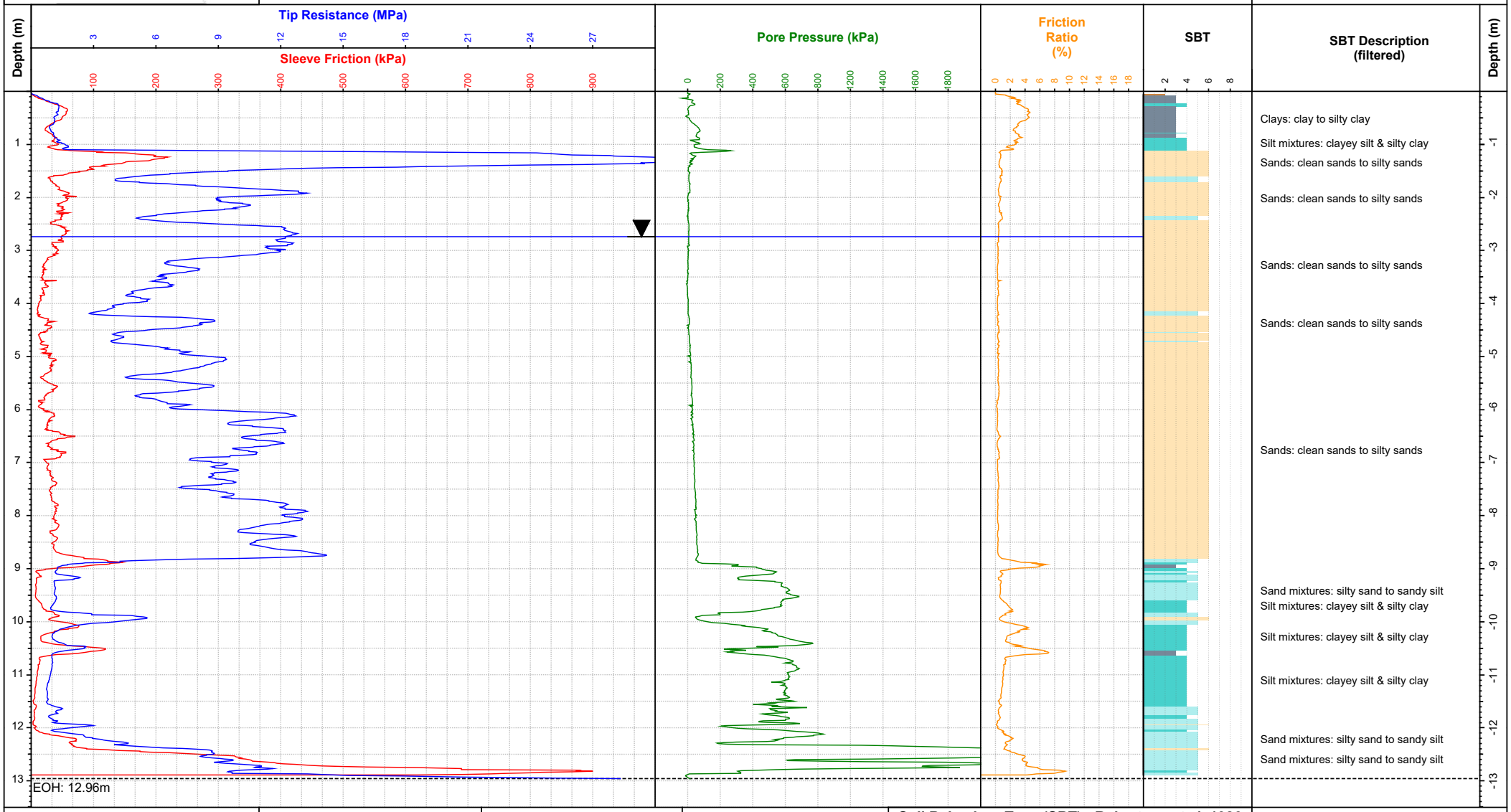
Generated with CORE-GS by Geroc - CPT - TopDrill 40 MPa - 4/09/2021 3:40:39 PM

CONE PENETRATION TEST LOG

Topdrill Geotech

Test No: CPT05

Client Ref.: HD2090



SBT Description (filtered)

Clays: clay to silty clay

Silt mixtures: clayey silt & silty clay

Sands: clean sands to silty sands

Sands: clean sands to silty sands

Sands: clean sands to silty sands

Sands: clean sands to silty sands

Sands: clean sands to silty sands

Sand mixtures: silty sand to sandy silt

Silt mixtures: clayey silt & silty clay

Silt mixtures: clayey silt & silty clay

Silt mixtures: clayey silt & silty clay

Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

Depth (m)

Client: HD Geo

Project: CPT Investigations

Location: 401 Racecourse Road, Te Awamutu

Contractor: Topdrill Ltd

Remarks:

GWL dipped at 2.75m

Termination Reason:

Refusal on anchor uplift

Northing:	5791654.0
Easting:	1803000.0
System:	NZTM
Elevation:	Ground
Datum:	N/A
Method:	Garmin GPS

Rig:	Pagani TG63 - 150
Cone ID:	MKs633
Cone Area:	10mm²
Sleeve Area:	150mm²
Area Ratio:	0.80
Predrill:	0.00

Soil Behaviour Type (SBT) - Robertson et al. 1986

0	Undefined
1	Sensitive fine-grained
2	Clay - organic soil
3	Clays: clay to silty clay
4	Silt mixtures: clayey silt & silty clay
5	Sand mixtures: silty sand to sandy silt
6	Sands: clean sands to silty sands
7	Dense sand to gravelly sand
8	Stiff sand to clayey sand
9	Stiff fine-grained

Test No:	CPT05
Topdrill Ref.:	TD202204
Client Ref.:	HD2090
Depth (m):	12.96
Date:	03/09/2021

SHEET 1 OF 1

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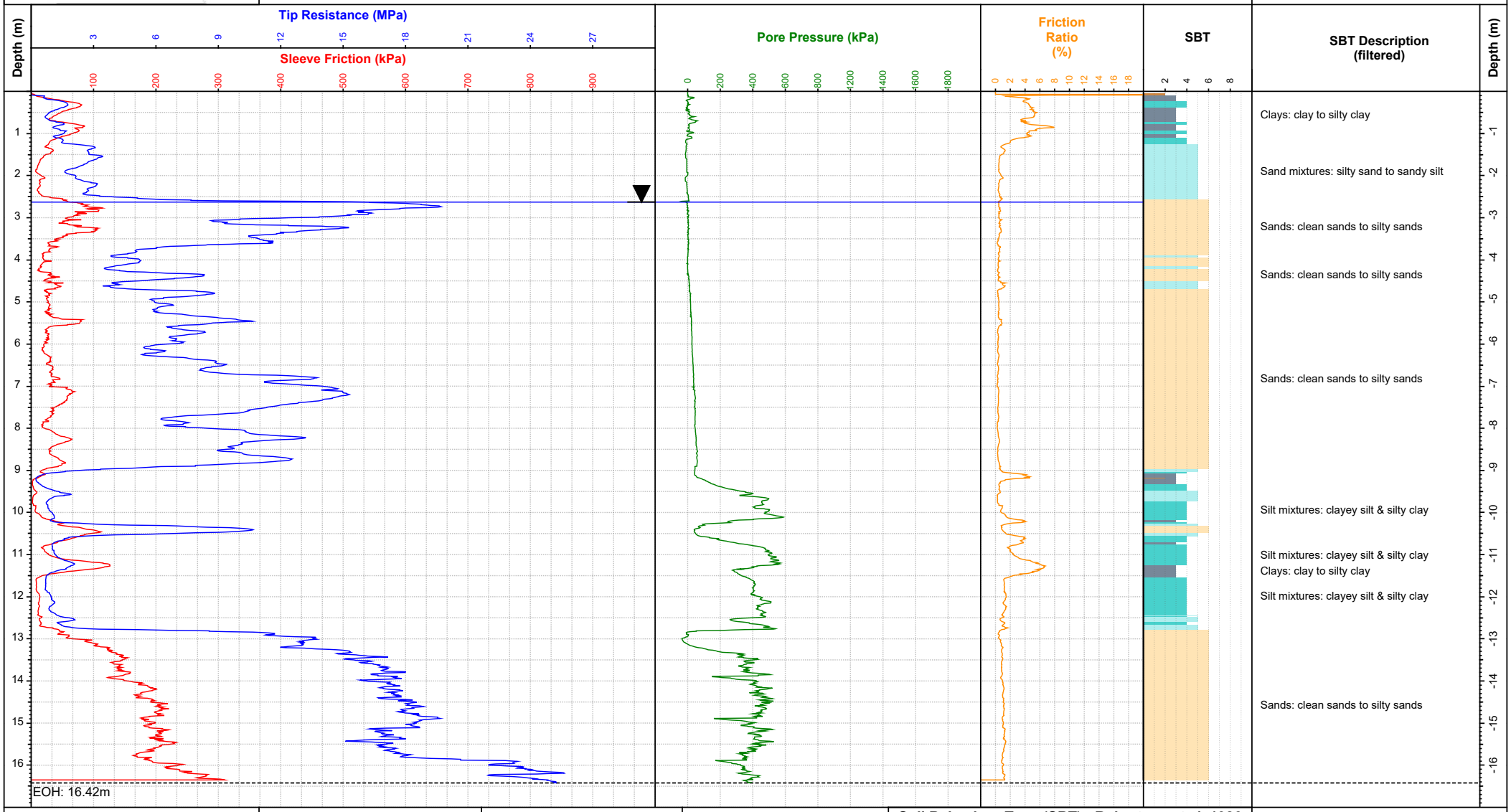
CONE PENETRATION TEST LOG

Topdrill Geotech

Test No: CPT06

Client Ref.: HD2090



SBT Description (filtered)

Clays: clay to silty clay

Sand mixtures: silty sand to sandy silt

Sands: clean sands to silty sands

Sands: clean sands to silty sands

Sands: clean sands to silty sands

Silt mixtures: clayey silt & silty clay

Silt mixtures: clayey silt & silty clay

Clays: clay to silty clay

Silt mixtures: clayey silt & silty clay

Sands: clean sands to silty sands

Client: HD Geo

Project: CPT Investigations

Location: 401 Racecourse Road, Te Awamutu

Contractor: Topdrill Ltd

Remarks:

