



Groundwater and Settlement Effects Report

Whenuapai Conveyance - Package 1

Prepared for

Beca Limited

Prepared by

Tonkin & Taylor Ltd

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Executive Summary

This Groundwater and Settlement Effects Report has been prepared to support an Assessment of Effects on the Environment (AEE), and presents our geotechnical and groundwater effects assessment for the installation of the proposed gravity and rising main pipelines and associated infrastructure including wet well, valve chambers and the storage tanks at the pump station location. The estimated total ground settlements (where assessed) are presented as settlement contours on the project site plan presented in Appendix A.

Based on our technical assessment, we conclude:

Pump Station

- Ground settlement effects arising from pump station and storage tank construction on surrounding structures is assessed to be negligible (0) to very slight risk (1) of damage.

Gravity Main

- Ground settlement effects arising from the construction of the gravity main (shafts, chamber and pipe jack) by means of open cut and/or direction drill on surrounding structures is assessed to be negligible (0).
- Ground settlement effects arising from the Brigham Creek Road pipe jack upon buried services expected to be low.
- Maximum total and differential settlements are assessed to be 25 mm and 1V:600H respectively. At this level of total and differential settlement, we assess that the risk of damage to underground services to be low.

Rising Main

- Ground settlement and groundwater drawdown effects arising from the chamber construction is assessed to be negligible as there are no structures or services within the zone of influence
- Damming effects associated with the Sinton Stream sheet piling works are assessed to be localised to the stream bank and not expected to significantly impact upon base flows into Sinton Stream.

Groundwater

- The risk of saline intrusion is assessed to be low.
- The impacting upon neighbouring groundwater bores is assessed to be negligible.
- Base flows through the wetland are unlikely to be materially reduced as excavations for the pump station and the Brigham Creek Road trenchless crossing are located downstream.
- We assess that changes to base flow in Sinton Stream arising from the pump station and Brigham Creek Road trenchless crossing construction activity will be low.

Monitoring

We recommend a groundwater and settlement monitoring programme during construction. In addition, groundwater monitoring bores located within the boreholes BH05A, BH05B, BH06, BH08, BH110, BH111, BH113, BH116, and BH117 (referenced in this assessment) should be monitoring for a minimum period of 6 months prior to commencement of construction to establish baseline levels.

1 Introduction

1.1 General

Beca Limited (Beca) has been engaged by Watercare under the Consultancy Services Panel Framework Agreement, to undertake Feasibility, Design and Consenting for Whenuapai-Redhills Wastewater Servicing Scheme– Package 1. Tonkin and Taylor Ltd (T+T) has been engaged as a subconsultant to Beca to provide geotechnical service for this project.

This Geotechnical Effects Report presents the results of our geotechnical effects assessment, regarding the installation approach, and potential settlement effects to surrounding assets and structures, due to the installation of the proposed gravity and rising main pipelines, as well as the wet well, valve chambers and the storage tanks at the pump station location. This report has been written to address the geotechnical and groundwater effects to inform an Assessment of Effects on the Environment (AEE) in support of a Notice of Requirement (NoR) and resource consent application.

At the time of preparing this report, the project drawings are in their detailed design stage. As such, this report should be reviewed to assess the validity of the results if changes are made to the proposed design drawings which are referenced herein.

This report is based on the T+T Geotechnical Factual Report² (GFR), GHD's Geotechnical Interpretative Report³ (GIR) and site observations from T+T's site walkover on 28 February 2020. Geotechnical and hydrogeological information presented in the GFR and GIR were used to inform the ground model and analysis to undertake this assessment.

2 Project overview and construction method

The Project aims to provide wastewater servicing capacity for approximately 10,240 dwellings, or 30,720 people, in the Whenuapai catchment. This growth is projected to occur by 2041. The Project includes the following five key components (see **Figure 1**):

1. A **Pump Station** at a point where the Whenuapai and Redhills Catchments meet at 23-27 Brigham Creek Road, with an emergency overflow outfall to Sinton Stream.
2. A **Gravity Main Pipeline** (approximately 700 m long and 375 – 475 mm in diameter) between Whenuapai Village Pump Station on Tamiro Road and the new pump station.
3. A **Rising Main** (approximately 1.5 km long and 500 mm in diameter) between the Pump Station and a proposed new break pressure chamber on Mamari Road (the boundary of Package 2)⁴.
4. A **Culvert** (approximately 63 m long including wing wall and rip rap) to provide access for the rising main across Sinton Stream.

² Tonkin and Taylor Ltd. *Whenuapai-Redhills Wastewater Servicing Rising Main/Gravity Main and Interim Pump Station Package 1. Geotechnical Factual Report*. Dated March 2022. T+T ref. 1014985.

³ GHD Ltd. *Whenuapai Redhills Wastewater Package 1. Geotechnical Interpretative Report*. Dated March 2021. Ref. 51/12508391

⁴ An extension of the rising main is part of 'Package 2' and will be designed to connect to the planned Northern Interceptor Phase 2 tunnel and deliver flows from the Whenuapai Catchment to the Rosedale Wastewater Treatment Plant for treatment. Package 2 is subject to a separate consent application.

5. A **Break Pressure Chamber** which connects to the Massey Connector rising main (proposed under Package 2).

The Project extends from the existing Whenuapai Village pump station site in Tamiro Road in the north, across Brigham Creek Road, to Spedding Road in the south.

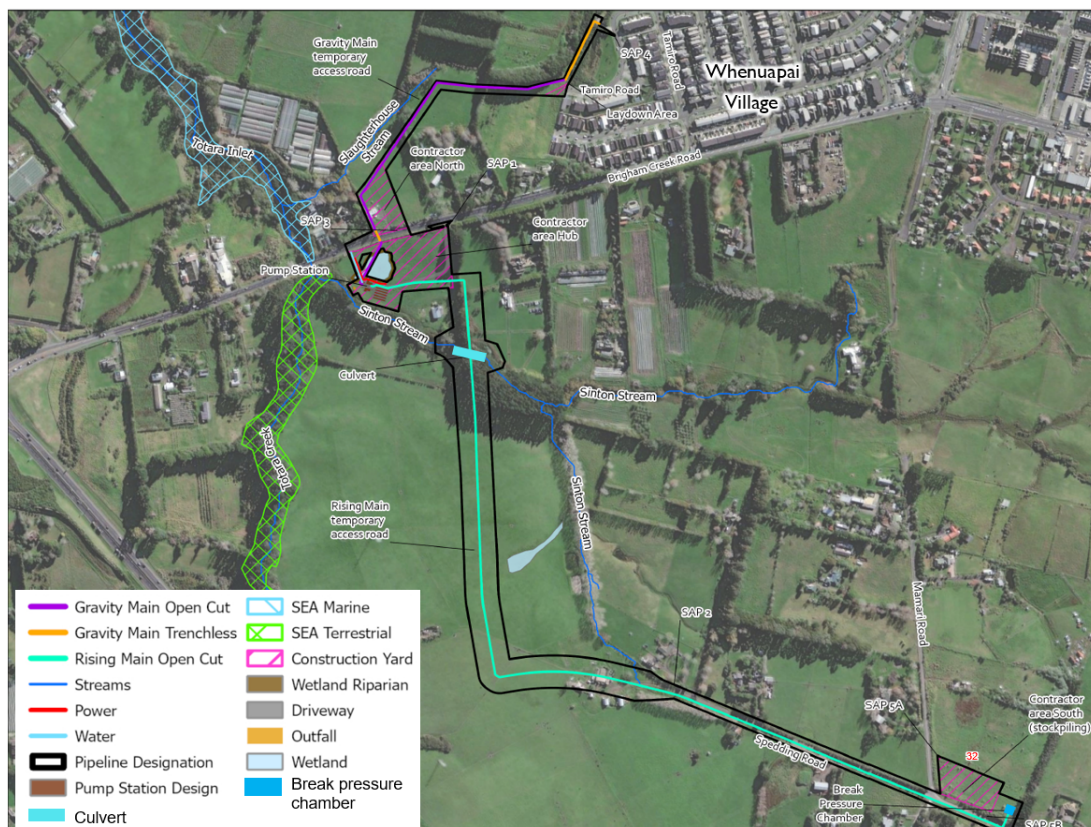


Figure 1 Package 1 – 'the Project' overview

Section 2.1 through section 2.3 provide further detail of the proposed infrastructure to be constructed.

2.1 Pump station at 23-27 Brigham Creek Road

A new wastewater pump station is proposed to be installed at 23-27 Brigham Creek Road. The pump station will comprise:

- 2 No. wet wells – approximately 8.65 m deep to invert which will require an excavated depth of approximately 9.5 m.
- 5 No. storage tanks – approximately 5.3 m depth to invert, which will require an excavated depth of approximately 6.0 m.

The construction methodology presented in the Beca Assessment of Effect proposes that the pump station is to be constructed by open bulk excavation. Temporary support for all excavations will be required to provide safe access, and limit ground deformations associated with mechanical and consolidation settlements. Temporary support options considered for the purposes of this assessment as outlined in the Contractor's proposed construction methodology are as follows:

- Sheet piles, with lateral bracing, that extend below the base of the excavation to reduce groundwater seepage flows into the excavation to enable construction of the wastewater wet well and storage tanks.

The Contractor may choose a different temporary support mechanism from those assessed in the report, such as secant piles with lateral bracing, as the design is developed, which should be acceptable provided that the chosen support method can be demonstrated to limit groundwater seepage and total ground deformations to the values presented in this report.

Pump station excavations with dewatering are expected to take up to 6 months.

2.2 Gravity Main

A gravity main is proposed from the existing Whenuapai Village pump station to the pump station comprising:

- Approximately 715 m long 375 mm – 475 mm diameter gravity pipeline with an invert level ranging between approximately 2.4 and 5.5 m below ground level. The pipeline will commence at the existing Whenuapai Village pump station and extend through farmland between 20 and 28 Brigham Creek Road before crossing underneath Brigham Creek Road to terminate at the pump station.
- 11 No 1540 mm diameter manholes (SSMH-1 through SSMH-11).

The construction methodology proposes:

- Pipe hammering underneath Brigham Creek Road between chambers SSMH3 and SSMH4.
- Trenchless construction between SMH11 and SMH12.
- The remainder of the alignment will be installed by open cut method. Trenches shall be progressively opened, closed and stabilised, and the part of the trench that is open at any given time will be no longer than 10 days, and manhole structures no longer than 30 days.

Temporary support for excavations will be required. Where excavations may be required for longer than 10 days such as the location of manhole SMH11 and SMH12 temporary support of the trench walls with seepage mitigation may be required to limit ground deformations and provide stable excavations. For the purposes of this assessment, we have considered:

- Sheet piles with lateral restraint.

Open cut methods may be required where trenchless methods are proposed in case of an obstruction. If this is the case, the settlement results from the driving and receiving shafts can be adopted to predict the settlement that may arise between these two points if the pipeline shall be trenched.

2.3 Rising Main

A rising main is proposed from the pump station to the break pressure chamber at 32 Mamari Road comprising:

- Approximately 1492 m long 500 mm diameter riser pipeline with an invert level ranging between approximately 0.5 and 5.9 m below the existing ground level. The pipeline will commence at the pump station and extend along the future extension of Spedding Road, then Spedding Road, and terminate 32 Mamari Road.

The construction methodology proposes:

- That the full length of the rising main is to be installed by open cut method. The pipeline is intended to run underground for its full length except where it passes through a culvert at

Sinton Stream. Trenches for the pipeline will be progressively opened, closed and stabilised, and the part of the trench that is open at any given time will be no longer than 10 days.

- To enable culvert construction at Sinton Stream, sheet piles shall be installed to provide ground support over a length of approximately 75 m for a duration of approximately 12 weeks.
- An air valve chamber and connection chamber are proposed at approximately chainage 155 and 235 respectively, north of Sinton Creek. The chambers will require excavations approximately 3.3 m and 2.4 m deep. The excavations are expected to take up to 4 weeks to construct and backfill.

As set out in the AEE, the rising main section of pipeline is being installed by open trenching, which is a permitted activity under Rules E7.4.1(E17) and (E27), and the E7.6.1.10. Therefore, any potential effects associated with groundwater dewatering and diversion for the open trenching have not been considered further in this report. The effects of the Sinton Stream sheet piles and rising main chamber excavations are assessed due their longer period of excavation.

3 Site setting and description

The site is located within Whenuapai, Auckland, and is bounded by Tamiro Road and a residential subdivision to the north, undeveloped subdivided land to the east and west, and Trig Road to the south (refer to Figure 1). The following sections provide further detail of the specific areas of assessment.

3.1 Pump station

The pump station site is bounded by Brigham Creek Road to the north, Sinton Stream to the west and south, and the proposed Spedding Road extension to the east.

There is a wetland located within the northern portion of the site, which is south from Brigham Creek Road. The wetland covers an area of approximately 1,400 m². The ground profile slopes relatively steeply towards Sinton Stream.

Adjoining land use is predominantly farmland with limited structure surrounding the site, other than Brigham Creek Road to the north and utility services within the roadway corridor.

A plan showing the existing underground services sourced from Auckland Council GeoMaps, before Udig and the detailed design drawings is presented in Figure 3.1 with a list of known public services in presented in Table 3.1.

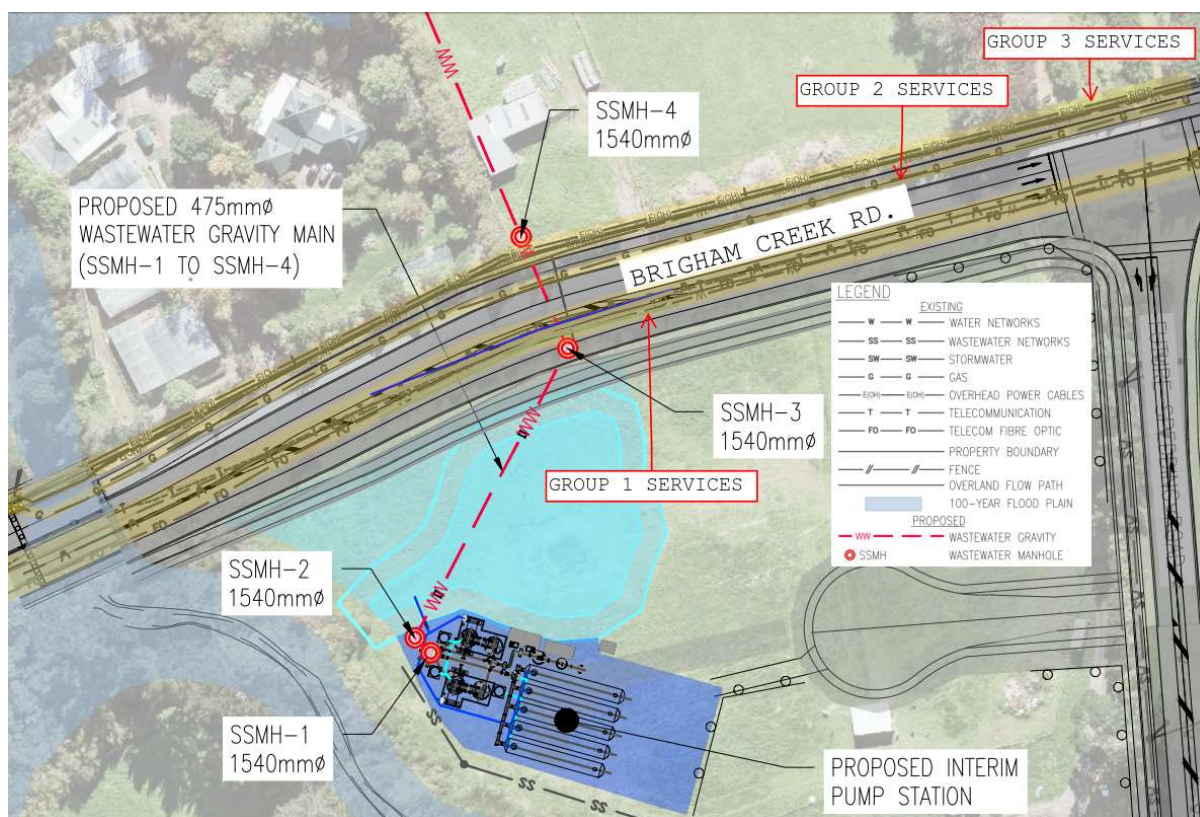


Figure 3.1: Location of existing underground services underneath Brigham Creek Road

Table 3.1: Summary of underground services underneath Brigham Creek Road

Underground service group	Services
Group 1	- Fibre Optic cable – Vodafone New Zealand Ltd, unknown material type - Water pipe local – Watercare Services Limited, 315 mm polyethylene - Telecommunications cable - Vocus Group NZ Limited, 32mmP (96F) - Telecommunication cable – Chorus New Zealand Limited, unknown material
Group 2	Gas line – Vector Limited, MP4 100 mm polyethylene
Group 3	Water pipe local – Watercare Services Limited, 150 mm asbestos-cement

3.2 Gravity Main

The alignment crosses private residential properties at the northern end of the alignment between Tamiro Road and Brigham Creek Road. This section is relatively flat and crosses paddocks and farmland with occasional minor gully features. A stormwater detention pond is located immediately to the west of Tamiro Road.

Predominant land use is agriculture and residential with the following properties having structures within 50 m of the proposed alignment:

- 18 Brigham Creek Road (residential dwelling and plastic greenhouses)
- 20-22 Brigham Creek Road (vacant/desert agricultural storage shed) to be removed
- 23-27 Brigham Creek Road (although it is understood that this building is vacant/deserted)30 Joseph McDonald Drive (residential dwelling)
- 40 Tamiro Road (residential dwelling)
- 42 Tamiro Road (residential dwelling)
- 44 Tamiro Road (residential dwelling)

3.3 Rising Main

The section of the rising main alignment from Brigham Creek Road to Spedding Road consists of gently rolling hills and is across farmland with a gully in the centre that forms Sinton Stream. The section of the alignment between Spedding Road and Trig Road extends along the road berm and is generally flat with a small hill at the Trig Road end.

Predominant land use is agriculture and residential with the following properties having structures within 50 m of the proposed alignment:

- 5 Spedding Road (residential dwelling)
- 9 Spedding Road (agriculture storage shed)
- 10 Spedding Road (residential dwelling)
- 11 Spedding Road (agriculture storage shed)
- 13 Spedding Road (residential dwelling)
- 14 Spedding Road (residential dwelling)
- 15-19 Spedding Road (residential dwelling and agricultural storage sheds)

4 Ground model

4.1 Ground conditions

4.1.1 Published geology

The published geological map of the area⁵ indicates that the site is underlain by undifferentiated alluvium of the Tauranga Group for the northern section of the alignment. Pumiceous deposits of the Tauranga Group occur near the surface for the remainder of the alignment and alternating sandstone and mudstone deposits of the East Coast Bays Formation (ECBF) is the basement geology for the area. Within the ECBF, layers of Albany Conglomerate have been identified.

The location of the alignment is shown in the context of the regional geology as presented on Figure 4.1 below.

⁵ Kermode, L.O. 1992. Geology of the Auckland Urban Area. 1:50,000. Institute of Geological & Nuclear Sciences.

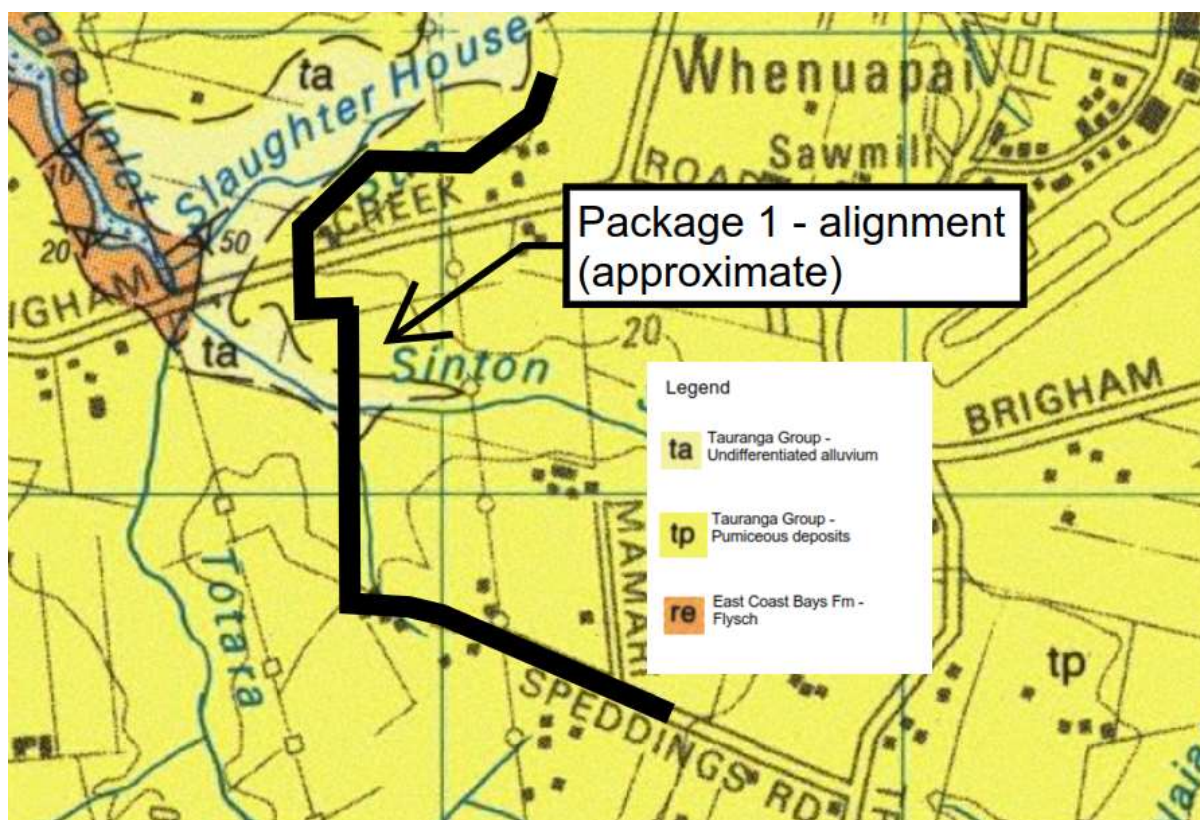


Figure 4.1: Published geology in relation to the project area

4.1.2 Site investigations

T+T carried out geotechnical site investigations and presented them in the March 2022 GFR. A summary of all relevant investigations undertaken for this study are presented below in Table 4.1 and shown on Figure 1 in Appendix A. The T+T GFR provides a comprehensive summary of the investigations and includes copies of borehole logs, CPTs and laboratory test data. Appendix B of this report includes copies of the borehole logs, CPTs and groundwater monitoring data for ease of reference.

Table 4.1: Summary of relevant site investigations

Investigation	Number
Rotary cored machine boreholes (BH)	BH05A, BH05B, BH06, BH07, BH08, BH110, BH111, BH111A, BH113, BH116, BH117
Cone Penetration Tests (CPT)	CPT02, CPT03, CPT04, CPT05, CPT06, CPT07, CPT08, CPT111, CPT112, CPT117, CPT121, CPT126, CPT128, CPT129, CPT131
Geotechnical hand augered boreholes with Scala penetrometer testing (HA)	HA03, HA04, HA05, HA06, HA06, HA07, HA07A, HA08, HA08A, HA107A, HA107B, HA108, HA109, HA110A, HA110B, HA111, HA112, HA113, HA114, HA115, HA116, HA117, HA119
Standpipe piezometer (PZ)	BH05A, BH05B, BH06, BH08, BH110, BH111, BH113, BH116, BH117

4.2 Groundwater

Existing geotechnical data indicates a variable depth to groundwater across the proposed pump station and pipeline alignments. Groundwater along the gravity main is assessed to generally flow to the north towards Slaughterhouse Stream, whereas groundwater at the location of the pump station generally flows west and south towards Sinton Stream.

Nine standpipe piezometers were installed across the project site in November and December 2020, and January 2021. Groundwater levels were measured with a handheld electronic dip meter and level loggers between November 2020 and December 2021.

The groundwater monitoring data indicates that the groundwater level varies between approximately 0.35 mbgl and 5.1 mbgl. Furthermore, the level logger data shows that the groundwater levels fall in the spring and summer and rise in the autumn and winter, with the shallowest groundwater levels occurring in the winter months. There appears to be a relationship between rainfall and groundwater levels where the groundwater is recharged by rainfall.

The GFR and the Whenuapai groundwater level monitoring memo⁶ presents the results from the level logger groundwater monitoring. The GIR provides an analysis of the groundwater data. These documents are provided in Appendix C.

4.3 Site Geological models

The site ground models for our effects assessment are based on the geomorphology, published geology, the previously completed project specific investigations and the GIR prepared by GHD.

The subsurface along the project area is interpreted to comprise the following geological units:

- i Topsoil; overlying
- ii Fill; overlying
- iii Tauranga Group; overlying
- iv Albany Conglomerate; overlying
- v East Coast Bays Formation.

Material descriptions can be generalised as follows:

Fill deposits comprising stiff to very stiff clay, generally of medium to high plasticity, and occasionally mixed topsoil organic matter.

Tauranga Group soils underlying the project area generally comprise silts and clays with varying amounts of sand. The stiffness of these cohesive soils range between firm to very stiff and they are generally highly plastic. Within the northern portion of the site, where the gravity main is located, the silts and clays are interbedded with thin layers (approximately 0.5 m thick) of stiff organic clay and loose to medium dense sand.

Albany Conglomerate rock was only identified in two separate areas along the conveyance. These locations were approximately CH200 along the rising main alignment and CH640 along the gravity main alignment. This unit underlies the Tauranga Group and is described as completely weathered to highly weathered sandstone or conglomerate. It was recovered as gravel material and is inferred to be weakly cemented.

⁶ Tonkin & Taylor Ltd (2022). *Memo – Whenuapai groundwater level monitoring*. From Troy McAlister to Reginald Barry. T+T ref. 1014985. Dated 10 January 2022

East Coast Bays Formation material consists of residual soils which are stiff to very stiff silts and medium dense sand. The residual soils are underlain by moderately to slightly weathered rock comprising siltstone and sandstone. Unweathered, weak interbedded siltstone and sandstone underlie these materials and have an average Uniaxial Compressive Strength of 910 kPa. The depth to top of unweathered rock varies along the project area.

4.3.1 Pump station

A representative ground model extending across the pump station/wet wells has been formed based upon the surrounding geotechnical investigations (BH110, BH111, BH117, CPT127, CPT129, HA113, HA116). Around the immediate vicinity of the pump station/ wet wells ECBF rock was encountered in the investigations at shallow depths (approximately -3.5 mRL) compared to investigation to the north of the pump station/wet wells which found ECBF rock at greater depths (approximately -9 mRL).

These varying depths to ECBF rock also mean a varying thickness of Tauranga Group Alluvium across the affected area. As the Tauranga Group Alluvium is likely to be the more compressible than other materials encountered on site, there is the potential for groundwater induced drawdown settlements to increase with distance back from the edge of the excavation due to the thickening deposits. The ground model has been established to ensure a conservative approach to the thickness of the Tauranga Group Alluvium under locations of interest, and hence estimation of groundwater drawdown settlement.

It has been assumed that the ECBF rock does not contribute to surface settlements due to the stiffness of this layer at lower strains. Groundwater drawdown induced settlements are considered to only occur within the Tauranga Group Alluvium, residual ECBF and Weathered ECBF rock.

A ground model representative of the location of the pump station/ wet wells summarised in Table 4.2 below has been adopted for the analysis.

Table 4.2: Ground model adopted for pump station excavations

	Geological unit	Pump station wet wells and storage tanks
Material thickness (m)	Engineered hardfill	0.4
	Tauranga Group silt and clay	2.1
	ECBF residual soils	1.9
	Weathered ECBF rock	3.5
	Unweathered ECBF rock	22.5 (confirmed within borehole)
Depth to static groundwater level (mbgl)		2 (7.75 mRL)
Depth to elevated groundwater level (mbgl)		0.5 (9.25 mRL)

4.3.2 Gravity Main

Sections for the gravity main have been selected based on, ground conditions, depth of excavation and the proximity of surrounding structures. For the gravity main, the ground models have been separated into the following regions:

- Brigham Creek Road Crossing due to the existing road and utility services. This ground model is based on BH117, CPT128, CPT129, and HA116.
- SMH11 due to its deep excavation (deepest excavation that is north of Brigham Creek Road), and proximity to existing structures. This ground model is based on BH116, CPT117, HA110A, HA110B, and HA111.

A summary of the adopted geological profiles are provided in Table 4.3 and Table 4.4.

Table 4.3: Ground model adopted for gravity main SSMH11

	Geological unit	Gravity main – SSMH11
Material thickness (m)	Non-engineered fill	2.45
	Tauranga Group silt and clay	13.4
	Albany Conglomerate	4.85 (confirmed)
Depth to static groundwater level (mbgl) () Groundwater elevation		1.73 (12.5 mRL)
Depth to elevated groundwater level (mbgl) () Groundwater elevation		0.5 (13.73 mRL)

Table 4.4: Ground model adopted for the driver and reception shafts excavations at the Brigham Creek Road crossing

	Geological unit	Brigham Creek Road crossing – driver and receiver shafts
Material thickness (m)	Tauranga Group silt and clay	2.15
	Tauranga Group organic clay	3.4
	Tauranga Group silt and clay	3.0
	Tauranga Group sand	1.05
	Tauranga Group silt and clay	0.65
	Tauranga Group sand	1.4
	Tauranga Group silt and clay	2.35
Depth to static groundwater level (mbgl)		2 (8.0 mRL)
Depth to elevated groundwater level (mbgl)		0.5 (9.5 mRL)

4.4 Geotechnical parameters

4.4.1 Retention design

Based on the results of geotechnical investigations and testing in this area, and past experience with similar ground conditions, the geotechnical analysis parameters presented in Table 4.5 below are considered appropriate for our assessment of settlement effects.

Table 4.5: Geotechnical analysis parameters for retention analysis

Geological unit	Bulk unit weight, γ (kN/m ³)	Effective cohesion, c' (kPa)	Angle of internal friction, ϕ' (°)	Undrained shear strength, S_u (kPa)	Poisson's ratio	Elastic Modulus, E (MPa)	At rest earth pressure, K_0	Active earth pressure, K_a	Passive earth pressure, K_p
Engineered hardfill	20	0	40	-	0.3	50	0.357	0.189	7.061
Non-engineered fill (cohesive)	18	0	28	50	0.3	10	0.530	0.320	3.485
Tauranga Group (clay and silt)	17	1	28	50	0.35	10	0.531	0.320	3.485
Tauranga Group (organics)	16	0	28	50	0.25	5	0.530	0.320	3.485
Tauranga Group (sands)	18	0	30	-	0.25	12	0.500	0.294	3.878
ECBF residual soil	18	5	30	60	0.35	20	0.500	0.294	3.878
ECBF weathered rock	21	25	35	1000	0.3	85	0.426	0.237	5.153
ECBF unweathered rock	22	100	40	-	0.25	400	0.357	0.189	7.061

4.4.2 Soil permeability

Subsoil hydraulic conductivity (“permeability”) has been assessed for groundwater analysis. The parameter is based on material descriptions, correlations with CPT results, insitu permeability testing and experience with similar materials in the Auckland area. For the purposes of the assessment of groundwater drawdown and settlements affects for the project, generalised ground models have been adopted. The permeability parameters used in this assessment are presented in Table 4.6.

Table 4.6: Analysis permeabilities

Geological unit	Horizontal permeabilities k_h (m/s)	KV/K_h	Volumetric water content
Tauranga Group	8×10^{-7} to 9×10^{-8}	0.1	0.4
Residual ECBF	1×10^{-6} to 1×10^{-8}	0.1	0.5
Weathered ECBF	1×10^{-7} to 1×10^{-8}	0.1	0.1
ECBF Rock	1×10^{-6} to 5×10^{-8}	0.1	0.1
Albany conglomerate	4×10^{-5} to 6×10^{-6}	0.1	0.1

4.4.3 Soil consolidation

The compressibility of the various soil units has been assessed from published correlations with soil strength, laboratory testing, CPT traces and experience with similar materials. Simplified ground

models have been adopted for assessing the upper bound consolidation effects for the project. Parameters used in this assessment for various geological units is presented in Table 4.7.

Table 4.7: Consolidation analysis parameters

Geological unit	M_v (m ² /kN)
Tauranga Group	1×10^{-4} to 4×10^{-5}
Residual ECBF	5×10^{-5} to 7×10^{-5}
Weathered ECBF	1×10^{-5} to 2×10^{-5}
ECBF Rock	5×10^{-6} to 8×10^{-6}
Albany conglomerate	1×10^{-4} to 2×10^{-5}

5 Geotechnical effects assessment methodology

5.1 General overview

The geotechnical effects likely associated with the works assessed in this report are:

- Mechanical induced surface ground settlement due to bulk excavations at the pump station, shaft excavations for the Brigham Creek Road trenchless crossing, and chamber, manhole, and pipeline trench excavations for the gravity and rising main.
- Ground surface settlement arising from the temporary groundwater drawdown associated with excavations below the lowest recorded groundwater table.

The proposed construction methodologies for the project are split between open excavation (pump station), trenched excavation, pipe hammer, and directional drilling. Specific comments on each of these methodologies is provided in the Section 2 and likely effects in Section 6. These construction methods are well understood and are frequently used across Auckland and New Zealand to construct pipelines for wastewater, stormwater, and water supply networks.

Potential adverse impacts of surface settlement are rarely associated with vertical settlement alone, but rather with tilting or angular distortion (differential settlement). Guidance on angular distortion limits is provided in Section 5.3.

5.2 Settlement estimation method

5.2.1 Mechanical settlement due to excavation

Mechanical settlement associated with retaining wall deflections excavations has been estimated using the computer software WALLAP⁷. Open cut excavations supported by sheet piles and lateral bracing such as anchors have been adopted for analyses as this retention system was proposed in the contractors construction methodology (relevant information summarised in sections below). The CIRIA 760 guide⁹ was used to assess the mechanical settlement (vertical ground settlement) behind the retaining wall excavation as a result of the wall deflections. A ratio between horizontal wall deflection and vertical ground settlement of 0.5 has been adopted.

⁷ Geosolve (2020). *WALLAP Retaining Wall Analysis Program*.

⁹ CIRIA 760 (2017). *Guidance on embedded retaining wall design*.

The sections chosen for mechanical settlement analyses are located within the vicinity of sensitive assets, such as dwellings and existing underground surfaces. Each section adopted a 5 m wide by 10 m long construction surcharge of 15 kPa behind the retaining wall. This surcharge allowed for construction traffic, stockpiling, and materials storage.

5.2.1.1 Structural properties of sheet pile

No structural details on the sheet piles have been provided at the time of this assessment. For the purpose of this assessment and report, and subject to contractor design, the following sheet pile retaining wall parameter assumptions have been adopted for our analysis:

- Sheet pile type adopted is STU-180010, with an effective moment of inertia (I_{eff}) of $3.24 \times 10^{-4} \text{ m}^4/\text{m}$ and Elastic Modulus of 200 GPa.
- Prop type is Freyssinet 50011, with a cross-sectional area of $1,257 \text{ mm}^2$, nominal diameter of 40 mm and an Elastic Modulus of 210 GPa.
- The effective moment of inertia is assumed to be 100% of the gross value under construction condition for the sheet piles and props.
- An installation reduction factor has not been considered.

5.2.1.2 Assumptions for analysis

The following assumptions have been made as part of our assessment:

- The feasibility of embedding sheet piles into ECBF weathered and unweathered rock has not been considered. From experience, the constructability of driving sheet piles greater than 0.5 m depth into ECBF rock (SPT N greater than 50) may be difficult. However, for the purposes of this assessment the effects of sheet pile retention for excavations have been analysed only.
- Trench excavations and any void between the permanent structure and ground will be backfilled with engineered hardfill back to existing ground surface. Undercut of 0.5 m has been assumed, unless specified in the design drawings^{12, 13, 14}.
- The retaining structures and soil are expected to completely relax through the duration of the works.
- A seismic case was not analysed as the ULS seismic case is not expected to be critical for the short return period of $1/250$ ¹⁵ (based on Importance Level 3 structure, design life less than 6-month period).
- Topsoil is removed and replaced with engineered hardfill prior to any excavation activity at the location of the pump station. These earthworks form part of the “Contractor Area Hub” which will be undertaken prior to construction.

¹⁰ Sheet Pile NZ Ltd. *SP3W and STU1800*. <https://sheetpile.co.nz/sp3w-or-stu1800/>

¹¹ Solentanche Freyssinet (2014). *Anchoring systems for geotechnical engineering*.

¹² WSP and GHD (2022). *Watercare Services Limited. Whenuapai-Redhills Wastewater Servicing Package 1. Wastewater Pump Station (DPISH). Detailed Design Issue*. Project no. 3-AWD32.00. Dated 14 January 2022.

¹³ WSP and GHD (2021). *Watercare Services Limited. Whenuapai-Redhills Wastewater Servicing. Brigham Creek Road, Whenuapai. Interim slaughterhouse PS – Wastewater Rising Main*. Dated July 2022.

¹⁴ WSP and GHD (2021). *Watercare Services Limited. Whenuapai-Redhills Wastewater Servicing. Brigham Creek Road, Whenuapai. Interim slaughterhouse PS – Wastewater Gravity Pipe*. Dated 15 December 2021.

¹⁵ NZS1170.0 (2002). *Structural design actions. Part 0: General principles*.

- The deadman anchor is assumed to be rigid and fixed (i.e. will not deform or displace). Depending on the final propping configuration and loads, a cast in-situ beam in lieu of the deadman sheet pile may be required to limit deformations.

5.2.1.3 Construction sequence

The adopted general construction sequence in the WALLAP model is summarised below:

- 1 Install steel sheet pile to design depth.
- 2 For open cut excavations, model the backslope (3H:1V) on the left-hand side (LHS) of the analysis as a triangular surcharge with an equivalent soil type of the backslope material.
- 3 Reset wall displacements to zero.
- 4 Apply a construction surcharge of 15 kPa behind the retaining wall (i.e. LHS).
- 5 Change the groundwater profile on the right-hand side (RHS) of the analysis so it is at least 250 mm below the proposed excavation level.
- 6 Excavate on the RHS to a ground level at least 1 m below proposed prop installation level.
- 7 Install steel prop (row 1) to represent a deadman anchor at appropriate spacing. The spacing varies for different excavations.
- 8 Repeat stages 5 to 7 if another row of props (row 2) is required.
- 9 Fill RHS with at least 0.5 m thick of engineered hardfill, unless the detailed design drawings indicate site concrete.
- 10 Increase the groundwater level for a high groundwater analysis to the shallowest elevations indicated by the groundwater monitoring data or to ground surface level.

5.2.2 Groundwater drawdown and consolidation settlement due to excavations

The effect of the groundwater drawdown and consolidation effects from the excavations works has been modelled through a series of 2-dimensional (2D) Seep/W models within GeoStudio software or hand calculations as presented in CIRIA R113. Our results are presented in Appendix D.

The methodology adopted (2D Seep/W model or hand calculations) is based upon the depth of excavation below the groundwater level, proximity of neighbouring structures/ infrastructure and construction methodology.

The trench excavations for the gravity main were assumed to have a typical over excavation of 0.5 m below the proposed excavation level. Trench excavations were modelled using hand calculations due to their typical shallow depth. Where trench excavations are deeper, there was not assessed to be a need for a more detailed assessment due to the low density of surrounding structures/ infrastructure that would be affected by the works and short duration that trench is expected to open (generally expected to be less than 10 days).

Groundwater drawdown was assessed with seepage mitigation measures for the retained excavations (sheet pile walls) and an open base during construction for both the shafts and pump station excavations. The sheet pile walls have been modelled with sealed clutches. Modelling guidance on equivalent permeabilities and thicknesses of steel sheet piles was taken from ArcelorMittal¹⁶. The base of the shafts and pump station are assumed to be sealed with a minimum 300 mm thick layer of concrete (50 mm blinding concrete and 250 mm thick concrete foundation slab).

¹⁶ ArcelorMittal (2014): Impervious steel sheet pile walls – Design and practical approach

Groundwater drawdown levels in this assessment have been based on observed groundwater levels from the groundwater monitoring programme. Actual groundwater drawdown levels and associated consolidation settlements should be verified again prior to construction once groundwater monitoring and detailed design has been completed. Note that following high rainfall events, groundwater levels may rise to close to or at the ground surface level. In this instance, most of the alignment would have the potential to lower groundwater levels by 2 m or more. However, from a settlement effects perspective, the controlling factor is the level that groundwater is lowered below the historical low groundwater level, rather than the absolute groundwater lowering. The assessments of settlement effects are therefore based on the lowest observed groundwater level.

Ground settlement resulting from groundwater drawdown occurs over a period of time. The greatest expected settlement due to groundwater drawdown at shafts and the pump station is considered to occur once excavations are completed prior to the sealing of the base. It is expected that it may take up to one month and three months to excavate and seal the base of the shafts and pump station, respectively. Our seepage analysis has conservatively adopted a 6-month dewatering programme in the event that dewatering is required for a longer period of time.

The majority of the settlement is likely to occur adjacent to the excavation and the effects to diminish away from the excavation. The extent of settlement influences is determined based on a combination of the SEEP/W analysis and comparing the horizontal model extents to simplified hand calculations presented in CIRIA R113.

Once the base of the shaft and pump station excavation are sealed, groundwater levels are expected to recover to near observed baseline levels. Once the wastewater network (package 1) is completed, groundwater levels are expected to return to baseline levels across the alignment.

5.2.3 Settlement due to directional drilling (Tamiro Road Stormwater Embankment)

The method of New and O'Reilly (1982) has been used to estimate the maximum magnitude and lateral extent of mechanically induced ground settlement due to construction of the proposed wastewater pipeline and pump station structures.

Tunnelling publications comprising experience from thousands of projects suggest that volume loss varies from zero to 4% depending partly on the ground conditions but primarily from the specific capabilities of the trenchless construction method being used and contractor performance. From experience the expected volume loss within the Auckland Region is approximately 1% or less. For the proposed trenchless pipeline alignment, a conservative estimate of 2.5% volume loss has been adopted for the purposes of assessing geotechnical effects for Resource Consent. Settlement associated with higher volume loss can be reduced with good construction techniques, and mitigation measures that are dependent on the contractor.

The pipeline alignment is expected to be excavated within the Tauranga Group soils SSMH11 to the Whenuapai Village pump station. For estimating settlements, it is assumed the pipeline is in cohesive soils.

Trenchless construction methods utilise the use of pressure balance or drillings muds to actively support the front face and tunnel until the tunnel opening is lined with the constructed wastewater pipe. These methods also reduce groundwater seepage into the tunnel opening limiting the potential of groundwater drawdown. As such, groundwater drawdown and related associated settlement during trenchless construction works is not expected to be significant, and a detailed assessment of groundwater drawdown is not considered necessary.

5.2.4 Settlement due to pipe hammering (Brigham Creek Road Crossing)

Settlement associated with pipe hammering is covered in our assessment of shaft excavations in Section 6.3.

5.2.5 Combined consolidation and mechanical settlement effects

The total settlement that occurs at the ground surface is a combination of consolidation settlement induced by groundwater drawdown and mechanically induced settlement. The mechanically induced settlement is expected to occur quickly (within days and weeks), compared to the consolidation settlement (within weeks to months) resulting from groundwater drawdown; however, the combination of effects has considered the long term, full occurrence of both types of settlement over a construction period of two years. The method adopted to combine the settlements is the addition of the two calculated amounts at a set horizontal distance and is therefore towards the upper bound of credible settlements. We have undertaken our assessment until settlements have reduce to 5 mm.

5.3 Settlement tolerances and zone of influence

5.3.1 General

The project infrastructure construction has the potential to induce vertical and lateral ground movements that can affect the condition of structures and infrastructure within the zone of influence. For purpose of this assessment, we have considered the zone of influence as the area where total ground settlements associated with the project may be equal to or greater than 5 mm. We have not undertaken an assessment where total ground settlements reduce to less than 5 mm as this level of ground deformation is considered negligible within the context of the receiving environment and within the natural seasonal fluctuation of ground movement.

Settlement guidelines are presented below for the potentially affected structures.

5.3.2 Buildings

The proposed works will be constructed near existing structures, principally private dwellings. In general, a building structure's tolerance to total and differential settlement depends upon the materials used in construction as well as type of foundation system adopted (shallow versus piled), the quality of the structure, and the existing condition of the structure.

The limiting values of total settlement and angular distortion along with damage classification as presented in CIRIA PR30 1996 have been used as guidance for assessment of potential effects on buildings. In addition, the New Zealand Building Code states that designers should limit the probable maximum differential settlement of a building to 1V:240H (25 mm over a 6 m horizontal distance) under serviceability limit state loading, or total settlement to 50 mm unless the structure is specifically designed to resist damage under a greater settlement. While the NZ Building Code applies to these structures, the residential house dwellings are likely to have been designed using acceptable solutions outlined in NZS 3604, which is appropriate for ground with movements less than 25 mm. The ground deformation limits outlined in NZS 3604 are approximately equivalent to Risk Category 2 in CIRIA PR30.

A site walkover was undertaken to assess the existing structures along the proposed gravity main and rising main alignments and at the pump station site. In general, buildings along the proposed alignment comprises one and two storey timber framed homes, and are likely supported on shallow timber piles, pad footings or strip footings. Cladding was observed to typically comprise timber

weather boards or metal sheet cladding. We assess these buildings are likely to have some tolerance to ground settlement.

It is important to note that the values presented in the New Zealand Building Code are total amounts of movement over the life of a building. The buildings in the vicinity of the project are existing, with unknown histories; and therefore, may have already been subjected to some movement. To account for historical movement, buildings that are subjected to less than 5 mm vertical settlement and differential settlement slopes no greater than 1:1000, have been assessed to have a negligible risk to damage and would not need to be further assessed.

For the purposes of this assessment, the settlement criteria in Table 5.1 (which is generally based on the Burland (1995), and Mair et al (1996) classification) has been adopted for our assessment:

Table 5.1: Settlement criteria for properties and buildings

Risk Category	Maximum settlement of building (mm)	Maximum differential settlement	Description of risk	General Category
0	-	-	Negligible: superficial damage unlikely	Aesthetic Damage
1	<10	< 1 in 500	Very Slight: Fine cracks easily treated during normal redecoration. Perhaps isolated slight fracture in building. Cracks in exterior visible upon close inspection. Typical crack widths up to 1mm.	
2	10 to 50	1 in 500 to 1 in 200	Slight: Cracks easily filled. Redecoration probably required. Several slight fractures inside building. Exterior cracks visible, some repainting may be required for weather-tightness. Doors and windows may stick slightly. Typical crack widths up to 5 mm.	
3	50-75	1 in 200 to 1 in 50	Moderate: Cracks may require cutting out and patching. Recurrent cracks can be masked by suitable linings. Brick pointing and possible replacement of a small amount of exterior brickwork may be required. Doors and windows sticking. Utility services may be interrupted. Weather tightness often impaired. Typical crack widths are 5 to 15 mm or several greater than 3 mm	Serviceability Damage
4	> 75	1 in 200 to 1 in 50	Severe: Extensive repair involving removal and replacement of walls especially over door and windows required. Window and door frames distorted. Floor slopes noticeably. Walls lean or bulge noticeably. Some loss of bearing in beams. Utility services disrupted. Typical crack widths are 15 to 25 mm but also depend on the number of cracks.	

Risk Category	Maximum settlement of building (mm)	Maximum differential settlement	Description of risk	General Category
5	> 75	> 1 in 50	Major repair required involving partial or complete reconstruction. Beams lose bearing walls lean badly and required shoring. Windows broken by distortion. Danger of instability. Typical crack widths are greater than 25 mm but depend on the number of cracks	Structural Damage

5.3.3 Underground services

Published literature¹⁷ indicates that the maximum differential settlement for cast iron pipes and brittle services with a diameter of 200 mm or greater is in the order of 1:250. Most of the major services near the proposed works (summarised in Table 3.1) appear to be more flexible materials such as concrete pipe, polyethylene pipes, electrical cables etc. Services running perpendicular to the excavation works are considered to be at the highest risk of damage. In general, where a service is parallel to the excavation works, it may experience horizontal displacement associated with ground loss at the excavation face, as well as similar total settlement but with a gentler settlement slope, i.e. differential settlement.

Settlement tolerance of a service will be dependent on the condition of the current asset and its tolerance to deformation. An allowable differential ground settlement of 1:500 has been conservatively adopted for the services along the proposed excavation works to assess the potential for adverse effects.

6 Geotechnical and groundwater effects assessment results

6.1 General

This section presents the general range of geotechnical effects that we have estimated that could occur from the project's construction activities for the:

- Pump station,
- Gravity main (Brigham Crossing, pipeline trenching and manhole construction);
- Sinton Stream culvert sheets piles, and
- Rising main chambers.

As discussed previously, the rising main pipeline works other than the rising main chambers are understood to meet the permitted activity criteria (refer AEE) and as such have not been assessed in this section.

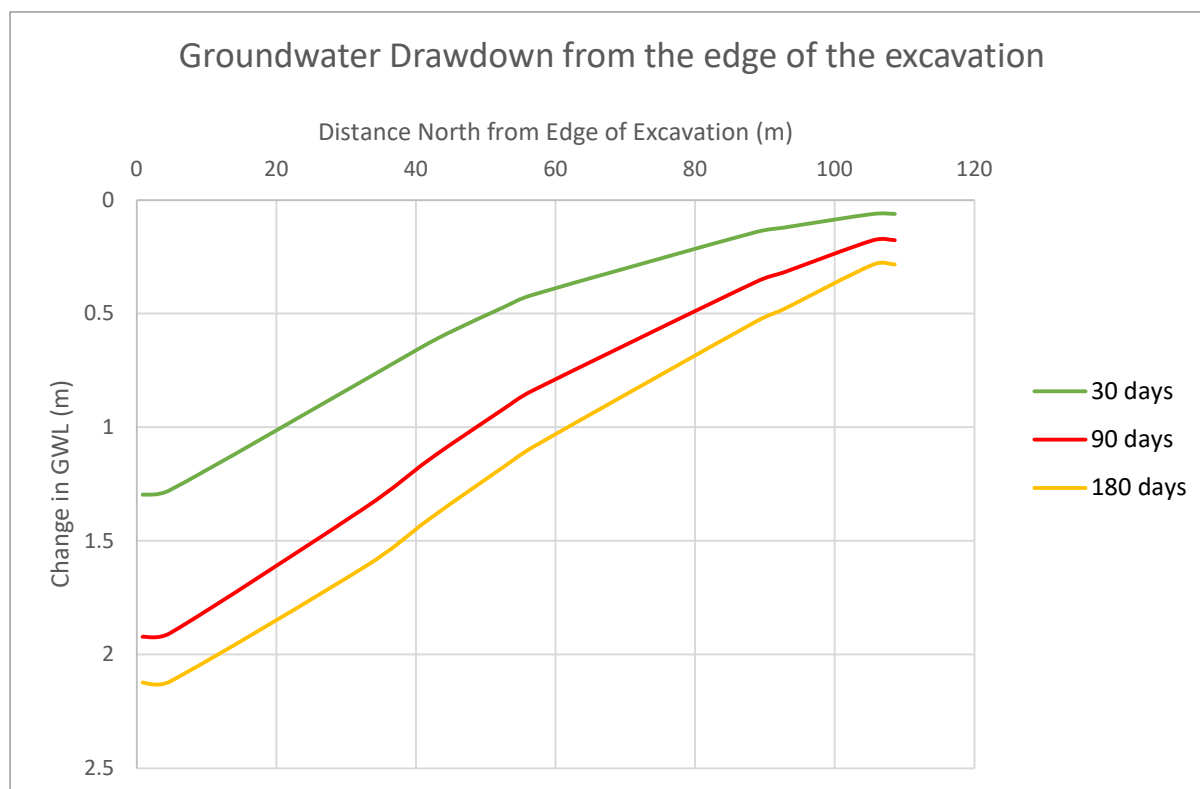
The estimated total ground settlements (where assessed) are presented as settlement contours on the project site plan presented in Appendix A.

¹⁷ O'Rourke, T D, and C H Trautmann. 1982. Buried pipeline response to tunnel ground movements. In Europipe 82 Conf., Basel, Switzerland, paper 1.

6.2 Pump station

6.2.1 Groundwater drawdown

The following section presents the assessed groundwater drawdown behind the sheet pile retention system extending back into the wetland area. Results of our analysis are presented for a dewatering period of 30, 60 and 180 days. No recharge has been allowed for using groundwater that is pumped out of the excavation.



6.2.2 Groundwater drawdown induced settlements

We have undertaken an assessment for the pump station and storage tank excavations assuming a retention system that provides seepage cut off (i.e. sheet piles) and that will be required to support the face of the excavation and limit groundwater drawdown to within limits expected to not cause damage to surrounding structures, underground services and Brigham Creek Road. Retention providing seepage cut-off should be embedded sufficiently deep (preliminary assessments indicate 2.5 m) below the base of the excavation to restrict groundwater seepage and drawdown.

A summary of the results of the groundwater drawdown assessment is presented in Appendix D.

Table 6.1: Groundwater drawdown assessment summary results – pump station

Excavation details	Excavation support type	Maximum groundwater drawdown behind retained cut face (m)	Maximum groundwater drawdown settlement behind retained cut face (mm)	Approximate maximum extent of groundwater drawdown (m) ¹
20 m wide with an excavation level of 0.5 mRL with an over excavation of 0.6 m from the tank invert level.	Braced sheet pile	2.2 (180 days)	10 mm	100 m

Notes:

1. Approximate extent where groundwater drawdown is calculated to be less than 0.5 m.
2. The results from the pump station are intended to be used for both the pump station and wet well excavation. The pump station has both a bigger width and depth of excavation.

6.2.3 Mechanically induced settlement due to excavation

The following section presents the assessed mechanically induced settlements at the proposed pump station open excavations. Our analysis has assessed the performance of laterally braced retention systems such as sheet piles with deadman anchors. Table 6.2 presents the assessed settlements for the pump station excavations.

Table 6.2: Maximum estimated vertical ground settlement due to mechanical settlement at the proposed pump station

Location	Excavation depth (m)	Maximum estimated vertical ground settlement due to excavation deformation (mm)
Wet wells ¹	9.5	9
Emergency storage tanks ²	6.4	6

Notes:

1. For the wet wells, lateral bracing has been used in our assessment
2. For the storage tanks, lateral bracing has been used in our assessment

The WALLAP outputs are provided in Appendix E.

6.2.4 Combined mechanical and groundwater drawdown settlements

The combined effect from both mechanical induced settlement and groundwater drawdown induced settlement for the pump station is presented in Table 6.3 below and graphically in Figure 6.1. The settlement does not decrease at a steady rate with distance from the excavation due to the increasing thickness of Tauranga Group Alluvium (refer to 4.3.1) to the north and east of the pump station.

Table 6.3 Maximum estimated vertical ground settlement due to excavation at the proposed pump station

Location	Excavation depth (m)	Maximum total estimated vertical ground settlement (mm)
Wet wells	9.5	13 (180 days)
Emergency storage tanks	6.4	12 (180 days)

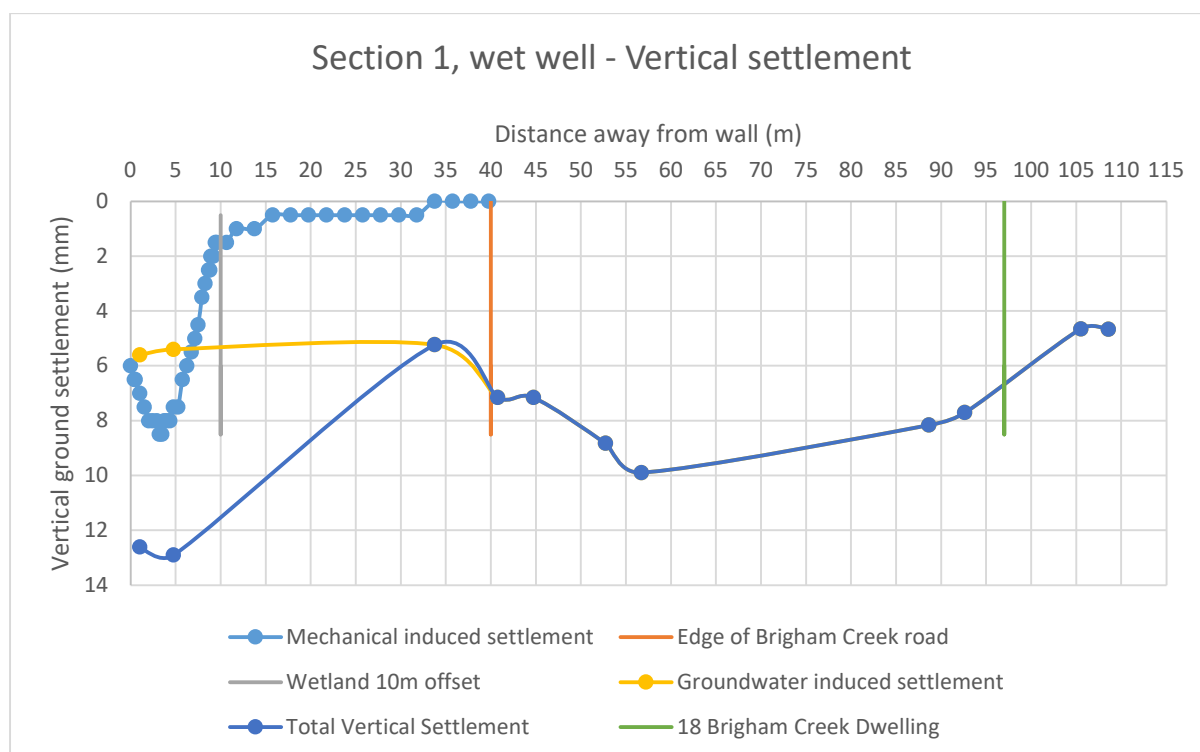


Figure 6.1: Total vertical settlement at wet well.

6.3 Gravity Main

6.3.1 Brigham Creek Road trenchless crossing

6.3.1.1 Groundwater drawdown induced settlements

We have undertaken an assessment for the Brigham Creek Road crossing adopting a shaft excavation retention system that provides seepage cut off (i.e. sheet piles) to limit groundwater drawdown to within limits expected to not cause damage to surrounding structures. Retention providing seepage cut-off should be embedded sufficiently deep below the base of the excavation to restrict groundwater seepage and drawdown.

A summary of the results of the groundwater drawdown assessment is presented in Table 6.4.

Table 6.4: Groundwater drawdown assessment summary results – Brigham Creek Road crossing shafts

Shaft	Excavation details	Excavation support type	Maximum groundwater drawdown behind retained cut face (m)	Maximum groundwater drawdown settlement behind retained cut face (mm)	Approximate maximum extent of groundwater drawdown (m) ¹
Drive shaft (SSMH-3)	21 m wide with an excavation level of 5.5 mRL including an over excavation of 5.5 mRL.	8.5 m long braced sheet piles with min 4 m embedment	1.0	7	90
Reception shaft (SSMH-4)	10 m wide with an excavation level of 6.0 mRL including an over excavation of 1.0 m.	8.0 m long braced sheet piles with min 4 m embedment	0.7	8	50

Notes: 1. Approximate extent where groundwater drawdown is calculated to be less than 0.5 m.

6.3.1.2 Mechanically induced settlement due to excavation

Table 6.5 presents the maximum expected mechanically induced settlements at the proposed open excavations for the driver and receiver shafts for the Brigham Creek Road crossing. Our analysis has assessed the performance of laterally braced retention systems such as sheet piles with deadman anchors. Table 6.5 presents the expected settlements for the Brigham Creek Road shaft excavations.

Table 6.5 Maximum estimated vertical ground settlement due to mechanical settlement

Location	Excavation depth (m)	Maximum estimated vertical ground settlement due to excavation deformation (mm)
Driver shaft ¹	4.5	19.5
Receiver shaft ²	4.0	16.5

Notes:

1. For the driver shaft, lateral bracing has been used in our assessment
2. For the receiver shaft, lateral bracing has been used in our assessment

The WALLAP outputs are provided in Appendix E.

6.3.1.3 Combined mechanical and groundwater drawdown settlements

The combined effect from both mechanical induced settlement and groundwater drawdown induced settlement for the Brigham Creek Road crossing is presented in Table 6.6 below and graphically in Figure 6.2 and Figure 6.3.

Table 6.6 Maximum estimated vertical ground settlement due to excavation at the proposed Brigham Creek Road Crossing

Location	Excavation depth (m)	Maximum total estimated vertical ground settlement (mm)
Driver shaft	4.5	23 (180 days)
Receiver shaft	4.0	23 (180 days)

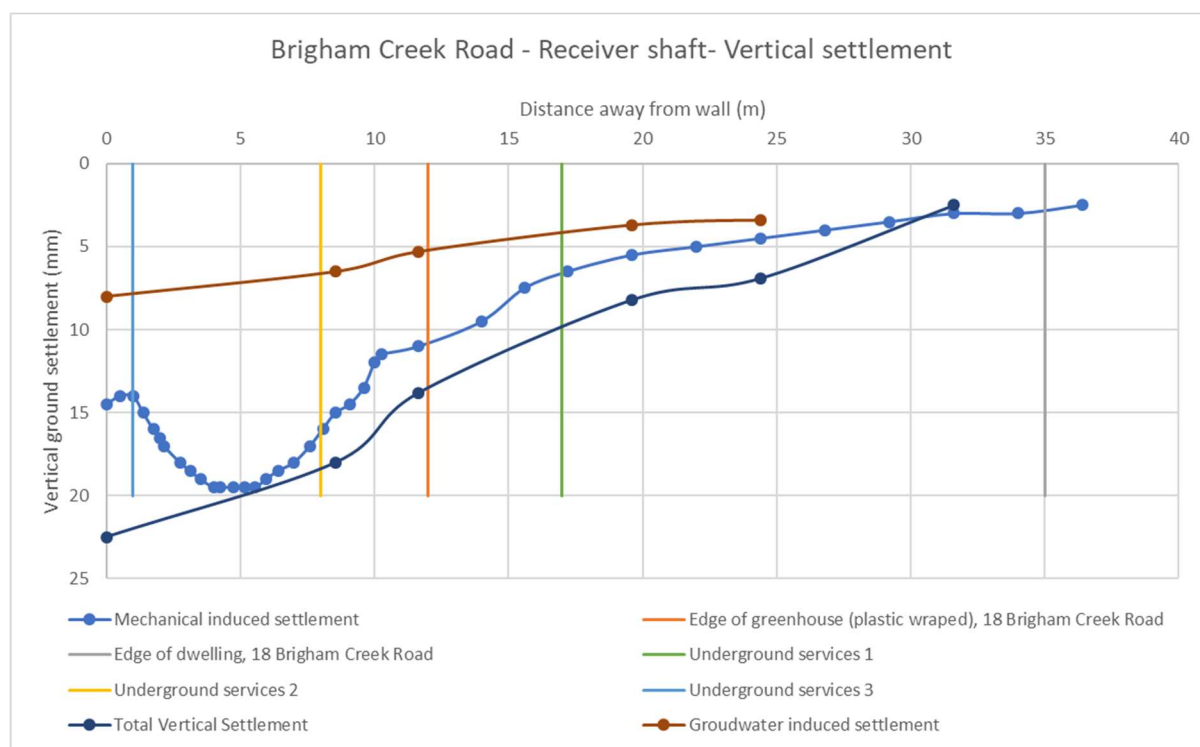


Figure 6.2: Total vertical settlement for the Brigham Creek Road receiver shaft

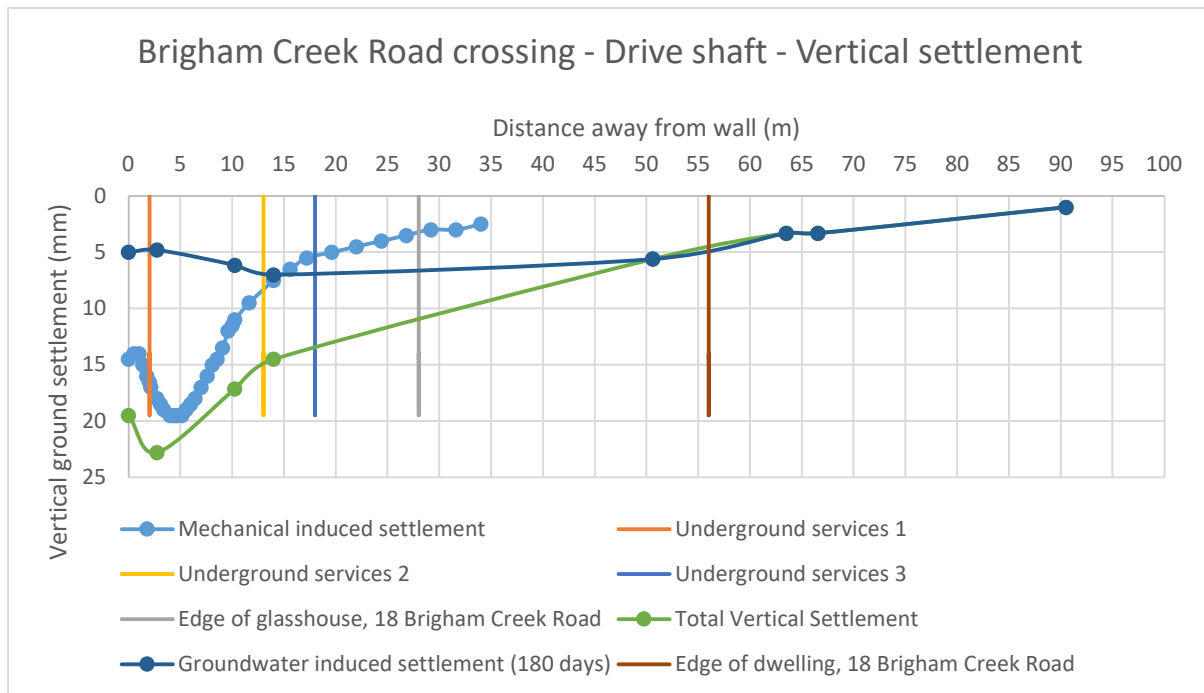


Figure 6.3: Total vertical settlement for the Brigham Creek Road drive shaft

6.3.2 Manhole SSMH11

We have undertaken groundwater drawdown and ground surface settlement analysis for SSMH11. The excavation at SSMH11 is expected to result in the greatest groundwater drawdown and ground settlement effect along the gravity main to the north of Brigham Creek Road due its depth of construction and surrounding ground conditions. We assess that the results from SSMH11 can be conservatively applied to SSMH5 through to SSMH10.

6.3.2.1 Groundwater drawdown induced settlements

A summary of the results of the groundwater drawdown assessment for SSMH11 is presented in Table 6.7.

Table 6.7: Groundwater drawdown assessment summary results – trenched excavations

Location	Excavation details	Excavation support type	Maximum groundwater drawdown behind retained cut face (m)	Maximum groundwater drawdown settlement behind retained cut face (mm)	Radius of influence (m) ¹
Gravity main – SSMH11 - 40, 42 and 44 Tamiro Road	5.1 m bgl (2.5 m below groundwater level)	Sheet pile with 1 m embedment	0.7	11	20

Notes: 1. Radius of influence assessed using CIRIA R113

6.3.2.2 Mechanically induced settlement due to excavation

The maximum expected mechanically induced settlements assessed at SSMH11 are presented in Table 6.8, respectively.

Table 6.8: Estimates of expected mechanically induced settlements along the proposed gravity main

Location	Excavation depth from existing ground level (m)	Maximum estimated vertical ground settlement due to excavation deformation (mm)
Gravity main – SSMH11 - 40, 42, 44 and 46 Tamiro Road	5.1	18 (steady state condition)

The WALLAP outputs are provided in Appendix E.

6.3.2.3 Combined mechanical and groundwater drawdown settlements

The combined effect from both mechanical induced settlement and groundwater drawdown induced settlement for SSMH11 is presented in Table 6.9 below.

Table 6.9 Maximum estimated vertical ground settlement due to excavation at SSMH11

Location	Maximum estimated vertical ground settlement due to excavation deformation (mm) [ZOI]	Maximum estimated vertical ground settlement due to groundwater drawdown (mm) [ZOI]	Total estimated vertical ground settlement (mm) [ZOI]
Gravity main – SSMH11 - 40, 42 and 44 Tamiro Road	18 [10]	7 [20]	25 [20]

6.3.3 Construction settlement due to micro-tunnelling (SSMH11 to SSMH12)

The pipeline will be excavated within Tauranga Group, so it can be expected that the annulus will close, either partially or entirely. Closure of the annulus reduces the effectiveness of attempting to fill the annulus and results in ground settlement. The potential ability to achieve a fully or partially grouted annulus is considered to be low to moderate, depending on the size of the annulus and the ability of the bentonite to maintain the annulus prior to being replaced by grout. For the purpose of an effects assessment, it is prudent to assume near-complete annulus closure. Adopting a 0.4 m external diameter pipe with minimum 1 m ground cover, the assessed mechanically induced settlement for 4% volume loss is less than 5 mm.

6.4 Rising Main

6.4.1 Sinton Stream sheet piling for culvert

To enable the construction of the Sinton Stream culvert, sheet piles shall be driven into the existing bank to provide slope stability to enable construction. The depth of the sheet piles have not been confirmed but are expected to be up to 5m deep. The sheet piles are expected to intersect groundwater and result in localised diversion for the period that the sheet piles are required (up to

12 weeks). Given the sloping terrain of the bank, the nature of the ground conditions (silt and sand rich mixtures), and the leaky nature of the sheet piles, we assess that damming of groundwater behind the sheets shall be localised in nature. Furthermore, any water dammed behind the sheets is ultimately expected to flow around the sheets into Sinton Stream and thus is not expected to reduce base flows in Sinton Stream.

6.4.2 Chamber construction

An air valve chamber and connection chamber will be constructed as part of the rising main. The chambers will require excavations approximately 3.3 m and 2.4 m deep respectively. The excavations are expected to take up to 4 weeks to construct and backfill.

The depth of excavation for both chambers is above the lowest groundwater level recorded (summary provided in Table 6.10). As such, groundwater drawdown effects are assessed to not be consequential upon ground settlement or groundwater users.

Mechanical settlement effects are assessed to be limited to a horizontal zone of influence equal to the excavation depth (3.3 m or less). As there are no structures within the zone of influence, a detailed assessment has not been undertaken.

Table 6.10: Summary of groundwater low levels near proposed chamber excavations

Chamber	Nearest monitoring well	Lowest groundwater level required (m bgl)	Approximate excavate depth for chamber (m)
Air valve chamber	BH05B	4.6	3.3
Connection chamber	BH06	3.8	3.4

6.5 Assessment effects on buildings

Total and differential settlements have been assessed for existing buildings along the proposed gravity main. Table 6.11 presents the buildings which have been assessed for potential damage induced by ground settlement associated with the proposed works.

Table 6.11: Summary of building settlements induced from construction works

Location	Horizontal distance from nearest excavation to edge of dwelling (m) from:	Estimated Maximum assessed surface settlement across building (mm)	Estimated Maximum assessed differential settlement across building (mm)	Assessed Settlement Risk Category
18 Brigham Creek Road Dwelling (Gravity main)	SSMH-5: 25 SSMH-4 Receiving shaft: 35	<7	Less than 1V:1000H	0 to 1 – negligible to very slight
44 Tamiro Road (Gravity main)	SSMH11 Drive Shaft: 25 (outside expected zone of influence)	<5	Less than 1V:2000H	0 – negligible
42 Tamiro Road (Gravity main)	SSMH11 Drive Shaft: 30 (outside expected zone of influence)	<5	Less than 1V:2000H	0 – negligible
40 Tamiro Road (Gravity main)	SSMH11 Drive Shaft: 40 (outside expected zone of influence)	<5	Less than 1V:2000H	0 – negligible

6.6 Assessment of effects on underground services

Underground services along Brigham Creek Road are within the zone of influence of the shaft excavations associated with the pipe jack works. Table 6.12 presents the services which have been assessed for potential damage induced by ground settlement associated with the proposed excavations.

Maximum total and differential settlements are assessed to be 25 mm and 1V:600H respectively. At this level of total and differential settlement, we assess that the risk of damage to underground services to be low.

We recommend that the asset owners of the underground services are engaged to manage risks to each service during detailed design to establish suitable controls.

Table 6.12: Summary of settlements to underground services induced from construction works

Location	Horizontal distance to edge of services (m) from:	Estimated Maximum assessed surface settlement across services (mm)	Estimated Maximum assessed differential settlement across service (mm)	Qualitative Risk Assessment of Damage
Group 1 - Fibre Optic cable – Vodafone New Zealand Ltd, unknown material type - Water pipe local – Watercare Services Limited, 315 mm polyethylene - Telecommunications cable - Vocus Group NZ Limited, 32 mmP (96F) - Telecommunication cable – Chorus New Zealand Limited, unknown material	Pump station: 60 Gravity Main ² : 0 Drive shaft ¹ : 2 Reception shaft ¹ : 20	23	1V:600H	low
Underground services – group 2 Gas line – Vector Limited, MP4 100 mm polyethylene	Pump station: 70 Gravity Main ² : 0 Drive shaft ¹ : 14 Reception shaft ¹ : 9	18	1V:700H	low
Underground services – group 3 Water pipe local – Watercare Services Limited, 150 mm asbestos-cement	Pump station: 74 Gravity Main: 0 Drive shaft ¹ : 18 Reception shaft ¹ : 5	14	1V:1000H	low

Notes:

1. Refers to the Bringham Creek Road crossing shafts.
2. Proposed Gravity Main crosses over these services at effects

6.6.1 Saline intrusion

We understand that dewatering will continue for up to 6 months. Our evaluation is that the risk of saline intrusion is low given the proposed construction methodology, the low hydraulic conductivity of the Tauranga Formation, the use of sheet piling, excavations are expected to be above sea level and that groundwater drawdown levels are expected to remain above sea level..

Given the relatively short pumping period and low pumping rates, while there is some limited potential for saline intrusion, any change in groundwater quality will be restricted to the vicinity of the works and therefore will not affect other groundwater users. After works and dewatering has

ceased the rainfall and associated groundwater aquifer recharge across the site any potential saline intrusion effects will be reversed.

6.6.2 Neighbouring bores

The closest recorded bore to the proposed excavation is bore ID WAT60277201, located approximately 140 m to the northwest of the proposed SSMH-5 excavation. Drawdowns are assessed as very small (less than 0.5 m) at distances greater than 100 m from the excavation edge. On this basis no other piezometers are likely to be affected.

Groundwater drawdown that may occur at neighbouring bores is assessed to be temporary in nature associated with construction excavations.

6.6.3 Neighbouring wetlands

There is a wetland located within the northern portion of the pump station site. Groundwater drawdown curves are presented in 6.2.1. The effects of groundwater drawdown are presented in the Ecological Impact Assessment.

We assess that base flows through the wetland are unlikely to be materially reduced as excavations for the pump station and the Brigham Creek Road trenchless crossing are downstream of the wetland.

6.6.4 Base flow to Sinton Stream

During construction, it is expected that groundwater pumped from excavations will be discharged into the local stormwater network which flows into Sinton Stream. Given the proximity of the excavations to the Sinton Stream outlet, the depth of groundwater dewatering, and general low groundwater flows into the excavations due to the sheet pile construction, we assess that changes to base flow will be low.

6.7 Long term effects

Ongoing long-term groundwater drawdown is considered unlikely as the completed pipeline, manhole and pump station infrastructure should be a closed or watertight system. Groundwater levels are expected to return back to similar levels as prior to construction.

Ground settlement associated with construction is likely to occur in a relatively short period of time. The rate of settlement is expected to be the greatest during construction and reduce once the excavations are complete and backfilled. Ground settlement will stop once groundwater levels return to above their natural historic low.

Any ground settlements that does occur is considered to be non-recoverable and therefore permanent, even when groundwater levels recover.

Backfilling of excavations should not result in long term changes in groundwater flow provided that the backfilling of excavations is carried out in accordance with appropriate geotechnical engineering recommendations, Watercare's Design Principles 07, and the Auckland Council Stormwater Code of Practice.

6.8 Monitoring programme

We recommend a groundwater and settlement monitoring programme during construction. The requirements of the monitoring programme, including Alert and Alarm levels, will be set out in the Groundwater and Surface Monitoring Contingency Plan (GSMCP). The plan includes groundwater drawdown, surface settlement and building settlement monitoring.

Baseline monitoring of ground surface settlement and building settlement points should be undertaken for a minimum of 6 months prior to commencement of construction to establish seasonal variability.

In addition, groundwater monitoring bores located within the boreholes BH05A, BH05B, BH06, BH08, BH110, BH111, BH113, BH116, and BH117 (referenced in this assessment) should be monitoring for a minimum period of 6 months prior to commencement of construction to establish baseline levels.

7 Conclusion

This Groundwater and Settlement Effects Report has been prepared by T+T to support an Assessment of Effects on the Environment (AEE).

The estimated total ground settlements (where assessed) are presented as settlement contours on the project site plan presented in Appendix A.

Based on our technical assessment, we conclude:

Pump Station

- Ground settlement effects arising from pump station and storage tank construction on surrounding structures is assessed to be negligible (0) to very slight risk (1) of damage.

Gravity Main

- Ground settlement effects arising from the construction of the gravity main (shafts, chamber and pipe jack) by means of open cut and/or direction drill on surrounding structures is assessed to be negligible (0).
- Ground settlement effects arising from the Brigham Creek Road pipe jack upon buried services expected to be low.
- Maximum total and differential settlements are assessed to be 25 mm and 1V:600H respectively. At this level of total and differential settlement, we assess that the risk of damage to underground services to be low.

Rising Main

- Ground settlement and groundwater drawdown effects arising from the chamber construction is assessed to be negligible as there are no structures or services within the zone of influence.
- Damming effects associated with the Sinton Stream sheet piling works are assessed to be localised to the stream bank and not expected to significantly impact upon base flows into Sinton Stream.

Groundwater

- The risk of saline intrusion is assessed to be low.
- The impacting upon neighbouring groundwater bores is assessed to be negligible.
- Base flows through the wetland are unlikely to be materially reduced as excavations for the pump station and the Brigham Creek Road trenchless crossing are downstream of the wetland.
- We assess that changes to base flow in Sinton Stream arising from the pump station and Brigham Creek Road trenchless crossing will be low.

Monitoring

We recommend a groundwater and settlement monitoring programme during construction that includes monitoring of groundwater drawdown, surface settlement and building settlement monitoring. In addition, groundwater monitoring bores located within the boreholes BH05A, BH05B, BH06, BH08, BH110, BH111, BH113, BH116, and BH117 (referenced in this assessment) should be monitoring for a minimum period of 6 months prior to commencement of construction to establish baseline levels.

8 Applicability

This report has been prepared for the exclusive use of our Beca Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Recommendations and opinions in this report are based on data from discrete investigation locations. The nature and continuity of subsoil away from these locations are inferred but it must be appreciated that actual conditions could vary from the assumed model.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:



.....
Eduard Mandru
Geotechnical Engineer

Authorised for Tonkin & Taylor Ltd by:



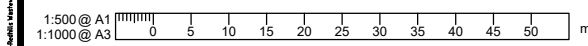
.....
Tim Coote
Project Director

EDMA

Appendix A Site investigation plan and settlement contour plans



Print Date: Apr 12, 2022 - 5:06pm W:\Projects\02\134\3-Alt032.dwg Whittipai-RedHills Wastewater Servicing Vienna\009 Drawings\01 Civil-AutoCAD\ 2013646.003.dwg



DETAILED DESIGN
NOT FOR CONSTRUCTION

CAD FILE	2013646.003	DATE	14-01-2022
ORIGINAL SCALE	A3 1:500	CONTRACT No.	6484-6934
REF No.	12508391	3-AWD32	
DWG No.	2013646.003	ISSUE 4	

LEGEND

EXISTING

- W — W — WATER NETWORKS
- SS — SS — WASTEWATER NETWORKS
- SW — SW — STORMWATER
- G — G — GAS
- E(OH) — E(OH) — OVERHEAD POWER CABLES
- T — T — TELECOMMUNICATION
- FO — FO — TELECOM FIBRE OPTIC
- — — — — PROPERTY BOUNDARY
- // — // — FENCE
- — — — — OVERLAND FLOW PATH
- 100-YEAR FLOOD PLAIN

PROPOSED

- WW — WW — WASTEWATER GRAVITY
- SSMH — SSMH — WASTEWATER MANHOLE

Settlement Contours:

- Approx 5mm settlement contour line
- Approx 10mm settlement contour line
- Approx 15mm settlement contour line
- Approx 20mm settlement contour line
- Approx 5mm settlement contour line if open trench method adopted

Note: settlement contours of greater than 5mm have not been displayed where there are no structures

Map Labels:

- EXISTING SSMH 2696093
- EXISTING WHENUAPAI VILLAGE PUMP STATION
- EXISTING SSMH 2695980
- SSMH-11 1540mmØ
- SSMH-10 1540mmØ
- SSMH-9 1540mmØ
- SSMH-8 1540mmØ
- SSMH-7 1540mmØ
- SSMH-6 1540mmØ
- SSMH-5 1540mmØ
- SSMH-4 1540mmØ
- SSMH-3 1540mmØ
- SSMH-2 1540mmØ
- SSMH-1 1540mmØ
- PROPOSED 375mmØ WASTEWATER GRAVITY MAIN (SSMH-4 TO EXISTING SSMH 2696093)
- PROPOSED 475mmØ WASTEWATER GRAVITY MAIN (SSMH-1 TO SSMH-4)
- PROPOSED INTERIM PUMP STATION
- 20 Brigham Creek Road to be occupied by WSL and used as laydown
- Pipe hammer construction method proposed between SSMH-3 and SSMH-4
- Trenchless construction proposed between SSMH-11 and Existing SSMH 2696093
- 18 Brigham Creek Road
- BRIGHAM CREEK RD.

DETAILED DESIGN
NOT FOR CONSTRUCTION

				DESIGNED	PH	12-21	 Watercare COPYRIGHT - This drawing, the design concept, remain the exclusive property of Watercare Services Limited and may not be used without approval. Copyright reserved.	 	CAD FILE	R0017910.002	DATE	10-12-21
				DES. APPROVED	SW	12-21			ORIGINAL SCALE	A3	CONTRACT No.	6484-6934
				DRAWN	JC	12-21			1:2000			
3	12-21	ISSUED FOR DETAILED DESIGN	J.C.	DWG. APPROVED	DJ	12-21			REF No.	12508391 3-AWD32		
2	8-21	RE-ISSUED FOR PRELIMINARY DESIGN	J.C.	WSL DESIGN MGMT.			DWG No.	R0017910.004	ISSUE	3		
1	5-21	ISSUED FOR PRELIMINARY DESIGN	J.C.	WSL PROJ. LEAD								
ISSUE	DATE	AMENDMENT	BY	APPD.	BY	DATE						

Appendix B Site investigation data



Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

BH05A

SHEET: 1 OF 4

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 17/11/2020

FINISH DATE: 18/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926551.90 mN
(NZTM2000) 1743191.10 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.00m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE				Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation												Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations						
Top	Sandy gravelly SILT, trace organics; brown & grey. Firm, moist, low plasticity; sand, fine to coarse, Quartz, gravel, fine to coarse, subangular, unweathered, Basalt & Concrete; organics, rootlets.						PQTT	46	1 @ 0.10m 1 x Glass Jar 1 x plastic Jar													
Tauranga Group	Silty CLAY, minor sand, trace organics; light brown mottled orange and dark brown, speckled black, homogeneous. Stiff, moist, high plasticity; sand, fine; organics, rootlets.								7 @ 0.35m 1 x plastic Jar (Corrosivity)		0.5					0.35m: PID - 1.3ppm						
	0.35 - 0.75m: CORE LOSS								0/- kPa							0.75m: Shear Vane failed						
	Silty CLAY, minor sand, trace organics; light brown mottled orange & dark brown, speckled black, homogeneous. Stiff, moist, high plasticity; sand, fine; organics, rootlets.						SPT	86	2 @ 1.00m 1 x Glass Jar 1 x plastic Jar		1.0											
	Sandy SILT, some clay; light brown mottled orange & dark brown speckled white and black, homogeneous. Stiff, moist, high plasticity; sand, fine.																					
	Silty CLAY, minor sand, trace organics; light brown mottled orange & dark brown speckled black & white, homogeneous. Stiff, moist; sand, fine; organics, rootlets.						PQTT	124	93/44 kPa 0/1 1/0 1/1 N=3		1.5											
	Sandy SILT, trace organics; brown spotted black, homogeneous. Stiff, moist, low plasticity; sand, fine; organics, rootlets.								3 @ 2.00m 1 x Glass Jar 1 x plastic Jar 1 x Split 1 x Duplicate		2.0					2.00m: PID - 0.4ppm						
	SILT, some sand, minor clay, trace organics; light brown mottled orange, homogeneous. Stiff, moist, low plasticity; sand, fine; organics, rootlets.						SPT	100			2.5											
	SILT, minor clay, trace organics; light green - grey, speckled black. Firm to stiff, moist, low plasticity; organics, fibrous.																					
	2.00 - 2.17m: Grey-brown mottled brown, speckled black																					
	SILT, trace clay; grey-brown mottled brown, speckled black. Firm to stiff, moist, low plasticity.						PQTT	0	8 @ 2.90m 1 x plastic Jar (Corrosivity)		3.0											
	3.0 - 3.5 m: Push Tube								4 @ 3.00m 1 x Glass Jar 1 x plastic Jar													
	SILT, trace clay; grey-brown mottled brown, speckled black. Firm, moist, low plasticity.						PT	173	28/9 kPa 0/0 0/1 1/1 N=3		3.5											
	SILT, trace organics; brown speckled black. Firm, moist, low plasticity; organics, fibrous.																					
	3.85m: grades light brown																					
	SILT, minor sand, trace organics and clay; light green, speckled black. Firm, moist, medium plasticity; sand, fine; organics, fibrous.						PQTT	100	5 @ 4.00m 1 x Glass Jar 1 x plastic Jar		4.0											
	4.03m: Light brown mottled brown, speckled black																					
	Sandy SILT, trace organics; light brown mottled brown, speckled black. Stiff, moist, low plasticity; sand, fine; organics, fibrous.																					
	Silty SAND; green speckled black, homogeneous. Medium dense, moist, poorly graded; sand, fine.						SPT	100	19/4 kPa Core disturbed by drilling		4.5											
	SAND, minor silt; light brown speckled black. Medium dense, moist, poorly graded; sand, fine.								2/3 3/3 3/4 N=13													

Box 1, 0.0-3.0m

COMMENTS: Piezometer installed with screened interval from 8.5 - 11.5 m.

Hole Depth
15.15m

Scale 1:25

Box 1, 0.0-3.0m

BOREHOLE LOG

BOREHOLE No.:

BH05A

SHEET: 2 OF 4

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 17/11/2020

FINISH DATE: 18/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926551.90 mN
(NZTM2000) 1743191.10 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.00m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
Tauranga Group	4.95 - 5.35 m: CORE LOSS						6 @ 5.00m 1 x Glass Jar 1x plastic Jar												
	Organic clayey SILT, trace rootlets; dark brown speckled black. Stiff, moist, high plasticity. Organics; amorphous				PQTT	61			5.5										
	6.25 - 6.45 m: CORE LOSS				SPT	55	0/- kPa 1/0 0/1 N=2		6.0					6.00m: Shear Vane failed					
	PEAT (AMORPHOUS), minor sand; dark brown, homogeneous. Firm to stiff, moist; sand, fine.								6.5										
	Organic SILT; dark brown speckled black. Stiff, moist, low plasticity. Organics; amorphous				PQTT	100			7.0										
Albany Conglomerate	PEAT (AMORPHOUS), minor sand; dark brown. Firm to stiff, moist; sand, fine.								7.5										
	7.50m: Very stiff				SPT	106	116/29 kPa 0/1 2/2 3/4 N=11		8.0										
	Completely weathered, grey, SANDSTONE. Extremely Weak, (Recovered as SAND; grey. Medium dense, moist, poorly graded; sand, fine).								8.5										
	8.2 - 9.0 m: CORE LOSS				PQTT	23			9.0										
	9.0 - 9.45 m: Solid Cone SPT				SPT	0	UTP 3/3 5/5 5/6 N=21 Solid		9.5					9.00 - 10.50m: Re-drilled due to core loss					
	Completely weathered, brown-grey, massive, SANDSTONE. Extremely Weak, (Recovered as SAND, minor gravel; brown-grey. Medium dense, moist, poorly graded; sand, fine to coarse; gravel, fine to coarse, subangular, unweathered, Sandstone & Siltstone).								9.5										

Box 2, 3, 4, 5, 8m

Box 2, 3, 0-6.8m

COMMENTS: Piezometer installed with screened interval from 8.5 - 11.5 m.

Hole Depth
15.15m

Scale 1:25

Rev.: A

BOREHOLE LOG

BOREHOLE No.:

BH05A

SHEET: 3 OF 4

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 17/11/2020

FINISH DATE: 18/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI

JOB No.: 1014985.0000

LOCATION: Whenuapai

CO-ORDINATES: 5926551.90 mN
(NZTM2000) 1743191.10 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.00m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F11 F12 F13 F14 F15 F16 F17 F18 F19 F20 F21 F22 F23 F24 F25 F26 F27 F28 F29 F30 F31 F32 F33 F34 F35 F36 F37 F38 F39 F40 F41 F42 F43 F44 F45 F46 F47 F48 F49 F50 F51 F52 F53 F54 F55 F56 F57 F58 F59 F60 F61 F62 F63 F64 F65 F66 F67 F68 F69 F70 F71 F72 F73 F74 F75 F76 F77 F78 F79 F80 F81 F82 F83 F84 F85 F86 F87 F88 F89 F90 F91 F92 F93 F94 F95 F96 F97 F98 F99 F100	Rock Strength C10 C15 C20 C25 C30 C35 C40 C45 C50 C55 C60 C65 C70 C75 C80 C85 C90 C95 C100	Sampling Method Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%) 25 50 75	Water Level	Casing	Installation	Core Box No
									Defect Log	Fracture Spacing (mm) 2000 1500 1000 500 200 100 50 20	RQD (%)	Description & Additional Observations					
Albany Conglomerate	10.05 - 10.5 m: CORE LOSS			PQTT	57												
	Highly weathered, brown and dark grey, CONGLOMERATE. Extremely Weak, Very weakly cemented (Recovered as Gravelly SAND; brown & dark grey. Medium dense, moist; sand, fine to coarse; gravel, fine to coarse, subangular, unweathered).			SPT	93	UTP 4/4 5/5 7/7 N=24	10.5										
	Highly weathered, grey, CONGLOMERATE. Extremely Weak, Very weakly cemented (Recovered as GRAVEL; grey. Moist; gravel, fine to coarse, subrounded to subangular, unweathered, Sandstone & Siltstone).						11.0										
	Moderately weathered, grey, SANDSTONE. Extremely Weak, Weakly cemented. SAND; grey. Very dense, moist, poorly graded; sand, fine.			PQTT	76		11.5				0						
	11.75 - 12.0 m: CORE LOSS																
	12.0 - 12.25 m: Solid cone SPT			SPT	100	UTP 5/21 27/23 N>=50	12.0										
	Highly weathered, brown & grey, CONGLOMERATE. Extremely Weak, Very weakly cemented (Recovered as Sandy GRAVEL; brown & grey. Medium dense, moist, poorly graded; gravel, fine to coarse, subrounded to subangular, unweathered, Sandstone & siltstone; sand, fine to coarse).						12.5										
	Highly weathered, grey, CONGLOMERATE. Extremely Weak, Very weakly cemented (recovered as GRAVEL; grey. Gravel, fine to coarse, subrounded to subangular, unweathered, Sandstone & Siltstone)			PQTT	56		13.0				0						
	Moderately weathered, grey, SANDSTONE. Extremely Weak, very weakly cemented. (Recovered as SAND; grey. Very dense, moist, poorly graded; sand, fine).						13.5										
	13.5 - 13.64 m: Solid Cone SPT			SPT	0	15/35 for 65mm N>=50 Solid											
	Unweathered, grey, SANDSTONE. Extremely Weak, Widely spaced fractures. (Recovered as SAND; grey. Very dense, moist, poorly graded; sand, fine).																
	13.96 - 13.98m: Slightly weathered, grey, SILTSTONE. Extremely Weak. SILT; grey. Hard, moist, low plasticity.			PQTT	129		14.0				63						

COMMENTS: Piezometer installed with screened interval from 8.5 - 11.5 m.