GWL dipped at 2.63m

Termination Reason:

Refusal on anchor uplift

Northing:	5791619.0
Easting:	1803090.0
System:	NZTM
Elevation:	Ground
Datum:	N/A
Method:	Garmin GPS

Rig:	Pagani TG63 - 150
Cone ID:	MKs633
Cone Area:	10mm²
Sleeve Area:	150mm²
Area Ratio:	0.80
Predrill:	0.00

Soil Behaviour Type (SBT) - Robertson et al. 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test No:	CPT06
Topdrill Ref.:	TD202204
Client Ref.:	HD2090
Depth (m):	16.42
Date:	03/09/2021

SHEET 1 OF 1

Generated with CORE-GS by Geroc - CPT - TopDrill 30 MPa - 5/09/2021 10:08:00 AM

APPENDIX D – LIQUEFACTION

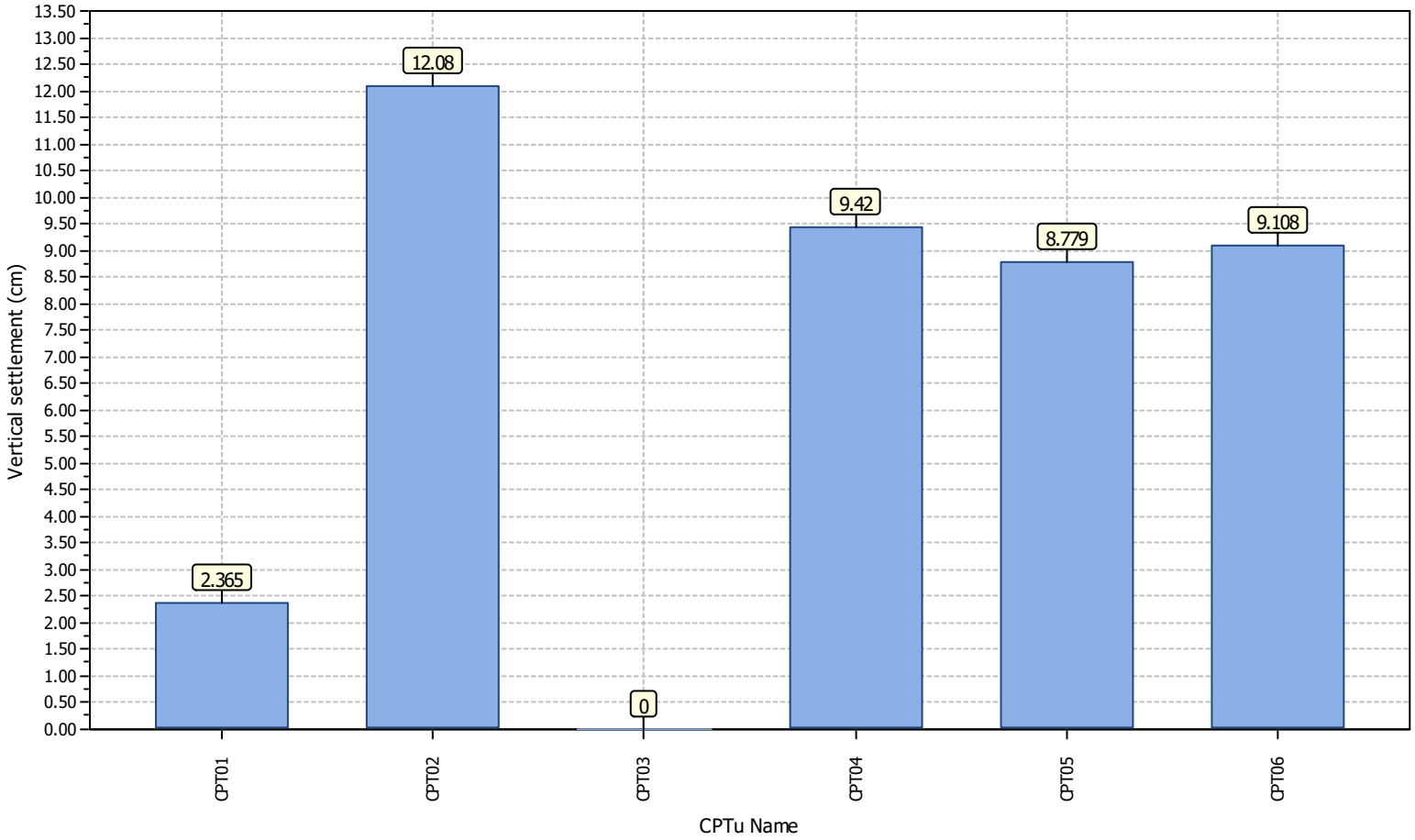
CLIQ

HD Geo
PO Box 9266
Waikato Mail Centre, Hamilton
www.hdgeo.co.nz

Project title : HD2090

Location : 401 Racecourse Road, Te Awamutu

Overall vertical settlements report

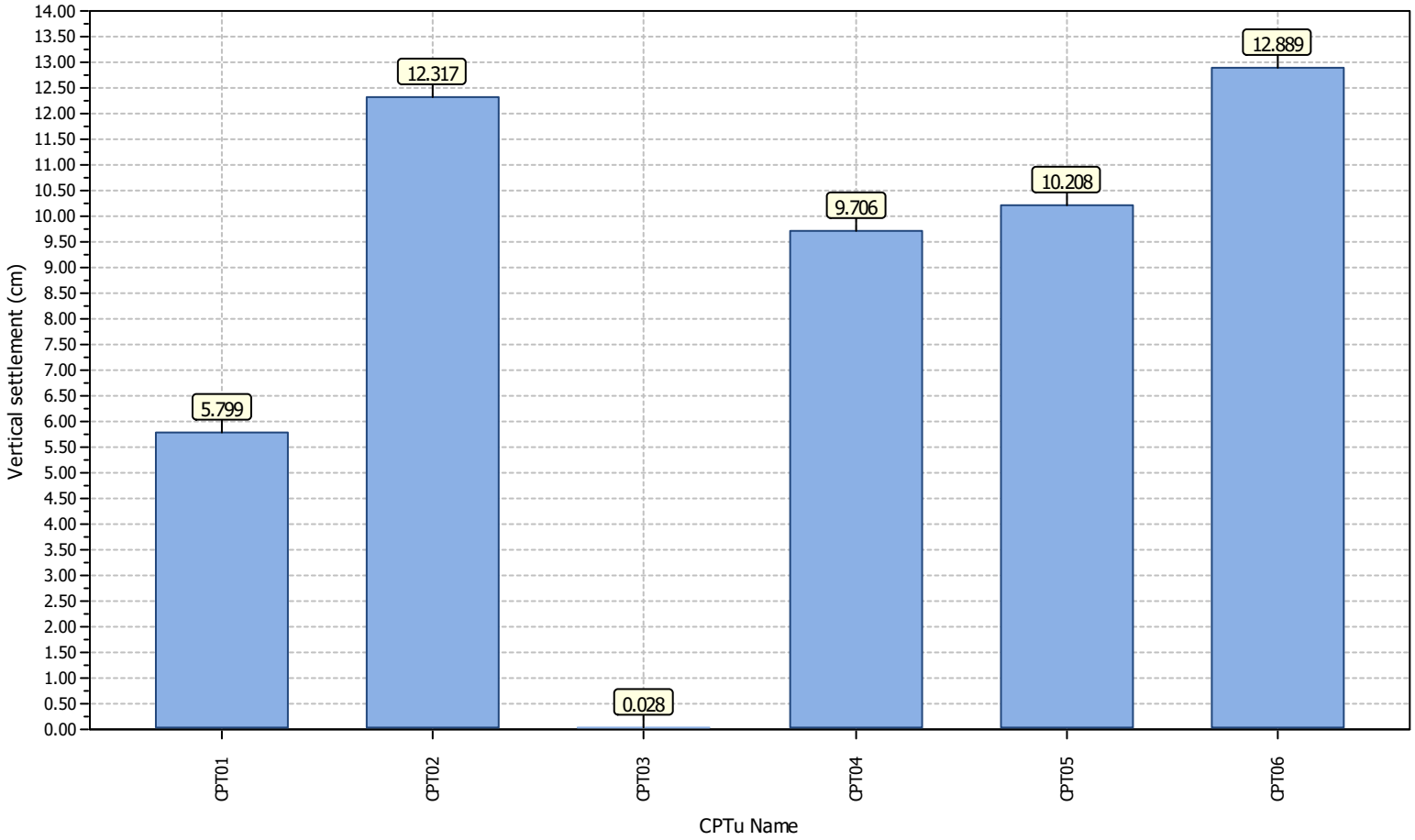


HD Geo
PO Box 9266
Waikato Mail Centre, Hamilton
www.hdgeo.co.nz

Project title : HD2090

Location : 401 Racecourse Road, Te Awamutu

Overall vertical settlements report - High GWT

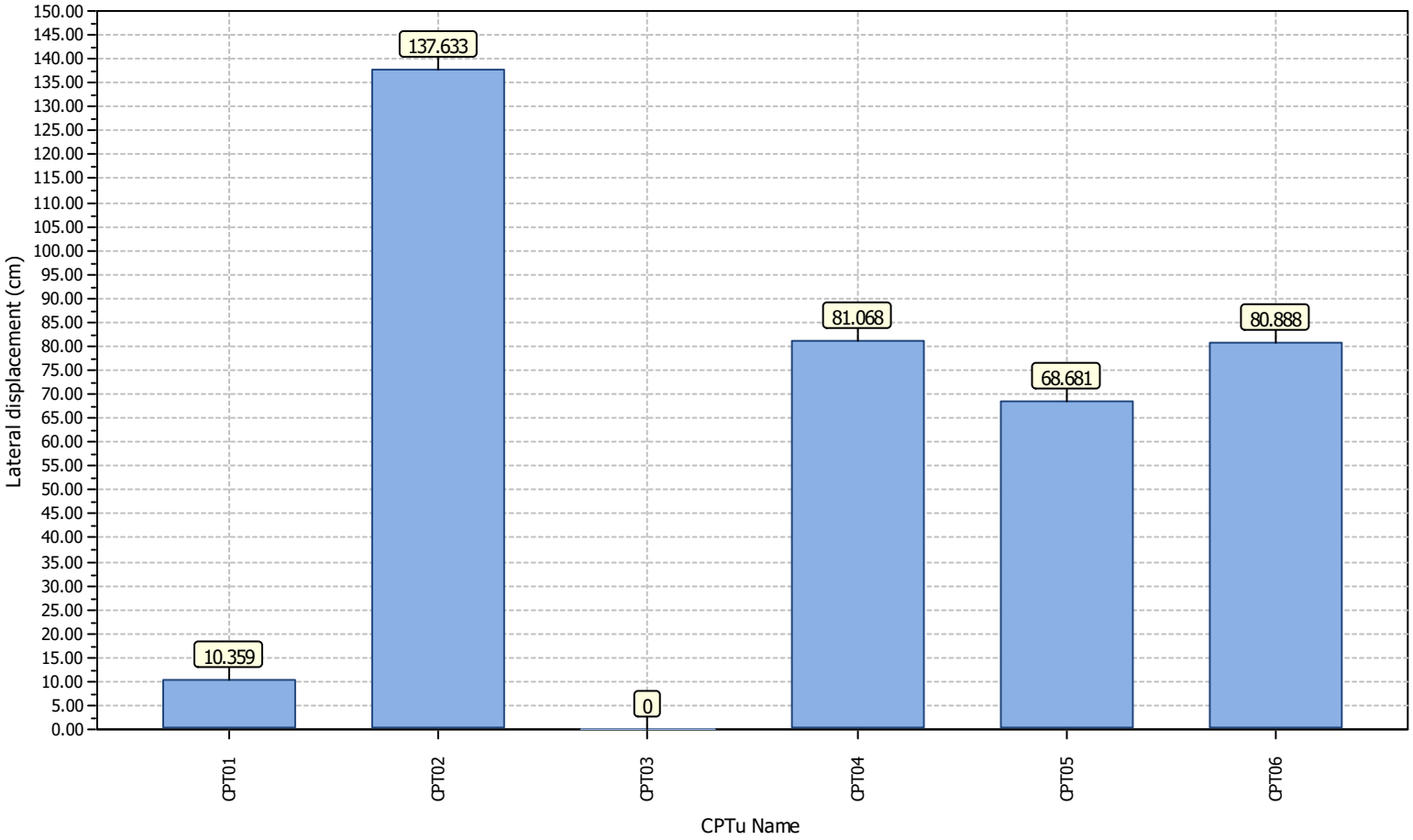


HD Geo
PO Box 9266
Waikato Mail Centre, Hamilton
www.hdgeo.co.nz

Project title : HD2090

Location : 401 Racecourse Road, Te Awamutu

Overall lateral displacements report

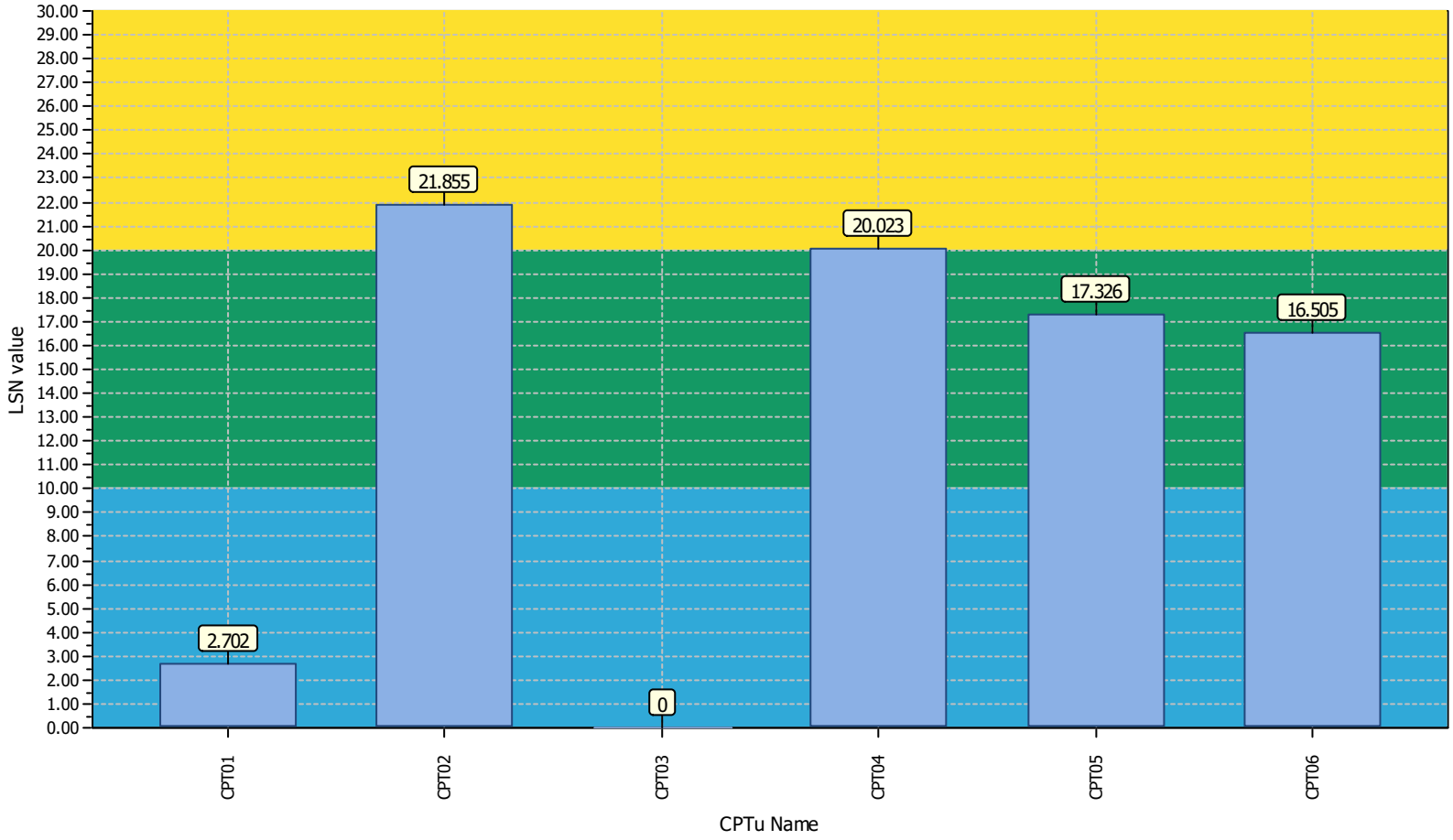


HD Geo
PO Box 9266
Waikato Mail Centre, Hamilton
www.hdgeo.co.nz

Project title : HD2090

Location : 401 Racecourse Road, Te Awamutu

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: 6

33% little liquefaction

33% minor liquefaction

33% moderate liquefaction

0% moderate to major liquefaction

0% major liquefaction

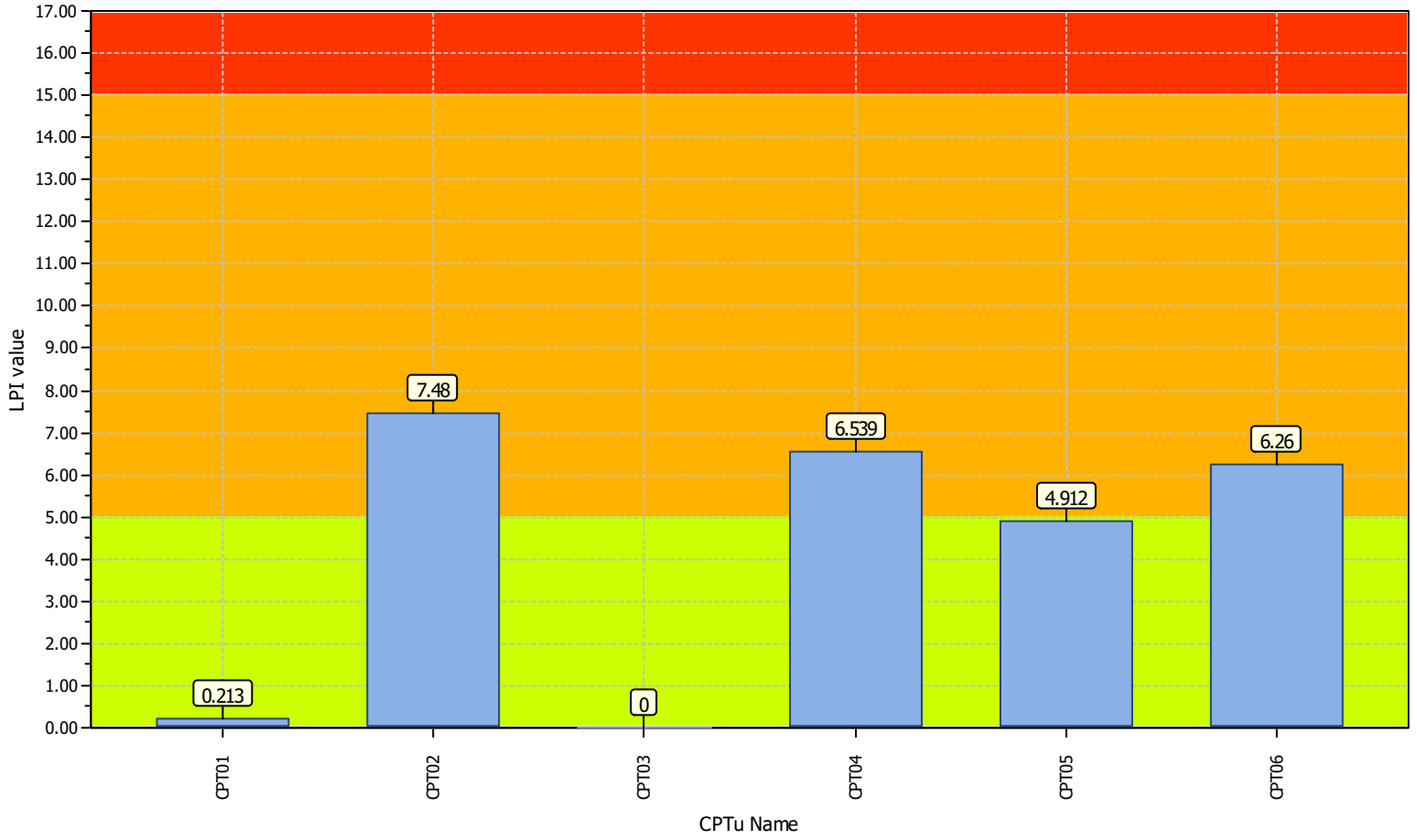
0% severe liquefaction

HD Geo
PO Box 9266
Waikato Mail Centre, Hamilton
www.hdgeo.co.nz

Project title : HD2090

Location : 401 Racecourse Road, Te Awamutu

Overall Liquefaction Potential Index report



LPI color scheme

- Very high risk
- High risk
- Low risk

Basic statistics

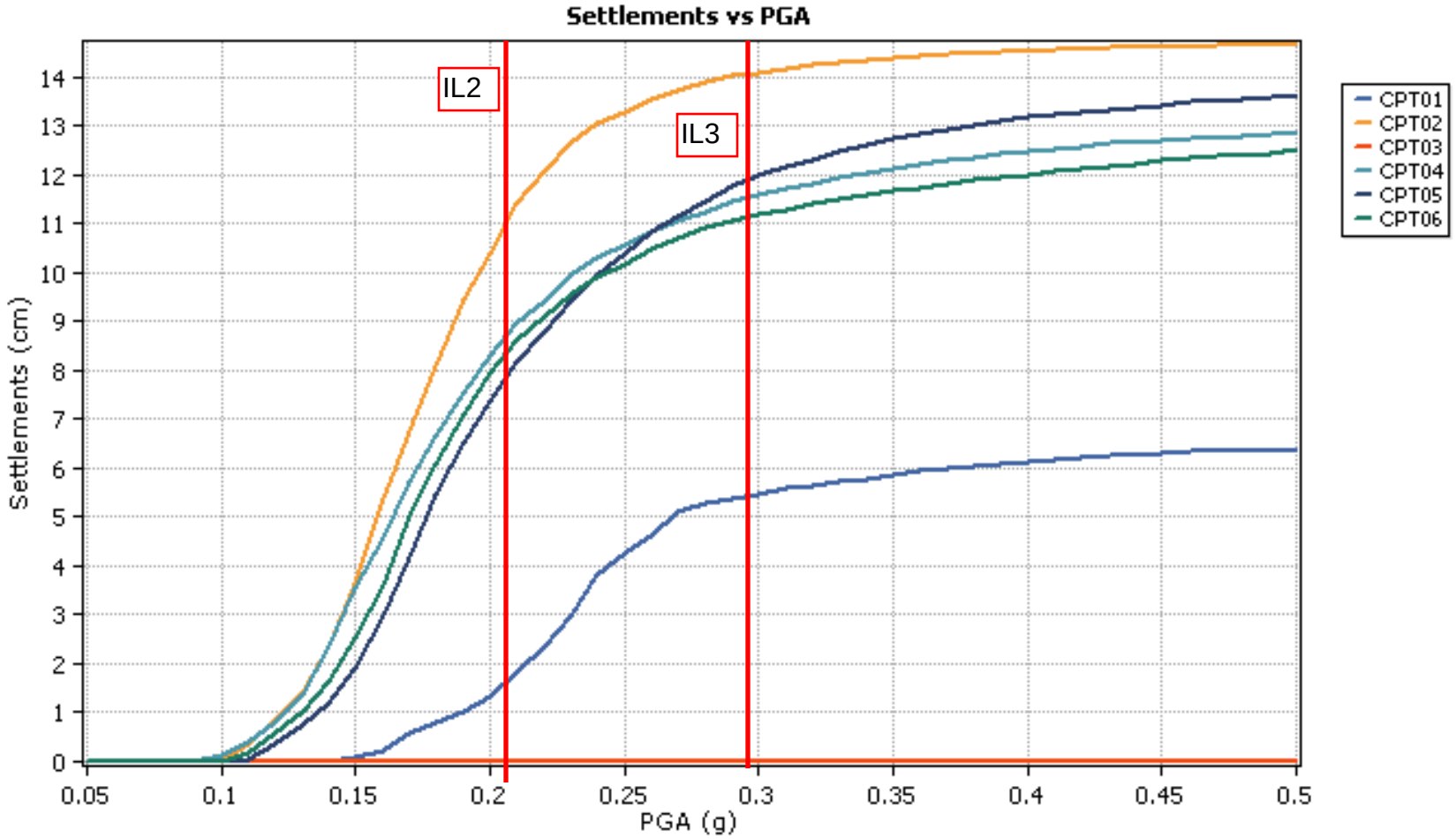
Total CPT number: 6
50% low risk
50% high risk
0% very high risk