Hole Depth
15.15m

Scale 1:25

Rev.: A

BOREHOLE LOG

BOREHOLE No.:
BH05A

SHEET: 4 OF 4

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 17/11/2020

FINISH DATE: 18/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI

JOB No.: 1014985.0000

LOCATION: Whenuapai

CO-ORDINATES: 5926551.90 mN
(NZTM2000) 1743191.10 mE

R.L. GROUND: 9.00m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station\Surveyed

DIRECTION:

ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation										2000 600 200 100 50 20			25 50 75				
	15.0 - 15.14 m: Solid Cone SPT			SPT	0	13/37 for 70mm N>=50 Solid												
								15.5										
								16.0										
								16.5										
								17.0										
								17.5										
								18.0										
								18.5										
								19.0										
								19.5										

COMMENTS: Piezometer installed with screened interval from 8.5 - 11.5 m.

Hole Depth
15.15m

Scale 1:25

Rev.: A

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926551.90 mN (NZTM2000) 1743191.10 mE		DRILL TYPE: Track-mounted	HOLE STARTED: 17/11/2020
R.L.: 9.00m		DRILL METHOD: RC	HOLE FINISHED: 18/11/2020
DATUM: NZVD2016		DRILLED BY: McMillan Drilling	LOGGED BY: ROM
			CHECKED: CBM



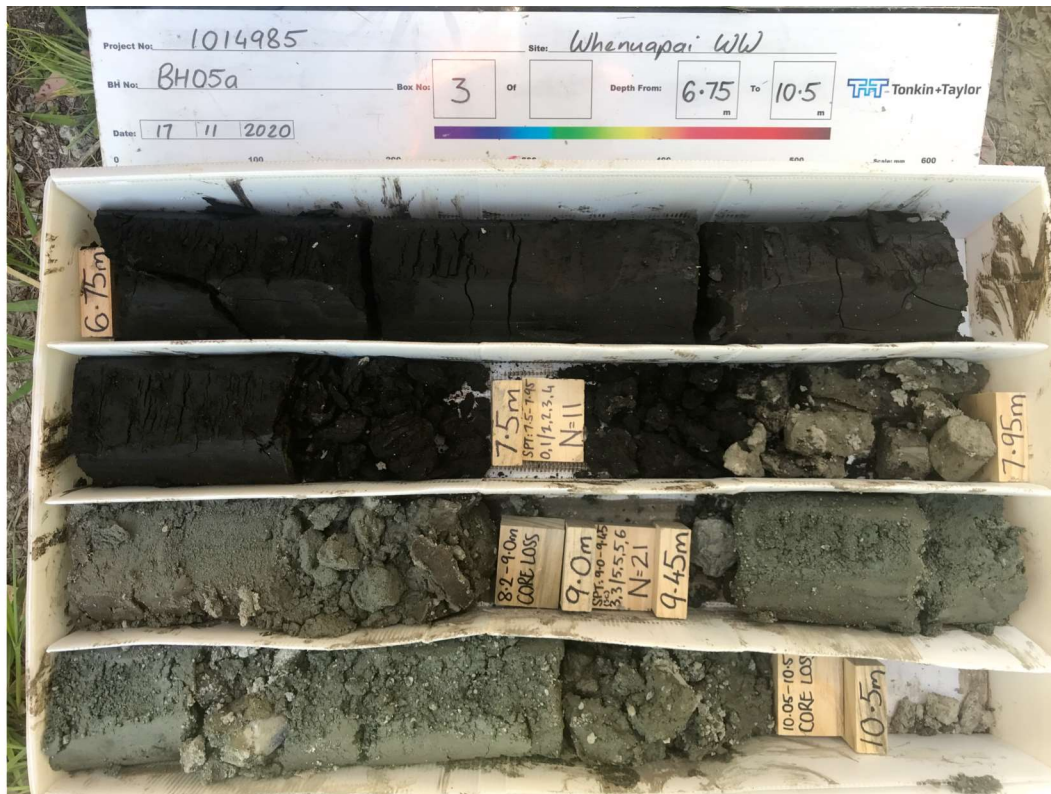
0.00-3.00m



3.00-6.75m

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926551.90 mN 1743191.10 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 17/11/2020
R.L.:	9.00m	DRILL METHOD: RC	HOLE FINISHED: 18/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



6.75-10.50m



10.50-13.20m

CORE PHOTOS

BOREHOLE No.: **BH05A**

SHEET: 3 OF 3

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926551.90 mN 1743191.10 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 17/11/2020
R.L.:	9.00m	DRILL METHOD: RC	HOLE FINISHED: 18/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: ROM CHECKED: CBM



13.20-15.14m

BOREHOLE LOG

BOREHOLE No.:
BH05B

SHEET: 1 OF 2

DRILLED BY: Vincent
LOGGED BY: ROM
CHECKED: CBM
START DATE: 18/11/2020
FINISH DATE: 18/11/2020
CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926553.70 mN
(NZTM2000) 1743191.30 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.20m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	UNW W1 W2 W3 W4 W5 W6 W7 W8 W9 W10 W11 W12 W13 W14 W15 W16 W17 W18 W19 W20 W21 W22 W23 W24 W25 W26 W27 W28 W29 W30 W31 W32 W33 W34 W35 W36 W37 W38 W39 W40 W41 W42 W43 W44 W45 W46 W47 W48 W49 W50 W51 W52 W53 W54 W55 W56 W57 W58 W59 W60 W61 W62 W63 W64 W65 W66 W67 W68 W69 W70 W71 W72 W73 W74 W75 W76 W77 W78 W79 W80 W81 W82 W83 W84 W85 W86 W87 W88 W89 W90 W91 W92 W93 W94 W95 W96 W97 W98 W99 W100	UNW W1 W2 W3 W4 W5 W6 W7 W8 W9 W10 W11 W12 W13 W14 W15 W16 W17 W18 W19 W20 W21 W22 W23 W24 W25 W26 W27 W28 W29 W30 W31 W32 W33 W34 W35 W36 W37 W38 W39 W40 W41 W42 W43 W44 W45 W46 W47 W48 W49 W50 W51 W52 W53 W54 W55 W56 W57 W58 W59 W60 W61 W62 W63 W64 W65 W66 W67 W68 W69 W70 W71 W72 W73 W74 W75 W76 W77 W78 W79 W80 W81 W82 W83 W84 W85 W86 W87 W88 W89 W90 W91 W92 W93 W94 W95 W96 W97 W98 W99 W100															
	Wash drilled to 7.0 m BGL. See BH05A for geology details																	

COMMENTS: 50 mm standpipe piezometer with screened interval from 3.5 - 5.5 m.

Hole Depth
7m

Scale 1:25

BOREHOLE LOG



Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

BH06

SHEET: 1 OF 4

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 19/11/2020

FINISH DATE: 19/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926435.00 mN
(NZTM2000) 1743208.20 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 12.60m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
TSoil	Organic SILT; brown. Hard, moist, non-plastic.																	
	0.30 - 0.40m: Very stiff; [Recovered from next run].			PQTT	40	● UTP												
Tauranga Group	SILT, trace sand; light brown mottled orangish brown. Stiff, moist, low plasticity; sand, fine.			PQTT				0.5					0.50m: PID - 0.1 ppm					
	0.6 - 0.75 m: CORE LOSS																	
	SILT, trace sand; light grey mottled orangish brown. Stiff, moist, low plasticity; sand, fine.			PQTT	140			1.0					1.00m: PID - 0.0 ppm					
	Clayey SILT, trace sand; light grey mottled orangish brown. Firm, moist, high plasticity; sand, fine.			PQTT		● 36/5 kPa 0/0 0/1 1/1 N=3		1.5										
	SILT, some clay, trace organics; light grey. Firm, moist, medium plasticity; organics, rootlets.			SPT	100			2.0										
	Sandy SILT, trace organics; light grey mottled orangish brown. Firm, moist, low plasticity; sand, fine; organics, rootlets.			PQTT	100			2.5										
East Coast Bays Formation	SILT, some clay and sand; grey. Stiff, moist, medium plasticity; sand, fine.			PQTT				3.0										
	SAND; grey. Loose, moist; sand, fine.			SPT	100	● 34/8 kPa 1/0 1/1 1/1 N=4		3.5										
	3.45 - 3.55 m: CORE LOSS																	
	SILT; grey. Stiff, moist, low plasticity.							4.0										
	Clayey SILT; grey. Stiff, moist, high plasticity.			PQTT	90			4.5										
	Sandy SILT; grey. Stiff, moist; sand, fine.																	
	Silty SAND; grey. Loose, moist; sand, fine.			SPT	100	● 0/- kPa crumble soils 1/1 1/2 1/2 N=6												

COMMENTS: Piezometer installed with screened interval from 3.5 - 5.0 m

Hole Depth
15.12m

Scale 1:25

BOREHOLE LOG

BOREHOLE No.:

BH06

SHEET: 2 OF 4

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 19/11/2020

FINISH DATE: 19/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926435.00 mN
(NZTM2000) 1743208.20 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 12.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation																	
East Coast Bays Formation	[Cont.] Silty SAND; grey. Loose, moist; sand, fine.																	
	Highly weathered, grey, SILTSTONE. Extremely Weak. (Recovered as SILT, trace sand; grey. Very Stiff, moist; sand, fine.).			PQTT	100			5.5										
	Highly weathered, grey, SILTSTONE. Extremely Weak. (Recovered as Sandy SILT; grey. Very Stiff, moist, non-plastic; sand, fine).																	
	Highly weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Loose, moist; sand, fine).			SPT	100	0/- kPa crumble soils 1/2 1/3 2/3 N=9		6.0										
	6.45 - 6.6 m: CORE LOSE							6.5										
	Highly weathered, grey, SILTSTONE. Extremely Weak. (Recovered as Sandy SILT; grey. Hard, moist, non-plastic; sand, fine). 6.90 - 6.95m: Silty SAND; grey. Loosely packed, moist; sand, fine. 6.95 - 7.17m: Very stiff.			PQTT	85			7.0										
	7.17 - 7.25m: Very stiff; carbonaceous.																	
	Highly weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Medium dense, moist; sand, fine). 7.40 - 7.50m: Sandy SILT; light grey. Very stiff, moist, non-plastic; sand, fine. 7.50 - 7.95m: Sand, coarse.			SPT	100	0/- kPa crumble soils 2/2 2/3 3/3 N=11		7.5										
	7.95 - 8.1 m: CORE LOSS							8.0										
	Highly weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Medium dense, moist; sand, fine). Highly weathered, grey, SILTSTONE. Extremely Weak. (Recovered as Clayey SILT, minor sand; grey. Hard, moist, high plasticity; sand, fine). Moderately weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Medium dense, moist; sand, fine).			PQTT	85			8.5										
	9.00 - 9.20m: Sand, coarse.							9.0										
	Moderately weathered, grey, SILTSTONE. Extremely Weak. (Recovered as SILT, trace sand; grey. Hard, moist; sand, fine).			SPT	100	0/- kPa crumble soils 2/3 4/5 6/7 N=22		9.5										
	Moderately weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Tightly packed, moist; sand, fine). 9.54 - 9.57m: Highly weathered, grey, SILTSTONE. Extremely Weak, (SILT; grey. Hard, moist, low plasticity).																	

COMMENTS: Piezometer installed with screened interval from 3.5 - 5.0 m

Hole Depth
15.12m

Scale 1:25

Rev.: A



Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

BH06

SHEET: 3 OF 4

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 19/11/2020

FINISH DATE: 19/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926435.00 mN
(NZTM2000) 1743208.20 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 12.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method		Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation			Defect Log	Fracture Spacing (mm)						RQD (%)	Description & Additional Observations							
East Coast Bays Formation	[Cont.] Moderately weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Tightly packed, moist; sand, fine).				PQTT	100		● UTP 9/15 20/26 4 for 10mm N>=50						81						
	Moderately weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Dense, moist; sand, medium). - INTERBEDDED WITH - Moderately weathered, grey, SILTSTONE. Extremely Weak.				SPT	100								0						
	Moderately weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Dense, moist; sand, medium). 10.81 - 11.1 m: CORE LOSS																			
	Unweathered, medium grained, SANDSTONE. Very Weak, very weakly cemented. 11.21 - 11.25m: Moderately weathered, SILTSTONE. Extremely Weak. 11.50 - 11.57m: Unweathered, grey, SILTSTONE. Very Weak.				PQTT	75								75						
	Unweathered, grey, medium grained, SANDSTONE. Very Weak. 11.78 - 11.84m: Unweathered, grey, SILTSTONE. Very Weak, Carbonaceous. 11.84 - 12.00m: Unweathered, grey, medium grained, SANDSTONE. Very Weak.																			
	12 - 12.12 m: SOLID SPT				SPT	0		25/25 for 45mm N>=50 Solid						0						
	12.12 - 12.6 m: CORE LOSS																			
	Unweathered, grey, medium grained, SANDSTONE. Very Weak. 13.18 - 13.26m: Unweathered, grey, SILTSTONE. Very Weak.				PQTT	65									28					
	13.5 13.65 m: SOLID SPT				SPT	0		16/34 for 55mm N>=50 Solid							0					
	13.63 - 13.8 m: CORE LOSS																			
Unweathered, grey, medium grained, SANDSTONE. Very Weak. 13.80 - 13.84m: Unweathered, grey, SILTSTONE. Very Weak.																				
14.40 - 14.90m: medium to coarse grained SANDSTONE				PQTT	87									73						
14.90 - 15.00m: Unweathered, grey, medium to coarse grained, SANDSTONE. Extremely Weak, Weakly cemented.																				

COMMENTS: Piezometer installed with screened interval from 3.5 - 5.0 m

Hole Depth
15.12m

Scale 1:25

Box 4, 8.6-11.5m

Box 5, 11.5-14.3m

BOREHOLE LOG

BOREHOLE No.:

BH06

SHEET: 4 OF 4

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 19/11/2020

FINISH DATE: 19/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926435.00 mN
(NZTM2000) 1743208.20 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 12.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation										2000 600 200 50 20							
	15 - 15.12 m: SOLID SPT			SPT	0	21/29 for 45mm N>=50 Solid						0	14.94m: BF, 10° dip, N, CN					
	15.12m: END OF INVESTIGATION																	

COMMENTS: Piezometer installed with screened interval from 3.5 - 5.0 m

Hole Depth
15.12m

Scale 1:25

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926435.00 mN	DRILL TYPE: Track-mounted	HOLE STARTED: 19/11/2020
	1743208.20 mE	DRILL METHOD: RC	HOLE FINISHED: 19/11/2020
			DRILLED BY: McMillan Drilling
R.L.:	12.60m		LOGGED BY: YCWA
DATUM:	NZVD2016		CHECKED: CBM



0.00-2.70m



2.70-5.55m

CORE PHOTOS

BOREHOLE No.: **BH06**

SHEET: 2 OF 3

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES:	5926435.00 mN (NZTM2000) 1743208.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 19/11/2020
R.L.:	12.60m	DRILL METHOD: RC	HOLE FINISHED: 19/11/2020
DATUM:	NZVD2016	LOGGED BY: YCWA	CHECKED: CBM



5.55-8.60m



8.60-11.48m

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES:	5926435.00 mN (NZTM2000)	DRILL TYPE: Track-mounted	HOLE STARTED: 19/11/2020
R.L.:	12.60m	DRILL METHOD: RC	HOLE FINISHED: 19/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: YCWA CHECKED: CBM



11.48-14.26m



14.26-15.12m

BOREHOLE LOG

BOREHOLE No.:
BH07

SHEET: 1 OF 2

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 20/11/2020

FINISH DATE: 20/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926205.30 mN
(NZTM2000) 1743224.80 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 21.80m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
TSoil	Organic SILT; brown. Stiff, moist, low plasticity; organics, amorphous and rootlets.				PQTT	100													
	0.35 - 0.50m: Light brown mottled orangish brown.																		
Tauranga Group	Clayey SILT; light grey mottled orangish brownm. Very stiff, moist, high plasticity.				PQTT	100	● 168/67 kPa		0.5					0.50m: PID - 0.1 ppm					
					PQTT	100		1.0						1.00m: PID - 0.0 ppm					
	1.95 - 2.40m: Stiff.				SPT	66	1/1 1/1 1/2 N=5		1.5										
	2.40 - 3.00m: Firm to stiff.				PQTT	100			2.0										
									2.5										
	3.0 - 3.5 m: PUSH TUBE				PT	100	● 58/11 kPa Push tube @ 3.00m		3.0										
East Coast Bays Formation	Clayey SILT; organish brown. Firm, moist, medium plasticity.				SPT	100	1/0 1/0 1/1 N=3		3.5										
	Sandy SILT; grey. Firm, moist, non-plastic; sand, fine.				PQTT	100			4.0										
	Clayey SILT; grey. Firm, moist, high plasticity.				SPT	100	● 40/9 kPa 1/0 1/1 1/1 N=4		4.5										
	Sandy SILT; grey. Firm, moist, low plasticity; sand, fine.																		

20/11/2020

Box 1, 0.0-2.6m

COMMENTS:

Hole Depth
6m

Scale 1:25

Box 1, 0.0-2.6m

Rev.: A

BOREHOLE LOG

BOREHOLE No.:
BH07

SHEET: 2 OF 2

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 20/11/2020

FINISH DATE: 20/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926205.30 mN
(NZTM2000) 1743224.80 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 21.80m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
East Coast Bays Formation	[Cont.] Sandy SILT; grey. Firm, moist, low plasticity; sand, fine.																	
	SILT, some clay, minor sand; grey. Stiff, moist, low plasticity; sand, fine.			PQTT	100			5.5										
	6m: END OF INVESTIGATION					● 93/17 kPa		6.0										Box 2, 2.6-5.0m

COMMENTS:

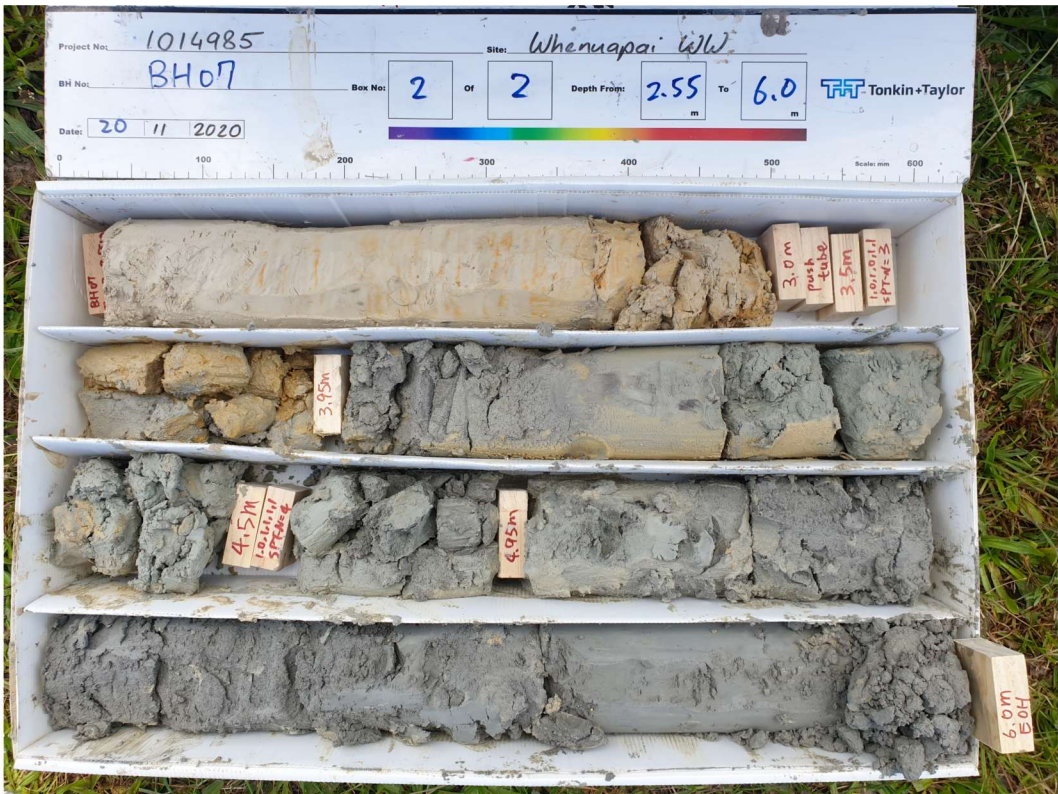
Hole Depth
6m

Scale 1:25

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926205.30 mN (NZTM2000) 1743224.80 mE		DRILL TYPE: Track-mounted	HOLE STARTED: 20/11/2020
R.L.: 21.80m		DRILL METHOD: RC	HOLE FINISHED: 20/11/2020
DATUM: NZVD2016		LOGGED BY: YCWA	CHECKED: CBM



0.00-2.55m



2.55-6.00m



Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

BH08

SHEET: 1 OF 3

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 23/11/2020

FINISH DATE: 23/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926036.50 mN
(NZTM2000) 1743457.30 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 24.60m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
Fill	Sandy SILT, trace organics; brown. Firm, moist, low plasticity; sand, fine; organics, rootlets.			PQTT	100	3 @ 0.10m 1 x Glass Jar 1 x Plastic Jar												
	Silty sandy CLAY, trace organics; brown, orange & light grey mottled orange. Stiff, moist, medium plasticity; sand, fine; organics, rootlets.			PQTT	100	1 @ 0.25m 1 x Plastic Jar Corrosivity												
	Sandy SILT; brown mottled orange. Stiff, moist, low plasticity; sand, fine.			PQTT	100	4 @ 0.50m 1 x Glass Jar 1 x Plastic Jar												
	Clayey sandy SILT; brown & orange mottled orange. Stiff, moist, medium plasticity; sand, fine.			PQTT	100	5 @ 1.00m 1 x Glass Jar 1 x Plastic Jar												
	Silty CLAY, trace organics; light grey-grey mottled orange & brown. Stiff, moist, high plasticity; organics, rootlets.			PQTT	100	81/41 kPa 1/1 1/1 1/2 N=5												
	1.95 - 2.05 m: CORE LOSS			PQTT	90	6 @ 2.00m 1 x Glass Jar 1 x Plastic Jar												
	Clayey sandy SILT, trace organics; grey mottled orange. Stiff, moist, medium plasticity; sand, fine; organics, fibrous.			PQTT	90	2 @ 2.30m 1 x Plastic Jar Corrosivity												
	Clayey SILT, minor sand, trace organics; light grey-brown mottled orange. Stiff, moist, medium plasticity; sand, fine; organics, fibrous.			PQTT	90	7 @ 3.00m 1 x Glass Jar 1 x Plastic Jar												
	SILT, minor sand, trace organics; light brown mottled orange, speckled black. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.			PQTT	66	8 @ 4.00m 1 x Glass Jar 1 x Plastic Jar												
	Sandy SILT, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.			PQTT	155	52/12 kPa 0/1 1/0 1/0 N=4												
Tauranga Group	Sandy SILT, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.			PQTT	155	52/12 kPa 0/1 1/0 1/0 N=4												
	Sandy SILT, trace organics; grey speckled black. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.			PQTT	155	52/12 kPa 0/1 1/0 1/0 N=4												
	Sandy SILT, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.			PQTT	155	52/12 kPa 0/1 1/0 1/0 N=4												
	Sandy SILT, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.			PQTT	155	52/12 kPa 0/1 1/0 1/0 N=4												
	Sandy SILT, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.			PQTT	155	52/12 kPa 0/1 1/0 1/0 N=4												
	Sandy SILT, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.			PQTT	155	52/12 kPa 0/1 1/0 1/0 N=4												
	Sandy SILT, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.			PQTT	155	52/12 kPa 0/1 1/0 1/0 N=4												
	Sandy SILT, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.			PQTT	155	52/12 kPa 0/1 1/0 1/0 N=4												
	Sandy SILT, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.			PQTT	155	52/12 kPa 0/1 1/0 1/0 N=4												
	Sandy SILT, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.			PQTT	155	52/12 kPa 0/1 1/0 1/0 N=4												
	Sandy SILT, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.			PQTT	155	52/12 kPa 0/1 1/0 1/0 N=4												

COMMENTS: Piezometer installed with screened interval from 3.0 to 6.0 m

Hole Depth
10.95m

Scale 1:25

Rev.: A

BOREHOLE LOG

BOREHOLE No.:

BH08

SHEET: 2 OF 3

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 23/11/2020

FINISH DATE: 23/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926036.50 mN
(NZTM2000) 1743457.30 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 24.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
Tauranga Group	SILT, minor clay, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; organics, fibrous.				PQTT	100	9 @ 5.00m 1 x Glass Jar 1 x Plastic Jar		5.5			2000 600 400 200 100 50 20			25 50 75				Box 2 3.4-5.3m
	6.0 - 6.5 m: Push tube				PT	0	47/19 kPa 1/0 1/1 1/2 N=5		6.0										
	SILT, minor clay, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; organics, fibrous. 6.80 - 6.92m: Grades to: Sandy SILT				SPT	100			6.5										
	SILT, minor sand, trace organics; brown speckled black. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous. 7.00m: Grades to: some sand				PQTT	100			7.0										
	Sandy SILT, trace organics; light brown & brown speckled black. Very loose, moist, poorly graded; sand, fine; organics, fibrous.								7.5					7.40 - 7.65m: Core disturbed due to core drop-out and re-drilling					
	SILT, some sand, trace organics; brown mottled light brown speckled black. Firm, moist, low plasticity; sand, fine; organics, fibrous.				SPT	100	0/0 0/1 1/1 N=3		8.0					7.65m: Core run extended to 7.65m due to core drop out of barrel					
	Sandy SILT, trace organics; light brown speckled black. Firm, moist, low plasticity; sand, fine; organics, fibrous.				PQTT	100			8.5					8.10 - 9.00m: Core disturbed due to core drop-out and re-drilling					
	Sandy SILT, trace organics; dark brown speckled black. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous. Sandy SILT, minor organics and clay; brown spotted black. Stiff, moist, low plasticity; sand, fine; organics, fibrous. 9.35m: Grades to: No Sand				SPT	117	59/19 kPa 1/1 2/2 2/2 N=8		9.0										

COMMENTS: Piezometer installed with screened interval from 3.0 to 6.0 m

Hole Depth
10.95m

Scale 1:25

BOREHOLE LOG

BOREHOLE No.:

BH08

SHEET: 3 OF 3

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 23/11/2020

FINISH DATE: 23/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926036.50 mN
(NZTM2000) 1743457.30 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 24.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
Tauranga Group	[CONT] Sandy SILT, minor clay and organics; brown spotted black. Stiff, moist, low plasticity; sand, fine; organics, fibrous		PQTT	100	SPT	100	133/31 2/2 3/3 N=10	14	10.5									Box 4, 8.4-11.0m	
	Silty SAND, trace organics; light brown-grey spotted black. Loose to medium dense, moist, poorly graded; sand, fine; organics, fibrous. 10.88 - 10.93m: Decomposed wood 10.93m: Brown spotted black																		
	10.95m: END OF INVESTIGATION								11.0										
								11.5	13										
								12.0											
								12.5	12										
								13.0											
								13.5	11										
								14.0											
								14.5	10										

COMMENTS: Piezometer installed with screened interval from 3.0 to 6.0 m

Hole Depth
10.95m

Scale 1:25

Rev.: A

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926036.50 mN (NZTM2000) 1743457.30 mE		DRILL TYPE: Track-mounted	HOLE STARTED: 23/11/2020
R.L.: 24.60m		DRILL METHOD: RC	HOLE FINISHED: 23/11/2020
DATUM: NZVD2016		LOGGED BY: ROM	CHECKED: CBM



0.00-2.40m



2.40-5.20m

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES:	5926036.50 mN (NZTM2000) 1743457.30 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 23/11/2020
R.L.:	24.60m	DRILL METHOD: RC	HOLE FINISHED: 23/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



5.20-8.35m



8.35-10.95m



Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

BH110

SHEET: 1 OF 4

DRILLED BY: Mackenzie, Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 13/11/2020

FINISH DATE: 16/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926611.70 mN
(NZTM2000) 1743051.90 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.60m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS					Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations						
TSoil	SILT, trace rootlets; brown. Stiff, moist, non-plastic.					1 @ 0.10m			TS										
	SILT, trace sand; light brown mottled orangish brown. Stiff to very stiff, moist, low plasticity; sand, fine. 0.50 - 0.80m: Trace rootlets.			PQTT	100	2 @ 0.50m		0.5	TS				0.50m: PID - 0.6 ppm						
Tauranga Group	Silty CLAY; light brown mottled orangish brown. Very stiff, moist, high plasticity. 0.80 - 0.90m: Trace rootlets.					8 @ 0.80m 3 @ 0.90m		1.0					1.00m: PID - 0.3 ppm						
	1.50 - 2.45m: Light brown.			SPT	84	153/59 kPa 1/1 2/1 3/2 N=8		1.5											
				PQTT	100	5 @ 1.95m		2.0											
East Coast Bays Formation	Silty SAND; light brown mottled orangish brown. Loosely packed, saturated; sand, fine.					96/16 kPa		2.5											
	Sandy SILT; grey. Tightly packed, moist; sand, fine.			PQTT	100	6 @ 2.90m		3.0											
	3.1 - 3.5 m: PUSH TUBE			PT	100	0/- kPa crumble Push Tube @ 3.10m		3.5											
	Sandy SILT; grey. Hard, moist, non-plastic; sand, fine.			SPT	100	5/10 15/17 18 for 65mm N>=50		4.0											
	3.87 - 4.0 m: CORE LOSS							4.0											
	Moderately weathered, grey, SANDSTONE. Extremely weak. (Recovered as SAND, grey. Very dense, moist; sand fine)			PQTT	79	7 @ 4.00m		4.5											
	Moderately weathered, grey, SILTSTONE. Extremely weak. (Recovered as Sandy SILT, grey. hard, moist, low plasticity; sand fine)			SPT	0	UTP 6/25 20/30 for 45mm N>=50 Solid		5.0											
	4.77 - 4.87 m: CORE LOSS							5.5											

COMMENTS: Piezometer installed with screened interval from 8.0 - 11.0 m

Hole Depth
15.11m

Scale 1:25

Box 1, 0.0-2.5m

16/11/2020

07/12/2020

Rev.: A

BOREHOLE LOG

BOREHOLE No.:

BH110

SHEET: 2 OF 4

DRILLED BY: Mackenzie, Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 13/11/2020

FINISH DATE: 16/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926611.70 mN
(NZTM2000) 1743051.90 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations						
East Coast Bays Formation	Moderately weathered, grey, fine, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Tightly packed, moist; sand, fine)				PQTT	91		10/25 35/15 for 10mm N>=50 Solid												
																				5.16m: DD
	Moderately weathered, grey, SILTSTONE. Very Weak.																			5.32m: BF, 0° dip, N, CN
	Moderately weathered, grey, fine SANDSTONE. Extremely weak. (Recovered as Silty SAND, grey. Very dense, moist; sand fine)																			5.40m: BF, 0° dip, N, CN
																				5.44m: DD
																				5.59m: DD
																				5.90m: DD
	Slightly weathered, grey, SANDSTONE. Extremely weak, very weakly cemented. (Recovered as Silty SAND, grey. Very dense, moist; sand fine)																			
	6.93m: Carbonaceous																			6.60m: BF, 0° dip, N, CN
																				6.85m: BF, 0° dip, T, CN
																				7.10 - 7.30m: BZ, 80° dip, N, CN
	Unweathered, grey, SANDSTONE. Very Weak.																			
	7.5 - 7.63 m: Solid SPT																			
	Unweathered, grey, fine to coarse, SANDSTONE. Very Weak.																			
																				7.91 - 7.93m: BF, 10° dip, N, CN
	8.00 - 8.15m: Unweathered SILTSTONE. Very Weak.																			7.98m: BF, 0° dip, N, CN
		8.07m: BF, 0° dip, VN, CN																		
8.15 - 8.3 m: CORE LOSS		8.42m: BF, 0° dip, N, CN																		
Unweathered, grey, fine to coarse, SANDSTONE. Very Weak.		8.65 - 8.67m: BF, 0° dip, N, coarse sands																		
Unweathered, grey, fine, SANDSTONE. Very Weak.		8.70m: BF, 0° dip, VN, CN																		
		8.73 - 8.77m: BZ, 30° dip, VN, CN																		
9.0 - 9.18 m: SOLID SPT		8.82m: BF, 0° dip, MN, medium grained sands																		
		8.86m: BF, 0° dip, VN, CN																		
Unweathered, grey, fine, SANDSTONE. Very Weak.		8.91m: BF, 0° dip, VN, CN																		
9.30 - 9.40m: Unweathered SILTSTONE. Very Weak.		8.94m: BF, 0° dip, VN, CN																		
		9.23m: DD																		
		9.36m: BF, 10° dip, VN, CN																		
		9.42m: BF, 0° dip, VN, CN																		
9.90 - 9.97m: Unweathered SILTSTONE. Very Weak.		9.61m: BF, 10° dip, VN, CN																		
		9.77m: BF, 0° dip, VN, CN																		
		9.90m: BF, 0° dip, VN, CN																		

COMMENTS: Piezometer installed with screened interval from 8.0 - 11.0 m

Hole Depth
15.11m

Scale 1:25

Rev.: A



Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

BH110

SHEET: 3 OF 4

DRILLED BY: Mackenzie, Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 13/11/2020

FINISH DATE: 16/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926611.70 mN
(NZTM2000) 1743051.90 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
East Coast Bays Formation	Unweathered, grey, medium to coarse, SANDSTONE. Very Weak, Weakly cemented.		CS S W W	CS S W W	PQTT	100	20/30 for 35mm N>=50 Solid	-1	10.5				54	0					
	Unweathered, grey, SILTSTONE. Very Weak.																		
	Unweathered, grey, fine, SANDSTONE. Very Weak.		PQTT	100	11.0	48	10.74 - 10.77m: BF, 30° dip, N, CN 10.84m: BF, 0° dip, N, CN 10.94m: DD												
	11.22 - 11.23m: Unweathered SILTSTONE. Very Weak.																		
	11.35 - 11.53m: SANDSTONE grades fine to medium grained		PQTT	100	11.5	21	11.53 - 11.57m: BF, 0° dip, MN, Sands 11.65 - 11.73m: BZ, VN, CN 11.79m: BF, 0° dip, VN, CN 11.85m: DD												
	11.85 - 11.95m: Unweathered SILTSTONE. Very Weak																		
	12.0 - 12.09 m: SOILD SPT		PQTT	100	12.0	0	12.19m: BF, 0° dip, VN, CN 12.23m: DD 12.29m: BF, 10° dip, VN, CN												
	Unweathered, grey, fine, SANDSTONE. Very Weak.																		
	Unweathered, grey, SILTSTONE. Very Weak. 12.21 - 12.29m: Carbonaceous		PQTT	100	12.5	55	12.48m: BF, 0° dip, VN, CN 12.59m: BF, 0° dip, N, Sandstone gravels 12.64m: BF, 10° dip, N, CN 12.68m: BF, 0° dip, VN, CN 12.70m: DD 12.75m: DD 12.99m: DD												
	12.29 - 12.35m: Carbonaceous 12.63 - 12.64m: SANDSTONE interbed 12.69 - 12.70m: SANDSTONE interbed																		
	Unweathered, grey, fine, SANDSTONE. Very Weak, Weakly cemented.		PQTT	100	13.0	0	13.17m: BF, 0° dip, VN, CN 13.29m: BF, 0° dip, VN, CN												
	13.37 - 13.46m: Unweathered SILTSTONE. Very Weak.																		
	Unweathered, grey mottled light grey, fine to medium grained, SANDSTONE. Weak, Moderately cemented.		PQTT	75	13.5	0	13.63m: BF, 10° dip, N, CN 13.74m: BF, 0° dip, MN, CN 13.77m: BF, 0° dip, N, CN 13.88m: BF, 0° dip, MN, CN												
	Unweathered, grey, fine, SANDSTONE. Very Weak. 14.21 - 14.22m: Unweathered SILTSTONE. Very Weak.																		
	14.4 - 14.75 m: CORE LOSS		PQTT	75	14.0	32	14.10m: DD 14.16m: BF, 0° dip, N, CN 14.25 - 14.29m: BF, VN, CN												
	Unweathered, grey, SANDSTONE. Very weak																		
Unweathered, grey, SILTSTONE. Very Weak.																			

Box 5, 9.6-11.9m

Box 6, 11.9-14.1m

COMMENTS: Piezometer installed with screened interval from 8.0 - 11.0 m

Hole Depth
15.11m

Scale 1:25

Rev.: A

BOREHOLE LOG

BOREHOLE No.:
BH110

SHEET: 4 OF 4

DRILLED BY: Mackenzie, Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 13/11/2020

FINISH DATE: 16/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI

JOB No.: 1014985.0000

LOCATION: Whenuapai

CO-ORDINATES: 5926611.70 mN
(NZTM2000) 1743051.90 mE

R.L. GROUND: 9.60m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station\Surveyed

DIRECTION:

ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation										2000 600 200 100 50 20							
	15.0 - 15.11 m: SOLID SPT			SPT	0	23/27 for						0						
	15.11m: END OF INVESTIGATION					35mm N>=50 Solid												
								15.5										
								16.0										
								16.5										
								17.0										
								17.5										
								18.0										
								18.5										
								19.0										
								19.5										

COMMENTS: Piezometer installed with screened interval from 8.0 - 11.0 m

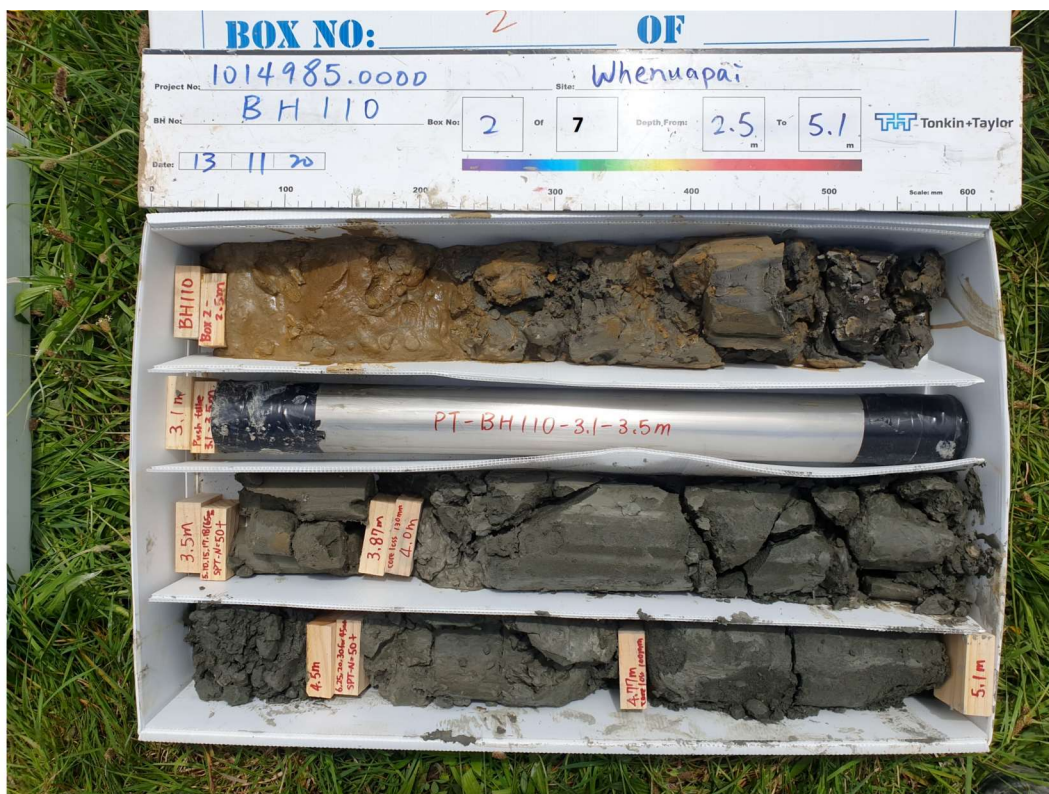
Hole Depth
15.11m

Scale 1:25

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES:	5926611.70 mN (NZTM2000) 1743051.90 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 13/11/2020
R.L.:	9.60m	DRILL METHOD: RC	HOLE FINISHED: 16/11/2020
DATUM:	NZVD2016	LOGGED BY: YCWA	CHECKED: CBM



0.00-2.50m



2.50-5.10m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES:	5926611.70 mN (NZTM2000) 1743051.90 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 13/11/2020
R.L.:	9.60m	DRILL METHOD: RC	HOLE FINISHED: 16/11/2020
DATUM:	NZVD2016	LOGGED BY: YCWA	CHECKED: CBM



5.10-7.10m



7.10-9.61m

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926611.70 mN (NZTM2000) 1743051.90 mE		DRILL TYPE: Track-mounted	HOLE STARTED: 13/11/2020
R.L.: 9.60m		DRILL METHOD: RC	HOLE FINISHED: 16/11/2020
DATUM: NZVD2016		DRILLED BY: McMillan Drilling	LOGGED BY: YCWA
			CHECKED: CBM



9.61-11.90m



11.90-14.10m

CORE PHOTOS

BOREHOLE No.: **BH110**

SHEET: 4 OF 4

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926611.70 mN (NZTM2000) 1743051.90 mE		DRILL TYPE: Track-mounted	HOLE STARTED: 13/11/2020
R.L.: 9.60m		DRILL METHOD: RC	HOLE FINISHED: 16/11/2020
DATUM: NZVD2016			DRILLED BY: McMillan Drilling
			LOGGED BY: YCWA CHECKED: CBM



14.10-15.11m



Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

BH111

SHEET: 1 OF 4

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 10/11/2020

FINISH DATE: 11/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926614.20 mN
(NZTM2000) 1743088.20 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.90m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
Top	Clayey SILT, some organics; brown. Very stiff, moist, high plasticity; organics, rootlets.					BH111 Sample 1 @ 0.05m												
Tauranga Group	Clayey SILT, trace sand; light brown. Stiff, moist, high plasticity; sand, fine. 0.3 - 1.4 m: CORE LOSS			PQTT	26			0.5										
	Clayey SILT, trace sand; light brown mottled brown. Stiff, moist, high plasticity; sand, fine.			SPT	100	73/31 kPa 1/1 0/1 1/2 N=4		1.5										
	Clayey SILT, minor organics, trace sand; brown. Firm, moist, high plasticity; sand, fine; organics, rootlets.			PQTT	100	BH111 Sample 2 @ 2.00m BH111 Sample 3 @ 2.20m		2.0										
	Sandy SILT; grey mottled orangish brown. Firm, moist, non-plastic; sand, fine.							2.5										
	Silty SAND; grey. Medium dense, moist; sand, fine.			SPT	100	BH111 Sample 4 @ 2.80m 2/3 5/6 7/7 N=25		3.0										
East Coast Bays Formation	3.45 - 3.7 m: CORE LOSS							3.5										
	Moderately weathered, grey, fine grained, SANDSTONE. Extremely Weak, (Recovered as Silty SAND; grey. Medium dense, moist; sand, fine) 3.90 - 4.05m: Recovered as GRAVEL			PQTT	76	BH111 Sample 5 @ 3.70m BH111 Sample 6 @ 3.90m		4.0										
	Moderately weathered, grey fine grained SANDSTONE; Extremely weak. (Recovered as fine grained SAND; grey. Dense, moist.)							4.5										
	Moderately weathered, grey SILTONE; Extremely weak. (Sandy SILT; grey. Hard, moist, low plasticity; sand, fine.) 4.70 - 4.72m: SILT; light brown. Moist, low plasticity. 4.85m: 2 mm thick SILT; light brown. 4.90 - 4.95m: SAND; grey. Dense, moist; sand, fine.			SPT	100	0/- kPa Crumble. 6/5 5/9 15/21 N>=50 Solid		5.0										

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 3.0 - 5.0 m.

Hole Depth
18.04m

Scale 1:25

Rev.: A

BOREHOLE LOG

BOREHOLE No.:

BH111

SHEET: 2 OF 4

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 10/11/2020

FINISH DATE: 11/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926614.20 mN
(NZTM2000) 1743088.20 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.90m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS					Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations						
East Coast Bays Formation	4.95 - 5.05 m: CORE LOSS																			
	Slightly weathered, grey, fine grained SANDSTONE. Very Weak. 5.05 - 5.15m: SAND; grey. Dense, moist; sand, fine. 5.28 - 5.32m: Slightly weathered, grey, SILTSTONE. Very Weak. 5.40m: Carbonaceous				PQTT	81								65	5.23m: BF, 10° dip, VN, CN 5.27 - 5.28m: BF, 0° dip, MN, light brown veneer					
	Unweathered, light grey, fine grained SANDSTONE. Weak. 5.56 - 6.0 m: CORE LOSS				PQTT	12								0						
	Slightly weathered, grey, fine grained SANDSTONE. Very Weak, Carbonaceous [logged after solid SPT testing].				SPT	100	8/15 15/25 10 for 15mm N>=50 Solid							0						
	Slightly weathered, grey, fine, SANDSTONE. Very Weak, (Recovered as GRAVEL). 6.42 - 6.6 m: CORE LOSS																			
	Unweathered, grey, fine grained SANDSTONE. Very Weak. 6.68 - 6.72m: SILTSTONE 6.90 - 6.92m: SILTSTONE				PQTT	84								53	6.60m: BF, 0° dip, N, CN 6.68m: BF, 0° dip, N, CN 6.77m: BF, 0° dip, N, CN 6.87m: BF, 0° dip, N, CN					
	7.20 - 7.26m: SILTSTONE														7.00m: DD 7.20m: DD					
	Unweathered, grey, SILTSTONE. Very Weak. - INTERBEDDED WITH - Unweathered, grey, fine, SANDSTONE. Very Weak.				SPT	100	8/12 17/23 10 for 20mm N>=50 Solid							0	7.40m: BF, 0° dip, VN, CN					
	Unweathered, grey, fine grained SANDSTONE. Very Weak. 8.32 - 8.33m: SILTSTONE 8.37 - 8.38m: SILTSTONE 8.44 - 8.53m: SILTSTONE 8.53 - 8.90m: Weakly cemented SANDSTONE				PQTT	80								45	8.15m: DD 8.30m: BF, 0° dip, VN, CN 8.42m: BF, 0° dip, VN, CN 8.44m: BF, 0° dip, VN, CN 8.49m: BF, 0° dip, VN, CN 8.53m: DD					
	8.9 - 9.0 m: CORE LOSS																			
	Unweathered, grey, SANDSTONE. Very Weak, carbonaceous. [logged after solid SPT test].				SPT	95	15/25 35/15 for 10mm N>=50 Solid							0						
	9.24 - 9.45 m: CORE LOSS																			
	Unweathered, grey, fine grained SANDSTONE. Very Weak. 9.78 - 9.80m: SILTSTONE 9.86 - 9.97m: SILTSTONE													31	9.50m: DD 9.68m: DD 9.78m: BF, 0° dip, N, CN 9.83m: DD 9.86m: DD					

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 3.0 - 5.0 m.

Hole Depth
18.04m

Scale 1:25

Rev.: A



Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

BH111

SHEET: 3 OF 4

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 10/11/2020

FINISH DATE: 11/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926614.20 mN
(NZTM2000) 1743088.20 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.90m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No			
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations								
East Coast Bays Formation	[CONT] unweathered, grey, fine grained SANDSTONE. Very Weak. 10.02 - 10.06m: Fine to coarse grained SANDSTONE 10.24 - 10.48m: Fine to coarse grained SANDSTONE				PQTT	83								31							10.02m: BF, 0° dip, VN, CN 10.06 - 10.11m: BF, 0° dip, N, CG (grey silt) 10.15m: DD 10.21m: BF, 0° dip, N, CN 10.24m: BF, 0° dip, N, CN 10.38m: DD 10.44m: DD	
	10.5 - 10.63 m: Solid SPT				SPT	0	20/27 for 50mm N≥50 Solid		10.5					0								
	10.63 - 11.15 m: CORE LOSS																					
	Unweathered, grey, fine grained SANDSTONE. Very Weak.				PQTT	62								9							11.22m: BF, 0° dip, N, CN 11.28m: BF, 0° dip, N, CN 11.36m: BF, 0° dip, N, CN 11.45m: DD 11.50m: DD 11.59m: DD	
	Unweathered, grey, coarse grained SANDSTONE. Very Weak.																					
	Unweathered, grey, fine grained SANDSTONE. Very Weak. 11.61 - 11.65m: SILTSTONE 11.77 - 11.82m: Coarse grained SANDSTONE																				11.73m: DD 11.77m: BF, 0° dip, N, CN 11.82m: DD 11.88m: DD	
	Unweathered, grey, SILTSTONE. Very Weak.				SPT	80	5/14 30/20 for 25mm N≥50 Solid		12.0					0								
	Unweathered, grey, fine grained SANDSTONE. Very Weak.																					
	12.74 - 12.77m: SILTSTONE				PQTT	100									61							12.46m: DD 12.63 - 12.73m: BZ, 70° dip, VN, CN 12.87m: DD
	13.14 - 13.20m: SILTSTONE																					
	Unweathered, grey, SILTSTONE. Very Weak.				SPT	100	20/30 for 30mm N≥50 Solid		13.5					0								13.14m: DD 13.27m: DD 13.32m: BF, 0° dip, N, CN 13.42m: DD
	Unweathered, grey, fine grained SANDSTONE. Very Weak.																					13.76m: DD 13.85m: DD
	14.26 - 14.41m: Weakly cemented				PQTT	73								46								14.02m: DD 14.10m: DD 14.15m: DD
	14.41 - 14.78 m: CORE LOSS																					
Unweathered, grey, fine grained SANDSTONE. Very Weak.																					14.88m: DD	

Box 4, 8.3-11.5m

Box 5, 11.5-13.6m

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 3.0 - 5.0 m.

Hole Depth
18.04m

Scale 1:25

Rev.: A

BOREHOLE LOG

BOREHOLE No.:

BH111

SHEET: 4 OF 4

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 10/11/2020

FINISH DATE: 11/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926614.20 mN
(NZTM2000) 1743088.20 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.90m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS					Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations						
East Coast Bays Formation	[CONT] Unweathered, grey, fine grained SANDSTONE. Very Weak.				SPT	100	20/30 for 45mm N>=50 Solid		15.5				0	15.27m: DD 15.35m: DD 15.40m: DD						
	15.65 - 15.75 m: CORE LOSS				PQTT	84							38							
	Unweathered, grey, coarse grained SANDSTONE. Very Weak.				PQTT	100							52	15.89m: DD 15.96m: DD 16.13m: DD 16.22m: DD 16.28m: DD 16.40m: DD						
	16.62 - 16.77 m: CORE LOSS				SPT	100	16/34 for 40mm N>=50 Solid		16.5				0							
	Unweathered, grey, coarse grained SANDSTONE. Weak.				PQTT	76			17.0				66	16.93m: DD 17.10m: DD 17.16m: DD						
	Unweathered, grey, SILTSTONE. Very Weak.																			
	17.25 - 17.4 m: CORE LOSS																			
	Unweathered, grey, fine grained SANDSTONE. Very Weak. 17.46 - 17.48m: SILTSTONE 17.51 - 17.55m: SILTSTONE 17.67 - 17.86m: SILTSTONE				PQTT	80			17.5				44	17.60m: BF, 0° dip, N, CN						
	Unweathered, grey, medium grained SANDSTONE. Very Weak.								18.0				0	18.00m: SPT calibration undertaken between 10.5 - 18.0m						
	18.0 - 18.04 m: Solid SPT						7 for 35mm N>=50 Solid Bouncing													
18.04m: END OF INVESTIGATION																				

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 3.0 - 5.0 m.

Hole Depth
18.04m

Scale 1:25

Rev.: A

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES:	5926614.20 mN (NZTM2000) 1743088.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 10/11/2020
R.L.:	9.90m	DRILL METHOD: RC	HOLE FINISHED: 11/11/2020
DATUM:	NZVD2016	LOGGED BY: YCWA	CHECKED: CBM



0.00-3.45m



3.45-6.00m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926614.20 mN (NZTM2000) 1743088.20 mE		DRILL TYPE: Track-mounted	HOLE STARTED: 10/11/2020
R.L.: 9.90m		DRILL METHOD: RC	HOLE FINISHED: 11/11/2020
DATUM: NZVD2016		LOGGED BY: YCWA	CHECKED: CBM



6.00-8.30m



8.30-11.45m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926614.20 mN (NZTM2000) 1743088.20 mE		DRILL TYPE: Track-mounted	HOLE STARTED: 10/11/2020
R.L.: 9.90m		DRILL METHOD: RC	HOLE FINISHED: 11/11/2020
DATUM: NZVD2016		LOGGED BY: YCWA	CHECKED: CBM



11.45-13.60m



13.60-16.50m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926614.20 mN (NZTM2000) 1743088.20 mE		DRILL TYPE: Track-mounted	HOLE STARTED: 10/11/2020
R.L.: 9.90m		DRILL METHOD: RC	HOLE FINISHED: 11/11/2020
DATUM: NZVD2016			DRILLED BY: McMillan Drilling
			LOGGED BY: YCWA CHECKED: CBM



16.50-18.00m

BOREHOLE LOG

BOREHOLE No.:
BH111A

SHEET: 1 OF 1

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 12/11/2020

FINISH DATE: 12/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI

JOB No.: 1014985.0000

LOCATION: Whenuapai

CO-ORDINATES: 5926614.20 mN
(NZTM2000) 1743090.20 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.90m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
Tauranga Group	SILT, minor rootlets; brown. Stiff to very stiff, low plasticity.																	
	Clayey SILT; light brown mottled orangish brown. Stiff, moist, high plasticity.																	
	0.60 - 0.80m: Trace rootlets. Firm.												0.50m: PID - 0.3 ppm					
	Clayey SILT, minor organics, trace sand; brown. Firm, moist, high plasticity; organics, fleck; sand, fine.												1.00m: PID - 0.5 ppm					
	1.75 - 2.0 m: CORE LOSS																	
	2.0 - 2.5 m: PUSH TUBE																	
	2.5m: END OF BOREHOLE																	

COMMENTS: Drilled 1.5 m from BH111 to recover core in the upper 2.5 m.

Hole Depth
2.5m

Scale 1:25

Rev.: A

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926614.20 mN 1743090.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 12/11/2020
R.L.:	9.90m	DRILL METHOD: RC	HOLE FINISHED: 12/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: YCWA CHECKED: CBM



0.00-2.50m

BOREHOLE LOG

BOREHOLE LOG

BOREHOLE No.:
BH113

SHEET: 2 OF 4

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 04/11/2020

FINISH DATE: 05/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI

JOB No.: 1014985.0000

LOCATION: Whenuapai

CO-ORDINATES: 5926965.50 mN
(NZTM2000) 1743286.20 mE

R.L. GROUND: 12.20m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station\Surveyed

DIRECTION:

ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS					Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations							
Tauranga Group	[CONT] SILT, some clay, trace organics; grey-green. Stiff, moist, moderate plasticity; organics, rootlets								7												
	5.50m: Grades: Light brown				PQTT	100			5.5												
	Organic SILT, minor clay, trace organics; brown speckled black. Firm, moist, low plasticity; organics, rootlets																				
	6.0 - 6.5 m: Push Tube				PT	0	96/10 kPa 1 @ 6.00m		6												
	SILT, trace clay, trace organics; grey speckled black. Firm to stiff, moist, low plasticity; organics, carbonaceous.				SPT	100	0/0 0/0 0/1 N=1		6.5												
					PQTT	100			7.0												
					SPT	111	0/- kPa 0/0 1/0 0/1 N=2		7.5												
	Clayey SILT, trace organics; grey-green speckled black. Stiff, moist, moderate plasticity; organics, rootlets.								8.0												
					PQTT	100			8.5												
	9.00 - 9.05m: Brown mottled grey-green, speckled black.				SPT	148	79/30 kPa 0/1 2/0 1/1 N=4		9.0												
	9.50m: Grey-brown speckled black.								9.5												

Box 2 4.0-7.3m

Box 3 7.3-9.6m

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 4.0 m. SPT calibration undertaken between 13.5 - 18.0 m.

Hole Depth
20m

Scale 1:25

Box 2, 4.0-7.3m

Box 3, 7.3-9.8m



Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

BH113

SHEET: 3 OF 4

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 04/11/2020

FINISH DATE: 05/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926965.50 mN
(NZTM2000) 1743286.20 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 12.20m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
Tauranga Group	[CONT] Clayey SILT, trace organics; grey-green speckled black. Stiff, moist, moderate plasticity; organics, rootlets.			PQTT	100		2											
	Clayey SILT, minor sand, trace organics; light green speckled black. Stiff, moist, moderate plasticity; Sand, fine; organics, rootlets.			SPT	122	78/38 kPa 1/1 1/2 1/3 N=7	10.5											
	SILT, trace organics; grey, brown & light green. Firm, moist, low plasticity; organics, rootlets.						11.0											
	Clayey SILT, trace organics; grey-brown & light green speckled black. Stiff, moist, moderate plasticity; organics, rootlets.			PQTT	100		11.5											
	SILT, trace organics; brown, grey-brown & light green. Firm - stiff, moist, low plasticity; organics, rootlets.						12.0											
	Clayey SILT, trace organics; grey-brown & light green speckled black. Stiff, moist, moderate plasticity; organics, rootlets.			SPT	128	44/10 kPa 0/1 3/3 3/3 N=12	12.0											
	Sandy SILT, trace organics; grey & grey-green. Stiff, moist, low plasticity; Sand, fine; organics, wood fragments.						12.5											
				PQTT	100		13.0											
	13.05m: Grey						13.5											
	Silty fine to coarse SAND, trace gravel, trace organics; grey & grey-green. Medium dense, moist, well graded; Gravel, fine to coarse grained, sub-angular Siltstone & Sandstone; organics, wood fragments.			SPT	124	UTP 5/5 6/12 10/12 N=40	14.0											
East Coast Bays Formation	Moderately weathered, grey and grey-green, fine, SANDSTONE. Extremely Weak, bedded, thin. - INTERBEDDED WITH - Moderately weathered, grey and grey-green, SILTSTONE. Extremely Weak, thin, (recovered as Gravelly SAND).			PQTT	100		14.5											
	Moderately weathered, grey SILTSTONE; Extremely weak (Recovered as, Clayey SILT, some sand; grey. Hard, moist, low plasticity).																	
	Slightly weathered, grey, SANDSTONE; EW																	

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 4.0 m. SPT calibration undertaken between 13.5 - 18.0 m.

Hole Depth
20m

Scale 1:25

Box 4, 9.8-12.5m

Box 5, 12.5-14.9m

Rev.: A

BOREHOLE LOG

BOREHOLE No.:
BH113

SHEET: 4 OF 4

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 04/11/2020

FINISH DATE: 05/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI

JOB No.: 1014985.0000

LOCATION: Whenuapai

CO-ORDINATES: 5926965.50 mN
(NZTM2000) 1743286.20 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 12.20m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS					Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations						
East Coast Bays Formation	15.0 - 5.37 m: Core Loss				SPT	0	2/5 10/17 24 for 75mm N>=50 Solid	-3					0							
	Slightly weathered, grey SILTSTONE; Very weak				PQTT	100			15.5						15.66m: BF, 12° dip, VN, CN					
	15.65m: Very weak								16.0				36		15.85 - 15.87m: BZ 15.90m: BF, 18° dip, VN, CN 15.98m: BF, 15° dip, VN, CN					
	16.5 - 16.91m: Solid cone SPT				SPT	0	2/4 6/8 23/13 for 35mm N>=50 Solid		16.5				0		16.10 - 16.19m: BZ 16.25 - 16.32m: BZ 16.35m: BF, 12° dip, VN, CN					
	Unweathered, grey, SILTSTONE. Weak, laminated. - INTERBEDDED WITH - Unweathered, grey, SANDSTONE. Weak.				PQTT	100			17.0						17.15m: BF, 15° dip, VN, CN 17.26m: BF, 0° dip, VN, CN 17.30m: BF, 15° dip, VN, CN					
	18.0 - 18.28 m: Solid cone SPT				SPT	0	12/25 30/20 for 50mm N>=50 Solid		17.5				28		17.45m: BF, 13° dip 17.49m: BF, 12° dip, VN, Brown veneer 17.51 - 18.00m: BZ 17.55m: J, 55° dip, N 17.60m: J, 55° dip, VN 17.88m: J, 55° dip, VN					
									18.0				0							
									18.5											
									19.0											
									19.5											

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 4.0 m. SPT calibration undertaken between 13.5 - 18.0 m.

Hole Depth
20m

Scale 1:25

Rev.: A

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES:	5926965.50 mN (NZTM2000) 1743286.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 04/11/2020
R.L.:	12.20m	DRILL METHOD: RC	HOLE FINISHED: 05/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: ROM CHECKED: CBM



0.00-4.00m



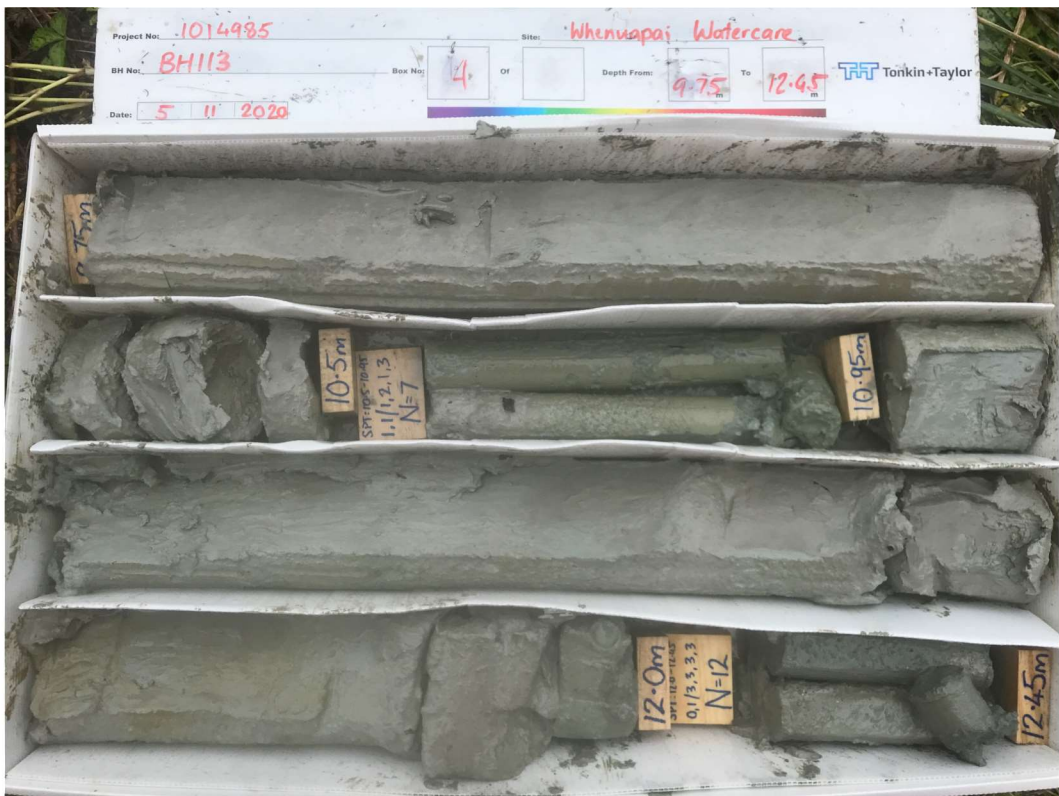
4.00-7.30m

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926965.50 mN 1743286.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 04/11/2020
R.L.:	12.20m	DRILL METHOD: RC	HOLE FINISHED: 05/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



7.30-9.75m



9.75-12.45m

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926965.50 mN 1743286.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 04/11/2020
R.L.:	12.20m	DRILL METHOD: RC	HOLE FINISHED: 05/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



12.45-14.90m



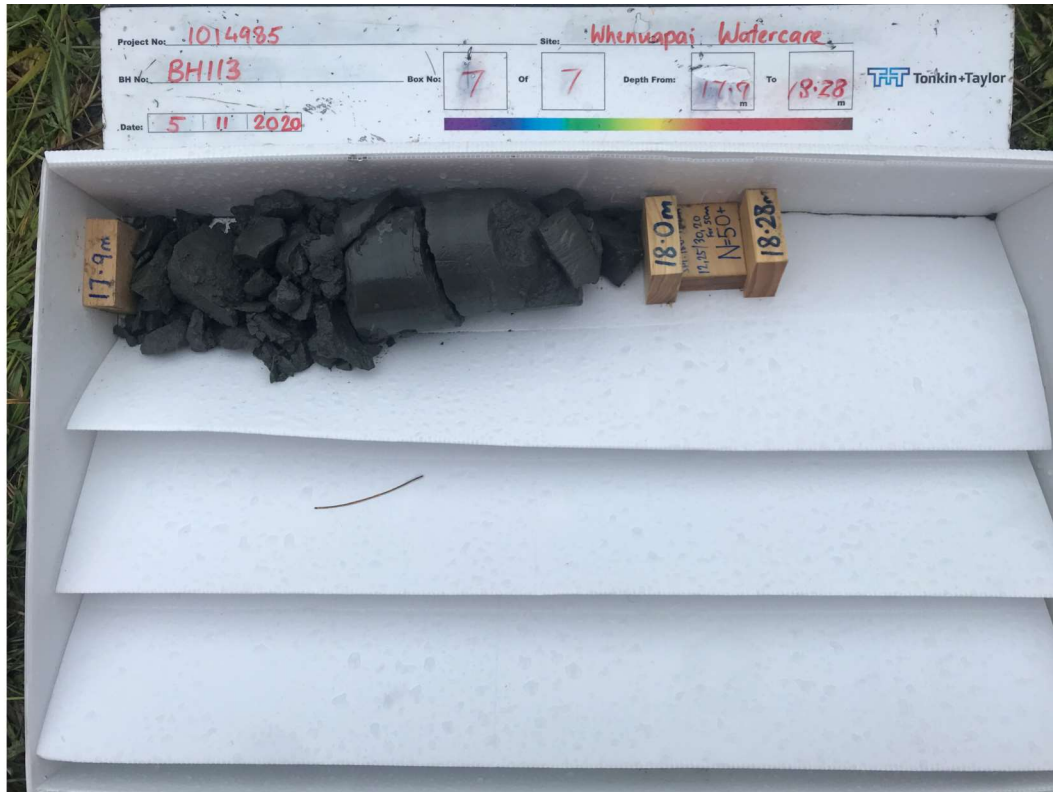
14.90-17.40m

CORE PHOTOS

BOREHOLE No.: **BH113**

SHEET: 4 OF 4

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926965.50 mN 1743286.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 04/11/2020
R.L.:	12.20m	DRILL METHOD: RC	HOLE FINISHED: 05/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: ROM CHECKED: CBM



17.40-18.28m

BOREHOLE LOG

BOREHOLE No.:

BH116

SHEET: 1 OF 4

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 02/11/2020

FINISH DATE: 03/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926934.40 mN
(NZTM2000) 1743342.70 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 13.60m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
Fill	SILT, some sand, minor clay, trace gravel, trace organics; Dark brown. Stiff, moist, moderate plasticity; Sand, fine grained; Gravel, fine grained, angular; organics, rootlets [FILL]						1 @ 0.10m												
	Silty CLAY; some sand, trace gravel; trace organics; Brown mottled orange and dark brown. Very stiff, moist, high plasticity. Sand, fine to coarse grained; Gravel; fine grained, angular Basalt; organics, rootlets [FILL].						2 @ 0.50m	13	0.5										
	Silty CLAY, some sand, trace organics; grey-brown mottled orange, speckled white. Very stiff, moist, high plasticity; Sand, fine grained; Gravel, fine grained, angular; organics, rootlets. 0.85 - 1.5 m: CORE LOSS				PQTT	56	3 @ 1.00m		1.0										
Tauranga Group	Sandy SILT, trace organics; grey mottled orange & brown. Stiff, moist, low plasticity; Sand, fine grained; organics, rootlets.						0/- kPa Geo not present - service clearance	12	1.5										
					SPT	77	1/0 1/1 1/1 N=4		2.0										
	Grades to: Silty fine grained SAND, trace organics; grey mottled orange & brown. Loose, moist, poorly graded; Sand, fine; organics, rootlets						4 @ 2.00m		2.5										
	2.80m: Grades: grey				PQTT	138	7 @ 3.00m		3.0										
	3.05 - 3.45 m: CORE LOSS						0/- kPa Geo not present - service clearance												
					SPT	11	0/1 0/1 0/1 N=2 5 @ 3.45m		3.5										
	3.45 - 3.95 m: PUSH TUBE				PT	0			4.0										
	Silty CLAY, minor sand; green-grey. Very stiff, moist, high plasticity; Sand, fine.						8 @ 4.00m		4.5										
Organic Silty CLAY, trace organics; dark brown speckled black, Firm, moist, high plasticity; organics, carbonaceous						6 @ 4.50m													
4.5 - 5.0 m: PUSH TUBE				PT	0	0/- kPa Geo not present - service clearance		9	4.5										

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 5.0 m.

Hole Depth
18.23m

Scale 1:25

Rev.: A

BOREHOLE LOG

BOREHOLE No.:

BH116

SHEET: 2 OF 4

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 02/11/2020

FINISH DATE: 03/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926934.40 mN
(NZTM2000) 1743342.70 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 13.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS					Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations						
Tauranga Group	[CONT] Organic Silty CLAY, trace organics; dark brown speckled black, Firm, moist, high plasticity; organics, carbonaceous			SPT	140	9 @ 5.00m 0/0 0/0 1/1 N=2		5.5					5.00 - 5.45m: Core extended						
	Silty CLAY, trace organics; grey speckled black. Stiff, moist, high plasticity; organics, rootlets			PQTT	100			6.0											
	6.00m: Grades: green speckled black			SPT	106	0/- kPa 1/1 1/1 0/1 N=3		6.5											
	6.90m: Grades: brown speckled black			PQTT	100			7.0											
	Grades to: Clayey SILT; grey-green. Firm to stiff, moist, moderate plasticity.			SPT	100	69/31 kPa 0/0 1/0 1/1 N=3		8.0											
	Grades to: SILT; grey. Soft to firm, moist, low plasticity, slightly sensitive.							8.5											
	Grades to: Clayey SILT; grey-green. Stiff, moist, moderate plasticity, slightly sensitive.			PQTT	60			9.0					9.00m: Shear vane indicates material is sensitive. Minimal sensitivity recognized during tactile remoulding						
	Grades to: SILT, minor clay; brown. Firm to stiff, moist, low plasticity, slightly sensitive.							9.5											
	Silty CLAY, grey-green. Stiff, moist, high plasticity.			SPT	133	53/9 kPa 1/1 1/1 1/2 N=5													
	SILT; grey-brown & grey-green. Soft to firm, moist, low plasticity, slightly sensitive.																		
	SILT, minor clay; grey-green & brown-grey. Firm to stiff, moist, low plasticity, slightly sensitive.																		

Box 2, 2.5-6.8m

Box 3, 6.8-9.5m

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 5.0 m.

Hole Depth
18.23m

Scale 1:25

Rev.: A

BOREHOLE LOG

BOREHOLE No.:
BH116

SHEET: 3 OF 4

DRILLED BY: Mackenzie
LOGGED BY: ROM
CHECKED: CBM
START DATE: 02/11/2020
FINISH DATE: 03/11/2020
CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926934.40 mN
(NZTM2000) 1743342.70 mE

R.L. GROUND: 13.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station\Surveyed

DIRECTION:
ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering		Rock Strength		Sampling Method		Core Recovery (%)		Testing		RL (m)		Depth (m)		Graphic Log		Defect Log		Fracture Spacing (mm)		RQD (%)		Description & Additional Observations		Fluid Loss (%)		Water Level		Casing		Installation		Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation																																			
Tauranga Group	Silty CLAY, grey-green. Stiff, moist, high plasticity.						PQTT		100																											
	Sandy CLAY, some silt, trace organics. Grey-green speckled black. Stiff, moist, moderate plasticity; Sand, fine; organics, carbonaceous						SPT		142		98/32 kPa 1/1 2/1 2/3 N=8																									
							PQTT		100																											
							SPT		128		85/31 kPa 0/1 2/1 2/2 N=7																									
Albany Conglomerate	12.6 - 13.5 m: CORE LOSS						PQTT		100																											
	Completely weathered, grey speckled black, SANDSTONE. Extremely Weak, (Recovered as Fine SAND, some silt, trace carbonaceous material; grey speckled black. Medium dense, moist, poorly graded)						SPT		115		119/57 kPa 2/2 3/4 3/4 N=14																									
	14.70m: Sand, fine to medium grained 14.85m: SILTSTONE coarse gravel-sized clasts x2						PQTT		100																											
	Completely weathered, grey-green, SANDSTONE. Extremely Weak, (Recovered as Gravelly SAND).																																			

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 5.0 m.

Hole Depth
18.23m

Scale 1:25

Rev.: A



Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

BH116

SHEET: 4 OF 4

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 02/11/2020

FINISH DATE: 03/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926934.40 mN
(NZTM2000) 1743342.70 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 13.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation										Description & Additional Observations								
Albany Conglomerate	[CONT] Completely weathered, grey-green, SANDSTONE. Extremely weak (Recovered as Gravelly SAND)				SPT	100	4/3 6/12 13/20 for 40mm N>=50												Box 5, 11.9-15.4m
	Slightly weathered, grey fine to medium grained SANDSTONE; Very weak				PQTT	100			15.5		15.42 - 15.53m: J, 35° dip, VN, CN 15.50m: BF, 6° dip, VN, CN 15.57m: BF, 6° dip, VN, CN 15.63m: BF, 15° dip, VN, CN 15.63 - 15.75m: J, VN, CN 15.74 - 15.84m: BZ, CN								
	15.92 - 15.94m: Slightly weathered, grey SILTSTONE; Extremely weak 16.00 - 16.50m: Recovered as: Gravelly SAND due to core drop-out and re-drilling.								16.0		12								
	16.5 - 16.88 m: Solid cone SPT				SPT	0	8/14 18/16 16 for 75mm N>=50 Solid		16.5		16.00 - 16.50m: Core disturbed due to drilling process (fell out of barrel)								
	Slightly weathered, grey, SANDSTONE. Very Weak, moderately thick, (60%). - INTERBEDDED WITH - Slightly weathered, grey, SILTSTONE. Very Weak, thin, (40%).				PQTT	84			17.0		36	16.88m: BF, 6° dip, VN, CN 16.94m: BF, 6° dip, VN, CN 16.95m: BF, 4° dip, VN, CN 16.97m: BF, 12° dip, VN, CN 17.11m: BF, 25° dip, VN, CN 17.11 - 17.28m: J, 45° dip, VN, CN 17.15m: BF, 4° dip, VN, CN 17.28m: BF, 10° dip, VN, CN 17.49m: BF, 10° dip, VN, CN							
	17.83 - 18.0 m: CORE LOSS								17.5			17.80m: DD							
	18.0 - 18.23 m: Solid cone SPT				SPT	0	11/22 45/5 for 5mm N>=50 Solid		18.0									Box 6, 15.4-18.2m	
	18.23m: END OF INVESTIGATION																		

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 5.0 m.

Hole Depth
18.23m

Scale 1:25

CORE PHOTOS

BOREHOLE No.: **BH116**

SHEET: 1 OF 3

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926934.40 mN 1743342.70 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 02/11/2020
R.L.:	13.60m	DRILL METHOD: RC	HOLE FINISHED: 03/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



0.00-2.90m



2.90-6.75m

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES:	5926934.40 mN (NZTM2000)	DRILL TYPE: Track-mounted	HOLE STARTED: 02/11/2020
R.L.:	13.60m	DRILL METHOD: RC	HOLE FINISHED: 03/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



6.75-9.45m



9.45-11.85m

CORE PHOTOS

BOREHOLE No.: **BH116**

SHEET: 3 OF 3

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES:	5926934.40 mN (NZTM2000)	DRILL TYPE: Track-mounted	HOLE STARTED: 02/11/2020
R.L.:	1743342.70 mE	DRILL METHOD: RC	HOLE FINISHED: 03/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



11.85-15.42m



15.42-18.23m

BOREHOLE LOG

BOREHOLE No.:

BH117

SHEET: 1 OF 5

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 06/11/2020

FINISH DATE: 09/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926691.00 mN
(NZTM2000) 1743092.70 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 10.90m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
TSoil	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation																	
	Sandy SILT, trace organics; dark brown. Firm, saturated, low plasticity; Sand, fine; organics, rootlets [TOPSOIL].					2 @ 0.10m												
Tauranga Group	Sandy SILT, some clay, trace organics; Brown mottled orange. Stiff, moist, moderate plasticity; Sand, fine; organics, rootlets 0.55m: Brown mottled orange speckled white			PQTT	52	3 @ 0.50m		0.5										
	0.78 - 1.5m: Core Loss							1.0										
	Silty fine grained SAND, minor organics; brown-grey. Medium dense, moist, poorly graded; organics, wood.			SPT	84	1/3 4/5 5/5 N=19		1.5										
	Clayey SILT, minor sand, trace organics; grey-brown speckled black. Stiff, moist, moderate plasticity; Sand, fine; organics, rootlets			PQTT	64	4 @ 2.00m		2.0										
	2.63 - 3.0m: Core Loss							2.5										
	Organic SILT, some clay, trace organics; dark grey - brown. Stiff, moist, low plasticity; organics, wood.			SPT	100	5 @ 3.00m 1/1 1/1 N=4		3.0										
	Grades to: Organic Clayey SILT, trace organics; dark grey-brown. Stiff, moist, low plasticity; organics, wood.			PQTT	83	6 @ 4.00m		4.0										
	4.5 - 5.0m: PUSH TUBE			PT	0	1 @ 4.50m		4.5										

COMMENTS: 50 mm standpipe piezometer with screened interval from 2.0 - 4.0 m.

Hole Depth
21.15m

Scale 1:25

Rev.: A

BOREHOLE LOG

BOREHOLE No.:
BH117

SHEET: 2 OF 5

DRILLED BY: Mackenzie
LOGGED BY: ROM
CHECKED: CBM
START DATE: 06/11/2020
FINISH DATE: 09/11/2020
CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926691.00 mN
(NZTM2000) 1743092.70 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 10.90m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
Tauranga Group	Organic Clayey SILT; dark grey-brown. Stiff, moist, low plasticity; organics, wood. 5.20m: grey-brown, mottled brown speckled black			SPT	100	7 @ 5.00m 0/0 1/1 2/1 N=5		5.5										
				PQTT	100			5										
	Sandy organic SILT; dark brown speckled black. Stiff, moist, low plasticity; Sand, fine; organics, fibrous			SPT	133	0/0 1/1 1/1 N=4		6.0										
	6.85m: Sand inclusions (5%); dark brown, speckled black spotted grey			PQTT	100			6.5										
	7.10m: Grades: grey-brown			PQTT	100			7.0										
	Sandy SILT, trace organics; light grey-green, speckled black. Stiff, moist, low plasticity; Sand, fine; organics, fibrous			SPT	100	0/0 2/1 2/2 N=7		7.5										
	8.10m: Grades: grey-brown, mottled brown, speckled black			PQTT	100			8.0										
	8.90 - 9.00m: Fine to medium grained SAND; grey. Medium dense, moist, poorly graded.			PQTT	100			8.5										
	Sandy SILT, trace organics; grey speckled black. Stiff, moist, low plasticity; Sand, fine; organics, fibrous			SPT	100	1/2 2/3 4/3 N=12		9.0										
	9.28 - 9.29m: Wood (10mm) 9.34 - 9.35m: Wood (10mm)							9.5										
	Fine to coarse SAND, minor silt, trace organics; grey. Medium dense, moist, poorly graded; organics, wood.																	
	Sandy SILT, some clay, trace organics; grey speckled black. Stiff, moist, low plasticity; sand, fine; organics, fibrous.																	

COMMENTS: 50 mm standpipe piezometer with screened interval from 2.0 - 4.0 m.

Hole Depth
21.15m

Scale 1:25

Box 2, 3, 5-7, 1m

Box 3, 7, 1-9, 8m

BOREHOLE LOG

BOREHOLE No.:
BH117

SHEET: 3 OF 5

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 06/11/2020

FINISH DATE: 09/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI

JOB No.: 1014985.0000

LOCATION: Whenuapai

CO-ORDINATES: 5926691.00 mN
(NZTM2000) 1743092.70 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 10.90m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations						
Tauranga Group	Fine SAND, some silt, trace organics; grey & brown. Loose, moist, poorly graded; organics, wood				PQTT	100														
	Fine SAND, some silt, some organics; grey. Loose, moist, poorly graded; organics, wood 9.75 - 9.80m: Wood				SPT	113	1/2 1/2 2/2 N=7		10.5											
	Clayey SILT, trace organics; light green. Stiff, moist, moderate plasticity; organics, fibrous. 10.34 - 10.39m: Wood																			
	Sandy SILT, some clay, trace organics; light grey-green. Stiff, moist, low plasticity; organics, fibrous. 10.40m: brown																			
	Silty SAND, trace organics; brown mottled grey. Medium dense, moist, poorly graded; sand, fine; organics, fibrous. 11.03 - 11.07m: Wood				PQTT	80														
	Silty SAND, some clay, trace organics; brown. Medium dense, moist, poorly graded; sand, fine; organics, wood.				SPT	108	1/2 3/4 4/4 N=15		12.0											
	SAND, some silt, trace organics; grey. Medium dense, moist, poorly graded; sand, fine; organics, wood.																			
	Grades to: Sandy SILT, minor clay, trace organics; grey. Very stiff, moist, low plasticity; Sand, fine; organics, wood				PQTT	90														
	13.50m: Grey & brown, speckled black				SPT	124	1/1 2/2 3/3 N=10		13.5											
	13.90m: Grey																			
	Sandy SILT, some clay, trace organics. Grey & brown speckled black. Very stiff, moist, low plasticity; Sand, fine; organics, carbonaceous.				PQTT	100														

Box 4, 9.8-12.5m

Box 5, 12.6-15.0m

COMMENTS: 50 mm standpipe piezometer with screened interval from 2.0 - 4.0 m.

Hole Depth
21.15m

Scale 1:25

Box 4: 9.8-12.6m

Box 5: 12.6-15.0m

BOREHOLE LOG

BOREHOLE No.:
BH117

SHEET: 4 OF 5

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 06/11/2020

FINISH DATE: 09/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI

JOB No.: 1014985.0000

LOCATION: Whenuapai

CO-ORDINATES: 5926691.00 mN
(NZTM2000) 1743092.70 mE

R.L. GROUND: 10.90m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station\Surveyed

DIRECTION:

ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
East Coast Bays Formation	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation																	
	Sandy SILT, some clay, trace carbonaceous. Grey & brown speckled black. Very stiff, moist, low plasticity; Sand, fine			SPT	144	2/2 3/3 3/5 N=14						0						
	Fine to medium grained SAND, some silt, trace carbonaceous; light green & brown. Medium dense, moist, poorly graded			PQTT	85			15.5				0						
	16.35 - 16.5m: Core Loss																	
	Sandy SILT, some clay, trace carbonaceous light green. Stiff, moist, low plasticity; Sand, fine			SPT	128	2/3 2/4 3/4 N=13		16.5				0						
	Fine SAND, some silt, trace carbonaceous; light green - grey. Loosely packed, moist, poorly graded			PQTT	80			17.0				0						
	17.30m: minor silt.							17.5				0						
	17.60m: some silt							18.0				0						
	18.10 - 18.14m: Wood (40mm)							18.5				0						
	Slight weathered, brown, fine grained SANDSTONE; Very weak			SPT	100	6/6 4/4 4/6 N=18		19.0				0						
	Highly weathered, grey-green speckled white, coarse, SANDSTONE. Extremely Weak, (Recovered as fine to coarse SAND, minor gravel; grey-green speckled white, red, brown & green. Medium dense, moist, poorly graded).							19.5				0						
	18.75 - 19.5m: Core Loss			PQTT	28			19.0				0						
	Highly weathered, grey-green speckled white, red, brown & green, coarse, SANDSTONE. Extremely Weak, (Recovered as Fine to coarse SAND, minor gravel; grey-green speckled white, red, brown & green. Very dense, moist, poorly graded).			SPT	77	4/4 5/7 21/18 for 50mm N>=50		19.5				0						

COMMENTS: 50 mm standpipe piezometer with screened interval from 2.0 - 4.0 m.