HD Geo
PO Box 9266
Waikato Mail Centre, Hamilton
www.hdgeo.co.nz

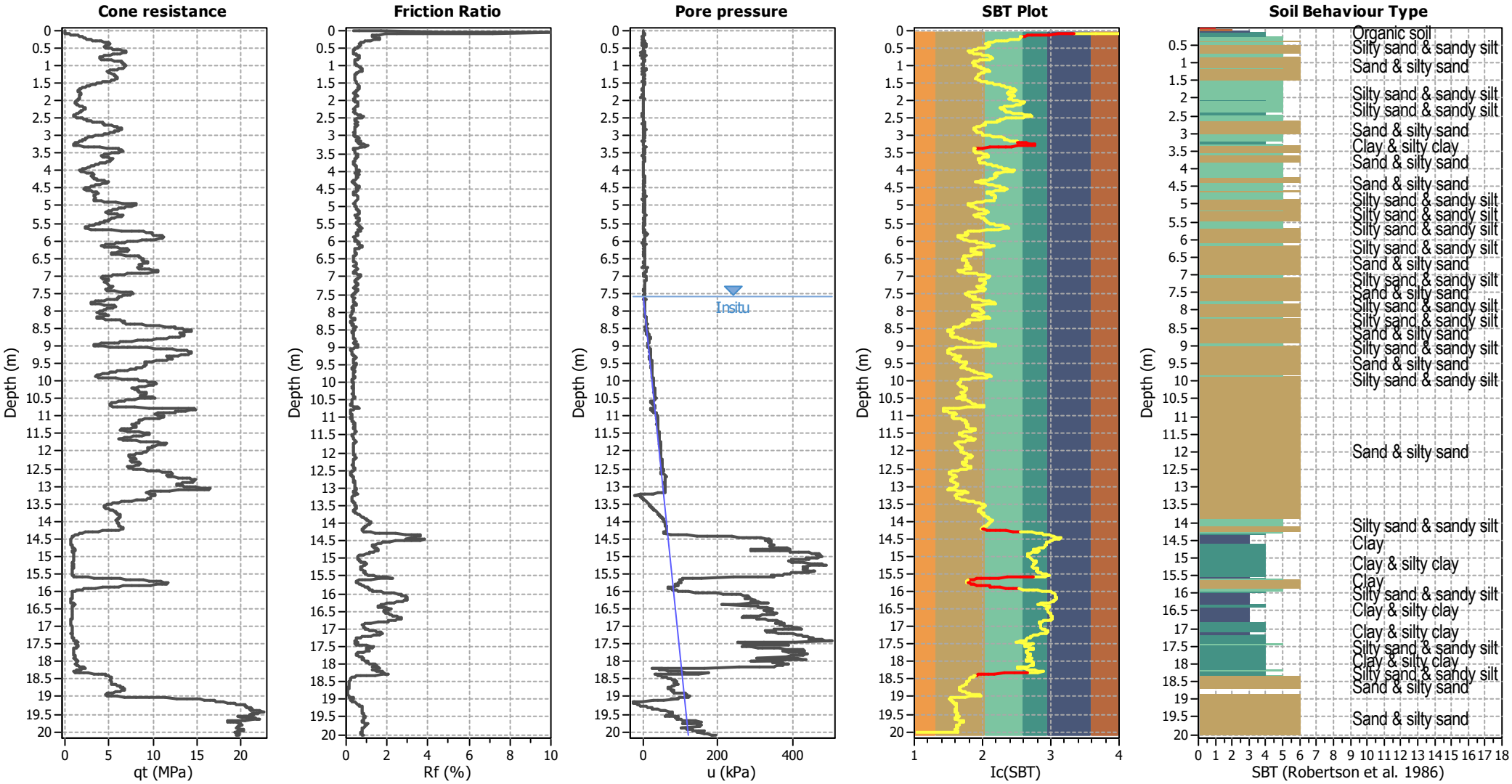
Project title : HD2090

Location : 401 Racecourse Road, Te Awamutu

Parametric assessment results



CPT basic interpretation plots



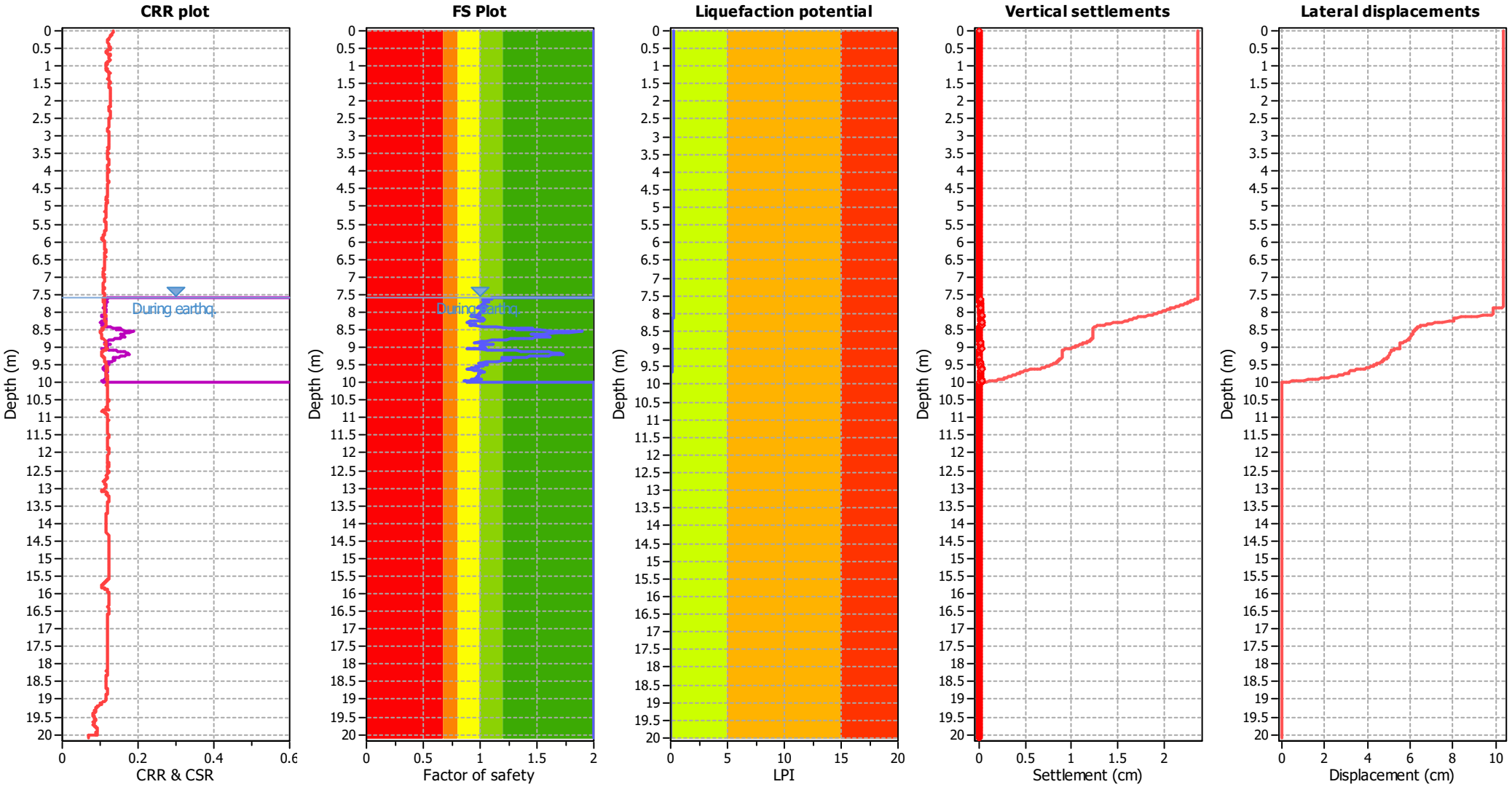
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	7.60 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	7.60 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	7.60 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	7.60 m	Fill height:	N/A	Limit depth:	10.00 m

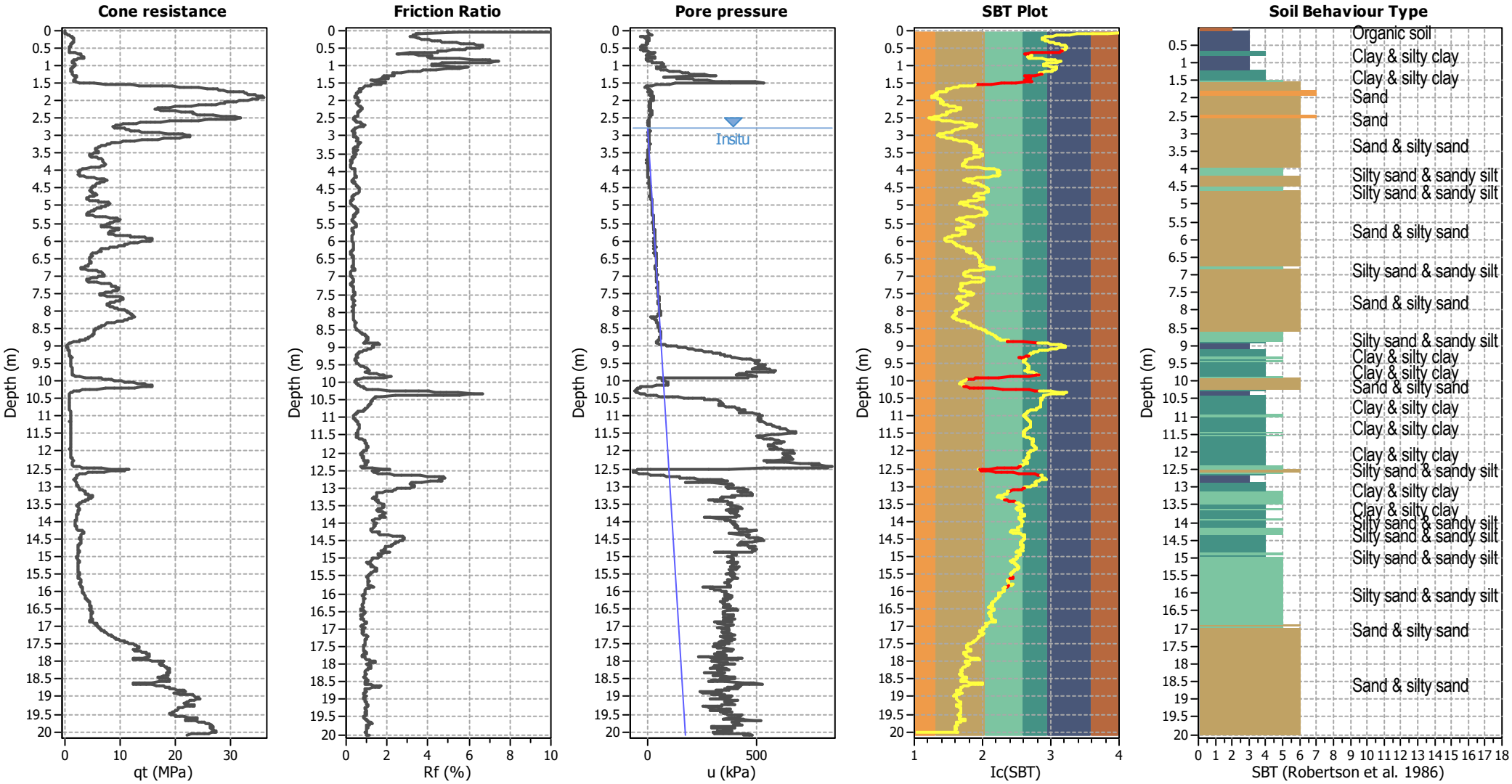
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



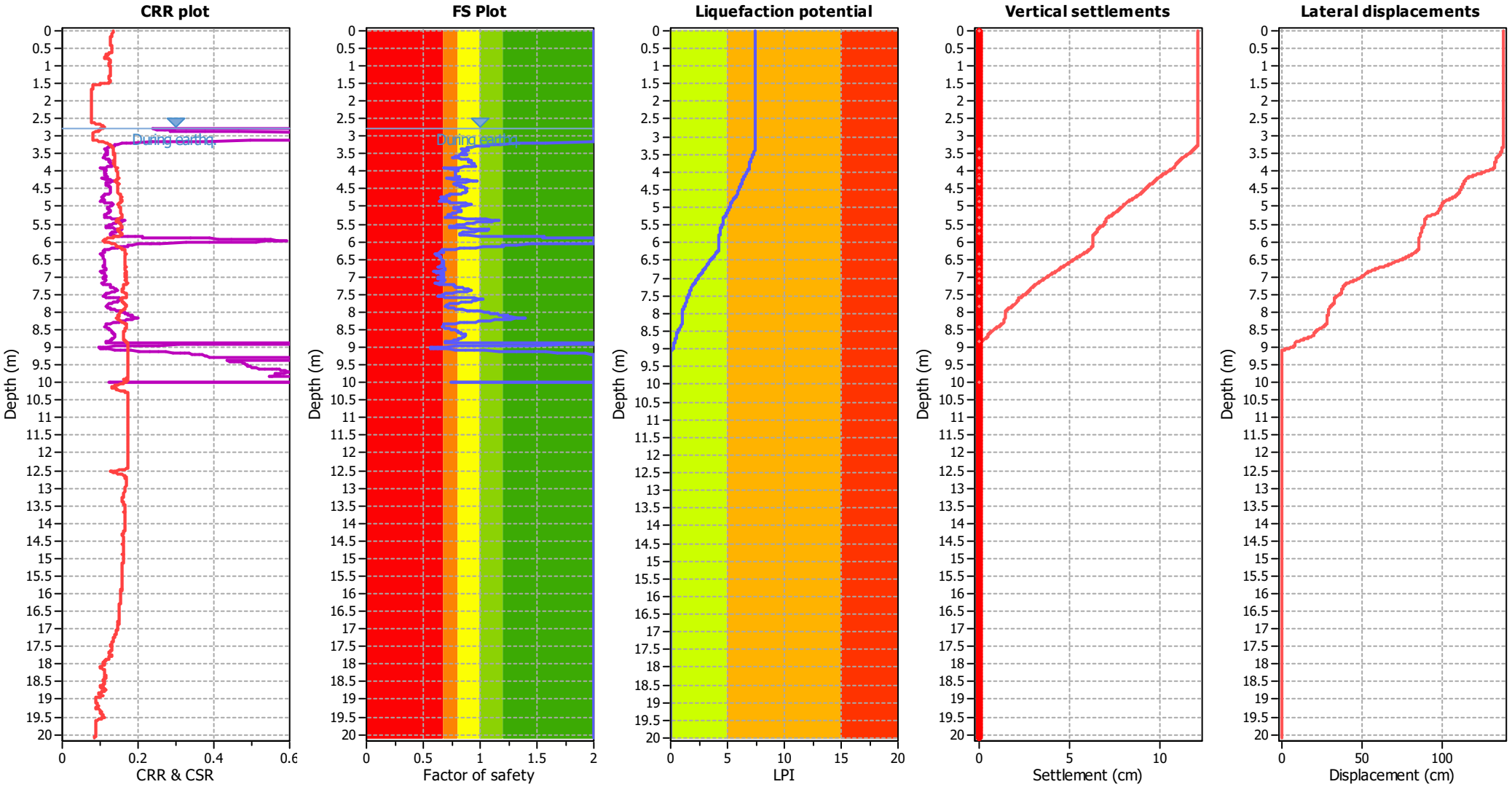
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.79 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.79 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.79 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.79 m	Fill height:	N/A	Limit depth:	10.00 m