Hole Depth
21.15m

Scale 1:25

Box 6, 15.0-17.8m

BOREHOLE LOG

BOREHOLE No.:

BH117

SHEET: 5 OF 5

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 06/11/2020

FINISH DATE: 09/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926691.00 mN
(NZTM2000) 1743092.70 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 10.90m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
East Coast Bays Formation	Moderately weathered, grey, fine SANDSTONE; Extremely weak, weakly cemented (Recovered as Fine grained SAND, trace silt; grey. Very dense, moist, poorly graded)																		
	20.38 - 21.0 m: Core Loss				PQTT	42			20.5				0						
	Moderately weathered, grey, fine SANDSTONE; Extremely weak, weakly cemented (Recovered as Fine grained SAND, trace silt; grey. Very dense, moist, poorly graded)				SPT	100	17/33 for 30mm N>=50		21.0				0					Box 7, 17.8-21.2m	
	21.15m: END OF INVESTIGATION								21.5										
									-11										
									-12										
									-13										
									-14										

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES:	5926691.00 mN (NZTM2000) 1743092.70 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 06/11/2020
R.L.:	10.90m	DRILL METHOD: RC	HOLE FINISHED: 09/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



0.00-3.75m



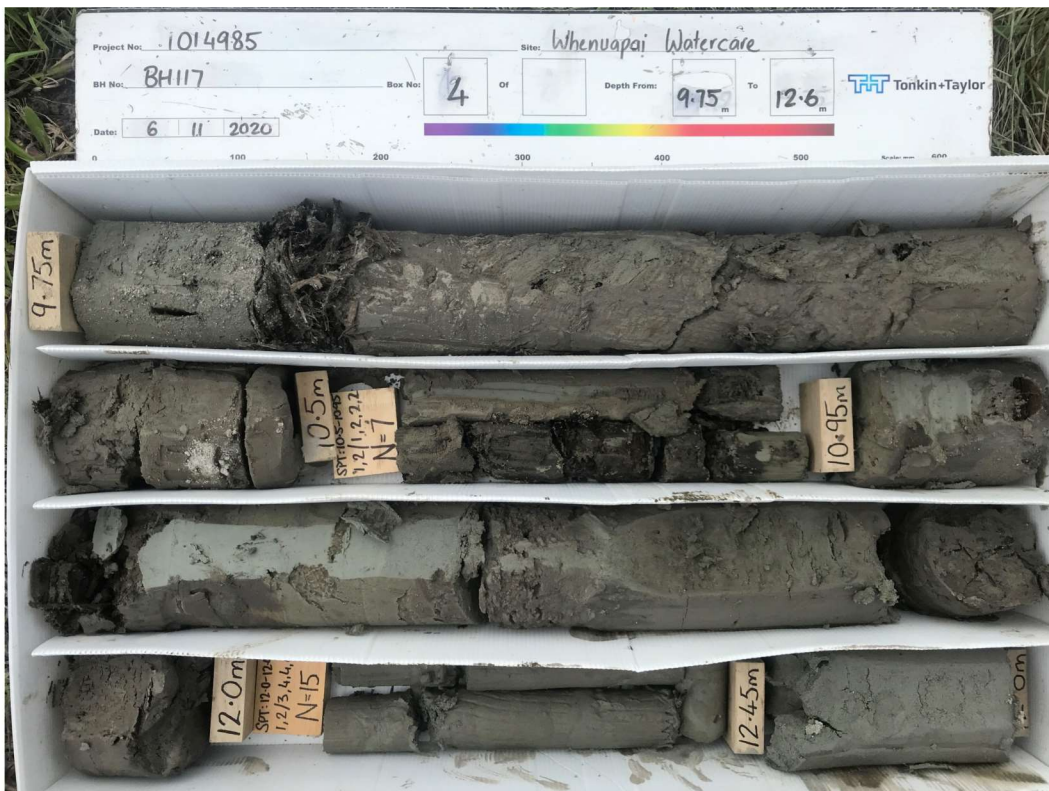
3.75-7.05m

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES:	5926691.00 mN (NZTM2000) 1743092.70 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 06/11/2020
R.L.:	10.90m	DRILL METHOD: RC	HOLE FINISHED: 09/11/2020
DATUM:	NZVD2016	DRILLED BY: McMillan Drilling	LOGGED BY: ROM
			CHECKED: CBM



7.05-9.75m



9.75-12.60m

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES:	5926691.00 mN (NZTM2000) 1743092.70 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 06/11/2020
R.L.:	10.90m	DRILL METHOD: RC	HOLE FINISHED: 09/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



12.60-15.00m



15.00-17.80m

CORE PHOTOS

BOREHOLE No.: **BH117**

SHEET: 4 OF 4

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926691.00 mN 1743092.70 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 06/11/2020
R.L.:	10.90m	DRILL METHOD: RC	HOLE FINISHED: 09/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: ROM CHECKED: CBM

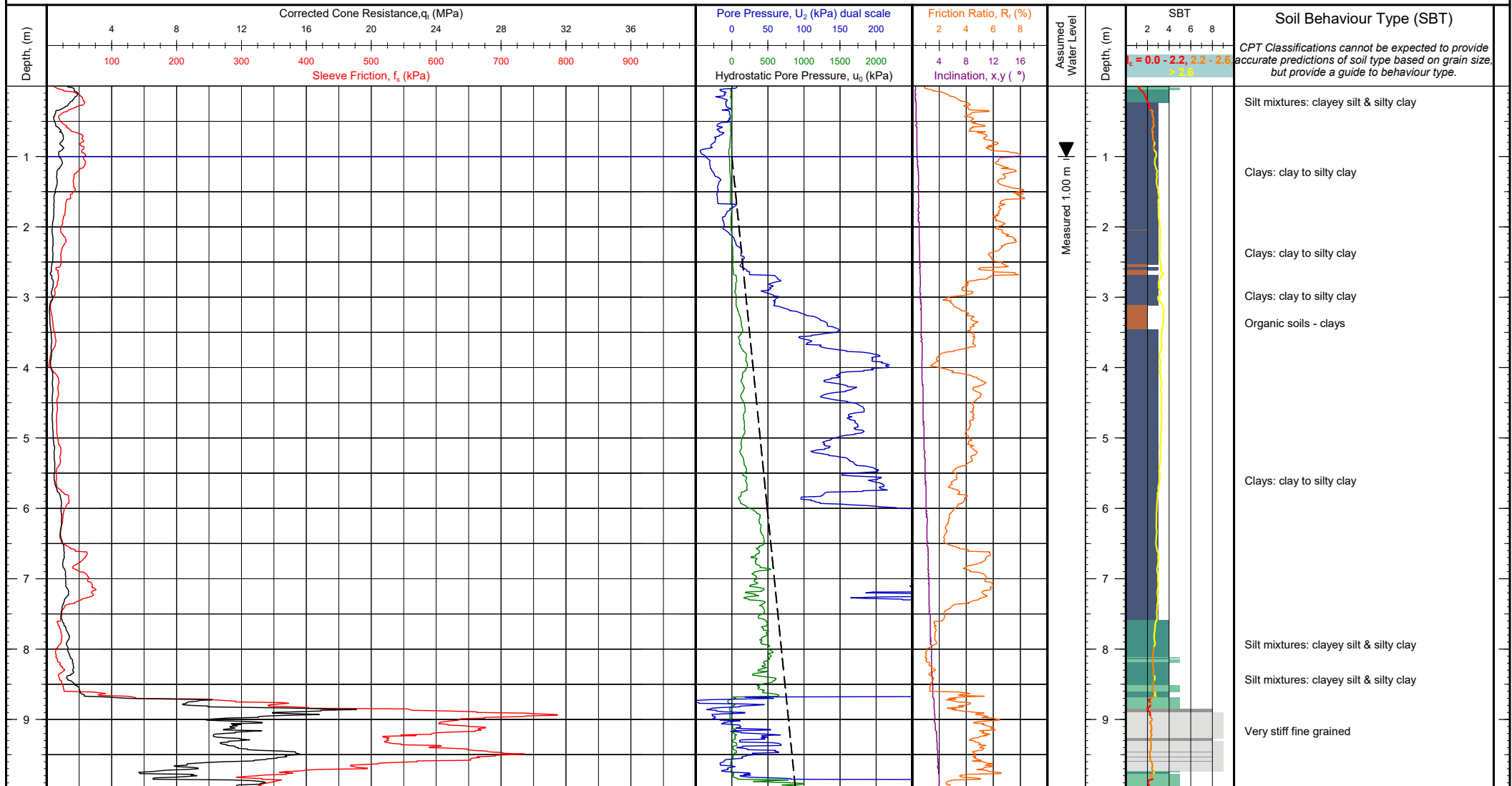


17.80-21.15m



Tonkin+Taylor

CONE PENETRATION TEST (CPT) LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Operator: Ben Thom
Cone Ref: MKJ325
Cone Type: 10cm² Compression
Area Ratio: 0.80
Filter Type: u_2

NZTM 2000 N, E (m): 5926555.13, 1743194.03
WGS84 (deg): -36.796009, 174.605017
Location Method: Handheld GPS
Surveyor:
Termination Reason: High friction resistance

Elevation (m): Unknown
Date of Test: 3/11/2020
Depth (m): 10.57
Pre Drill (m): N/A

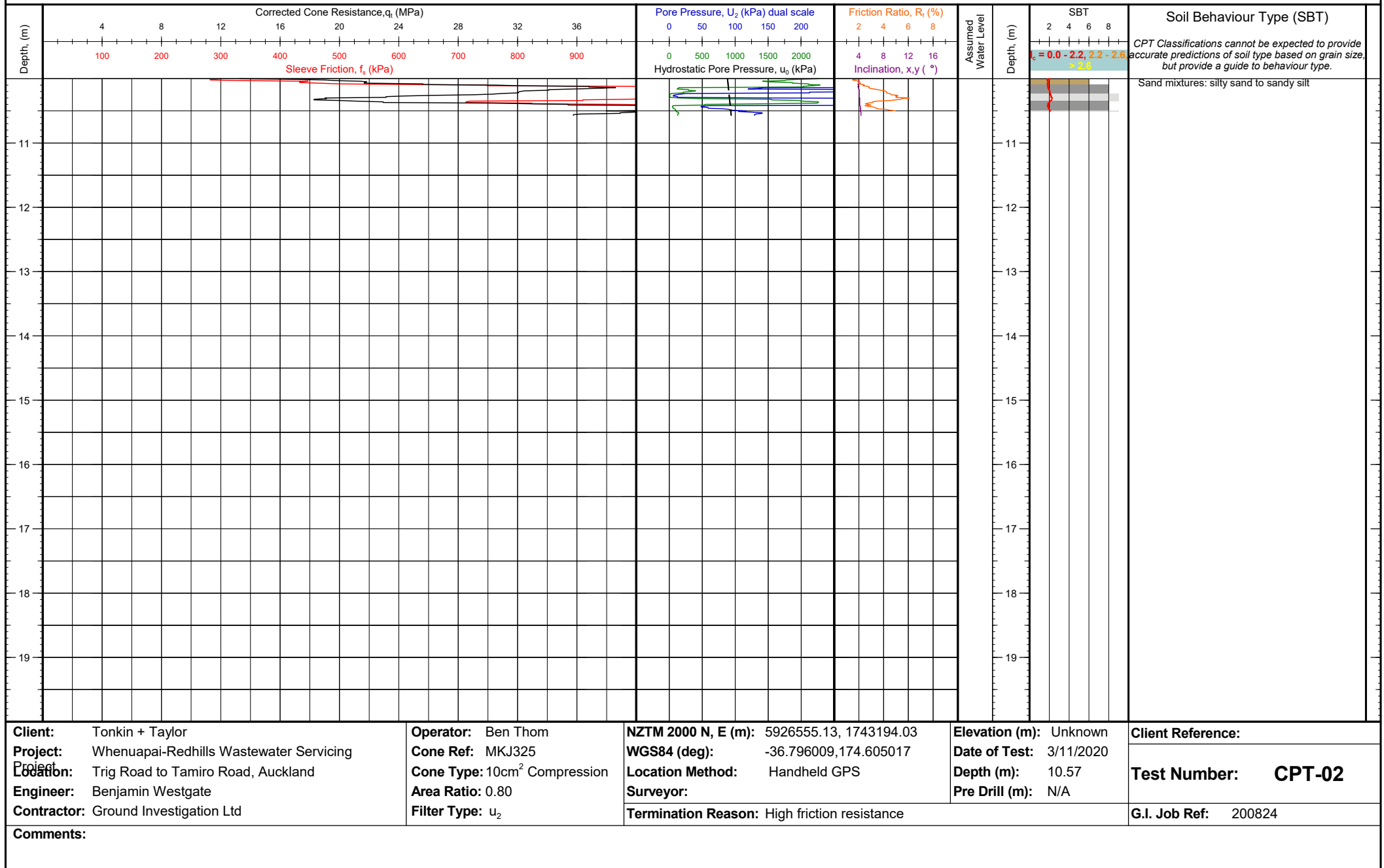
Client Reference:
Test Number: CPT-02
G.I. Job Ref: 200824

Comments:



Tonkin + Taylor

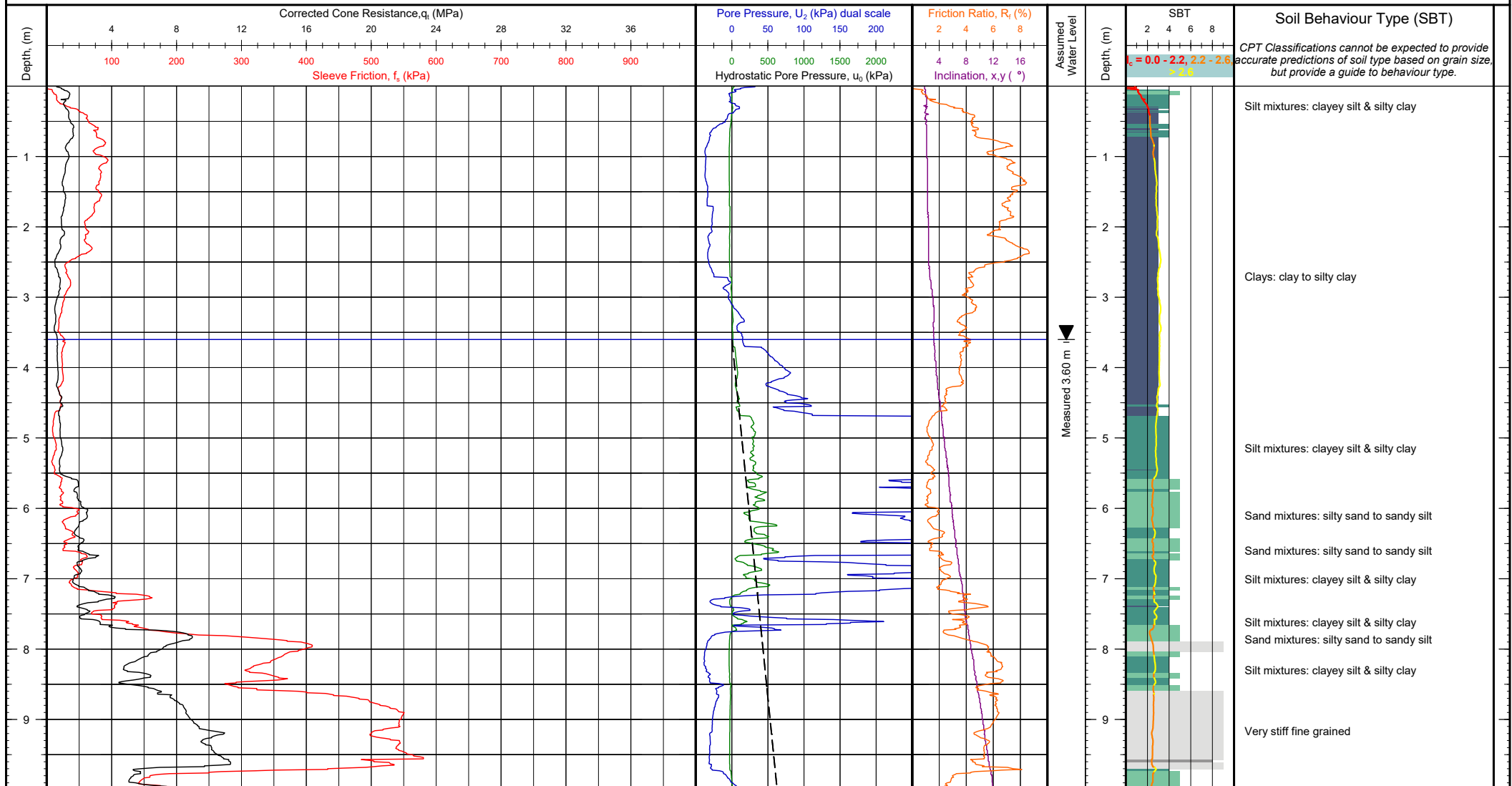
CONE PENETRATION TEST (CPT) LOG





Tonkin + Taylor

CONE PENETRATION TEST (CPT) LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Operator: Ben Thom
Cone Ref: MKJ309
Cone Type: 10cm² Compression
Area Ratio: 0.80
Filter Type: u_2

NZTM 2000 N, E (m): 5926510.40, 1743188.37
WGS84 (deg): -36.796413, 174.604962
Location Method: Handheld GPS
Surveyor:
Termination Reason: Danger of buckling rods

Elevation (m): Unknown
Date of Test: 3/11/2020
Depth (m): 11.23
Pre Drill (m): N/A

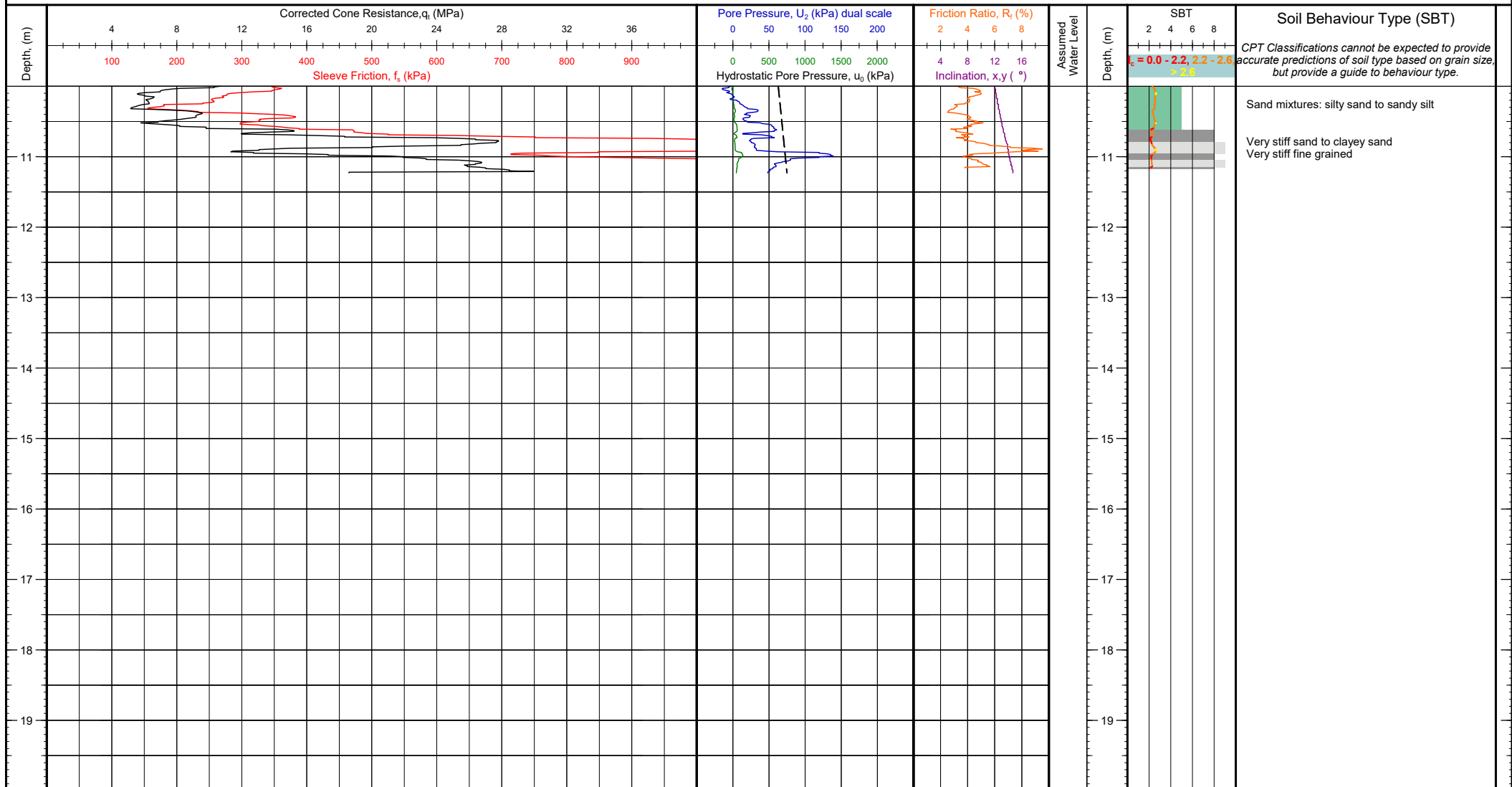
Client Reference:
Test Number: CPT-03
G.I. Job Ref: 200824

Comments:



Tonkin + Taylor

CONE PENETRATION TEST (CPT) LOG



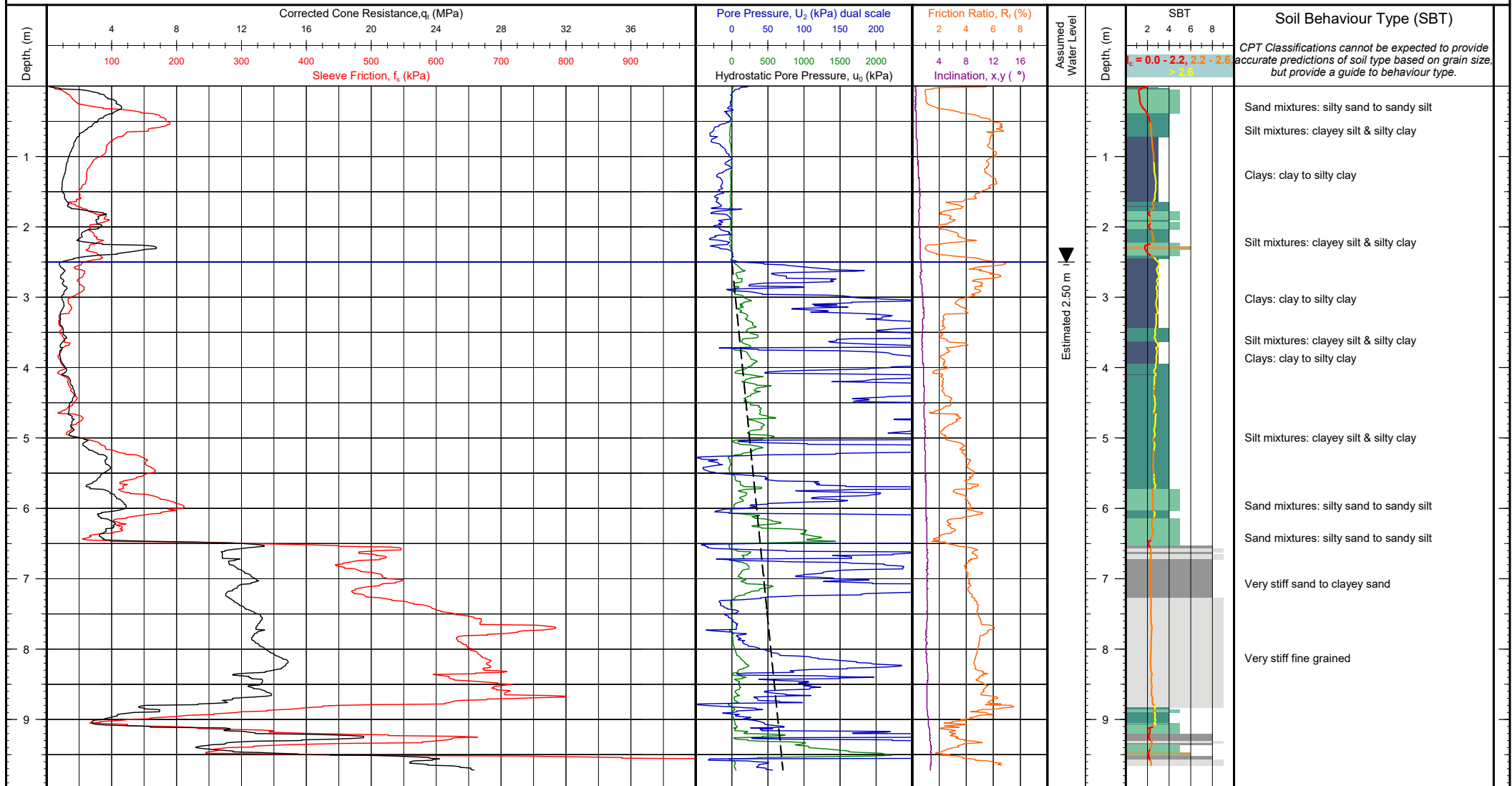
Client: Tonkin + Taylor Project: Whenuapai-Redhills Wastewater Servicing Location: Trig Road to Tamiro Road, Auckland Engineer: Benjamin Westgate Contractor: Ground Investigation Ltd	Operator: Ben Thom Cone Ref: MKJ309 Cone Type: 10cm ² Compression Area Ratio: 0.80 Filter Type: u_2	NZTM 2000 N, E (m): 5926510.40, 1743188.37 WGS84 (deg): -36.796413, 174.604962 Location Method: Handheld GPS Surveyor: Termination Reason: Danger of buckling rods	Elevation (m): Unknown Date of Test: 3/11/2020 Depth (m): 11.23 Pre Drill (m): N/A	Client Reference:
				Test Number: CPT-03 G.I. Job Ref: 200824

Comments:



Tonkin+Taylor

CONE PENETRATION TEST (CPT) LOG



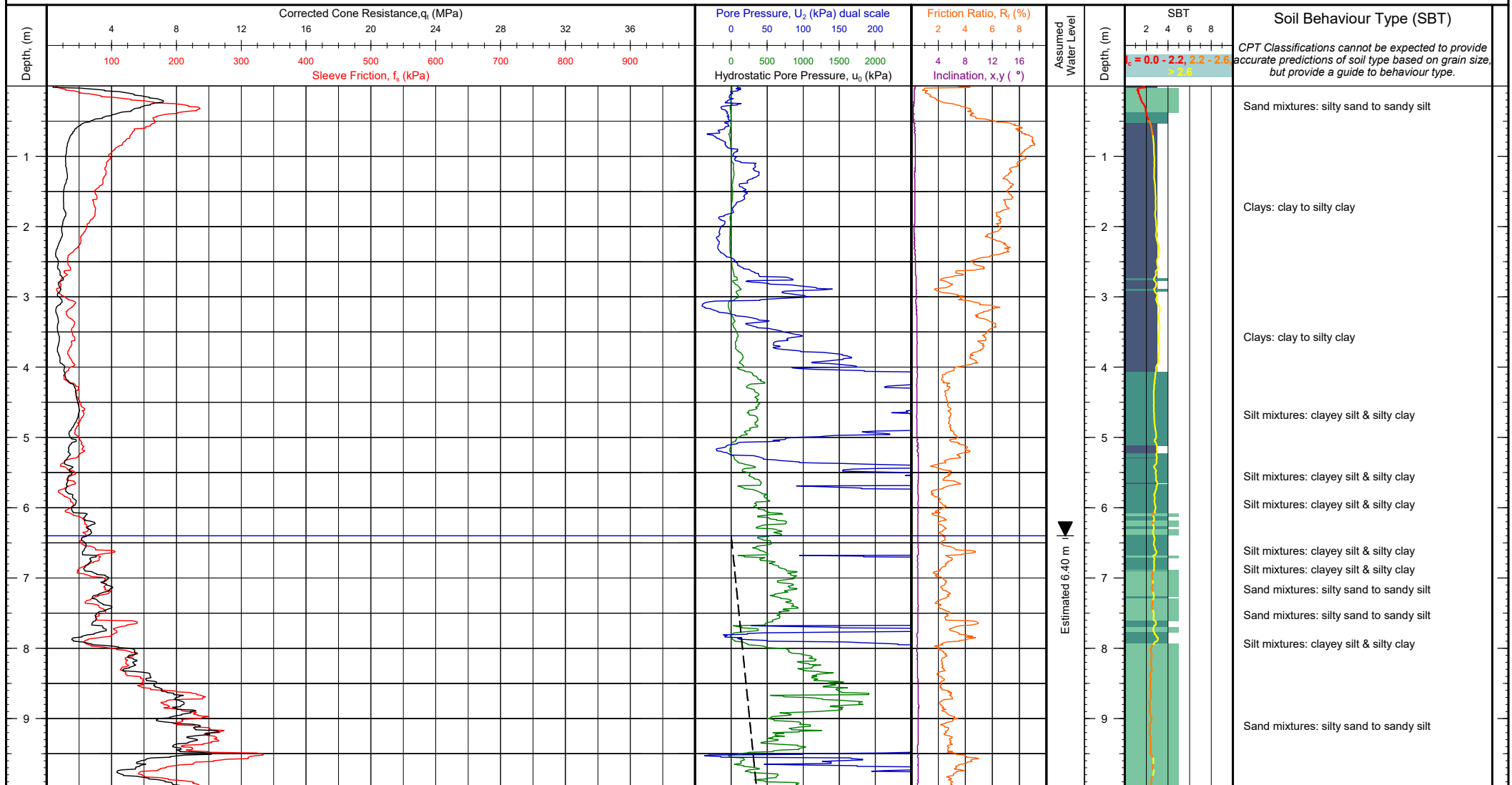
Client: Tonkin + Taylor Project: Whenuapai-Redhills Wastewater Servicing Location: Trig Road to Tamiro Road, Auckland Engineer: Benjamin Westgate Contractor: Ground Investigation Ltd	Operator: Ben Thom Cone Ref: MKJ325 Cone Type: 10cm ² Compression Area Ratio: 0.80 Filter Type: u_2	NZTM 2000 N, E (m): 5926415.00, 1743205.87 WGS84 (deg): -36.797270, 174.605176 Location Method: Handheld GPS Surveyor: Termination Reason: High friction resistance	Elevation (m): Unknown Date of Test: 3/11/2020 Depth (m): 9.72 Pre Drill (m): N/A	Client Reference:
				Test Number: CPT-04 G.I. Job Ref: 200824

Comments:



Tonkin+Taylor

CONE PENETRATION TEST (CPT) LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Operator: Ben Thom
Cone Ref: MKJ309
Cone Type: 10cm² Compression
Area Ratio: 0.80
Filter Type: u_2

NZTM 2000 N, E (m): 5926270.32, 1743217.01
WGS84 (deg): -36.798572, 174.605328
Location Method: Handheld GPS
Surveyor:
Termination Reason: High friction resistance

Elevation (m): Unknown
Date of Test: 3/11/2020
Depth (m): 19.27
Pre Drill (m): N/A

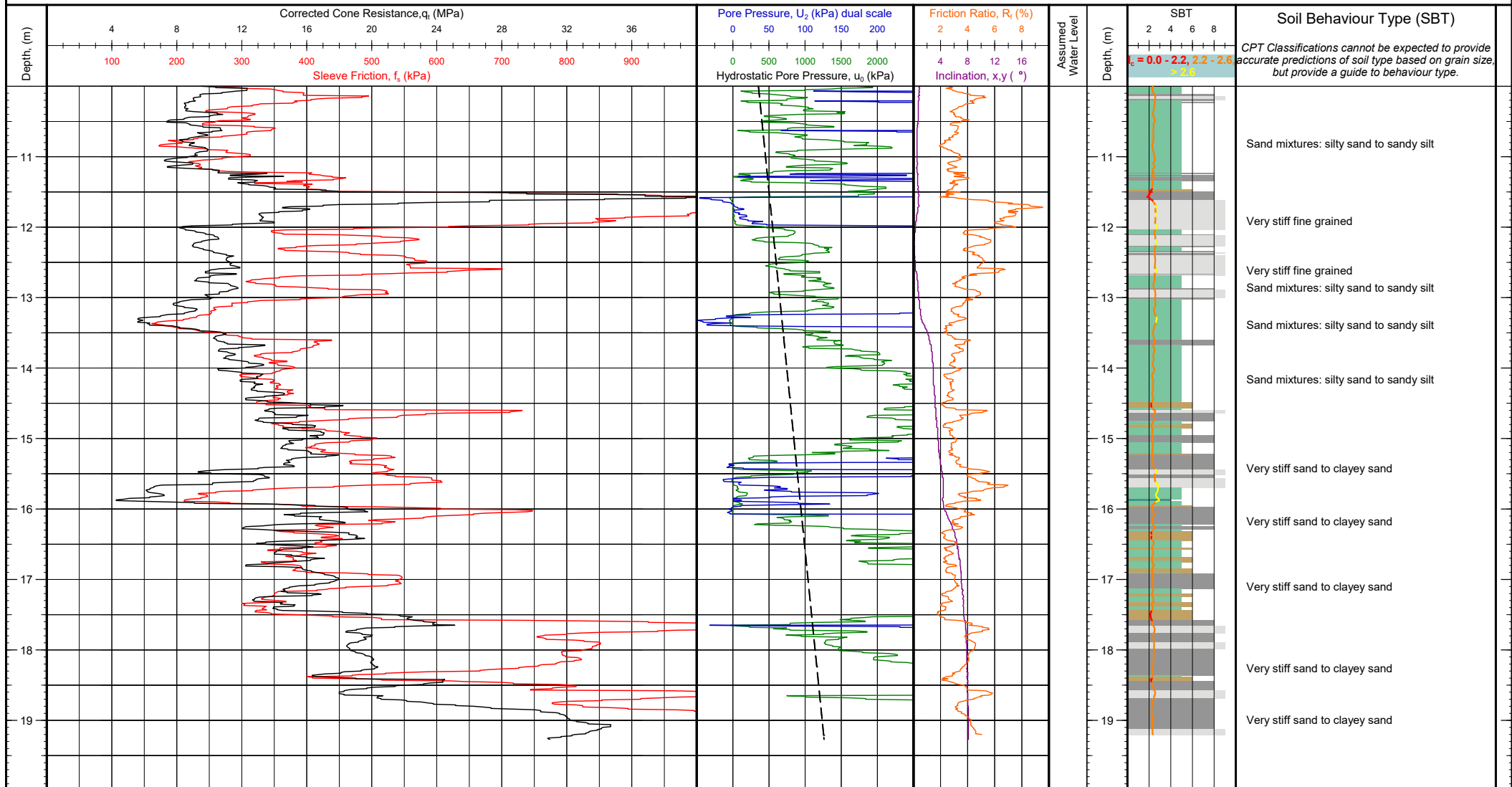
Client Reference:
Test Number: CPT-05
G.I. Job Ref: 200824

Comments:



Tonkin + Taylor

CONE PENETRATION TEST (CPT) LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Operator: Ben Thom
Cone Ref: MKJ309
Cone Type: 10cm² Compression
Area Ratio: 0.80
Filter Type: u_2

NZTM 2000 N, E (m): 5926270.32, 1743217.01
WGS84 (deg): -36.798572, 174.605328
Location Method: Handheld GPS
Surveyor:
Termination Reason: High friction resistance

Elevation (m): Unknown
Date of Test: 3/11/2020
Depth (m): 19.27
Pre Drill (m): N/A

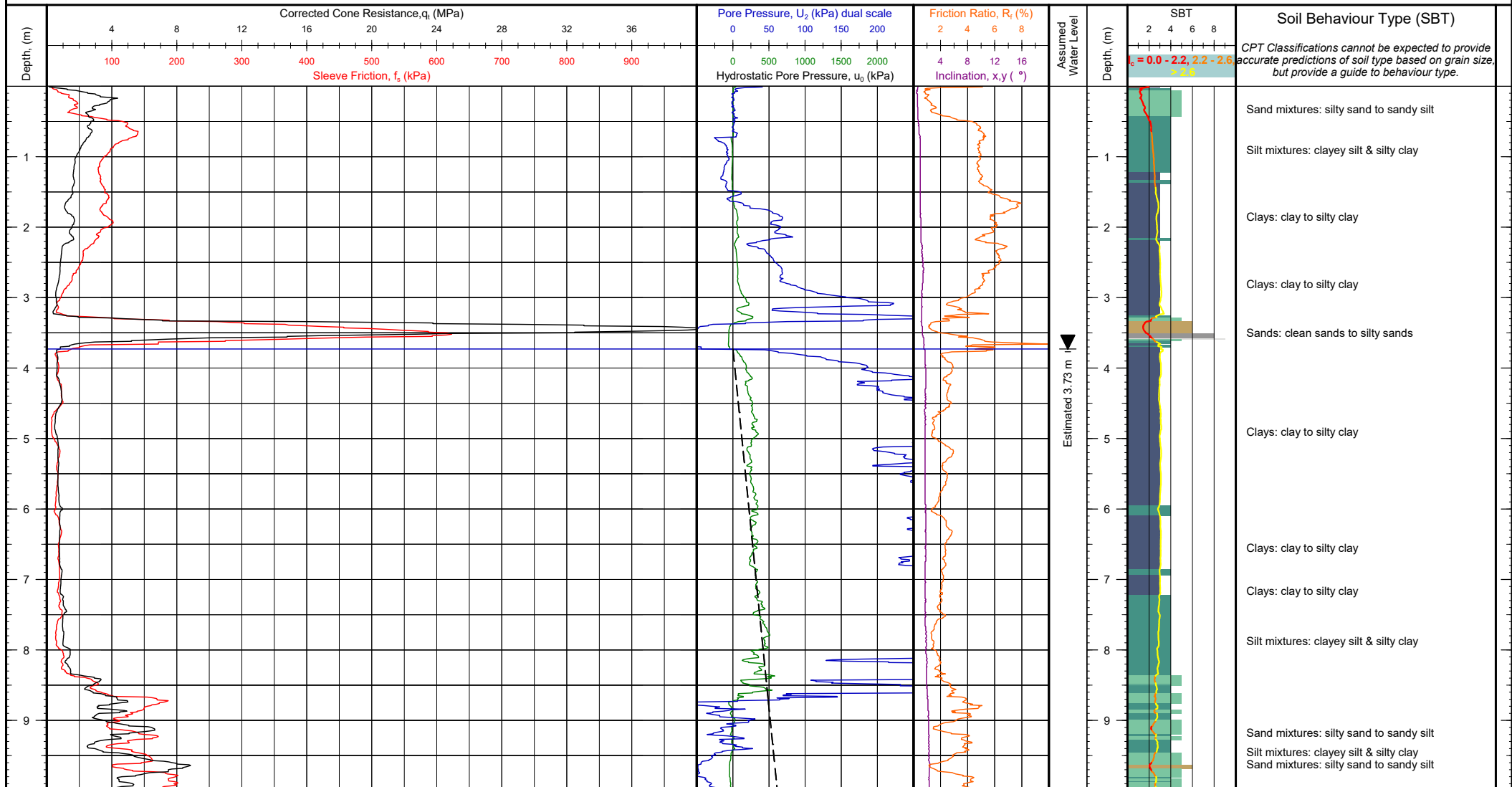
Client Reference:
Test Number: CPT-05
G.I. Job Ref: 200824

Comments:



Tonkin+Taylor

CONE PENETRATION TEST (CPT) LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Operator: Ben Thom
Cone Ref: MKJ333
Cone Type: 10cm² Compression
Area Ratio: 0.80
Filter Type: u_2

NZTM 2000 N, E (m): 5926158.21, 1743337.57
WGS84 (deg): -36.799564, 174.606700
Location Method: Handheld GPS
Surveyor:
Termination Reason: Inclination high or rapid increase

Elevation (m): Unknown
Date of Test: 4/11/2020
Depth (m): 13.46
Pre Drill (m): N/A

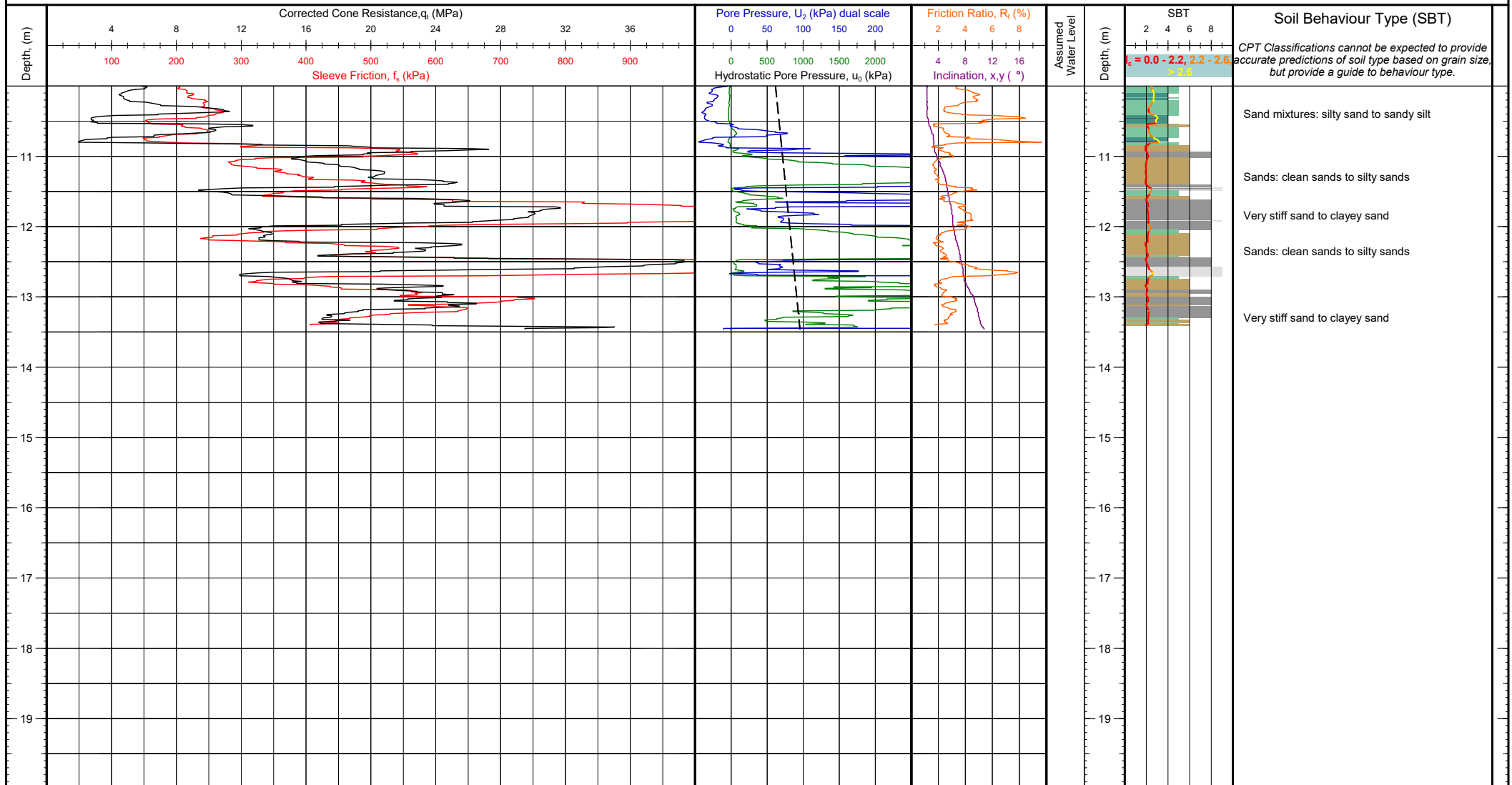
Client Reference:
Test Number: CPT-06
G.I. Job Ref: 200824

Comments:



Tonkin+Taylor

CONE PENETRATION TEST (CPT) LOG



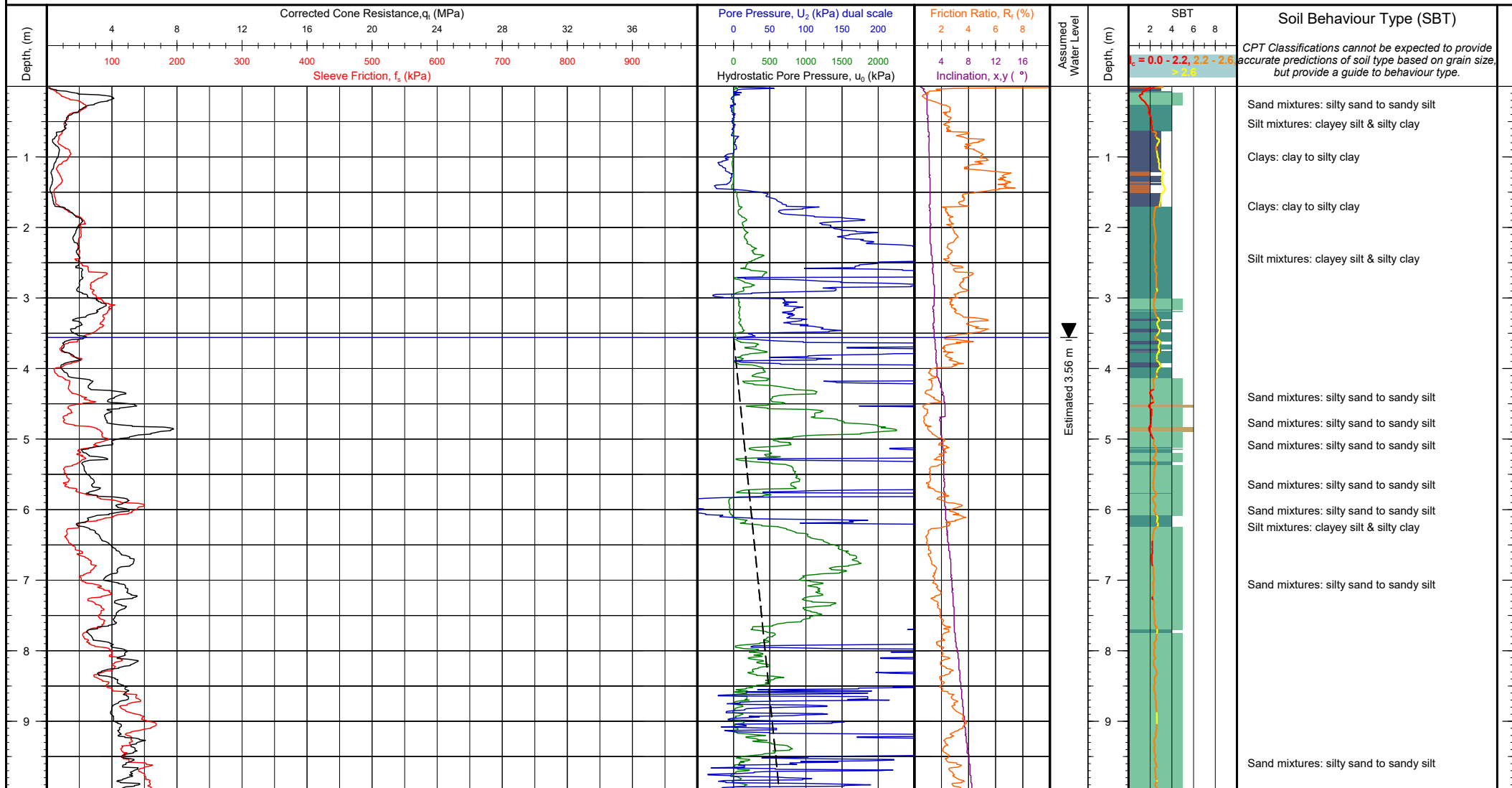
Client: Tonkin + Taylor Project: Whenuapai-Redhills Wastewater Servicing Location: Trig Road to Tamiro Road, Auckland Engineer: Benjamin Westgate Contractor: Ground Investigation Ltd	Operator: Ben Thom Cone Ref: MKJ333 Cone Type: 10cm ² Compression Area Ratio: 0.80 Filter Type: u_2	NZTM 2000 N, E (m): 5926158.21, 1743337.57 WGS84 (deg): -36.799564, 174.606700 Location Method: Handheld GPS Surveyor: Termination Reason: Inclination high or rapid increase	Elevation (m): Unknown Date of Test: 4/11/2020 Depth (m): 13.46 Pre Drill (m): N/A	Client Reference:
				Test Number: CPT-06 G.I. Job Ref: 200824

Comments:



Tonkin+Taylor

CONE PENETRATION TEST (CPT) LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Operator: Ben Thom
Cone Ref: MKJ333
Cone Type: 10cm² Compression
Area Ratio: 0.80
Filter Type: u_2

NZTM 2000 N, E (m): 5926057.82, 1743414.41
WGS84 (deg): -36.800457, 174.607580
Location Method: Handheld GPS
Surveyor:
Termination Reason: Inclination high or rapid increase

Elevation (m): Unknown
Date of Test: 4/11/2020
Depth (m): 16.06
Pre Drill (m): N/A

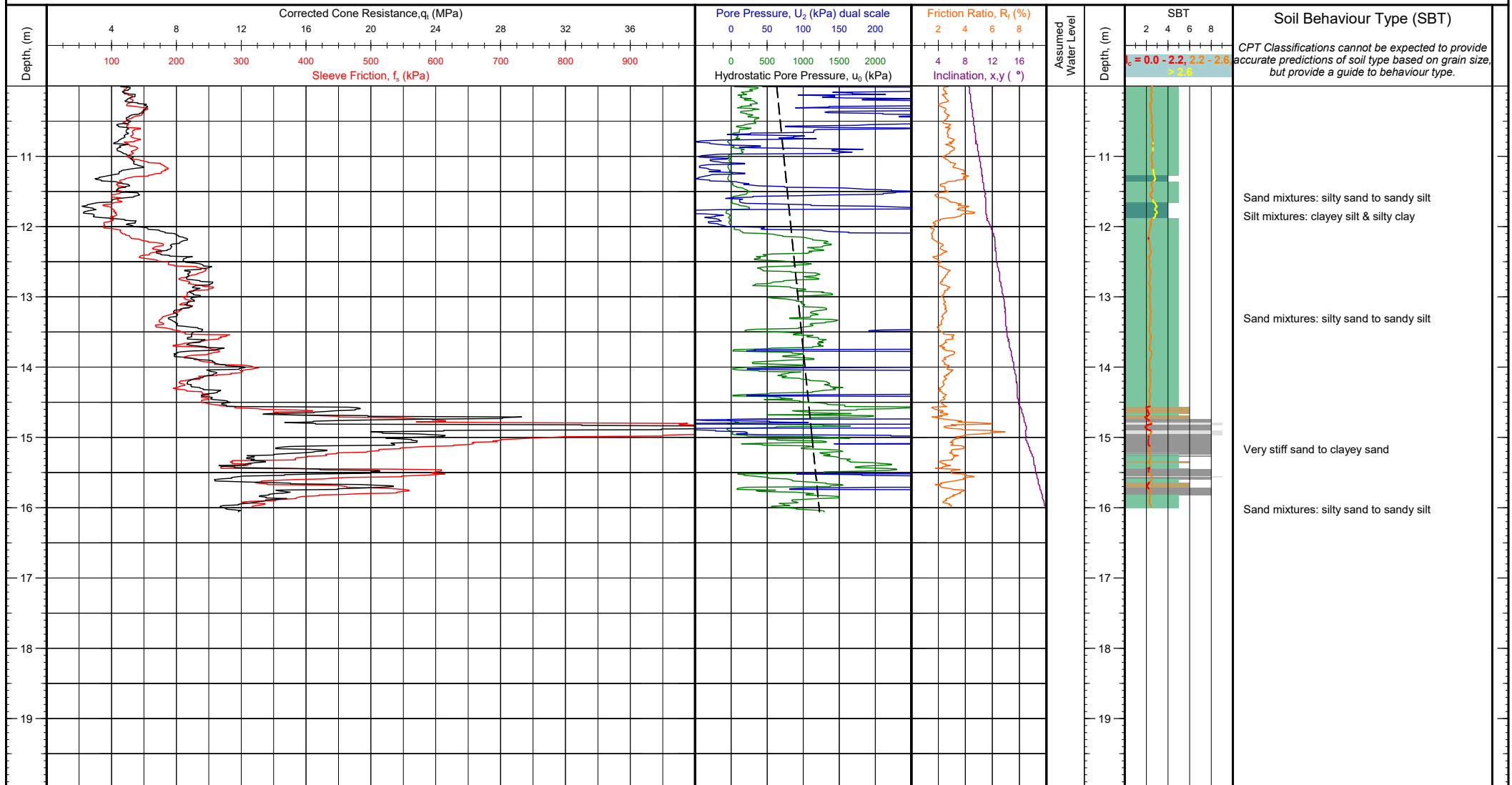
Client Reference:
Test Number: CPT-07
G.I. Job Ref: 200824

Comments:



Tonkin+Taylor

CONE PENETRATION TEST (CPT) LOG



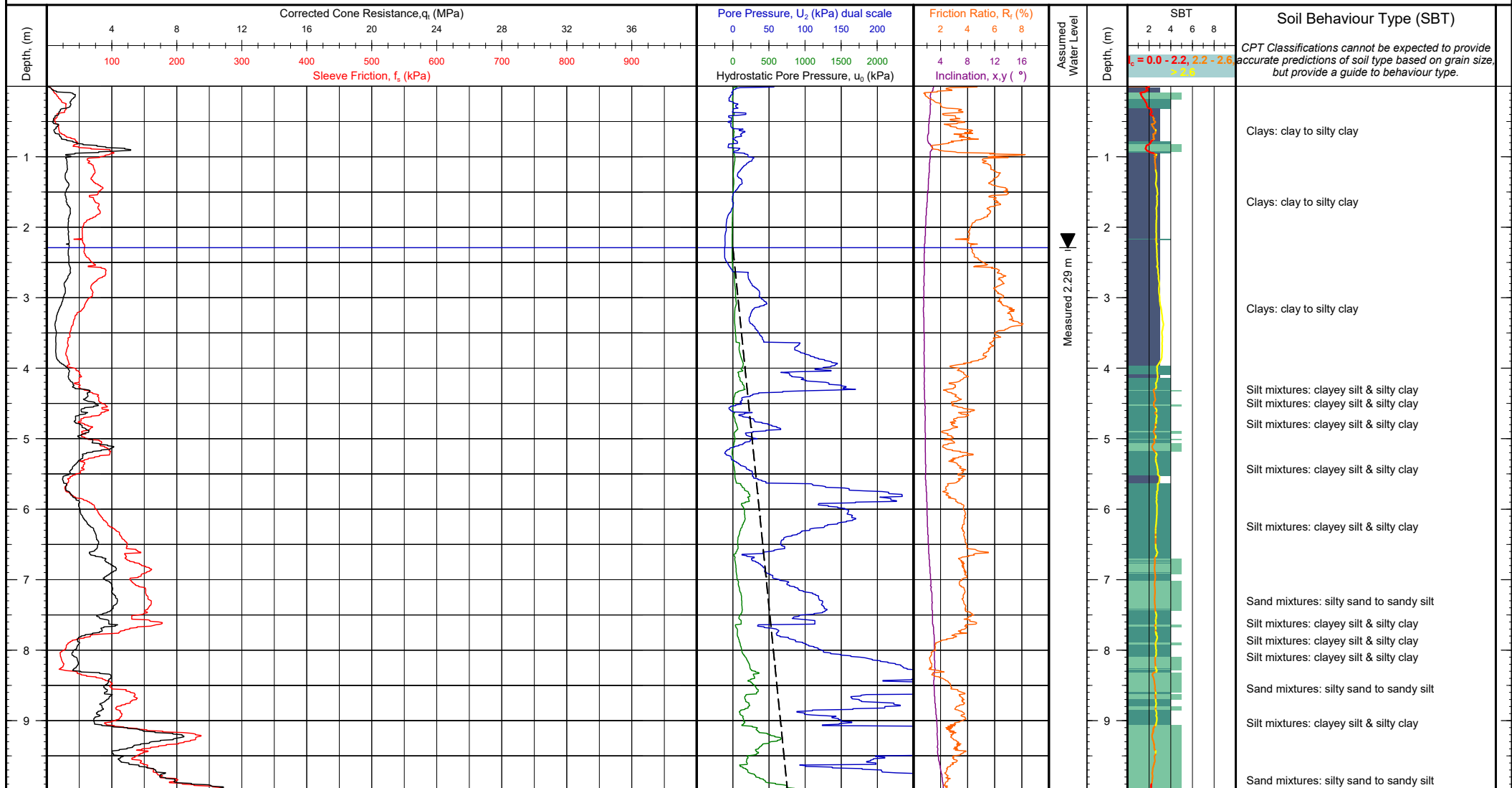
Client: Tonkin + Taylor Project: Whenuapai-Redhills Wastewater Servicing Location: Trig Road to Tamiro Road, Auckland Engineer: Benjamin Westgate Contractor: Ground Investigation Ltd	Operator: Ben Thom Cone Ref: MKJ333 Cone Type: 10cm ² Compression Area Ratio: 0.80 Filter Type: u_2	NZTM 2000 N, E (m): 5926057.82, 1743414.41 WGS84 (deg): -36.800457, 174.607580 Location Method: Handheld GPS Surveyor: Termination Reason: Inclination high or rapid increase	Elevation (m): Unknown Date of Test: 4/11/2020 Depth (m): 16.06 Pre Drill (m): N/A	Client Reference:
				Test Number: CPT-07 G.I. Job Ref: 200824

Comments:



Tonkin + Taylor

CONE PENETRATION TEST (CPT) LOG



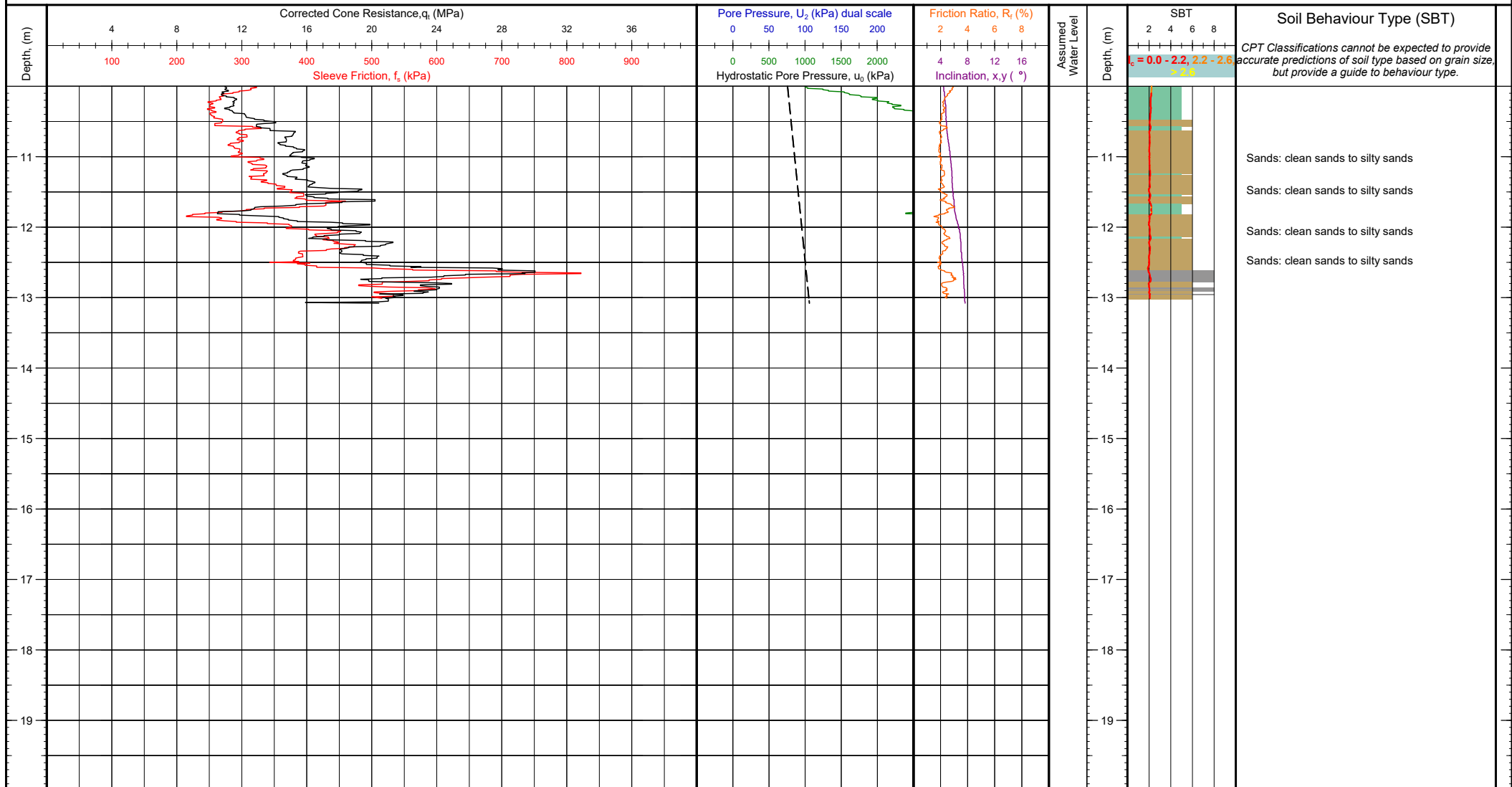
Client: Tonkin + Taylor	Operator: Ben Thom	NZTM 2000 N, E (m): 5925758.53, 1744112.15	Elevation (m): Unknown	Client Reference:
Project: Whenuapai-Redhills Wastewater Servicing	Cone Ref: MKJ539	WGS84 (deg): -36.803048, 174.615455	Date of Test: 18/11/2020	
Location: Trig Road to Tamiro Road, Auckland	Cone Type: 10cm ² Compression	Location Method: Handheld GPS	Depth (m): 13.08	Test Number: CPT-08
Engineer: Benjamin Westgate	Area Ratio: 0.80	Surveyor:	Pre Drill (m): N/A	
Contractor: Ground Investigation Ltd	Filter Type: u_2	Termination Reason: High pore water pressure		G.I. Job Ref: 200824

Comments:



Tonkin + Taylor

CONE PENETRATION TEST (CPT) LOG



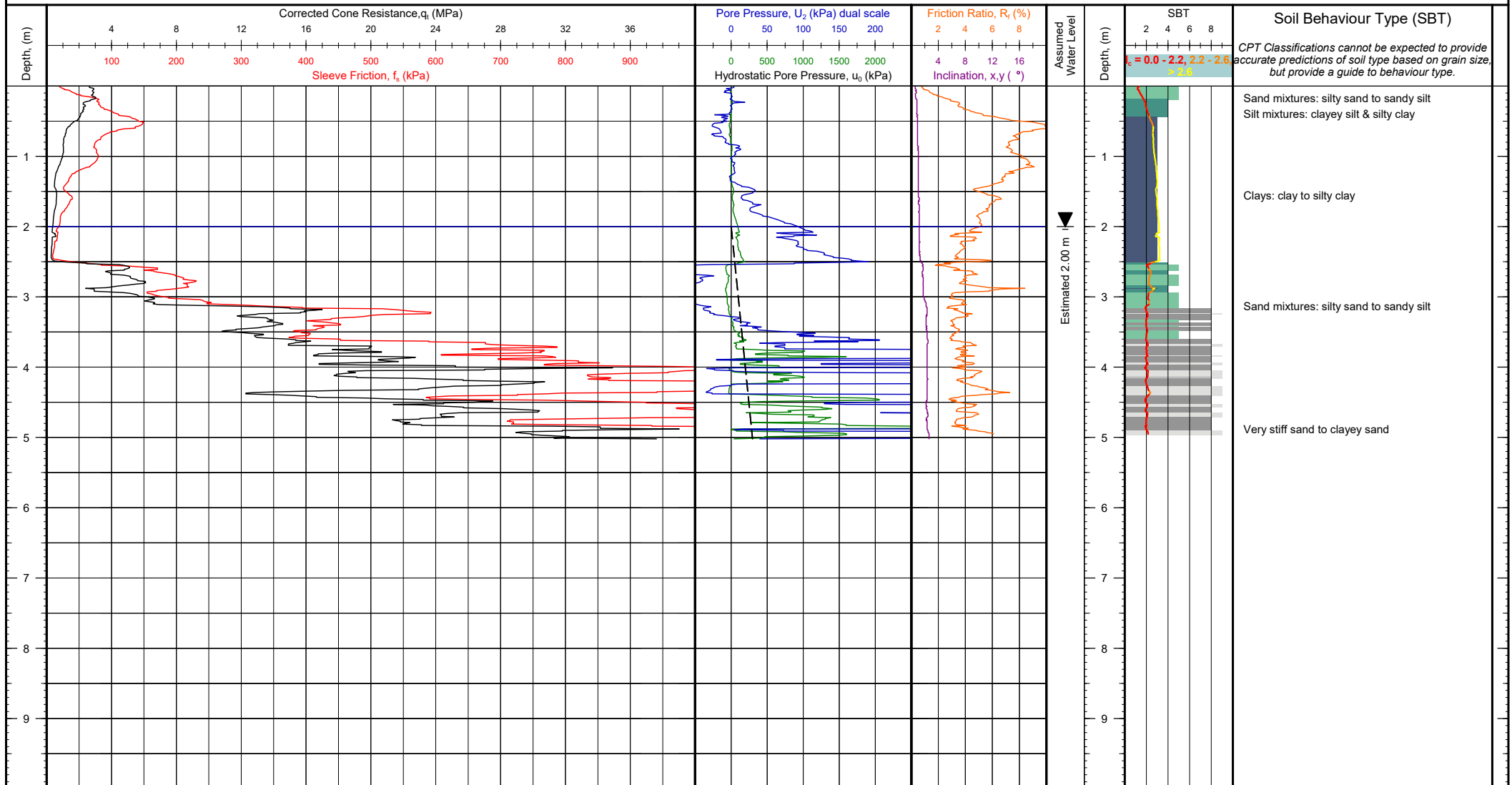
Client: Tonkin + Taylor	Operator: Ben Thom	NZTM 2000 N, E (m): 5925758.53, 1744112.15	Elevation (m): Unknown	Client Reference:
Project: Whenuapai-Redhills Wastewater Servicing	Cone Ref: MKJ539	WGS84 (deg): -36.803048, 174.615455	Date of Test: 18/11/2020	
Location: Trig Road to Tamiro Road, Auckland	Cone Type: 10cm ² Compression	Location Method: Handheld GPS	Depth (m): 13.08	Test Number: CPT-08
Engineer: Benjamin Westgate	Area Ratio: 0.80	Surveyor:	Pre Drill (m): N/A	
Contractor: Ground Investigation Ltd	Filter Type: u_2	Termination Reason: High pore water pressure		G.I. Job Ref: 200824

Comments:



Tonkin + Taylor

CONE PENETRATION TEST (CPT) LOG

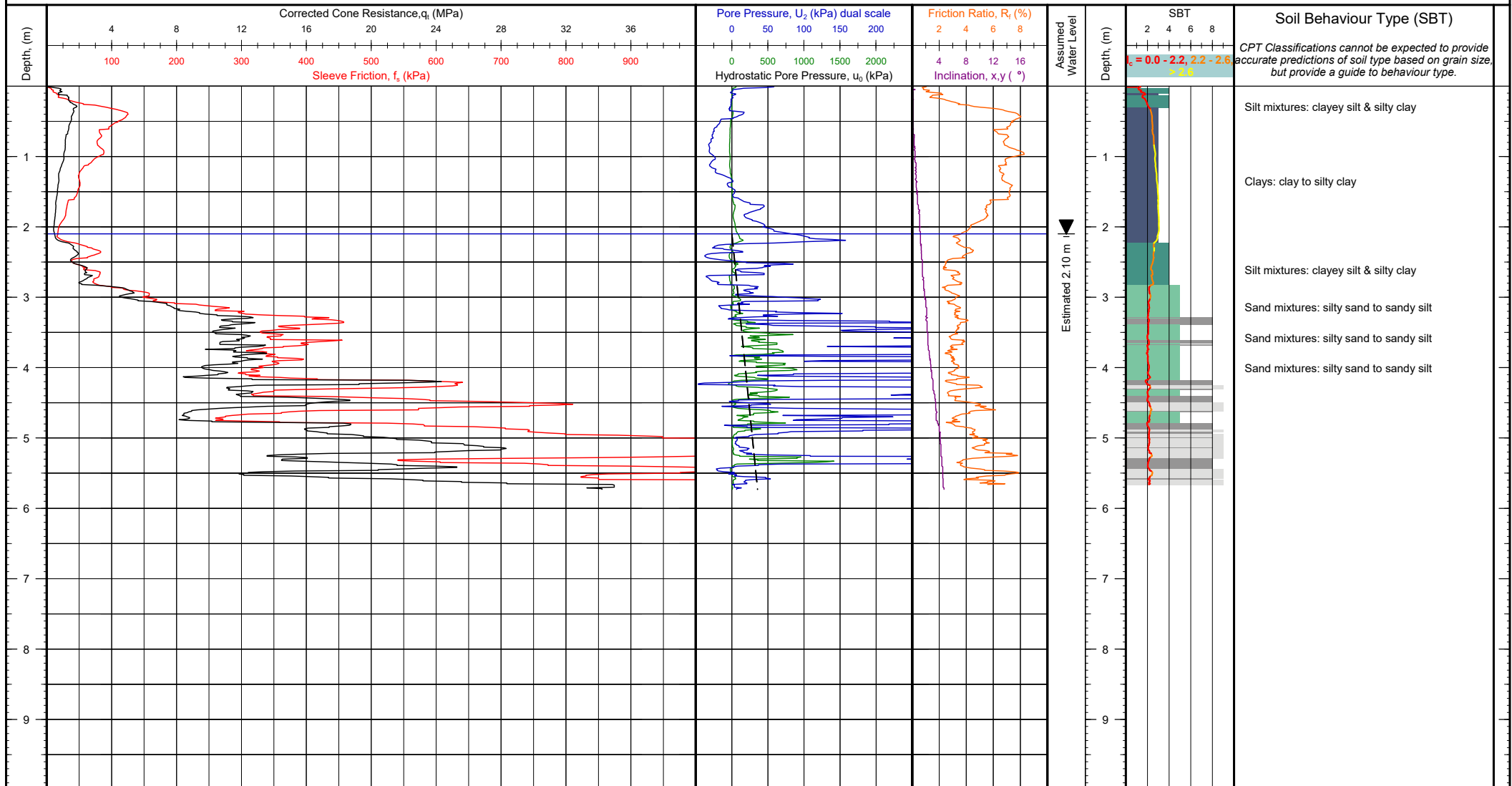


Client: Tonkin + Taylor Project: Whenuapai-Redhills Wastewater Servicing Location: Trig Road to Tamiro Road, Auckland Engineer: Benjamin Westgate Contractor: Ground Investigation Ltd	Operator: Ben Thom Cone Ref: MKJ309 Cone Type: 10cm ² Compression Area Ratio: 0.80 Filter Type: u_2	NZTM 2000 N, E (m): 5926630.28, 1743073.91 WGS84 (deg): -36.795350, 174.603657 Location Method: Handheld GPS Surveyor: Termination Reason: High friction resistance	Elevation (m): Unknown Date of Test: 3/11/2020 Depth (m): 5.02 Pre Drill (m): N/A	Client Reference: Test Number: CPT-111 G.I. Job Ref: 200824
Comments:				



Tonkin + Taylor

CONE PENETRATION TEST (CPT) LOG



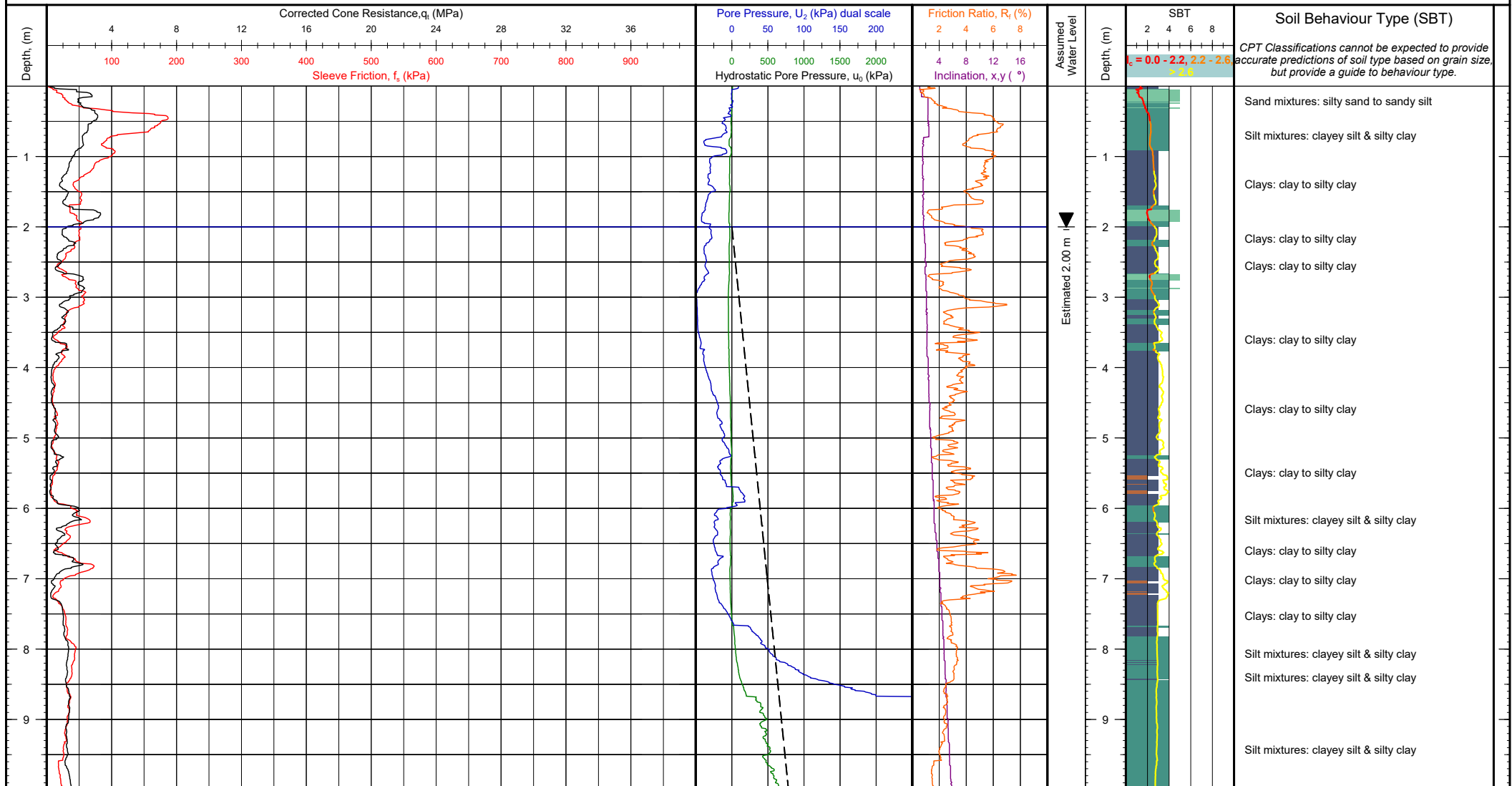
Client: Tonkin + Taylor Project: Whenuapai-Redhills Wastewater Servicing Location: Trig Road to Tamiro Road, Auckland Engineer: Benjamin Westgate Contractor: Ground Investigation Ltd	Operator: Ben Thom Cone Ref: MKJ325 Cone Type: 10cm ² Compression Area Ratio: 0.80 Filter Type: u_2	NZTM 2000 N, E (m): 5926598.39, 1743076.23 WGS84 (deg): -36.795637, 174.603689 Location Method: Handheld GPS Surveyor: Termination Reason: High friction resistance	Elevation (m): Unknown Date of Test: 3/11/2020 Depth (m): 5.73 Pre Drill (m): N/A	Client Reference:
				Test Number: CPT-112 G.I. Job Ref: 200824

Comments:



Tonkin+Taylor

CONE PENETRATION TEST (CPT) LOG



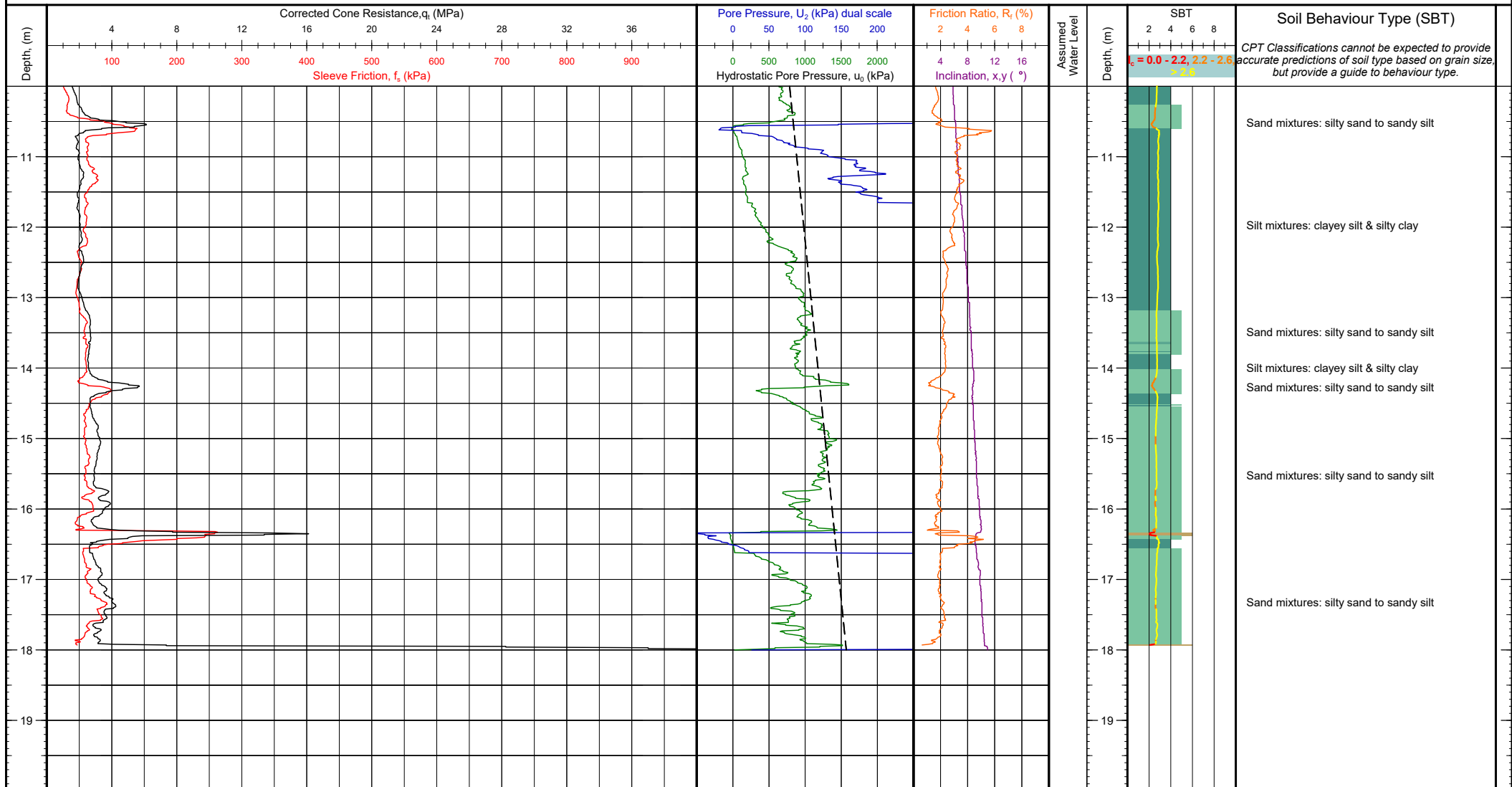
Client: Tonkin + Taylor Project: Whenuapai-Redhills Wastewater Servicing Location: Trig Road to Tamiro Road, Auckland Engineer: Benjamin Westgate Contractor: Ground Investigation Ltd	Operator: Ben Thom Cone Ref: MKJ325 Cone Type: 10cm ² Compression Area Ratio: 0.80 Filter Type: u_2	NZTM 2000 N, E (m): 5927036.96, 1743360.27 WGS84 (deg): -36.791642, 174.606789 Location Method: Handheld GPS Surveyor: Termination Reason: High cone end resistance	Elevation (m): Unknown Date of Test: 2/11/2020 Depth (m): 18.00 Pre Drill (m): N/A	Client Reference:
				Test Number: CPT-117 G.I. Job Ref: 200824

Comments:



Tonkin + Taylor

CONE PENETRATION TEST (CPT) LOG



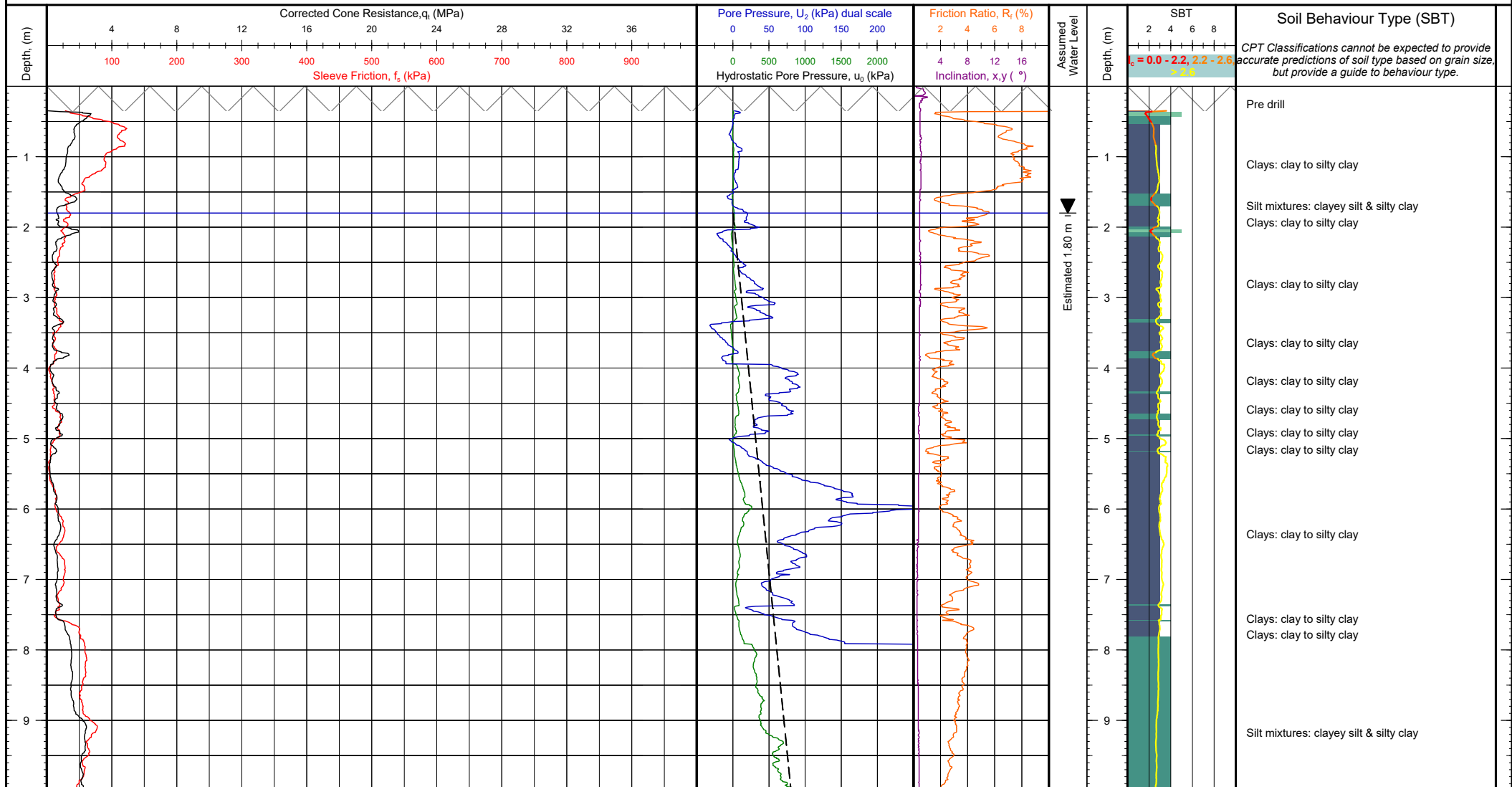
Client: Tonkin + Taylor Project: Whenuapai-Redhills Wastewater Servicing Location: Trig Road to Tamiro Road, Auckland Engineer: Benjamin Westgate Contractor: Ground Investigation Ltd	Operator: Ben Thom Cone Ref: MKJ325 Cone Type: 10cm ² Compression Area Ratio: 0.80 Filter Type: u_2	NZTM 2000 N, E (m): 5927036.96, 1743360.27 WGS84 (deg): -36.791642, 174.606789 Location Method: Handheld GPS Surveyor: Termination Reason: High cone end resistance	Elevation (m): Unknown Date of Test: 2/11/2020 Depth (m): 18.00 Pre Drill (m): N/A	Client Reference:
				Test Number: CPT-117 G.I. Job Ref: 200824

Comments:



Tonkin + Taylor

CONE PENETRATION TEST (CPT) LOG



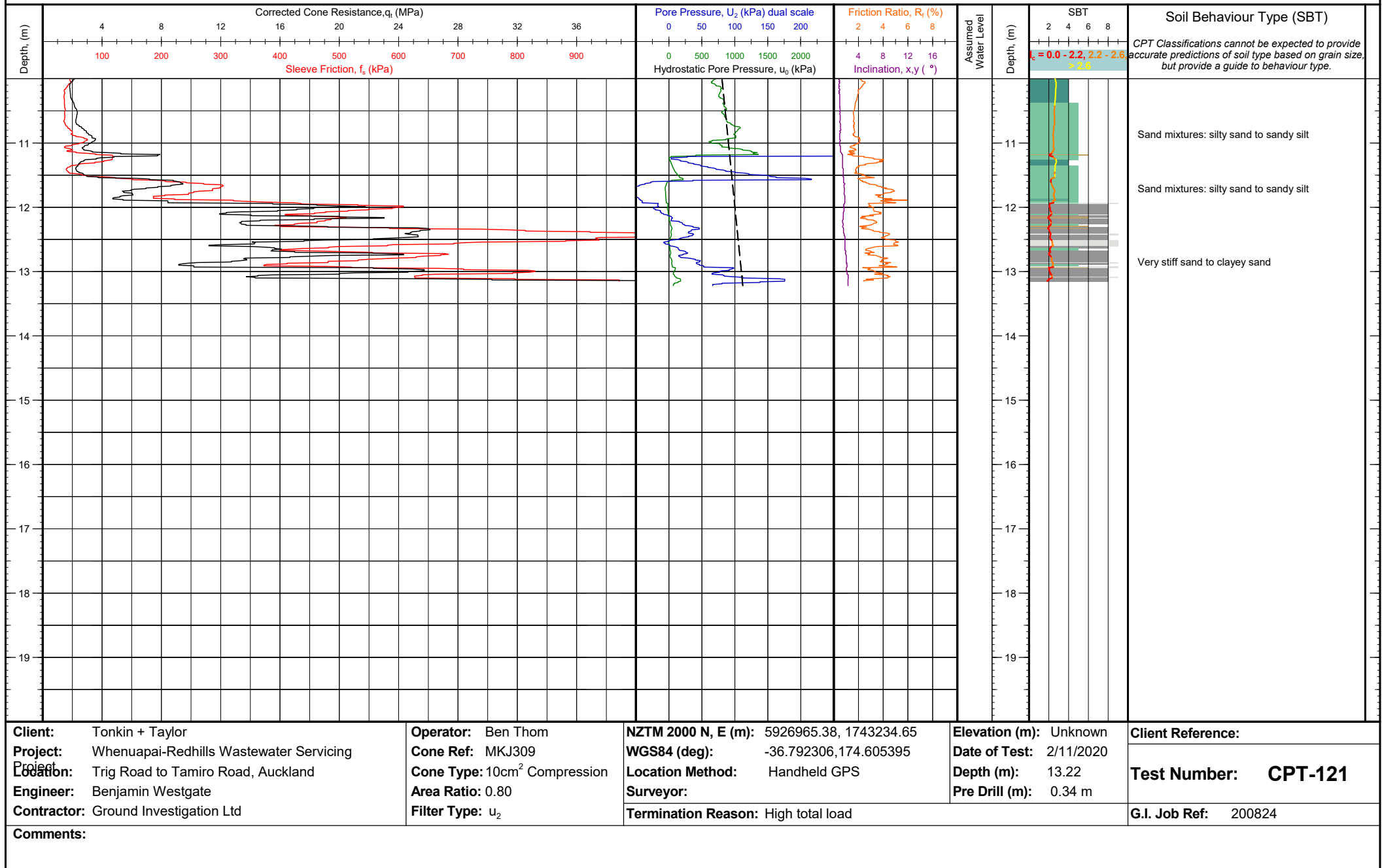
Client: Tonkin + Taylor	Operator: Ben Thom	NZTM 2000 N, E (m): 5926965.38, 1743234.65	Elevation (m): Unknown	Client Reference:
Project: Whenuapai-Redhills Wastewater Servicing	Cone Ref: MKJ309	WGS84 (deg): -36.792306, 174.605395	Date of Test: 2/11/2020	
Location: Trig Road to Tamiro Road, Auckland	Cone Type: 10cm ² Compression	Location Method: Handheld GPS	Depth (m): 13.22	Test Number: CPT-121
Engineer: Benjamin Westgate	Area Ratio: 0.80	Surveyor:	Pre Drill (m): 0.34 m	
Contractor: Ground Investigation Ltd	Filter Type: u_2	Termination Reason: High total load		G.I. Job Ref: 200824

Comments:



Tonkin+Taylor

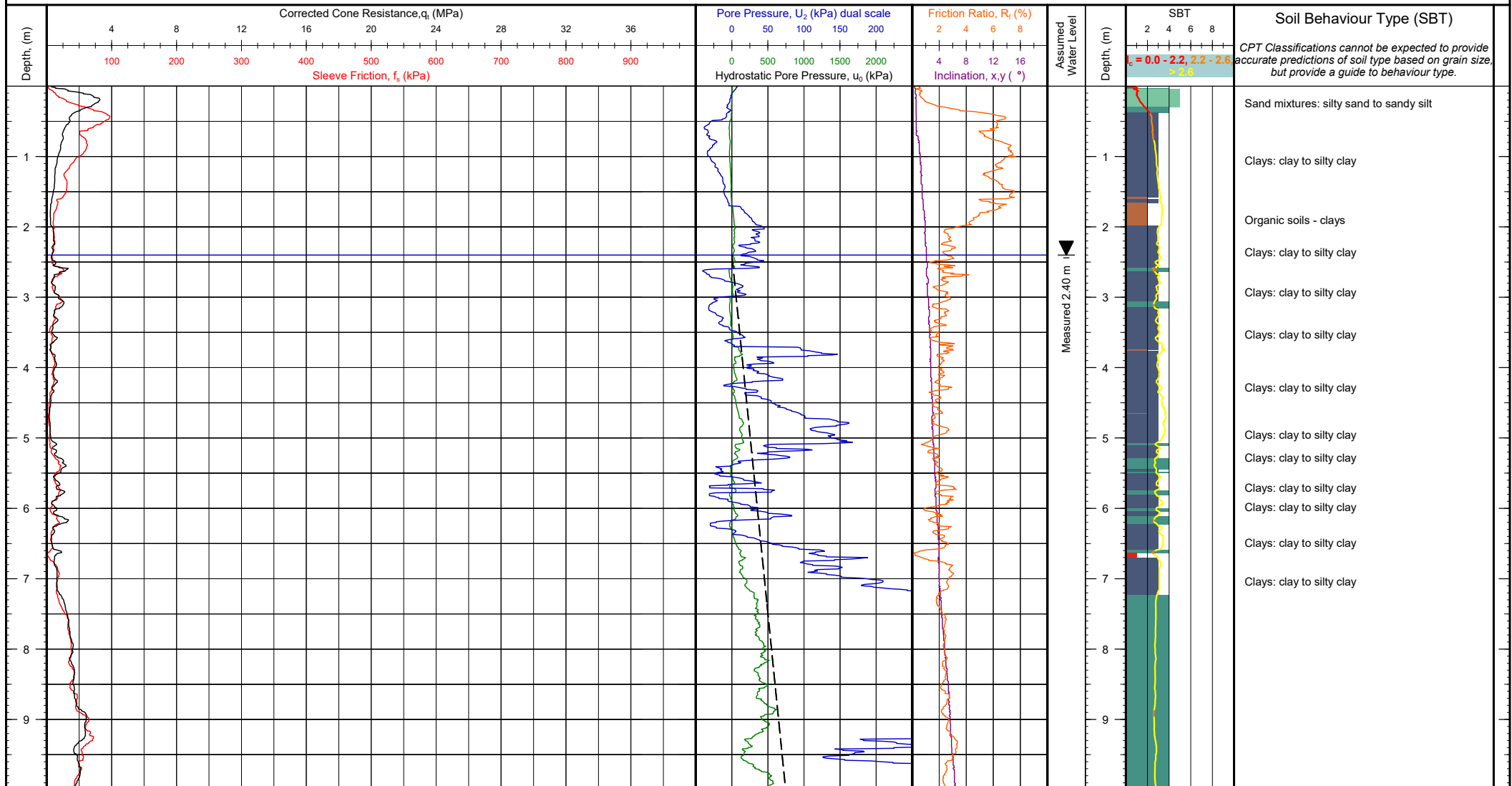
CONE PENETRATION TEST (CPT) LOG





Tonkin + Taylor

CONE PENETRATION TEST (CPT) LOG



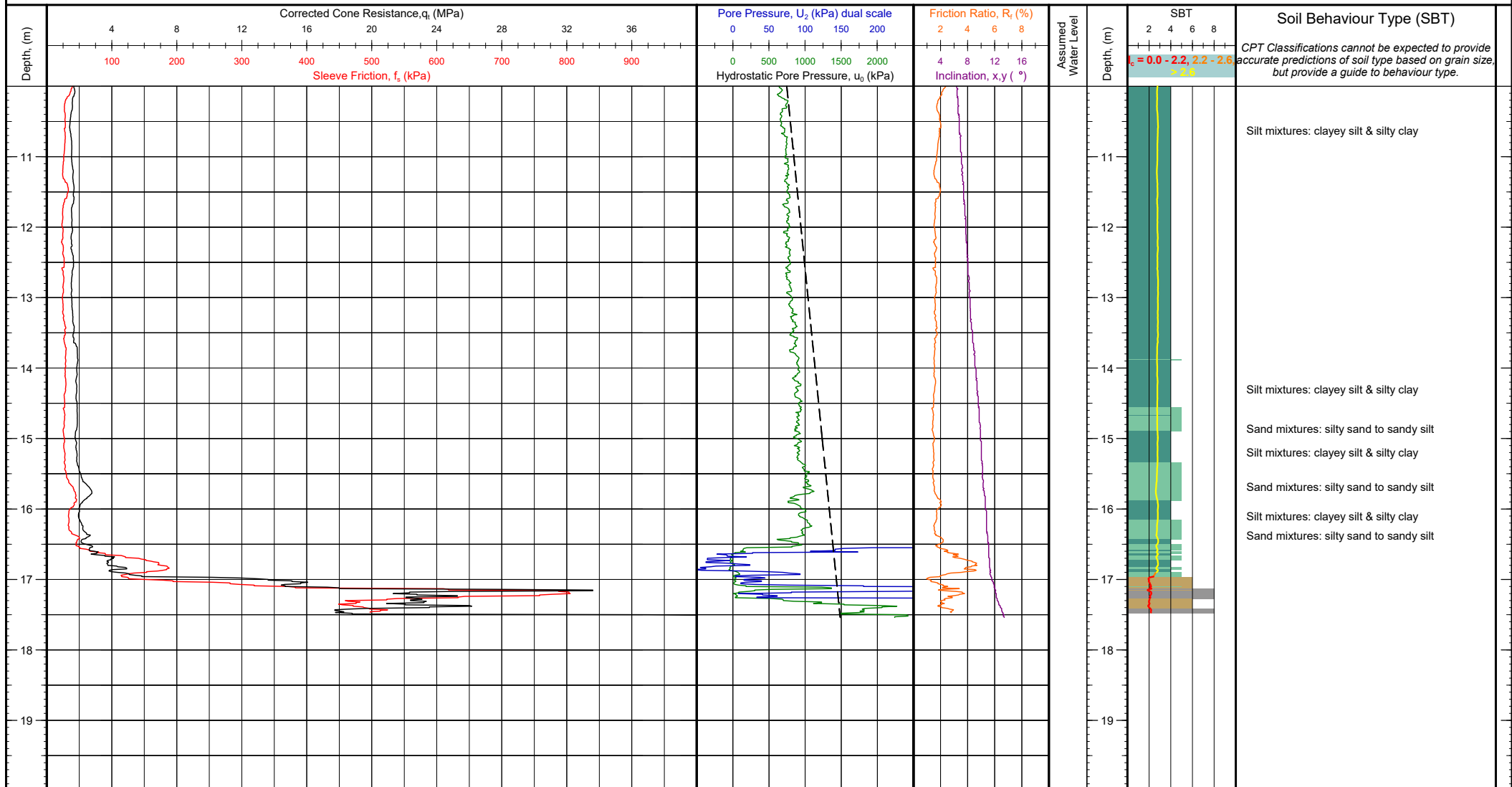
Client: Tonkin + Taylor Project: Whenuapai-Redhills Wastewater Servicing Location: Trig Road to Tamiro Road, Auckland Engineer: Benjamin Westgate Contractor: Ground Investigation Ltd	Operator: Ben Thom Cone Ref: MKJ325 Cone Type: 10cm ² Compression Area Ratio: 0.80 Filter Type: u_2	NZTM 2000 N, E (m): 5926924.83, 1743237.45 WGS84 (deg): -36.792671, 174.605434 Location Method: Handheld GPS Surveyor: Termination Reason: Limit of reaction force	Elevation (m): Unknown Date of Test: 2/11/2020 Depth (m): 17.54 Pre Drill (m): N/A	Client Reference:
				Test Number: CPT-126 G.I. Job Ref: 200824

Comments:



Tonkin + Taylor

CONE PENETRATION TEST (CPT) LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Operator: Ben Thom
Cone Ref: MKJ325
Cone Type: 10cm² Compression
Area Ratio: 0.80
Filter Type: u_2

NZTM 2000 N, E (m): 5926924.83, 1743237.45
WGS84 (deg): -36.792671, 174.605434
Location Method: Handheld GPS
Surveyor:
Termination Reason: Limit of reaction force

Elevation (m): Unknown
Date of Test: 2/11/2020
Depth (m): 17.54
Pre Drill (m): N/A

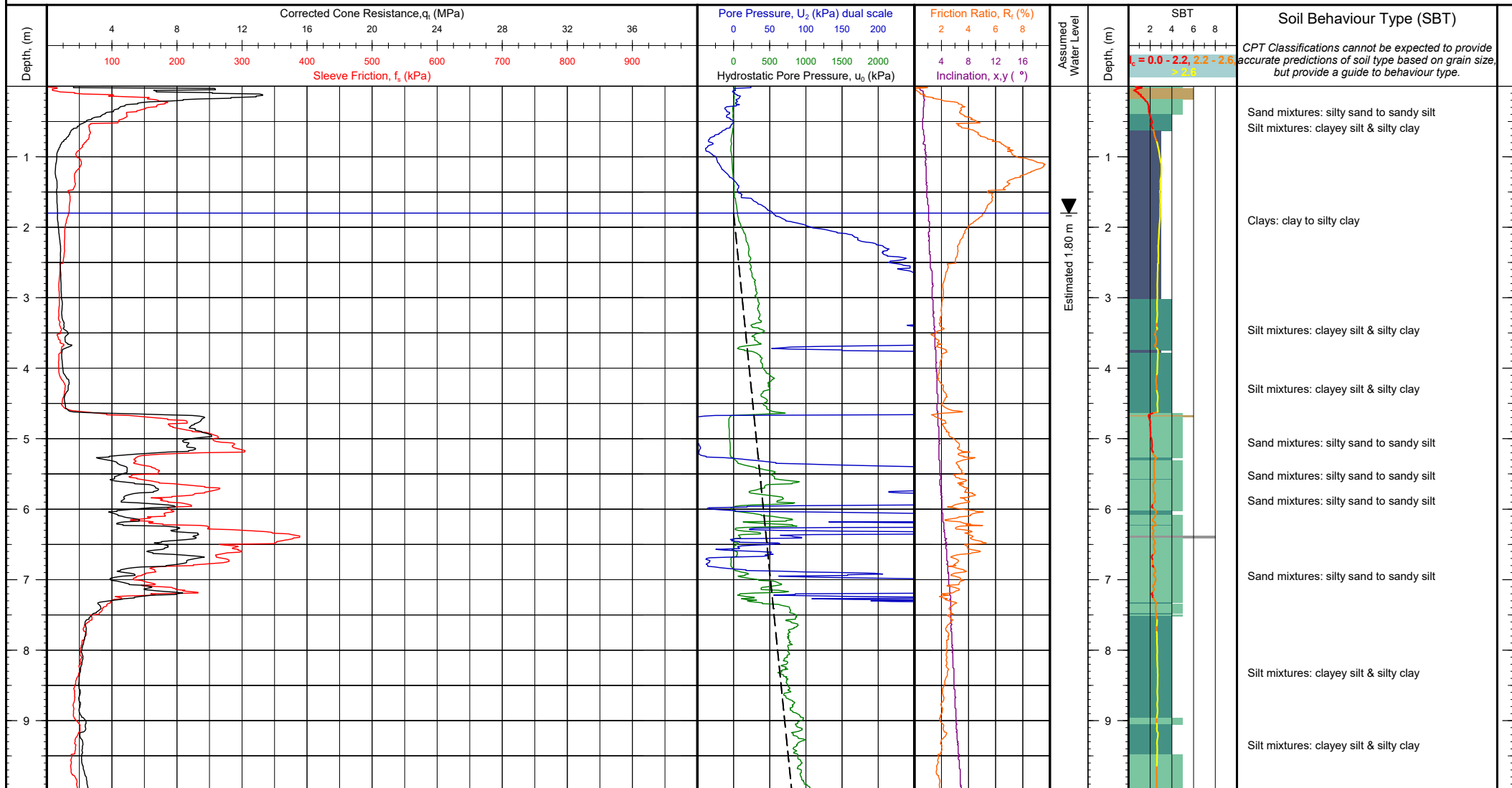
Client Reference:
Test Number: CPT-126
G.I. Job Ref: 200824

Comments:



Tonkin+Taylor

CONE PENETRATION TEST (CPT) LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Operator: Ben Thom
Cone Ref: MKJ325
Cone Type: 10cm² Compression
Area Ratio: 0.80
Filter Type: u_2

NZTM 2000 N, E (m): 5926740.32, 1743076.38
WGS84 (deg): -36.794358, 174.603664
Location Method: Handheld GPS
Surveyor:
Termination Reason: High total load

Elevation (m): Unknown
Date of Test: 2/11/2020
Depth (m): 16.05
Pre Drill (m): N/A

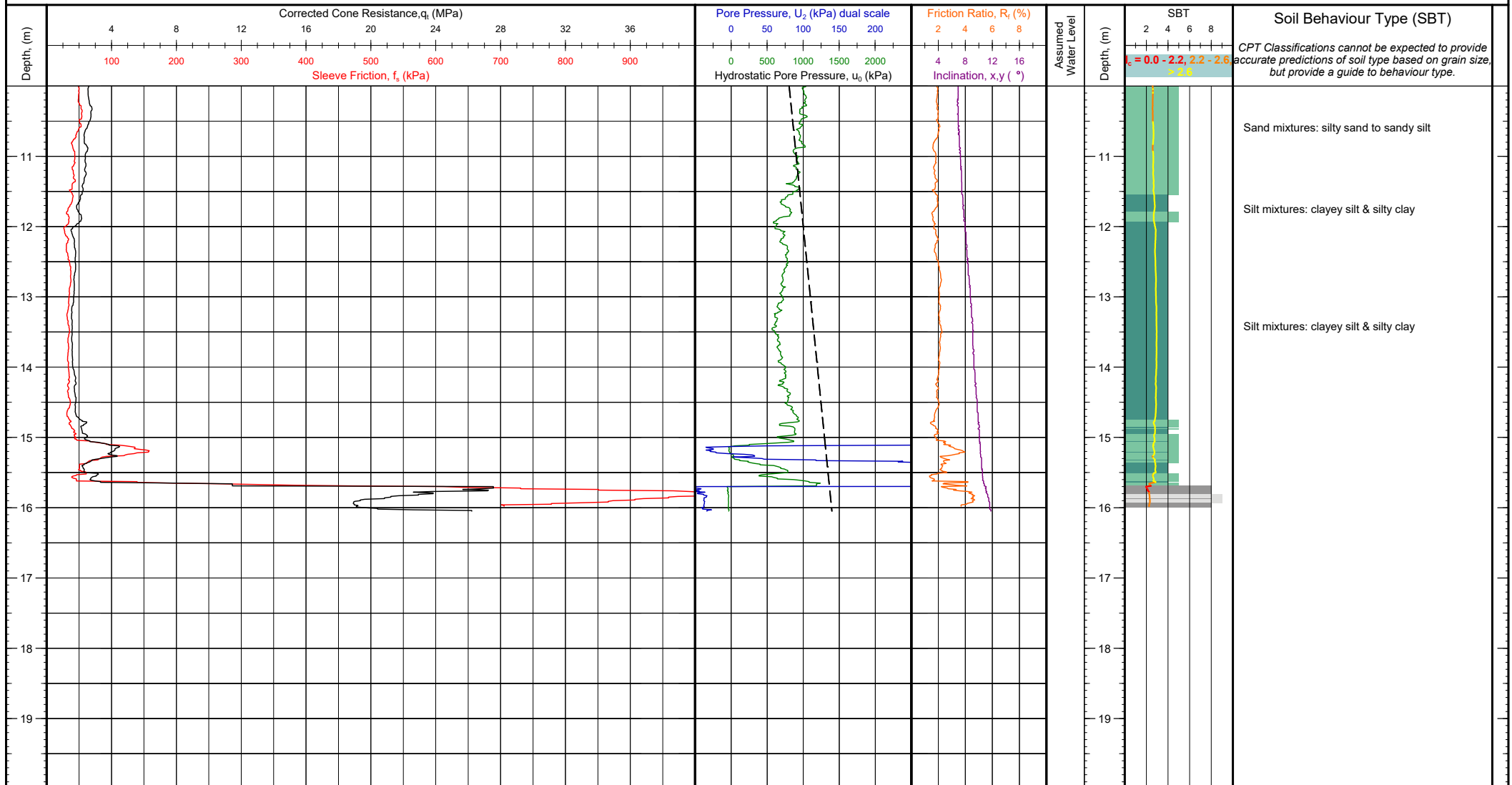
Client Reference:
Test Number: CPT-128
G.I. Job Ref: 200824

Comments:



Tonkin + Taylor

CONE PENETRATION TEST (CPT) LOG



Client: Tonkin + Taylor Project: Whenuapai-Redhills Wastewater Servicing Location: Trig Road to Tamiro Road, Auckland Engineer: Benjamin Westgate Contractor: Ground Investigation Ltd	Operator: Ben Thom Cone Ref: MKJ325 Cone Type: 10cm ² Compression Area Ratio: 0.80 Filter Type: u_2	NZTM 2000 N, E (m): 5926740.32, 1743076.38 WGS84 (deg): -36.794358, 174.603664 Location Method: Handheld GPS Surveyor: Termination Reason: High total load	Elevation (m): Unknown Date of Test: 2/11/2020 Depth (m): 16.05 Pre Drill (m): N/A	Client Reference:
				Test Number: CPT-128 G.I. Job Ref: 200824

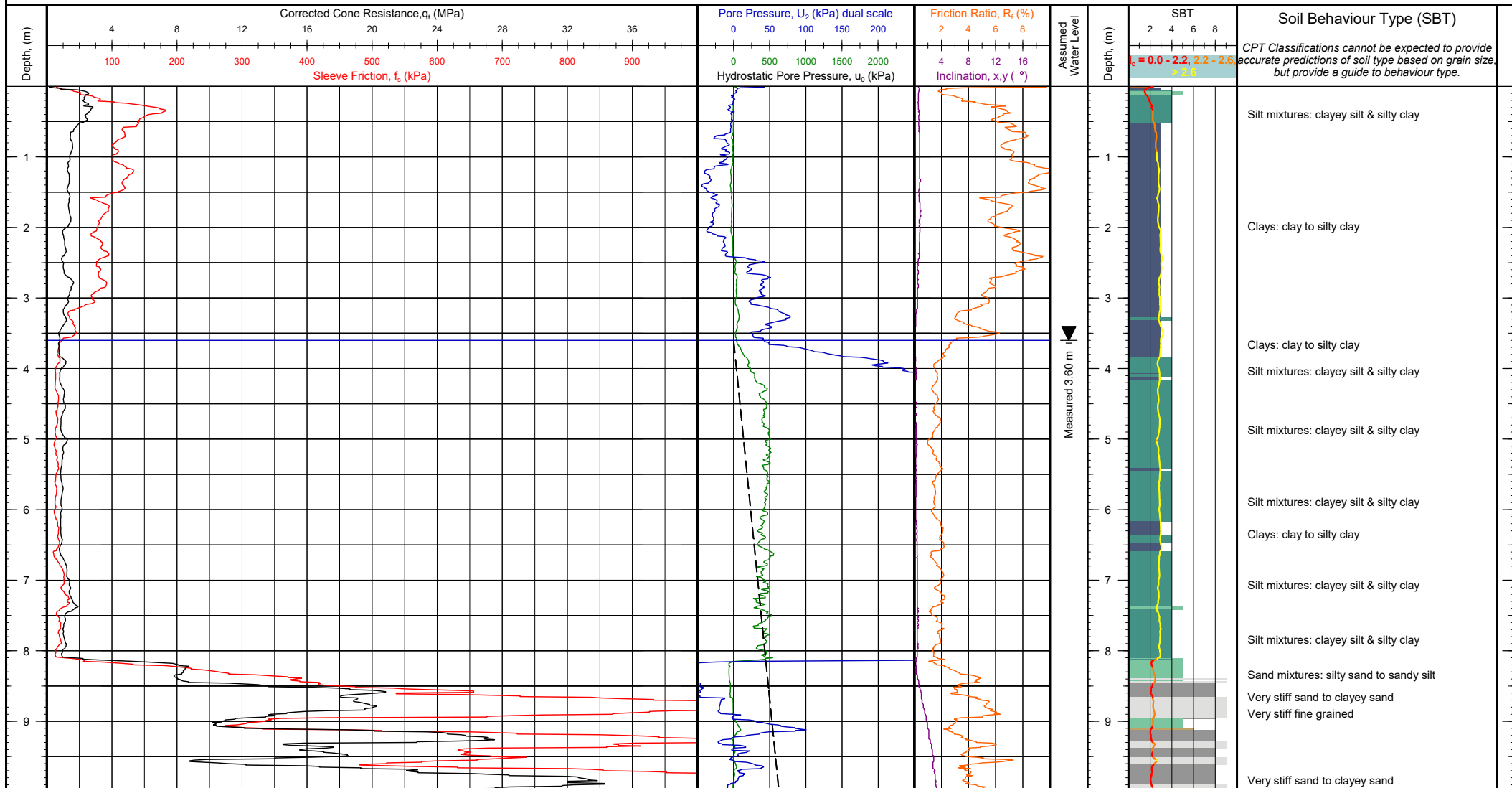
Comments:





Tonkin+Taylor

CONE PENETRATION TEST (CPT) LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Operator: Ben Thom
Cone Ref: MKJ309
Cone Type: 10cm² Compression
Area Ratio: 0.80
Filter Type: u_2

NZTM 2000 N, E (m): 5926584.78, 1743106.98
WGS84 (deg): -36.795755, 174.604036
Location Method: Handheld GPS
Surveyor:
Termination Reason: High friction resistance

Elevation (m): Unknown
Date of Test: 3/11/2020
Depth (m): 11.29
Pre Drill (m): N/A

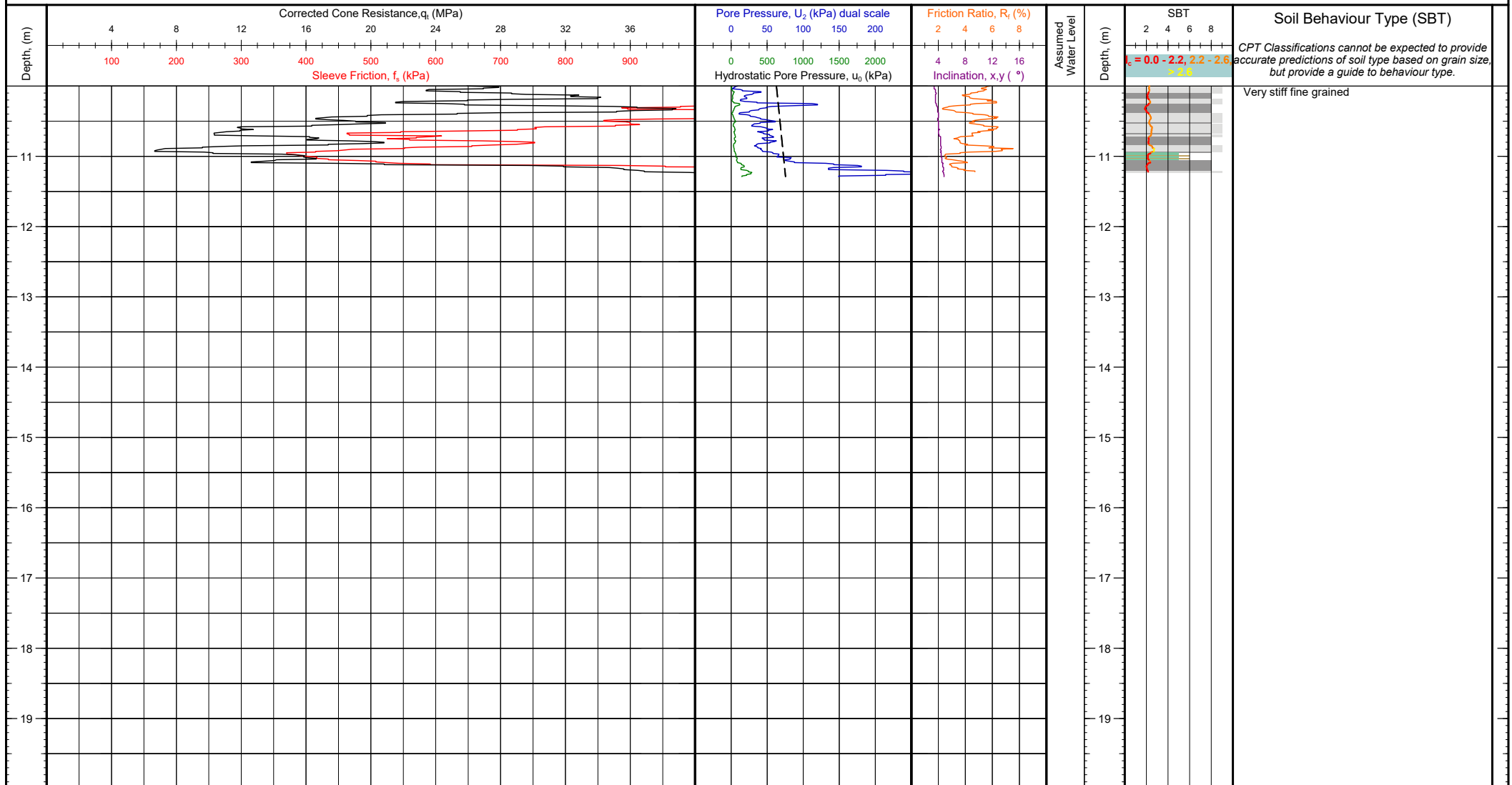
Client Reference:
Test Number: CPT-131
G.I. Job Ref: 200824

Comments:



Tonkin + Taylor

CONE PENETRATION TEST (CPT) LOG



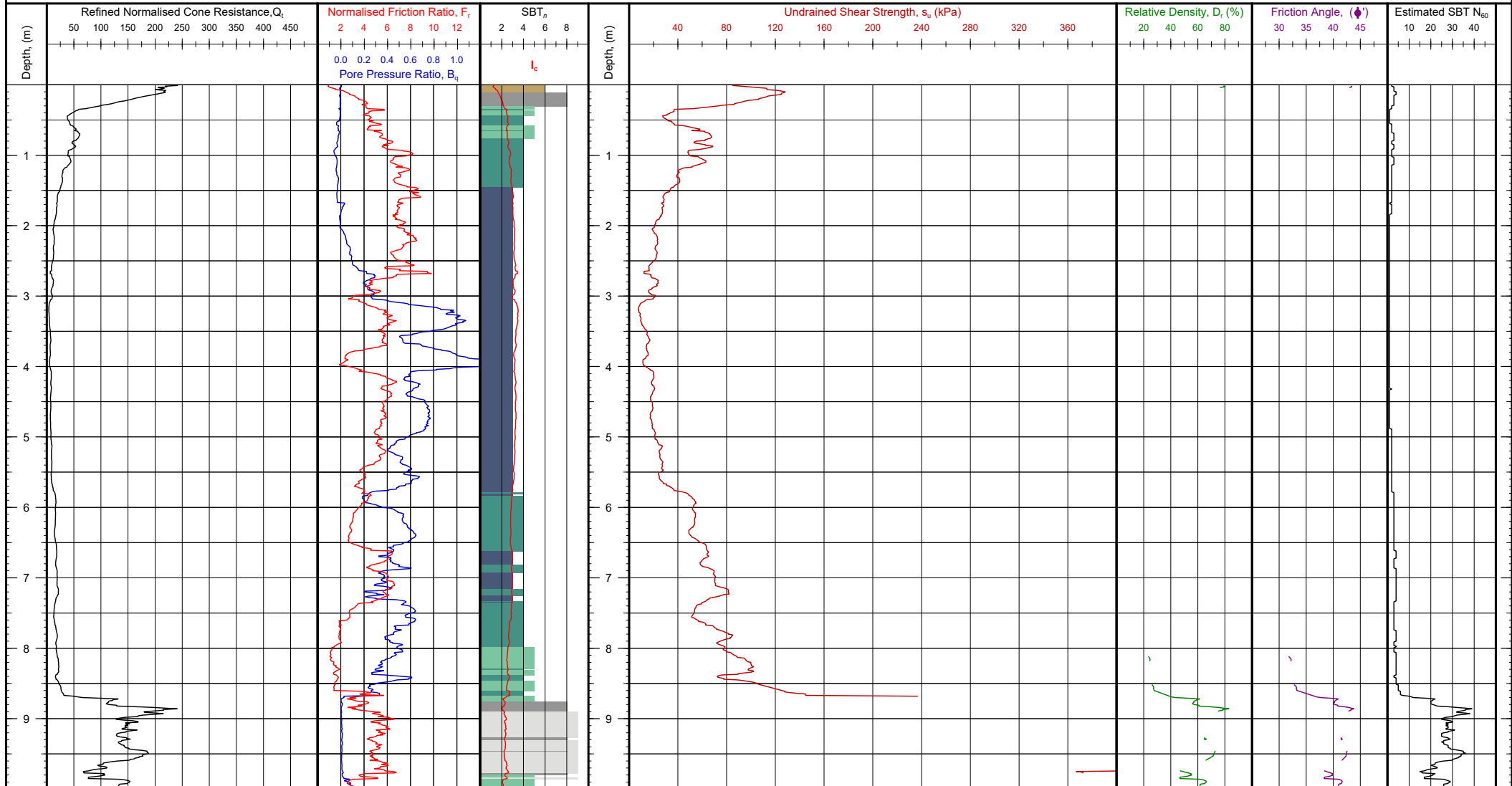
Client: Tonkin + Taylor Project: Whenuapai-Redhills Wastewater Servicing Location: Trig Road to Tamiro Road, Auckland Engineer: Benjamin Westgate Contractor: Ground Investigation Ltd	Operator: Ben Thom Cone Ref: MKJ309 Cone Type: 10cm ² Compression Area Ratio: 0.80 Filter Type: u_2	NZTM 2000 N, E (m): 5926584.78, 1743106.98 WGS84 (deg): -36.795755, 174.604036 Location Method: Handheld GPS Surveyor: Termination Reason: High friction resistance	Elevation (m): Unknown Date of Test: 3/11/2020 Depth (m): 11.29 Pre Drill (m): N/A	Client Reference:
				Test Number: CPT-131 G.I. Job Ref: 200824

Comments:



Tonkin+Taylor

CPT PARAMETER LOG



Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-02**

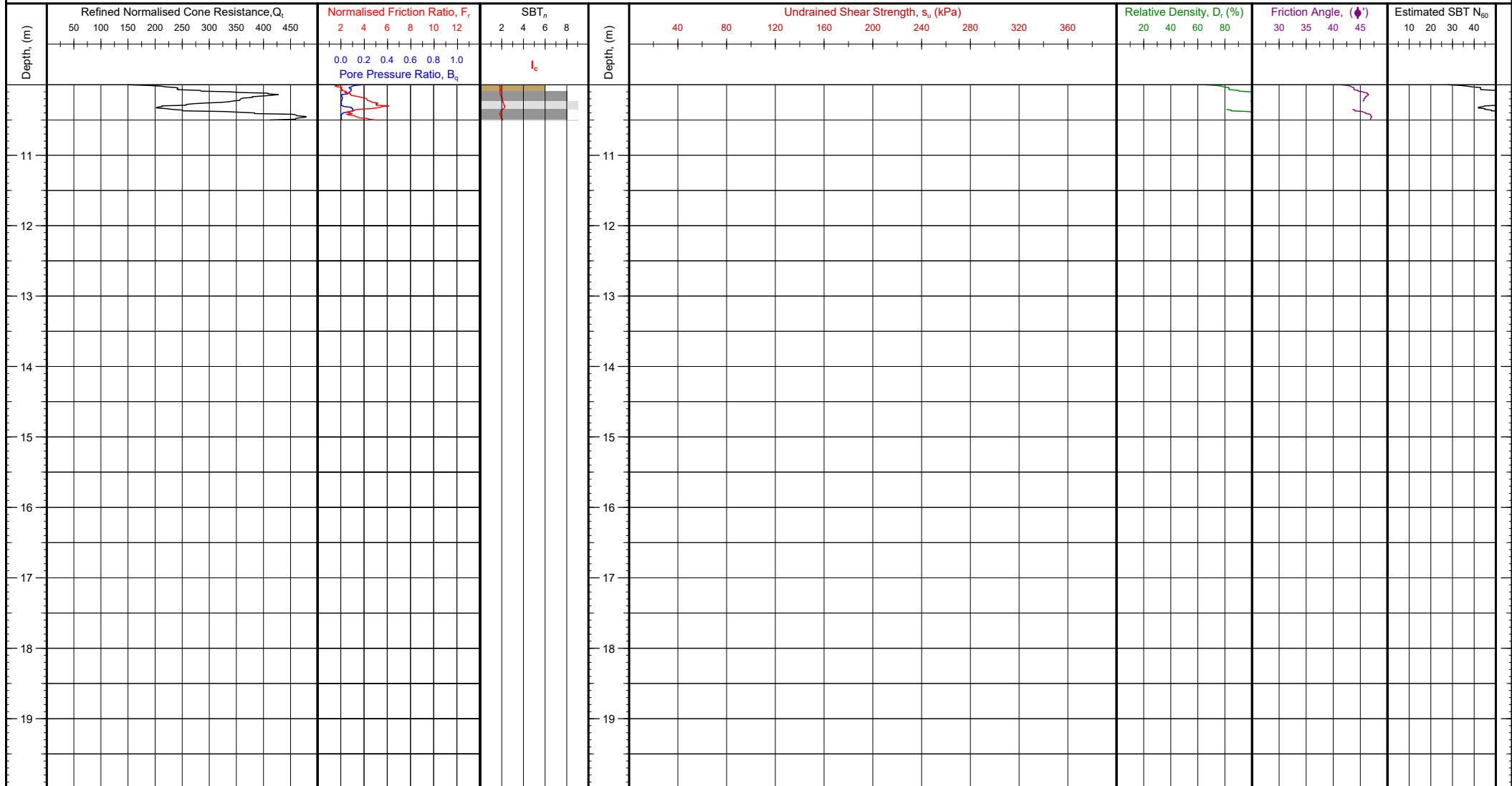
G.I. Job Ref: 200824

Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd



Tonkin + Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor

Project: Whenuapai-Redhills Wastewater Servicing

Location: Trig Road to Tamiro Road, Auckland

Engineer: Benjamin Westgate

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

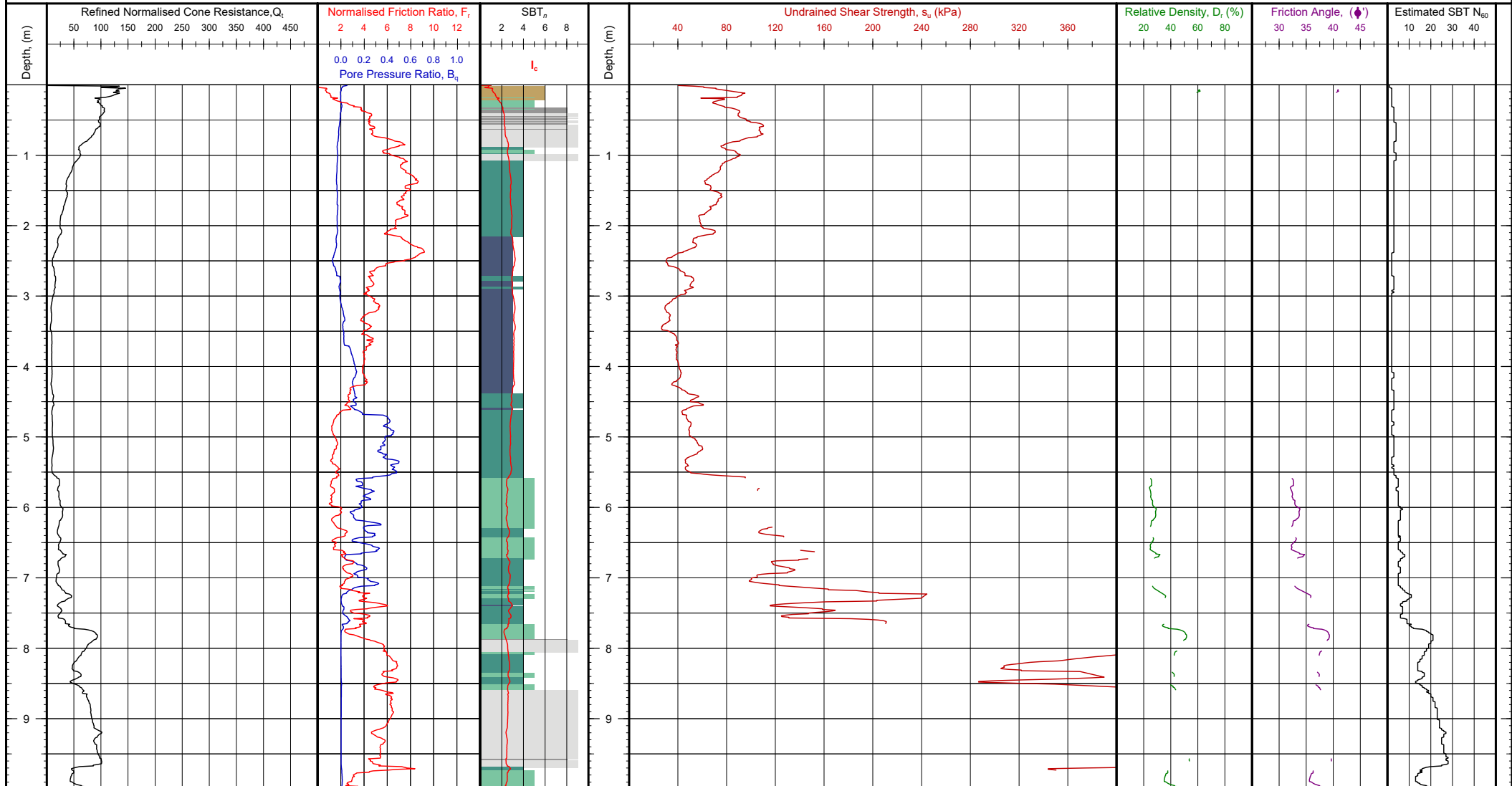
Test Number: CPT-02

G.I. Job Ref: 200824



Tonkin + Taylor

CPT PARAMETER LOG



Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-03**

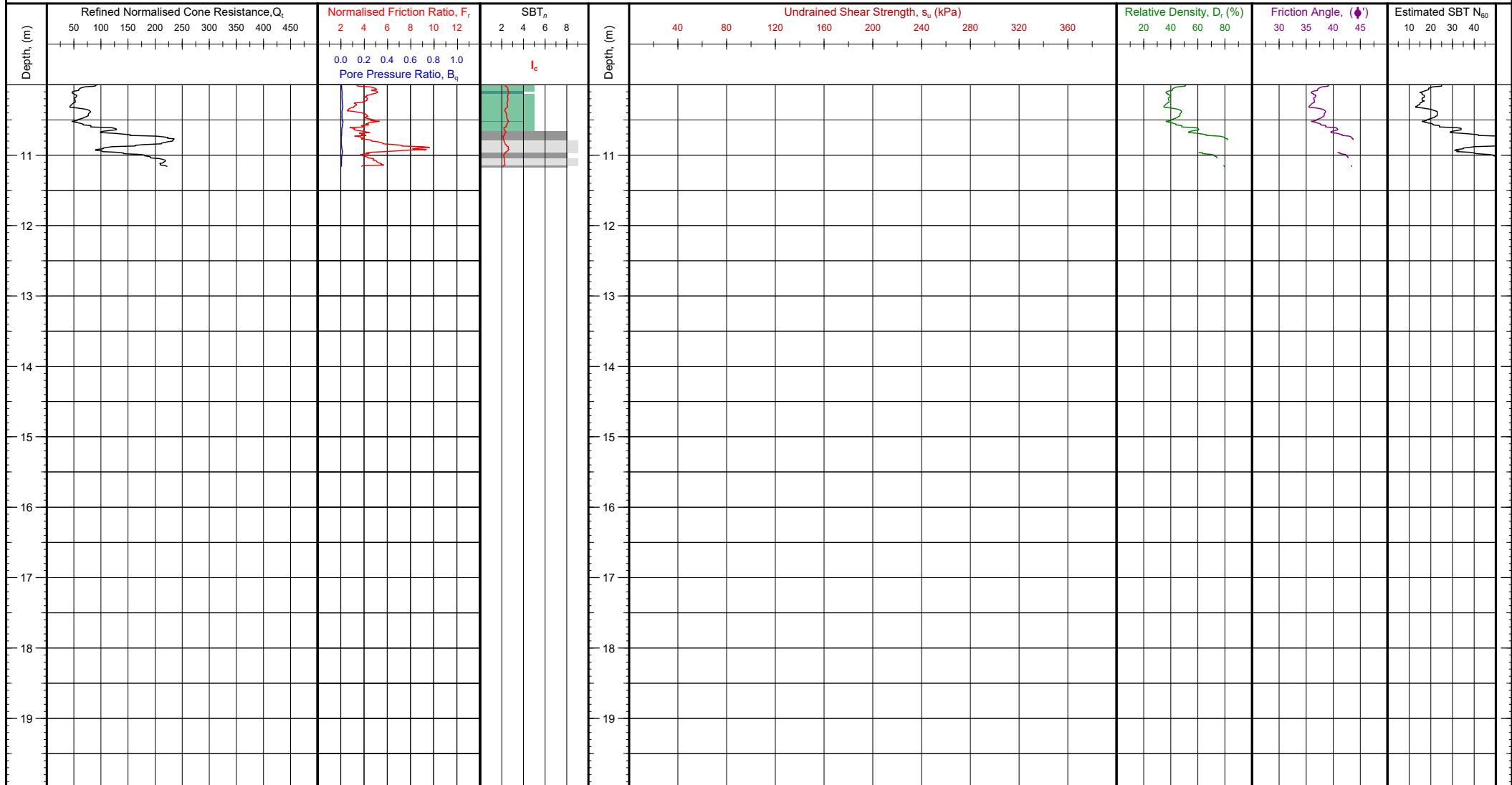
G.I. Job Ref: 200824

Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd



Tonkin + Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: CPT-03

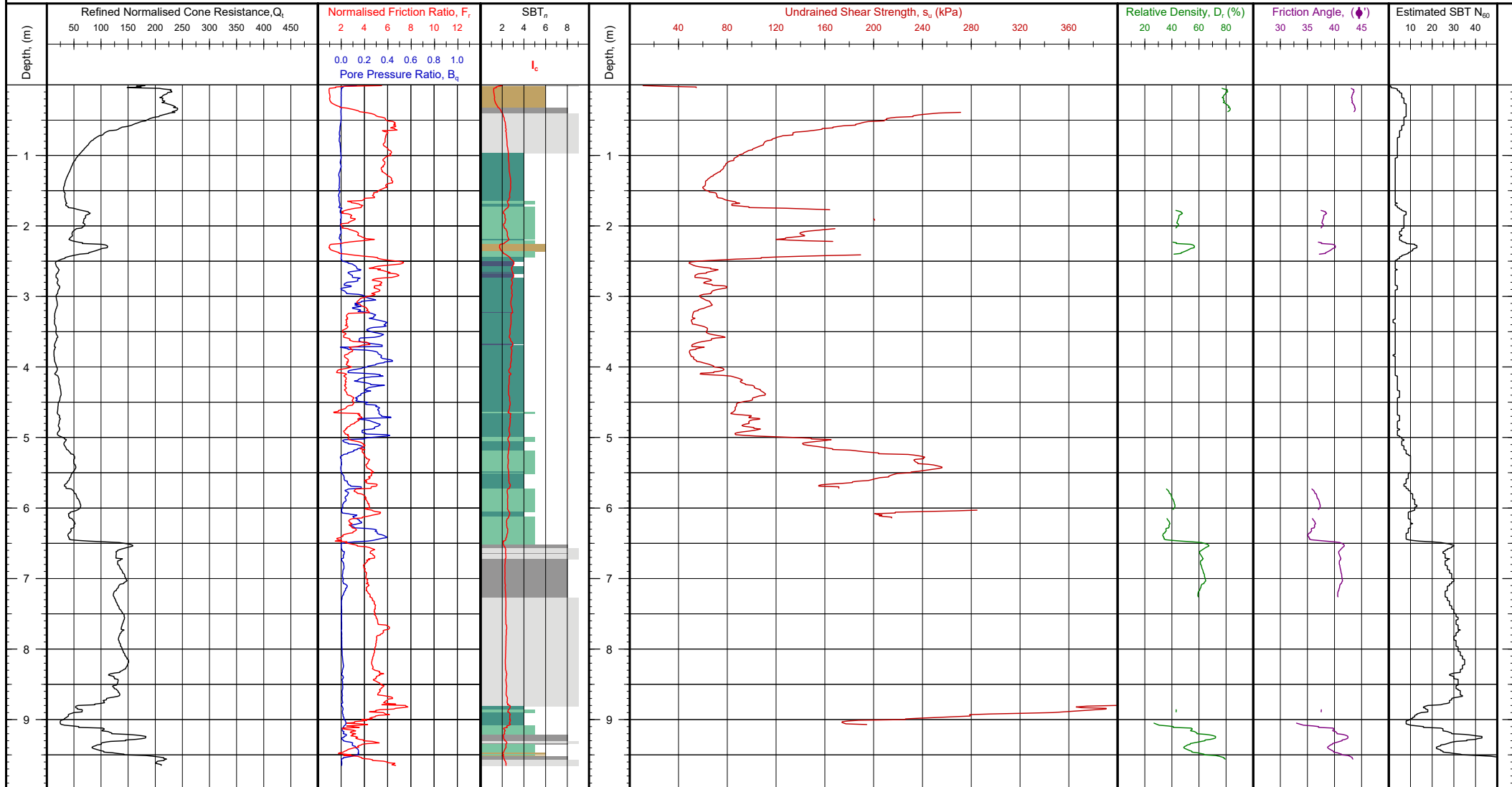
G.I. Job Ref: 200824



Tonkin+Taylor

CPT PARAMETER LOG

GROUND
INVESTIGATION



Client: Tonkin + Taylor

Project: Whenuapai-Redhills Wastewater Servicing

Location: Trig Road to Tamiro Road, Auckland

Engineer: Benjamin Westgate

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

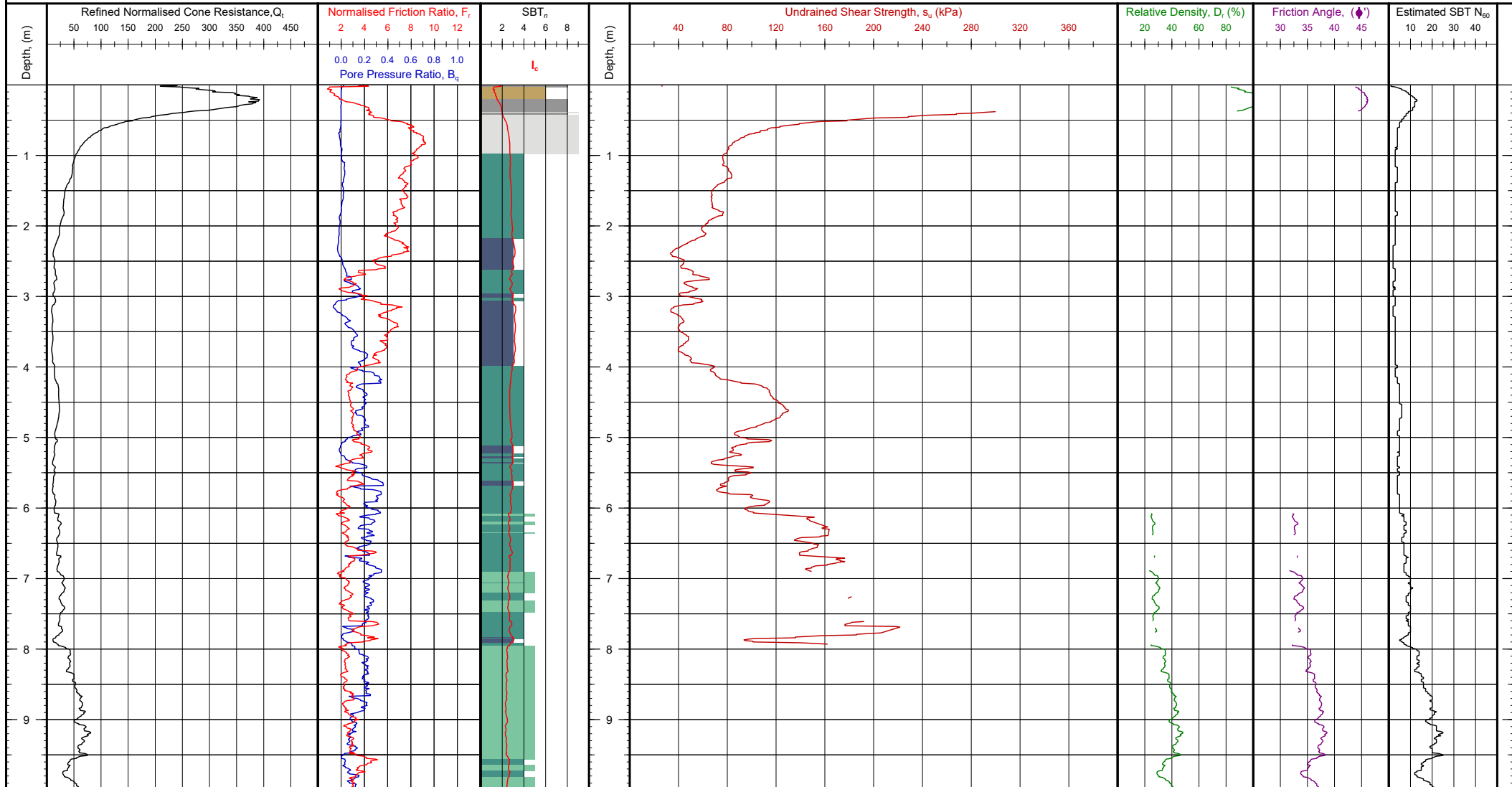
Test Number: CPT-04

G.I. Job Ref: 200824



Tonkin+Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

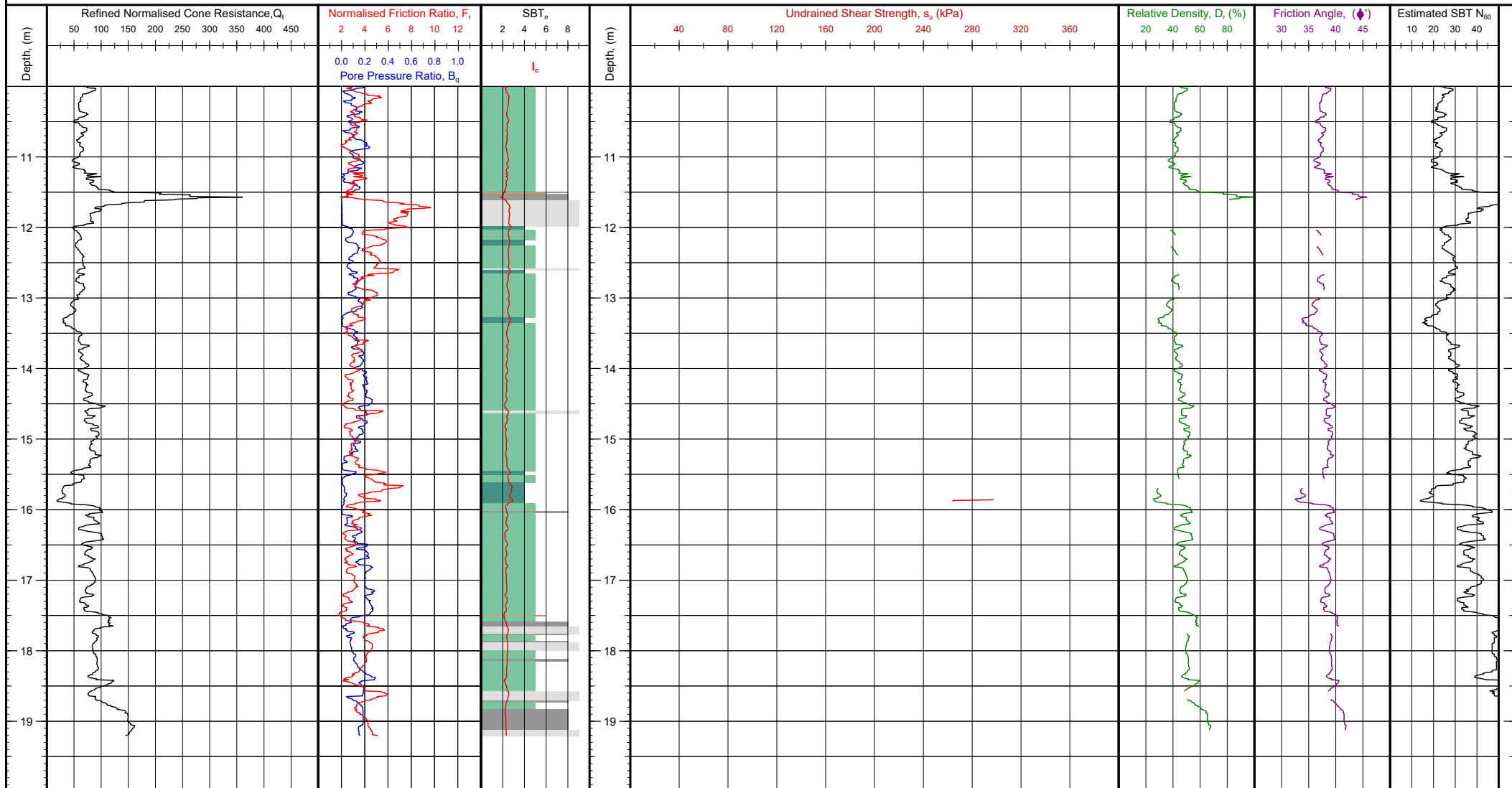
Test Number: CPT-05

G.I. Job Ref: 200824



Tonkin+Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

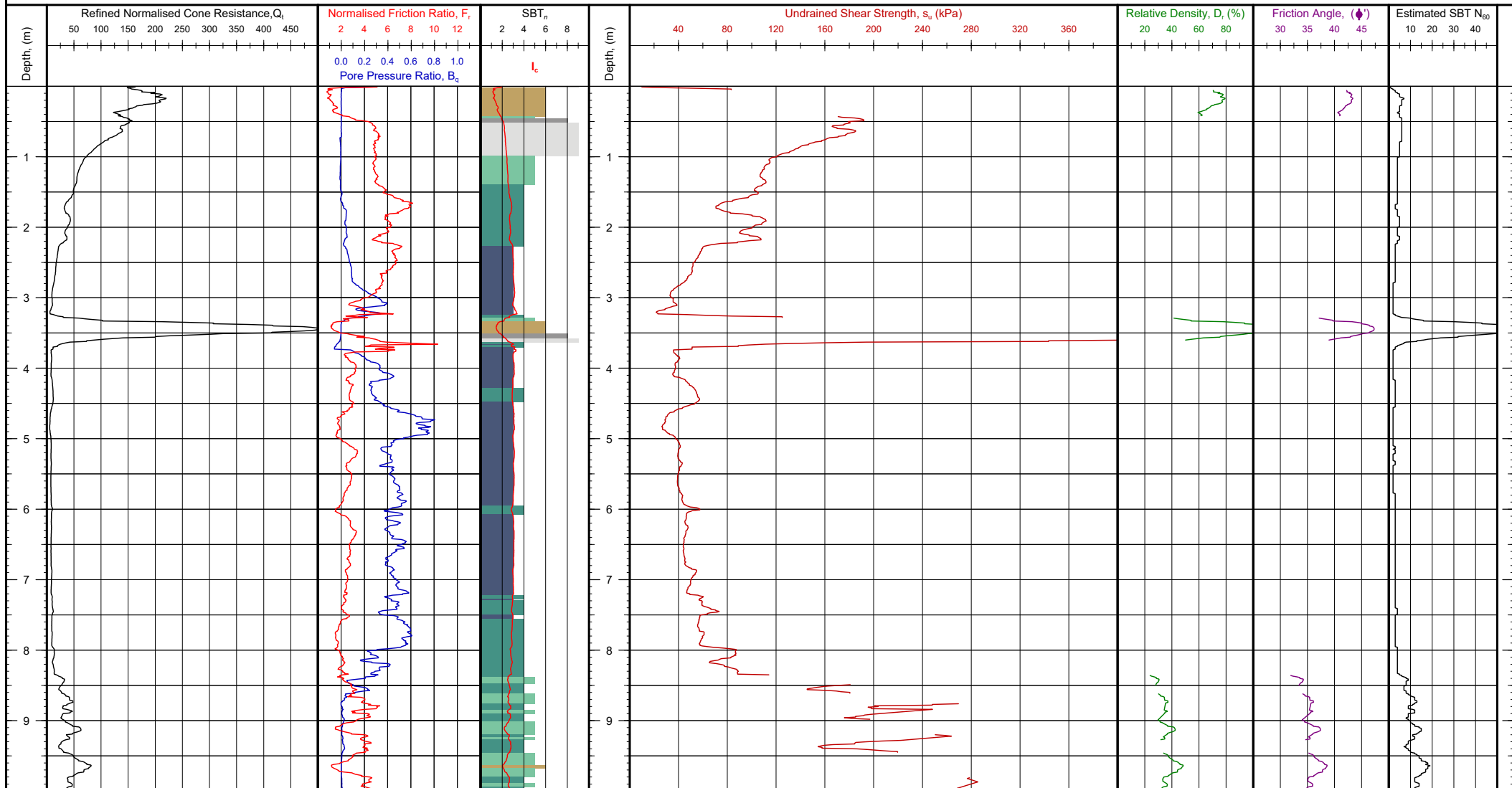
Test Number: CPT-05

G.I. Job Ref: 200824



Tonkin+Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor

Project: Whenuapai-Redhills Wastewater Servicing

Location: Trig Road to Tamiro Road, Auckland

Engineer: Benjamin Westgate

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

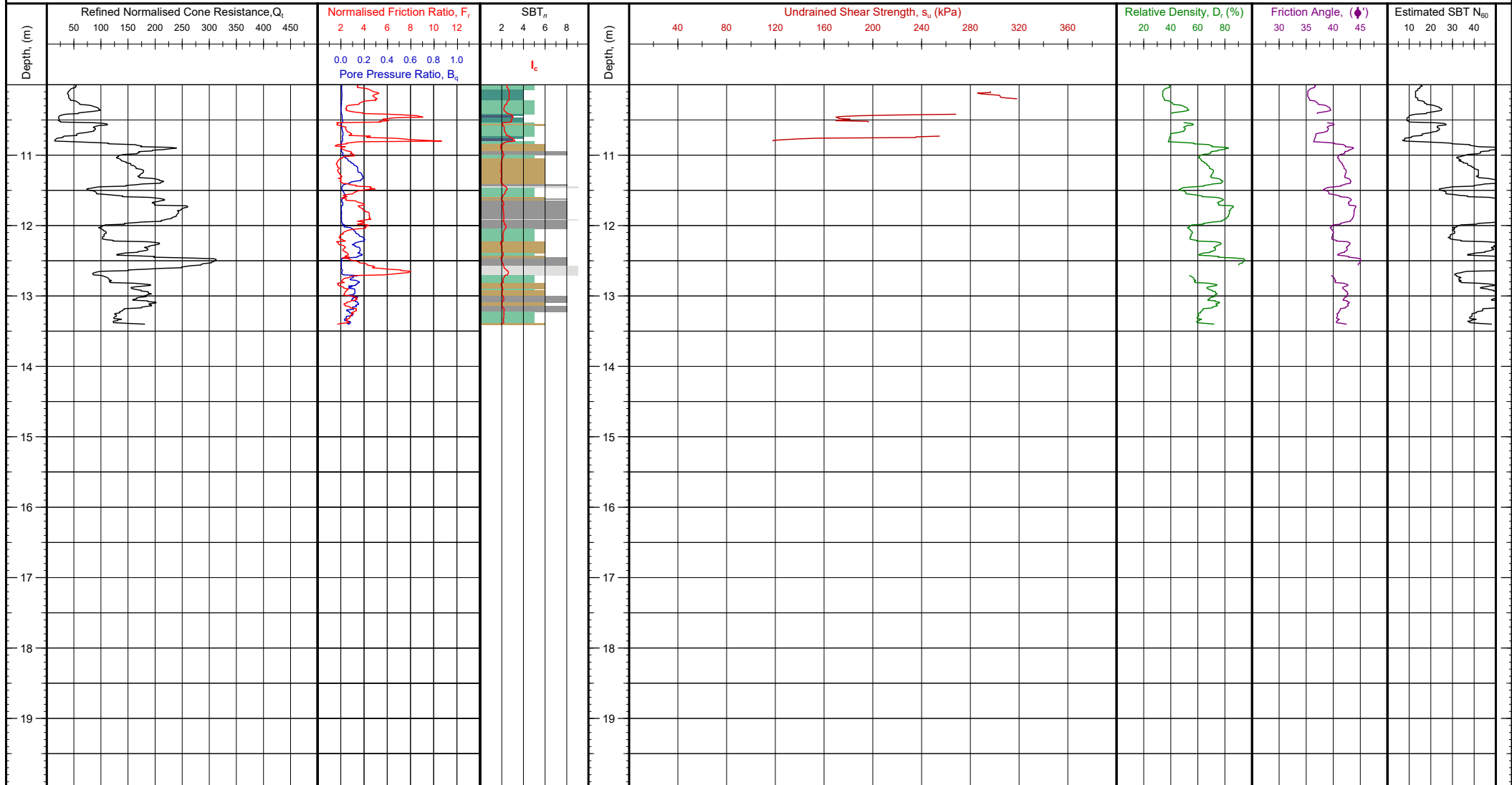
Test Number: CPT-06

G.I. Job Ref: 200824



Tonkin + Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

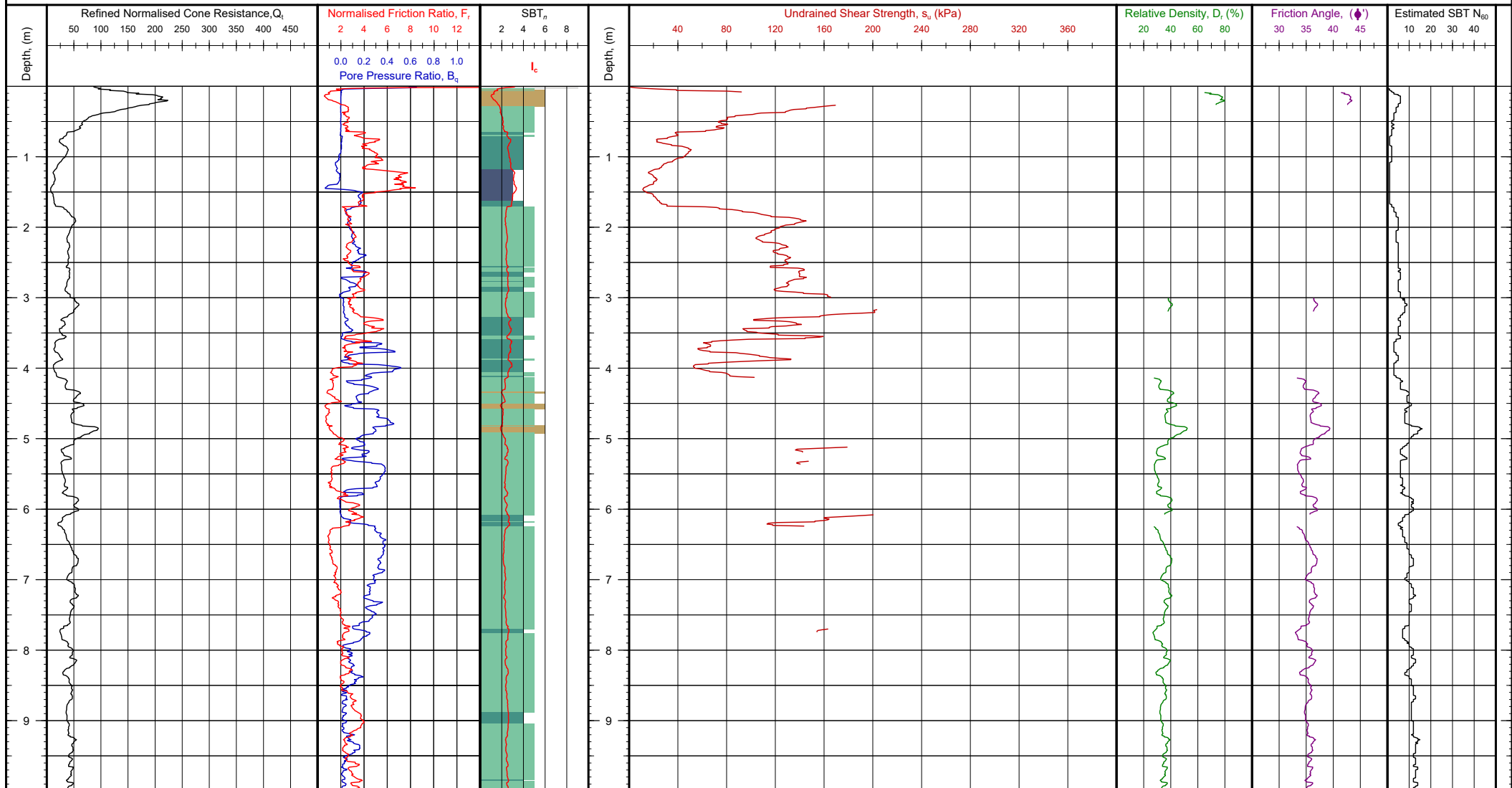
Test Number: CPT-06

G.I. Job Ref: 200824



Tonkin+Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

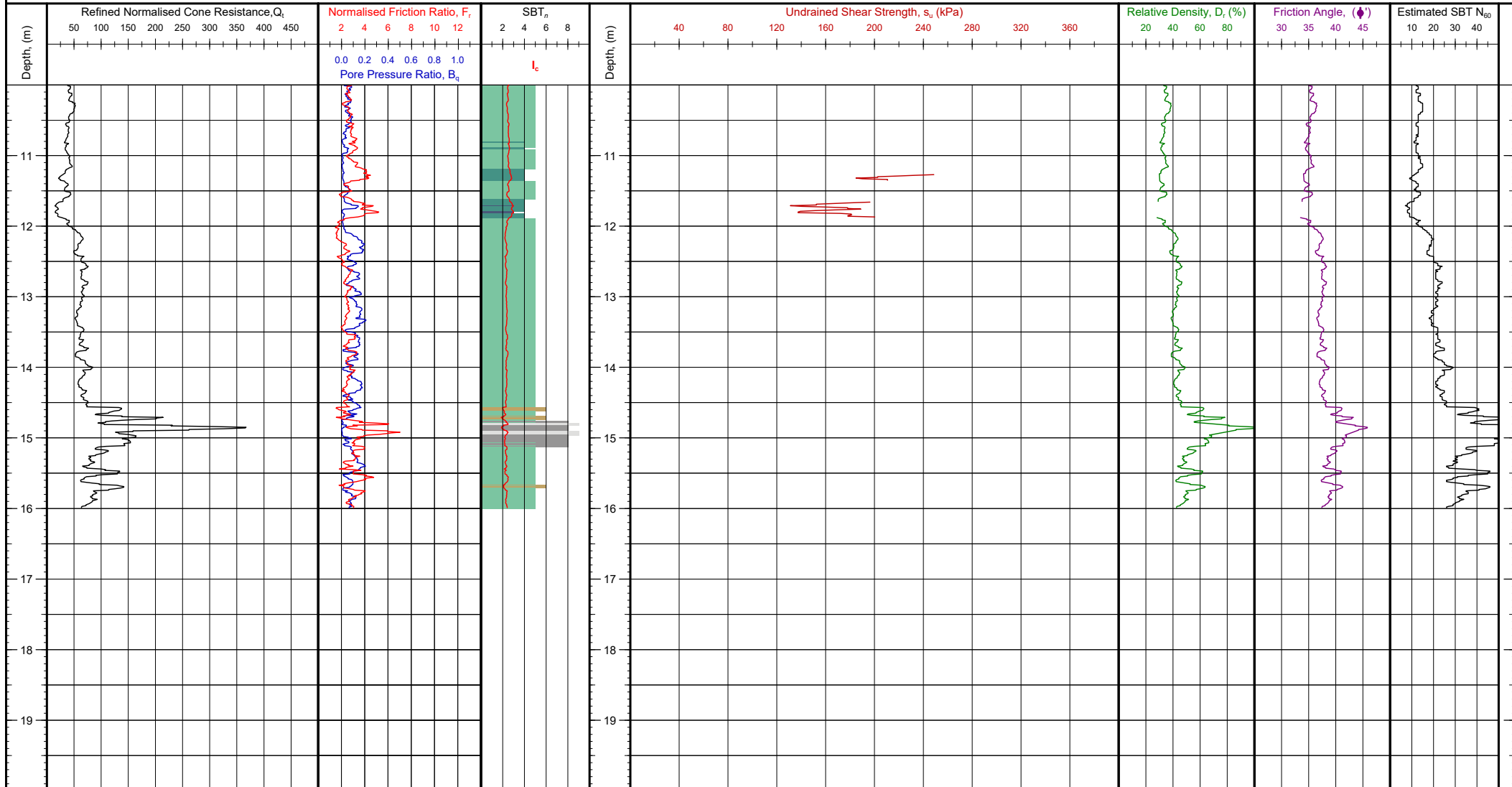
Test Number: CPT-07

G.I. Job Ref: 200824



Tonkin + Taylor

CPT PARAMETER LOG



Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-07**

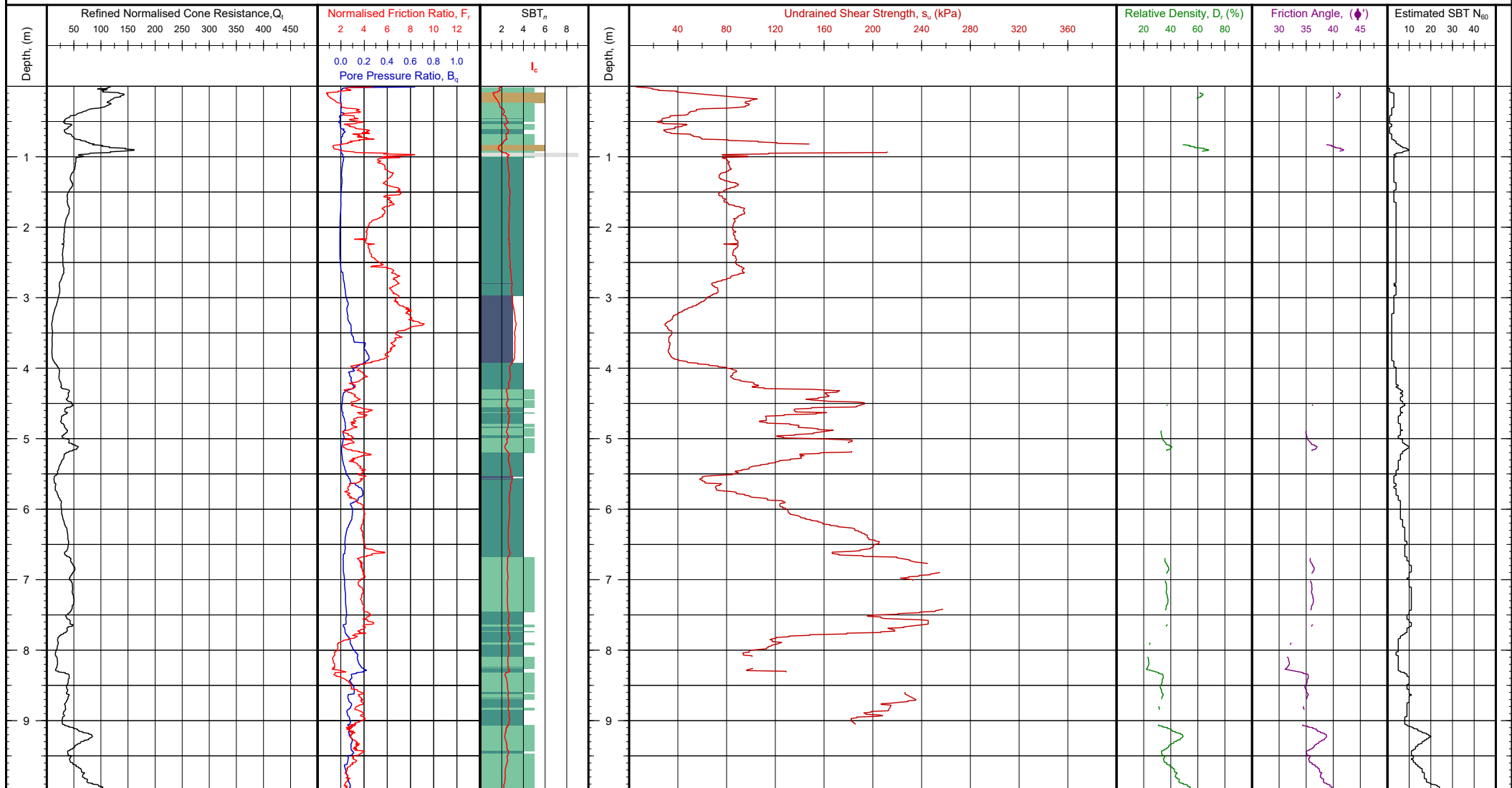
G.I. Job Ref: 200824

Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd



Tonkin+Taylor

CPT PARAMETER LOG



Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-08**

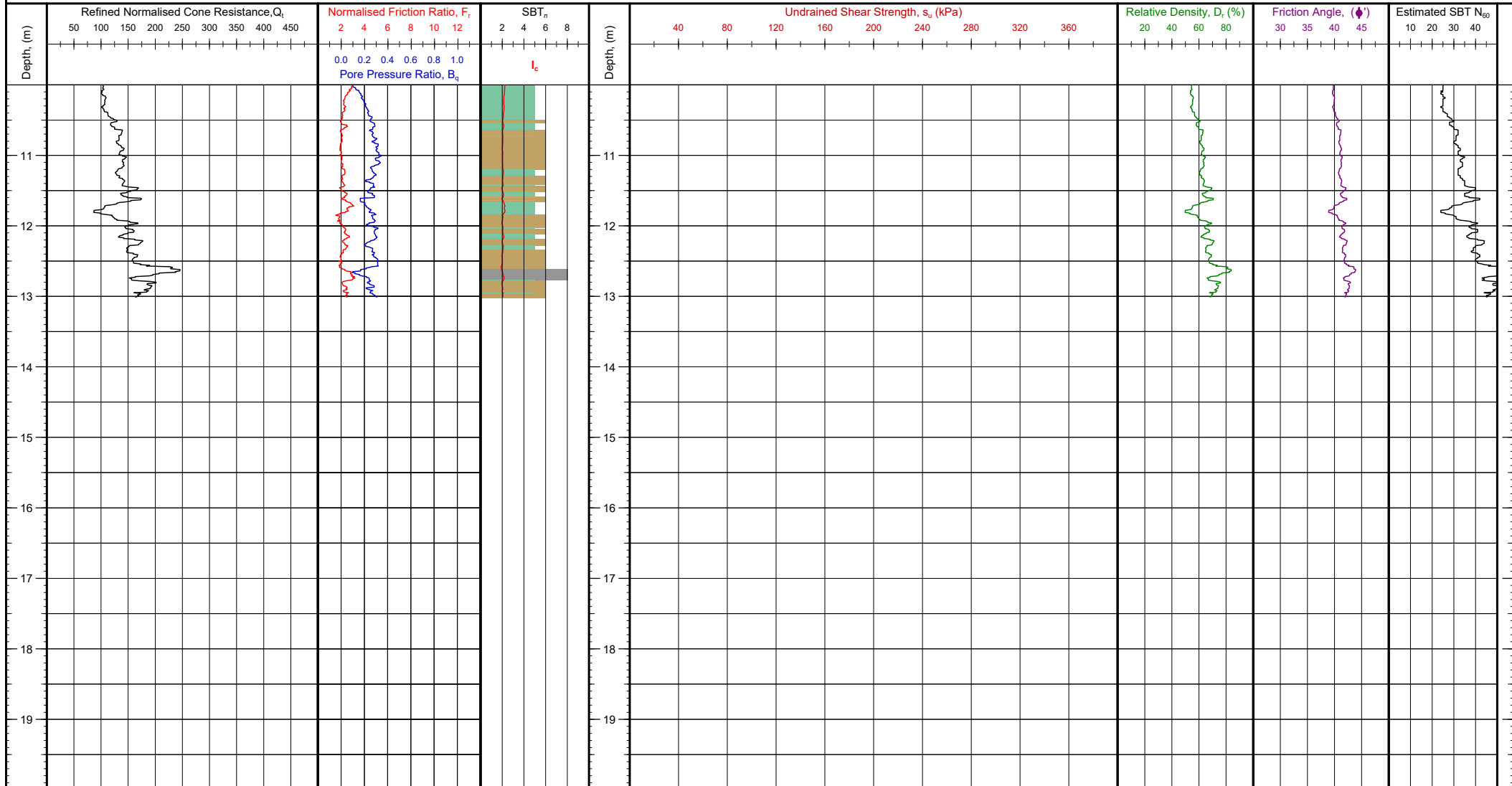
G.I. Job Ref: 200824

Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd



Tonkin + Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

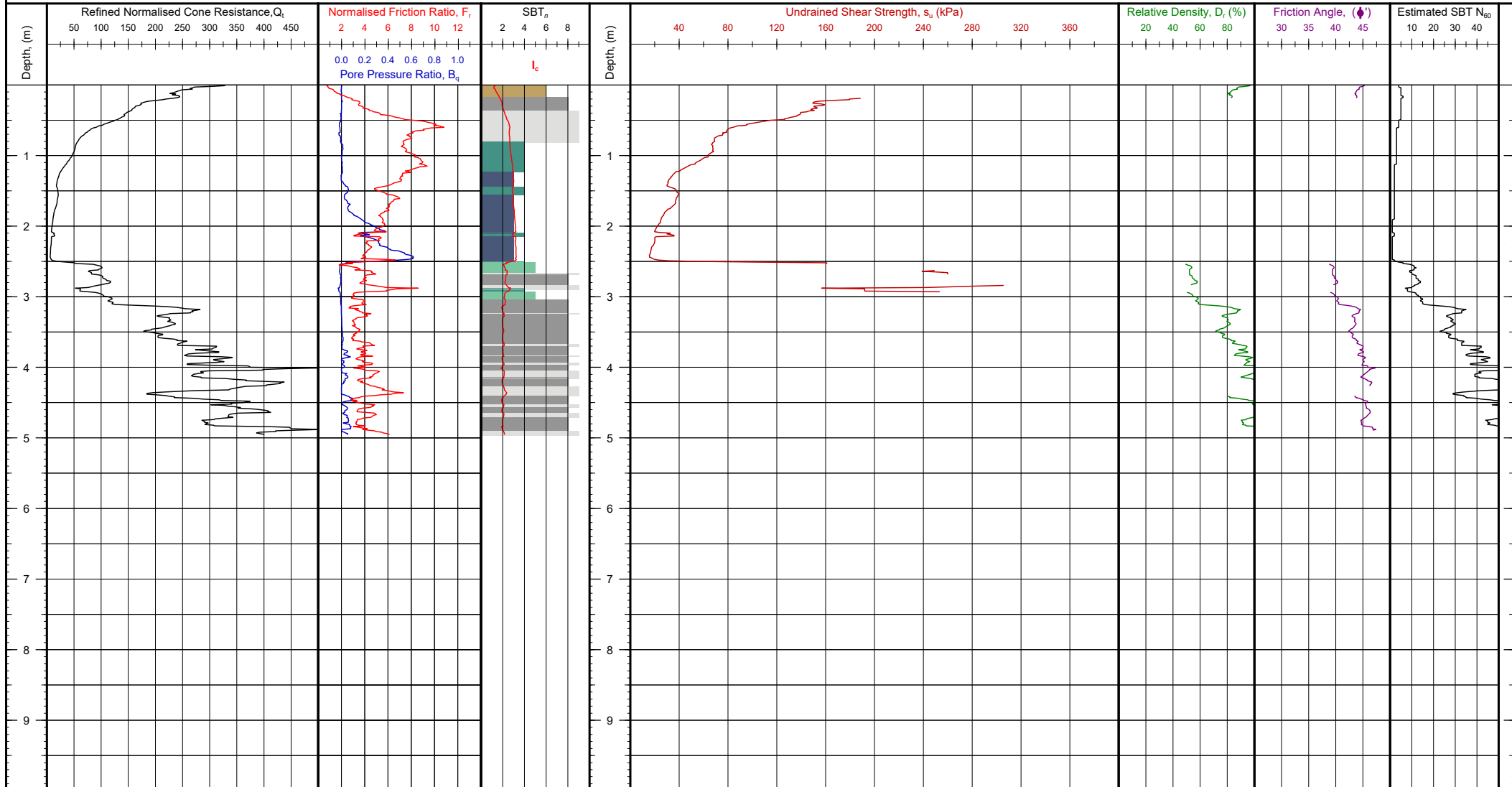
Test Number: CPT-08

G.I. Job Ref: 200824



Tonkin+Taylor

CPT PARAMETER LOG



Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-111**

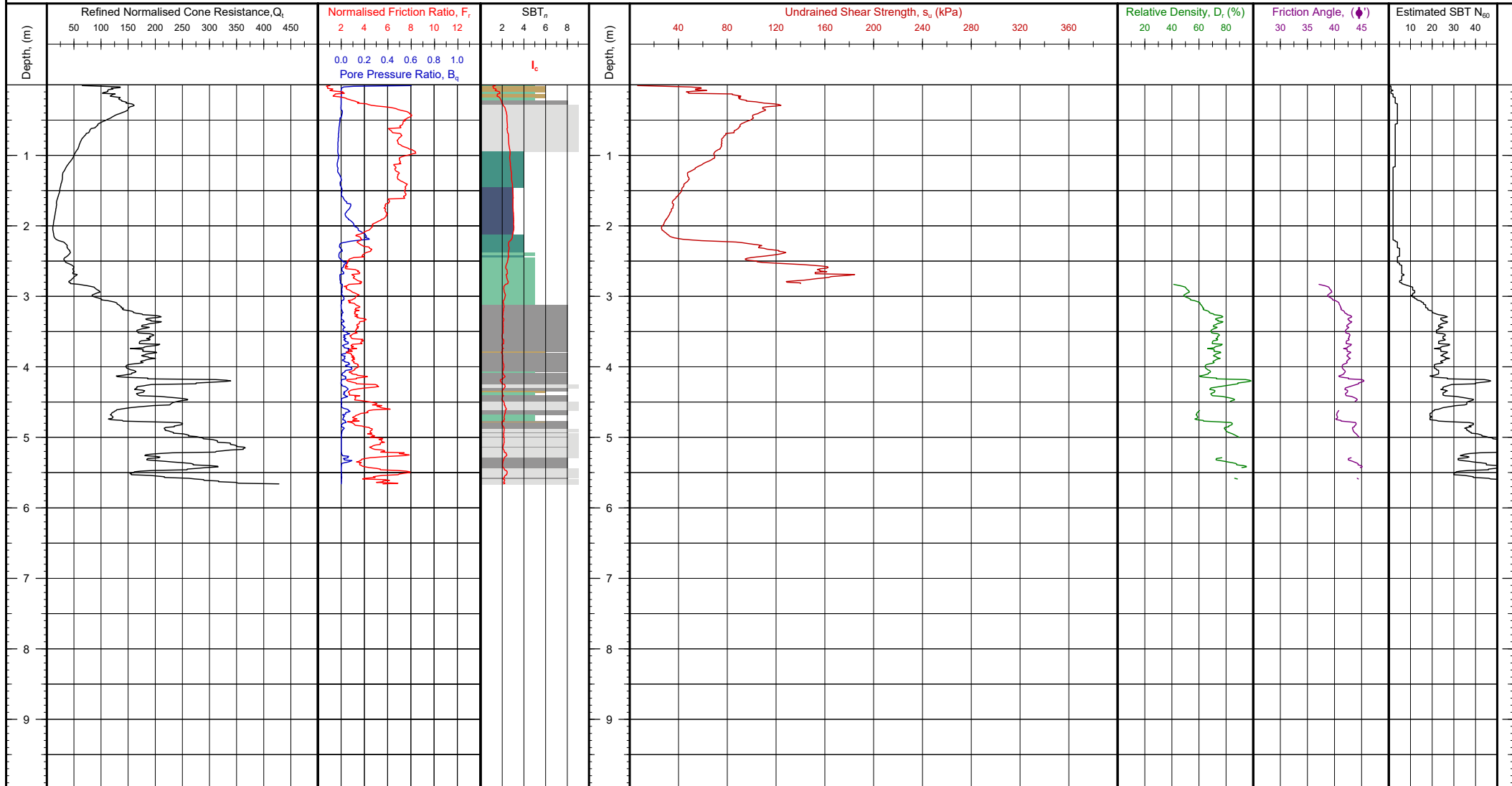
G.I. Job Ref: 200824

Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd



Tonkin + Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor

Project: Whenuapai-Redhills Wastewater Servicing

Location: Trig Road to Tamiro Road, Auckland

Engineer: Benjamin Westgate

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

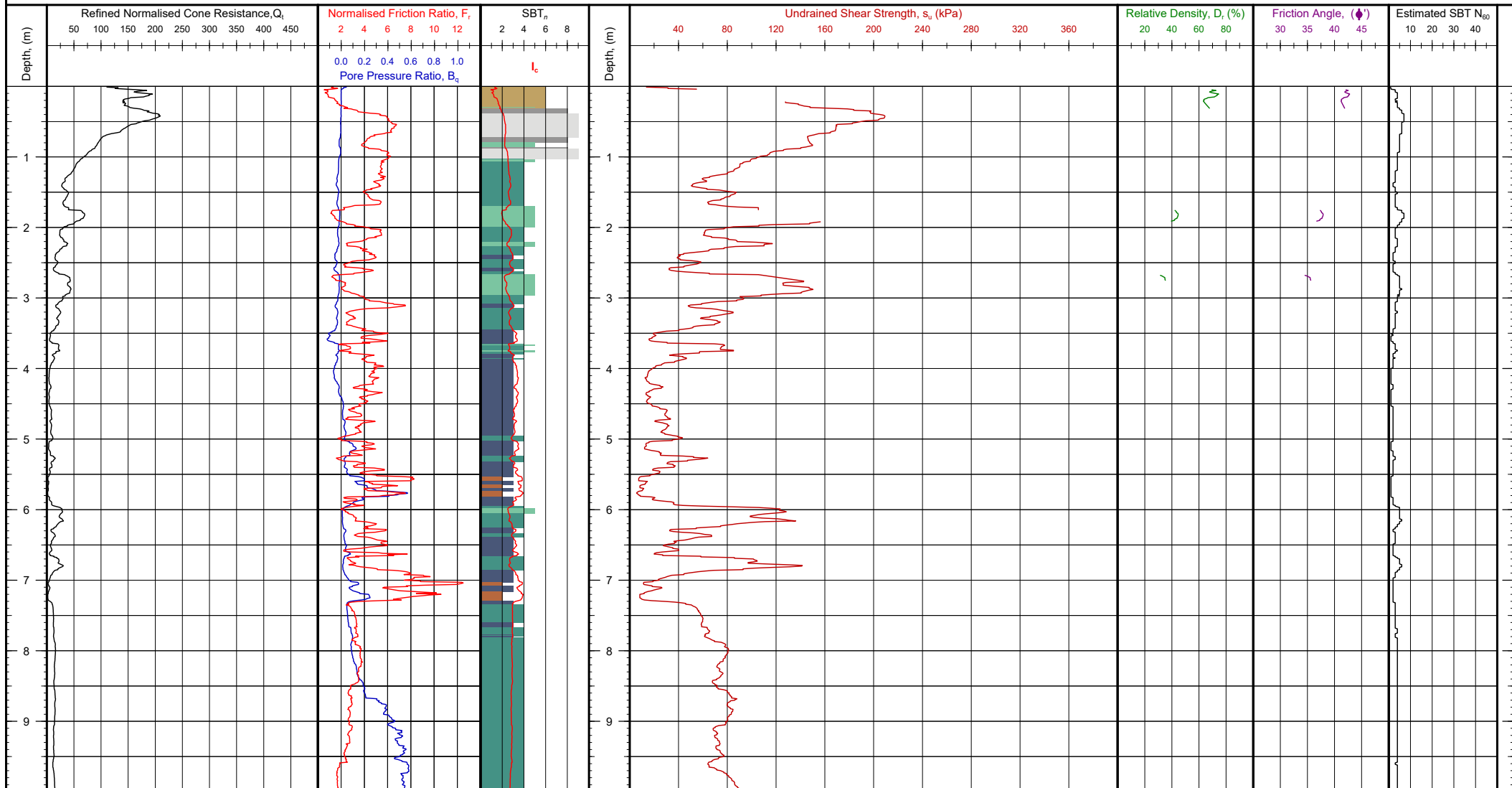
Test Number: CPT-112

G.I. Job Ref: 200824



Tonkin+Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor

Project: Whenuapai-Redhills Wastewater Servicing

Location: Trig Road to Tamiro Road, Auckland

Engineer: Benjamin Westgate

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: CPT-117

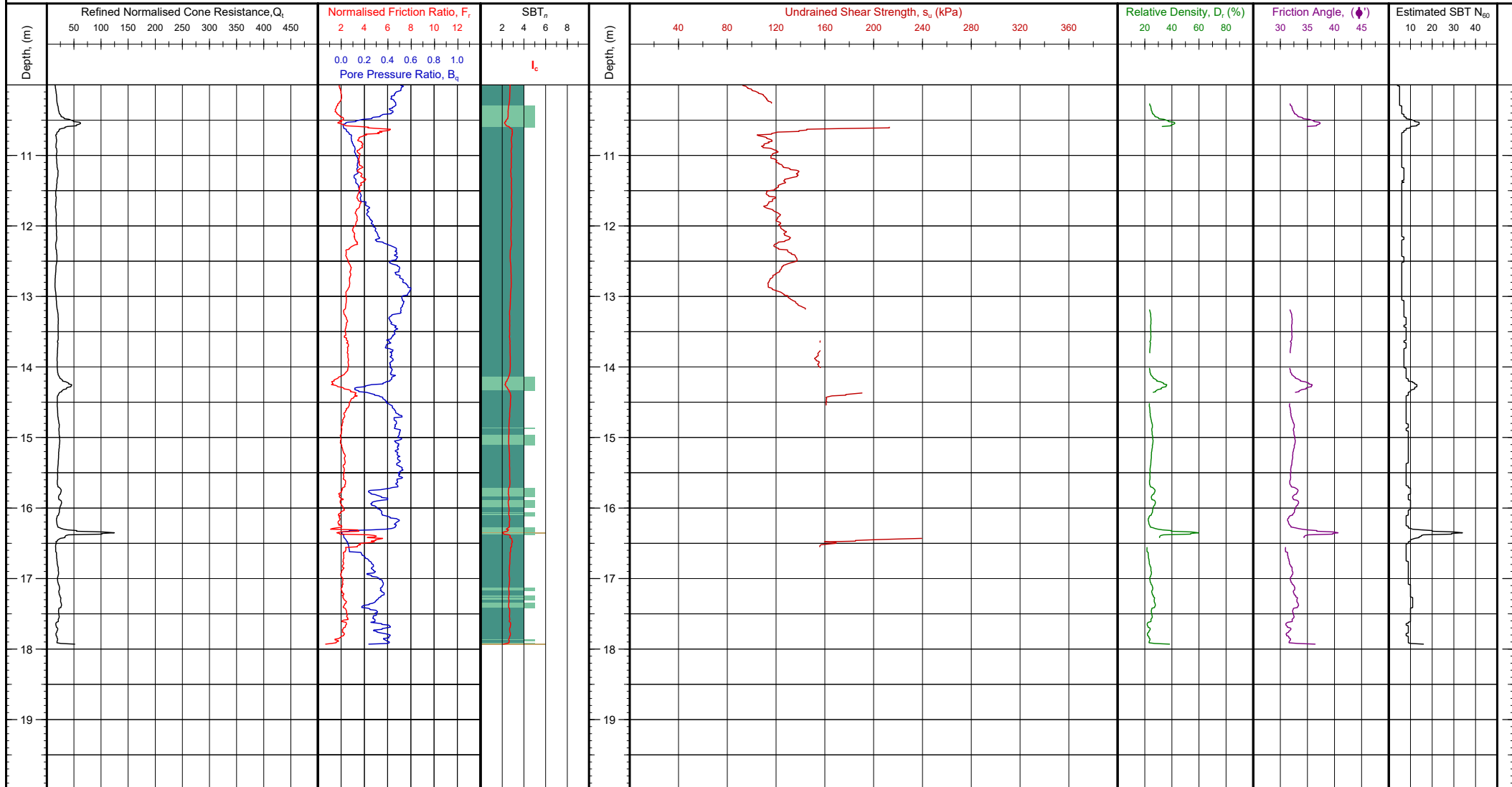
G.I. Job Ref: 200824



Tonkin + Taylor

CPT PARAMETER LOG

GROUND
INVESTIGATION



Client: Tonkin + Taylor

Project: Whenuapai-Redhills Wastewater Servicing

Location: Trig Road to Tamiro Road, Auckland

Engineer: Benjamin Westgate

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

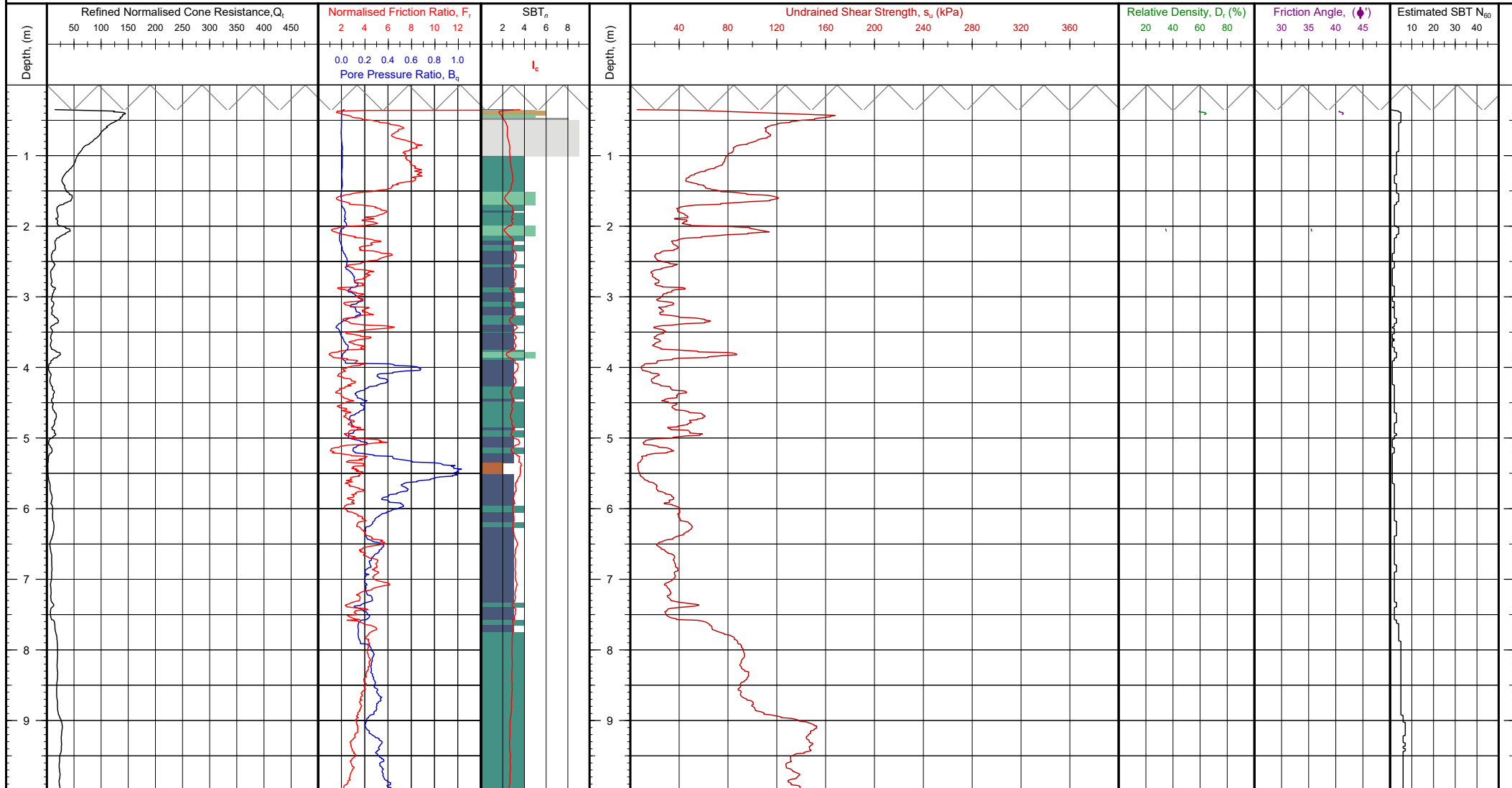
Test Number: CPT-117

G.I. Job Ref: 200824



Tonkin+Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor

Project: Whenuapai-Redhills Wastewater Servicing

Location: Trig Road to Tamiro Road, Auckland

Engineer: Benjamin Westgate

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

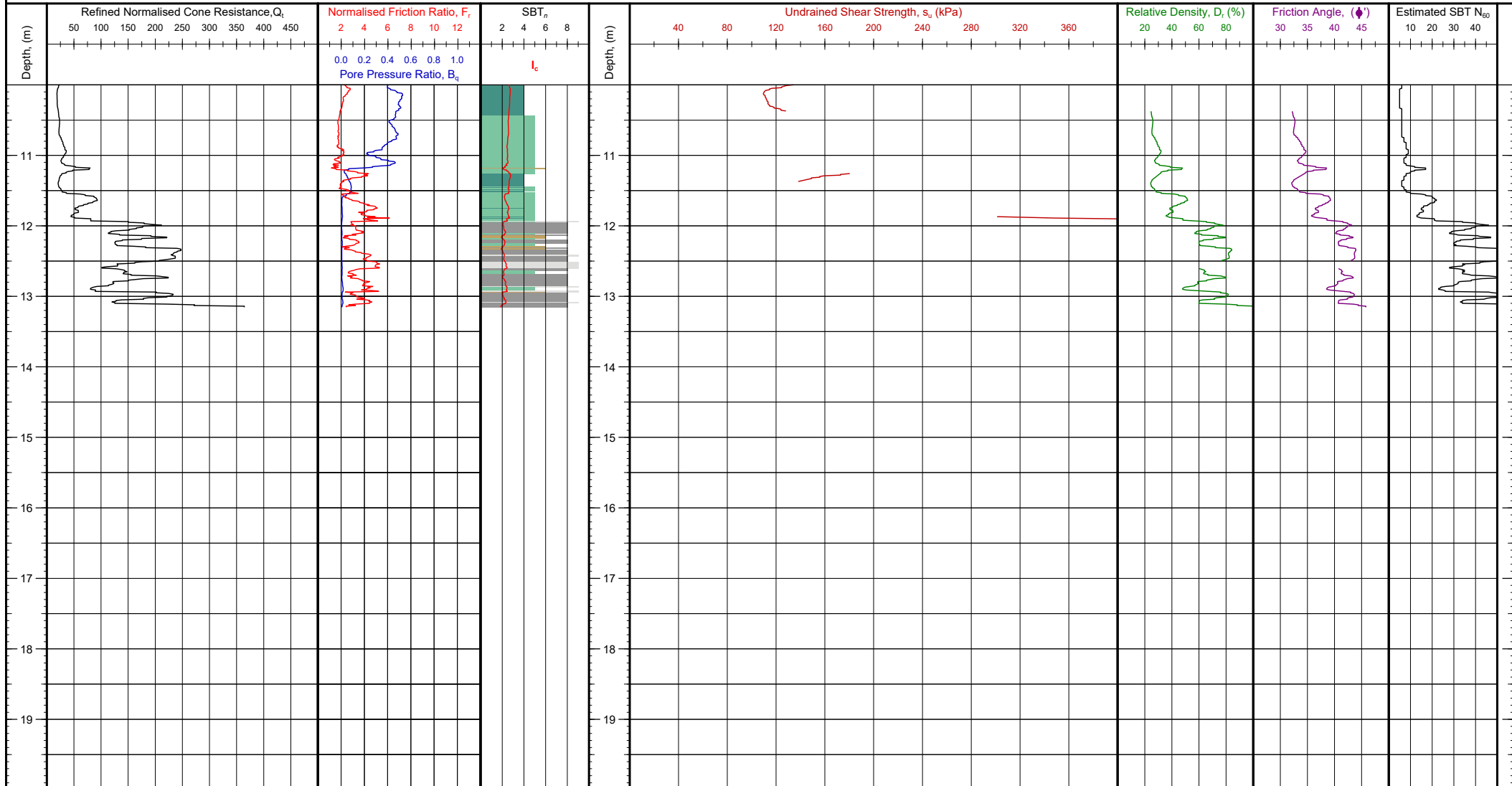
Test Number: CPT-121

G.I. Job Ref: 200824



Tonkin + Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

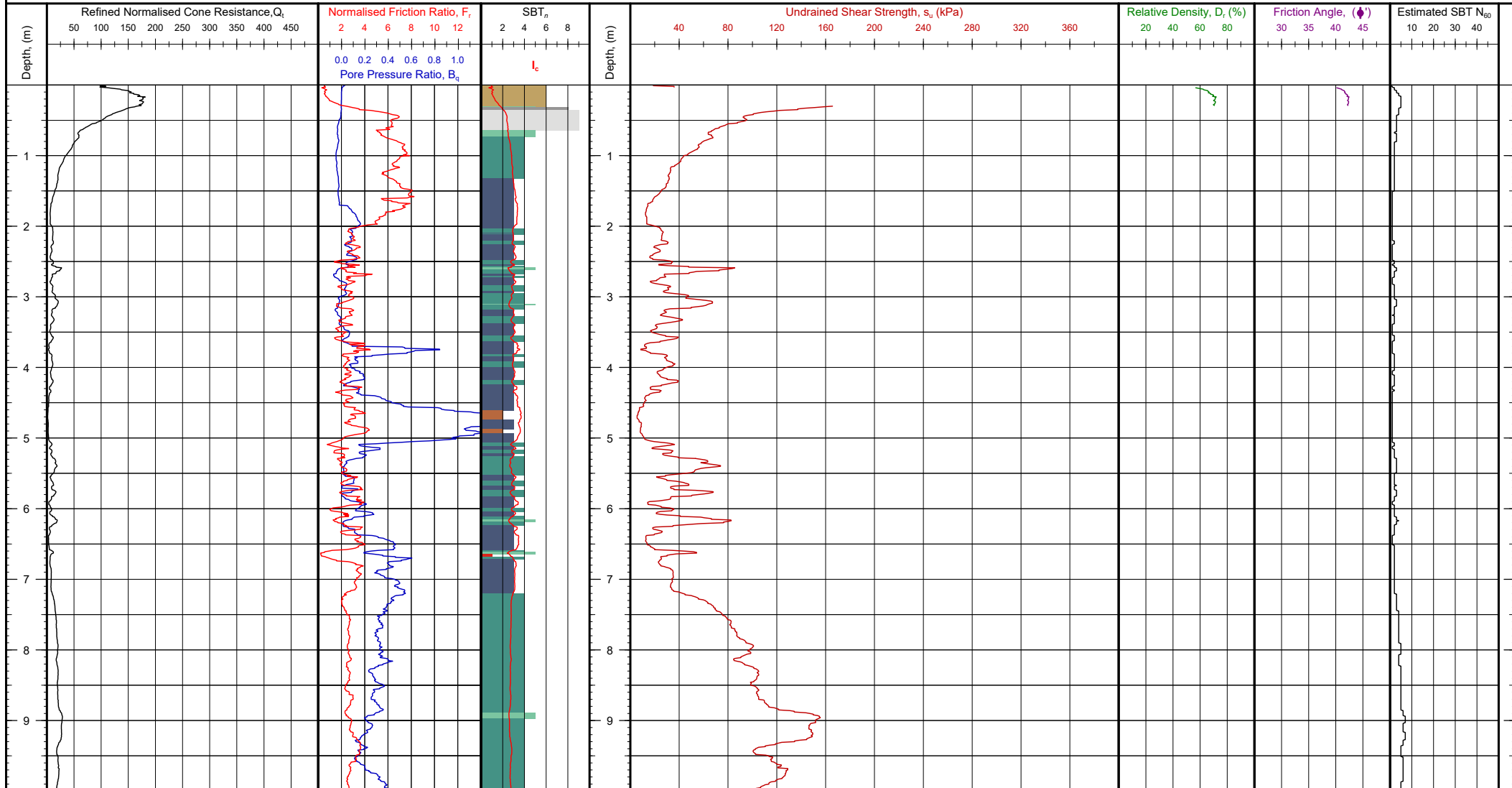
Test Number: CPT-121

G.I. Job Ref: 200824



Tonkin + Taylor

CPT PARAMETER LOG



Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-126**

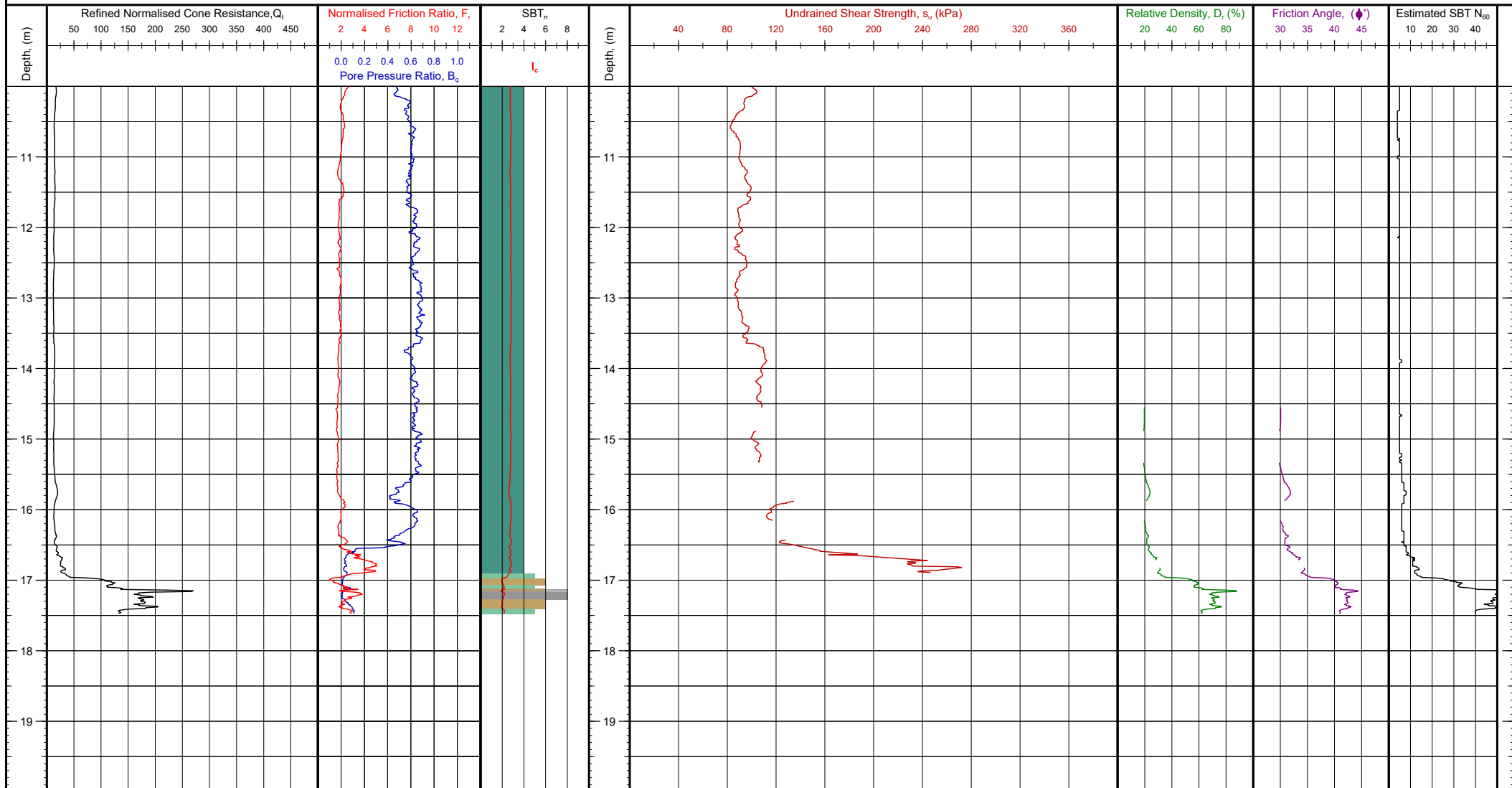
G.I. Job Ref: 200824

Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd



Tonkin + Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: CPT-126

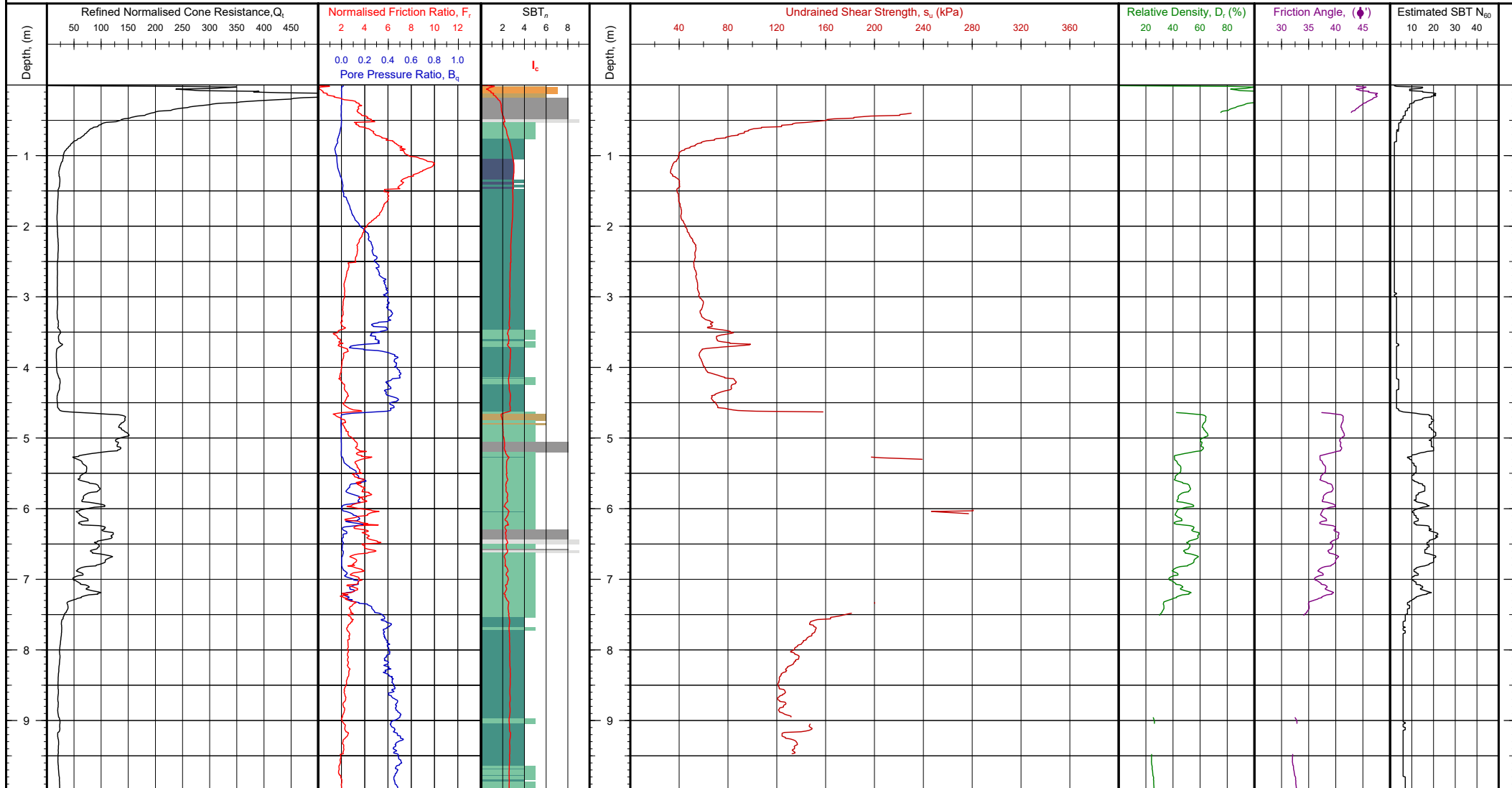
G.I. Job Ref: 200824



Tonkin+Taylor

CPT PARAMETER LOG

GROUND
INVESTIGATION



Client: Tonkin + Taylor

Project: Whenuapai-Redhills Wastewater Servicing

Location: Trig Road to Tamiro Road, Auckland

Engineer: Benjamin Westgate

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

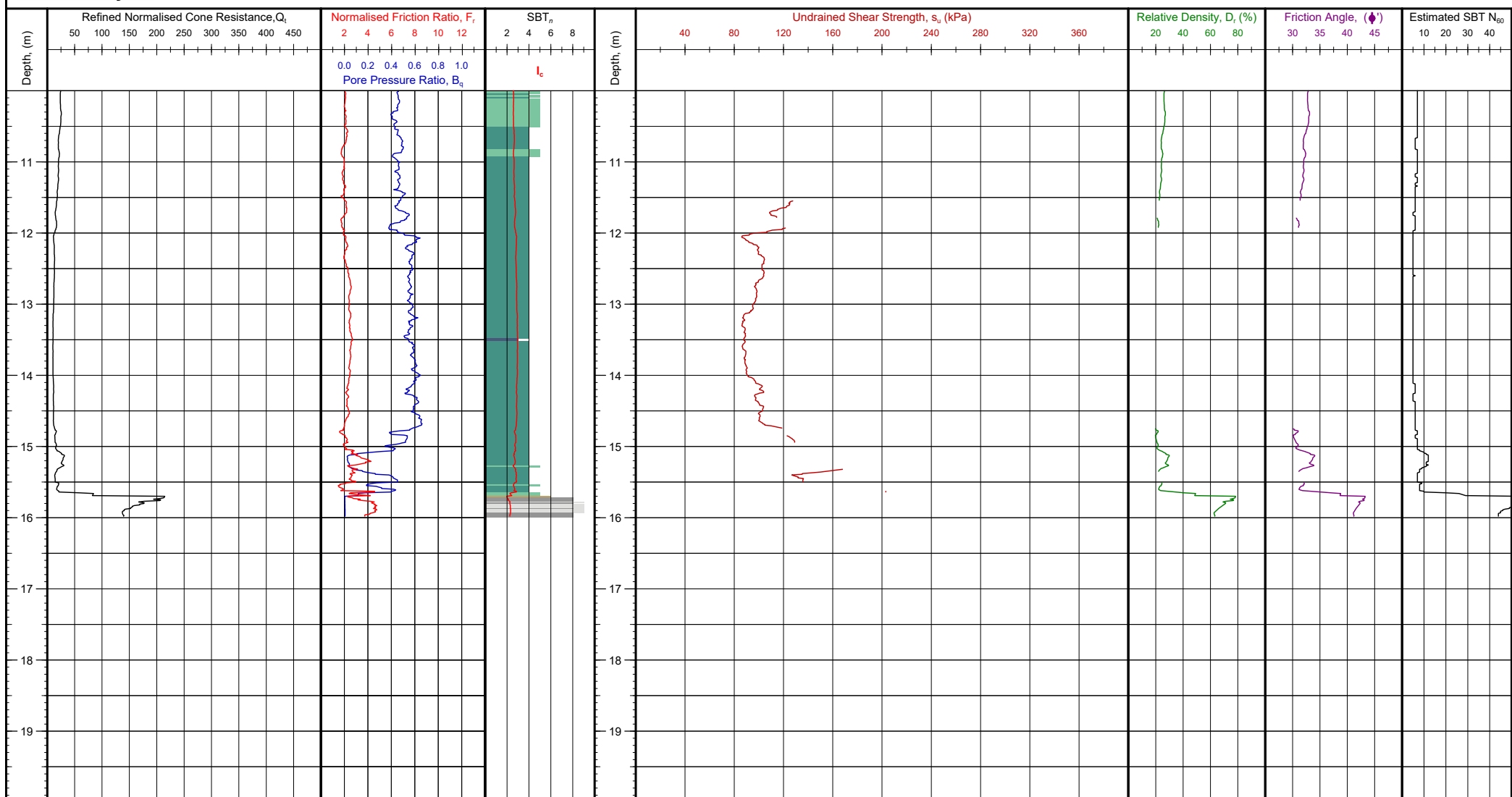
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: CPT-128