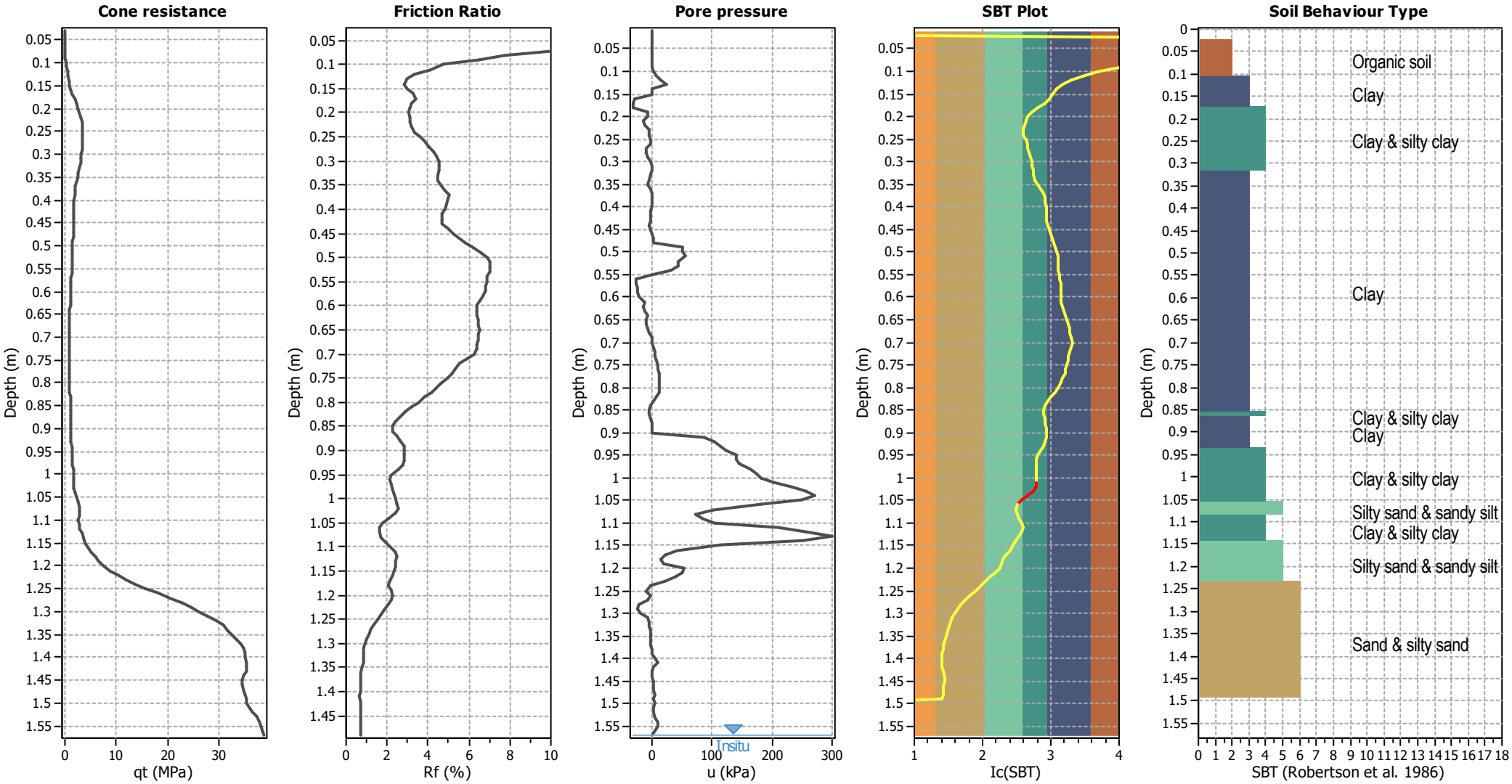
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



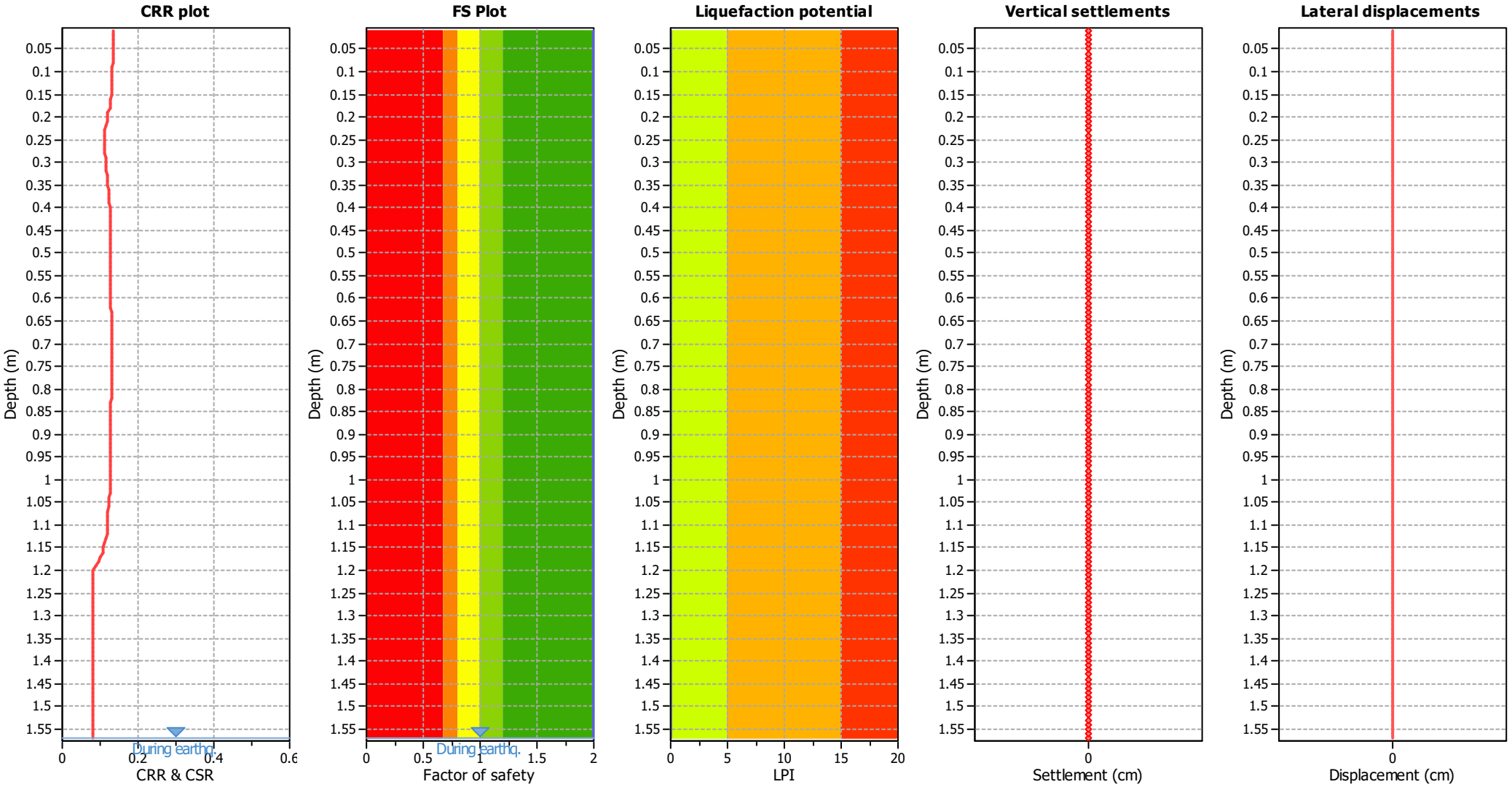
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.57 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.57 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.57 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.57 m	Fill height:	N/A	Limit depth:	10.00 m

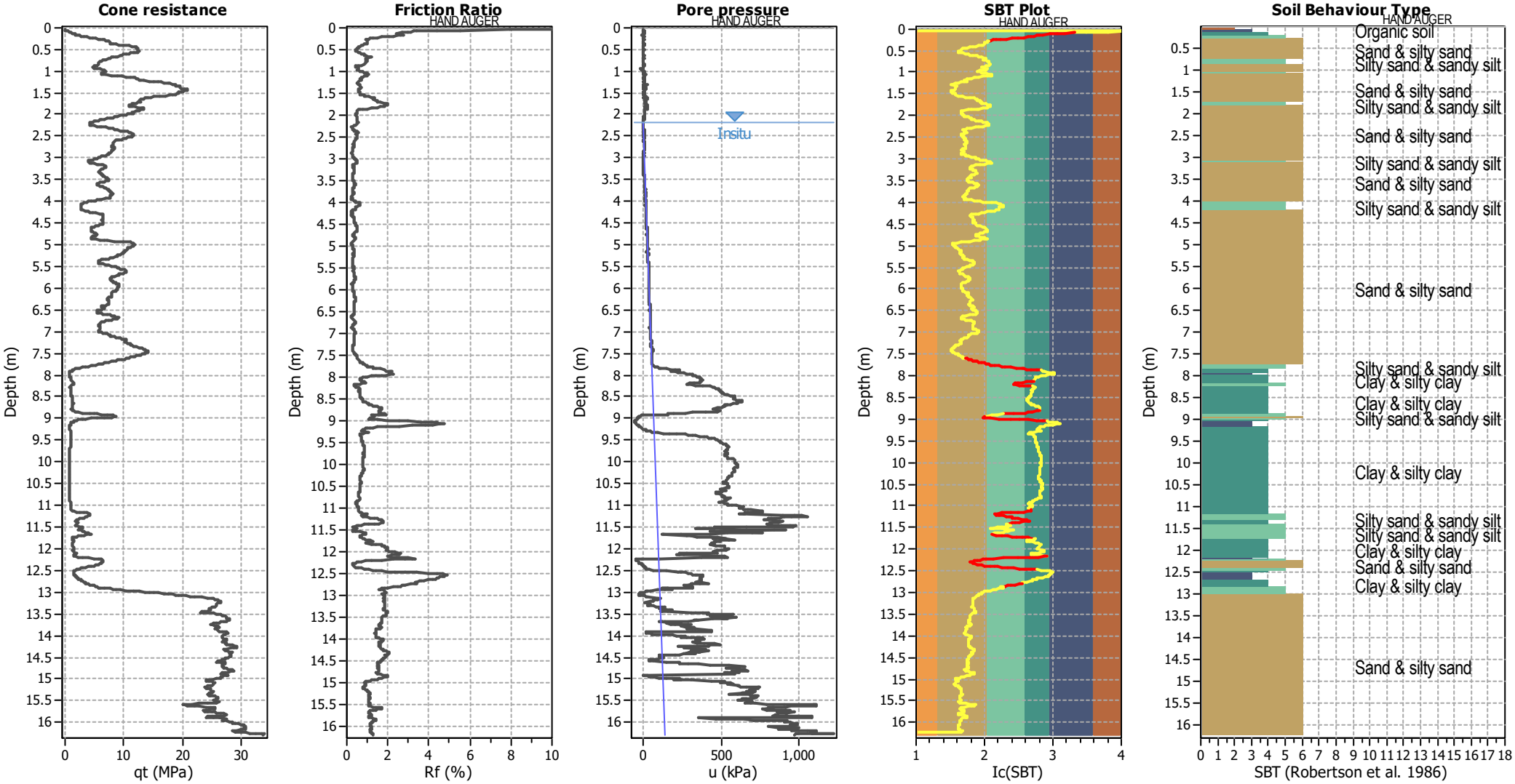
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