G.I. Job Ref: 200824

CPT PARAMETER LOG



Client: Tonkin + Taylor

Project: Whenuapai-Redhills Wastewater Servicing

Location: Trig Road to Tamiro Road, Auckland

Engineer: Benjamin Westgate

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:	
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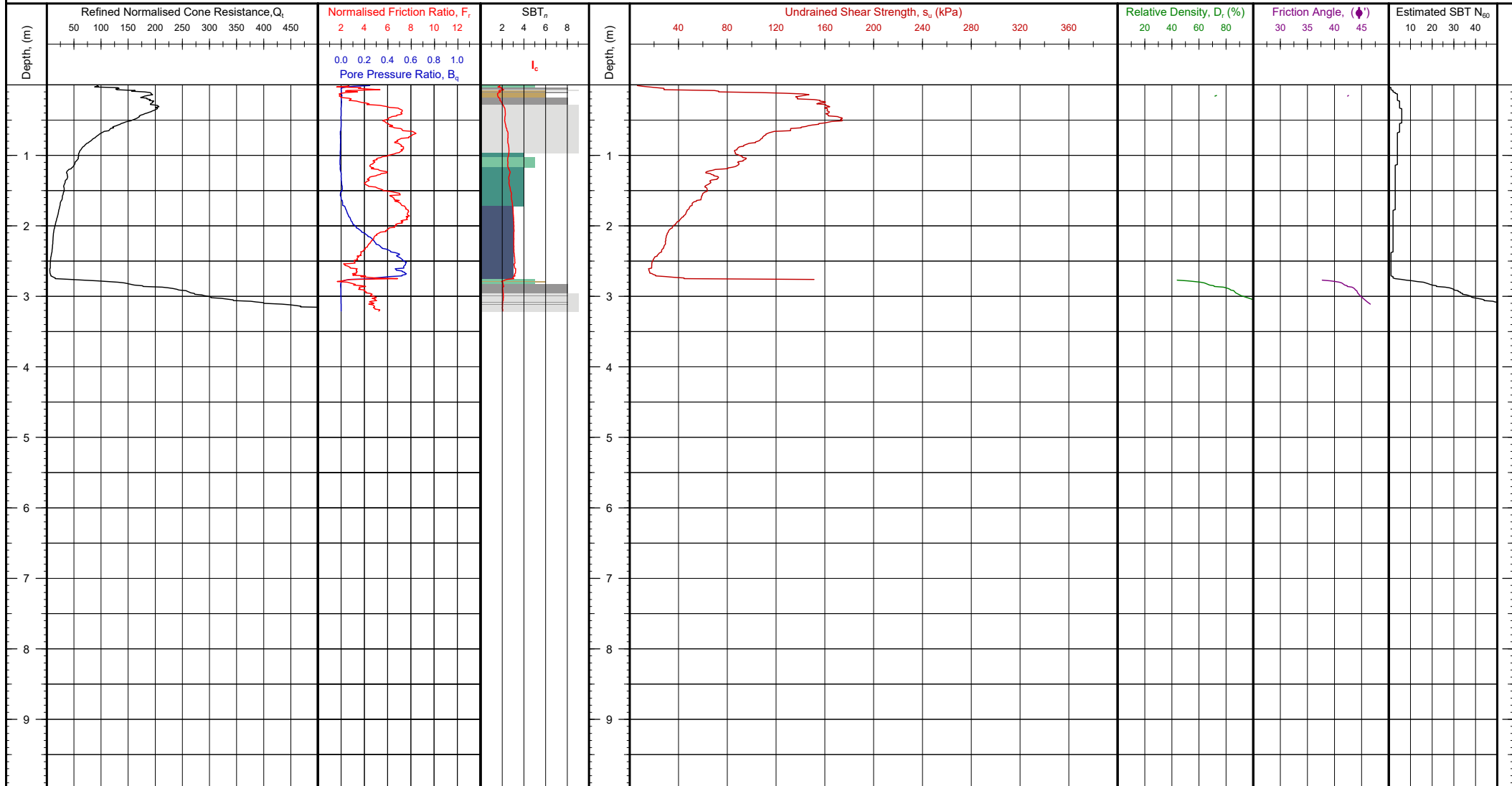
Test Number: CPT-128

G.I. Job Ref: 200824



Tonkin+Taylor

CPT PARAMETER LOG



Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: CPT-129

G.I. Job Ref: 200824

Client: Tonkin + Taylor

Project: Whenuapai-Redhills Wastewater Servicing

Location: Trig Road to Tamiro Road, Auckland

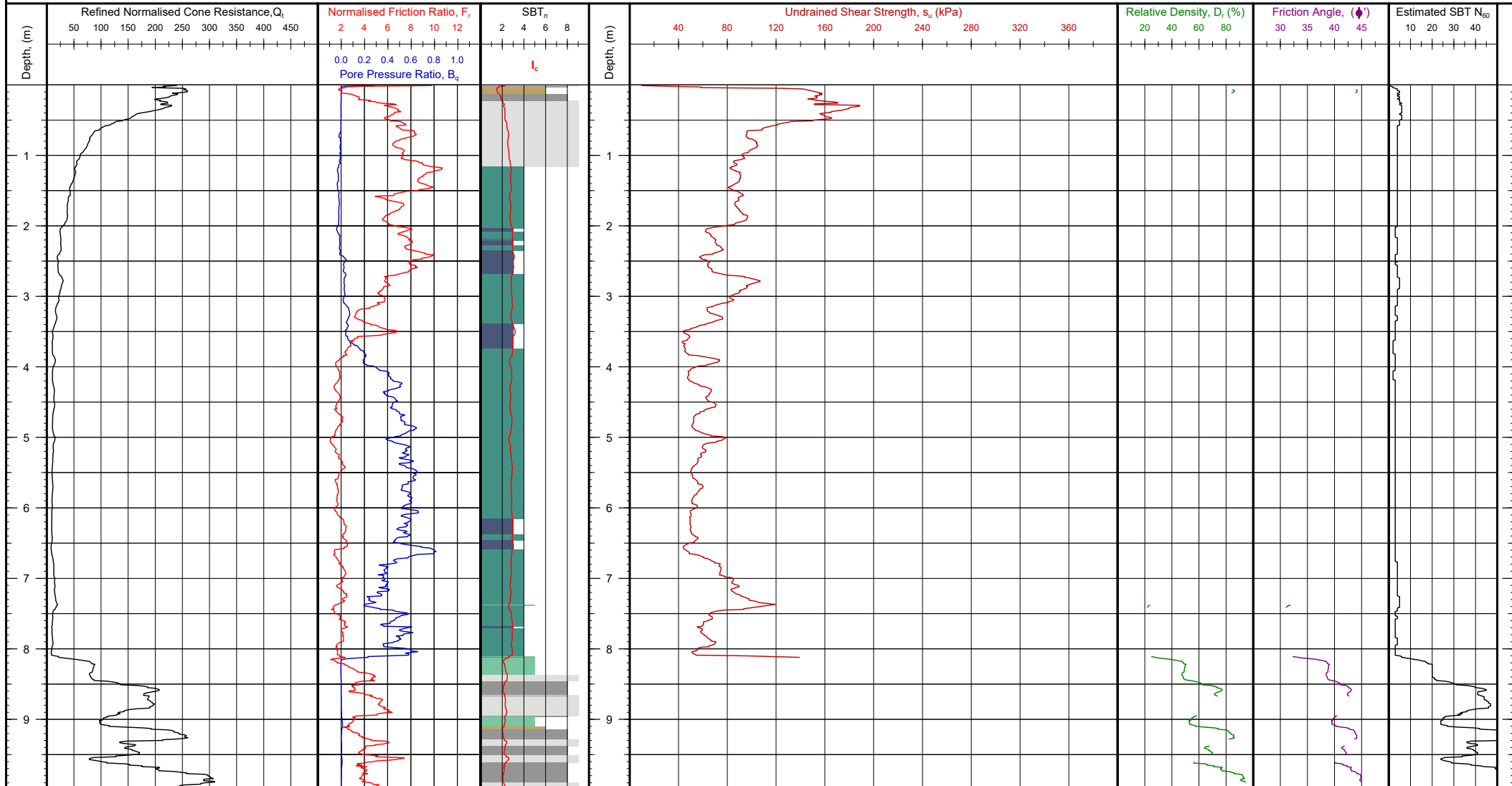
Engineer: Benjamin Westgate

Contractor: Ground Investigation Ltd



Tonkin+Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

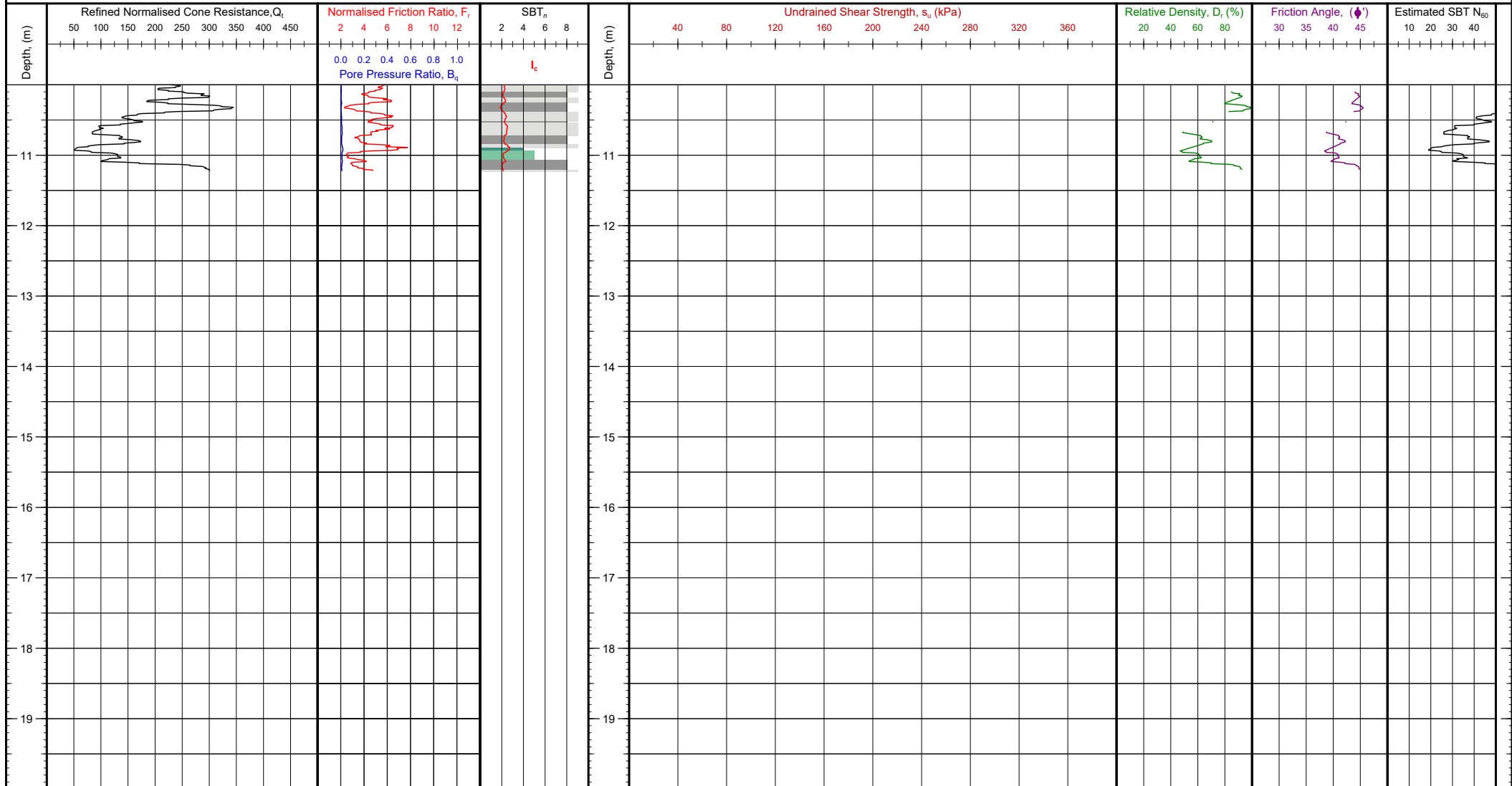
Test Number: CPT-131

G.I. Job Ref: 200824



Tonkin + Taylor

CPT PARAMETER LOG



Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing
Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate
Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

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

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: CPT-131

G.I. Job Ref: 200824

CPT ZEROS AND DRIFT

Cone Reference	CPT Name	Push Number	Tip Resistance			Local Friction			Pore Pressure		
			Initial (MPa)	Final (MPa)	Difference (kPa)	Initial (MPa)	Final (MPa)	Difference (kPa)	Initial (MPa)	Final (MPa)	Difference (kPa)
MKJ325	CPT-02	1	24.048	23.931	-117.3	0.2954	0.2954	0.0	2.7970	2.7994	2.4
MKJ309	CPT-03	1	9.804	9.762	-41.7	0.1323	0.1322	-0.1	1.4208	1.4215	0.7
MKJ325	CPT-04	1	24.091	24.027	-64.0	0.2951	0.2955	0.4	2.8024	2.8040	1.6
MKJ309	CPT-05	1	9.835	9.736	-99.0	0.1337	0.1324	-1.3	1.4195	1.4218	2.3
MKJ333	CPT-06	1	9.470	9.470	0.0	0.1200	0.1207	0.7	0.9416	0.9423	0.7
MKJ333	CPT-07	1	9.470	9.470	0.0	0.1215	0.1205	-1.0	0.9407	0.9426	1.9
MKJ539	CPT-08	1	20.626	20.611	-15.5	0.2498	0.2498	0.0	2.8176	2.8176	0.0
MKJ309	CPT-111	1	9.820	9.814	-5.3	0.1330	0.1331	0.1	1.4205	1.4213	0.8
MKJ325	CPT-112	1	23.995	23.974	-21.3	0.2940	0.2948	0.8	2.7981	2.7988	0.7
MKJ325	CPT-117	1	24.144	24.006	-138.6	0.2954	0.2952	-0.2	2.8047	2.8083	3.6
MKJ309	CPT-121	1	9.830	9.741	-88.6	0.1343	0.1315	-2.8	1.4169	1.4194	2.5
MKJ325	CPT-126	1	24.123	23.984	-138.6	0.2956	0.2954	-0.2	2.8048	2.8069	2.1
MKJ325	CPT-128	1	24.064	24.022	-42.6	0.2947	0.2951	0.4	2.8065	2.8067	0.2
MKJ309	CPT-129	1	9.783	9.773	-10.5	0.1315	0.1318	0.3	1.4210	1.4219	0.9

Client: Tonkin + Taylor
Project: Whenuapai-Redhills Wastewater Servicing Project

Location: Trig Road to Tamiro Road, Auckland
Engineer: Benjamin Westgate

Note: Zero difference colour-coded based on application classes following ISO 22476-1:2012. Blue indicates Class 1, green Class 2, orange Class 3 and red Class 4. Grey represents if a test is below Class 4.

CPT ZEROS AND DRIFT

Cone Reference	CPT Name	Push Number	Tip Resistance			Local Friction			Pore Pressure		
			Initial (MPa)	Final (MPa)	Difference (kPa)	Initial (MPa)	Final (MPa)	Difference (kPa)	Initial (MPa)	Final (MPa)	Difference (kPa)
MKJ309	CPT-131	1	9.866	9.767	-99.1	0.1340	0.1322	-1.8	1.4200	1.4219	1.9

HAND AUGER LOG

HOLE Id: **ENVR-HA03**

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI										LOCATION: Whenuapai										JOB No.: 1014985.0000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
CO-ORDINATES: 5925787.00 mN (NZTM2000) 1744024.40 mE										DRILL TYPE: 50 mm HA										HOLE STARTED: 10/11/2020																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
R.L.: 36.70m										DRILL METHOD: HA										HOLE FINISHED: 10/11/2020																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
DATUM: NZVD2016																				DRILLED BY: Tonkin + Taylor Ltd																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.															WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/100mm)									TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION	WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5925787.00 mN 1744024.40 mE	DRILL TYPE: 50 mm HA	HOLE STARTED: 10/11/2020
R.L.:	36.70m	DRILL METHOD: HA	HOLE FINISHED: 10/11/2020
DATUM:	NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
			LOGGED BY: RVDK CHECKED: CBM



0.00-1.00m

HAND AUGER LOG

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5925759.80 mN 1744104.70 mE	DRILL TYPE: 50 mm HA	HOLE STARTED: 10/11/2020
R.L.:	39.50m	DRILL METHOD: HA	HOLE FINISHED: 10/11/2020
DATUM:	NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
			LOGGED BY: RVDK CHECKED: CBM



0.00-1.00m

HAND AUGER LOG

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5925739.90 mN 1744151.80 mE	DRILL TYPE: 50 mm HA	HOLE STARTED: 10/11/2020
R.L.:	41.00m	DRILL METHOD: HA	HOLE FINISHED: 10/11/2020
DATUM:	NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
			LOGGED BY: RVDK CHECKED: CBM



0.00-1.00m

HAND AUGER LOG

HOLE Id: **ENVR-HA101**

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI	LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926989.60 mN (NZTM2000) 1743340.30 mE	DRILL TYPE: 50 mm HA	HOLE STARTED: 04/11/2020
R.L.: 12.80m	DRILL METHOD: HA	HOLE FINISHED: 04/11/2020
DATUM: NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
		LOGGED BY: RVDK CHECKED: CBM

GEOLOGICAL													ENGINEERING DESCRIPTION												
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION,	WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/100mm)									TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations				
				0	1	2	3	4	5	6	7	8										9			
Tauranga Group	04/11/2020												ENVR-HA 101-0.0- 0.1m @ 0.00m		12					Clayey SILT; greyish brown. Stiff, dry, non-plastic.					
													ENVR-HA 101-0.5- 0.6m @ 0.50m							0.5m: PID= 0.0ppm					
													ENVR-HA 101-1.6- 1.8m @ 1.60m							1.0m: PID= 0.0ppm					
																				SILT, trace sand; light greyish brown with orange mottle. Stiff, moist, non-plastic.					
																				2m: Target depth					

COMMENTS:
Hole Depth 2m

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926989.60 mN 1743340.30 mE	DRILL TYPE: 50 mm HA	HOLE STARTED: 04/11/2020
R.L.:	12.80m	DRILL METHOD: HA	HOLE FINISHED: 04/11/2020
DATUM:	NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
			LOGGED BY: RVDK CHECKED: CBM



0.00-2.00m

HAND AUGER LOG

HOLE Id: **HA03**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000																			
CO-ORDINATES: 5926343.50 mN (NZTM2000) 1743214.30 mE		DRILL TYPE: 75 and 50 mm Hand auger				HOLE STARTED: 02/12/2020																					
R.L.: 19.40m		DRILL METHOD: HA+DCP				HOLE FINISHED: 02/12/2020																					
DATUM: NZVD2016						DRILLED BY: GEOTECHNICS																					
								LOGGED BY: RBE		CHECKED: CBM																	
GEOLOGICAL								ENGINEERING DESCRIPTION																			
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER		CORE RECOVERY (%)		METHOD		SCALA PENETROMETER (Blows/100mm)		TESTS		SAMPLES		RL (m)		DEPTH (m)		GRAPHIC LOG		WEATHERING MOISTURE CONDITION		STRENGTH/DENSITY CLASSIFICATION		SHEAR STRENGTH (kPa)		Description and Additional Observations	
								0 2 4 6 8 10 12 14 16 18																			
Topsoil										asb/gl/split @ 0.00m								TS		M						SILT; brown. Moist, non-plastic.	
										● 186/56 kPa				19		0.5						VSt				SILT; friable. Very stiff, moist, non-plastic.	
										asb/gl @ 0.40m																Silty CLAY; light greyish white mottled orange brown. Very stiff, moist, high plasticity.	
										PID, 0.0ppm																	
										● 121/48 kPa																0.5m: mottled yellowish brown	
										● 180/77 kPa																	
										asb/gl @ 0.90m																	
										PID, 0.0ppm																	
										● 114/60 kPa				18													
										● 104/54 kPa																	
										att/psd @ 1.45m																	
										● 114/60 kPa																	
										asb/gl @ 1.90m																	
										● 162/77 kPa																2.1m: light greyish white, low plasticity	
										● 122/66 kPa				17													
										● 119/72 kPa																	
										asb/gl @ 2.80m																	
										● 175/74 kPa																Sandy SILT; light whitish grey. Moist to wet, non-plastic.	
										● 122/85 kPa				16												SILT; light greyish white mottled yellowish brown. Very stiff, moist, non-plastic.	
										att/psd @ 3.45m																Clayey SILT; light whitish grey mottled yellowish brown and brown. Very stiff to stiff, moist, low plasticity.	
										● 186/85 kPa																	
										● 122/82 kPa																	
										asb/gl @ 3.80m																	
										● 123/77 kPa																	
														15													
										● 147/101 kPa																	
										● 96/32 kPa																	
										asb/gl @																Peaty clayey SILT; black. Stiff, moist, low	

COMMENTS: Farmland end Spedding Rd

Hole Depth
6.45m

Scale 1:25

HAND AUGER LOG

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES:	5926343.50 mN (NZTM2000) 1743214.30 mE	DRILL TYPE: 75 and 50 mm Hand auger	HOLE STARTED: 02/12/2020
R.L.:	19.40m	DRILL METHOD: HA+DCP	HOLE FINISHED: 02/12/2020
DATUM:	NZVD2016		DRILLED BY: GEOTECHNICS
			LOGGED BY: RBE CHECKED: CBM



0.00-5.20m

HAND AUGER LOG

HOLE Id: **HA04**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000							
CO-ORDINATES: (NZTM2000)		5926082.10 mN 1743388.90 mE		DRILL TYPE: 75 and 50 mm Hand auger				HOLE STARTED: 02/12/2020							
R.L.:		21.20m		DRILL METHOD: HA+DCP				HOLE FINISHED: 02/12/2020							
DATUM:		NZVD2016						DRILLED BY: GEOTECHNICS							
								LOGGED BY: RBE							
								CHECKED: CBM							
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/100mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations	
Topsoil						asb/gl/dupB @ 0.00m		21		TS	M	St		SILT; dark brown. Stiff, moist, non-plastic; inclusion of agricultural plastic sheet.	
						• >186 kPa asb/gl @ 0.40m						VSt		Sandy SILT; light whitish brown. Very stiff, moist, non-plastic.	
Tauranga Group						PID, 0.0ppm @ 0.50m		0.5				St-VSt		Silty CLAY; light greyish white mottled yellowish brown. Very stiff to stiff, moist, high plasticity.	
						• 179/50 kPa									
						• 159/61 kPa asb/gl @ 0.90m									
						PID, 0.1ppm @ 1.00m									
						• 122/54 kPa									
						• 109/44 kPa									
						att/psd @ 1.45m									
						• 90/35 kPa									
						asb/gl @ 1.90m									
						• 127/46 kPa									
						att/psd @ 2.45m									
													1.0m: light grey mottled yellowish brown		
													1.8m: some sand, light brownish white		
													Clayey SILT; light brown. Very stiff, moist, low plasticity.		
													Silty SAND; white. Moist to wet; sand, fine to medium; well packed.		
													2.5m: Scala (blows per 100mm): 13,22,22,20,18		
													3.0m: light brown		
													SILT; light brown. Stiff, moist, non-plastic; Scala (blows per 100mm): 5,6,8.		
													Clayey SILT; grey. Stiff, moist, low plasticity.		
													Silty SAND; greyish brown. Wet; sand, fine to medium.		
													SILT; brown and grey. Very stiff, moist, non-plastic.		
													4.4m: abundant organics and inclusions of decomposed wood		
													Clayey SILT; light grey. Very stiff, moist, low plasticity.		

COMMENTS: Farmland end Spedding Rd

Hole Depth
6.85m

Scale 1:25

Rev.: A

HAND AUGER LOG

HOLE Id: **HA04**

SHEET: 2 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000							
CO-ORDINATES:		5926082.10 mN (NZTM2000) 1743388.90 mE		DRILL TYPE: 75 and 50 mm Hand auger				HOLE STARTED: 02/12/2020							
R.L.:		21.20m		DRILL METHOD: HA+DCP				HOLE FINISHED: 02/12/2020							
DATUM:		NZVD2016						DRILLED BY: GEOTECHNICS							
								LOGGED BY: RBE							
								CHECKED: CBM							
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/100mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations	
Borehole 1, 100m	Tauranga Group				0 2 4 6 8 10 12 14 16 18	4.80m ● 117/42 kPa		16						[CONT] Clayey SILT; light grey. Very stiff, moist, low plasticity. 5.15m: brown with some organics	
					1 2 2 2 2 3 3 3 4 4 5 6 6 6 6 6 6 6 7 7 7 8 8 8 8 8 10 11 12 12			5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5					End of handauger 5.2m. Scala (blows per 100mm): 3,4,5,6,7,8,11,12,11,12, 14,15,16,16,21,24		
								14						6.85m: Refusal	

COMMENTS: Farmland end Spedding Rd

Hole Depth
6.85m
Scale 1:25

CORE PHOTOS

BOREHOLE No.: **HA04**

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926082.10 mN (NZTM2000) 1743388.90 mE		DRILL TYPE: 75 and 50 mm Hand auger	HOLE STARTED: 02/12/2020
R.L.: 21.20m		DRILL METHOD: HA+DCP	HOLE FINISHED: 02/12/2020
DATUM: NZVD2016		LOGGED BY: RBE	CHECKED: CBM



0.00-5.20m

HAND AUGER LOG

HOLE Id: **HA05**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000							
CO-ORDINATES: 5925977.70 mN (NZTM2000) 1743549.70 mE				DRILL TYPE: 75 and 50mm Hand auger				HOLE STARTED: 01/12/2020							
R.L.: 27.20m				DRILL METHOD: HA+DCP				HOLE FINISHED: 01/12/2020							
DATUM: NZVD2016								DRILLED BY: GEOTECHNICS							
								LOGGED BY: RBE							
								CHECKED: CBM							
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/100mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations	
Fill					0 2 4 6 8 10 12 14 16 18	asb/gl/split @ 0.00m		27		TS	M			SILT; dark brown. Moist, non-plastic; inclusions of gravel, black plastic twine.	
Tauranga Group		01/12/2020 W/L on completion				● 130/32 kPa asb/gl @ 0.40m PID, 0.1ppm @ 0.50m ● 88/29 kPa			0.5			St-Vst		Silty CLAY; light grey. Stiff to very stiff, moist, high plasticity.	
						● 82/32 kPa asb/gl @ 0.90m PID, 0.1ppm @ 1.00m ● 108/35 kPa			1.0						
						● 80/33 kPa att/psd @ 1.45m ● 96/41 kPa asb/gl @ 1.90m			1.5				1.8m: light greyish brown. Low plasticity		
									2.0	W	St		Sandy SILT; light greyish brown. Stiff, wet, non-plastic.		
						● 56/19 kPa att/psd2 @ 2.45m			2.5		M	F-St		Clayey SILT, trace sand; light brown. Stiff to firm, moist, low plasticity.	
						● 37/20 kPa asb/gl @ 2.70m									
						● 41/21 kPa			3.0			F		Silty CLAY; light grey. Firm, moist, high plasticity.	
						● 40/24 kPa			3.5						
						● 35/16 kPa asb/gl @ 3.70m			4.0				4.0m: brown		
						● 35/13 kPa							4.2m: blackish brown		
						● 35/13 kPa									
						● 41/21 kPa			4.5				4.5m: brown		
						● 45/21 kPa									
asb/gl @											St				
COMMENTS: Spedding Road															
Hole Depth 7.25m															

COMMENTS: Spedding Road

Hole Depth
7.25m

Scale 1:25

HAND AUGER LOG

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5925977.70 mN 1743549.70 mE	DRILL TYPE: 75 and 50mm Hand auger	HOLE STARTED: 01/12/2020
R.L.:	27.20m	DRILL METHOD: HA+DCP	HOLE FINISHED: 01/12/2020
DATUM:	NZVD2016		DRILLED BY: GEOTECHNICS
			LOGGED BY: RBE CHECKED: CBM



0.00-5.20m

HAND AUGER LOG

HOLE Id: **HA06**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000							
CO-ORDINATES: 5925924.30 mN (NZTM2000) 1743672.80 mE				DRILL TYPE: 75 and 50 mm Hand auger				HOLE STARTED: 01/12/2020							
R.L.: 30.70m				DRILL METHOD: HA+DCP				HOLE FINISHED: 01/12/2020							
DATUM: NZVD2016								DRILLED BY: GEOTECHNICS							
								LOGGED BY: RBE							
								CHECKED: CBM							
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.								Description and Additional Observations							
WATER CORE RECOVERY (%) METHOD SCALA PENETROMETER (Blows/100mm) TESTS SAMPLES RL (m) DEPTH (m) GRAPHIC LOG WEATHERING MOISTURE CONDITION STRENGTH/DENSITY CLASSIFICATION SHEAR STRENGTH (kPa)															
Tauranga Group								SILT; dark brown. Moist, non-plastic; friable.							
								SILT; light yellowish brown. Very stiff, moist, non-plastic.							
								Clayey SILT; yellowish brown. Stiff to very stiff, moist; low to medium plasticity.							
								Silty CLAY; light brownish grey. Very stiff, moist, high plasticity.							
								Clayey SILT; light brown. Stiff to very stiff, moist, medium plasticity.							
								Sandy SILT; grey. Stiff, moist, low plasticity; sand, fine.							

COMMENTS: Spedding Road

Hole Depth
7.25m

Scale 1:25

HAND AUGER LOG

HOLE Id: HA06

SHEET: 2 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000							
CO-ORDINATES:		5925924.30 mN (NZTM2000) 1743672.80 mE		DRILL TYPE: 75 and 50 mm Hand auger				HOLE STARTED: 01/12/2020							
R.L.:		30.70m		DRILL METHOD: HA+DCP				HOLE FINISHED: 01/12/2020							
DATUM:		NZVD2016						DRILLED BY: GEOTECHNICS							
								LOGGED BY: RBE							
								CHECKED: CBM							
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/100mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations	
Tauranga Group					0 2 4 6 8 10 12 14 16 18	4.70m ● 96/32 kPa							0 20 40 60 80 100 120 140 160 180 200	[CONT] Sandy SILT; grey. Stiff, moist, low plasticity; sand, fine.	
					3 4 4 5 6 8 9 10 13 11 11 13 14 15 16 16 16 17 0										

COMMENTS: Spedding Road

Hole Depth
7.25m

Scale 1:25

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5925924.30 mN 1743672.80 mE	DRILL TYPE: 75 and 50 mm Hand auger	HOLE STARTED: 01/12/2020
R.L.:	30.70m	DRILL METHOD: HA+DCP	HOLE FINISHED: 01/12/2020
DATUM:	NZVD2016		DRILLED BY: GEOTECHNICS
			LOGGED BY: RBE CHECKED: CBM



0.00-5.20m

HAND AUGER LOG

HOLE Id: **HA07**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000							
CO-ORDINATES: 5925859.50 mN (NZTM2000) 1743823.00 mE				DRILL TYPE: 50 mm Hand auger				HOLE STARTED: 01/12/2020							
R.L.: 32.90m				DRILL METHOD: HA+DCP				HOLE FINISHED: 01/12/2020							
DATUM: NZVD2016								DRILLED BY: Tonkin + Taylor Ltd							
								LOGGED BY: ROM							
								CHECKED: CBM							
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION	WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations
					0 2 4 6 8 10 12 14 16 18										
Topsoil						asb/gl @ 0.10m				TS	M	F			Sandy SILT; dark brown. Firm, moist, low plasticity; sand, fine.
						85/22 kPa PID, 0.1ppm @ 0.50m asb/gl @ 0.50m			0.5			St			Sandy SILT, trace organics; brown, mottled orange. Stiff, moist, low plasticity; sand, fine; organics, rootlets. 0.5m: Light brown, mottled orange. PID test, 0.1ppm.
						att/psd @ 0.80m									Clayey SILT, minor sand, trace organics; light brown. Stiff, moist, medium plasticity; sand, fine; organics, rootlets. 1.0m: PID test, 0.2ppm
						82/47 kPa PID, 0.2ppm @ 1.00m asb/gl & att/psd @ 1.00m			1.0						SILT, some clay, minor sand; light brown, mottled orange. Stiff, moist, medium plasticity; sand, fine.
						69/37 kPa			1.5						SILT, some clay and sand; light brown, mottled orange and brown. Stiff, moist, medium plasticity; sand, fine.
						corrosivity @ 1.80m									Sandy SILT, trace organics and clay; light brown, mottled orange. Stiff, moist, low plasticity; sand, fine; organics, rootlets. 2.5m: Grey and orange.
						63/33 kPa asb/gl @ 2.00m			2.0						Sandy SILT, trace organics; light brown, mottled orange. Stiff to very stiff, moist, low plasticity; sand, fine; organics, rootlets. 3.4m: Light brown, mottled orange. 3.5m: Grey.
						corrosivity @ 2.40m			2.5						
						90/47 kPa									
						87/31 kPa asb/gl @ 3.00m			3.0						
						131/31 kPa			3.5						
						>218 kPa asb/gl @ 4.00m			4.0			D-VD			Silty SAND, trace organics; light brown mottled orange. Dense to very dense, moist, poorly graded; sand, fine to medium; organics, rootlets.
						UTP			4.5						
						UTP			28						
COMMENTS:															
Hole Depth 5.9m															

COMMENTS:

Hole Depth
5.9m

Scale 1:25

Rev.: A

HAND AUGER LOG

HOLE Id: **HA07**

SHEET: 2 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000							
CO-ORDINATES:		5925859.50 mN (NZTM2000) 1743823.00 mE		DRILL TYPE: 50 mm Hand auger				HOLE STARTED: 01/12/2020							
R.L.:		32.90m		DRILL METHOD: HA+DCP				HOLE FINISHED: 01/12/2020							
DATUM:		NZVD2016						DRILLED BY: Tonkin + Taylor Ltd							
								LOGGED BY: ROM		CHECKED: CBM					
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION	WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations
			0	DCP	<										

COMMENTS:

Hole Depth
5.9m

Scale 1:25

Rev.: A

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5925859.50 mN (NZTM2000) 1743823.00 mE		DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 01/12/2020
R.L.: 32.90m		DRILL METHOD: HA+DCP	HOLE FINISHED: 01/12/2020
DATUM: NZVD2016		LOGGED BY: ROM	CHECKED: CBM



0.00-3.00m



3.00-5.00m

HAND AUGER LOG

HOLE Id: **HA07a**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI	LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5925813.70 mN (NZTM2000) 1743968.70 mE	DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 25/11/2020
R.L.: 35.60m	DRILL METHOD: HA+DCP	HOLE FINISHED: 25/11/2020
DATUM: NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
		LOGGED BY: ROM CHECKED: CBM

GEOLOGICAL										ENGINEERING DESCRIPTION									
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION										Description and Additional Observations									
WATER										SHEAR STRENGTH (kPa)									
CORE RECOVERY (%)										STRENGTH/DENSITY CLASSIFICATION									
METHOD										WEATHERING									
SCALA PENETROMETER (Blows/50mm)										STRENGTH/DENSITY CLASSIFICATION									
TESTS										SHEAR STRENGTH (kPa)									
SAMPLES										STRENGTH/DENSITY CLASSIFICATION									
RL (m)										STRENGTH/DENSITY CLASSIFICATION									
DEPTH (m)										STRENGTH/DENSITY CLASSIFICATION									
GRAPHIC LOG										STRENGTH/DENSITY CLASSIFICATION									
MOISTURE CONDITION										STRENGTH/DENSITY CLASSIFICATION									
STRENGTH/DENSITY CLASSIFICATION										STRENGTH/DENSITY CLASSIFICATION									
SHEAR STRENGTH (kPa)										STRENGTH/DENSITY CLASSIFICATION									
Topsoil										Sandy SILT, trace organics; dark brown. Firm, moist, low plasticity; sand, fine; organics, rootlets.									
Tauranga Group										SILT, some sand, minor clay, trace organics; orange, mottled brown-red and brown. Very stiff, moist, low plasticity. Organics, rootlets.									
										Grades to: clayey SILT, minor sand, trace organics; grey and brown mottled orange. Very stiff to hard, moist, medium plasticity. Sand, fine; organics, rootlets.									
										Sandy SILT, some clay, trace organics; grey mottled orange and brown. Very stiff, moist, low to medium plasticity. Organics, rootlets.									
										2.1m: trace clay; grey, mottled orange.									
										Silty CLAY; grey, mottled orange and pink. Very stiff, moist, high plasticity.									
										Sandy SILT, some clay, trace organics; grey mottled orange and brown. Very stiff, moist, low to medium plasticity. 2.8 - 2.9m: orange, mottled grey.									
										Sandy SILT; grey, speckled white. Very stiff to hard, moist, low plasticity; sand, fine to coarse.									
										Grades to: Silty, fine to coarse SAND; grey, speckled white. Very dense, moist, well graded.									
										Sandy SILT; grey, speckled white. Very stiff to hard, moist, low plasticity; sand, fine to coarse.									
										4.6m: minor fine, rounded gravel.									

COMMENTS:

Hole Depth
5.85m

Scale 1:25

HAND AUGER LOG

HOLE Id: **HA07a**

SHEET: 2 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000						
CO-ORDINATES:		5925813.70 mN (NZTM2000) 1743968.70 mE		DRILL TYPE: 50 mm Hand auger				HOLE STARTED: 25/11/2020						
R.L.:		35.60m		DRILL METHOD: HA+DCP				HOLE FINISHED: 25/11/2020						
DATUM:		NZVD2016						DRILLED BY: Tonkin + Taylor Ltd						
								LOGGED BY: ROM		CHECKED: CBM				
GEOLOGICAL						ENGINEERING DESCRIPTION								
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations
					0 2 4 6 8 10 12 14 16 18	asb @ 5.00m					M			Silty CLAY; grey. Hard, moist, high plasticity. 5.0 m: END OF HAND AUGER. Scala only to 5.85 m (blows per 50 mm): 5,5,6,7,8,5,7,8,11,10,11,10,11,10,10,11,11
								30	5.5					
								29	6.0					5.85m: END OF INVESTIGATION
								28	6.5					
								27	7.0					
								26	7.5					
									8.0					
									8.5					
									9.0					
									9.5					

COMMENTS:

Hole Depth
5.85m

Scale 1:25

Rev.: A

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5925813.70 mN (NZTM2000) 1743968.70 mE		DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 25/11/2020
R.L.: 35.60m		DRILL METHOD: HA+DCP	HOLE FINISHED: 25/11/2020
DATUM: NZVD2016		LOGGED BY: ROM	CHECKED: CBM



0.00-3.00m



3.00-5.00m

HAND AUGER LOG

HOLE Id: **HA08**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI	LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5925683.60 mN (NZTM2000) 1744277.50 mE	DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 24/11/2020
R.L.: 49.10m	DRILL METHOD: HA+DCP	HOLE FINISHED: 24/11/2020
DATUM: NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
		LOGGED BY: ROM CHECKED: CBM

GEOLOGICAL					ENGINEERING DESCRIPTION									
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION	WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations	
Topsoil					Env @ 0.10m		49		TS	M	F		Sandy SILT, trace organics; brown. Firm, moist, low plasticity; sand, fine. Organics, rootlets	
					48/16 kPa Env @ 0.50m PID, 1.8ppm @ 0.50m		0.5		TS				Sandy SILT, minor organics; grey-brown, mottled orange. Firm, moist, low plasticity; sand, fine; organics, rootlets.	
Tauranga Group	24/11/2020		94 HA+DCP		57/11 kPa Env @ 1.00m PID, 2.5ppm @ 1.00m		1.0	48					1.2-1.5m: CORE LOSS	
					82/6 kPa		1.5				St		SILT, some sand, mior clay, trace organics; grey-brown, speckled black. Stiff, moist, high plasticity; sand, fine; organics, rootlets.	
					>200 kPa Env @ 2.00m		2.0	47			VSt-H		Grades to: Silty CLAY, minor sand, trace organics; brown, mottled orange, speckled brown. Very stiff to hard, moist, high plasticity; sand, fine; organics, rootlets.	
					>200 kPa		2.5						2.4m: dark brown.	
					>200 kPa Env @ 3.00m		3.0	46			VSt		Sandy SILT, minor clay, trace organics; brown, spotted brown. Very stiff to hard, moist, low plasticity; sand, fine ; organics, rootlets.	
					135/73 kPa		3.5				VSt-H		Sandy, silty CLAY, trace organics; brown, spotted dark brown. Very stiff, moist, medium plasticity; sand, fine; organics, rootlets.	
					149/72 kPa Env @ 4.00m		4.0	45			VSt		Grades to: Sandy SILT; brown, mottled orange, spotted black and dark brown. Very stiff, moist, low plasticity; sand, fine; organics, rootlets.	
					129/56 kPa		4.5						4.2m: light grey-brown, spotted black.	
					>200 kPa						H		4.9m: hard.	

COMMENTS:

Hole Depth
5.85m

Scale 1:25

HAND AUGER LOG

HOLE Id: HA08

SHEET: 2 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000							
CO-ORDINATES: 5925683.60 mN (NZTM2000) 1744277.50 mE				DRILL TYPE: 50 mm Hand auger				HOLE STARTED: 24/11/2020							
R.L.: 49.10m				DRILL METHOD: HA+DCP				HOLE FINISHED: 24/11/2020							
DATUM: NZVD2016								DRILLED BY: Tonkin + Taylor Ltd							
								LOGGED BY: ROM CHECKED: CBM							
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION,		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION	WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations
					024681012141618 4 5 6 7 8 9 10 11 12	Env @ 5.00m									

COMMENTS:

Hole Depth
5.85m

Scale 1:25

Rev.: A

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5925683.60 mN (NZTM2000) 1744277.50 mE		DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 24/11/2020
R.L.: 49.10m		DRILL METHOD: HA+DCP	HOLE FINISHED: 24/11/2020
DATUM: NZVD2016		LOGGED BY: ROM	CHECKED: CBM



0.00-3.00m



3.00-5.00m

HAND AUGER LOG

HOLE Id: **HA08a**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000							
CO-ORDINATES: 5925734.60 mN (NZTM2000) 1744164.50 mE				DRILL TYPE: 50 mm Hand auger				HOLE STARTED: 24/11/2020							
R.L.: 41.80m				DRILL METHOD: HA+DCP				HOLE FINISHED: 24/11/2020							
DATUM: NZVD2016								DRILLED BY: Tonkin + Taylor Ltd							
								LOGGED BY: ROM							
								CHECKED: CBM							
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations	
Topsoil					0 2 4 6 8 10 12 14 16 18	asb/gl @ 0.10m 1 x Glass Jar 1x plastic Jar				TS	M	F		Sandy SILT, trace organics; dark brown. Firm, moist, low plasticity; sand, fine; organics, rootlets.	
															0.55m: Rootlet
Tauranga Group						● >218 kPa asb/gl @ 0.50m 1 x Glass Jar 1x plastic Jar PID - 27.3ppm @ 0.51m ● PID - 27.3ppm 130/44 kPa asb/gl @ 1.00m 1 x Glass Jar 1x plastic Jar PID - 17.2ppm @ 1.01m ● PID - 17.2ppm 184/93 kPa Corrosivity @ 1.20m 1 x plastic jar		41			VSt		Silty CLAY, minor sand, trace organics; light brown mottled orange. Very stiff, moist, high plasticity; sand, fine; organics, rootlets.		
														Clayey SILT, some sand, trace organics; light brown & brown. Very stiff, moist, medium plasticity; sand, fine; organics, rootlets.	
															Sandy SILT, some clay, trace organics; light brown & brown. Very stiff, moist, low plasticity; sand, fine; organics, rootlets.
						● 181/83 kPa asb/gl @ 2.00m 1 x Glass Jar 1x plastic Jar									
						● 171/78 kPa									
						att/psd @ 2.70m Atterberg/PSD		39							
						● 106/53 kPa asb/gl @ 3.00m 1 x Glass Jar 1x plastic Jar									
						● 131/59 kPa Corrosivity @ 3.50m 1 x plastic jar						W		Sandy SILT, trace organics; light brown. Very stiff, wet, low plasticity; sand, fine; organics, rootlets.	
						● 149/62 kPa asb/gl @ 4.00m 1 x Glass Jar 1x plastic Jar									
						● 188/62 kPa									
						● 177/84 kPa									

COMMENTS:

Hole Depth
6.2m

Scale 1:25

Rev.: A

HAND AUGER LOG

HOLE Id: **HA08a**

SHEET: 2 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000							
CO-ORDINATES:		5925734.60 mN (NZTM2000) 1744164.50 mE		DRILL TYPE: 50 mm Hand auger				HOLE STARTED: 24/11/2020							
R.L.:		41.80m		DRILL METHOD: HA+DCP				HOLE FINISHED: 24/11/2020							
DATUM:		NZVD2016						DRILLED BY: Tonkin + Taylor Ltd							
								LOGGED BY: ROM		CHECKED: CBM					
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION	WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations
					0 2 4 6 8 10 12 14 16 18	asb/gl @ 5.00m 1 x Glass Jar 1x plastic Jar									5.0m: END OF HAND AUGER. Scala only to 6.2 m (blows per 50 mm): 2,2,3,2,4,5,4,5,4,4,4,7,5,5,7,7,7,8,9,8,7,9,10,10 ,9,10,10,10,12,12
									5.5						
								36	6.0						
									6.5						
								35	7.0						
									7.5						
								34	8.0						
									8.5						
								33	9.0						
									9.5						
								32							

COMMENTS:

Hole Depth
6.2m

Scale 1:25

CORE PHOTOS

BOREHOLE No.: HA08a

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5925734.60 mN 1744164.50 mE	DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 24/11/2020
R.L.:	41.80m	DRILL METHOD: HA+DCP	HOLE FINISHED: 24/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



0.00-3.00m



3.00-5.00m

HAND AUGER LOG

HOLE Id: **HA107a**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI	LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926927.60 mN (NZTM2000) 1743320.80 mE	DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 03/12/2020
R.L.: 13.50m	DRILL METHOD: HA+DCP	HOLE FINISHED: 03/12/2020
DATUM: NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
		LOGGED BY: ROM CHECKED: CBM

GEOLOGICAL														ENGINEERING DESCRIPTION																			
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION				WATER		CORE RECOVERY (%)		METHOD		SCALA PENETROMETER (Blows/50mm)						TESTS		SAMPLES		RL (m)		DEPTH (m)		GRAPHIC LOG		MOISTURE CONDITION WEATHERING		STRENGTH/DENSITY CLASSIFICATION		SHEAR STRENGTH (kPa)		Description and Additional Observations	
										0 2 4 6 8 10 12 14 16 18																							
Topsoil																Env @ 0.10m				13		0.5		TS		M		L				Silty SAND, trace organics; brown. Loose, moist, poorly graded; sand, fine; organics, rootlets.	
Tauranga Group				03/12/2020		100		HA+DCP								● 202/47 kPa Env @ 0.50m PID - 0.0ppm @ 0.51m		13		0.5		TS		VSI-H						Silty CLAY, minor sand, trace organics; brown mottled orange and dark brown, speckled white. Very stiff to hard, moist, high plasticity; sand, fine; organics, rootlets.			
																● 137/31 kPa Env @ 1.00m PID 0.0ppm @ 1.01m		12		1.0		TS		St						Clayey SILT, minor sand; grey and grey brown mottled orange speckled black. Stiff, moist, high plasticity; sand, fine.			
																● 81/31 kPa		12		1.5		TS						Sandy SILT, minor clay, trace organics; brown mottled orange, speckled white. Stiff, moist, low plasticity; sand, fine; organics, rootlets.					
																● 67/31 kPa Env @ 2.00m att/psd/corr osivity @ 2.20m		11		2.0		TS						Sandy SILT, trace organics; grey & brown mottled orange. Stiff, moist, low plasticity; sand, fine; organics, rootlets.					
																● 38/16 kPa		11		2.5		TS											
																● 31/22 kPa		10		3.0		TS		W		L				Silty SAND, trace organics; grey. Loose, wet, poorly graded; sand, fine; organics, rootlets.			
																● 68/28 kPa corrosivity @ 3.50m		10		3.5		TS											
																● 87/34 kPa		9		4.0		TS		M		St				Sandy SILT, trace organics; grey and brown speckled black. Stiff, moist, low plasticity; sand, fine; organics, rootlets.			
																● 72/30 kPa		9		4.5		TS								SILT, some clay and sand, trace organics; brown speckled dark brown. Stiff, moist, low plasticity; sand, fine; organics, rootlets.			
																● 100/31 kPa																	

COMMENTS:

Hole Depth
6.65m

Scale 1:25

Rev.: A

HAND AUGER LOG

HOLE Id: **HA107a**

SHEET: 2 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000						
CO-ORDINATES: 5926927.60 mN (NZTM2000) 1743320.80 mE				DRILL TYPE: 50 mm Hand auger				HOLE STARTED: 03/12/2020						
R.L.: 13.50m				DRILL METHOD: HA+DCP				HOLE FINISHED: 03/12/2020						
DATUM: NZVD2016								DRILLED BY: Tonkin + Taylor Ltd						
								LOGGED BY: ROM CHECKED: CBM						
GEOLOGICAL								ENGINEERING DESCRIPTION						
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALES PENETROMETER (Blows/50mm) 024681012141618	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations
					243345434454445577676710911101088988		8	5.5					5.0 m: END OF HAND AUGER. Scala only to 6.65 m (blows per 50 mm): 1,2,2,2,1,2,4,3,3,3,4,5,4,3,4,4,4,5,6,5,5,7,7,6,7,6, 7,10,9,11,10,10,8,8,9,8,8	
								7	6.5					6.65m: END OF INVESTIGATION
									7.0					
								6	7.5					
									8.0					
								5	8.5					
									9.0					
								4	9.5					

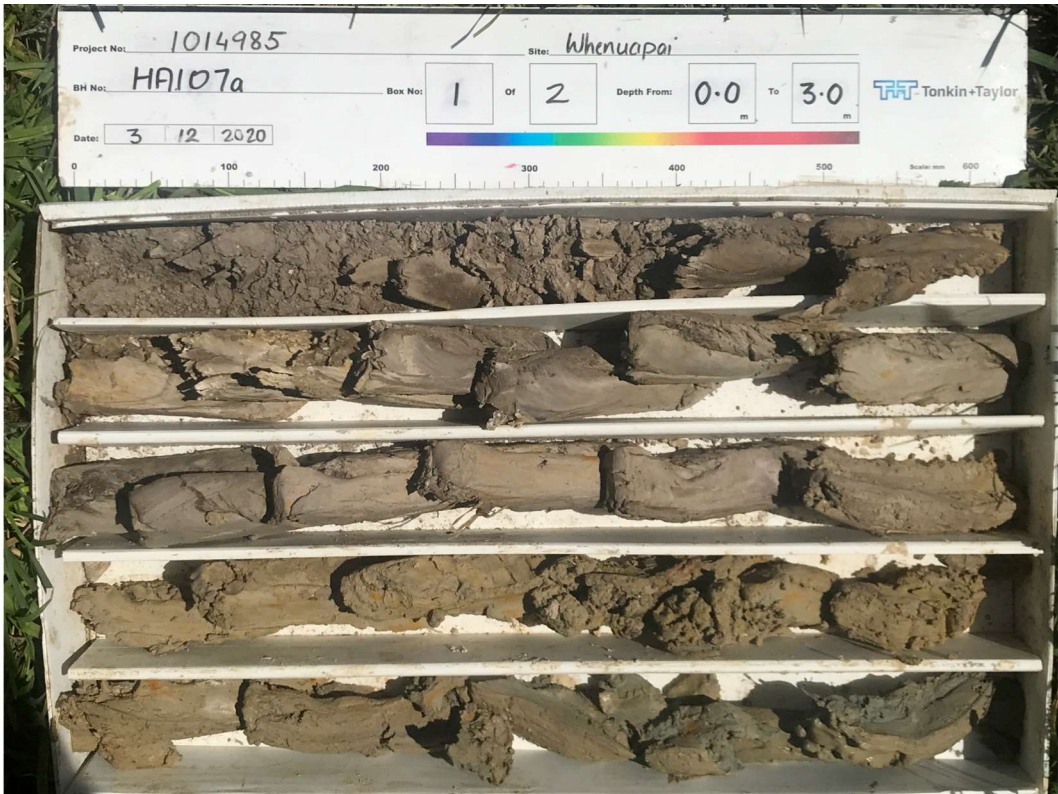
COMMENTS:

Hole Depth
6.65m

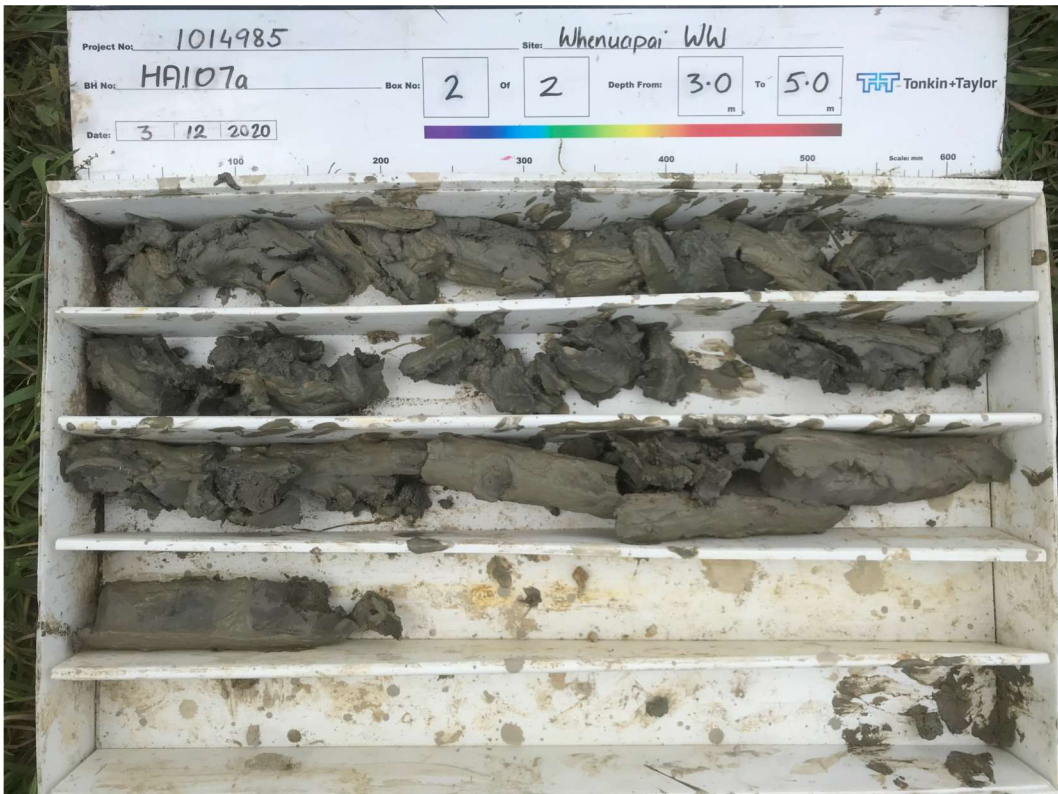
Scale 1:25

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926927.60 mN (NZTM2000) 1743320.80 mE		DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 03/12/2020
R.L.: 13.50m		DRILL METHOD: HA+DCP	HOLE FINISHED: 03/12/2020
DATUM: NZVD2016		LOGGED BY: ROM	CHECKED: CBM



0.00-3.00m



3.00-5.00m

HAND AUGER LOG

HOLE Id: **HA107b**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI	LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926922.30 mN (NZTM2000) 1743265.20 mE	DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 04/12/2020
R.L.: 12.30m	DRILL METHOD: HA+DCP	HOLE FINISHED: 04/12/2020
DATUM: NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
		LOGGED BY: ROM CHECKED: CBM

GEOLOGICAL										ENGINEERING DESCRIPTION																										
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION	WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)														TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations										
				0	2	4	6	8	10	12	14	16	18																							
Topsoil	100		HA+DCP															Env @ 0.10m		12		D-M	F	Sandy SILT, trace organics; brown. Firm, dry to moist, low plasticity; sand, fine; organics, rootlets. Sandy SILT, trace organics; light brown and orange brown. Very stiff, dry to moist, low plasticity; sand, fine; organics, rootlets.												
Fill																		● 124/31 kPa Env @ 0.50m PID 0.5ppm @ 0.51m		0.5		D	VSt													
																		● 152/34 kPa Env @ 1.00m PID 0.1ppm @ 1.01m corrosivity @ 1.20m		1.0		M	St	Sandy SILT, trace organics and clay; grey-brown mottled orange speckled white and black. Stiff, moist, low plasticity; sand, fine; organics, rootlets.												
																		● 93/53 kPa		1.5		F														
Tauranga Group																		● 35/16 kPa Env @ 2.00m		2.0			VSt	SILT, some sand, trace organics; dark brown speckled black. Firm, moist, low plasticity; sand, fine; organics, rootlets. Sandy SILT, trace organics; grey mottled orange speckled white. Very stiff, low plasticity; sand, fine; organics, rootlets.												
																		● 82/22 kPa		2.5																
																		corrosivity @ 2.70m		3.0		M-W	F	Sandy SILT, trace organics; grey mottled orange. Firm, moist to wet, low plasticity; sand, fine; organics, rootlets.												
																		● 51/19 kPa		3.5		M														
																		● 75/20 kPa		4.0		M-W	L-MD	Silty SAND, trace organics; grey mottled brown. Loose to medium dense, moist to wet, poorly graded; sand, fine; organics, rootlets.												
																		● 45/28 kPa		4.5																
																		● 59/34 kPa																		
																		● 62/32 kPa																		

COMMENTS:

Hole Depth
6.85m

Scale 1:25

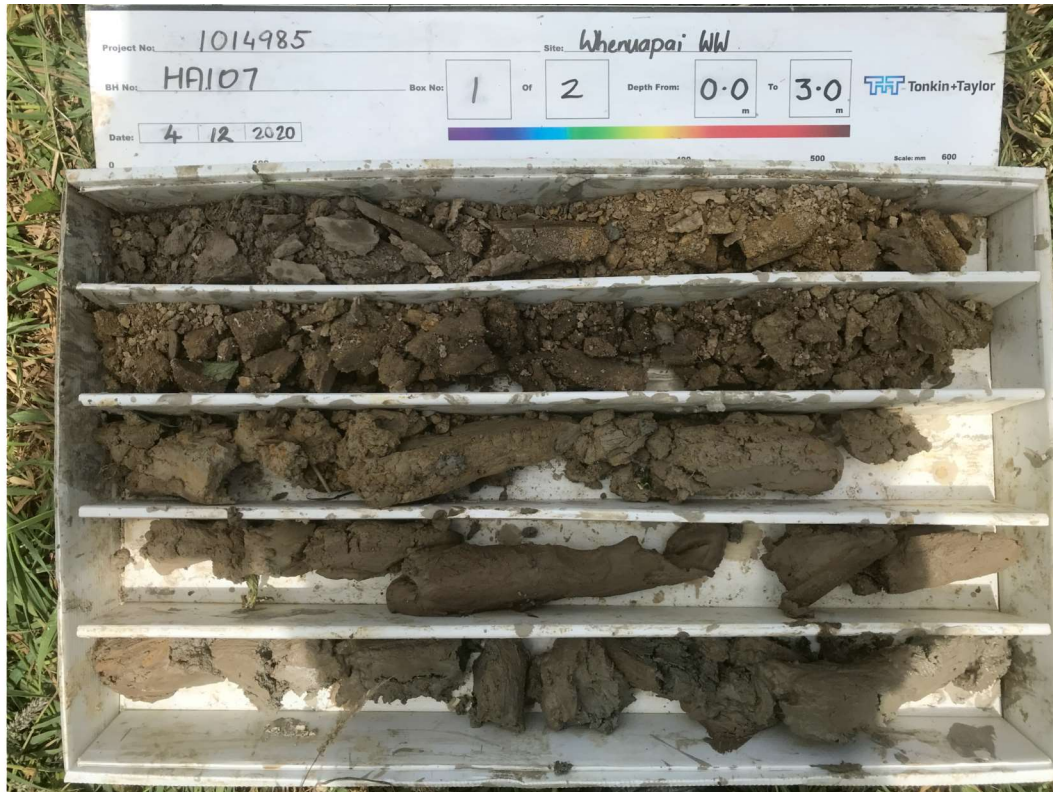
Rev.: A

CORE PHOTOS

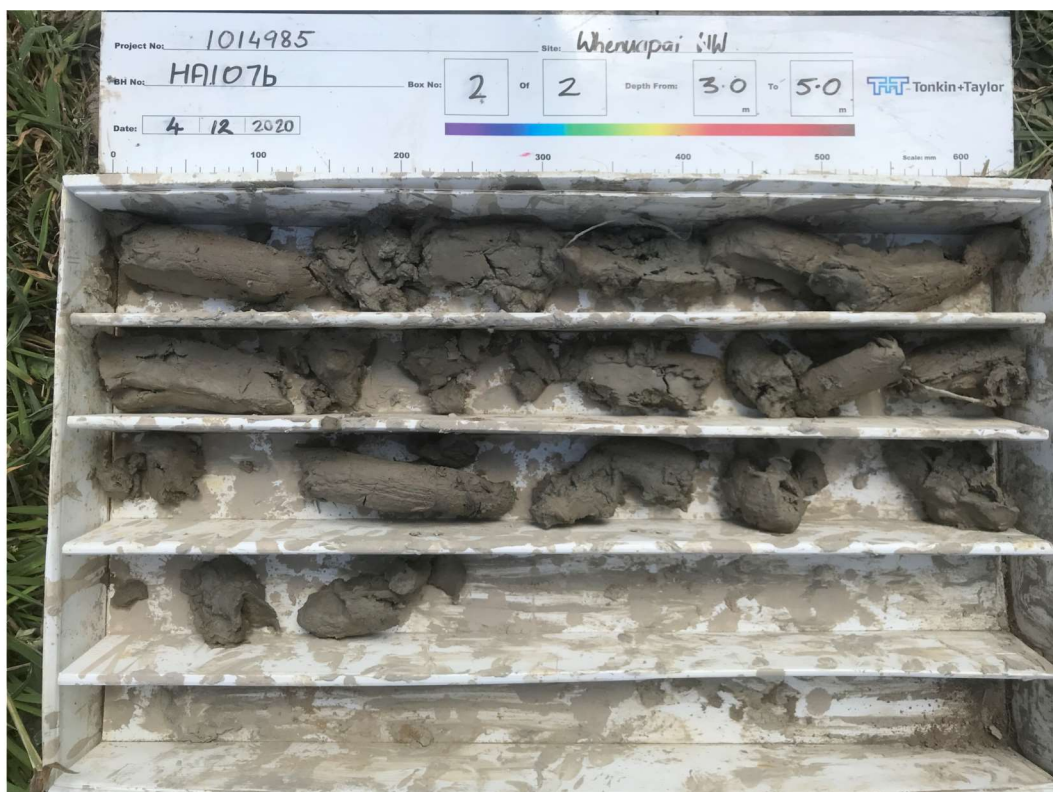
BOREHOLE No.: HA107b

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926922.30 mN 1743265.20 mE	DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 04/12/2020
R.L.:	12.30m	DRILL METHOD: HA+DCP	HOLE FINISHED: 04/12/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



0.00-3.00m



3.00-5.00m

HAND AUGER LOG

HOLE Id: **HA108**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000							
CO-ORDINATES: 5926898.60 mN (NZTM2000) 1743173.50 mE				DRILL TYPE: 50 mm Hand auger				HOLE STARTED: 03/12/2020							
R.L.: 11.50m				DRILL METHOD: HA+DCP				HOLE FINISHED: 03/12/2020							
DATUM: NZVD2016								DRILLED BY: Tonkin + Taylor Ltd							
								LOGGED BY: ROM CHECKED: CBM							
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.	WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations		
														0	2
Topsoil					Env @ 0.10m				TS	M	F		Sandy SILT, trace organics; brown. Firm, moist, low plasticity; sand, fine; organics, rootlets.		
Tauranga Group	03/12/2020	100	HA+DCP		131/25 kPa Env @ 0.50m		11	0.5		VSt			Sandy SILT, trace organics; brown, mottled orange. Very stiff, moist, low plasticity; sand, fine; organics, rootlets.		
					73/28 kPa Env @ 1.00m			1.0		St		Sandy SILT, minor clay, trace organics; brown, mottled orange. Stiff, moist, low plasticity; sand, fine; organics, rootlets.			
					54/21 kPa		10	1.5			SILT, minor sand and clay, trace organics; light brown, mottled orange. Stiff, moist, low plasticity; sand, fine; organics, rootlets.				
					26/9 kPa Env @ 2.00m			2.0			Sandy SILT, trace organics; greyish brown, mottled orange, spotted blue. Firm to stiff, wet, low plasticity; sand, fine; organics, rootlets.				
					Att/psd @ 2.40m 37/28 kPa		9	2.5			SILT, minor sand, trace organics; brown. Firm, saturated, low plasticity; sand, fine; organics, rootlets.				
					32/17 kPa			3.0							
					51/17 kPa			3.5							
					22/9 kPa			4.0					3.95m: grades to soft		
					31/16 kPa			4.5					4.45m: grades to firm		
					40/18 kPa										
COMMENTS: Hole Depth 6.7m															

HAND AUGER LOG

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926898.60 mN (NZTM2000) 1743173.50 mE		DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 03/12/2020
R.L.: 11.50m		DRILL METHOD: HA+DCP	HOLE FINISHED: 03/12/2020
DATUM: NZVD2016		LOGGED BY: ROM	CHECKED: CBM



0.00-3.00m



3.00-5.00m

HAND AUGER LOG

HOLE Id: **HA109**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000																				
CO-ORDINATES: 5926901.80 mN (NZTM2000) 1743136.40 mE		DRILL TYPE: 75 and 50mm handauger				HOLE STARTED: 03/12/2020																						
R.L.: 11.00m		DRILL METHOD: HA+DCP				HOLE FINISHED: 03/12/2020																						
DATUM: NZVD2016						DRILLED BY: GEOTECHNICS																						
				LOGGED BY: RBE				CHECKED: CBM																				
GEOLOGICAL										ENGINEERING DESCRIPTION																		
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/100mm)				TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations											
Topsoil									asb/gl/split @ 0.00m				TS	D-M			SILT; light brown. Dry to moist, non-plastic.											
Tauranga Group		03/12/2020 Inflow 1.5m WL+2hrs							● 122/21 kPa asb/gl @ 0.40m			0.5		M	VSt		SILT; yellowish brown. Very stiff, moist, non-plastic.											
									● 76/15 kPa								St		SILT, some clay; light brown mottled yellowish brown. Very stiff, moist; low to no plasticity.									
																			SILT; light brown. Stiff, moist, non-plastic.									
									● 76/8 kPa																			
									asb/gl @ 0.90m											Silty CLAY; light brown mottled yellowish brown. Firm, moist, high plasticity.								
									● 29/16 kPa																			
									● 48/19 kPa																			
									att/psd @ 1.40m																			
									● 32/8 kPa												Clayey SILT; light brown. Firm, moist, low plasticity.							
									asb/gl @ 1.70m																			
									● 40/21 kPa												Silty CLAY; light brown mottled yellowish brown. Firm, moist, medium plasticity.							
									● 24/13 kPa													W			Clayey SILT; light grey. Firm, wet, low plasticity.			
									att/psd @ 2.45m													M	S		Silty CLAY; light brownish grey. Soft, moist, high plasticity.			
● 24/13 kPa													S			Sandy SILT; grey. Soft, saturated, non-plastic.												
asb/gl @ 2.70m																												
● 27/16 kPa														W	F		Clayey SILT; grey. Firm, wet, medium plasticity.											
● 62/24 kPa															F-St			Clayey sandy SILT; grey. Firm to stiff, wet, low plasticity.										
● 32/20 kPa																												
asb/gl @ 3.70m																												
● 32/16 kPa																		Clayey SILT; light grey. Firm, wet, medium plasticity.										
● 37/15 kPa																												
● 36/20 kPa																		Clayey sandy SILT; light grey. Firm, wet, low plasticity.										
● 32/17 kPa																												
asb/gl @																		Clayey SILT; light grey. Firm to stiff, moist, medium plasticity; sandy layers at 4.8m and 5m.										

COMMENTS: 26 Brigham Ck Rd

Hole Depth
7.25m

Scale 1:25

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926901.80 mN 1743136.40 mE	DRILL TYPE: 75 and 50mm handauger	HOLE STARTED: 03/12/2020
R.L.:	11.00m	DRILL METHOD: HA+DCP	HOLE FINISHED: 03/12/2020
DATUM:	NZVD2016		DRILLED BY: GEOTECHNICS
			LOGGED BY: RBE CHECKED: CBM



0.00-5.20m

HAND AUGER LOG

HOLE Id: **HA110a**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI	LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926999.30 mN (NZTM2000) 1743387.70 mE	DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 08/12/2020
R.L.: 14.60m	DRILL METHOD: HA+DCP	HOLE FINISHED: 08/12/2020
DATUM: NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
		LOGGED BY: ROM CHECKED: CBM

GEOLOGICAL										ENGINEERING DESCRIPTION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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				SCALA PENETROMETER (Blows/50mm)																TESTS				SAMPLES				RL (m)				DEPTH (m)				GRAPHIC LOG				WEATHERING MOISTURE CONDITION				STRENGTH/DENSITY CLASSIFICATION				SHEAR STRENGTH (kPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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COMMENTS:

Hole Depth
6.85m

Scale 1:25

Rev.: A

HAND AUGER LOG

CORE PHOTOS

BOREHOLE No.: HA110a

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926999.30 mN 1743387.70 mE	DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 08/12/2020
R.L.:	14.60m	DRILL METHOD: HA+DCP	HOLE FINISHED: 08/12/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



0.00-3.00m



3.00-5.00m

HAND AUGER LOG

HOLE Id: **HA110b**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI	LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926965.40 mN (NZTM2000) 1743376.70 mE	DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 08/12/2020
R.L.: 14.70m	DRILL METHOD: HA+DCP	HOLE FINISHED: 08/12/2020
DATUM: NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
		LOGGED BY: ROM CHECKED: CBM

GEOLOGICAL										ENGINEERING DESCRIPTION									
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.										Description and Additional Observations									
WATER										SHEAR STRENGTH (kPa)									
CORE RECOVERY (%)										STRENGTH/DENSITY CLASSIFICATION									
METHOD										MOISTURE CONDITION									
SCALA PENETROMETER (Blows/50mm)										GRAPHIC LOG									
TESTS										WEATHERING									
SAMPLES										STRENGTH/DENSITY CLASSIFICATION									
RL (m)										SHEAR STRENGTH (kPa)									
DEPTH (m)										STRENGTH/DENSITY CLASSIFICATION									
Fill										Silty, fine SAND, minor gravel, trace organics; brown. Tightly packed, moist, poorly graded; organics, rootlets.									
● UTP Env/asb @ 0.10m										Sandy SILT, minor gravel, trace organics; light grey-brown. Stiff, moist, low plasticity; organics, rootlets.									
● UTP Env/asb @ 0.50m PID, 0.0ppm @ 0.51m Corrosivity @ 0.60m										Silty CLAY, minor sand and gravel, trace organics; brown, mottled orange and dark brown. Very stiff, moist, high plasticity; sand, fine; gravel, fine to medium, sub-angular, sandstone; organics, rootlets.									
● UTP Env/asb @ 1.00m PID, 0.0ppm @ 1.01m										Grades to: SILT, some sand, minor clay, trace organics; brown and grey. Stiff, moist, medium plasticity; sand, fine; organics, rootlets.									
● 79/25 kPa										Sandy SILT, minor organics; brown, speckled black and white, mottled orange. Stiff, moist, low plasticity; sand, fine to medium; organics, rootlets.									
● 65/34 kPa Env/asb @ 2.00m										Silty, fine to coarse SAND, trace gravel and organics; grey, speckled white. Loosely packed, wet, poorly graded; gravel, fine, sub-angular, mudstone; organics, rootlets.									
● 93/37 kPa										Sandy SILT, minor organics; brown, speckled black and white, mottled orange. Stiff, moist, low plasticity; sand, fine to medium; organics, rootlets.									
Corrosivity @ 2.90m										Organic SILT; brown. Firm, moist, low plasticity.									
att/psd @ 3.35m																			
Box 1: 0.0-3.0m																			
Box 2: 3.0-5.0m																			
Tauranga Group																			
08/12/2020																			

COMMENTS:

Hole Depth
6.95m

Scale 1:25

HAND AUGER LOG

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926965.40 mN (NZTM2000) 1743376.70 mE		DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 08/12/2020
R.L.: 14.70m		DRILL METHOD: HA+DCP	HOLE FINISHED: 08/12/2020
DATUM: NZVD2016		LOGGED BY: ROM	CHECKED: CBM



0.00-3.00m



3.00-5.00m

HAND AUGER LOG

HOLE Id: HA111

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI	LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5927039.30 mN (NZTM2000) 1743395.90 mE	DRILL TYPE: 75 and 50 mm Hand auger	HOLE STARTED: 07/12/2020
R.L.: 14.40m	DRILL METHOD: HA+DCP	HOLE FINISHED: 07/12/2020
DATUM: NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
		LOGGED BY: ROM CHECKED: CBM

GEOLOGICAL										ENGINEERING DESCRIPTION									
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION										Description and Additional Observations									
WATER										SHEAR STRENGTH (kPa)									
CORE RECOVERY (%)										STRENGTH/DENSITY CLASSIFICATION									
METHOD										MOISTURE / WEATHERING									
SCALA PENETROMETER (Blows/50mm)										STRENGTH/DENSITY CLASSIFICATION									
TESTS										SHEAR STRENGTH (kPa)									
SAMPLES										STRENGTH/DENSITY CLASSIFICATION									
RL (m)										STRENGTH/DENSITY CLASSIFICATION									
DEPTH (m)										STRENGTH/DENSITY CLASSIFICATION									
GRAPHIC LOG										STRENGTH/DENSITY CLASSIFICATION									
D										STRENGTH/DENSITY CLASSIFICATION									
F										STRENGTH/DENSITY CLASSIFICATION									
SANDY SILT, trace organics; dark brown. Firm, dry, low plasticity; sand, fine; organics, rootlets.										STRENGTH/DENSITY CLASSIFICATION									
SILT, some sand, minor clay, trace gravel, and organics; light brown, mottled orange, dark grey and grey. Sand, fine; gravel, fine to medium, sub-angular, sandstone; organics, rootlets.										STRENGTH/DENSITY CLASSIFICATION									
SANDY SILT, some gravel; dark brown. Firm, moist, low plasticity; sand, fine; gravel, fine, angular, sandstone.										STRENGTH/DENSITY CLASSIFICATION									
1.6m: wet.										STRENGTH/DENSITY CLASSIFICATION									
SILT, some sand, minor clay and gravel, trace organics; dark brown and black. Stiff, moist, low plasticity; sand, fine; gravel, fine, sub-angular, sandstone; organics, rootlets.										STRENGTH/DENSITY CLASSIFICATION									
Gravelly, fine SAND, some silt; dark brown. Loosely packed, wet, poorly graded; gravel, fine to medium, sub-angular, sandstone.										STRENGTH/DENSITY CLASSIFICATION									
3.1 - 3.5m: NO RECOVERY										STRENGTH/DENSITY CLASSIFICATION									
3.5 m: END OF HAND AUGER. Scala only to 6.5 m (blows per 50 mm): 1,0,1,1,0,2,2,2,2,1,2,1,1,2,2,3,4,3,4,3,3,3,3,4,3,4,3,4,3,4,5,4,4,5,6,5,5,6,6,7,7,6,7,6,9,8,7,8,9,7,8,8,7,9,9,9										STRENGTH/DENSITY CLASSIFICATION									

COMMENTS:

Hole Depth
6.45m

Scale 1:25

HAND AUGER LOG

CORE PHOTOS

BOREHOLE No.: HA111

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5927039.30 mN 1743395.90 mE	DRILL TYPE: 75 and 50 mm Hand auger	HOLE STARTED: 07/12/2020
R.L.:	14.40m	DRILL METHOD: HA+DCP	HOLE FINISHED: 07/12/2020
DATUM:	NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
			LOGGED BY: ROM CHECKED: CBM



0.00-3.10m

HAND AUGER LOG

HOLE Id: **HA112**

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000															
CO-ORDINATES: 5926554.90 mN (NZTM2000) 1743164.20 mE				DRILL TYPE: 50 mm Hand auger				HOLE STARTED: 02/12/2020															
R.L.: 9.60m				DRILL METHOD: HA+DCP				HOLE FINISHED: 02/12/2020															
DATUM: NZVD2016								DRILLED BY: Tonkin + Taylor Ltd															
								LOGGED BY: ROM				CHECKED: CBM											
GEOLOGICAL												ENGINEERING DESCRIPTION											
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.												Description and Additional Observations											
WATER												GRAPHIC LOG											
CORE RECOVERY (%)												MOISTURE CONDITION											
METHOD												STRENGTH/DENSITY CLASSIFICATION											
0 1 2 3 4 5 6 7 8 9												SHEAR STRENGTH (kPa)											
SCALA PENETROMETER (Blows/100mm)												10 25 50 100 200											
TESTS																							
SAMPLES																							
RL (m)																							
DEPTH (m)																							
Env/asb @ 0.10m												M											
● 72/16 kPa Env/asb @ 0.50m PID 0.9ppm @ 0.51m												St											
● 116/22 kPa Env/asb @ 1.00m PID 1.8ppm @ 1.01m																							
● UTP																							
Env @ 1.80m												VSt											
Env/corrosiv ity @ 2.00m												Sandy SILT, trace organics; brown and grey mottled orange, spotted black and white. Stiff, moist, low plasticity; sand, fine; organics, rootlets & carbonaceous material.											
												Sandy SILT, trace organics; dark grey brown, spotted black. Stiff, moist, low plasticity; sand, fine; organics, rootlets.											
												Silty CLAY, some sand, trace organics; grey, some orange spots. Very stiff, moist, medium plasticity; sand, fine; organics, rootlets.											
												1.8m: Strong chemical odour 2.0m: roots, white/cream coloured powder.											
												2m: Refusal											

CORE PHOTOS

BOREHOLE No.: HA112

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926554.90 mN 1743164.20 mE	DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 02/12/2020
R.L.:	9.60m	DRILL METHOD: HA+DCP	HOLE FINISHED: 02/12/2020
DATUM:	NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
			LOGGED BY: ROM CHECKED: CBM



0.00-2.00m

HAND AUGER LOG

HOLE Id: **HA113**

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000																																																																																																														
CO-ORDINATES: 5926630.20 mN (NZTM2000) 1743032.10 mE				DRILL TYPE: 75 and 50 mm Hand auger				HOLE STARTED: 02/12/2020																																																																																																														
R.L.: 7.90m				DRILL METHOD: HA+DCP				HOLE FINISHED: 02/12/2020																																																																																																														
DATUM: NZVD2016								DRILLED BY: GEOTECHNICS																																																																																																														
								LOGGED BY: RBE																																																																																																														
								CHECKED: CBM																																																																																																														
GEOLOGICAL								ENGINEERING DESCRIPTION																																																																																																														
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations																																																																																																								
Topsoil		02/12/2020 Water info/level on completion ▼				asb/gl/dupC @ 0.00m				TS	M			SILT; brown with yellowish brown inclusions. Very stiff, moist, non-plastic.																																																																																																								
										TS	VSt		SILT; dark brown. Very stiff, moist, non-plastic.																																																																																																									
Tauranga Group									● 161/21 kPa asb/gl @ 0.40m PID, 0.0ppm @ 0.50m ● 150/37 kPa		0.5			St-VSt		SILT, some clay; light brown. Very stiff, moist; low to no plasticity.																																																																																																						
									● 96/32 kPa asb/gl @ 0.90m PID, 0.4ppm @ 1.00m ● 66/21 kPa	7	1.0			1.1m: medium plasticity																																																																																																								
															● 54/16 kPa att/psd @ 1.45m ● 88/24 kPa asb/gl @ 1.90m	6	2.0		S		Sandy SILT; light brown mottled orange brown. Stiff, moist, non-plastic; sand, fine.																																																																																																	
																						● 114/13 kPa att/psd @ 2.45m	2.5				Silty SAND; brown, grey from 2.2m. Saturated, non-plastic.																																																																																											
East Coast Bays Formation													2.4m: Scala (blows per 50mm): 4.5, 4.5, 12, 26, bouncing Over augered, solid refusal at 2.6m																																																																																																									
														2.6m: Refusal																																																																																																								
Box 1, 0.0-2.8m																																																																																																																						

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926630.20 mN (NZTM2000) 1743032.10 mE		DRILL TYPE: 75 and 50 mm Hand auger	HOLE STARTED: 02/12/2020
R.L.: 7.90m		DRILL METHOD: HA+DCP	HOLE FINISHED: 02/12/2020
DATUM: NZVD2016			DRILLED BY: GEOTECHNICS
			LOGGED BY: RBE CHECKED: CBM



0.00-2.60m

HAND AUGER LOG

HOLE Id: HA114

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000								
CO-ORDINATES: 5926872.80 mN (NZTM2000) 1743108.40 mE				DRILL TYPE: 75 and 50 mm Hand auger				HOLE STARTED: 03/12/2020								
R.L.: 11.00m				DRILL METHOD: HA+DCP				HOLE FINISHED: 03/12/2020								
DATUM: NZVD2016								DRILLED BY: GEOTECHNICS								
								LOGGED BY: RBE								
								CHECKED: CBM								
GEOLOGICAL								ENGINEERING DESCRIPTION								
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION,	WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/100mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations			
Fill	03/12/2020 inflow 2.6m, w/l after 4hrs				Dup D, Asb/gl @ 0.00m					D			Gravelly SILT; brown. Dry, non-plastic; (farm track).			
Topsoil					● 184/32 kPa asb/gl @ 0.40m					M			VSt	SILT; greyish brown. Very stiff, moist, non-plastic.		
					● 186/29 kPa									SILT; light brown. Very stiff, moist, non-plastic.		
					● 109/33 kPa asb/gl @ 0.90m					10			1.0	St-VSt	Clayey SILT; light grey mottled yellowish brown. Stiff to very stiff, moist, low plasticity.	
					● 104/42 kPa										1.0m: medium plasticity 1.2m: low plasticity	
					● 56/27 kPa att/psd @ 1.45m								1.5	F	Silty CLAY; light greyish brown. Firm, moist, high plasticity.	
					● 40/24 kPa asb/gl @ 1.90m								2.0	W		
					● 41/27 kPa					9				M	SILT; light brown. Firm, wet, non-plastic.	
					● 42/21 kPa								2.5		Clayey SILT; light brown mottled orange brown. Firm, moist, medium plasticity.	
					● 61/16 kPa asb/gl @ 2.70m								3.0	F-St	Sandy SILT; light brown. Stiff to firm, moist, non-plastic.	
					● 56/15 kPa					8					3.0m: grey	
					● 37/16 kPa att/psd @ 3.45m								3.5	M-W	F	Silty CLAY; light greyish brown. Firm, moist to wet, high plasticity; difficult to recover.
					● 40/9 kPa asb/gl @ 3.70m								4.0			
					● 27/11 kPa					7			4.0			
					● 27/11 kPa											
	● 49/24 kPa		4.5													
	● 37/20 kPa asb/gl @			M	F-St	Clayey SILT; greyish brown. Firm to stiff, moist, low plasticity.										