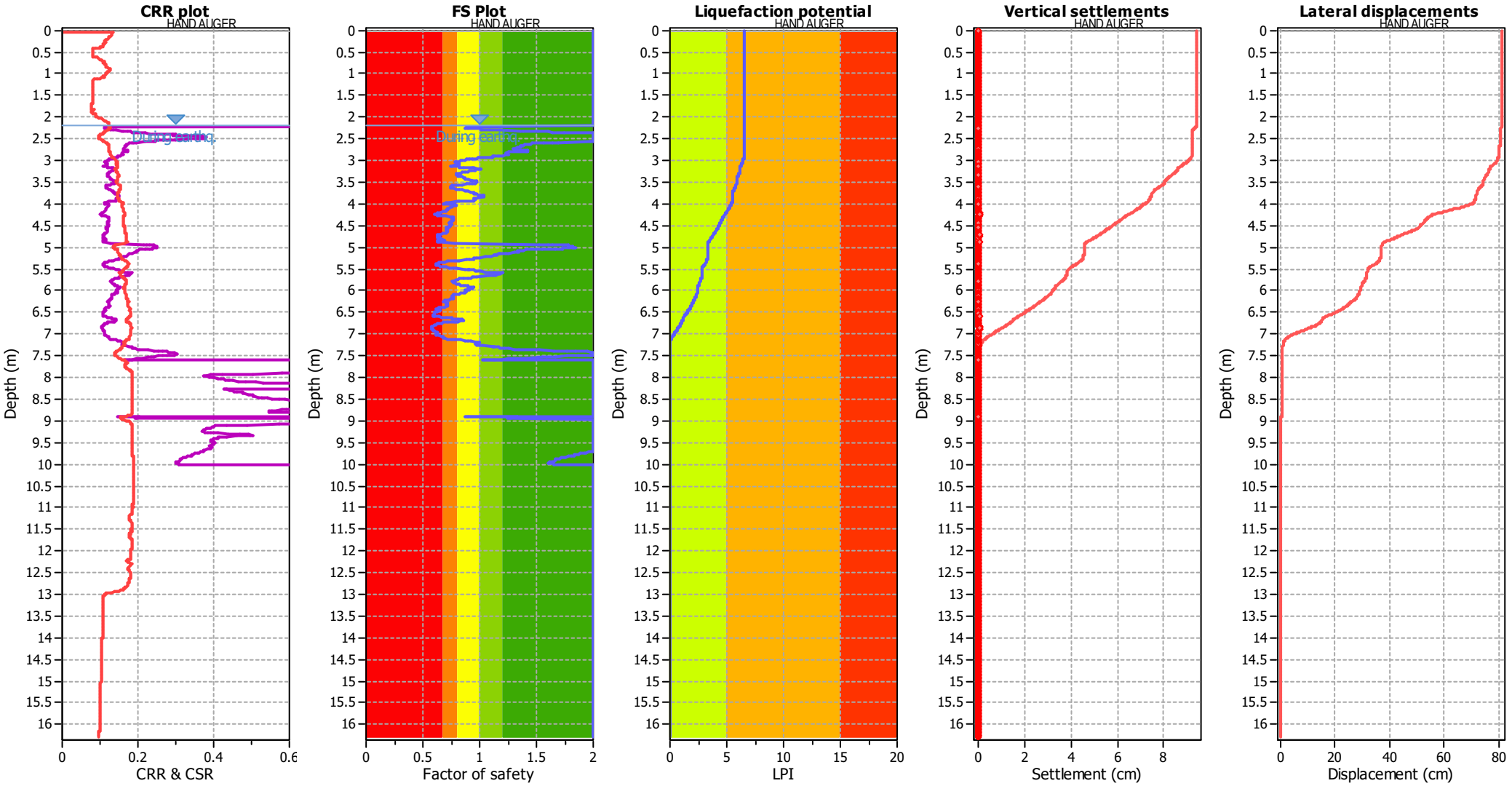
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.20 m	Fill height:	N/A	Limit depth:	10.00 m

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LPI color scheme

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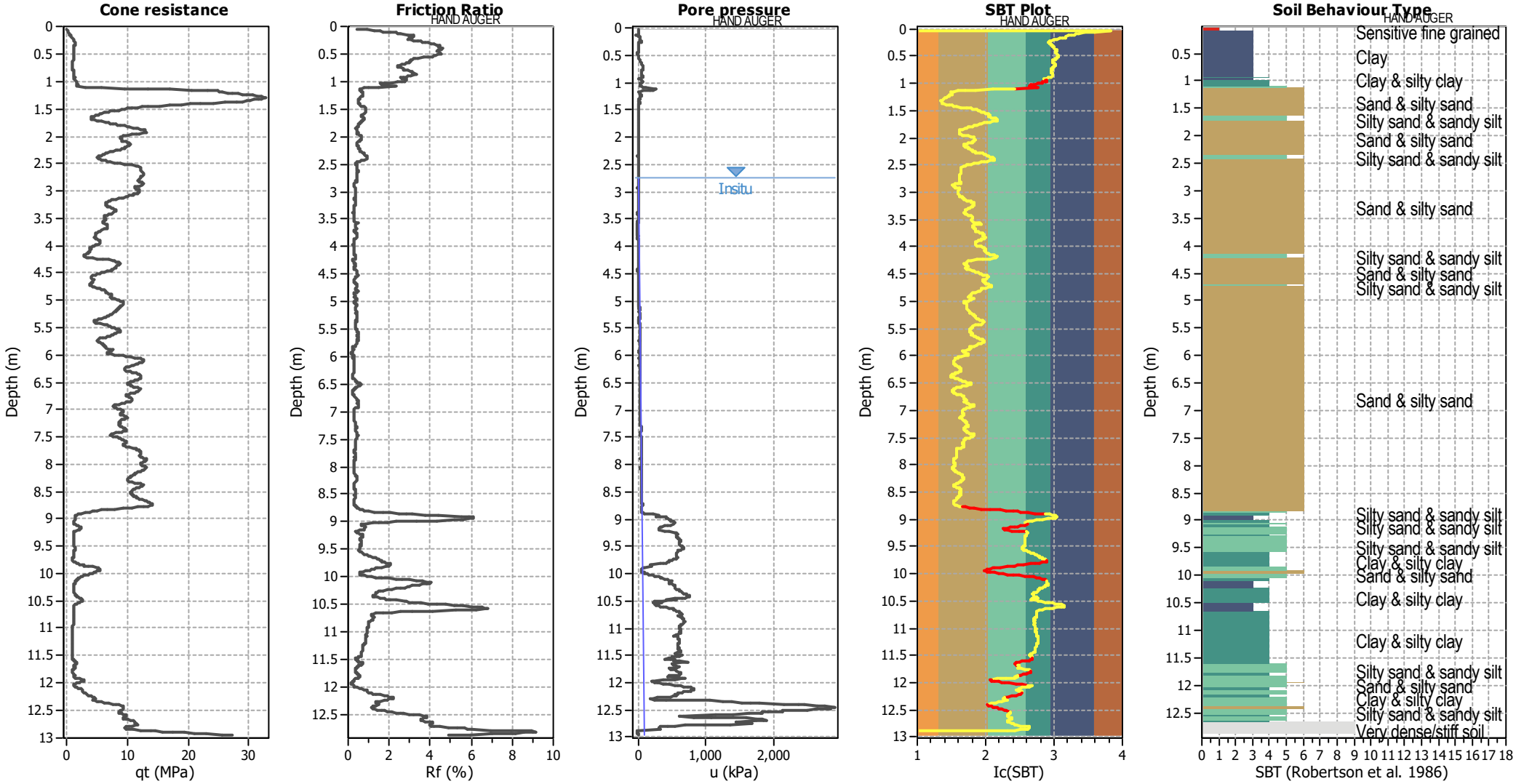
- High risk
- Low risk