COMMENTS: 26 Brigham Ck Rd

Hole Depth
7.25m

Scale 1:25

HAND AUGER LOG

HOLE Id: **HA114**

SHEET: 2 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000							
CO-ORDINATES: (NZTM2000)		5926872.80 mN 1743108.40 mE		DRILL TYPE: 75 and 50 mm Hand auger				HOLE STARTED: 03/12/2020							
R.L.:		11.00m		DRILL METHOD: HA+DCP				HOLE FINISHED: 03/12/2020							
DATUM:		NZVD2016						DRILLED BY: GEOTECHNICS		LOGGED BY: RBE					
								CHECKED: CBM							
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION. <															

CORE PHOTOS

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926872.80 mN 1743108.40 mE	DRILL TYPE: 75 and 50 mm Hand auger	HOLE STARTED: 03/12/2020
R.L.:	11.00m	DRILL METHOD: HA+DCP	HOLE FINISHED: 03/12/2020
DATUM:	NZVD2016		DRILLED BY: GEOTECHNICS
			LOGGED BY: RBE CHECKED: CBM



0.00-5.20m

HAND AUGER LOG

HOLE Id: **HA115**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI	LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926794.20 mN (NZTM2000) 1743054.00 mE	DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 03/12/2020
R.L.: 9.90m	DRILL METHOD: HA+DCP	HOLE FINISHED: 03/12/2020
DATUM: NZVD2016		DRILLED BY: Tonkin + Taylor Ltd
		LOGGED BY: ROM CHECKED: CBM

GEOLOGICAL										ENGINEERING DESCRIPTION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION,	WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)														TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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COMMENTS:

Hole Depth
6m

Scale 1:25

Rev.: A

HAND AUGER LOG

CORE PHOTOS

BOREHOLE No.: HA115

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926794.20 mN 1743054.00 mE	DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 03/12/2020
R.L.:	9.90m	DRILL METHOD: HA+DCP	HOLE FINISHED: 03/12/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



0.00-3.00m



3.00-5.00m

HAND AUGER LOG

HOLE Id: HA116

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI					LOCATION: Whenuapai					JOB No.: 1014985.0000									
CO-ORDINATES: (NZTM2000)		5926675.90 mN 1743047.90 mE			DRILL TYPE: 75 and 50 mm Hand auger					HOLE STARTED: 02/12/2020									
R.L.:		8.80m			DRILL METHOD: HA+DCP					HOLE FINISHED: 02/12/2020									
DATUM:		NZVD2016								DRILLED BY: GEOTECHNICS									
										LOGGED BY: RBE		CHECKED: CBM							
GEOLOGICAL										ENGINEERING DESCRIPTION									
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION,		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations					
Topsoil		02/12/2020 level on completion				asb/g/l/split @ 0.00m				TS	M			SILT; dark brown. Moist, non-plastic.					
						● 86/27 kPa asb/gl @ 0.40m PID, 0.5ppm @ 0.50m ● 72/7 kPa		0.5		M-W	F-St			Clayey SILT; greyish brown. Stiff to firm, moist, medium plasticity.					
Tauranga Group						● 49/12 kPa asb/gl @ 0.90m PID, 1.0ppm @ 1.00m ● 58/5 kPa		1.0						1.0m: wet to saturated					
						● 80/19 kPa att/psd @ 1.45m ● 73/24 kPa asb/gl @ 1.90m ● 66/20 kPa		1.5											
East Coast Bays Formation						● >186 kPa		2.5			W	St-Vst		Sandy SILT; brown and orange brown; grey from 2.3m. Stiff to very stiff, wet, non-plastic.					
						● UTP		3.0			M	VSt		Clayey SILT; grey. Very stiff, moist, low plasticity.					
						att/psd @ 2.95m		3.0			S			Silty SAND; grey. Saturated; well packed.					
								6						2.95m: Scala (blows per 50mm) 7,7,7,8,11,16,18,23 then bouncing Over augered, solid refusal at 3.35m					
								4						3.35m: Refusal					
								5											
								4											
COMMENTS: Brigham Creek																			
Hole Depth 3.35m																			

CORE PHOTOS

BOREHOLE No.: **HA116**

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926675.90 mN 1743047.90 mE	DRILL TYPE: 75 and 50 mm Hand auger	HOLE STARTED: 02/12/2020
R.L.:	8.80m	DRILL METHOD: HA+DCP	HOLE FINISHED: 02/12/2020
DATUM:	NZVD2016		DRILLED BY: GEOTECHNICS
			LOGGED BY: RBE CHECKED: CBM



0.00-3.35m

HAND AUGER LOG

HOLE Id: **HA117**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000																			
CO-ORDINATES: (NZTM2000)		5926564.40 mN 1743138.40 mE		DRILL TYPE: 50 mm Hand auger				HOLE STARTED: 02/12/2020																			
R.L.:		10.00m		DRILL METHOD: HA+DCP				HOLE FINISHED: 02/12/2020																			
DATUM:		NZVD2016						DRILLED BY: Tonkin + Taylor Ltd																			
								LOGGED BY: ROM		CHECKED: CBM																	
GEOLOGICAL								ENGINEERING DESCRIPTION																			
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER		CORE RECOVERY (%)		METHOD		SCALA PENETROMETER (Blows/50mm)		TESTS		SAMPLES		RL (m)		DEPTH (m)		GRAPHIC LOG		WEATHERING MOISTURE CONDITION		STRENGTH/DENSITY CLASSIFICATION		SHEAR STRENGTH (kPa)		Description and Additional Observations	
								0 2 4 6 8 10 12 14 16 18																			
Fill										Env/asb @ 0.10m										D		St				Sandy SILT, trace organics; light brown mottled orange and brown. Stiff, dry, low plasticity; sand, fine; organics, rootlets..	
										● 152/19 kPa Env/asb @ 0.50m PID 0.8ppm @ 0.51m				0.5						M		VSt				Silty CLAY, minor sand, trace organics & insulation fibres; light brown mottled orange. Very stiff, moist, high plasticity; sand, fine; organics, rootlets.	
										● 137/16 kPa Env/asb @ 1.00m PID 6.0ppm @ 1.01m				1.0						D-M				Sandy SILT, trace organics; dark brown and light brown mottled orange. Very stiff, dry to moist, low plasticity; sand, fine; organics, rootlets.			
Tauranga Group										● 112/25 kPa										M						Silty CLAY, trace organics; light brown mottled orange. Very stiff, moist, high plasticity; organics, rootlets.	
										● 186/76 kPa Env/corrosiv ity @ 2.00m				2.0										Silty CLAY, some sand, minor organics; brown spotted black, speckled white and orange. Very stiff, moist, high plasticity; sand, fine; organics, carbonaceous.			
										● 218/81 kPa				2.5						VSt-H				Sandy SILT; grey and brown speckled orange. Very stiff to hard, moist, low plasticity; sand, fine.			
										att/psd @ 2.70m																	
										● 171/48 kPa				3.0								VSt		SILT, some clay and sand, trace peat (spongy); brown mottled orange, streaked black. Very stiff, moist, low plasticity; sand, fine.			
										● 156/75 kPa				3.5										3.6m: Grey mottled orange			
										● 199/75 kPa				4.0										Sandy SILT, trace organics; light brown mottled orange, streaked black. Very stiff, moist, low plasticity; sand, fine; carbonaceous & decomposed wood.			
										● 209/72 kPa				4.5													
										● 184/73 kPa												D		Silty SAND, trace organics; grey streaked black and brown. Moist, poorly graded; sand, fine, tightly packed; carbonaceous & decomposed wood.			

COMMENTS:

Hole Depth
6.3m

Scale 1:25

Rev.: A

HAND AUGER LOG

CORE PHOTOS

BOREHOLE No.: HA117

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926564.40 mN 1743138.40 mE	DRILL TYPE: 50 mm Hand auger	HOLE STARTED: 02/12/2020
R.L.:	10.00m	DRILL METHOD: HA+DCP	HOLE FINISHED: 02/12/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



0.00-3.00m



3.00-5.00m

HAND AUGER LOG

HOLE Id: **HA119**

SHEET: 1 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000							
CO-ORDINATES: (NZTM2000)		5926938.00 mN 1743195.90 mE		DRILL TYPE: 75 and 50 mm Hand auger				HOLE STARTED: 03/12/2020							
R.L.:		11.40m		DRILL METHOD: HA+DCP				HOLE FINISHED: 03/12/2020							
DATUM:		NZVD2016						DRILLED BY: GEOTECHNICS							
								LOGGED BY: RBE		CHECKED: CBM					
GEOLOGICAL								ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations	
Topsoil		03/12/2020 inflow 1.6m, W/L after 45mins			0 2 4 6 8 10 12 14 16 18	Dup E/ash/gl @ 0.00m					D			SILT; light brown. Dry, non-plastic.	
Tauranga Group	● 125/4 kPa ash/gl @ 0.40m						11	0.5		M	VSt		Clayey SILT; light brown. Very stiff, moist, low plasticity.		
	● 81/32 kPa										St		Silty CLAY; light brown mottled yellowish brown. Stiff, moist, medium plasticity.		
	● 74/21 kPa ash/gl @ 0.90m							1.0					1.1m: sandy layer		
	● 56/19 kPa												Clayey SILT; light brown mottled yellowish brown. Stiff, moist, low plasticity.		
	● 58/19 kPa att/psd @ 1.45m						10	1.5		S	F-St		Sandy SILT; brown mottled yellowish brown. Firm to stiff, saturated, non-plastic.		
	● 60/11 kPa ash/gl @ 1.90m							2.0							
	● 42/19 kPa									W	S-F		Clayey SILT; grey. Soft to firm, wet, medium plasticity.		
	● 66/16 kPa att/psd @ 2.45m						9	2.5							
	● 23/8 kPa ash/gl @ 2.70m														
	● 29/11 kPa							3.0							
	● 48/20 kPa						8	3.5			F		Clayey sandy SILT; grey. Firm, wet, low plasticity.		
	● 50/20 kPa ash/gl @ 3.70m														
	● 56/19 kPa							4.0		M	St		Clayey SILT; grey. Stiff, moist, medium plasticity.		
	● 61/32 kPa									W			Clayey sandy SILT; light grey. Stiff, moist, low plasticity.		
● 25/11 kPa		7	4.5		M	F-St		Sandy SILT; grey. Stiff, wet, non-plastic.							
● 32/19 kPa ash/gl @								Clayey SILT; grey. Firm to stiff, moist, medium plasticity.							

COMMENTS: 26 Brigham Ck Rd. No core photograph, the soil is very similar to HA109

Hole Depth
7.25m

Scale 1:25

Rev.: A

HAND AUGER LOG

HOLE Id: **HA119**

SHEET: 2 OF 2

PROJECT: Watercare Whenuapai-Redhill GI				LOCATION: Whenuapai				JOB No.: 1014985.0000						
CO-ORDINATES:		5926938.00 mN (NZTM2000) 1743195.90 mE		DRILL TYPE: 75 and 50 mm Hand auger				HOLE STARTED: 03/12/2020						
R.L.:		11.40m		DRILL METHOD: HA+DCP				HOLE FINISHED: 03/12/2020						
DATUM:		NZVD2016						DRILLED BY: GEOTECHNICS						
								LOGGED BY: RBE		CHECKED: CBM				
GEOLOGICAL								ENGINEERING DESCRIPTION						
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm)	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	WEATHERING MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	Description and Additional Observations
Borehole 1014985.0000	Tauranga Group				0 2 4 6 8 10 12 14 16 18	4.70m ● 54/13 kPa								[CONT] Clayey SILT; grey. Firm to stiff, moist, medium plasticity. 5.1m: some sand, minor organics
					0 0 0 0 1									

COMMENTS: 26 Brigham Ck Rd. No core photograph, the soil is very similar to HA109

Hole Depth
7.25m
Scale 1:25

Appendix C Groundwater monitoring results

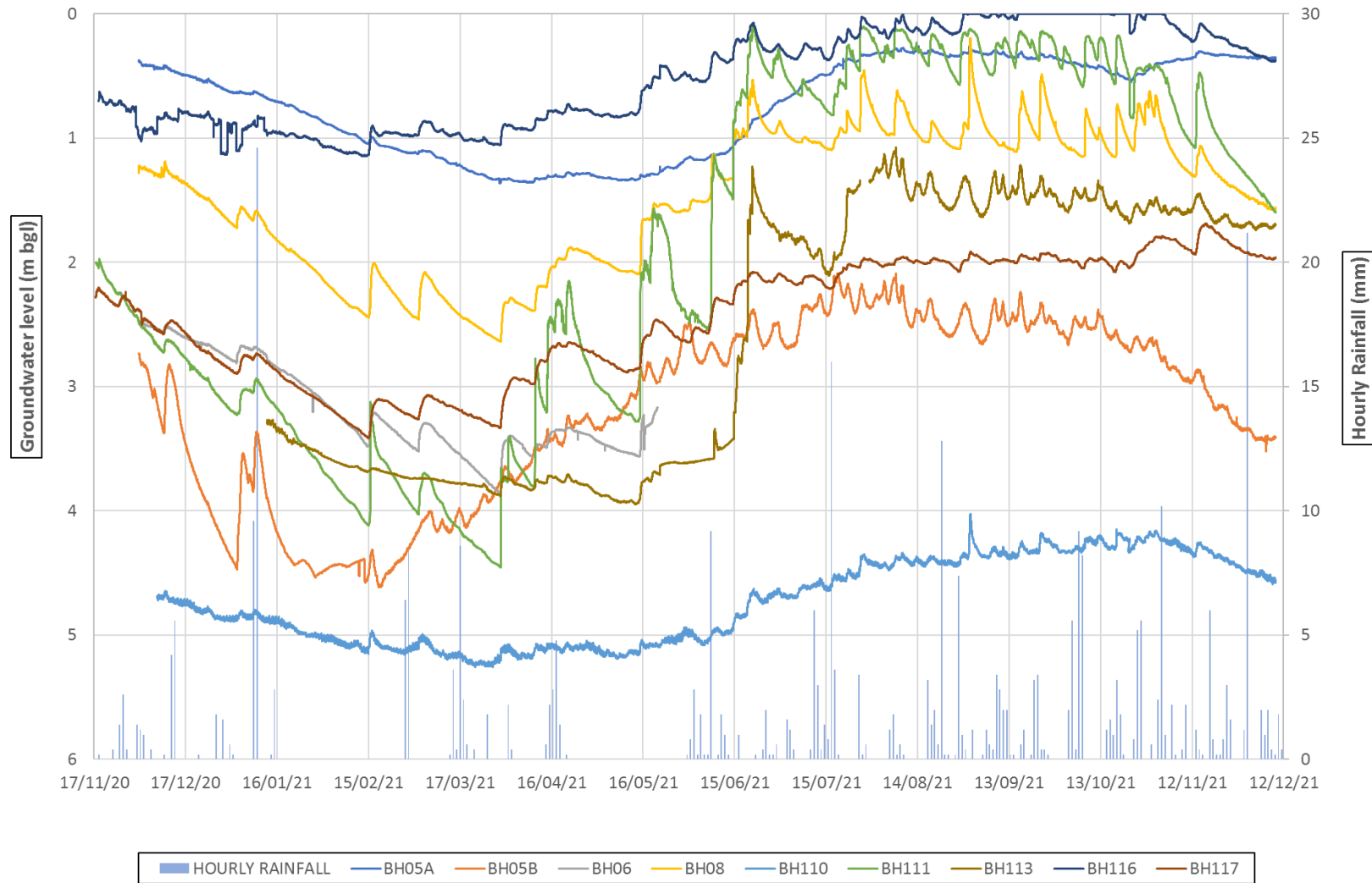


Figure 1.1: Continuous groundwater level monitoring results (m bgl) and rainfall (mm) recorded at the MOTAT gauging site located approx. 13 km southeast of the site.

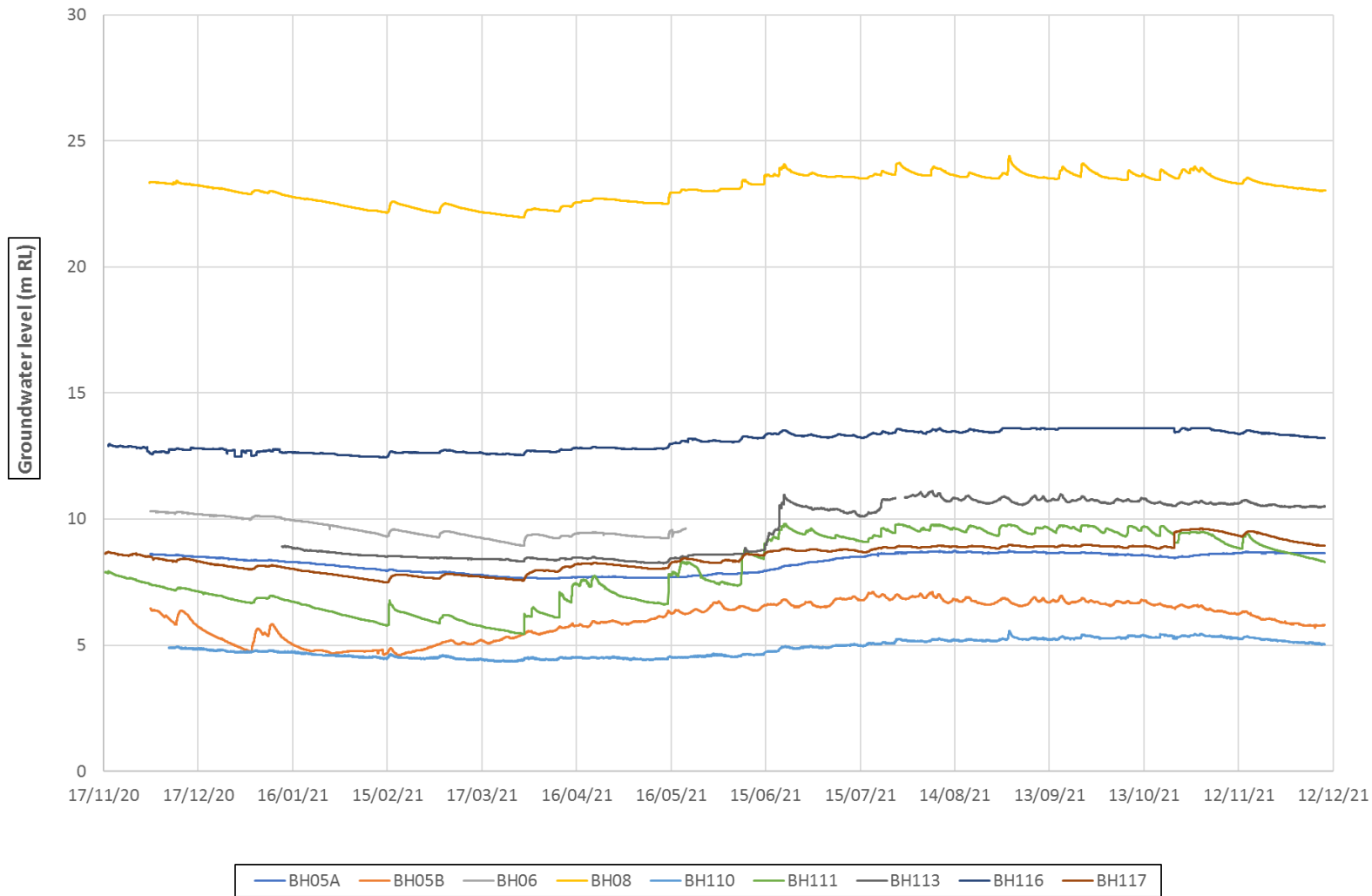


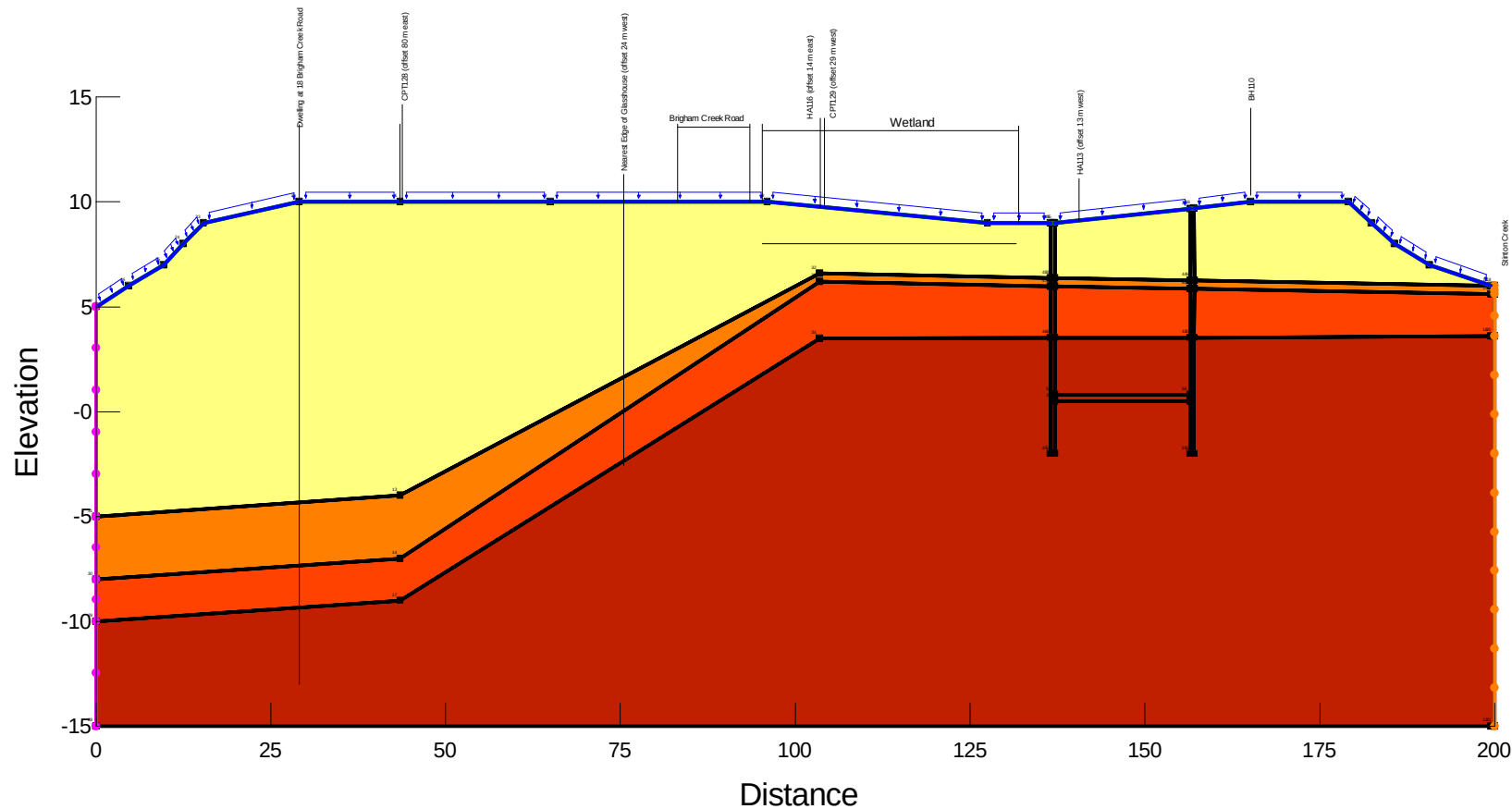
Figure 1.2: Continuous groundwater level monitoring results (m RL).

Appendix D SEEP/W outputs and groundwater induced settlement troughs

Analysis Notes:

1. Name: 1.1 Pre-Construction Conditions
2. Method: Steady-State

Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio	Rotation (°)	Volumetric Water Content	Compressibility (/kPa)
	01. Alluvium	Saturated Only	4e-08	0.1	0	0.4	0.0001
	02. Residual ECBF	Saturated Only	5e-08	0.1	0	0.5	5e-05
	03. Weathered ECBF	Saturated Only	6e-08	0.1	0	0.1	1e-05
	04. Unweathered ECBF	Saturated Only	6e-08	0.1	0	0.1	5e-06



Title: 20220405_GWDrawdownAssessment_PumpStation.gsz

Job Number: 1013050

Analysis: 1.1 Pre-Construction Conditions

Analysed by: JROB

Comments:

Scale: 1:1,000 @ A4

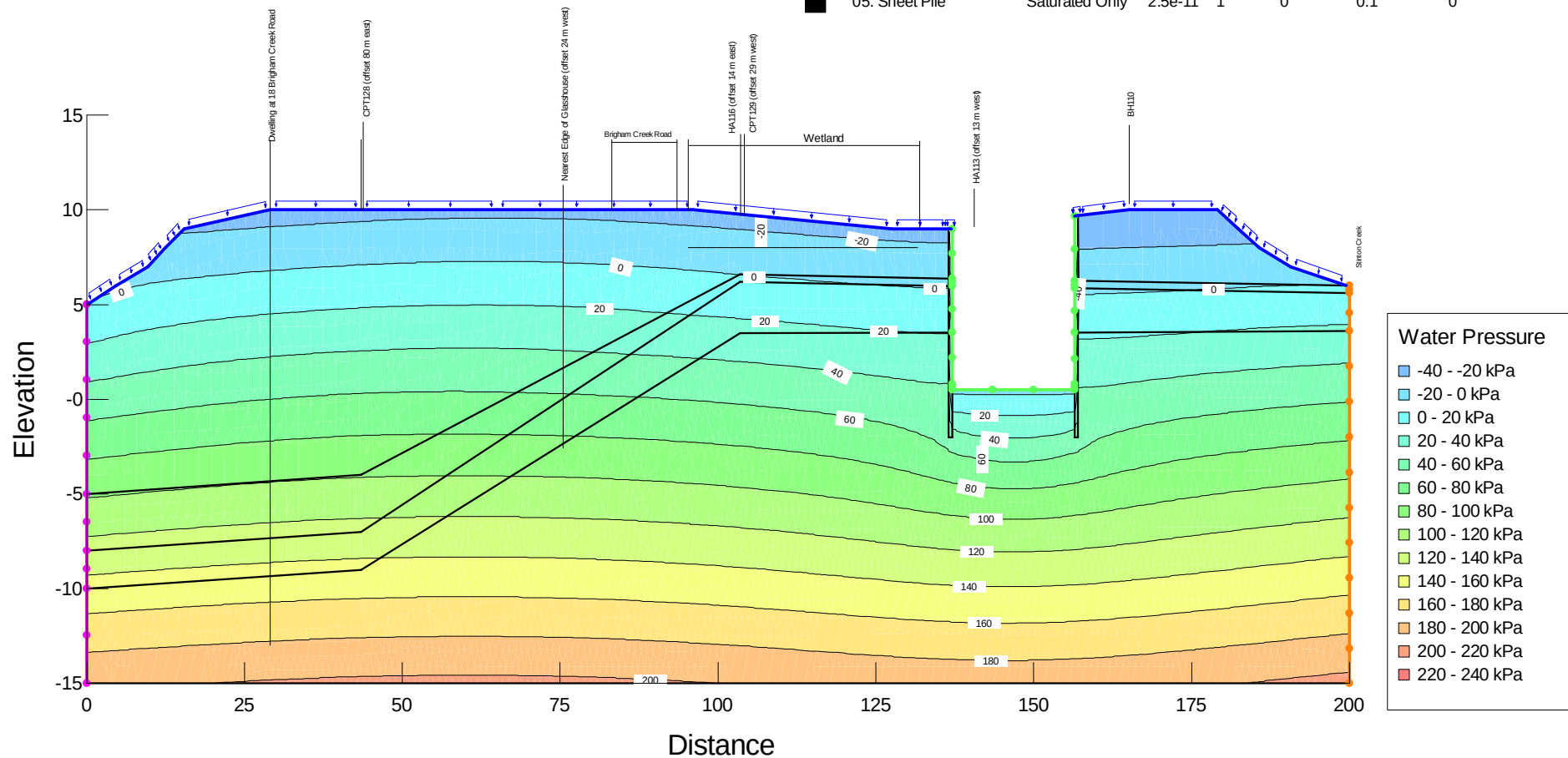
Checked by: EDMA

Analysis Notes:

1. Name: 1.2 Wet Well Excavation
2. Method: Transient

180 Days

Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky/Kx' Ratio	Rotation (°)	Volumetric Water Content	Compressibility (1/kPa)
Yellow	01. Alluvium	Saturated Only	4e-08	0.1	0	0.4	0.0001
Orange	02. Residual ECBF	Saturated Only	5e-08	0.1	0	0.5	5e-05
Red	03. Weathered ECBF	Saturated Only	6e-08	0.1	0	0.1	1e-05
Dark Red	04. Unweathered ECBF	Saturated Only	6e-08	0.1	0	0	5e-06
Black	05. Sheet Pile	Saturated Only	2.5e-11	1	0	0.1	0



Title: 20220405_GWDrawdownAssessment_PumpStation.gsz

Job Number: 1013050

Analysis: 1.2 Wet Well Excavation

Analysed by: JROB

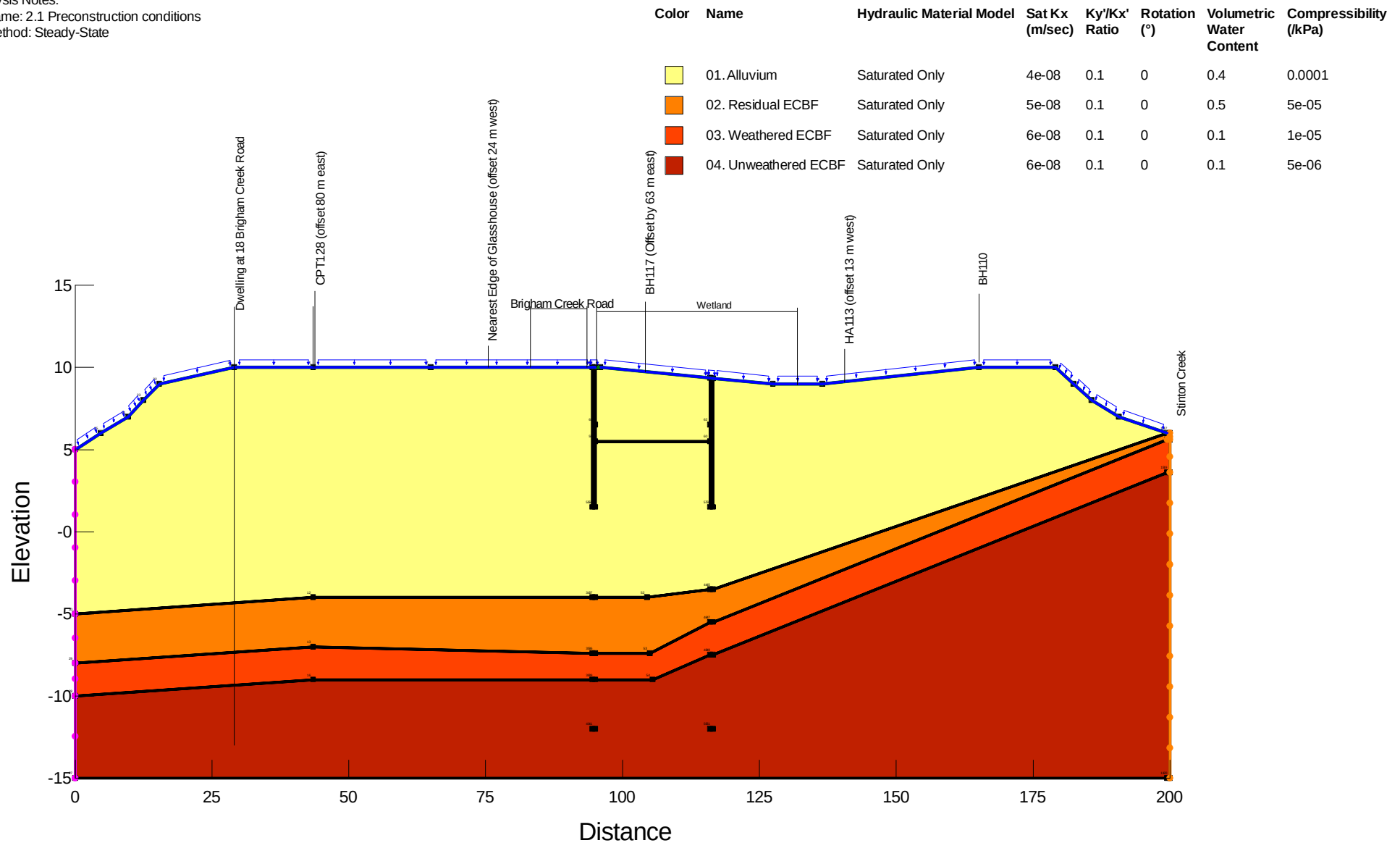
Comments:

Scale: 1:1,000 @ A4

Checked by: EDMA

Analysis Notes:

1. Name: 2.1 Preconstruction conditions
2. Method: Steady-State



Title: 20220405_GWDrawdownAssessment_PumpStation.gsz

Job Number: 1013050

Analysis: 2.1 Preconstruction conditions

Analysed by: JROB

Comments:

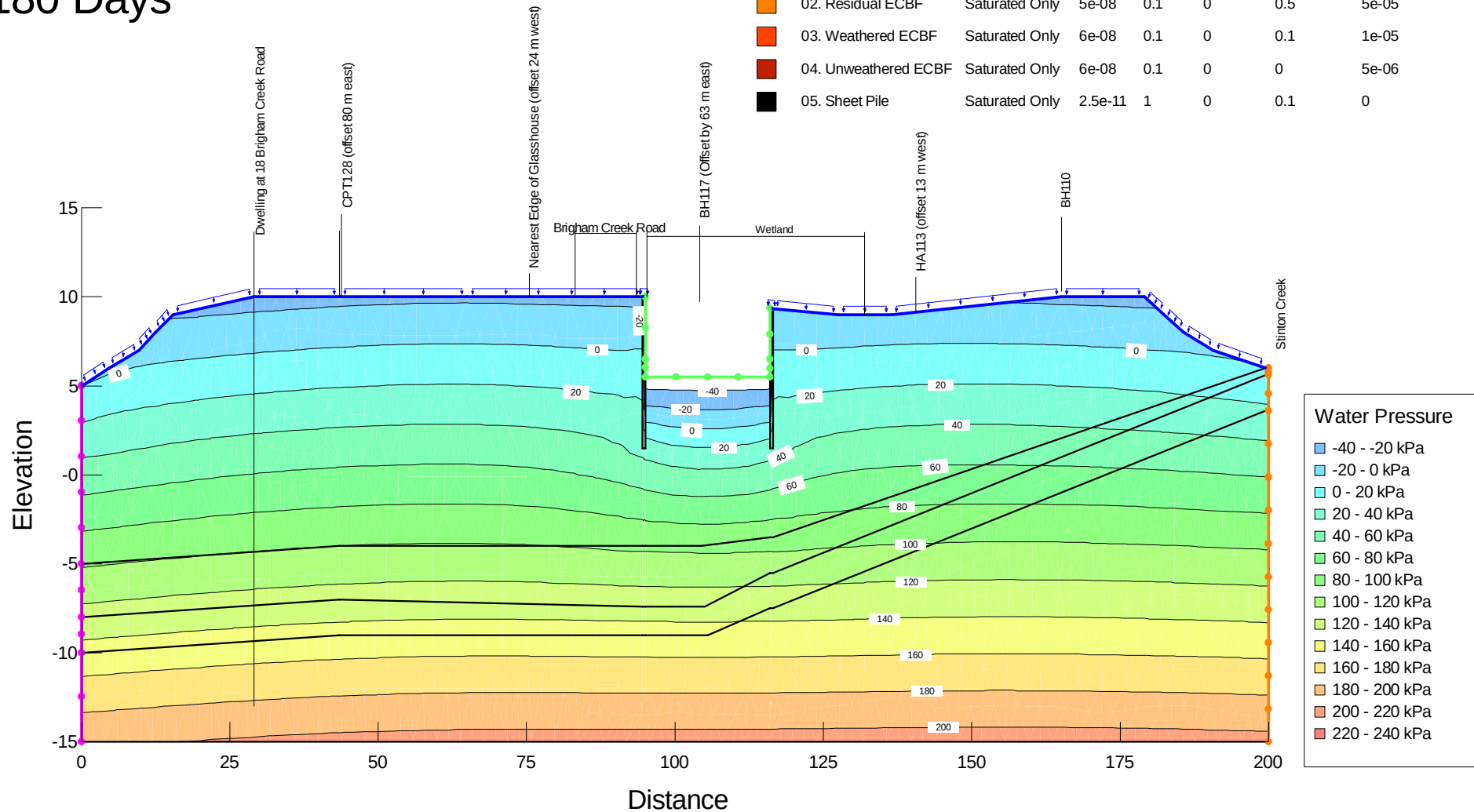
Scale: 1:1,000 @ A4

Checked by: EDMA

Analysis Notes:
 1. Name: 2.2 Drive Shaft Excavation
 2. Method: Transient

180 Days

Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky/Kx' Ratio	Rotation (°)	Volumetric Water Content	Compressibility (/kPa)
01. Alluvium		Saturated Only	4e-08	0.1	0	0.4	0.0001
02. Residual ECBF		Saturated Only	5e-08	0.1	0	0.5	5e-05
03. Weathered ECBF		Saturated Only	6e-08	0.1	0	0.1	1e-05
04. Unweathered ECBF		Saturated Only	6e-08	0.1	0	0	5e-06
05. Sheet Pile		Saturated Only	2.5e-11	1	0	0.1	0



Title: 20220405_GWDrawdownAssessment_PumpStation.gsz

Job Number: 1013050

Analysis: 2.2 Drive Shaft Excavation

Analysed by: JROB

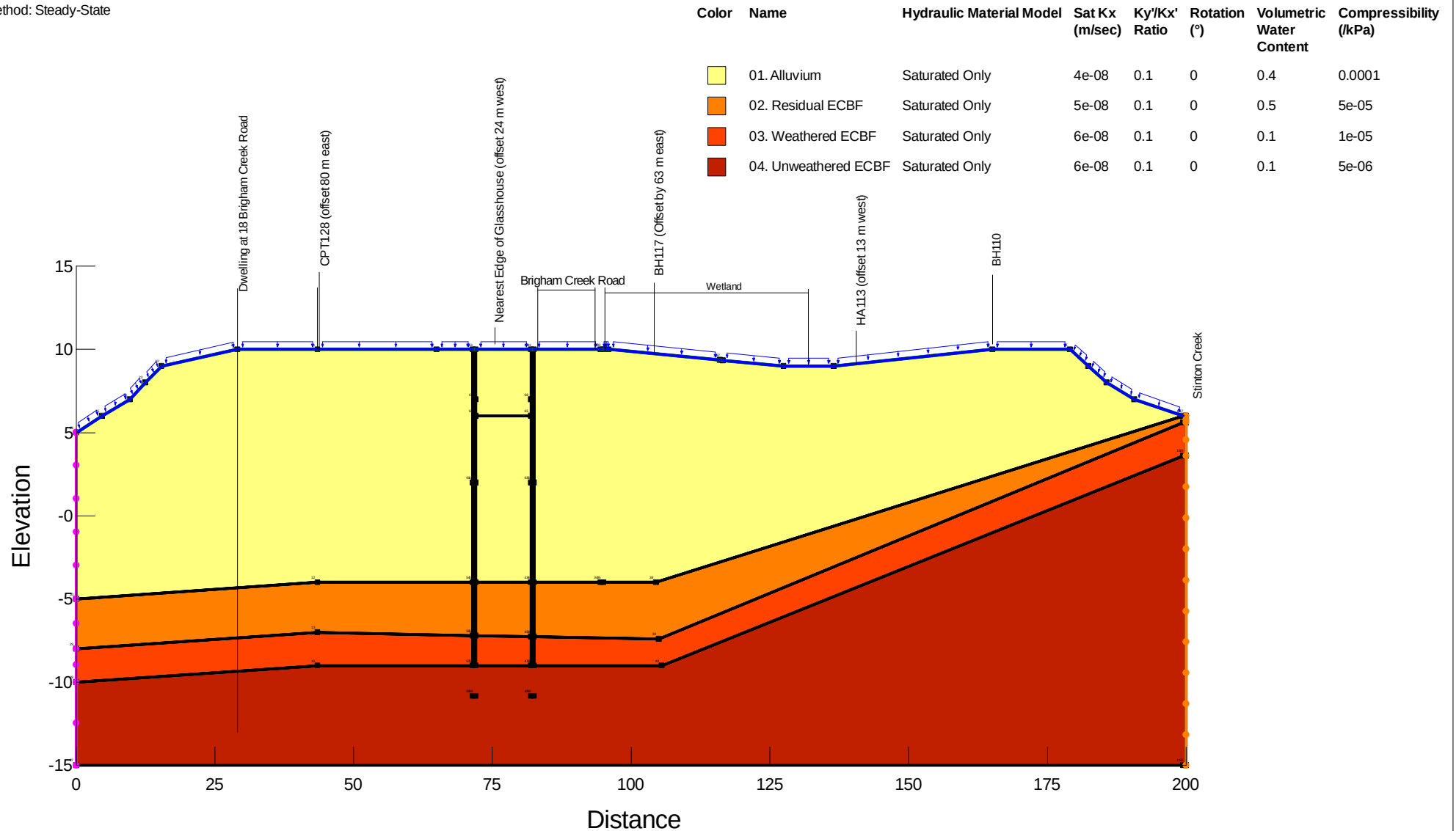
Comments:

Scale: 1:1,000 @ A4

Checked by: EDMA

Analysis Notes:

1. Name: 3.1 Pre construction conditions
2. Method: Steady-State



Title: 20220405_GWDrawdownAssessment_PumpStation.gsz

Job Number: 1013050

Analysis: 3.1 Pre construction conditions

Analysed by: JROB

Comments:

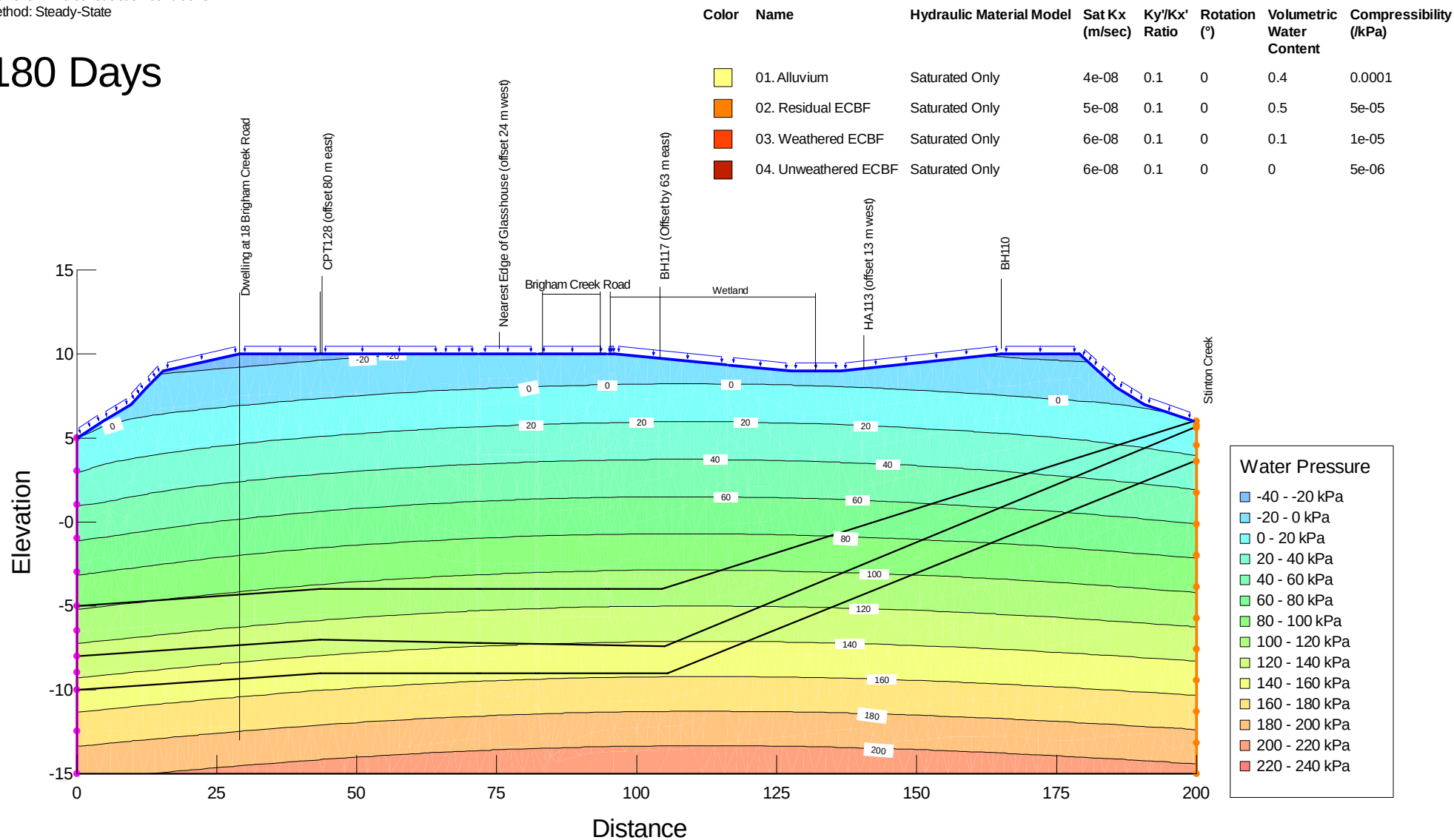
Scale: 1:1,000 @ A4

Checked by: EDMA

Analysis Notes:

1. Name: 3.1 Pre construction conditions
2. Method: Steady-State

180 Days



Title: 20220405_GWDrawdownAssessment_PumpStation.gsz

Job Number: 1013050

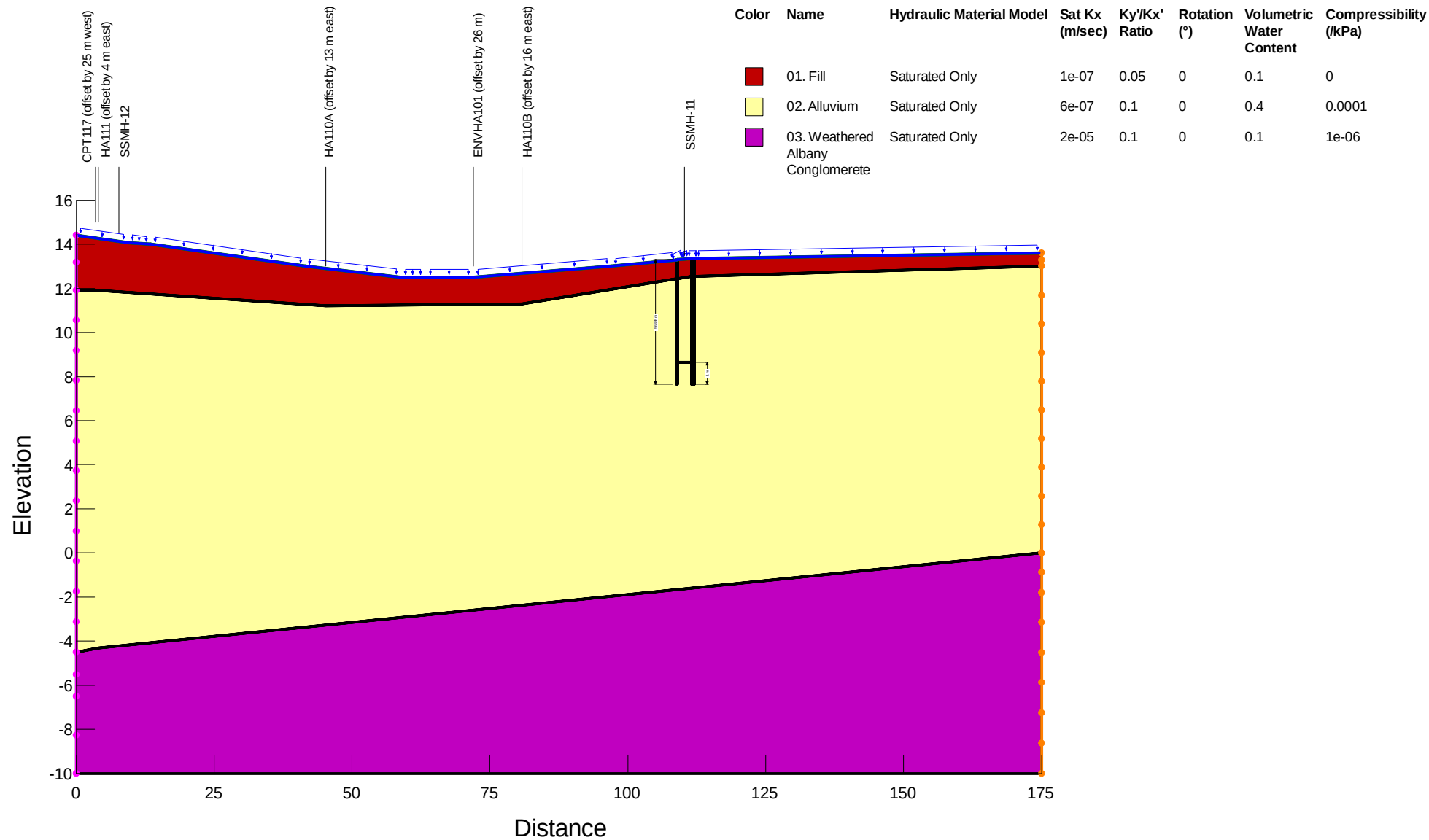
Analysis: 3.1 Pre construction conditions

Analysed by: JROB

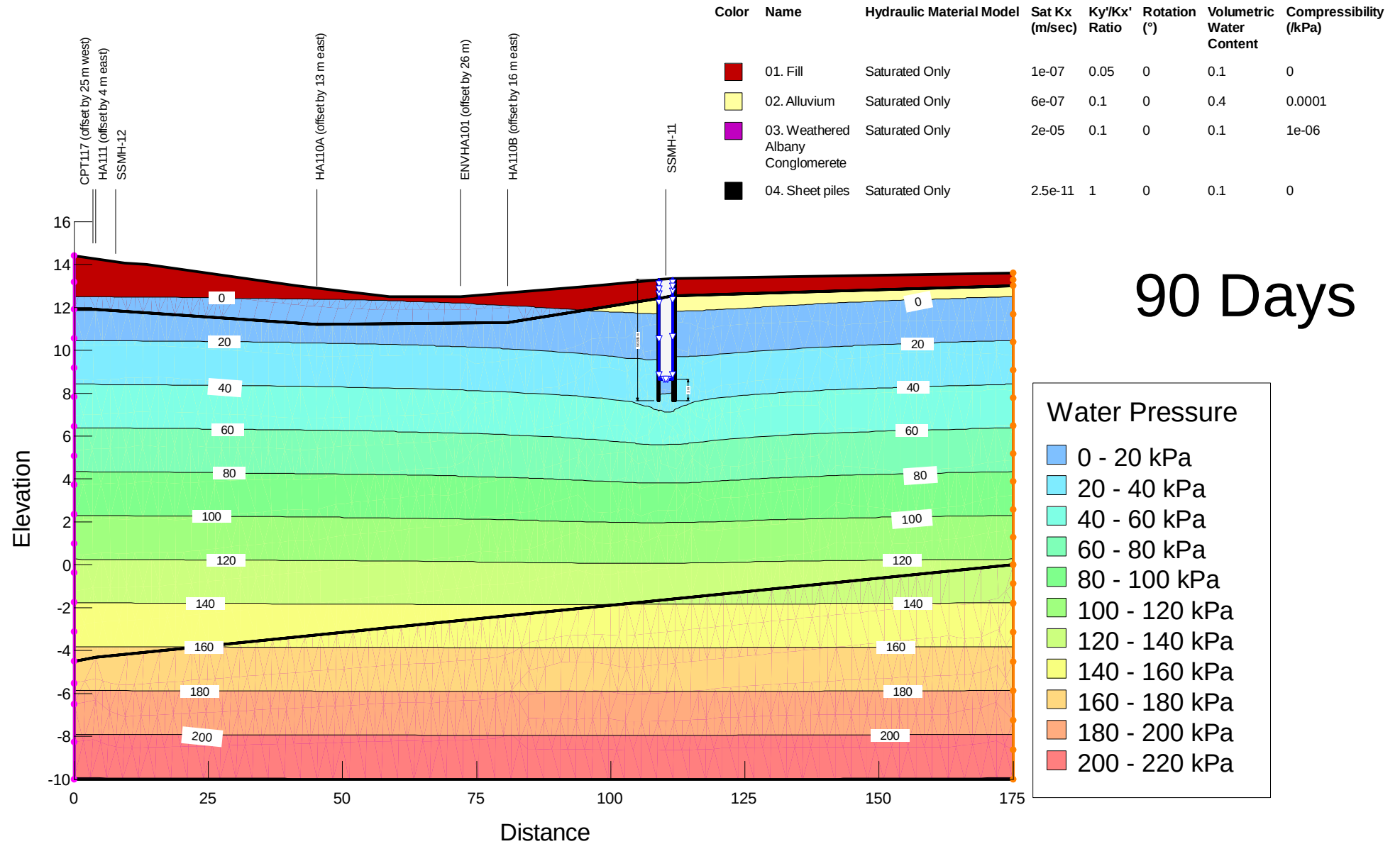
Comments:

Scale: 1:1,000 @ A4

Checked by: EDMA



Title: 20220405_GWDrawdownAssessment_SSMH11.gsz		Job Number:
Analysis: Pre-construction conditions		Analysed by:
Comments:	Scale: 1:1,000 @ A4	Checked by:



Appendix E Wallap outputs and mechanical settlement troughs

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum		Elevation of		Soil types			
no.	top of stratum	Left side	Right side				
1	10.00	2 TA silt & clay	2 TA silt & clay				
2	7.85	7 TA organic clay	7 TA organic clay				
3	4.45	2 TA silt & clay	2 TA silt & clay				
4	1.45	8 TA sand	8 TA sand				
5	0.40	2 TA silt & clay	2 TA silt & clay				
6	-0.25	8 TA sand	8 TA sand				
7	-1.65	2 TA silt & clay	2 TA silt & clay				
8	-4.00	3 ECBF residual soils	3 ECBF residual soils				

SOIL PROPERTIES

-- Soil type --	Bulk density	Young's Modulus	At rest coeff.	Consol state.	Active limit	Passive limit	Cohesion
No. Description (Datum elev.)	kN/m3	Eh, kN/m2 (dEh/dy)	Ko (dKo/dy)	NC/OC (Nu)	Ka (Kac)	Kp (Kpc)	dc/dy)
1 Engineered hardfill	20.00	50000	0.254	OC (0.300)	0.189 (0.000)	7.061 (0.000)	
2 TA silt & clay	17.00	10000	0.531	OC (0.350)	0.320 (1.278)	3.485 (4.674)	1.000d
3 ECBF residual soils	18.00	20000	0.500	OC (0.350)	0.294 (1.222)	3.878 (4.985)	5.000d
4 ECBF Weathered rock	21.00	85000	0.426	OC (0.350)	0.237 (1.089)	5.153 (5.931)	25.00d
5 ECBF UW rock	22.00	400000	0.357	OC (0.250)	0.189 (0.966)	7.061 (7.223)	100.0d
6 Concrete	24.00	500000	0.000	OC (0.490)	1.000 (0.851)	1.000 (2.233)	500.0u
7 TA organic clay	16.00	5000	0.531	OC (0.250)	0.320 (1.278)	3.812 (5.289)	0.0d
8 TA sand	18.00	12000	0.500	OC (0.250)	0.294 (0.000)	3.878 (0.000)	

Additional soil parameters associated with Ka and Kp

--- parameters for Ka ---				--- parameters for Kp ---			
Soil		Wall	Back-	Soil		Wall	Back-
friction		adhesion	fill	friction		adhesion	fill
No. Description	angle	coeff.	angle	No. Description	angle	coeff.	angle
1 Engineered hardfill	40.00	0.434	0.00	1 Engineered hardfill	40.00	0.280	0.00
2 TA silt & clay	28.00	0.469	0.00	2 TA silt & clay	28.00	0.306	0.00
3 ECBF residual soils	30.00	0.464	0.00	3 ECBF residual soils	30.00	0.302	0.00
4 ECBF weathered rock	35.00	0.450	0.00	4 ECBF weathered rock	35.00	0.292	0.00
5 ECBF UW rock	40.00	0.434	0.00	5 ECBF UW rock	40.00	0.280	0.00
6 Concrete	0.00	0.736	0.00	6 Concrete	0.00	0.265	0.00
7 TA organic clay	28.00	0.469	0.00	7 TA organic clay	28.00	0.469	0.00
8 TA sand	30.00	0.464	0.00	8 TA sand	30.00	0.302	0.00

parameters not used

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3					Left side		Right side	
Initial water table elevation					8.00		8.00	
Automatic water pressure balancing at toe of wall : Yes								
Water press.		Left side			Right side			
profile no.	Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Point no.	Elev. m	Piezo elev. m	Water press kN/m2
1	1	9.50	9.50	0.0	1	5.75	5.75	0.0
2	1	8.00	8.00	0.0	1	5.25	5.25	0.0
3	1	8.00	8.00	0.0	1	7.25	7.25	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 0.00
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.0000E+08 kN/m2
Moment of inertia of wall I = 3.2400E-04 m4/m run
(Sumitomo SX18) E.I = 64800 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin -ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	9.00	4.00	0.011400	2.000E+08	10.00	0.00	0	Anchor	n/a	R

SURCHARGE LOADS

Surch -arge no.	Distance from wall	Length parallel to wall	Width perpnd. to wall	Surcharge kn/m2	Equiv. soil type	Partial factor/ Category
1	10.00	0.50(L)	21.00	10.00	15.00	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 10.00
2	Apply water pressure profile no.3
3	Excavate to elevation 8.25 on RIGHT side
4	Install strut or anchor no.1 at elevation 9.00
5	Apply water pressure profile no.2
6	Excavate to elevation 5.50 on RIGHT side
7	Fill to elevation 6.00 on RIGHT side with soil type 1
8	Apply water pressure profile no.1

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - Strength Factor method
Factor on soil strength for calculating wall depth = 1.50

Parameters for undrained strata:
Minimum equivalent fluid density = 5.00 kN/m3
Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - No
Non-linear Modulus Parameter (L) = 8.500 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 20.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 30.00 m
Distance to rigid boundary on Right side = 30.00 m

Brigham Creek Road crossing
Driver shaft

Elevation of rigid lower boundary = -30.00

Lower rigid boundary at elevation -30.00 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Smooth

OUTPUT OPTIONS

Stage no.	Stage description	Displacement Bending mom. Shear force	Output options Active, Passive pressures	Graphical output
1	Apply surcharge no.1 at elev. 10.00	Yes	Yes	Yes
2	Apply water pressure profile no.3	Yes	Yes	Yes
3	Excav. to elev. 8.25 on RIGHT side	Yes	Yes	Yes
4	Install prop no.1 at elev. 9.00	Yes	Yes	Yes
5	Apply water pressure profile no.2	Yes	Yes	Yes
6	Excav. to elev. 5.50 on RIGHT side	Yes	Yes	Yes
7	Fill to elev. 6.00 on RIGHT side	Yes	Yes	Yes
8	Apply water pressure profile no.1	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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Brigham Creek Road
crossing
Driver shaft

Units: kN,m

Stage No. 1 Apply surcharge no.1 at elevation 10.00

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

		FoS for toe		Toe elev. for			
		elev. = 0.00		FoS = 1.500			
Stage	Ground level	Prop	Factor	Moment	Toe	Wall	Direction
No.	Act.	Pass.	Elev.	of	elev.	Penetr	of
				Safety	at elev.	-ation	failure
1	10.00	10.00	Cant.	Conditions not suitable for FoS calc.			

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.05
 Right side = 1.05

Rigid boundaries: Left side 30.00 from wall Rough boundary
 Right side 30.00 from wall Rough boundary
Lower rigid boundary at elevation -30.00 Rough boundary

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	10.00	-1.18	0.003	-1.00E-04	0.0	-0.0	
2	9.50	-1.80	0.003	-1.00E-04	-0.7	-0.1	
3	9.00	-0.53	0.003	-9.75E-05	-1.3	-0.6	
4	8.63	-0.25	0.003	-9.26E-05	-1.5	-1.1	
5	8.25	-0.13	0.003	-8.46E-05	-1.5	-1.7	
6	8.00	-0.18	0.003	-7.75E-05	-1.6	-2.0	
7	7.85	-0.14	0.003	-7.25E-05	-1.6	-2.3	
		0.61	0.003	-7.25E-05	-1.6	-2.3	
8	7.25	0.83	0.003	-4.74E-05	-1.2	-3.1	
9	6.93	0.82	0.003	-3.09E-05	-0.9	-3.5	
10	6.60	0.80	0.003	-1.30E-05	-0.6	-3.7	
11	6.00	0.82	0.003	2.24E-05	-0.2	-3.9	
12	5.75	0.80	0.003	3.76E-05	0.0	-4.0	
13	5.50	0.81	0.003	5.28E-05	0.2	-3.9	
14	5.25	0.81	0.003	6.77E-05	0.4	-3.8	
15	4.85	0.82	0.003	9.07E-05	0.8	-3.6	
16	4.45	0.73	0.003	1.11E-04	1.1	-3.2	
		-0.10	0.003	1.11E-04	1.1	-3.2	
17	4.03	-0.22	0.003	1.31E-04	1.0	-2.8	
18	3.60	-0.13	0.003	1.48E-04	0.9	-2.4	
19	3.00	0.02	0.002	1.67E-04	0.9	-1.8	
20	2.40	0.20	0.002	1.81E-04	1.0	-1.3	
21	1.93	0.40	0.002	1.89E-04	1.1	-0.8	
22	1.45	0.88	0.002	1.93E-04	1.4	-0.2	
		-2.34	0.002	1.93E-04	1.4	-0.2	
23	0.93	-1.76	0.002	1.93E-04	0.3	0.2	
24	0.40	-1.67	0.002	1.92E-04	-0.6	0.1	
		1.28	0.002	1.92E-04	-0.6	0.1	
25	0.00	0.93	0.002	1.91E-04	-0.1	0.0	

(continued)

Stage No.1 Apply surcharge no.1 at elevation 10.00

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
26	-0.25	2.30	0.002	0	0.3	0.0	
		-0.32	0.002	0	0.3	0.0	
27	-1.65	-1.52	0.002	0	-1.0	0.0	
		1.09	0.002	0	-1.0	0.0	
28	-4.00	1.14	0.001	0	1.6	0.0	
		-1.87	0.001	0	1.6	0.0	
29	-5.60	-0.01	0.001	0	0.1	0.0	
30	-7.20	0.05	0.001	0	0.1	0.0	
31	-9.60	-0.01	0.001	0	0.2	0.0	
32	-12.00	-0.01	0.001	0	0.2	0.0	
33	-14.40	-0.01	0.000	0	0.1	0.0	
34	-16.80	-0.01	0.000	0	0.1	0.0	
35	-19.20	-0.01	0.000	0	0.1	0.0	
36	-21.60	-0.01	0.000	0	0.1	0.0	
37	-24.00	-0.00	0.000	0	0.1	0.0	
38	-26.40	-0.01	0.000	0	0.0	0.0	
39	-28.20	-0.00	0.000	0	0.0	0.0	
40	-30.00	-0.03	0.000	0	0.0	0.0	

		LEFT side					Total earth	Adjusted soil
		Effective stresses						
Node	Y	Water	Vertic	Active	Passive	Earth		

		LEFT side					Total earth	Adjusted soil
		Effective stresses						
Node	Y	Water	Vertic	Active	Passive	Earth		

		RIGHT side					Total earth	Adjusted soil
		Effective stresses						
Node	Y	Water	Vertic	Active	Passive	Earth		

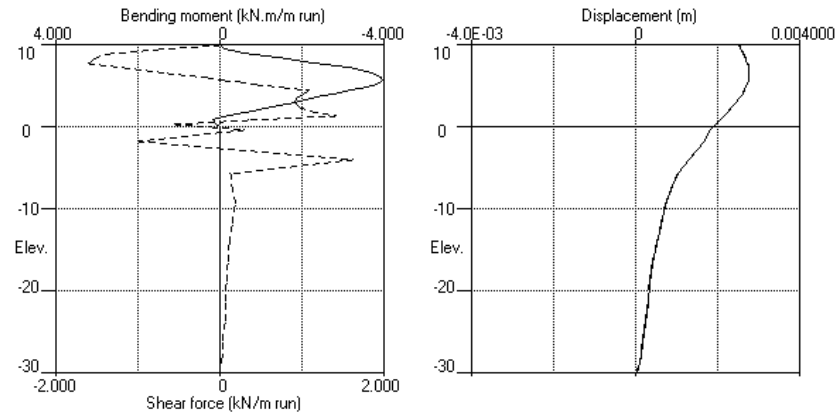
		RIGHT side					Total earth	Adjusted soil
		Effective stresses						
Node	Y	Water	Vertic	Active	Passive	Earth		

TONKIN and TAYLOR GROUP LTD.
Program: WALLAP Version 6.07 Revision A55.B74.R58
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Whenupai - Brigham Creek Road crossing - Drive shaft
Sheet pile STU1800 w 250UC89 (v3)

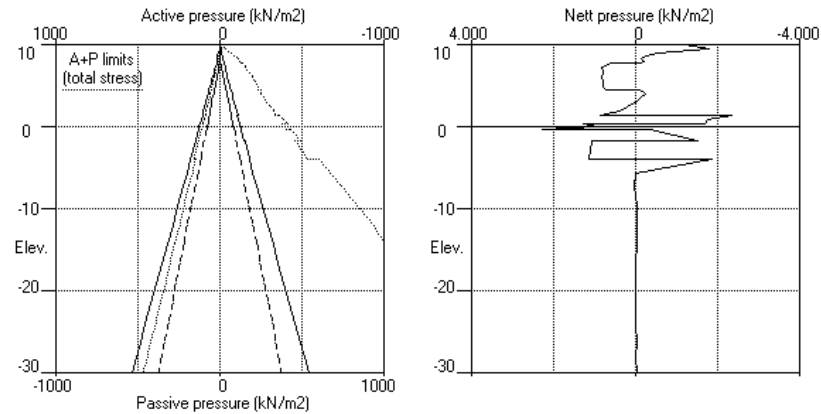
Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m

Stage No.1 Apply surcharge no.1 at elev. 10.00



Stage No.1 Apply surcharge no.1 at elev. 10.00



TONKIN and TAYLOR GROUP LTD.
Program: WALLAP Version 6.07 Revision A55.B74.R58
Data filename/Run ID: Whenuapai-BCRcross-DriveShaft_v3
Whenupai - Brigham Creek Road crossing - Drive shaft
Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m

Stage No. 2 Apply water pressure profile no.3

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Prop Pass.	Prop Elev.	FoS for toe		Toe elev. for		Direction of failure
				Factor	Moment of equil.	Toe elev.	Wall Penetr.	
2	10.00	10.00	Cant.	0.00	1.500	0.00	1.500	Conditions not suitable for FoS calc.

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options
Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.05
Right side = 1.05

Rigid boundaries: Left side 30.00 from wall
Right side 30.00 from wall
Lower rigid boundary at elevation -30.00
Rough boundary
Rough boundary
Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	-1.19	0.003	-2.15E-04	0.0	-0.0	
2	9.50	-2.52	0.003	-2.14E-04	-0.9	-0.1	
3	9.00	-1.98	0.004	-2.11E-04	-2.1	-0.8	
4	8.63	-2.30	0.004	-2.04E-04	-2.9	-1.7	
5	8.25	-2.65	0.004	-1.91E-04	-3.8	-2.9	
6	8.00	-3.06	0.004	-1.78E-04	-4.5	-3.9	
7	7.85	-2.63	0.004	-1.68E-04	-4.9	-4.6	
		-0.02	0.004	-1.68E-04	-4.9	-4.6	
8	7.25	3.84	0.004	-1.13E-04	-3.8	-7.3	
9	6.93	3.48	0.004	-7.36E-05	-2.6	-8.4	
10	6.60	3.17	0.004	-3.01E-05	-1.5	-9.0	
11	6.00	2.77	0.004	5.49E-05	0.3	-9.4	
12	5.75	2.59	0.004	9.08E-05	0.9	-9.2	
13	5.50	2.46	0.004	1.25E-04	1.6	-8.9	
14	5.25	2.35	0.004	1.59E-04	2.2	-8.4	
15	4.85	2.16	0.004	2.07E-04	3.1	-7.4	
16	4.45	1.86	0.004	2.49E-04	3.9	-6.0	
		-1.57	0.004	2.49E-04	3.9	-6.0	
17	4.03	-1.62	0.004	2.83E-04	3.2	-4.5	
18	3.60	-1.28	0.003	3.08E-04	2.6	-3.3	
19	3.00	-0.93	0.003	3.33E-04	1.9	-2.0	
20	2.40	-0.56	0.003	3.47E-04	1.5	-1.0	
21	1.93	-0.20	0.003	3.52E-04	1.3	-0.4	
22	1.45	0.41	0.003	3.52E-04	1.3	0.2	
		-2.74	0.003	3.52E-04	1.3	0.2	
23	0.93	-2.04	0.003	3.50E-04	0.1	0.5	
24	0.40	-1.62	0.002	3.46E-04	-0.9	0.3	
		1.29	0.002	3.46E-04	-0.9	0.3	
25	0.00	1.88	0.002	3.46E-04	-0.2	0.0	

Brigham Creek
Road crossing
Driver shaft

Stage No.2 Apply water pressure profile no.3

(continued)

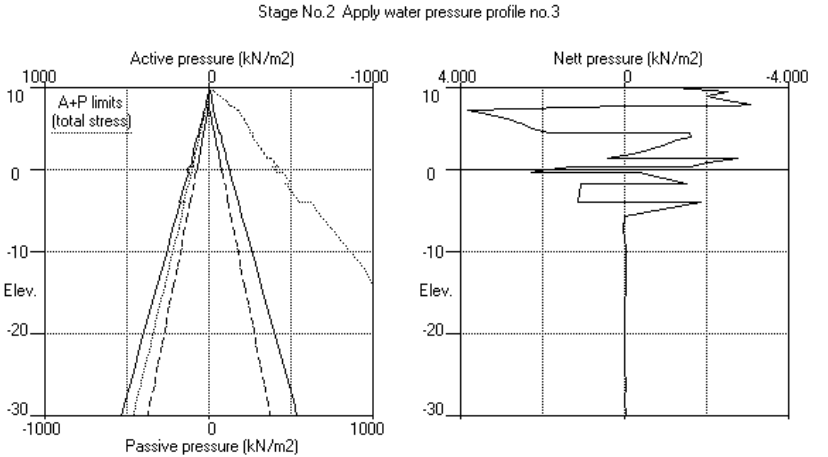
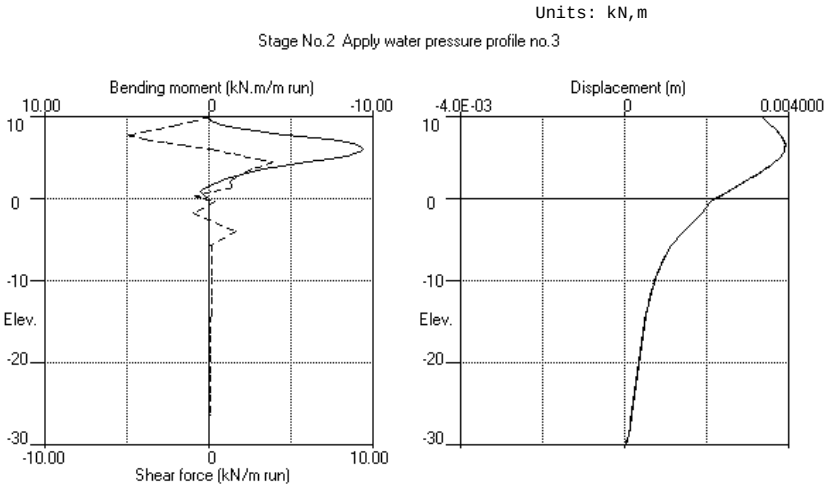
Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
26	-0.25	2.30	0.002	0	0.3	0.0	
		-0.32	0.002	0	0.3	0.0	
27	-1.65	-1.52	0.002	0	-1.0	0.0	
		1.09	0.002	0	-1.0	0.0	
28	-4.00	1.14	0.001	0	1.6	0.0	
		-1.87	0.001	0	1.6	0.0	
29	-5.60	-0.01	0.001	0	0.1	0.0	
30	-7.20	0.05	0.001	0	0.1	0.0	
31	-9.60	-0.01	0.001	0	0.2	0.0	
32	-12.00	-0.01	0.001	0	0.2	0.0	
33	-14.40	-0.01	0.001	0	0.1	0.0	
34	-16.80	-0.01	0.000	0	0.1	0.0	
35	-19.20	-0.01	0.000	0	0.1	0.0	
36	-21.60	-0.01	0.000	0	0.1	0.0	
37	-24.00	-0.00	0.000	0	0.1	0.0	
38	-26.40	-0.01	0.000	0	0.0	0.0	
39	-28.20	-0.00	0.000	0	0.0	0.0	
40	-30.00	-0.03	0.000	0	0.0	0.0	

LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							

LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							

RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							

RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							



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Data filename/Run ID: Whenuapai-BCRcross-DriveShaft_v3
Whenuapai - Brigham Creek Road crossing - Drive shaft
Sheet pile STU1800 w 250UC89 (v3)
Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Run ID. Whenuapai-BCRcross-DriveShaft_v3
Whenuapai - Brigham Creek Road crossing - Drive shaft
Sheet pile STU1800 w 250UC89 (v3)
Sheet No.
Date: 4-05-2022
Checked :

Brigham Creek
Road crossing
Driver shaft

(continued)

Stage No.3 Excavate to elevation 8.25 on RIGHT side

Units: kN,m
Stage No. 3 Excavate to elevation 8.25 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

		FoS for toe		Toe elev. for			
		elev. = 0.00		FoS = 1.500			
Stage	Ground level	Prop	Factor	Moment	Toe	Wall	Direction
No.	Act.	Pass.	Elev.	of	elev.	Penetr	of
				Safety	at elev.	-ation	failure
3	10.00	8.25	Cant.	2.144	0.72	4.26	3.99
							L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m

2-D finite element model. Active limit arching not modelled.

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

All soil moduli were factored to take account of

3-D effects due to the finite length of wall:

Modulus factors - Left side = 1.05

Right side = 1.05

Rigid boundaries: Left side 30.00 from wall
Right side 30.00 from wall
Lower rigid boundary at elevation -30.00
Rough boundary
Rough boundary
Rough boundary

Node	Y	Nett	Wall	Wall	Shear	Bending	Prop
no.	coord	pressure	disp.	rotation	Force	moment	forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	10.00	0.00	0.029	2.80E-03	0.0	0.0	
2	9.50	2.32	0.028	2.80E-03	0.6	0.3	
3	9.00	6.33	0.026	2.79E-03	2.7	1.2	
4	8.63	8.95	0.025	2.78E-03	5.6	2.8	
5	8.25	11.38	0.024	2.76E-03	9.4	5.6	
		6.70	0.024	2.76E-03	9.4	5.6	
6	8.00	-6.57	0.024	2.73E-03	9.4	8.2	
7	7.85	-13.60	0.023	2.71E-03	7.9	9.5	
		-8.42	0.023	2.71E-03	7.9	9.5	
8	7.25	-3.60	0.021	2.61E-03	4.3	13.0	
9	6.93	-2.91	0.021	2.54E-03	3.3	14.2	
10	6.60	-2.46	0.020	2.47E-03	2.4	15.1	
11	6.00	-1.91	0.018	2.32E-03	1.1	16.1	
12	5.75	-0.81	0.018	2.26E-03	0.7	16.3	
13	5.50	-0.21	0.017	2.20E-03	0.6	16.4	
14	5.25	0.47	0.017	2.13E-03	0.6	16.6	
15	4.85	1.10	0.016	2.03E-03	1.0	16.9	
16	4.45	0.95	0.015	1.92E-03	1.4	17.3	
		-7.21	0.015	1.92E-03	1.4	17.3	
17	4.03	-5.54	0.014	1.81E-03	-1.3	17.3	
18	3.60	-3.04	0.014	1.70E-03	-3.2	16.2	
19	3.00	-0.84	0.013	1.56E-03	-4.3	13.7	
20	2.40	1.07	0.012	1.45E-03	-4.3	10.9	
21	1.93	2.76	0.011	1.38E-03	-3.4	9.0	
22	1.45	4.06	0.010	1.31E-03	-1.7	7.7	
		-7.53	0.010	1.31E-03	-1.7	7.7	
23	0.93	-5.74	0.010	1.26E-03	-5.2	5.7	
24	0.40	-1.83	0.009	1.23E-03	-7.2	2.2	
		8.70	0.009	1.23E-03	-7.2	2.2	

Node	Y	Nett	Wall	Wall	Shear	Bending	Prop
no.	coord	pressure	disp.	rotation	Force	moment	forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
25	0.00	16.83	0.009	1.22E-03	-2.1	-0.0	
26	-0.25	8.90	0.008	0	1.1	0.0	
		-1.46	0.008	0	1.1	0.0	
27	-1.65	-6.65	0.008	0	-4.6	0.0	
		4.26	0.008	0	-4.6	0.0	
28	-4.00	5.42	0.007	0	6.8	0.0	
		-8.26	0.007	0	6.8	0.0	
29	-5.60	-0.00	0.005	0	0.2	0.0	
30	-7.20	0.12	0.005	0	0.3	0.0	
31	-9.60	-0.01	0.004	0	0.4	0.0	
32	-12.00	-0.01	0.004	0	0.4	0.0	
33	-14.40	-0.01	0.003	0	0.4	0.0	
34	-16.80	-0.01	0.003	0	0.3	0.0	
35	-19.20	-0.01	0.003	0	0.3	0.0	
36	-21.60	-0.01	0.002	0	0.3	0.0	
37	-24.00	-0.01	0.002	0	0.3	0.0	
38	-26.40	-0.06	0.002	0	0.2	0.0	
39	-28.20	-0.00	0.001	0	0.1	0.0	
40	-30.00	-0.13	0.000	0	0.0	0.0	

		LEFT side						
		Effective stresses					Total	Adjusted
Node	Y	Water	Vertic	Active	Passive	Earth	earth	soil

		LEFT side						
		Effective stresses					Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		

		RIGHT side						
		Effective stresses					Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		

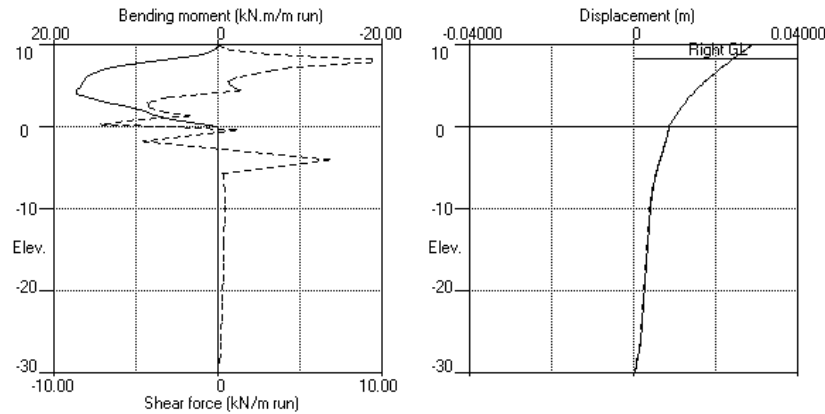
		RIGHT side						
		Effective stresses					Total	Adjusted
Node	Y	Water	Vertic	Active	Passive	Earth	earth	soil

TONKIN and TAYLOR GROUP LTD.
 Program: WALLAP Version 6.07 Revision A55.B74.R58
 Data filename/Run ID: Whenuapai-BCRcross-DriveShaft_v3
 Whenuapai - Brigham Creek Road crossing - Drive shaft
 Sheet pile STU1800 w 250UC89 (v3)

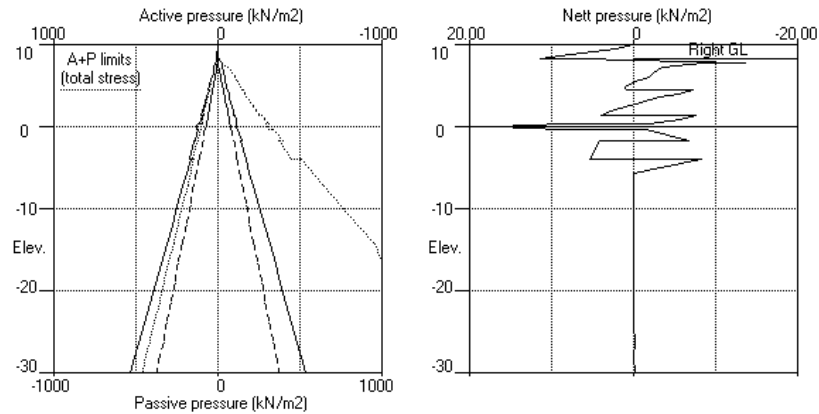
Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Units: kN,m

Stage No.3 Excav. to elev. 8.25 on RIGHT side



Stage No.3 Excav. to elev. 8.25 on RIGHT side



TONKIN and TAYLOR GROUP LTD.
 Program: WALLAP Version 6.07 Revision A55.B74.R58
 Data filename/Run ID: Whenuapai-BCRcross-DriveShaft_v3
 Whenuapai - Brigham Creek Road crossing - Drive shaft
 Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Units: kN,m

Stage No. 5 Apply water pressure profile no.2

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
 Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 0.00	Moment of equilib. at elev.	Toe elev. for FoS = 1.500	Wall Penetr-ation	Direction of failure
				Factor of Safety				
5	10.00	8.25	9.00	4.512	n/a	7.13	1.12	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m

2-D finite element model. Active limit arching not modelled.

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

All soil moduli were factored to take account of

3-D effects due to the finite length of wall:

Modulus factors - Left side = 1.05

Right side = 1.05

Rigid boundaries: Left side 30.00 from wall
 Right side 30.00 from wall

Lower rigid boundary at elevation -30.00

Rough boundary
 Rough boundary
 Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	3.77	0.029	2.20E-03	0.0	0.0	
2	9.50	5.05	0.028	2.19E-03	2.2	0.8	
3	9.00	7.90	0.026	2.18E-03	5.4	2.8	-9.3
		7.90	0.026	2.18E-03	-3.9	2.8	
4	8.63	9.49	0.026	2.17E-03	-0.6	2.0	
5	8.25	11.38	0.025	2.15E-03	3.3	2.6	
		9.99	0.025	2.15E-03	3.3	2.6	
6	8.00	-4.50	0.024	2.14E-03	4.0	3.7	
7	7.85	-13.01	0.024	2.13E-03	2.7	4.3	
		-8.21	0.024	2.13E-03	2.7	4.3	
8	7.25	-4.53	0.023	2.09E-03	-1.1	4.6	
9	6.93	-2.44	0.022	2.07E-03	-2.3	4.0	
10	6.60	-0.47	0.021	2.05E-03	-2.7	3.2	
11	6.00	2.48	0.020	2.03E-03	-2.1	1.6	
12	5.75	3.96	0.020	2.02E-03	-1.3	1.2	
13	5.50	5.72	0.019	2.02E-03	-0.1	1.0	
14	5.25	7.74	0.019	2.01E-03	1.6	1.1	
15	4.85	7.48	0.018	2.00E-03	4.6	2.4	
16	4.45	6.45	0.017	1.98E-03	7.4	4.8	
		-6.54	0.017	1.98E-03	7.4	4.8	
17	4.03	-7.16	0.016	1.94E-03	4.5	7.3	
18	3.60	-4.76	0.015	1.89E-03	1.9	8.5	
19	3.00	-2.63	0.014	1.81E-03	-0.3	8.7	
20	2.40	-0.71	0.013	1.73E-03	-1.3	8.0	
21	1.93	1.09	0.012	1.68E-03	-1.2	7.3	
22	1.45	2.70	0.012	1.62E-03	-0.3	6.8	
		-8.66	0.012	1.62E-03	-0.3	6.8	
23	0.93	-6.72	0.011	1.58E-03	-4.3	5.4	
24	0.40	-2.83	0.010	1.54E-03	-6.8	2.1	
		7.74	0.010	1.54E-03	-6.8	2.1	

Brigham Creek
 Road crossing
 Driver shaft

Run ID: Whenuapai-BCRcross-DriveShaft_v3 | Sheet No.
 Whenuapai - Brigham Creek Road crossing - Drive shaft | Date: 4-05-2022
 Sheet pile STU1800 w 250UC89 (v3) | Checked :

TONKIN and TAYLOR GROUP LTD.
 Program: WALLAP Version 6.07 Revision A55.B74.R58
 Licensed from GEOSOLVE
 Data filename/Run ID: Whenuapai-BCRcross-DriveShaft_v3
 Whenuapai - Brigham Creek Road crossing - Drive shaft
 Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Brigham Creek
 Road crossing
 Driver shaft

Stage No.5 Apply water pressure profile no.2

(continued)

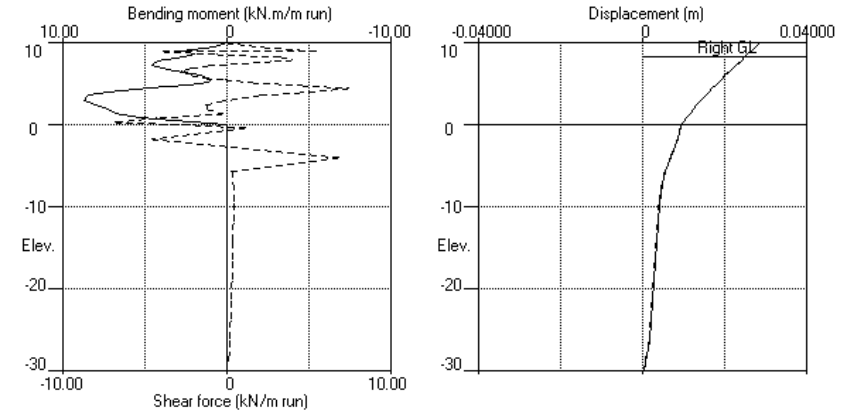
Node no.	Y coord	Nett pressure kN/m ²	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
25	0.00	16.25	0.009	1.54E-03	-2.0	-0.0	
26	-0.25	8.90	0.009	0	1.1	0.0	
		-1.46	0.009	0	1.1	0.0	
27	-1.65	-6.65	0.008	0	-4.6	0.0	
		4.26	0.008	0	-4.6	0.0	
28	-4.00	5.42	0.007	0	6.8	0.0	
		-8.26	0.007	0	6.8	0.0	
29	-5.60	-0.00	0.006	0	0.2	0.0	
30	-7.20	0.12	0.005	0	0.3	0.0	
31	-9.60	-0.01	0.004	0	0.4	0.0	
32	-12.00	-0.01	0.004	0	0.4	0.0	
33	-14.40	-0.01	0.003	0	0.4	0.0	
34	-16.80	-0.01	0.003	0	0.3	0.0	
35	-19.20	-0.01	0.003	0	0.3	0.0	
36	-21.60	-0.01	0.002	0	0.3	0.0	
37	-24.00	-0.01	0.002	0	0.3	0.0	
38	-26.40	-0.06	0.002	0	0.2	0.0	
39	-28.20	-0.00	0.001	0	0.1	0.0	
40	-30.00	-0.13	0.000	0	0.0	0.0	

At elev. 9.00 Prop force = 9.3 kN/m run

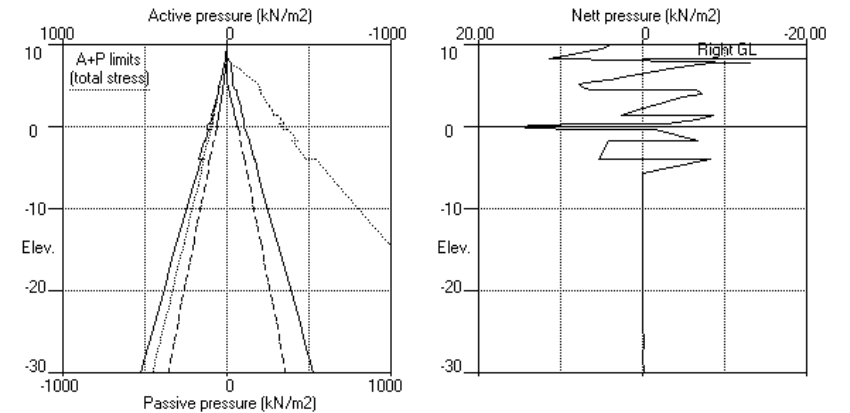
LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Adjusted soil
LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Adjusted soil
RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Adjusted soil
RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Adjusted soil

Units: kN,m

Stage No.5 Apply water pressure profile no.2



Stage No.5 Apply water pressure profile no.2



TONKIN and TAYLOR GROUP LTD.
Program: WALLAP Version 6.07 Revision A55.B74.R58
Data filename/Run ID: Whenuapai-BCRcross-DriveShaft_v3
Whenuapai - Brigham Creek Road crossing - Drive shaft
Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m
Stage No. 6 Excavate to elevation 5.50 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe Factor of Safety	Toe elev. for Moment at elev. n/a	Toe Wall Penetr-ation ***	Direction of failure L to R
6	10.00	5.50	9.00	1.292	n/a	***	L to R

Legend: *** Result not found

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.05
Right side = 1.04

Rigid boundaries: Left side 30.00 from wall
Right side 30.00 from wall
Lower rigid boundary at elevation -30.00

Rough boundary
Rough boundary
Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	4.67	0.023	-4.55E-03	0.0	0.0	
2	9.50	36.57	0.026	-4.55E-03	10.3	0.9	
3	9.00	26.67	0.028	-4.60E-03	26.1	10.9	-101.1
		26.67	0.028	-4.60E-03	-75.0	10.9	
4	8.63	17.10	0.030	-4.59E-03	-66.8	-15.2	
5	8.25	11.38	0.031	-4.43E-03	-61.4	-39.0	
6	8.00	12.92	0.033	-4.25E-03	-58.4	-53.8	
7	7.85	14.62	0.033	-4.12E-03	-56.3	-62.4	
		15.90	0.033	-4.12E-03	-56.3	-62.4	
8	7.25	22.40	0.035	-3.40E-03	-44.8	-92.9	
9	6.93	25.87	0.036	-2.90E-03	-37.0	-106.3	
10	6.60	29.32	0.037	-2.34E-03	-28.0	-116.9	
11	6.00	35.64	0.038	-1.20E-03	-8.5	-128.0	
12	5.75	38.25	0.039	-7.13E-04	0.7	-129.0	
13	5.50	40.86	0.039	-2.18E-04	10.6	-127.6	
14	5.25	28.22	0.039	2.66E-04	19.2	-123.8	
15	4.85	21.30	0.039	1.00E-03	29.1	-114.1	
16	4.45	14.35	0.038	1.66E-03	36.3	-100.8	
		10.80	0.038	1.66E-03	36.3	-100.8	
17	4.03	2.62	0.037	2.27E-03	39.1	-84.4	
18	3.60	-5.58	0.036	2.76E-03	38.5	-67.6	
19	3.00	-11.57	0.034	3.29E-03	33.3	-45.6	
20	2.40	-10.56	0.032	3.63E-03	26.7	-27.7	
21	1.93	-8.91	0.030	3.79E-03	22.1	-16.3	
22	1.45	-6.18	0.029	3.87E-03	18.5	-6.9	
		-22.66	0.029	3.87E-03	18.5	-6.9	
23	0.93	-19.32	0.027	3.90E-03	7.5	-0.3	

Run ID. Whenuapai-BCRcross-DriveShaft_v3
Whenuapai - Brigham Creek Road crossing - Drive shaft
Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
Date: 4-05-2022
Checked :

Brigham Creek
Road crossing
Driver shaft

Stage No.6 Excavate to elevation 5.50 on RIGHT side

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
24	0.40	-16.64	0.024	3.90E-03	-2.0	0.8	
		-0.37	0.024	3.90E-03	-2.0	0.8	
25	0.00	6.31	0.023	3.90E-03	-0.8	-0.0	
26	-0.25	19.02	0.022	0	2.4	0.0	
		-3.25	0.022	0	2.4	0.0	
27	-1.65	-14.67	0.019	0	-10.2	0.0	
		9.13	0.019	0	-10.2	0.0	
28	-4.00	12.19	0.015	0	14.9	0.0	
		-18.26	0.015	0	14.9	0.0	
29	-5.60	0.01	0.013	0	0.3	0.0	
30	-7.20	0.21	0.011	0	0.5	0.0	
31	-9.60	0.01	0.010	0	0.7	0.0	
32	-12.00	-0.00	0.009	0	0.7	0.0	
33	-14.40	-0.01	0.008	0	0.7	0.0	
34	-16.80	-0.01	0.007	0	0.7	0.0	
35	-19.20	-0.02	0.006	0	0.7	0.0	
36	-21.60	-0.02	0.006	0	0.6	0.0	
37	-24.00	-0.02	0.005	0	0.6	0.0	
38	-26.40	-0.13	0.004	0	0.4	0.0	
39	-28.20	-0.01	0.003	0	0.3	0.0	
40	-30.00	-0.31	0.000	0	0.0	0.0	
At elev.	9.00				Prop force =	101.1 kN/m run	

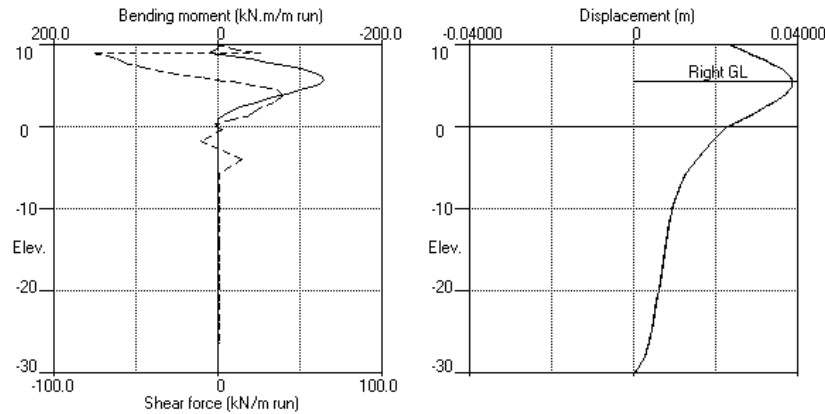
LEFT side							
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth	Adjusted soil
LEFT side							
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth	Adjusted soil
RIGHT side							
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth	Adjusted soil
RIGHT side							
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth	Adjusted soil

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Data filename/Run ID: Whenuapai-BCRcross-DriveShaft_v3
Whenuapai - Brigham Creek Road crossing - Drive shaft
Sheet pile STU1800 w 250UC89 (v3)

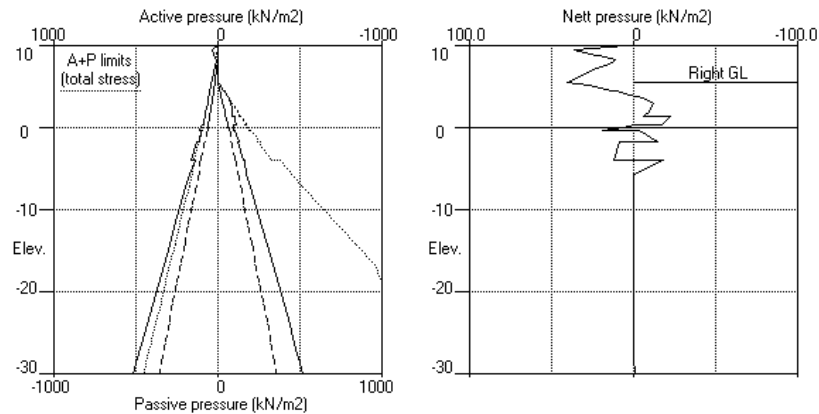
Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m

Stage No.6 Excav. to elev. 5.50 on RIGHT side



Stage No.6 Excav. to elev. 5.50 on RIGHT side



TONKIN and TAYLOR GROUP LTD.
Program: WALLAP Version 6.07 Revision A55.B74.R58
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Data filename/Run ID: Whenuapai-BCRcross-DriveShaft_v3
Whenuapai - Brigham Creek Road crossing - Drive shaft
Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m

Stage No. 7 Fill to elevation 6.00 on RIGHT side with soil type 1

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 0.00	Moment of equilib. at elev.	Toe elev. for FoS = 1.500	Wall Penetr -ation	Direction of failure
				Factor of Safety				
7	10.00	6.00	9.00	1.719	n/a	1.18	4.82	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m

2-D finite element model. Active limit arching not modelled.

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

All soil moduli were factored to take account of

3-D effects due to the finite length of wall:

Modulus factors - Left side = 1.05

Right side = 1.04

Rigid boundaries: Left side 30.00 from wall

Right side 30.00 from wall

Lower rigid boundary at elevation -30.00

Rough boundary

Rough boundary

Rough boundary

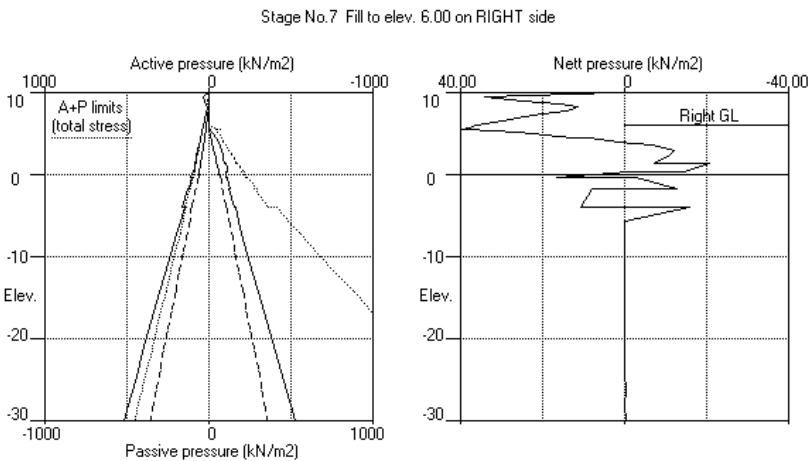
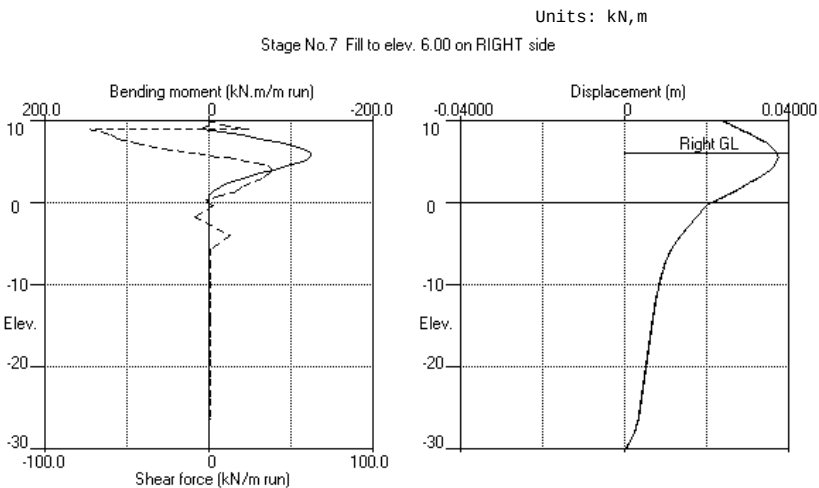
Node no.	Y coord	Nett pressure kN/m²	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	2.04	0.024	-4.17E-03	0.0	0.0	
2	9.50	34.41	0.026	-4.17E-03	9.1	0.5	
3	9.00	25.08	0.028	-4.21E-03	24.0	9.7	-96.7
		25.08	0.028	-4.21E-03	-72.7	9.7	
4	8.63	16.02	0.030	-4.20E-03	-65.0	-15.7	
5	8.25	11.38	0.031	-4.04E-03	-59.9	-38.8	
6	8.00	12.92	0.032	-3.86E-03	-56.8	-53.3	
7	7.85	14.67	0.033	-3.73E-03	-54.8	-61.6	
		15.92	0.033	-3.73E-03	-54.8	-61.6	
8	7.25	22.56	0.035	-3.02E-03	-43.2	-91.2	
9	6.93	26.18	0.036	-2.53E-03	-35.3	-104.0	
10	6.60	29.77	0.036	-1.98E-03	-26.2	-114.1	
11	6.00	36.22	0.037	-8.85E-04	-6.4	-124.1	
12	5.75	38.01	0.037	-4.05E-04	2.9	-124.5	
13	5.50	39.74	0.037	7.08E-05	12.6	-122.6	
		38.43	0.037	7.08E-05	12.6	-122.6	
14	5.25	26.28	0.037	5.35E-04	20.7	-118.4	
15	4.85	19.51	0.037	1.23E-03	29.8	-108.2	
16	4.45	12.75	0.036	1.86E-03	36.3	-94.8	
		8.88	0.036	1.86E-03	36.3	-94.8	
17	4.03	1.32	0.035	2.43E-03	38.4	-78.6	
18	3.60	-6.42	0.034	2.89E-03	37.4	-62.2	
19	3.00	-12.13	0.032	3.37E-03	31.8	-41.0	
20	2.40	-11.00	0.030	3.67E-03	24.8	-24.2	
21	1.93	-9.33	0.029	3.81E-03	20.0	-13.7	
22	1.45	-7.06	0.027	3.87E-03	16.1	-5.3	
		-20.56	0.027	3.87E-03	16.1	-5.3	
23	0.93	-17.62	0.025	3.90E-03	6.1	0.3	
24	0.40	-14.27	0.023	3.89E-03	-2.3	1.0	
		-1.02	0.023	3.89E-03	-2.3	1.0	

Brigham Creek
Road crossing
Driver shaft

(continued)
Stage No.7 Fill to elevation 6.00 on RIGHT side with soil type 1

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
25	0.00	7.62	0.021	3.89E-03	-0.9	-0.0	
26	-0.25	16.73	0.020	0	2.1	0.0	
		-2.84	0.020	0	2.1	0.0	
27	-1.65	-12.83	0.018	0	-8.9	0.0	
		8.03	0.018	0	-8.9	0.0	
28	-4.00	10.64	0.014	0	13.1	0.0	
		-15.97	0.014	0	13.1	0.0	
29	-5.60	0.01	0.011	0	0.3	0.0	
30	-7.20	0.20	0.010	0	0.5	0.0	
31	-9.60	0.00	0.009	0	0.7	0.0	
32	-12.00	-0.01	0.008	0	0.7	0.0	
33	-14.40	-0.01	0.007	0	0.7	0.0	
34	-16.80	-0.01	0.006	0	0.6	0.0	
35	-19.20	-0.02	0.005	0	0.6	0.0	
36	-21.60	-0.02	0.005	0	0.6	0.0	
37	-24.00	-0.02	0.004	0	0.5	0.0	
38	-26.40	-0.11	0.003	0	0.4	0.0	
39	-28.20	-0.01	0.002	0	0.3	0.0	
40	-30.00	-0.28	0.000	0	0.0	0.0	
At elev. 9.00		Prop force = 96.7 kN/m run					

LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							
LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							
RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							
RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							



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Program: WALLAP Version 6.07 Revision A55.B74.R58
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Data filename/Run ID: Whenuapai-BCRcross-DriveShaft_v3
Whenuapai - Brigham Creek Road crossing - Drive shaft
Sheet pile STU1800 w 250UC89 (v3)
Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m
Stage No. 8 Apply water pressure profile no.1

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe Factor of Safety	Moment of equilib. at elev.	Toe elev. for FoS = 1.500	Wall Penetr-ation	Direction of failure
8	10.00	6.00	9.00	1.437	n/a	***	***	L to R

Legend: *** Result not found

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.05
Right side = 1.04

Rigid boundaries: Left side 30.00 from wall
Right side 30.00 from wall
Lower rigid boundary at elevation -30.00
Rough boundary
Rough boundary
Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	4.67	0.023	-4.81E-03	0.0	0.0	
2	9.50	36.99	0.026	-4.82E-03	10.4	0.9	
3	9.00	27.99	0.028	-4.86E-03	26.7	11.1	-113.2
		27.99	0.028	-4.86E-03	-86.5	11.1	
4	8.63	18.97	0.030	-4.84E-03	-77.7	-19.2	
5	8.25	17.66	0.032	-4.65E-03	-70.8	-46.9	
6	8.00	20.46	0.033	-4.43E-03	-66.1	-63.9	
7	7.85	22.13	0.034	-4.27E-03	-62.9	-73.5	
		23.40	0.034	-4.27E-03	-62.9	-73.5	
8	7.25	29.75	0.036	-3.44E-03	-46.9	-106.7	
9	6.93	33.14	0.037	-2.87E-03	-36.7	-120.3	
10	6.60	36.50	0.038	-2.24E-03	-25.4	-130.4	
11	6.00	42.67	0.039	-1.00E-03	-1.6	-138.7	
12	5.75	34.45	0.039	-4.67E-04	8.0	-137.8	
13	5.50	32.64	0.039	5.80E-05	16.4	-134.7	
		41.38	0.039	5.80E-05	16.4	-134.7	
14	5.25	26.96	0.039	5.67E-04	24.9	-129.5	
15	4.85	19.91	0.039	1.33E-03	34.3	-117.6	
16	4.45	12.85	0.038	2.00E-03	40.8	-102.3	
		8.03	0.038	2.00E-03	40.8	-102.3	
17	4.03	0.06	0.037	2.62E-03	42.6	-84.3	
18	3.60	-7.84	0.036	3.11E-03	40.9	-66.2	
19	3.00	-13.59	0.034	3.62E-03	34.5	-43.2	
20	2.40	-12.41	0.031	3.93E-03	26.7	-25.0	
21	1.93	-10.62	0.030	4.07E-03	21.2	-13.8	
22	1.45	-8.00	0.028	4.14E-03	16.8	-4.9	
		-22.31	0.028	4.14E-03	16.8	-4.9	

Run ID. Whenuapai-BCRcross-DriveShaft_v3
Whenuapai - Brigham Creek Road crossing - Drive shaft
Sheet pile STU1800 w 250UC89 (v3)
Sheet No.
Date: 4-05-2022
Checked :

Brigham Creek
Road crossing
Driver shaft

Stage No.8 Apply water pressure profile no.1

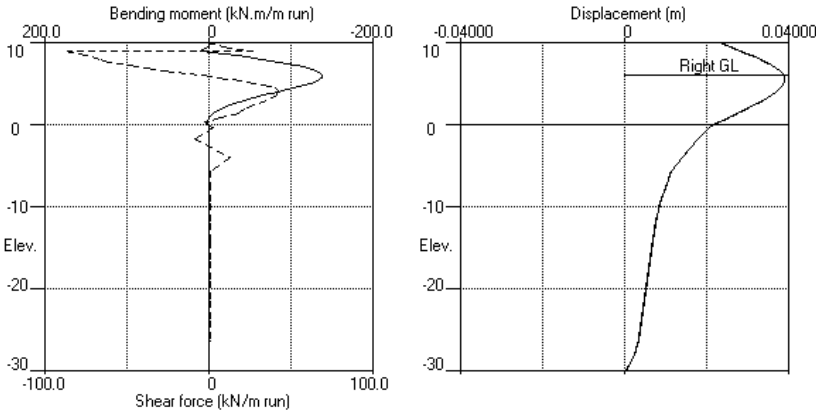
(continued)

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
23	0.93	-18.73	0.025	4.16E-03	6.0	0.7	
24	0.40	-14.50	0.023	4.15E-03	-2.7	1.2	
		-1.24	0.023	4.15E-03	-2.7	1.2	
25	0.00	9.09	0.022	4.15E-03	-1.1	-0.0	
26	-0.25	16.73	0.021	0	2.1	0.0	
		-2.84	0.021	0	2.1	0.0	
27	-1.65	-12.83	0.018	0	-8.9	0.0	
		8.03	0.018	0	-8.9	0.0	
28	-4.00	10.64	0.014	0	13.1	0.0	
		-15.97	0.014	0	13.1	0.0	
29	-5.60	0.01	0.011	0	0.3	0.0	
30	-7.20	0.20	0.010	0	0.5	0.0	
31	-9.60	0.00	0.009	0	0.7	0.0	
32	-12.00	-0.01	0.008	0	0.7	0.0	
33	-14.40	-0.01	0.007	0	0.7	0.0	
34	-16.80	-0.01	0.006	0	0.6	0.0	
35	-19.20	-0.02	0.005	0	0.6	0.0	
36	-21.60	-0.02	0.005	0	0.6	0.0	
37	-24.00	-0.02	0.004	0	0.5	0.0	
38	-26.40	-0.11	0.003	0	0.4	0.0	
39	-28.20	-0.01	0.002	0	0.3	0.0	
40	-30.00	-0.28	0.000	0	0.0	0.0	
At elev. 9.00		Prop force = 113.2 kN/m run					

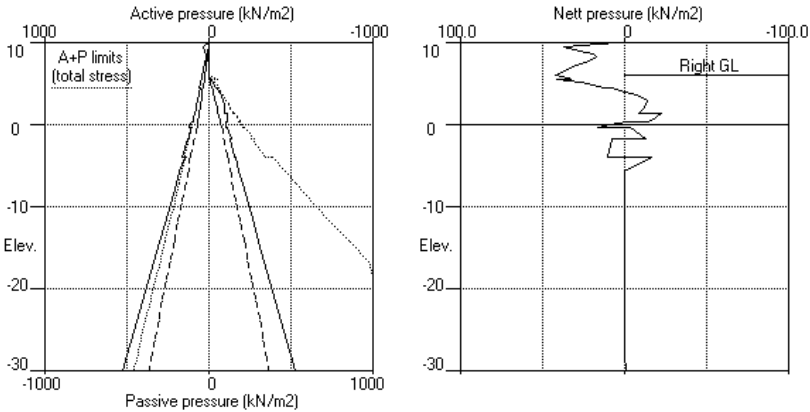
LEFT side							
		Effective stresses				Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	
LEFT side							
		Effective stresses				Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	
RIGHT side							
		Effective stresses				Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	
RIGHT side							
		Effective stresses				Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	

Units: kN,m

Stage No.8 Apply water pressure profile no.1



Stage No.8 Apply water pressure profile no.1



Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

				FoS for toe		Toe elev. for			
				elev. = 0.00		FoS = 1.500			
<u>Stage</u>	<u>Ground level</u>	<u>Prop</u>	<u>Factor</u>	<u>Moment</u>	<u>Toe</u>	<u>Wall</u>	<u>Direction</u>		
<u>No.</u>	<u>Act.</u>	<u>Pass.</u>	<u>Elev.</u>	<u>of</u>	<u>equilib.</u>	<u>elev.</u>	<u>Penetr</u>	<u>of</u>	
				<u>Safety</u>	<u>at elev.</u>		<u>-ation</u>	<u>failure</u>	
1	10.00	10.00	Cant.	Conditions not suitable for FoS calc.					
2	10.00	10.00	Cant.	Conditions not suitable for FoS calc.					
3	10.00	8.25	Cant.	2.144	0.72	4.26	3.99	L to R	
4	10.00	8.25		No analysis at this stage					
5	10.00	8.25	9.00	4.512	n/a	7.13	1.12	L to R	
6	10.00	5.50	9.00	1.292	n/a	***	***	L to R	
7	10.00	6.00	9.00	1.719	n/a	1.18	4.82	L to R	
8	10.00	6.00	9.00	1.437	n/a	***	***	L to R	

Legend: *** Result not found

Summary of results

Units: kN,m

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options
Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.05
Right side = 1.04

Rigid boundaries: Left side 30.00 from wall Rough boundary
Right side 30.00 from wall Rough boundary
Lower rigid boundary at elevation -30.00 Rough boundary

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement		Bending moment		Shear force	
		maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	10.00	0.029	0.000	0.0	-0.0	0.0	0.0
2	9.50	0.028	0.000	0.9	-0.1	10.4	-0.9
3	9.00	0.028	0.000	11.1	-0.8	26.7	-86.5
4	8.63	0.030	0.000	2.8	-19.2	5.6	-77.7
5	8.25	0.032	0.000	5.6	-46.9	9.4	-70.8
6	8.00	0.033	0.000	8.2	-63.9	9.4	-66.1
7	7.85	0.034	0.000	9.5	-73.5	7.9	-62.9
8	7.25	0.036	0.000	13.0	-106.7	4.3	-46.9
9	6.93	0.037	0.000	14.2	-120.3	3.3	-37.0
10	6.60	0.038	0.000	15.1	-130.4	2.4	-28.0
11	6.00	0.039	0.000	16.1	-138.7	1.1	-8.5
12	5.75	0.039	0.000	16.3	-137.8	8.0	-1.3
13	5.50	0.039	0.000	16.4	-134.7	16.4	-0.1
14	5.25	0.039	0.000	16.6	-129.5	24.9	0.0
15	4.85	0.039	0.000	16.9	-117.6	34.3	0.0
16	4.45	0.038	0.000	17.3	-102.3	40.8	0.0
17	4.03	0.037	0.000	17.3	-84.4	42.6	-1.3
18	3.60	0.036	0.000	16.2	-67.6	40.9	-3.2
19	3.00	0.034	0.000	13.7	-45.6	34.5	-4.3
20	2.40	0.032	0.000	10.9	-27.7	26.7	-4.3
21	1.93	0.030	0.000	9.0	-16.3	22.1	-3.4
22	1.45	0.029	0.000	7.7	-6.9	18.5	-1.7
23	0.93	0.027	0.000	5.7	-0.3	7.5	-5.2
24	0.40	0.024	0.000	2.2	0.0	0.0	-7.2
25	0.00	0.023	0.000	0.0	-0.0	0.0	-2.1
26	-0.25	0.022	0.000	0.0	0.0	2.4	0.0
27	-1.65	0.019	0.000	0.0	0.0	0.0	-10.2
28	-4.00	0.015	0.000	0.0	0.0	14.9	0.0
29	-5.60	0.013	0.000	0.0	0.0	0.3	0.0
30	-7.20	0.011	0.000	0.0	0.0	0.5	0.0
31	-9.60	0.010	0.000	0.0	0.0	0.7	0.0
32	-12.00	0.009	0.000	0.0	0.0	0.7	0.0
33	-14.40	0.008	0.000	0.0	0.0	0.7	0.0
34	-16.80	0.007	0.000	0.0	0.0	0.7	0.0
35	-19.20	0.006	0.000	0.0	0.0	0.7	0.0
36	-21.60	0.006	0.000	0.0	0.0	0.6	0.0
37	-24.00	0.005	0.000	0.0	0.0	0.6	0.0
38	-26.40	0.004	0.000	0.0	0.0	0.4	0.0
39	-28.20	0.003	0.000	0.0	0.0	0.3	0.0

Brigham Creek
Road crossing
Driver shaft

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement		Bending moment		Shear force	
		maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
40	-30.00	0.000	0.000	0.0	0.0	0.0	0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment				Shear force			
	maximum	elev.	minimum	elev.	maximum	elev.	minimum	elev.
	kN.m/m		kN.m/m		kN/m		kN/m	
1	0.2	0.93	-4.0	5.75	1.6	-4.00	-1.6	7.85
2	0.5	0.93	-9.4	6.00	3.9	4.45	-4.9	7.85
3	17.3	4.45	-0.0	0.00	9.4	8.00	-7.2	0.40
4	No calculation at this stage							
5	8.7	3.00	-0.0	0.00	7.4	4.45	-6.8	0.40
6	10.9	9.00	-129.0	5.75	39.1	4.03	-75.0	9.00
7	9.7	9.00	-124.5	5.75	38.4	4.03	-72.7	9.00
8	11.1	9.00	-138.7	6.00	42.6	4.03	-86.5	9.00

Maximum and minimum displacement at each stage

Stage no.	Displacement				Stage description
	maximum	elev.	minimum	elev.	
	m		m		
1	0.003	6.60	0.000	10.00	Apply surcharge no.1 at elev. 10.00
2	0.004	6.60	0.000	10.00	Apply water pressure profile no.3
3	0.029	10.00	0.000	10.00	Excav. to elev. 8.25 on RIGHT side
4	No calculation at this stage				Install prop no.1 at elev. 9.00
5	0.029	10.00	0.000	10.00	Apply water pressure profile no.2
6	0.039	5.50	0.000	10.00	Excav. to elev. 5.50 on RIGHT side
7	0.037	5.50	0.000	10.00	Fill to elev. 6.00 on RIGHT side
8	0.039	5.50	0.000	10.00	Apply water pressure profile no.1

Prop forces at each stage (horizontal components)

Stage no.	Anchor no. 1 --- at elev. 9.00	
	kN/m run	kN/prop
5	9.31	37.25
6	101.10	404.42
7	96.71	386.85
8	113.18	452.72

TONKIN and TAYLOR GROUP LTD.
Program: WALLAP Version 6.07 Revision A55.B74.R58
Data filename/Run ID: Whenuapai-BCRcross-ReceiverShaft_v3
Whenuapai - Brigham Creek Road crossing - Receiver shaft
Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types			
		Left side		Right side	
1	10.00	2	TA silt & clay	2	TA silt & clay
2	7.85	7	TA organic clay	7	TA organic clay
3	4.45	2	TA silt & clay	2	TA silt & clay
4	1.45	8	TA sand	8	TA sand
5	0.40	2	TA silt & clay	2	TA silt & clay
6	-0.25	8	TA sand	8	TA sand
7	-1.65	2	TA silt & clay	2	TA silt & clay
8	-4.00	3	ECBF residual soils	3	ECBF residual soils

SOIL PROPERTIES

-- Soil type --	Bulk density	Young's Modulus	At rest coeff.	Consol state	Active limit	Passive limit	Cohesion
No. Description (Datum elev.)	kN/m3	Eh, kN/m2 (dEh/dy)	Ko (dKo/dy)	NC/OC (Nu)	Ka (Kac)	Kp (Kpc)	dc/dy)
1 Engineered hardfill	20.00	50000	0.254	OC (0.300)	0.189 (0.000)	7.061 (0.000)	
2 TA silt & clay	17.00	10000	0.531	OC (0.350)	0.320 (1.278)	3.485 (4.674)	1.000d
3 ECBF residual soils	18.00	20000	0.500	OC (0.350)	0.294 (1.222)	3.878 (4.985)	5.000d
4 ECBF Weathered rock	21.00	85000	0.426	OC (0.350)	0.237 (1.089)	5.153 (5.931)	25.00d
5 ECBF UW rock	22.00	400000	0.357	OC (0.250)	0.189 (0.966)	7.061 (7.223)	100.0d
6 Concrete	24.00	500000	0.000	OC (0.490)	1.000 (0.851)	1.000 (2.233)	500.0u
7 TA organic clay	16.00	5000	0.531	OC (0.250)	0.320 (1.278)	3.812 (5.289)	0.0d
8 TA sand	18.00	12000	0.500	OC (0.250)	0.294 (0.000)	3.878 (0.000)	

Additional soil parameters associated with Ka and Kp

--- parameters for Ka ---				--- parameters for Kp ---			
Soil friction		Wall adhesion		Soil friction		Wall adhesion	
No. Description	angle	coeff.	angle	No. Description	angle	coeff.	angle
1 Engineered hardfill	40.00	0.434	0.00	1 Engineered hardfill	40.00	0.280	0.00
2 TA silt & clay	28.00	0.469	0.00	2 TA silt & clay	28.00	0.306	0.00
3 ECBF residual soils	30.00	0.464	0.00	3 ECBF residual soils	30.00	0.302	0.00
4 ECBF weathered rock	35.00	0.450	0.00	4 ECBF weathered rock	35.00	0.292	0.00
5 ECBF UW rock	40.00	0.434	0.00	5 ECBF UW rock	40.00	0.280	0.00
6 Concrete	0.00	0.736	0.00	6 Concrete	0.00	0.265	0.00
7 TA organic clay	28.00	0.469	0.00	7 TA organic clay	28.00	0.469	0.00
8 TA sand	30.00	0.464	0.00	8 TA sand	30.00	0.302	0.00

parameters not used

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3
Initial water table elevation Left side 8.00 Right side 8.00

Automatic water pressure balancing at toe of wall : Yes

Water press.		Left side			Right side			
profile no.	Point no.	Elev.	Piezo elev.	Water press.	Point no.	Elev.	Piezo elev.	Water press.
		m	m	kN/m2		m	m	kN/m2
1	1	9.50	9.50	0.0	1	5.75	5.75	0.0
2	1	8.00	8.00	0.0	1	5.25	5.25	0.0
3	1	8.00	8.00	0.0	1	7.25	7.25	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 0.00
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.0000E+08 kN/m2
Moment of inertia of wall I = 3.2400E-04 m4/m run
(Sumitomo SX18) E.I = 64800 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing	Cross-section area	Youngs modulus	Free length	Inclin -ation	Pre-stress	Strut or Anchor	Allow tension
		m	sq.m	kN/m2	m	(deg)	/prop kN		? L/R
1	9.00	4.00	0.011400	2.000E+08	10.00	0.00	0	Anchor	n/a R

SURCHARGE LOADS

Surcharge	Distance	Length	Width	Surcharge	Equiv. soil	Partial
-arge no.	Elev.	from wall	parallel to wall	perpend. to wall	kn/m2	factor/
1	10.00	0.50(L)	21.00	10.00	15.00	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 10.00
2	Apply water pressure profile no.3
3	Excavate to elevation 8.25 on RIGHT side
4	Install strut or anchor no.1 at elevation 9.00
5	Apply water pressure profile no.2
6	Excavate to elevation 6.00 on RIGHT side
7	Fill to elevation 6.50 on RIGHT side with soil type 1
8	Apply water pressure profile no.1

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - Strength Factor method
Factor on soil strength for calculating wall depth = 1.50

Parameters for undrained strata:
Minimum equivalent fluid density = 5.00 kN/m3
Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - No
Non-linear Modulus Parameter (L) = 8.500 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 20.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 30.00 m
Distance to rigid boundary on Right side = 30.00 m

Brigham Creek
Road crossing
Receiver shaft

Elevation of rigid lower boundary = -30.00

Lower rigid boundary at elevation -30.00 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Smooth

OUTPUT OPTIONS

Stage no.	Stage description	Output options		
		Displacement	Active, Graph.	
		Bending mom.	Passive	output
		Shear force	pressures	
1	Apply surcharge no.1 at elev. 10.00	Yes	Yes	Yes
2	Apply water pressure profile no.3	Yes	Yes	Yes
3	Excav. to elev. 8.25 on RIGHT side	Yes	Yes	Yes
4	Install prop no.1 at elev. 9.00	Yes	Yes	Yes
5	Apply water pressure profile no.2	Yes	Yes	Yes
6	Excav. to elev. 6.00 on RIGHT side	Yes	Yes	Yes
7	Fill to elev. 6.50 on RIGHT side	Yes	Yes	Yes
8	Apply water pressure profile no.1	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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Brigham Creek
Road crossing
Receiver shaft

TONKIN and TAYLOR GROUP LTD.
Program: WALLAP Version 6.07 Revision A55.B74.R58
Licensed from GEOSOLVE
Data filename/Run ID: Whenuapai-BCRcross-ReceiverShaft_v3
Whenuapai - Brigham Creek Road crossing - Receiver shaft
Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m
Stage No. 1 Apply surcharge no.1 at elevation 10.00

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

FoS for toe elev. = 0.00 Toe elev. for FoS = 1.500

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	Factor of Safety	Moment of equilb. at elev.	Toe elev. Penetr	Wall Direction of failure
1	10.00	10.00	Cant.		Conditions not suitable for FoS calc.		

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.05
Right side = 1.05

Rigid boundaries: Left side 30.00 from wall Rough boundary
Right side 30.00 from wall Rough boundary
Lower rigid boundary at elevation -30.00 Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	-1.18	0.003	-1.00E-04	0.0	-0.0	
2	9.50	-1.80	0.003	-1.00E-04	-0.7	-0.1	
3	9.00	-0.53	0.003	-9.75E-05	-1.3	-0.6	
4	8.63	-0.25	0.003	-9.26E-05	-1.5	-1.1	
5	8.25	-0.13	0.003	-8.46E-05	-1.5	-1.7	
6	8.00	-0.18	0.003	-7.75E-05	-1.6	-2.0	
7	7.85	-0.14	0.003	-7.25E-05	-1.6	-2.3	
		0.61	0.003	-7.25E-05	-1.6	-2.3	
8	7.25	0.83	0.003	-4.74E-05	-1.2	-3.1	
9	6.88	0.82	0.003	-2.83E-05	-0.9	-3.5	
10	6.50	0.81	0.003	-7.27E-06	-0.6	-3.8	
11	6.00	0.82	0.003	2.24E-05	-0.2	-3.9	
12	5.75	0.80	0.003	3.77E-05	0.0	-4.0	
13	5.25	0.81	0.003	6.77E-05	0.4	-3.8	
14	4.85	0.82	0.003	9.06E-05	0.8	-3.6	
15	4.45	0.73	0.003	1.11E-04	1.1	-3.2	
		-0.10	0.003	1.11E-04	1.1	-3.2	
16	4.03	-0.22	0.003	1.31E-04	1.0	-2.8	
17	3.60	-0.13	0.003	1.48E-04	0.9	-2.4	
18	3.00	0.02	0.002	1.67E-04	0.9	-1.8	
19	2.40	0.20	0.002	1.81E-04	1.0	-1.3	
20	1.93	0.40	0.002	1.89E-04	1.1	-0.8	
21	1.45	0.88	0.002	1.93E-04	1.4	-0.2	
		-2.34	0.002	1.93E-04	1.4	-0.2	
22	0.93	-1.76	0.002	1.93E-04	0.3	0.2	
23	0.40	-1.67	0.002	1.92E-04	-0.6	0.1	
		1.28	0.002	1.92E-04	-0.6	0.1	
24	0.00	0.93	0.002	1.91E-04	-0.1	-0.0	
25	-0.25	2.30	0.002	0	0.3	0.0	
		-0.32	0.002	0	0.3	0.0	

Run ID. Whenuapai-BCRcross-ReceiverShaft_v3
Whenuapai - Brigham Creek Road crossing - Receiver shaft
Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
Date: 4-05-2022
Checked :

Stage No.1 Apply surcharge no.1 at elevation 10.00

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
26	-1.65	-1.52	0.002	0	-1.0	0.0	
		1.09	0.002	0	-1.0	0.0	
27	-4.00	1.14	0.001	0	1.6	0.0	
		-1.87	0.001	0	1.6	0.0	
28	-5.60	-0.01	0.001	0	0.1	0.0	
29	-7.20	0.05	0.001	0	0.1	0.0	
30	-9.60	-0.01	0.001	0	0.2	0.0	
31	-12.00	-0.01	0.001	0	0.2	0.0	
32	-14.40	-0.01	0.000	0	0.1	0.0	
33	-16.80	-0.01	0.000	0	0.1	0.0	
34	-19.20	-0.01	0.000	0	0.1	0.0	
35	-21.60	-0.01	0.000	0	0.1	0.0	
36	-24.00	-0.00	0.000	0	0.1	0.0	
37	-26.40	-0.01	0.000	0	0.0	0.0	
38	-28.20	-0.00	0.000	0	0.0	0.0	
39	-30.00	-0.03	0.000	0	-0.0	0.0	

LEFT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		

LEFT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		

RIGHT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		

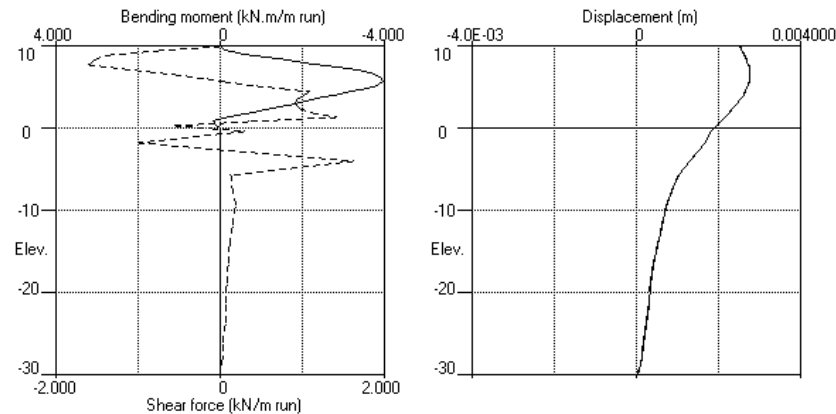
RIGHT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		

Brigham Creek
Road crossing
Receiver shaft

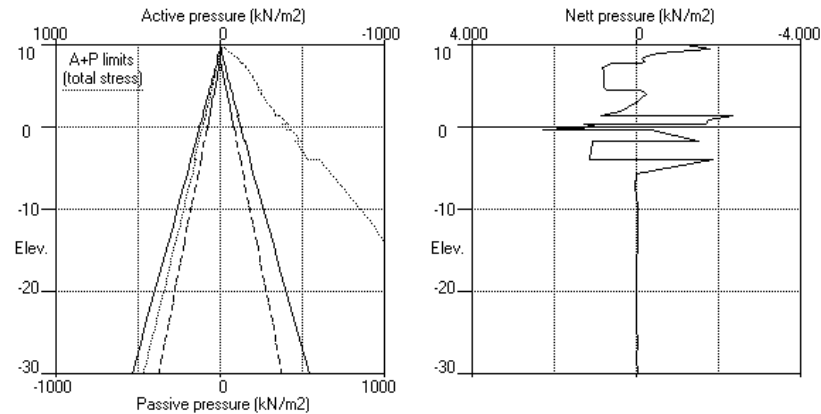
(continued)

Units: kN,m

Stage No.1 Apply surcharge no.1 at elev. 10.00



Stage No.1 Apply surcharge no.1 at elev. 10.00



Units: kN,m

Stage No. 2 Apply water pressure profile no.3

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
 Factor of safety on soil strength

Stage No.	Ground level Act.	Prop Elev.	FoS Factor of Safety	FoS for toe elev. = 0.00	Toe elev. for FoS = 1.500	Direction of failure
2	10.00	10.00	Cant.	Conditions not suitable for FoS calc.		

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m

2-D finite element model. Active limit arching not modelled.

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

All soil moduli were factored to take account of

3-D effects due to the finite length of wall:

Modulus factors - Left side = 1.05

Right side = 1.05

Rigid boundaries: Left side 30.00 from wall

Right side 30.00 from wall

Lower rigid boundary at elevation -30.00

Rough boundary

Rough boundary

Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	-1.19	0.003	-2.15E-04	0.0	-0.0	
2	9.50	-2.52	0.003	-2.14E-04	-0.9	-0.1	
3	9.00	-1.98	0.004	-2.11E-04	-2.1	-0.8	
4	8.63	-2.30	0.004	-2.04E-04	-2.9	-1.7	
5	8.25	-2.65	0.004	-1.91E-04	-3.8	-2.9	
6	8.00	-3.06	0.004	-1.78E-04	-4.5	-3.9	
7	7.85	-2.63	0.004	-1.68E-04	-4.9	-4.6	
		-0.02	0.004	-1.68E-04	-4.9	-4.6	
8	7.25	3.83	0.004	-1.12E-04	-3.8	-7.3	
9	6.88	3.44	0.004	-6.72E-05	-2.4	-8.5	
10	6.50	3.11	0.004	-1.62E-05	-1.2	-9.1	
11	6.00	2.76	0.004	5.51E-05	0.3	-9.4	
12	5.75	2.60	0.004	9.10E-05	0.9	-9.2	
13	5.25	2.34	0.004	1.59E-04	2.2	-8.4	
14	4.85	2.16	0.004	2.07E-04	3.1	-7.4	
15	4.45	1.86	0.004	2.49E-04	3.9	-6.0	
		-1.57	0.004	2.49E-04	3.9	-6.0	
16	4.03	-1.61	0.004	2.83E-04	3.2	-4.5	
17	3.60	-1.28	0.003	3.08E-04	2.6	-3.3	
18	3.00	-0.93	0.003	3.33E-04	1.9	-2.0	
19	2.40	-0.56	0.003	3.47E-04	1.5	-1.0	
20	1.93	-0.20	0.003	3.52E-04	1.3	-0.4	
21	1.45	0.41	0.003	3.52E-04	1.3	0.2	
		-2.74	0.003	3.52E-04	1.3	0.2	
22	0.93	-2.04	0.003	3.50E-04	0.1	0.5	
23	0.40	-1.62	0.002	3.46E-04	-0.9	0.3	
		1.29	0.002	3.46E-04	-0.9	0.3	
24	0.00	1.88	0.002	3.46E-04	-0.2	-0.0	
25	-0.25	2.30	0.002	0	0.3	0.0	
		-0.32	0.002	0	0.3	0.0	

Stage No.2 Apply water pressure profile no.3

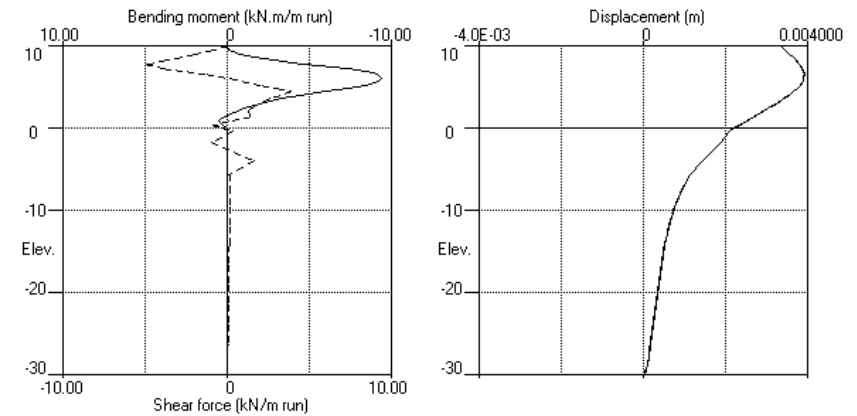
(continued)

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
26	-1.65	-1.52	0.002	0	-1.0	0.0	
27	-4.00	1.09	0.002	0	-1.0	0.0	
		1.14	0.001	0	1.6	0.0	
		-1.87	0.001	0	1.6	0.0	
28	-5.60	-0.01	0.001	0	0.1	0.0	
29	-7.20	0.05	0.001	0	0.1	0.0	
30	-9.60	-0.01	0.001	0	0.2	0.0	
31	-12.00	-0.01	0.001	0	0.2	0.0	
32	-14.40	-0.01	0.001	0	0.1	0.0	
33	-16.80	-0.01	0.000	0	0.1	0.0	
34	-19.20	-0.01	0.000	0	0.1	0.0	
35	-21.60	-0.01	0.000	0	0.1	0.0	
36	-24.00	-0.00	0.000	0	0.1	0.0	
37	-26.40	-0.01	0.000	0	0.0	0.0	
38	-28.20	-0.00	0.000	0	0.0	0.0	
39	-30.00	-0.03	0.000	0	-0.0	0.0	

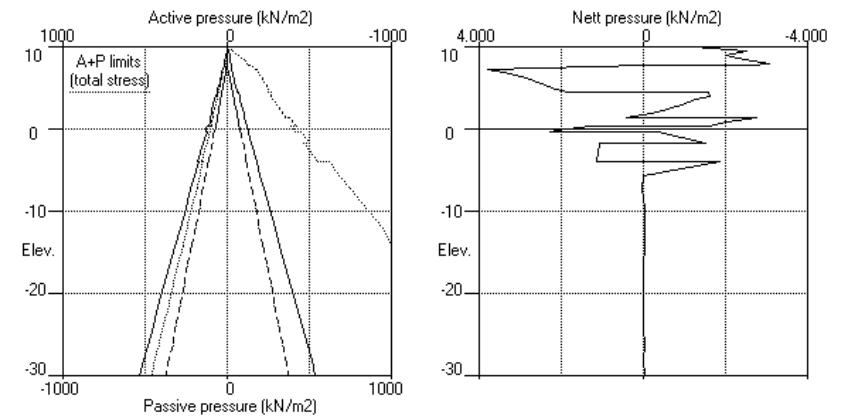
LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							
LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							
RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							
RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							

Units: kN,m

Stage No.2 Apply water pressure profile no.3



Stage No.2 Apply water pressure profile no.3



TONKIN and TAYLOR GROUP LTD.
Program: WALLAP Version 6.07 Revision A55.B74.R58
Data filename/Run ID: Whenuapai-BCRcross-ReceiverShaft_v3
Whenuapai - Brigham Creek Road crossing - Receiver shaft
Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m
Stage No. 3 Excavate to elevation 8.25 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

FoS for toe		Toe elev. for	
elev. = 0.00		FoS = 1.500	
Stage	Ground level	Prop	Fo factor
No.	Act.	Pass.	Elev.
3	10.00	8.25	Cant.
Factor of safety		Moment at elev.	
2.144		0.72	
Toe elev.		Wall Penetr	
4.26		-ation	
3.99		Direction of failure	
L to R			

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.05
Right side = 1.05

Rigid boundaries: Left side 30.00 from wall Rough boundary
Right side 30.00 from wall Rough boundary
Lower rigid boundary at elevation -30.00 Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	0.00	0.029	2.80E-03	0.0	0.0	
2	9.50	2.32	0.028	2.80E-03	0.6	0.3	
3	9.00	6.33	0.026	2.79E-03	2.7	1.2	
4	8.63	8.95	0.025	2.78E-03	5.6	2.8	
5	8.25	11.38	0.024	2.76E-03	9.4	5.6	
6	8.00	6.70	0.024	2.76E-03	9.4	5.6	
7	7.85	-6.57	0.023	2.73E-03	9.4	8.2	
8	7.25	-13.60	0.023	2.71E-03	7.9	9.5	
9	6.88	-8.42	0.023	2.71E-03	7.9	9.5	
10	6.50	-3.54	0.021	2.61E-03	4.3	13.0	
11	6.00	-2.86	0.021	2.53E-03	3.1	14.4	
12	5.75	-2.51	0.020	2.44E-03	2.1	15.3	
13	5.25	-1.78	0.018	2.32E-03	1.1	16.1	
14	4.85	-0.56	0.018	2.26E-03	0.8	16.3	
15	4.45	0.24	0.017	2.13E-03	0.7	16.6	
16	4.03	1.11	0.016	2.03E-03	1.0	16.9	
17	3.60	0.95	0.015	1.92E-03	1.4	17.3	
18	3.00	-7.20	0.015	1.92E-03	1.4	17.3	
19	2.40	-5.53	0.014	1.81E-03	-1.3	17.2	
20	1.93	-3.03	0.014	1.70E-03	-3.2	16.2	
21	1.45	-0.84	0.013	1.56E-03	-4.3	13.7	
22	0.93	1.07	0.012	1.45E-03	-4.3	10.9	
23	0.40	2.76	0.011	1.37E-03	-3.3	9.0	
24	0.00	4.06	0.010	1.31E-03	-1.7	7.7	
		-7.53	0.010	1.31E-03	-1.7	7.7	
		-5.74	0.010	1.26E-03	-5.2	5.7	
		-1.83	0.009	1.23E-03	-7.2	2.2	
		8.70	0.009	1.23E-03	-7.2	2.2	
		16.82	0.009	1.22E-03	-2.1	-0.0	

Run ID: Whenuapai-BCRcross-ReceiverShaft_v3
Whenuapai - Brigham Creek Road crossing - Receiver shaft
Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
Date: 4-05-2022
Checked :

Stage No.3 Excavate to elevation 8.25 on RIGHT side

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
25	-0.25	8.90	0.008	0	1.1	0.0	
26	-1.65	-1.46	0.008	0	1.1	0.0	
27	-4.00	-6.65	0.008	0	-4.6	0.0	
28	-5.60	4.26	0.008	0	-4.6	0.0	
29	-7.20	5.42	0.007	0	6.8	0.0	
30	-9.60	-8.26	0.007	0	6.8	0.0	
31	-12.00	-0.00	0.005	0	0.2	0.0	
32	-14.40	0.12	0.005	0	0.3	0.0	
33	-16.80	-0.01	0.004	0	0.4	0.0	
34	-19.20	-0.01	0.004	0	0.4	0.0	
35	-21.60	-0.01	0.003	0	0.4	0.0	
36	-24.00	-0.01	0.003	0	0.3	0.0	
37	-26.40	-0.01	0.003	0	0.3	0.0	
38	-28.20	-0.06	0.002	0	0.3	0.0	
39	-30.00	-0.00	0.001	0	0.2	0.0	
		-0.13	0.000	0	0.1	0.0	
					0.0	0.0	

		LEFT side					Total earth	Adjusted soil
Node	Y	Water	Vertic	Effective stresses		Earth		
				Active	Passive			
		LEFT side					Total earth	Adjusted soil
Node	Y	Water	Vertic	Effective stresses		Earth		
				Active	Passive			
		RIGHT side					Total earth	Adjusted soil
Node	Y	Water	Vertic	Effective stresses		Earth		
				Active	Passive			
		RIGHT side					Total earth	Adjusted soil
Node	Y	Water	Vertic	Effective stresses		Earth		
				Active	Passive			

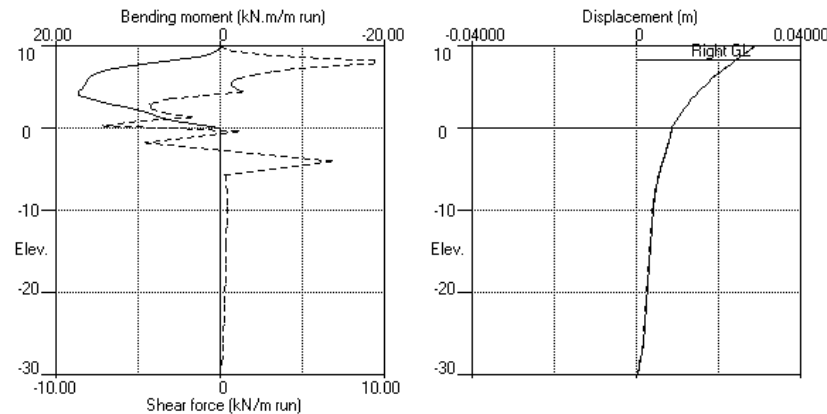
Brigham Creek
Road crossing
Receiver shaft

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 Data filename/Run ID: Whenuapai-BCRcross-ReceiverShaft_v3
 Whenuapai - Brigham Creek Road crossing - Receiver shaft
 Sheet pile STU1800 w 250UC89 (v3)

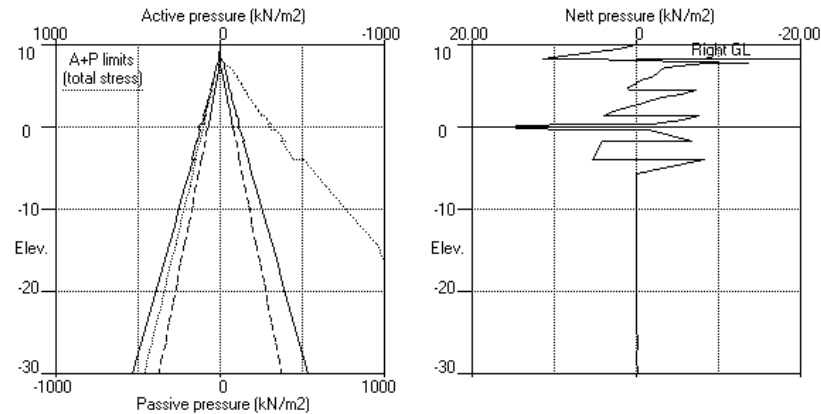
Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Units: kN,m

Stage No.3 Excav. to elev. 8.25 on RIGHT side



Stage No.3 Excav. to elev. 8.25 on RIGHT side



TONKIN and TAYLOR GROUP LTD.
 Program: WALLAP Version 6.07 Revision A55.B74.R58
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 Data filename/Run ID: Whenuapai-BCRcross-ReceiverShaft_v3
 Whenuapai - Brigham Creek Road crossing - Receiver shaft
 Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Units: kN,m

Stage No. 5 Apply water pressure profile no.2

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
 Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 0.00 Factor of Safety	Moment of equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
5	10.00	8.25	9.00	4.512	n/a	7.13	1.12	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
 Analysis options

Length of wall perpendicular to section = 20.00m
 2-D finite element model. Active limit arching not modelled.
 Soil deformations are elastic until the active or passive limit is reached
 Open Tension Crack analysis - No
 All soil moduli were factored to take account of
 3-D effects due to the finite length of wall:
 Modulus factors - Left side = 1.05
 Right side = 1.05

Rigid boundaries: Left side 30.00 from wall
 Right side 30.00 from wall
 Lower rigid boundary at elevation -30.00
 Rough boundary
 Rough boundary
 Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	3.77	0.029	2.19E-03	0.0	0.0	
2	9.50	5.05	0.028	2.19E-03	2.2	0.8	
3	9.00	7.90	0.026	2.18E-03	5.4	2.8	-9.3
		7.90	0.026	2.18E-03	-3.9	2.8	
4	8.63	9.49	0.026	2.16E-03	-0.6	2.0	
5	8.25	11.38	0.025	2.15E-03	3.3	2.6	
		9.99	0.025	2.15E-03	3.3	2.6	
6	8.00	-4.50	0.024	2.14E-03	4.0	3.7	
7	7.85	-13.01	0.024	2.13E-03	2.7	4.3	
		-8.20	0.024	2.13E-03	2.7	4.3	
8	7.25	-4.49	0.023	2.09E-03	-1.1	4.6	
9	6.88	-2.15	0.022	2.06E-03	-2.4	3.9	
10	6.50	0.01	0.021	2.04E-03	-2.8	2.9	
11	6.00	2.53	0.020	2.03E-03	-2.1	1.6	
12	5.75	4.08	0.020	2.02E-03	-1.3	1.2	
13	5.25	7.55	0.019	2.01E-03	1.6	1.1	
14	4.85	7.49	0.018	2.00E-03	4.6	2.3	
15	4.45	6.45	0.017	1.98E-03	7.4	4.7	
		-6.53	0.017	1.98E-03	7.4	4.7	
16	4.03	-7.15	0.016	1.94E-03	4.5	7.3	
17	3.60	-4.75	0.015	1.89E-03	1.9	8.5	
18	3.00	-2.63	0.014	1.81E-03	-0.3	8.7	
19	2.40	-0.71	0.013	1.73E-03	-1.3	8.0	
20	1.93	1.09	0.012	1.68E-03	-1.2	7.3	
21	1.45	2.70	0.012	1.62E-03	-0.3	6.8	
		-8.66	0.012	1.62E-03	-0.3	6.8	
22	0.93	-6.72	0.011	1.57E-03	-4.3	5.4	
23	0.40	-2.84	0.010	1.54E-03	-6.8	2.1	
		7.74	0.010	1.54E-03	-6.8	2.1	

Brigham Creek
 Road crossing
 Receiver shaft

Run ID: Whenuapai-BCRcross-ReceiverShaft_v3 | Sheet No.
 Whenuapai - Brigham Creek Road crossing - Receiver shaft | Date: 4-05-2022
 Sheet pile STU1800 w 250UC89 (v3) | Checked :

TONKIN and TAYLOR GROUP LTD. | Sheet No.
 Program: WALLAP Version 6.07 Revision A55.B74.R58 | Job No. 1013050
 Licensed from GEOSOLVE | Made by : op
 Data filename/Run ID: Whenuapai-BCRcross-ReceiverShaft_v3
 Whenuapai - Brigham Creek Road crossing - Receiver shaft | Date: 4-05-2022
 Sheet pile STU1800 w 250UC89 (v3) | Checked :

Brigham Creek
 Road crossing
 Receiver shaft

Stage No.5 Apply water pressure profile no.2

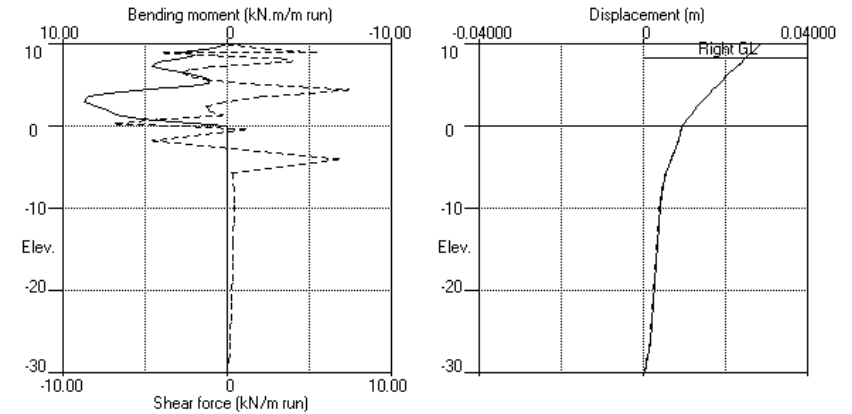
(continued)

Node no.	Y coord	Nett pressure kN/m ²	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
24	0.00	16.24	0.009	1.54E-03	-2.0	-0.0	
25	-0.25	8.90	0.009	0	1.1	0.0	
		-1.46	0.009	0	1.1	0.0	
26	-1.65	-6.65	0.008	0	-4.6	0.0	
		4.26	0.008	0	-4.6	0.0	
27	-4.00	5.42	0.007	0	6.8	0.0	
		-8.26	0.007	0	6.8	0.0	
28	-5.60	-0.00	0.006	0	0.2	0.0	
29	-7.20	0.12	0.005	0	0.3	0.0	
30	-9.60	-0.01	0.004	0	0.4	0.0	
31	-12.00	-0.01	0.004	0	0.4	0.0	
32	-14.40	-0.01	0.003	0	0.4	0.0	
33	-16.80	-0.01	0.003	0	0.3	0.0	
34	-19.20	-0.01	0.003	0	0.3	0.0	
35	-21.60	-0.01	0.002	0	0.3	0.0	
36	-24.00	-0.01	0.002	0	0.3	0.0	
37	-26.40	-0.06	0.002	0	0.2	0.0	
38	-28.20	-0.00	0.001	0	0.1	0.0	
39	-30.00	-0.13	0.000	0	0.0	0.0	
At elev. 9.00		Prop force = 9.3 kN/m run					

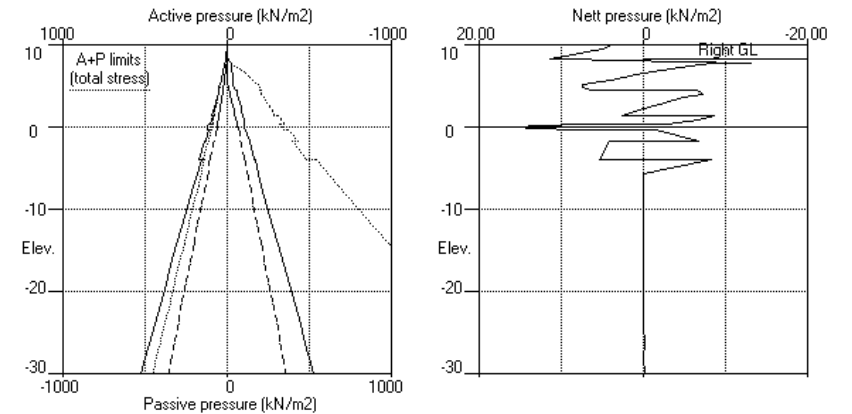
LEFT side							
Node	Y	Water	Vertic	Effective stresses	Active	Passive	Earth
							Total earth
							Adjusted soil
LEFT side							
Node	Y	Water	Vertic	Effective stresses	Active	Passive	Earth
							Total earth
							Adjusted soil
RIGHT side							
Node	Y	Water	Vertic	Effective stresses	Active	Passive	Earth
							Total earth
							Adjusted soil
RIGHT side							
Node	Y	Water	Vertic	Effective stresses	Active	Passive	Earth
							Total earth
							Adjusted soil

Units: kN,m

Stage No.5 Apply water pressure profile no.2



Stage No.5 Apply water pressure profile no.2



TONKIN and TAYLOR GROUP LTD.
Program: WALLAP Version 6.07 Revision A55.B74.R58
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Data filename/Run ID: Whenuapai-BCRcross-ReceiverShaft_v3
Whenuapai - Brigham Creek Road crossing - Receiver shaft
Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m
Stage No. 6 Excavate to elevation 6.00 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

		FoS for toe		Toe elev. for				
		elev. = 0.00		FoS = 1.500				
Stage	Ground level	Prop	Factor	Moment	Toe	Wall	Direction	
No.	Act.	Pass.	Elev.	of	elev.	Penetr	of	
				Safety	at elev.	-ation	failure	
6	10.00	6.00	9.00	1.626	n/a	0.72	5.28	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m

2-D finite element model. Active limit arching not modelled.

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

All soil moduli were factored to take account of

3-D effects due to the finite length of wall:

Modulus factors - Left side = 1.05

Right side = 1.04

Rigid boundaries: Left side 30.00 from wall
Right side 30.00 from wall
Lower rigid boundary at elevation -30.00

Rough boundary
Rough boundary
Rough boundary

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	
1	10.00	4.67	0.025	-2.61E-03	0.0	0.0		
2	9.50	27.33	0.026	-2.61E-03	8.0	0.9		
3	9.00	20.98	0.028	-2.65E-03	20.1	8.6	-80.2	
		20.98	0.028	-2.65E-03	-60.2	8.6		
4	8.63	14.48	0.029	-2.64E-03	-53.5	-12.4		
5	8.25	11.38	0.030	-2.51E-03	-48.7	-31.3		
6	8.00	12.92	0.030	-2.37E-03	-45.6	-43.0		
7	7.85	14.62	0.031	-2.26E-03	-43.6	-49.6		
		15.90	0.031	-2.26E-03	-43.6	-49.6		
8	7.25	22.40	0.032	-1.70E-03	-32.1	-72.5		
9	6.88	26.40	0.032	-1.25E-03	-22.9	-82.9		
10	6.50	30.38	0.033	-7.54E-04	-12.3	-89.5		
11	6.00	35.64	0.033	-5.54E-05	4.2	-91.6		
12	5.75	23.01	0.033	2.94E-04	11.6	-89.6		
13	5.25	13.48	0.033	9.52E-04	20.7	-81.1		
14	4.85	10.53	0.032	1.42E-03	25.5	-71.8		
15	4.45	7.74	0.031	1.83E-03	29.1	-60.8		
		-3.51	0.031	1.83E-03	29.1	-60.8		
16	4.03	-6.21	0.031	2.19E-03	27.1	-48.7		
17	3.60	-6.73	0.030	2.47E-03	24.3	-37.8		
18	3.00	-6.82	0.028	2.76E-03	20.3	-24.5		
19	2.40	-6.39	0.026	2.94E-03	16.3	-13.7		
20	1.93	-5.51	0.025	3.01E-03	13.5	-6.7		
21	1.45	-3.91	0.023	3.04E-03	11.2	-0.9		
		-17.41	0.023	3.04E-03	11.2	-0.9		
22	0.93	-15.48	0.022	3.03E-03	2.6	2.5		
23	0.40	-13.78	0.020	3.02E-03	-5.1	1.7		
		5.00	0.020	3.02E-03	-5.1	1.7		
24	0.00	12.54	0.019	3.01E-03	-1.6	0.0		

Run ID. Whenuapai-BCRcross-ReceiverShaft_v3
Whenuapai - Brigham Creek Road crossing - Receiver shaft
Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
Date: 4-05-2022
Checked :

Brigham Creek
Road crossing
Receiver shaft

Stage No.6 Excavate to elevation 6.00 on RIGHT side

(continued)

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
25	-0.25	17.18	0.018	0	2.2	0.0	
		-2.92	0.018	0	2.2	0.0	
26	-1.65	-13.20	0.017	0	-9.1	0.0	
		8.25	0.017	0	-9.1	0.0	
27	-4.00	10.95	0.013	0	13.4	0.0	
		-16.43	0.013	0	13.4	0.0	
28	-5.60	0.01	0.011	0	0.3	0.0	
29	-7.20	0.20	0.010	0	0.5	0.0	
30	-9.60	0.00	0.009	0	0.7	0.0	
31	-12.00	-0.01	0.008	0	0.7	0.0	
32	-14.40	-0.01	0.007	0	0.7	0.0	
33	-16.80	-0.01	0.006	0	0.6	0.0	
34	-19.20	-0.02	0.006	0	0.6	0.0	
35	-21.60	-0.02	0.005	0	0.6	0.0	
36	-24.00	-0.02	0.004	0	0.5	0.0	
37	-26.40	-0.11	0.003	0	0.4	0.0	
38	-28.20	-0.01	0.002	0	0.3	0.0	
39	-30.00	-0.28	0.000	0	0.0	0.0	
At elev.	9.00				Prop force =	80.2 kN/m run	

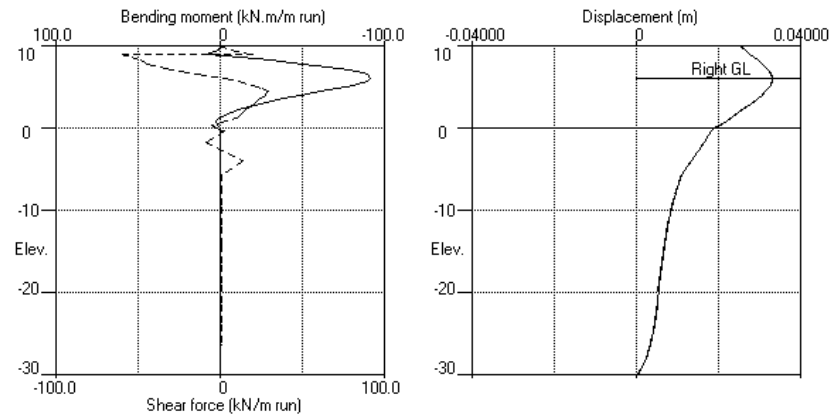
LEFT side							
Effective stresses						Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	
LEFT side							
Effective stresses						Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	
RIGHT side							
Effective stresses						Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	
RIGHT side							
Effective stresses						Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	

TONKIN and TAYLOR GROUP LTD.
 Program: WALLAP Version 6.07 Revision A55.B74.R58
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 Data filename/Run ID: Whenuapai-BCRcross-ReceiverShaft_v3
 Whenuapai - Brigham Creek Road crossing - Receiver shaft
 Sheet pile STU1800 w 250UC89 (v3)

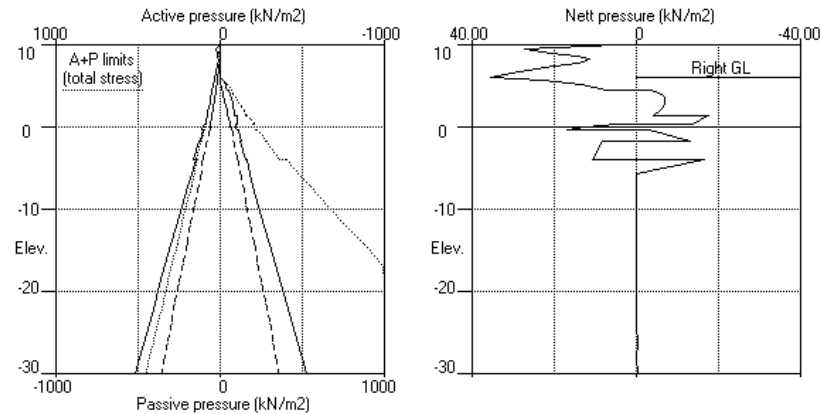
Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Units: kN,m

Stage No.6 Excav. to elev. 6.00 on RIGHT side



Stage No.6 Excav. to elev. 6.00 on RIGHT side



TONKIN and TAYLOR GROUP LTD.
 Program: WALLAP Version 6.07 Revision A55.B74.R58
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 Data filename/Run ID: Whenuapai-BCRcross-ReceiverShaft_v3
 Whenuapai - Brigham Creek Road crossing - Receiver shaft
 Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Units: kN,m

Stage No. 7 Fill to elevation 6.50 on RIGHT side with soil type 1

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
 Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 0.00	Moment of equilib. at elev.	Toe elev. for FoS = 1.500	Wall Penetr.	Direction of failure
				Factor of Safety	n/a	Toe elev.	3.42	L to R
7	10.00	6.50	9.00	2.128	n/a	3.08		

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m

2-D finite element model. Active limit arching not modelled.

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

All soil moduli were factored to take account of

3-D effects due to the finite length of wall:

Modulus factors - Left side = 1.05

Right side = 1.04

Rigid boundaries: Left side 30.00 from wall

Right side 30.00 from wall

Lower rigid boundary at elevation -30.00

Rough boundary

Rough boundary

Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	1.87	0.025	-2.20E-03	0.0	0.0	
2	9.50	25.05	0.026	-2.21E-03	6.7	0.5	
3	9.00	19.33	0.028	-2.24E-03	17.8	7.3	-75.3
		19.33	0.028	-2.24E-03	-57.5	7.3	
4	8.63	13.41	0.028	-2.22E-03	-51.3	-12.7	
5	8.25	11.38	0.029	-2.09E-03	-46.7	-30.9	
6	8.00	12.92	0.030	-1.95E-03	-43.6	-42.1	
7	7.85	14.79	0.030	-1.85E-03	-41.6	-48.4	
		15.98	0.030	-1.85E-03	-41.6	-48.4	
8	7.25	22.63	0.031	-1.30E-03	-30.0	-70.1	
9	6.88	26.81	0.031	-8.70E-04	-20.7	-79.7	
10	6.50	30.94	0.032	-3.92E-04	-9.9	-85.5	
11	6.00	34.40	0.032	2.71E-04	6.5	-86.5	
		33.13	0.032	2.71E-04	6.5	-86.5	
12	5.75	21.04	0.032	5.99E-04	13.2	-84.0	
13	5.25	11.72	0.031	1.21E-03	21.4	-74.9	
14	4.85	8.96	0.031	1.64E-03	25.6	-65.4	
15	4.45	6.34	0.030	2.01E-03	28.6	-54.5	
		-5.03	0.030	2.01E-03	28.6	-54.5	
16	4.03	-7.17	0.029	2.33E-03	26.0	-42.8	
17	3.60	-7.31	0.028	2.58E-03	23.0	-32.4	
18	3.00	-7.20	0.026	2.82E-03	18.6	-20.1	
19	2.40	-6.70	0.024	2.96E-03	14.4	-10.3	
20	1.93	-5.83	0.023	3.01E-03	11.5	-4.2	
21	1.45	-4.73	0.022	3.03E-03	8.9	0.5	
		-15.25	0.022	3.03E-03	8.9	0.5	
22	0.93	-13.77	0.020	3.01E-03	1.3	3.1	
23	0.40	-11.47	0.018	2.99E-03	-5.3	1.8	
		4.31	0.018	2.99E-03	-5.3	1.8	

Brigham Creek
 Road crossing
 Receiver shaft

Run ID: Whenuapai-BCRcross-ReceiverShaft_v3 | Sheet No.
 Whenuapai - Brigham Creek Road crossing - Receiver shaft | Date: 4-05-2022
 Sheet pile STU1800 w 250UC89 (v3) | Checked :

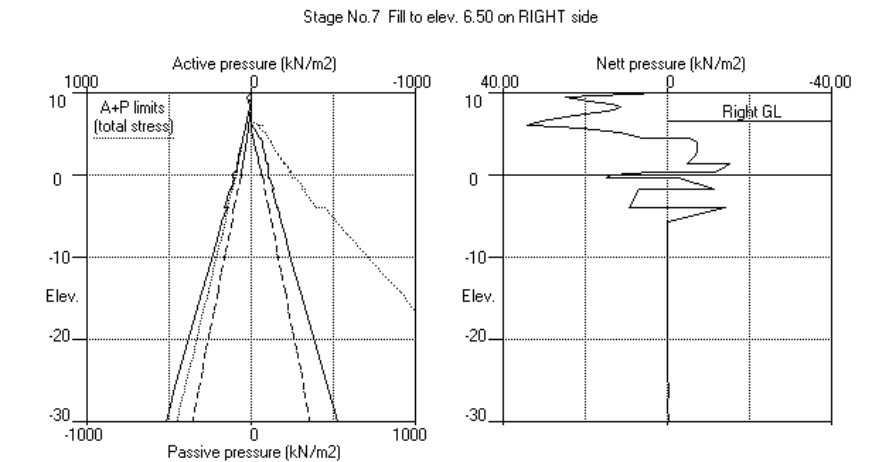
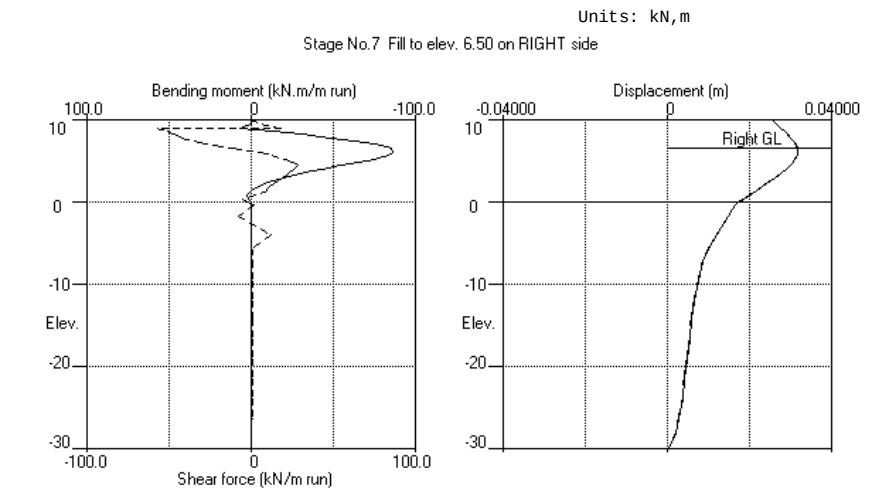
TONKIN and TAYLOR GROUP LTD. | Sheet No.
 Program: WALLAP Version 6.07 Revision A55.B74.R58 | Job No. 1013050
 Licensed from GEOSOLVE | Made by : op
 Data filename/Run ID: Whenuapai-BCRcross-ReceiverShaft_v3 | Date: 4-05-2022
 Whenuapai - Brigham Creek Road crossing - Receiver shaft | Checked :
 Sheet pile STU1800 w 250UC89 (v3)

Brigham Creek
 Road crossing
 Receiver shaft

(continued)
 Stage No.7 Fill to elevation 6.50 on RIGHT side with soil type 1

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
24	0.00	13.65	0.017	2.99E-03	-1.7	-0.0	
25	-0.25	14.90	0.017	0	1.9	0.0	
		-2.51	0.017	0	1.9	0.0	
26	-1.65	-11.37	0.015	0	-7.9	0.0	
		7.15	0.015	0	-7.9	0.0	
27	-4.00	9.40	0.012	0	11.6	0.0	
		-14.15	0.012	0	11.6	0.0	
28	-5.60	0.01	0.010	0	0.3	0.0	
29	-7.20	0.18	0.009	0	0.4	0.0	
30	-9.60	-0.00	0.007	0	0.6	0.0	
31	-12.00	-0.01	0.007	0	0.6	0.0	
32	-14.40	-0.01	0.006	0	0.6	0.0	
33	-16.80	-0.01	0.005	0	0.6	0.0	
34	-19.20	-0.01	0.005	0	0.5	0.0	
35	-21.60	-0.02	0.004	0	0.5	0.0	
36	-24.00	-0.01	0.004	0	0.5	0.0	
37	-26.40	-0.10	0.003	0	0.3	0.0	
38	-28.20	-0.01	0.002	0	0.2	0.0	
39	-30.00	-0.24	0.000	0	0.0	0.0	
At elev. 9.00		Prop force = 75.3 kN/m run					

LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							
LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							
RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							
RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth
Adjusted soil							



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Program: WALLAP Version 6.07 Revision A55.B74.R58
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Data filename/Run ID: Whenuapai-BCRcross-ReceiverShaft_v3
Whenuapai - Brigham Creek Road crossing - Receiver shaft
Sheet pile STU1800 w 250UC89 (v3)
Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m
Stage No. 8 Apply water pressure profile no.1

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

		FoS for toe		Toe elev. for			
		elev. = 0.00		FoS = 1.500			
Stage	Ground level	Prop	Factor	Moment	Toe	Wall	Direction
No.	Act.	Pass.	Elev.	of	elev.	Penetr	of
				Safety	at elev.	-ation	failure
8	10.00	6.50	9.00	1.828	n/a	1.65	4.85
							L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.05
Right side = 1.04

Rigid boundaries: Left side 30.00 from wall
Right side 30.00 from wall
Lower rigid boundary at elevation -30.00
Rough boundary
Rough boundary
Rough boundary

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	10.00	4.67	0.025	-2.84E-03	0.0	0.0	
2	9.50	27.64	0.026	-2.85E-03	8.1	0.9	
3	9.00	22.25	0.028	-2.88E-03	20.5	8.7	-91.7
		22.25	0.028	-2.88E-03	-71.2	8.7	
4	8.63	16.37	0.029	-2.86E-03	-63.9	-16.2	
5	8.25	17.66	0.030	-2.70E-03	-57.5	-38.9	
6	8.00	20.46	0.031	-2.53E-03	-52.8	-52.6	
7	7.85	22.13	0.031	-2.40E-03	-49.6	-60.2	
		23.40	0.031	-2.40E-03	-49.6	-60.2	
8	7.25	29.75	0.032	-1.72E-03	-33.6	-85.4	
9	6.88	33.66	0.033	-1.20E-03	-21.7	-95.8	
10	6.50	37.54	0.033	-6.32E-04	-8.4	-101.5	
11	6.00	30.55	0.033	1.49E-04	8.6	-101.0	
		38.45	0.033	1.49E-04	8.6	-101.0	
12	5.75	25.87	0.033	5.32E-04	16.7	-97.8	
13	5.25	12.23	0.033	1.24E-03	26.2	-86.5	
14	4.85	9.18	0.032	1.74E-03	30.5	-75.1	
15	4.45	6.28	0.031	2.16E-03	33.6	-62.2	
		-6.20	0.031	2.16E-03	33.6	-62.2	
16	4.03	-8.68	0.030	2.52E-03	30.4	-48.6	
17	3.60	-8.91	0.029	2.80E-03	26.7	-36.5	
18	3.00	-8.78	0.027	3.07E-03	21.4	-22.1	
19	2.40	-8.19	0.026	3.23E-03	16.3	-11.0	
20	1.93	-7.18	0.024	3.28E-03	12.6	-4.2	
21	1.45	-5.68	0.022	3.30E-03	9.6	0.9	
		-17.00	0.022	3.30E-03	9.6	0.9	
22	0.93	-14.86	0.021	3.28E-03	1.2	3.5	
23	0.40	-11.66	0.019	3.26E-03	-5.8	2.0	
		4.12	0.019	3.26E-03	-5.8	2.0	

Run ID. Whenuapai-BCRcross-ReceiverShaft_v3
Whenuapai - Brigham Creek Road crossing - Receiver shaft
Sheet pile STU1800 w 250UC89 (v3)
Sheet No.
Date: 4-05-2022
Checked :

Stage No.8 Apply water pressure profile no.1

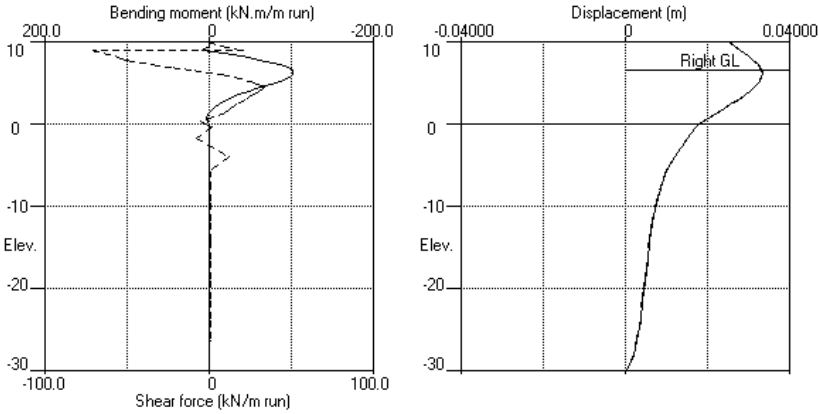
Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
24	0.00	15.19	0.018	3.25E-03	-1.9	0.0	
25	-0.25	14.90	0.017	0	1.9	0.0	
		-2.51	0.017	0	1.9	0.0	
26	-1.65	-11.37	0.015	0	-7.9	0.0	
		7.15	0.015	0	-7.9	0.0	
27	-4.00	9.40	0.012	0	11.6	0.0	
		-14.15	0.012	0	11.6	0.0	
28	-5.60	0.01	0.010	0	0.3	0.0	
29	-7.20	0.18	0.009	0	0.4	0.0	
30	-9.60	-0.00	0.008	0	0.6	0.0	
31	-12.00	-0.01	0.007	0	0.6	0.0	
32	-14.40	-0.01	0.006	0	0.6	0.0	
33	-16.80	-0.01	0.005	0	0.6	0.0	
34	-19.20	-0.01	0.005	0	0.5	0.0	
35	-21.60	-0.02	0.004	0	0.5	0.0	
36	-24.00	-0.01	0.004	0	0.5	0.0	
37	-26.40	-0.10	0.003	0	0.3	0.0	
38	-28.20	-0.01	0.002	0	0.2	0.0	
39	-30.00	-0.24	0.000	0	0.0	0.0	
At elev.	9.00				Prop force =	91.7 kN/m run	

LEFT side							
		Effective stresses				Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	
LEFT side							
		Effective stresses				Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	
RIGHT side							
		Effective stresses				Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	
RIGHT side							
		Effective stresses				Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	

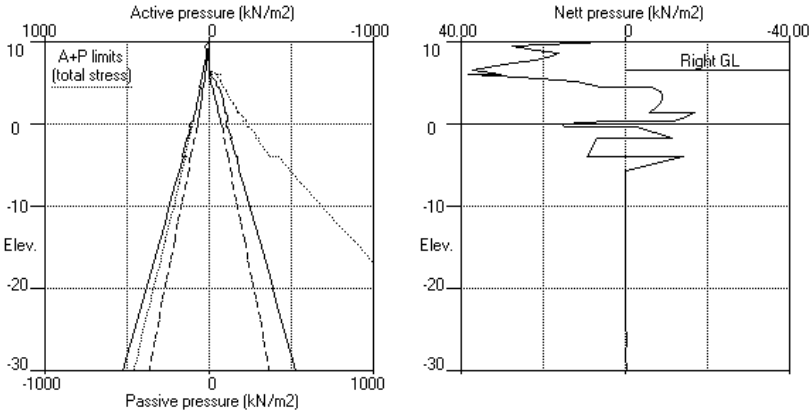
Brigham Creek
Road crossing
Receiver shaft

Units: kN,m

Stage No.8 Apply water pressure profile no.1



Stage No.8 Apply water pressure profile no.1



Units: kN,m

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

				FoS for toe		Toe elev. for		
				elev. = 0.00		FoS = 1.500		
<u>Stage</u>	<u>Ground</u>	<u>level</u>	<u>Prop</u>	<u>Factor</u>	<u>Moment</u>	<u>Toe</u>	<u>Wall</u>	<u>Direction</u>
<u>No.</u>	<u>Act.</u>	<u>Pass.</u>	<u>Elev.</u>	<u>of</u>	<u>equilib.</u>	<u>elev.</u>	<u>Penetr</u>	<u>of</u>
				<u>Safety</u>	<u>at elev.</u>	<u>elev.</u>	<u>-ation</u>	<u>failure</u>
1	10.00	10.00	Cant.	Conditions not suitable for FoS calc.				
2	10.00	10.00	Cant.	Conditions not suitable for FoS calc.				
3	10.00	8.25	Cant.	2.144	0.72	4.26	3.99	L to R
4	10.00	8.25		No analysis at this stage				
5	10.00	8.25	9.00	4.512	n/a	7.13	1.12	L to R
6	10.00	6.00	9.00	1.626	n/a	0.72	5.28	L to R
7	10.00	6.50	9.00	2.128	n/a	3.08	3.42	L to R
8	10.00	6.50	9.00	1.828	n/a	1.65	4.85	L to R

TONKIN and TAYLOR GROUP LTD.
Program: WALLAP Version 6.07 Revision A55.B74.R58
Data filename/Run ID: Whenuapai-BCRcross-ReceiverShaft_v3
Whenuapai - Brigham Creek Road crossing - Receiver shaft
Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Run ID. Whenuapai-BCRcross-ReceiverShaft_v3
Whenuapai - Brigham Creek Road crossing - Receiver shaft
Sheet pile STU1800 w 250UC89 (v3)

Sheet No.
Date: 4-05-2022
Checked :

Brigham Creek
Road crossing
Receiver shaft

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment				Shear force			
	maximum kN.m/m	elev.	minimum kN.m/m	elev.	maximum kN/m	elev.	minimum kN/m	elev.
1	0.2	0.93	-4.0	5.75	1.6	-4.00	-1.6	7.85
2	0.5	0.93	-9.4	6.00	3.9	4.45	-4.9	7.85
3	17.3	4.45	-0.0	0.00	9.4	8.00	-7.2	0.40
4	No calculation at this stage							
5	8.7	3.00	-0.0	0.00	7.4	4.45	-6.8	0.40
6	8.6	9.00	-91.6	6.00	29.1	4.45	-60.2	9.00
7	7.3	9.00	-86.5	6.00	28.6	4.45	-57.5	9.00
8	8.7	9.00	-101.5	6.50	33.6	4.45	-71.2	9.00

Maximum and minimum displacement at each stage

Stage no.	Displacement				Stage description
	maximum m	elev.	minimum m	elev.	
1	0.003	6.50	0.000	10.00	Apply surcharge no.1 at elev. 10.00
2	0.004	6.50	0.000	10.00	Apply water pressure profile no.3
3	0.029	10.00	0.000	10.00	Excav. to elev. 8.25 on RIGHT side
4	No calculation at this stage				Install prop no.1 at elev. 9.00
5	0.029	10.00	0.000	10.00	Apply water pressure profile no.2
6	0.033	6.00	0.000	10.00	Excav. to elev. 6.00 on RIGHT side
7	0.032	6.00	0.000	10.00	Fill to elev. 6.50 on RIGHT side
8	0.033	6.00	0.000	10.00	Apply water pressure profile no.1

Prop forces at each stage (horizontal components)

Anchor no. 1 --- at elev. 9.00			
Stage no.	kN/m run	kN/prop	
5	9.32	37.26	
6	80.23	320.93	
7	75.28	301.13	
8	91.71	366.84	

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.05
Right side = 1.04

Rigid boundaries: Left side 30.00 from wall Rough boundary
Right side 30.00 from wall Rough boundary
Lower rigid boundary at elevation -30.00 Rough boundary

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement		Bending moment		Shear force	
		maximum m	minimum m	maximum kN.m/m	minimum kN.m/m	maximum kN/m	minimum kN/m
1	10.00	0.029	0.000	0.0	-0.0	0.0	0.0
2	9.50	0.028	0.000	0.9	-0.1	8.1	-0.9
3	9.00	0.028	0.000	8.7	-0.8	20.5	-71.2
4	8.63	0.029	0.000	2.8	-16.2	5.6	-63.9
5	8.25	0.030	0.000	5.6	-38.9	9.4	-57.5
6	8.00	0.031	0.000	8.2	-52.6	9.4	-52.8
7	7.85	0.031	0.000	9.5	-60.2	7.9	-49.6
8	7.25	0.032	0.000	13.0	-85.4	4.3	-33.6
9	6.88	0.033	0.000	14.4	-95.8	3.1	-22.9
10	6.50	0.033	0.000	15.3	-101.5	2.1	-12.3
11	6.00	0.033	0.000	16.1	-101.0	8.6	-2.1
12	5.75	0.033	0.000	16.3	-97.8	16.7	-1.3
13	5.25	0.033	0.000	16.6	-86.5	26.2	0.0
14	4.85	0.032	0.000	16.9	-75.1	30.5	0.0
15	4.45	0.031	0.000	17.3	-62.2	33.6	0.0
16	4.03	0.031	0.000	17.2	-48.7	30.4	-1.3
17	3.60	0.030	0.000	16.2	-37.8	26.7	-3.2
18	3.00	0.028	0.000	13.7	-24.5	21.4	-4.3
19	2.40	0.026	0.000	10.9	-13.7	16.3	-4.3
20	1.93	0.025	0.000	9.0	-6.7	13.5	-3.3
21	1.45	0.023	0.000	7.7	-0.9	11.2	-1.7
22	0.93	0.022	0.000	5.7	0.0	2.6	-5.2
23	0.40	0.020	0.000	2.2	0.0	0.0	-7.2
24	0.00	0.019	0.000	0.0	-0.0	0.0	-2.1
25	-0.25	0.018	0.000	0.0	0.0	2.2	0.0
26	-1.65	0.017	0.000	0.0	0.0	0.0	-9.1
27	-4.00	0.013	0.000	0.0	0.0	13.4	0.0
28	-5.60	0.011	0.000	0.0	0.0	0.3	0.0
29	-7.20	0.010	0.000	0.0	0.0	0.5	0.0
30	-9.60	0.009	0.000	0.0	0.0	0.7	0.0
31	-12.00	0.008	0.000	0.0	0.0	0.7	0.0
32	-14.40	0.007	0.000	0.0	0.0	0.7	0.0
33	-16.80	0.006	0.000	0.0	0.0	0.6	0.0
34	-19.20	0.006	0.000	0.0	0.0	0.6	0.0
35	-21.60	0.005	0.000	0.0	0.0	0.6	0.0
36	-24.00	0.004	0.000	0.0	0.0	0.5	0.0
37	-26.40	0.003	0.000	0.0	0.0	0.4	0.0
38	-28.20	0.002	0.000	0.0	0.0	0.3	0.0
39	-30.00	0.000	0.000	0.0	0.0	0.0	-0.0

TONKIN and TAYLOR GROUP LTD.
Program: WALLAP Version 6.07 Revision A55.B74.R58
Data filename/Run ID: Whenuapai-GravityMain-SSMH11-CH561-v5
Whenuapai - Gravity main - CH561
Sheet pile STU1800 (v5)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types			
		Left side		Right side	
1	14.23	9 Non-engineered fill		9 Non-engineered fill	
2	13.38	2 TA silt & clay		2 TA silt & clay	
3	0.83	3 ECBF residual soils		3 ECBF residual soils	

SOIL PROPERTIES

No.	Description	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol. state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Engineered hardfill	20.00	50000	0.357	OC (0.300)	0.189 (0.000)	7.061 (0.000)	
2	TA silt & clay	17.00	10000	0.531	OC (0.350)	0.320 (1.278)	3.485 (4.674)	1.000d
3	ECBF residual soils	18.00	20000	0.500	OC (0.350)	0.294 (1.222)	3.878 (4.985)	5.000d
4	ECBF Weathered rock	21.00	85000	0.426	OC (0.350)	0.237 (1.089)	5.153 (5.931)	25.00d
5	ECBF UW rock	22.00	400000	0.357	OC (0.250)	0.180 (0.966)	7.061 (7.223)	100.0d
6	Concrete	24.00	500000	0.292	OC (0.400)	0.140 (0.851)	10.07 (9.074)	500.0d
7	TA organics	16.00	5000	0.530	OC (0.250)	0.320 (1.278)	3.485 (4.674)	0.0d
8	TA sand	18.00	12000	0.500	OC (0.250)	0.294 (0.000)	3.878 (0.000)	
9	Non-engineered fill	18.00	10000	0.530	OC (0.300)	0.320 (1.278)	3.485 (4.674)	0.0d

Additional soil parameters associated with Ka and Kp

--- parameters for Ka ---				--- parameters for Kp ---			
Soil type		Soil friction	Wall adhesion	Back-fill	Soil friction	Wall adhesion	Back-fill
No.	Description	angle	coeff.	angle	angle	coeff.	angle
1	Engineered hardfill	40.00	0.434	0.00	40.00	0.280	0.00
2	TA silt & clay	28.00	0.469	0.00	28.00	0.306	0.00
3	ECBF residual soils	30.00	0.464	0.00	30.00	0.302	0.00
4	ECBF Weathered rock	35.00	0.450	0.00	35.00	0.292	0.00
5	ECBF UW rock	40.00	0.434	0.00	40.00	0.280	0.00
6	Concrete	45.00	0.414	0.00	45.00	0.265	0.00
7	TA organics	28.00	0.469	0.00	28.00	0.306	0.00
8	TA sand	30.00	0.464	0.00	30.00	0.302	0.00
9	Non-engineered fill	28.00	0.469	0.00	28.00	0.306	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	12.50	12.50

Automatic water pressure balancing at toe of wall : Yes

Left side				Right side			
Water press.	Point no.	Elev.	Piezo elev.	Water press.	Point no.	Elev.	Piezo elev.
m			m	kN/m2		m	m
	1	13.73	13.73	0.0	1	9.40	9.40
	2	12.50	12.50	0.0	1	8.90	8.90
	3	12.50	12.50	0.0	1	10.98	10.98
	4	12.50	12.50	0.0	1	11.98	11.98
	5	12.50	12.50	0.0	1	8.95	8.95

parameters not used

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 4.23
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.0000E+08 kN/m2
Moment of inertia of wall I = 3.2400E-04 m4/m run
(Sumitomo SX18) E.I = 64800 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin -ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	13.23	2.00	0.001257	2.000E+08	5.00	0.00	0	Anchor	n/a	R
2	11.69	2.00	0.001257	2.000E+08	5.00	0.00	0	Anchor	n/a	R

SURCHARGE LOADS

Surch -arge no.	Distance from wall	Length parallel to wall	Width perpnd. to wall	Surcharge kn/m2	Equiv. soil type	Partial factor/ Category
1	14.23	0.50(L)	10.00	5.00	15.00	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 14.23
2	Apply water pressure profile no.4
3	Excavate to elevation 12.73 on RIGHT side
4	Install strut or anchor no.1 at elevation 13.23
5	Apply water pressure profile no.3
6	Excavate to elevation 11.19 on RIGHT side
7	Install strut or anchor no.2 at elevation 11.69
8	Apply water pressure profile no.5
9	Excavate to elevation 9.15 on RIGHT side
10	Fill to elevation 9.65 on RIGHT side with soil type 1
11	Apply water pressure profile no.1

Gravity main
Ch561

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:

Method of analysis - Strength Factor method
Factor on soil strength for calculating wall depth = 1.50

Parameters for undrained strata:

Minimum equivalent fluid density = 5.00 kN/m3
Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:

Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - No
Non-linear Modulus Parameter (L) = 10.00 m

Boundary conditions:

Length of wall (normal to plane of analysis) = 20.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 30.00 m
Distance to rigid boundary on Right side = 30.00 m
Elevation of rigid lower boundary = -30.00

Lower rigid boundary at elevation -30.00 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Smooth

OUTPUT OPTIONS

Stage no.	Stage description	Output options	Displacement	Active, Graph.
			Bending mom.	Passive output
			Shear force	pressures
1	Apply surcharge no.1 at elev. 14.23	Yes	Yes	Yes
2	Apply water pressure profile no.4	Yes	Yes	Yes
3	Excav. to elev. 12.73 on RIGHT side	Yes	Yes	Yes
4	Install prop no.1 at elev. 13.23	Yes	Yes	Yes
5	Apply water pressure profile no.3	Yes	Yes	Yes
6	Excav. to elev. 11.19 on RIGHT side	Yes	Yes	Yes
7	Install prop no.2 at elev. 11.69	Yes	Yes	Yes
8	Apply water pressure profile no.5	Yes	Yes	Yes
9	Excav. to elev. 9.15 on RIGHT side	Yes	Yes	Yes
10	Fill to elev. 9.65 on RIGHT side	Yes	Yes	Yes
11	Apply water pressure profile no.1	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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Data filename/Run ID: Whenuapai-GravityMain-SSMH11-CH561-v5

Whenuapai - Gravity main - CH561

Sheet pile STU1800 (v5)

Sheet No.