CPT basic interpretation plots



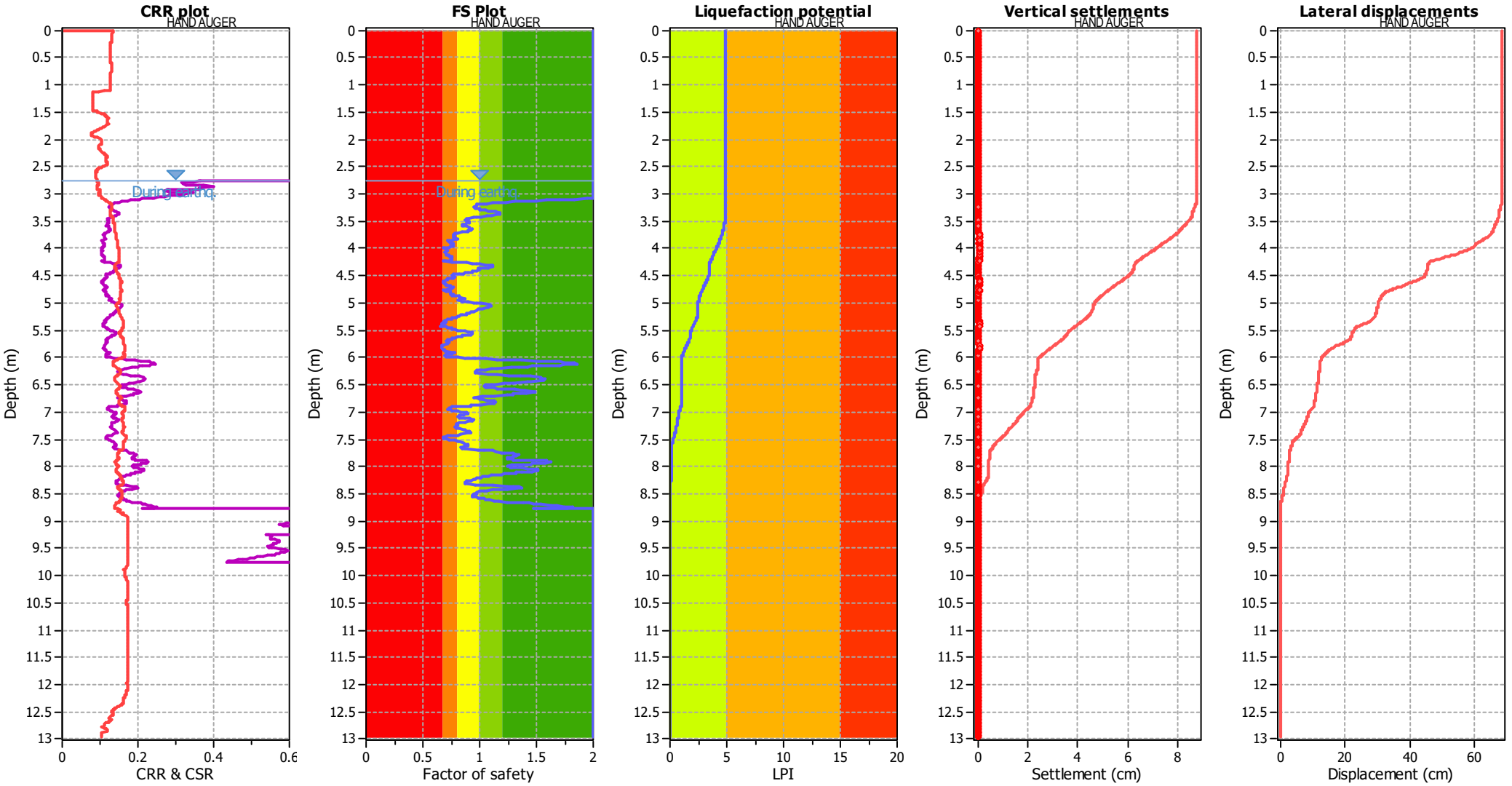
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.75 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.75 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.75 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.75 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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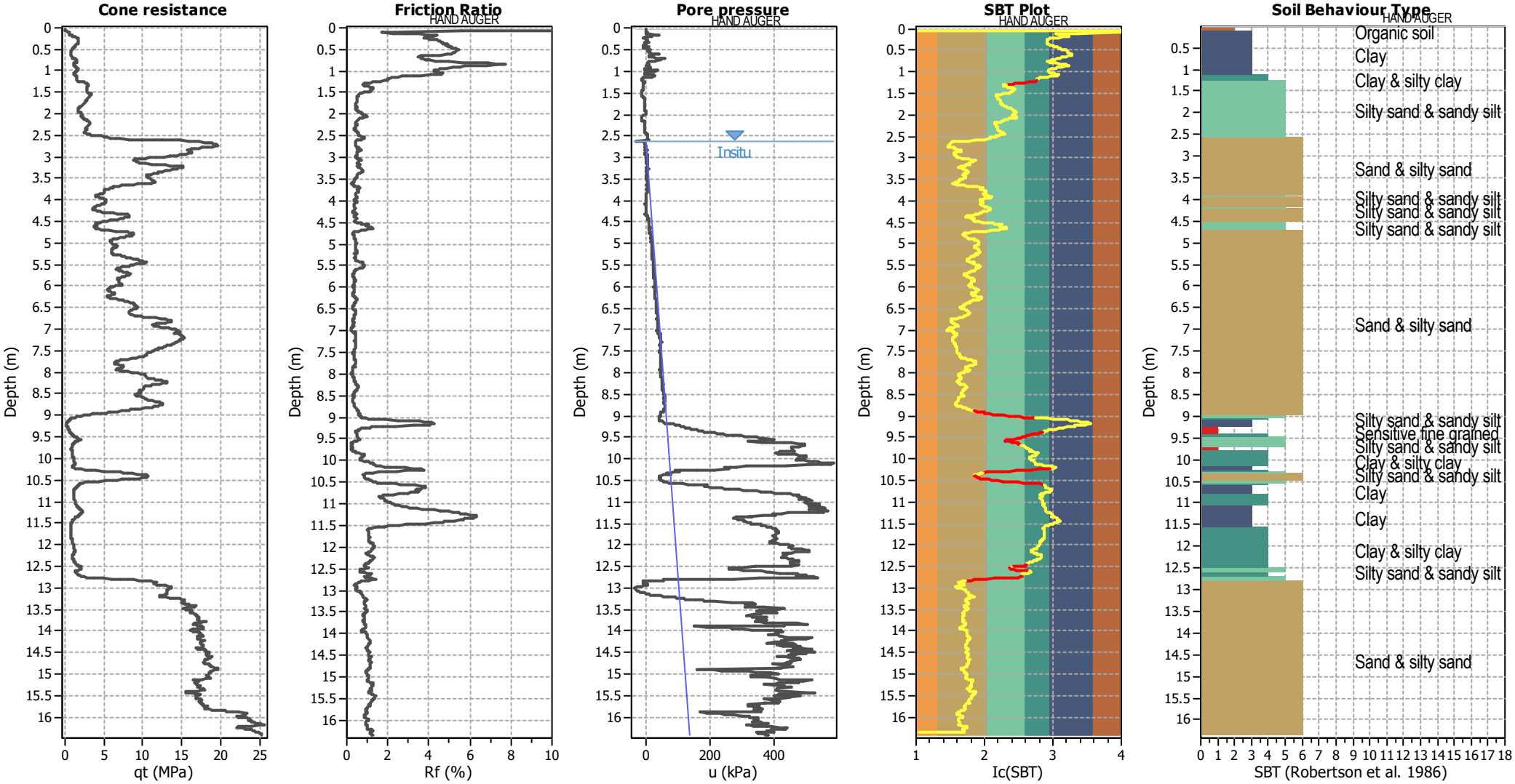
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



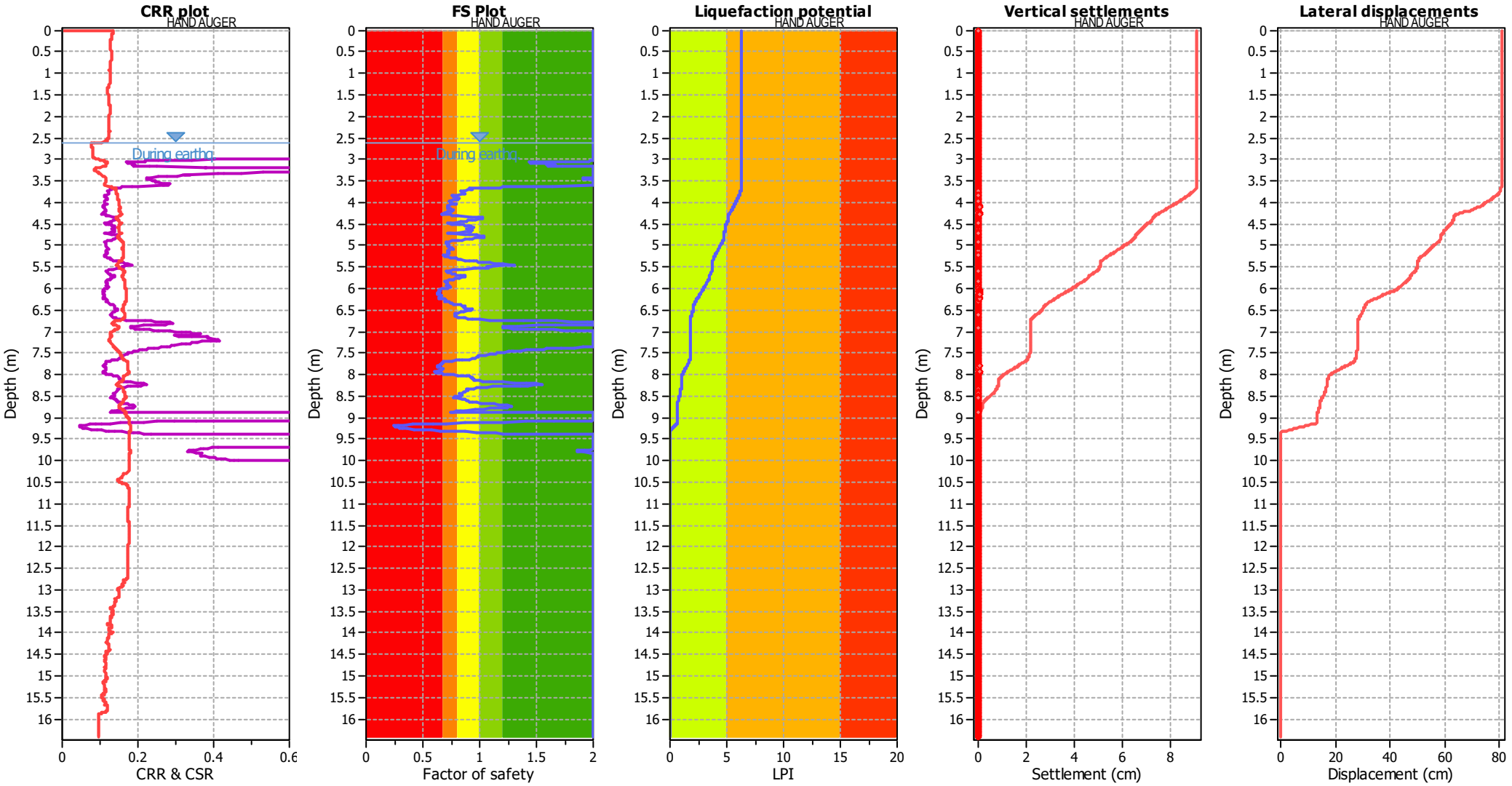
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.63 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.63 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.63 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.63 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LPI color scheme

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