Job No. 1013050

Made by : op

Date: 4-05-2022

Checked :

Units: kN,m

Stage No. 1 Apply surcharge no.1 at elevation 14.23

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 4.23 Factor of Safety	Toe elev. for FoS = 1.500 Wall Penetr. -ation failure	Direction of failure
1	14.23	14.23	Cant.	Conditions not suitable for FoS calc.		

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.06
Right side = 1.06

Rigid boundaries: Left side 30.00 from wall Rough boundary
Right side 30.00 from wall Rough boundary
Lower rigid boundary at elevation -30.00 Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	14.23	0.00	0.002	2.04E-05	0.0	0.0	
2	13.73	-2.13	0.002	2.02E-05	-0.5	0.0	
3	13.38	-1.23	0.002	2.07E-05	-1.1	-0.2	
		-0.60	0.002	2.07E-05	-1.1	-0.2	
4	13.23	-0.46	0.002	2.15E-05	-1.2	-0.4	
5	12.73	0.46	0.002	2.70E-05	-1.2	-1.0	
6	12.50	0.52	0.002	3.11E-05	-1.1	-1.3	
7	11.98	0.76	0.002	4.33E-05	-0.8	-1.8	
8	11.69	0.70	0.002	5.16E-05	-0.5	-1.9	
9	11.19	0.67	0.002	6.73E-05	-0.2	-2.1	
10	10.98	0.59	0.002	7.42E-05	-0.1	-2.2	
11	10.65	0.50	0.002	8.52E-05	0.1	-2.1	
12	10.32	0.41	0.002	9.61E-05	0.3	-2.1	
13	9.98	0.31	0.002	1.06E-04	0.4	-2.0	
14	9.65	0.21	0.002	1.16E-04	0.5	-1.8	
15	9.40	0.16	0.002	1.23E-04	0.5	-1.7	
16	9.15	0.09	0.002	1.29E-04	0.5	-1.6	
17	8.95	0.10	0.002	1.34E-04	0.6	-1.5	
18	8.38	-0.04	0.002	1.45E-04	0.6	-1.1	
19	7.80	-0.11	0.002	1.54E-04	0.5	-0.8	
20	7.20	-0.16	0.002	1.60E-04	0.5	-0.5	
21	6.60	-0.18	0.002	1.64E-04	0.4	-0.3	
22	6.00	-0.18	0.002	1.66E-04	0.2	-0.1	
23	5.40	-0.17	0.001	1.67E-04	0.1	-0.0	
24	4.82	-0.12	0.001	1.67E-04	0.1	-0.0	
25	4.23	-0.06	0.001	1.67E-04	0.0	-0.0	
26	4.08	0.14	0.001	0	0.0	0.0	
27	2.46	-0.02	0.001	0	0.1	0.0	
28	0.83	0.55	0.001	0	0.5	0.0	
		-0.58	0.001	0	0.5	0.0	

Gravity main
Ch561

Stage No.1 Apply surcharge no.1 at elevation 14.23

(continued)

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
29	-0.79	-0.01	0.001	0	0.1	0.0	
30	-2.40	0.02	0.000	0	0.1	0.0	
31	-4.80	-0.01	0.000	0	0.1	0.0	
32	-7.20	-0.01	0.000	0	0.1	0.0	
33	-9.60	-0.01	0.000	0	0.0	0.0	
34	-12.00	-0.00	0.000	0	0.0	0.0	
35	-14.40	-0.00	0.000	0	0.0	0.0	
36	-16.80	-0.00	0.000	0	0.0	0.0	
37	-19.20	-0.00	0.000	0	0.0	0.0	
38	-21.60	-0.00	0.000	0	0.0	0.0	
39	-24.00	-0.00	0.000	0	0.0	0.0	
40	-26.40	-0.00	0.000	0	0.0	0.0	
41	-28.20	-0.00	0.000	0	0.0	0.0	
42	-30.00	-0.01	0.000	0	0.0	0.0	

LEFT side								
Node	Y	Water	Vertic	Effective stresses	Active	Passive	Earth	Total earth
								Adjusted soil

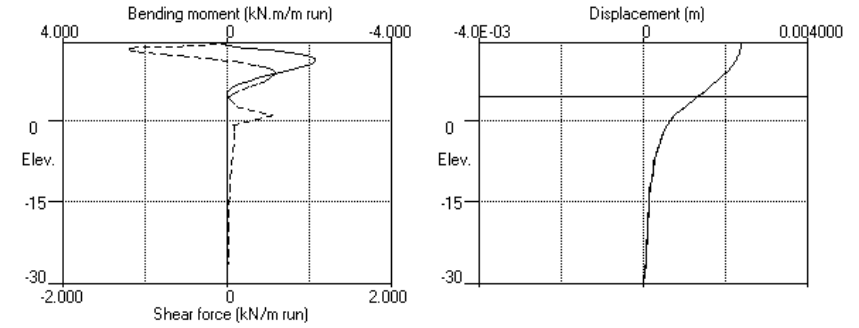
LEFT side								
Node	Y	Water	Vertic	Effective stresses	Active	Passive	Earth	Total earth
								Adjusted soil

RIGHT side								
Node	Y	Water	Vertic	Effective stresses	Active	Passive	Earth	Total earth
								Adjusted soil

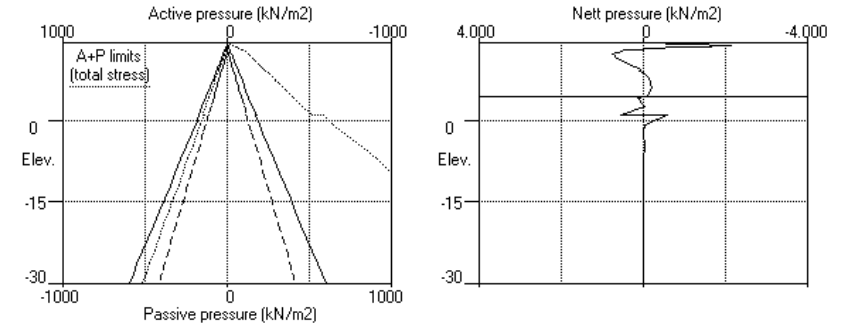
RIGHT side								
Node	Y	Water	Vertic	Effective stresses	Active	Passive	Earth	Total earth
								Adjusted soil

Units: kN,m

Stage No.1 Apply surcharge no.1 at elev. 14.23



Stage No.1 Apply surcharge no.1 at elev. 14.23



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 Data filename/Run ID: Whenuapai-GravityMain-SSMH11-CH561-v5
 Whenuapai - Gravity main - CH561
 Sheet pile STU1800 (v5)

Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Run ID. Whenuapai-GravityMain-SSMH11-CH561-v5
 Whenuapai - Gravity main - CH561
 Sheet pile STU1800 (v5)

Sheet No.
 Date: 4-05-2022
 Checked :

Gravity main
 Ch561

(continued)

Stage No.2 Apply water pressure profile no.4

Units: kN,m
 Stage No. 2 Apply water pressure profile no.4

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
 Factor of safety on soil strength

FoS for toe elev. = 4.23 Toe elev. for FoS = 1.500

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS Factor	Moment of equilb. at elev.	Toe elev. Penetr	Wall Direction of failure
2	14.23	14.23	Cant.		Conditions not suitable for FoS calc.		

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
 Analysis options

Length of wall perpendicular to section = 20.00m
 2-D finite element model. Active limit arching not modelled.
 Soil deformations are elastic until the active or passive limit is reached
 Open Tension Crack analysis - No
 All soil moduli were factored to take account of
 3-D effects due to the finite length of wall:
 Modulus factors - Left side = 1.06
 Right side = 1.06

Rigid boundaries: Left side 30.00 from wall Rough boundary
 Right side 30.00 from wall Rough boundary
 Lower rigid boundary at elevation -30.00 Rough boundary

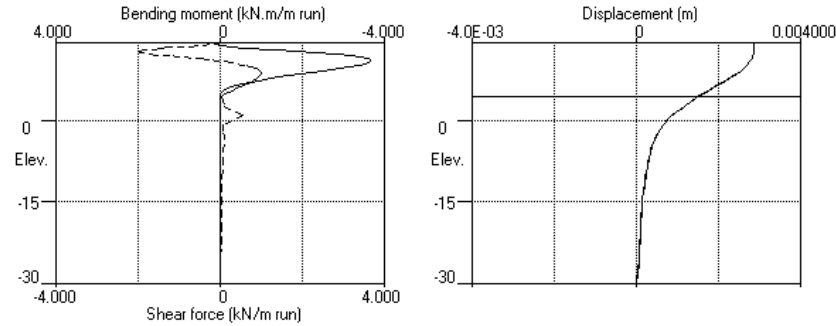
Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	14.23	0.00	0.003	-8.66E-06	0.0	-0.0	
2	13.73	-2.47	0.003	-8.85E-06	-0.6	0.0	
3	13.38	-1.76	0.003	-8.19E-06	-1.4	-0.3	
		-1.14	0.003	-8.19E-06	-1.4	-0.3	
4	13.23	-1.17	0.003	-7.26E-06	-1.5	-0.5	
5	12.73	-0.38	0.003	-2.79E-08	-1.9	-1.4	
6	12.50	-0.50	0.003	5.62E-06	-2.0	-1.8	
7	11.98	1.88	0.003	2.42E-05	-1.7	-2.8	
8	11.69	1.60	0.003	3.77E-05	-1.2	-3.2	
9	11.19	1.33	0.003	6.40E-05	-0.4	-3.6	
10	10.98	1.13	0.003	7.57E-05	-0.2	-3.7	
11	10.65	0.92	0.003	9.45E-05	0.2	-3.7	
12	10.32	0.72	0.003	1.13E-04	0.4	-3.6	
13	9.98	0.53	0.003	1.30E-04	0.7	-3.4	
14	9.65	0.36	0.003	1.47E-04	0.8	-3.1	
15	9.40	0.25	0.003	1.59E-04	0.9	-2.9	
16	9.15	0.15	0.003	1.69E-04	0.9	-2.7	
17	8.95	0.15	0.003	1.77E-04	1.0	-2.5	
18	8.38	-0.07	0.002	1.97E-04	1.0	-2.0	
19	7.80	-0.17	0.002	2.12E-04	0.9	-1.4	
20	7.20	-0.25	0.002	2.23E-04	0.8	-0.9	
21	6.60	-0.29	0.002	2.30E-04	0.6	-0.5	
22	6.00	-0.31	0.002	2.34E-04	0.4	-0.2	
23	5.40	-0.31	0.002	2.35E-04	0.3	-0.1	
24	4.82	-0.24	0.002	2.35E-04	0.1	0.0	
25	4.23	-0.06	0.001	2.35E-04	0.0	-0.0	
26	4.08	0.14	0.001		0	0.0	
27	2.46	-0.02	0.001		0	0.0	
28	0.83	0.55	0.001		0	0.0	
		-0.58	0.001		0	0.5	

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
29	-0.79	-0.01	0.001	0	0.1	0.0	
30	-2.40	0.02	0.001	0	0.1	0.0	
31	-4.80	-0.01	0.000	0	0.1	0.0	
32	-7.20	-0.01	0.000	0	0.1	0.0	
33	-9.60	-0.01	0.000	0	0.0	0.0	
34	-12.00	-0.00	0.000	0	0.0	0.0	
35	-14.40	-0.00	0.000	0	0.0	0.0	
36	-16.80	-0.00	0.000	0	0.0	0.0	
37	-19.20	-0.00	0.000	0	0.0	0.0	
38	-21.60	-0.00	0.000	0	0.0	0.0	
39	-24.00	-0.00	0.000	0	0.0	0.0	
40	-26.40	-0.00	0.000	0	0.0	0.0	
41	-28.20	-0.00	0.000	0	0.0	0.0	
42	-30.00	-0.01	0.000	0	0.0	0.0	

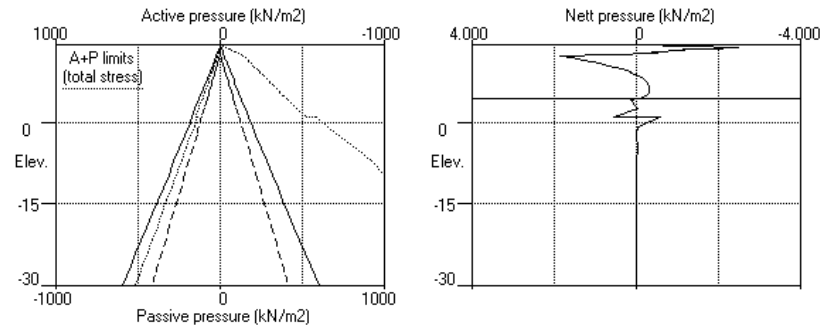
LEFT side							
Node	Y	Water	Vertic	Effective stresses Active	Effective stresses Passive	Earth	Adjusted soil
LEFT side							
Node	Y	Water	Vertic	Effective stresses Active	Effective stresses Passive	Earth	Adjusted soil
RIGHT side							
Node	Y	Water	Vertic	Effective stresses Active	Effective stresses Passive	Earth	Adjusted soil
RIGHT side							
Node	Y	Water	Vertic	Effective stresses Active	Effective stresses Passive	Earth	Adjusted soil

Units: kN,m

Stage No.2 Apply water pressure profile no.4



Stage No.2 Apply water pressure profile no.4



Units: kN,m

Stage No. 3 Excavate to elevation 12.73 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe Factor of Safety	Toe elev. for Moment equilb. at elev.	Toe Wall Penetr -ation	Direction of failure
3	14.23	12.73	Cant.	2.462	5.05	9.37	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m

2-D finite element model. Active limit arching not modelled.

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

All soil moduli were factored to take account of

3-D effects due to the finite length of wall:

Modulus factors - Left side = 1.06

Right side = 1.06

Rigid boundaries: Left side 30.00 from wall

Right side 30.00 from wall

Lower rigid boundary at elevation -30.00

Rough boundary

Rough boundary

Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	14.23	0.00	0.018	1.48E-03	0.0	-0.0	
2	13.73	3.75	0.017	1.48E-03	0.9	0.3	
3	13.38	6.73	0.017	1.47E-03	2.8	1.0	
		5.45	0.017	1.47E-03	2.8	1.0	
4	13.23	6.58	0.017	1.47E-03	3.7	1.5	
5	12.73	9.99	0.016	1.45E-03	7.8	4.4	
		5.32	0.016	1.45E-03	7.8	4.4	
6	12.50	-6.87	0.015	1.43E-03	7.6	6.3	
7	11.98	-5.06	0.015	1.37E-03	4.5	9.5	
8	11.69	-4.08	0.014	1.32E-03	3.2	10.6	
9	11.19	-4.01	0.014	1.24E-03	1.2	11.7	
10	10.98	-3.53	0.013	1.20E-03	0.4	11.8	
11	10.65	-2.66	0.013	1.14E-03	-0.6	11.8	
12	10.32	-1.85	0.013	1.08E-03	-1.4	11.4	
13	9.98	-1.22	0.012	1.02E-03	-1.9	10.8	
14	9.65	-0.78	0.012	9.72E-04	-2.2	10.1	
15	9.40	-0.44	0.012	9.34E-04	-2.4	9.5	
16	9.15	-0.22	0.012	8.99E-04	-2.5	8.9	
17	8.95	0.08	0.011	8.72E-04	-2.5	8.4	
18	8.38	0.21	0.011	8.03E-04	-2.4	7.0	
19	7.80	0.34	0.010	7.47E-04	-2.2	5.6	
20	7.20	0.38	0.010	7.01E-04	-2.0	4.3	
21	6.60	0.38	0.010	6.67E-04	-1.8	3.1	
22	6.00	0.39	0.009	6.42E-04	-1.6	2.1	
23	5.40	0.43	0.009	6.27E-04	-1.3	1.2	
24	4.82	0.70	0.008	6.20E-04	-1.0	0.5	
25	4.23	2.13	0.008	6.17E-04	-0.2	-0.0	
26	4.08	0.21	0.008	0	0.0	0.0	
27	2.46	-0.01	0.007	0	0.2	0.0	

Stage No.3 Excavate to elevation 12.73 on RIGHT side

(continued)

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
28	0.83	4.98	0.006	0	4.2	0.0	
		-5.03	0.006	0	4.2	0.0	
29	-0.79	-0.01	0.005	0	0.2	0.0	
30	-2.40	0.08	0.004	0	0.2	0.0	
31	-4.80	-0.01	0.004	0	0.3	0.0	
32	-7.20	-0.01	0.003	0	0.3	0.0	
33	-9.60	-0.01	0.003	0	0.3	0.0	
34	-12.00	-0.01	0.003	0	0.2	0.0	
35	-14.40	-0.01	0.002	0	0.2	0.0	
36	-16.80	-0.01	0.002	0	0.2	0.0	
37	-19.20	-0.01	0.002	0	0.2	0.0	
38	-21.60	-0.01	0.002	0	0.2	0.0	
39	-24.00	-0.01	0.002	0	0.2	0.0	
40	-26.40	-0.04	0.001	0	0.1	0.0	
41	-28.20	-0.00	0.001	0	0.1	0.0	
42	-30.00	-0.09	0.000	0	0.0	0.0	

LEFT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		

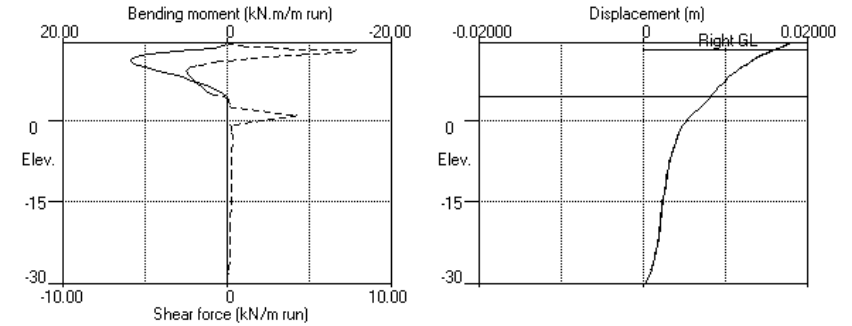
LEFT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		

RIGHT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		

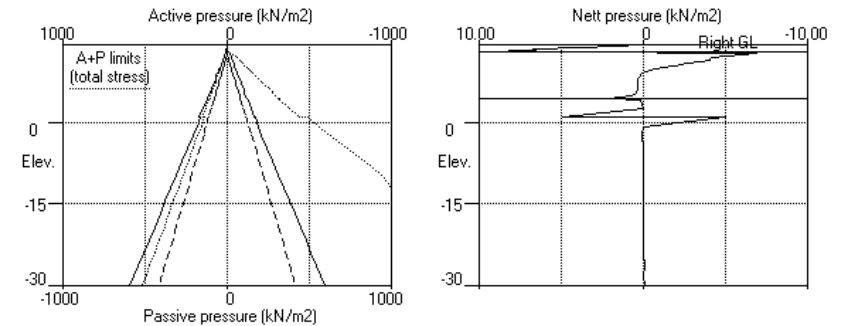
RIGHT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		

Units: kN,m

Stage No.3 Excav. to elev. 12.73 on RIGHT side



Stage No.3 Excav. to elev. 12.73 on RIGHT side



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 Data filename/Run ID: Whenuapai-GravityMain-SSMH11-CH561-v5
 Whenuapai - Gravity main - CH561
 Sheet pile STU1800 (v5)

Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Run ID. Whenuapai-GravityMain-SSMH11-CH561-v5
 Whenuapai - Gravity main - CH561
 Sheet pile STU1800 (v5)

Sheet No.
 Date: 4-05-2022
 Checked :

Gravity main
 Ch561

(continued)

Stage No.5 Apply water pressure profile no.3

Units: kN,m
 Stage No. 5 Apply water pressure profile no.3

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
 Factor of safety on soil strength

		FoS for toe		Toe elev. for					
		elev. = 4.23		FoS = 1.500					
Stage	Ground level	Prop	Factor	Moment	Toe	Wall	Direction		
No.	Act.	Pass.	Elev.	of	elev.	Penetr	of		
				Safety	at elev.	-ation	failure		
5	14.23	12.73	13.23	4.998	n/a	11.96	-0.77	L to R	

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
 Analysis options

Length of wall perpendicular to section = 20.00m
 2-D finite element model. Active limit arching not modelled.
 Soil deformations are elastic until the active or passive limit is reached
 Open Tension Crack analysis - No
 All soil moduli were factored to take account of
 3-D effects due to the finite length of wall:
 Modulus factors - Left side = 1.06
 Right side = 1.06

Rigid boundaries: Left side 30.00 from wall Rough boundary
 Right side 30.00 from wall Rough boundary
 Lower rigid boundary at elevation -30.00 Rough boundary

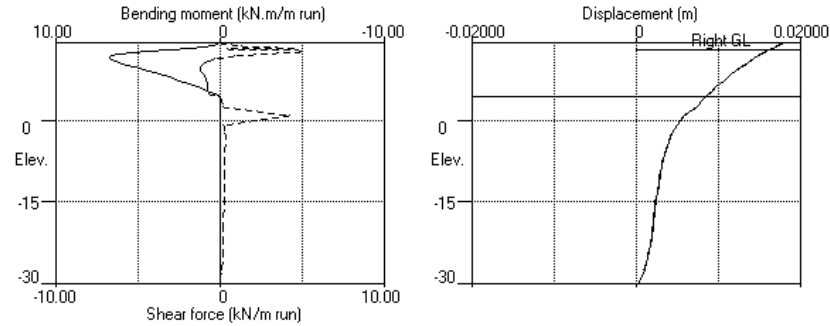
Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	14.23	0.00	0.018	1.24E-03	0.0	0.0	
2	13.73	4.98	0.017	1.24E-03	1.2	0.3	
3	13.38	7.61	0.017	1.24E-03	3.4	1.2	
		6.34	0.017	1.24E-03	3.4	1.2	
4	13.23	7.16	0.017	1.23E-03	4.5	1.8	-4.0
		7.16	0.017	1.23E-03	0.4	1.8	
5	12.73	10.27	0.016	1.21E-03	4.8	3.1	
		7.15	0.016	1.21E-03	4.8	3.1	
6	12.50	-6.00	0.016	1.20E-03	4.9	4.4	
7	11.98	-5.02	0.015	1.16E-03	2.0	6.3	
8	11.69	-3.33	0.015	1.13E-03	0.8	6.7	
9	11.19	-1.48	0.014	1.08E-03	-0.4	6.7	
10	10.98	-0.47	0.014	1.06E-03	-0.6	6.6	
11	10.65	-0.90	0.014	1.02E-03	-0.8	6.4	
12	10.32	-0.53	0.013	9.94E-04	-1.0	6.1	
13	9.98	-0.27	0.013	9.64E-04	-1.2	5.7	
14	9.65	-0.12	0.013	9.36E-04	-1.2	5.3	
15	9.40	0.02	0.012	9.16E-04	-1.3	5.0	
16	9.15	0.07	0.012	8.97E-04	-1.2	4.7	
17	8.95	0.30	0.012	8.83E-04	-1.2	4.4	
18	8.38	0.18	0.012	8.47E-04	-1.1	3.7	
19	7.80	0.18	0.011	8.17E-04	-1.0	3.1	
20	7.20	0.12	0.011	7.91E-04	-0.9	2.5	
21	6.60	0.06	0.010	7.71E-04	-0.8	1.9	
22	6.00	0.03	0.010	7.55E-04	-0.8	1.4	
23	5.40	0.03	0.009	7.45E-04	-0.8	0.9	
24	4.82	0.28	0.009	7.39E-04	-0.7	0.4	
25	4.23	1.63	0.008	7.37E-04	-0.1	-0.0	
26	4.08	0.21	0.008	0	0.0	0.0	

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
27	2.46	-0.01	0.007	0	0.2	0.0	
28	0.83	4.98	0.006	0	4.2	0.0	
		-5.03	0.006	0	4.2	0.0	
29	-0.79	-0.01	0.005	0	0.2	0.0	
30	-2.40	0.08	0.004	0	0.2	0.0	
31	-4.80	-0.01	0.004	0	0.3	0.0	
32	-7.20	-0.01	0.003	0	0.3	0.0	
33	-9.60	-0.01	0.003	0	0.3	0.0	
34	-12.00	-0.01	0.003	0	0.2	0.0	
35	-14.40	-0.01	0.002	0	0.2	0.0	
36	-16.80	-0.01	0.002	0	0.2	0.0	
37	-19.20	-0.01	0.002	0	0.2	0.0	
38	-21.60	-0.01	0.002	0	0.2	0.0	
39	-24.00	-0.01	0.002	0	0.2	0.0	
40	-26.40	-0.04	0.001	0	0.1	0.0	
41	-28.20	-0.00	0.001	0	0.1	0.0	
42	-30.00	-0.09	0.000	0	0.0	0.0	
At elev. 13.23		Prop force = 4.0 kN/m run					

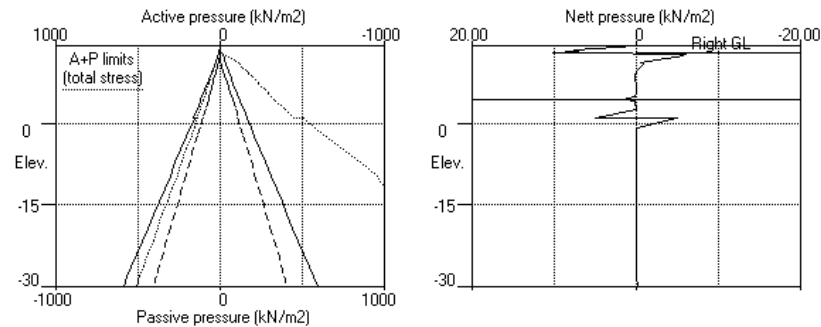
		LEFT side						
Node	Y	Water	Vertic	Effective stresses		Earth	Total earth	Adjusted soil
				Active	Passive			
		LEFT side						
Node	Y	Water	Vertic	Effective stresses		Earth	Total earth	Adjusted soil
				Active	Passive			
		RIGHT side						
Node	Y	Water	Vertic	Effective stresses		Earth	Total earth	Adjusted soil
				Active	Passive			
		RIGHT side						
Node	Y	Water	Vertic	Effective stresses		Earth	Total earth	Adjusted soil
				Active	Passive			

Units: kN,m

Stage No.5 Apply water pressure profile no.3



Stage No.5 Apply water pressure profile no.3



Units: kN,m

Stage No. 6 Excavate to elevation 11.19 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Prop Elev. Pass.	FoS for toe Factor of Safety	Toe elev. for Moment equil. at elev. n/a	Toe elev. for Wall Penetr. 4.18	Direction of failure L to R
6	14.23	11.19	13.23	2.112	7.01	

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.06
Right side = 1.05

Rigid boundaries: Left side 30.00 from wall
Right side 30.00 from wall
Lower rigid boundary at elevation -30.00
Rough boundary
Rough boundary
Rough boundary

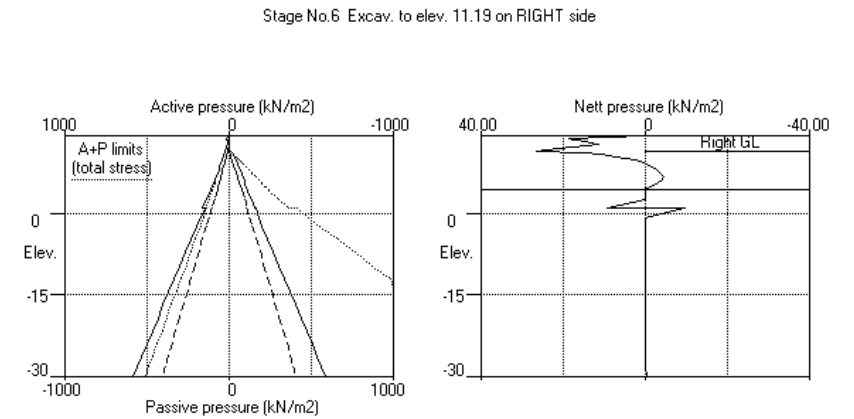
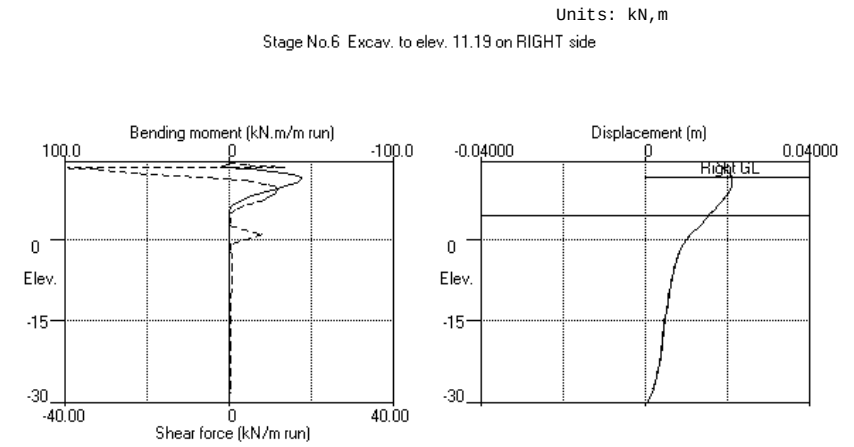
Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	14.23	0.00	0.017	-1.35E-03	0.0	-0.0	
2	13.73	18.69	0.018	-1.35E-03	4.7	0.3	
3	13.38	17.73	0.018	-1.36E-03	11.0	3.2	
		16.45	0.018	-1.36E-03	11.0	3.2	
4	13.23	14.12	0.019	-1.37E-03	13.3	5.1	-52.7
		14.12	0.019	-1.37E-03	-39.3	5.1	
5	12.73	13.89	0.019	-1.34E-03	-32.3	-12.6	
6	12.50	11.43	0.020	-1.28E-03	-29.4	-19.5	
7	11.98	17.63	0.020	-1.07E-03	-21.8	-32.9	
8	11.69	21.01	0.020	-9.15E-04	-16.2	-38.5	
9	11.19	26.76	0.021	-5.98E-04	-4.3	-43.7	
10	10.98	15.60	0.021	-4.55E-04	0.1	-44.1	
11	10.65	10.87	0.021	-2.31E-04	4.5	-43.2	
12	10.32	7.32	0.021	-1.57E-05	7.6	-41.1	
13	9.98	4.75	0.021	1.87E-04	9.6	-38.2	
14	9.65	2.85	0.021	3.74E-04	10.8	-34.7	
15	9.40	1.60	0.021	5.03E-04	11.4	-31.9	
16	9.15	0.62	0.021	6.20E-04	11.7	-29.0	
17	8.95	-0.04	0.021	7.07E-04	11.7	-26.7	
18	8.38	-1.53	0.020	9.14E-04	11.3	-20.0	
19	7.80	-2.63	0.020	1.06E-03	10.1	-13.8	
20	7.20	-3.55	0.019	1.16E-03	8.2	-8.3	
21	6.60	-4.37	0.018	1.22E-03	5.9	-4.1	
22	6.00	-3.90	0.017	1.24E-03	3.4	-1.4	
23	5.40	-2.71	0.017	1.25E-03	1.4	-0.1	
24	4.82	-1.43	0.016	1.25E-03	0.2	0.2	
25	4.23	0.65	0.015	1.25E-03	-0.0	0.0	
26	4.08	0.25	0.015	0	0.0	0.0	
27	2.46	-0.00	0.013	0	0.2	0.0	

Stage No.6 Excavate to elevation 11.19 on RIGHT side

(continued)

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
28	0.83	9.55	0.011	0	8.0	0.0	
		-9.61	0.011	0	8.0	0.0	
29	-0.79	0.00	0.009	0	0.2	0.0	
30	-2.40	0.14	0.008	0	0.3	0.0	
31	-4.80	0.00	0.007	0	0.5	0.0	
32	-7.20	-0.00	0.006	0	0.5	0.0	
33	-9.60	-0.01	0.006	0	0.5	0.0	
34	-12.00	-0.01	0.005	0	0.5	0.0	
35	-14.40	-0.01	0.005	0	0.4	0.0	
36	-16.80	-0.01	0.004	0	0.4	0.0	
37	-19.20	-0.01	0.004	0	0.4	0.0	
38	-21.60	-0.01	0.004	0	0.4	0.0	
39	-24.00	-0.01	0.003	0	0.3	0.0	
40	-26.40	-0.07	0.002	0	0.2	0.0	
41	-28.20	-0.01	0.002	0	0.2	0.0	
42	-30.00	-0.18	0.000	0	0.0	0.0	
At elev. 13.23		Prop force = 52.7 kN/m run					

LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Adjusted soil
LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Adjusted soil
RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Adjusted soil
RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Adjusted soil



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Whenuapai - Gravity main - CH561
Sheet pile STU1800 (v5)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m
Stage No. 8 Apply water pressure profile no.5

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

FoS for toe elev. = 4.23 Toe elev. for FoS = 1.500
Stage Ground level Prop Factor Moment Toe Wall Direction
No. Act. Pass. Elev. of equil. elev. Penetr of failure
8 14.23 11.19 More than one prop. No FoS calc.

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.06
Right side = 1.05

Rigid boundaries: Left side 30.00 from wall Rough boundary
Right side 30.00 from wall Rough boundary
Lower rigid boundary at elevation -30.00 Rough boundary

Node no.	Y coord	Nett pressure kN/m ²	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	14.23	0.00	0.017	-1.55E-03	0.0	-0.0	
2	13.73	20.04	0.018	-1.55E-03	5.0	0.3	
3	13.38	18.93	0.018	-1.56E-03	11.8	3.4	
		17.65	0.018	-1.56E-03	11.8	3.4	
4	13.23	15.19	0.019	-1.57E-03	14.3	5.4	-51.7
		15.19	0.019	-1.57E-03	-37.4	5.4	
5	12.73	14.81	0.019	-1.55E-03	-29.9	-11.2	
6	12.50	12.17	0.020	-1.50E-03	-26.8	-17.5	
7	11.98	17.79	0.020	-1.31E-03	-19.0	-29.5	
8	11.69	20.66	0.021	-1.17E-03	-13.4	-34.2	-7.7
		20.66	0.021	-1.17E-03	-21.1	-34.2	
9	11.19	25.71	0.021	-8.80E-04	-9.5	-41.9	
10	10.98	15.33	0.021	-7.42E-04	-5.2	-43.4	
11	10.65	11.07	0.022	-5.17E-04	-0.8	-44.3	
12	10.32	8.17	0.022	-2.90E-04	2.4	-43.9	
13	9.98	6.36	0.022	-6.84E-05	4.8	-42.7	
14	9.65	5.33	0.022	1.45E-04	6.7	-40.7	
15	9.40	4.73	0.022	2.99E-04	8.0	-38.9	
16	9.15	4.48	0.022	4.45E-04	9.1	-36.7	
17	8.95	4.34	0.022	5.55E-04	10.0	-34.8	
18	8.38	1.53	0.021	8.36E-04	11.7	-28.4	
19	7.80	-0.80	0.021	1.05E-03	11.9	-21.6	
20	7.20	-2.83	0.020	1.22E-03	10.8	-14.7	
21	6.60	-4.44	0.019	1.33E-03	8.6	-8.8	
22	6.00	-4.39	0.018	1.39E-03	6.0	-4.5	
23	5.40	-3.59	0.018	1.42E-03	3.6	-1.8	
24	4.82	-2.80	0.017	1.43E-03	1.7	-0.4	
25	4.23	-2.46	0.016	1.43E-03	0.2	0.0	
26	4.08	0.25	0.016	0	0.0	0.0	

Run ID. Whenuapai-GravityMain-SSMH11-CH561-v5
Whenuapai - Gravity main - CH561
Sheet pile STU1800 (v5)

Sheet No.
Date: 4-05-2022
Checked :

Gravity main
Ch561

Stage No.8 Apply water pressure profile no.5

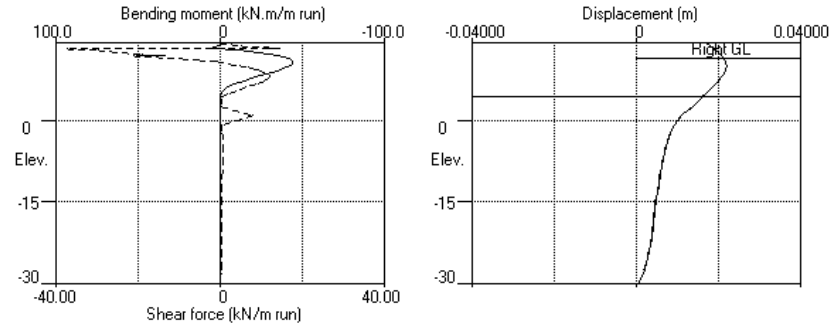
(continued)

Node no.	Y coord	Nett pressure kN/m ²	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
27	2.46	-0.00	0.014	0	0.2	0.0	
28	0.83	9.55	0.011	0	8.0	0.0	
		-9.61	0.011	0	8.0	0.0	
29	-0.79	0.00	0.009	0	0.2	0.0	
30	-2.40	0.14	0.008	0	0.3	0.0	
31	-4.80	0.00	0.007	0	0.5	0.0	
32	-7.20	-0.00	0.006	0	0.5	0.0	
33	-9.60	-0.01	0.006	0	0.5	0.0	
34	-12.00	-0.01	0.005	0	0.5	0.0	
35	-14.40	-0.01	0.005	0	0.4	0.0	
36	-16.80	-0.01	0.004	0	0.4	0.0	
37	-19.20	-0.01	0.004	0	0.4	0.0	
38	-21.60	-0.01	0.004	0	0.4	0.0	
39	-24.00	-0.01	0.003	0	0.3	0.0	
40	-26.40	-0.07	0.002	0	0.2	0.0	
41	-28.20	-0.01	0.002	0	0.2	0.0	
42	-30.00	-0.18	0.000	0	0.0	0.0	
At elev. 13.23		Prop force =		51.7 kN/m run			
At elev. 11.69		Prop force =		7.7 kN/m run			

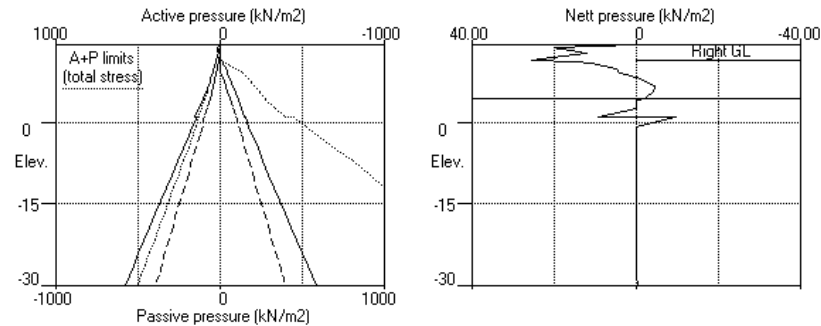
LEFT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		
LEFT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		
RIGHT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		
RIGHT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		

Units: kN,m

Stage No.8 Apply water pressure profile no.5



Stage No.8 Apply water pressure profile no.5



Units: kN,m

Stage No. 9 Excavate to elevation 9.15 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Prop. Pass.	FoS for toe elev. = 4.23	Factor of Safety at elev. More than one prop.	Toe elev. for FoS = 1.500	Wall Penetr. -ation	Direction of failure
9	14.23	9.15				No FoS calc.	

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.06
Right side = 1.04

Rigid boundaries: Left side 30.00 from wall
Right side 30.00 from wall
Lower rigid boundary at elevation -30.00
Rough boundary
Rough boundary
Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	14.23	0.00	0.014	-4.24E-03	0.0	-0.0	
2	13.73	38.30	0.016	-4.24E-03	9.6	0.3	
3	13.38	35.26	0.018	-4.26E-03	22.4	6.1	
		33.98	0.018	-4.26E-03	22.4	6.1	
4	13.23	30.07	0.018	-4.28E-03	27.3	9.9	-43.7
		30.07	0.018	-4.28E-03	-16.4	9.9	
5	12.73	27.79	0.020	-4.34E-03	-2.0	5.7	
6	12.50	22.86	0.021	-4.36E-03	3.9	6.1	
7	11.98	26.22	0.024	-4.43E-03	16.6	11.5	
8	11.69	25.67	0.025	-4.49E-03	24.1	17.5	-112.7
		25.67	0.025	-4.49E-03	-88.6	17.5	
9	11.19	27.01	0.027	-4.47E-03	-75.4	-23.4	
10	10.98	27.40	0.028	-4.37E-03	-69.7	-38.6	
11	10.65	30.78	0.030	-4.11E-03	-60.0	-60.1	
12	10.32	34.13	0.031	-3.76E-03	-49.2	-78.2	
13	9.98	37.47	0.032	-3.32E-03	-37.3	-92.6	
14	9.65	40.80	0.033	-2.82E-03	-24.3	-102.8	
15	9.40	43.30	0.034	-2.41E-03	-13.8	-107.6	
16	9.15	45.79	0.034	-2.00E-03	-2.7	-109.7	
17	8.95	31.26	0.035	-1.66E-03	5.0	-109.3	
18	8.38	20.77	0.035	-7.25E-04	20.0	-101.8	
19	7.80	10.25	0.036	1.12E-04	28.9	-87.0	
20	7.20	-0.77	0.035	8.29E-04	31.8	-67.9	
21	6.60	-5.00	0.035	1.37E-03	30.0	-49.1	
22	6.00	-7.07	0.034	1.74E-03	26.4	-32.1	
23	5.40	-8.95	0.032	1.97E-03	21.6	-17.6	
24	4.82	-12.75	0.031	2.08E-03	15.3	-6.6	
25	4.23	-31.34	0.030	2.11E-03	2.4	0.0	
26	4.08	0.25	0.029	0	0.0	0.0	

Stage No.9 Excavate to elevation 9.15 on RIGHT side

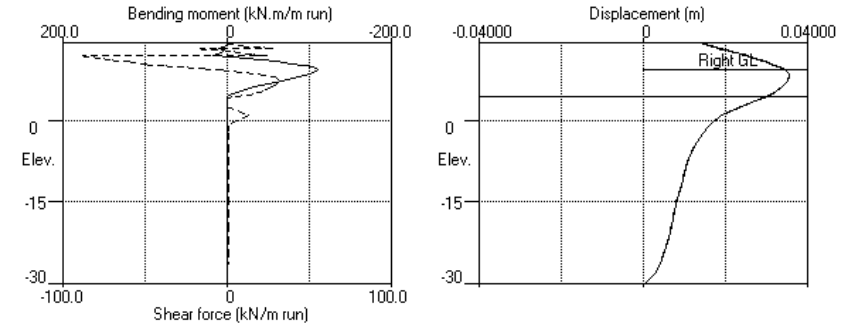
(continued)

Node no.	Y coord	Nett pressure kN/m ²	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
27	2.46	0.01	0.024	0	0.2	0.0	
28	0.83	15.80	0.019	0	13.1	0.0	
		-15.87	0.019	0	13.1	0.0	
29	-0.79	0.01	0.016	0	0.3	0.0	
30	-2.40	0.20	0.014	0	0.4	0.0	
31	-4.80	0.02	0.012	0	0.7	0.0	
32	-7.20	0.01	0.011	0	0.7	0.0	
33	-9.60	-0.00	0.010	0	0.8	0.0	
34	-12.00	-0.01	0.009	0	0.7	0.0	
35	-14.40	-0.01	0.008	0	0.7	0.0	
36	-16.80	-0.02	0.008	0	0.7	0.0	
37	-19.20	-0.02	0.007	0	0.7	0.0	
38	-21.60	-0.02	0.006	0	0.6	0.0	
39	-24.00	-0.02	0.005	0	0.6	0.0	
40	-26.40	-0.12	0.004	0	0.4	0.0	
41	-28.20	-0.01	0.003	0	0.3	0.0	
42	-30.00	-0.31	0.000	0	0.0	0.0	
At elev. 13.23		Prop force = 43.7 kN/m run					
At elev. 11.69		Prop force = 112.7 kN/m run					

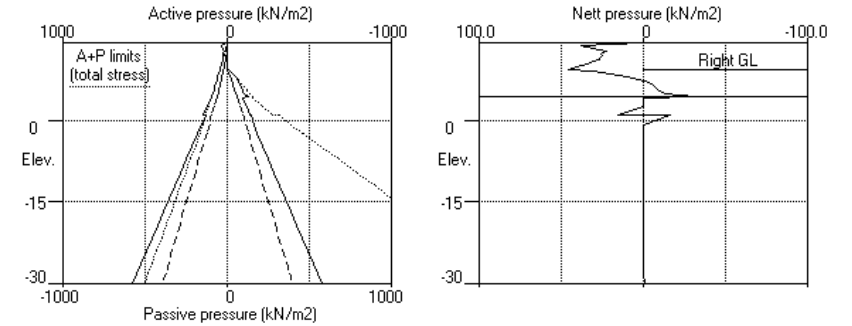
LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Adjusted soil
LEFT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Adjusted soil
RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Adjusted soil
RIGHT side							
Effective stresses							
Node	Y	Water	Vertic	Active	Passive	Earth	Adjusted soil

Units: kN,m

Stage No.9 Excav. to elev. 9.15 on RIGHT side

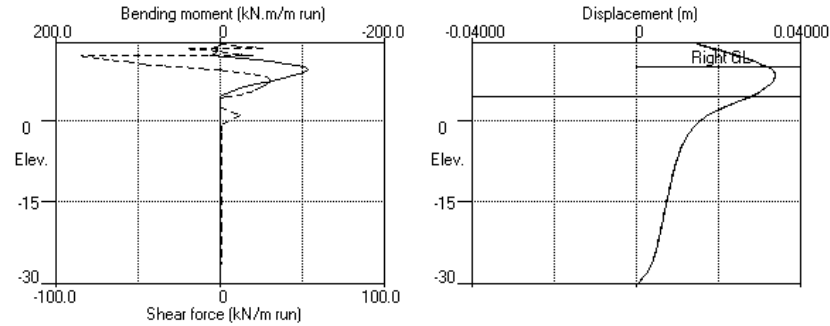


Stage No.9 Excav. to elev. 9.15 on RIGHT side

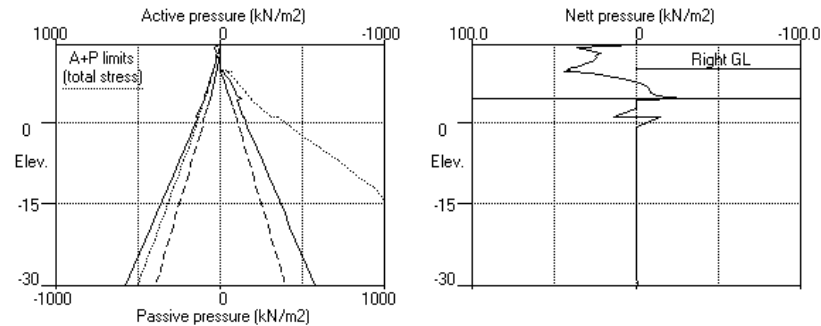


Units: kN,m

Stage No.10 Fill to elev. 9.65 on RIGHT side



Stage No.10 Fill to elev. 9.65 on RIGHT side



Units: kN,m

Stage No. 11 Apply water pressure profile no.1

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Prop Pass.	FoS for toe elev. = 4.23	Factor of Safety	Moment of equil. at elev.	Toe elev. for Wall Penetr. -ation	Direction of failure
11	14.23	9.65	More than one prop.	No	FoS calc.		

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m

2-D finite element model. Active limit arching not modelled.

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

All soil moduli were factored to take account of

3-D effects due to the finite length of wall:

Modulus factors - Left side = 1.06

Right side = 1.05

Rigid boundaries: Left side 30.00 from wall

Right side 30.00 from wall

Lower rigid boundary at elevation -30.00

Rough boundary

Rough boundary

Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	14.23	0.00	0.014	-4.20E-03	0.0	-0.0	
2	13.73	37.54	0.016	-4.20E-03	9.4	0.3	
3	13.38	35.70	0.018	-4.22E-03	22.2	6.0	
		34.16	0.018	-4.22E-03	22.2	6.0	
4	13.23	30.56	0.018	-4.24E-03	27.1	9.8	-48.4
		30.56	0.018	-4.24E-03	-21.3	9.8	
5	12.73	29.75	0.021	-4.29E-03	-6.3	3.2	
6	12.50	25.41	0.022	-4.30E-03	0.1	2.7	
7	11.98	28.63	0.024	-4.33E-03	14.1	6.5	
8	11.69	27.99	0.025	-4.37E-03	22.3	11.8	-114.8
		27.99	0.025	-4.37E-03	-92.5	11.8	
9	11.19	30.84	0.027	-4.30E-03	-77.8	-30.7	
10	10.98	32.96	0.028	-4.18E-03	-71.1	-46.3	
11	10.65	36.29	0.029	-3.88E-03	-59.6	-68.0	
12	10.32	39.60	0.031	-3.49E-03	-47.0	-85.6	
13	9.98	42.89	0.032	-3.02E-03	-33.2	-99.0	
14	9.65	46.17	0.033	-2.49E-03	-18.4	-107.5	
15	9.40	40.89	0.033	-2.07E-03	-7.6	-110.7	
16	9.15	41.39	0.034	-1.64E-03	2.7	-111.3	
		43.52	0.034	-1.64E-03	2.7	-111.3	
17	8.95	28.15	0.034	-1.30E-03	9.9	-110.0	
18	8.38	17.98	0.035	-3.68E-04	23.2	-100.1	
19	7.80	7.88	0.034	4.48E-04	30.6	-84.0	
20	7.20	-2.77	0.034	1.13E-03	32.1	-64.3	
21	6.60	-6.36	0.033	1.64E-03	29.4	-45.7	
22	6.00	-7.91	0.032	1.99E-03	25.1	-29.3	
23	5.40	-9.29	0.031	2.20E-03	19.9	-15.8	
24	4.82	-12.19	0.029	2.29E-03	13.7	-5.8	
25	4.23	-27.48	0.028	2.32E-03	2.1	0.0	

Sheet No.
Date: 4-05-2022
Checked :

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Stage No.11 Apply water pressure profile no.1

Units: kN,m

At elev. 13.23	Prop force =	48.4 kN/m run
At elev. 11.69	Prop force =	114.8 kN/m run

The figure consists of two side-by-side plots sharing a common vertical axis labeled 'Elev.' with values 0, -15, and -30.

The left plot is titled 'Bending moment (kN.m/m run)' and 'Shear force (kN/m run)'. The horizontal axis for bending moment ranges from -200.0 to 200.0, and for shear force from -100.0 to 100.0. The bending moment diagram shows a sharp peak at the top (Elev. 0) and a smaller peak around Elev. -10. The shear force diagram shows a constant value of approximately -100 kN/m run from Elev. 0 to -10, and then drops to zero.

The right plot is titled 'Displacement (m)'. The horizontal axis ranges from -0.04000 to 0.04000. The displacement curve starts at zero at Elev. 0, reaches a maximum displacement of approximately 0.035 m at Elev. -10, and then returns to zero at Elev. -30. A label 'Right Gt.' is placed near the peak of the curve.

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Whenuapai - Gravity main - CH561
Sheet pile STU1800 (v5)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

<u>Stage</u> <u>No.</u>	<u>Ground</u> <u>Act.</u>	<u>level</u> <u>Pass.</u>	<u>Prop</u> <u>Elev.</u>	FoS for toe	Toe elev. for			<u>Direction</u> <u>of</u> <u>failure</u>
				elev. = 4.23	FoS = 1.500			
				<u>Factor</u> <u>of</u> <u>Safety</u>	<u>Moment</u> <u>at equilb.</u> <u>at elev.</u>	<u>Toe</u> <u>elev.</u>	<u>Wall</u> <u>Penetr</u> <u>-ation</u>	
1	14.23	14.23	Cant.	Conditions not suitable for FoS calc.				
2	14.23	14.23	Cant.	Conditions not suitable for FoS calc.				
3	14.23	12.73	Cant.	2.462	5.05	9.37	3.36	L to R
4	14.23	12.73		No analysis at this stage				
5	14.23	12.73	13.23	4.998	n/a	11.96	0.77	L to R
6	14.23	11.19	13.23	2.112	n/a	7.01	4.18	L to R
7	14.23	11.19		No analysis at this stage				
All remaining stages have more than one prop - FoS calculation n/a								

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Data filename/Run ID: Whenuapai-GravityMain-SSMH11-CH561-v5
Whenuapai - Gravity main - CH561
Sheet pile STU1800 (v5)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.06
Right side = 1.05

Rigid boundaries: Left side 30.00 from wall Rough boundary
Right side 30.00 from wall Rough boundary
Lower rigid boundary at elevation -30.00 Rough boundary

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement		Bending moment		Shear force	
		maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	14.23	0.018	0.000	0.0	-0.0	0.0	0.0
2	13.73	0.018	0.000	0.3	0.0	9.6	-0.6
3	13.38	0.018	0.000	6.1	-0.3	22.4	-1.4
4	13.23	0.019	0.000	9.9	-0.5	27.3	-39.3
5	12.73	0.021	0.000	5.7	-12.6	7.8	-32.3
6	12.50	0.022	0.000	6.3	-19.5	7.6	-29.4
7	11.98	0.024	0.000	11.5	-32.9	16.6	-21.8
8	11.69	0.025	0.000	17.5	-38.5	24.1	-92.5
9	11.19	0.027	0.000	11.7	-43.7	1.2	-77.8
10	10.98	0.028	0.000	11.8	-46.3	0.4	-71.1
11	10.65	0.030	0.000	11.8	-68.0	4.5	-60.0
12	10.32	0.031	0.000	11.4	-85.6	7.6	-49.2
13	9.98	0.032	0.000	10.8	-99.0	9.6	-37.3
14	9.65	0.033	0.000	10.1	-107.5	10.8	-24.3
15	9.40	0.034	0.000	9.5	-110.7	11.4	-13.8
16	9.15	0.034	0.000	8.9	-111.3	11.7	-2.7
17	8.95	0.035	0.000	8.4	-110.0	11.7	-2.5
18	8.38	0.035	0.000	7.0	-101.8	23.2	-2.4
19	7.80	0.036	0.000	5.6	-87.0	30.6	-2.2
20	7.20	0.035	0.000	4.3	-67.9	32.1	-2.0
21	6.60	0.035	0.000	3.1	-49.1	30.0	-1.8
22	6.00	0.034	0.000	2.1	-32.1	26.4	-1.6
23	5.40	0.032	0.000	1.2	-17.6	21.6	-1.3
24	4.82	0.031	0.000	0.5	-6.6	15.3	-1.0
25	4.23	0.030	0.000	0.0	-0.0	2.4	-0.2
26	4.08	0.029	0.000	0.0	0.0	0.0	0.0
27	2.46	0.024	0.000	0.0	0.0	0.2	0.0
28	0.83	0.019	0.000	0.0	0.0	13.1	0.0
29	-0.79	0.016	0.000	0.0	0.0	0.3	0.0
30	-2.40	0.014	0.000	0.0	0.0	0.4	0.0
31	-4.80	0.012	0.000	0.0	0.0	0.7	0.0
32	-7.20	0.011	0.000	0.0	0.0	0.7	0.0
33	-9.60	0.010	0.000	0.0	0.0	0.8	0.0
34	-12.00	0.009	0.000	0.0	0.0	0.7	0.0
35	-14.40	0.008	0.000	0.0	0.0	0.7	0.0
36	-16.80	0.008	0.000	0.0	0.0	0.7	0.0
37	-19.20	0.007	0.000	0.0	0.0	0.7	0.0
38	-21.60	0.006	0.000	0.0	0.0	0.6	0.0
39	-24.00	0.005	0.000	0.0	0.0	0.6	0.0

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement		Bending moment		Shear force	
		maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
40	-26.40	0.004	0.000	0.0	0.0	0.4	0.0
41	-28.20	0.003	0.000	0.0	0.0	0.3	0.0
42	-30.00	0.000	0.000	0.0	0.0	0.0	0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment				Shear force			
	maximum	elev.	minimum	elev.	maximum	elev.	minimum	elev.
	kN.m/m		kN.m/m		kN/m		kN/m	
1	0.0	13.73	-2.2	10.98	0.6	8.38	-1.2	12.73
2	0.0	13.73	-3.7	10.98	1.0	8.38	-2.0	12.50
3	11.8	10.98	-0.0	4.23	7.8	12.73	-2.5	8.95
4	No calculation at this stage							
5	6.7	11.19	-0.0	4.23	4.9	12.50	-1.3	9.40
6	5.1	13.23	-44.1	10.98	13.3	13.23	-39.3	13.23
7	No calculation at this stage							
8	5.4	13.23	-44.3	10.65	14.3	13.23	-37.4	13.23
9	17.5	11.69	-109.7	9.15	31.8	7.20	-88.6	11.69
10	11.6	11.69	-106.2	9.15	30.7	7.20	-84.4	11.69
11	11.8	11.69	-111.3	9.15	32.1	7.20	-92.5	11.69

Maximum and minimum displacement at each stage

Stage no.	Displacement				Stage description
	maximum	elev.	minimum	elev.	
	m		m		
1	0.002	14.23	0.000	14.23	Apply surcharge no.1 at elev. 14.23
2	0.003	12.73	0.000	14.23	Apply water pressure profile no.4
3	0.018	14.23	0.000	14.23	Excav. to elev. 12.73 on RIGHT side
4	No calculation at this stage				Install prop no.1 at elev. 13.23
5	0.018	14.23	0.000	14.23	Apply water pressure profile no.3
6	0.021	10.32	0.000	14.23	Excav. to elev. 11.19 on RIGHT side
7	No calculation at this stage				Install prop no.2 at elev. 11.69
8	0.022	9.98	0.000	14.23	Apply water pressure profile no.5
9	0.036	7.80	0.000	14.23	Excav. to elev. 9.15 on RIGHT side
10	0.034	7.80	0.000	14.23	Fill to elev. 9.65 on RIGHT side
11	0.035	8.38	0.000	14.23	Apply water pressure profile no.1

Prop forces at each stage (horizontal components)

Stage no.	Anchor no. 1 --- at elev. 13.23		Anchor no. 2 --- at elev. 11.69	
	kN/m run	kN/prop	kN/m run	kN/prop
5	4.05	8.09	---	---
6	52.65	105.30	---	---
8	51.67	103.35	7.72	15.44
9	43.69	87.38	112.72	225.45
10	44.80	89.60	104.05	208.11
11	48.40	96.80	114.83	229.66

Units: kN.m

SOIL PROFILE

SOIL PROPERTIES

Additional soil parameters associated with Ka and Kp

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m^3

	Left side	Right side
Initial water table elevation	7.75	7.75

Automatic water pressure balancing at toe of wall : Yes

Water press. profile no.	Left side				Right side			
	Point no.	Elev.	Piezo elev.	Water press.	Point no.	Elev.	Piezo elev.	Water press.
		m	m	kN/m2		m	m	kN/m2
1	1	9.25	9.25	0.0	1	0.95	0.95	0.0
2	1	7.75	7.75	0.0	1	0.60	0.60	0.0

```

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 0.35
Maximum finite element length = 0.50 m
Youngs modulus of wall E = 2.0000E+08 kN/m2
Moment of inertia of wall I = 3.2400E-04 m4/m run
(Sumitomo SX18) E.I = 64800 kN.m2/m run
Yield Moment of wall = Not defined

```

STRUTS and ANCHORS

SURCHARGE LOADS

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 9.75
2	Excavate to elevation 8.25 on RIGHT side
3	Install strut or anchor no.1 at elevation 9.25
4	Excavate to elevation 0.85 on RIGHT side
5	Apply water pressure profile no.2
6	Install strut or anchor no.2 at elevation 1.85
7	Fill to elevation 1.10 on RIGHT side with soil type 6
8	Apply water pressure profile no.1

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - Strength Factor method
Factor on soil strength for calculating wall depth = 1.50

Parameters for undrained strata:
 Minimum equivalent fluid density = 5.00 kN/m3
 Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:
 Method - 2-D finite element model
 Open Tension Crack analysis? - No
 Active limit arching modelled? - No
 Non-linear Modulus Parameter (L) = 9.400 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 20.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 30.00 m
Distance to rigid boundary on Right side = 30.00 m
Elevation of rigid lower boundary = -30.00

Lower rigid boundary at elevation -30.00 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Smooth

Pump station
Wet wells

OUTPUT OPTIONS

Stage no.	Stage description	Displacement Bending mom. Shear force	Output options Active, Passive pressures	Graph. output
1	Apply surcharge no.1 at elev. 9.75	Yes	Yes	Yes
2	Excav. to elev. 8.25 on RIGHT side	Yes	Yes	Yes
3	Install prop no.1 at elev. 9.25	Yes	Yes	Yes
4	Excav. to elev. 0.85 on RIGHT side	Yes	Yes	Yes
5	Apply water pressure profile no.2	Yes	Yes	Yes
6	Install prop no.2 at elev. 1.85	Yes	Yes	Yes
7	Fill to elev. 1.10 on RIGHT side	Yes	Yes	Yes
8	Apply water pressure profile no.1	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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Data filename/Run ID: Whenuapai-PumpStation-Section_1v4dat

Whenuapai pump station

Section 1 - wet well - sheet pile STU1800 (v5)

Sheet No.

Job No. 1013050

Made by : op

Date: 4-05-2022

Checked :

Pump station
Wet wells

Units: kN,m

Stage No. 1 Apply surcharge no.1 at elevation 9.75

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Prop Pass.	FoF Factor of Safety	FoF for toe elev. = 0.35 Moment of equilib. at elev. Conditions not suitable for FoS calc.	Toe elev. for FoS = 1.500 Wall Penetr. -ation failure	Direction of failure
1	9.75	9.75	Cant.			

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m

2-D finite element model. Active limit arching not modelled.

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

All soil moduli were factored to take account of

3-D effects due to the finite length of wall:

Modulus factors - Left side = 1.06

Right side = 1.06

Rigid boundaries: Left side 30.00 from wall Rough boundary
Right side 30.00 from wall Rough boundary
Lower rigid boundary at elevation -30.00 Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	9.75	0.00	0.001	1.01E-04	0.0	0.0	
2	9.35	-6.99	0.001	1.01E-04	-1.4	0.0	
		-1.77	0.001	1.01E-04	-1.4	0.0	
3	9.25	-1.36	0.001	1.01E-04	-1.6	-0.1	
4	8.75	0.77	0.001	1.05E-04	-1.7	-1.0	
5	8.25	1.90	0.001	1.16E-04	-1.0	-1.7	
6	7.75	2.46	0.001	1.30E-04	0.1	-2.0	
7	7.30	2.74	0.001	1.42E-04	1.2	-1.7	
8	6.85	2.77	0.001	1.51E-04	2.5	-0.8	
		0.32	0.001	1.51E-04	2.5	-0.8	
9	6.58	0.77	0.001	1.53E-04	2.6	-0.2	
10	6.30	1.25	0.000	1.52E-04	2.9	0.6	
11	6.03	1.64	0.000	1.48E-04	3.3	1.4	
12	5.75	1.44	0.000	1.40E-04	3.7	2.4	
		-9.73	0.000	1.40E-04	3.7	2.4	
13	5.38	-5.67	0.000	1.24E-04	0.8	3.1	
14	5.00	-2.37	0.000	1.06E-04	-0.7	3.0	
15	4.50	-0.44	0.000	8.60E-05	-1.4	2.4	
16	4.00	0.67	0.000	7.07E-05	-1.3	1.6	
17	3.50	1.35	0.000	6.06E-05	-0.8	1.0	
18	3.00	1.96	0.000	5.37E-05	0.0	0.8	
19	2.63	2.80	0.000	4.89E-05	0.9	0.9	
20	2.25	1.50	0.000	4.22E-05	1.7	1.4	
		-7.09	0.000	4.22E-05	1.7	1.4	
21	1.85	-3.31	0.000	3.30E-05	-0.4	1.5	
22	1.48	-0.47	0.000	2.52E-05	-1.1	1.2	
23	1.10	0.20	0.000	1.98E-05	-1.1	0.7	
24	0.95	0.38	0.000	1.83E-05	-1.1	0.5	
25	0.85	0.48	0.000	1.75E-05	-1.1	0.4	

Run ID: Whenuapai-PumpStation-Section_1v4dat
 Whenuapai pump station
 Section 1 - wet well - sheet pile STU1800 (v5)

Sheet No.
 Date: 4-05-2022
 Checked :

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 Whenuapai pump station
 Section 1 - wet well - sheet pile STU1800 (v5)

Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Pump station
 Wet wells

Stage No.1 Apply surcharge no.1 at elevation 9.75

(continued)

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
26	0.60	0.88	0.000	1.63E-05	-0.9	0.2	
27	0.35	4.12	0.000	1.59E-05	-0.3	0.0	
28	0.22	0.05	0.000	0	0.0	0.0	
29	-0.89	-0.00	0.000	0	0.0	0.0	
30	-2.00	0.03	0.000	0	0.0	0.0	
31	-4.00	-0.01	0.000	0	0.1	0.0	
32	-6.00	-0.01	0.000	0	0.1	0.0	
33	-8.00	-0.00	0.000	0	0.0	0.0	
34	-10.00	-0.00	0.000	0	0.0	0.0	
35	-12.00	-0.00	0.000	0	0.0	0.0	
36	-14.00	-0.00	0.000	0	0.0	0.0	
37	-16.00	-0.00	0.000	0	0.0	0.0	
38	-18.00	-0.00	0.000	0	0.0	0.0	
39	-20.00	-0.00	0.000	0	0.0	0.0	
40	-22.00	-0.00	0.000	0	0.0	0.0	
41	-24.00	-0.00	0.000	0	0.0	0.0	
42	-26.00	-0.00	0.000	0	0.0	0.0	
43	-28.00	-0.00	0.000	0	0.0	0.0	
44	-30.00	-0.01	0.000	0	0.0	0.0	

LEFT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth		

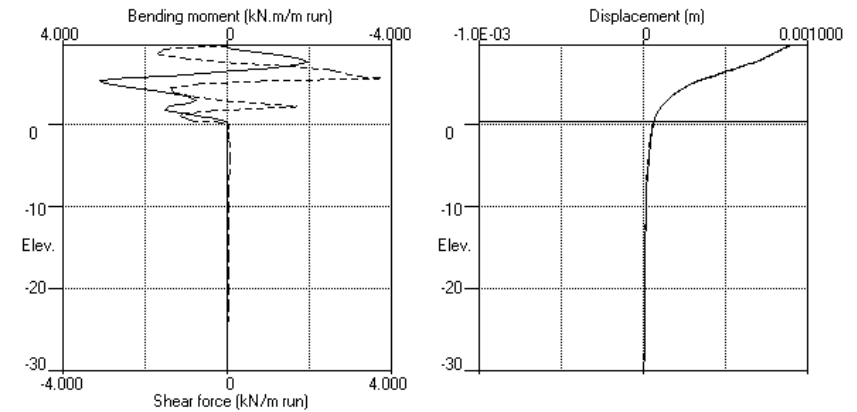
LEFT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth		

RIGHT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth		

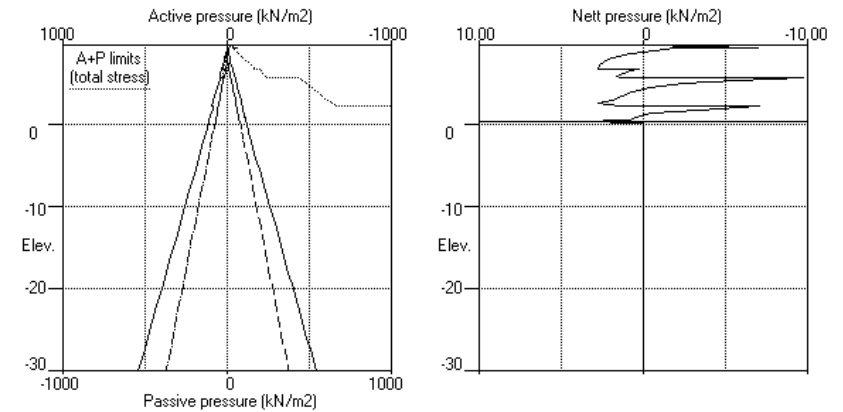
RIGHT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth		

Units: kN,m

Stage No.1 Apply surcharge no.1 at elev. 9.75



Stage No.1 Apply surcharge no.1 at elev. 9.75



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 Program: WALLAP Version 6.07 Revision A55.B74.R58
 Data filename/Run ID: Whenuapai-PumpStation-Section_1v4dat
 Whenuapai pump station
 Section 1 - wet well - sheet pile STU1800 (v5)

Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Run ID: Whenuapai-PumpStation-Section_1v4dat
 Whenuapai pump station
 Section 1 - wet well - sheet pile STU1800 (v5)

Sheet No.
 Date: 4-05-2022
 Checked :

Pump station
 Wet wells

(continued)

Stage No.2 Excavate to elevation 8.25 on RIGHT side

Units: kN,m
 Stage No. 2 Excavate to elevation 8.25 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
 Factor of safety on soil strength

		FoS for toe		Toe elev. for			
		elev. = 0.35		FoS = 1.500			
Stage	Ground level	Prop	Factor	Moment	Toe	Wall	Direction
No.	Act.	Pass.	Elev.	of	elev.	Penetr	of
				Safety	at elev.	-ation	failure
2	9.75	8.25	Cant.	4.356	1.28	5.48	2.77
							L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
 Analysis options

Length of wall perpendicular to section = 20.00m
 2-D finite element model. Active limit arching not modelled.
 Soil deformations are elastic until the active or passive limit is reached
 Open Tension Crack analysis - No
 All soil moduli were factored to take account of
 3-D effects due to the finite length of wall:
 Modulus factors - Left side = 1.06
 Right side = 1.05

Rigid boundaries: Left side 30.00 from wall Rough boundary
 Right side 30.00 from wall Rough boundary
 Lower rigid boundary at elevation -30.00 Rough boundary

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	9.75	0.00	0.007	1.48E-03	0.0	0.0	
2	9.35	1.85	0.007	1.48E-03	0.4	0.3	
3	9.25	2.69	0.007	1.48E-03	0.6	0.3	
4	8.75	6.66	0.006	1.48E-03	2.9	1.2	
5	8.25	10.03	0.005	1.46E-03	7.1	3.7	
		5.35	0.005	1.46E-03	7.1	3.7	
6	7.75	-0.32	0.004	1.41E-03	8.4	8.0	
7	7.30	3.68	0.004	1.34E-03	9.1	11.7	
8	6.85	5.03	0.003	1.25E-03	11.1	16.2	
		-9.55	0.003	1.25E-03	11.1	16.2	
9	6.58	-4.79	0.003	1.17E-03	9.1	18.9	
10	6.30	0.06	0.003	1.09E-03	8.5	21.2	
11	6.03	3.95	0.002	9.97E-04	9.0	23.5	
12	5.75	1.80	0.002	8.92E-04	9.8	26.2	
		-46.35	0.002	8.92E-04	9.8	26.2	
13	5.38	-28.22	0.002	7.39E-04	-4.2	26.6	
14	5.00	-8.41	0.001	5.96E-04	-11.0	23.0	
15	4.50	1.73	0.001	4.43E-04	-12.7	16.4	
16	4.00	6.54	0.001	3.40E-04	-10.7	10.3	
17	3.50	8.99	0.001	2.78E-04	-6.8	5.8	
18	3.00	11.61	0.001	2.43E-04	-1.6	3.5	
19	2.63	15.88	0.001	2.22E-04	3.5	3.7	
20	2.25	8.77	0.001	1.93E-04	8.2	6.1	
		-31.00	0.001	1.93E-04	8.2	6.1	
21	1.85	-16.00	0.000	1.53E-04	-1.2	6.9	
22	1.48	-2.80	0.000	1.17E-04	-4.8	5.3	
23	1.10	0.55	0.000	9.29E-05	-5.2	3.3	
24	0.95	1.44	0.000	8.60E-05	-5.0	2.6	
25	0.85	1.93	0.000	8.25E-05	-4.9	2.1	

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
26	0.60	3.96	0.000	7.67E-05	-4.1	0.9	
27	0.35	19.42	0.000	7.50E-05	-1.2	0.0	
28	0.22	0.07	0.000		0.0	0.0	
29	-0.89	-0.00	0.000		0.0	0.0	
30	-2.00	0.06	0.000		0.1	0.0	
31	-4.00	-0.00	0.000		0.1	0.0	
32	-6.00	-0.00	0.000		0.1	0.0	
33	-8.00	-0.00	0.000		0.1	0.0	
34	-10.00	-0.00	0.000		0.1	0.0	
35	-12.00	-0.00	0.000		0.1	0.0	
36	-14.00	-0.00	0.000		0.1	0.0	
37	-16.00	-0.00	0.000		0.1	0.0	
38	-18.00	-0.00	0.000		0.1	0.0	
39	-20.00	-0.00	0.000		0.1	0.0	
40	-22.00	-0.00	0.000		0.1	0.0	
41	-24.00	-0.00	0.000		0.1	0.0	
42	-26.00	-0.00	0.000		0.1	0.0	
43	-28.00	-0.00	0.000		0.1	0.0	
44	-30.00	-0.07	0.000		0.0	0.0	

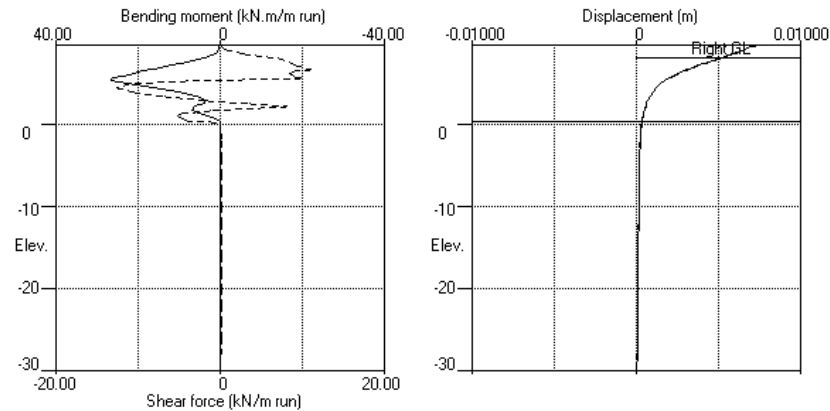
		LEFT side				Total earth	Adjusted soil
		Effective stresses					
Node	Y	Water	Vertic	Active	Passive	Earth	
		LEFT side				Total earth	Adjusted soil
		Effective stresses					
Node	Y	Water	Vertic	Active	Passive	Earth	
		RIGHT side				Total earth	Adjusted soil
		Effective stresses					
Node	Y	Water	Vertic	Active	Passive	Earth	
		RIGHT side				Total earth	Adjusted soil
		Effective stresses					
Node	Y	Water	Vertic	Active	Passive	Earth	

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 Data filename/Run ID: Whenuapai-PumpStation-Section_1v4dat
 Whenuapai pump station
 Section 1 - wet well - sheet pile STU1800 (v5)

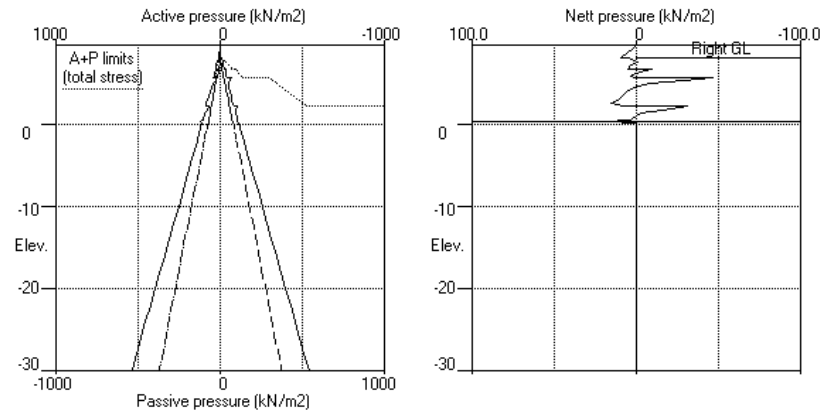
Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Units: kN,m

Stage No.2 Excav. to elev. 8.25 on RIGHT side



Stage No.2 Excav. to elev. 8.25 on RIGHT side



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 Data filename/Run ID: Whenuapai-PumpStation-Section_1v4dat
 Whenuapai pump station
 Section 1 - wet well - sheet pile STU1800 (v5)

Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Pump station
 Wet wells

Units: kN,m

Stage No. 4 Excavate to elevation 0.85 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
 Factor of safety on soil strength

Stage No.	Ground level Act.	Prop. Elev.	FoS for toe elev. = 0.35 Factor of Safety	Moment equilb. at elev. n/a	Toe elev. for FoS = 1.500 Toe elev. 0.77	Wall Penetr -ation 0.08	Direction of failure L to R
4	9.75	0.85	9.25	2.473	n/a	0.77	0.08

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m

2-D finite element model. Active limit arching not modelled.

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

All soil moduli were factored to take account of

3-D effects due to the finite length of wall:

Modulus factors - Left side = 1.06

Right side = 1.02

Rigid boundaries: Left side 30.00 from wall

Right side 30.00 from wall

Lower rigid boundary at elevation -30.00

Rough boundary

Rough boundary

Rough boundary

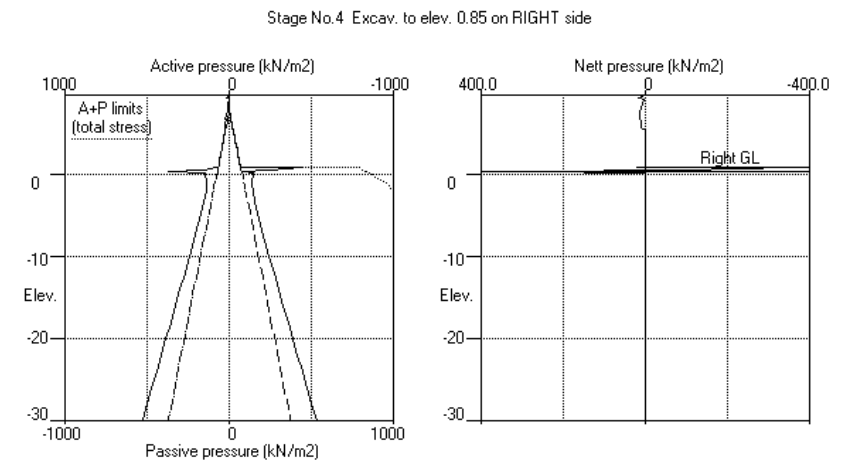
Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	9.75	0.00	0.010	-3.82E-04	0.0	-0.0	
2	9.35	17.99	0.011	-3.83E-04	3.6	0.3	
		5.08	0.011	-3.83E-04	3.6	0.3	
3	9.25	2.69	0.011	-3.83E-04	4.0	0.6	-29.4
		2.69	0.011	-3.83E-04	-25.4	0.6	
4	8.75	6.66	0.011	-3.42E-04	-23.1	-11.4	
5	8.25	10.03	0.011	-2.13E-04	-18.9	-21.9	
6	7.75	13.03	0.011	-1.49E-05	-13.1	-29.6	
7	7.30	14.15	0.011	2.06E-04	-7.0	-34.2	
8	6.85	15.17	0.011	4.49E-04	-0.4	-35.9	
		9.02	0.011	4.49E-04	-0.4	-35.9	
9	6.58	9.65	0.011	6.01E-04	2.2	-35.7	
10	6.30	10.26	0.010	7.51E-04	4.9	-34.8	
11	6.03	10.87	0.010	8.95E-04	7.8	-33.0	
12	5.75	11.48	0.010	1.02E-03	10.9	-30.5	
		0.00	0.010	1.02E-03	10.9	-30.5	
13	5.38	0.00	0.010	1.19E-03	10.9	-26.7	
14	5.00	0.00	0.009	1.33E-03	10.9	-22.8	
15	4.50	0.00	0.008	1.49E-03	10.9	-17.5	
16	4.00	0.00	0.008	1.60E-03	10.9	-12.1	
17	3.50	0.00	0.007	1.68E-03	10.9	-6.6	
18	3.00	0.00	0.006	1.71E-03	10.9	-1.1	
19	2.63	0.00	0.005	1.70E-03	10.9	2.9	
20	2.25	0.00	0.005	1.67E-03	10.9	7.1	
21	1.85	0.00	0.004	1.61E-03	10.9	11.3	
22	1.48	0.00	0.003	1.54E-03	10.9	15.2	
23	1.10	0.00	0.003	1.44E-03	10.9	19.3	
24	0.95	0.00	0.003	1.39E-03	10.9	20.9	
25	0.85	22.86	0.002	1.36E-03	12.0	22.0	
		-351.37	0.002	1.36E-03	12.0	22.0	

Sheet No.
Date: 4-05-2022
Checked :

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

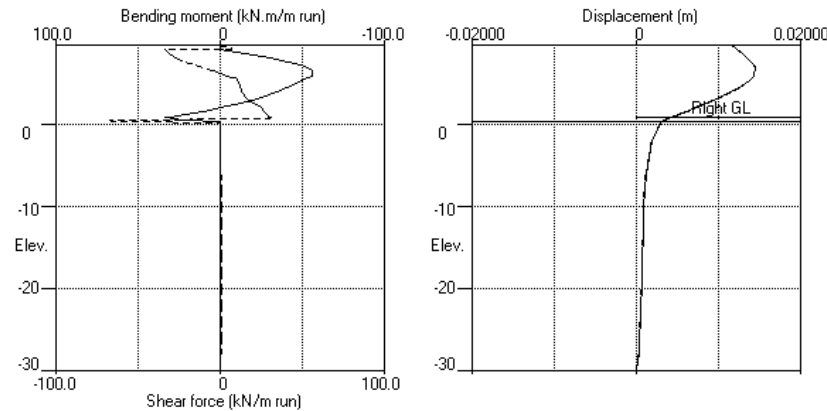
(continued)

		RIGHT side						
		Effective stresses				Total	Adjusted	
Node	Y	Water	Vertic	Active	Passive	Earth	earth	soil

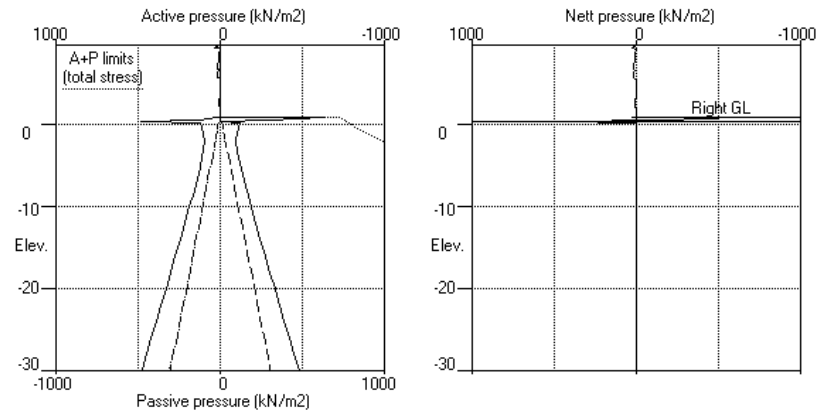


Units: kN,m

Stage No.5 Apply water pressure profile no.2



Stage No.5 Apply water pressure profile no.2



Units: kN,m

Stage No. 7 Fill to elevation 1.10 on RIGHT side with soil type 6

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Prop. Pass.	FoS for toe elev. = 0.35	Factor of Safety at elev. More than one prop.	Toe elev. for FoS = 1.500	Wall Penetr. -ation	Direction of failure
7	9.75	1.10				No FoS calc.	

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options
Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.06
Right side = 1.02

Rigid boundaries: Left side 30.00 from wall
Right side 30.00 from wall
Lower rigid boundary at elevation -30.00
Rough boundary
Rough boundary
Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	9.75	0.00	0.012	-1.33E-03	0.0	-0.0	
2	9.35	32.00	0.012	-1.33E-03	6.4	0.3	
		7.88	0.012	-1.33E-03	6.4	0.3	
3	9.25	4.05	0.012	-1.33E-03	7.0	0.9	-40.9
		4.05	0.012	-1.33E-03	-33.9	0.9	
4	8.75	6.88	0.013	-1.28E-03	-31.1	-15.2	
5	8.25	10.03	0.013	-1.10E-03	-26.9	-29.7	
6	7.75	13.03	0.014	-8.35E-04	-21.1	-41.4	
7	7.30	15.76	0.014	-5.20E-04	-14.7	-49.5	
8	6.85	18.39	0.014	-1.59E-04	-7.0	-54.4	
		12.02	0.014	-1.59E-04	-7.0	-54.4	
9	6.58	13.57	0.014	7.45E-05	-3.5	-55.9	
10	6.30	15.11	0.014	3.12E-04	0.5	-56.3	
11	6.03	16.64	0.014	5.49E-04	4.9	-55.6	
12	5.75	18.16	0.014	7.81E-04	9.6	-53.6	
		1.28	0.014	7.81E-04	9.6	-53.6	
13	5.38	1.52	0.014	1.08E-03	10.2	-50.1	
14	5.00	1.76	0.013	1.36E-03	10.8	-46.4	
15	4.50	2.08	0.012	1.69E-03	11.7	-40.8	
16	4.00	2.40	0.012	1.98E-03	12.9	-34.5	
17	3.50	4.47	0.010	2.22E-03	14.6	-27.7	
18	3.00	7.13	0.009	2.40E-03	17.5	-19.7	
19	2.63	9.12	0.008	2.50E-03	20.5	-12.6	
20	2.25	11.11	0.007	2.55E-03	24.3	-4.1	
		3.53	0.007	2.55E-03	24.3	-4.1	
21	1.85	3.95	0.006	2.54E-03	25.8	5.8	0.0
22	1.48	4.50	0.005	2.48E-03	27.4	15.7	
23	1.10	5.01	0.005	2.36E-03	29.2	26.3	
		3.52	0.005	2.36E-03	29.2	26.3	

Run ID: Whenuapai-PumpStation-Section_1v4dat
 Whenuapai pump station
 Section 1 - wet well - sheet pile STU1800 (v5)

Sheet No.
 Date: 4-05-2022
 Checked :

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 Whenuapai pump station
 Section 1 - wet well - sheet pile STU1800 (v5)

Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Pump station
 Wet wells

(continued)
 Stage No.7 Fill to elevation 1.10 on RIGHT side with soil type 6

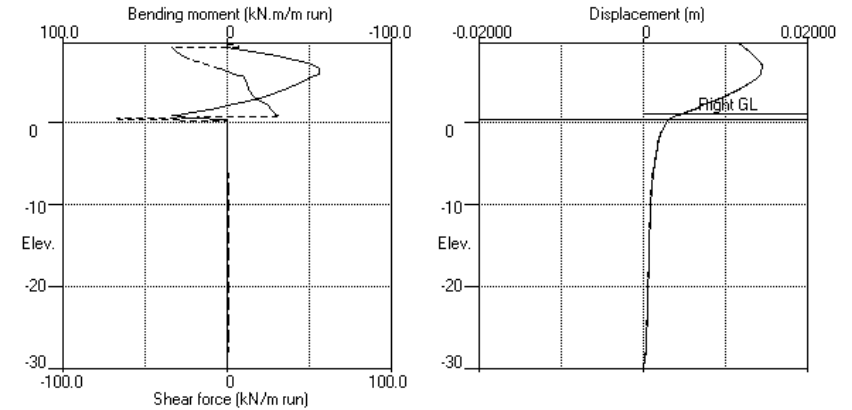
Node no.	Y coord	Nett pressure kN/m ²	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
24	0.95	2.25	0.004	2.29E-03	29.6	30.7	
25	0.85	20.25	0.004	2.24E-03	30.7	33.7	
		-605.38	0.004	2.24E-03	30.7	33.7	
26	0.60	-179.12	0.003	2.13E-03	-67.3	22.5	
27	0.35	478.44	0.003	2.09E-03	-29.9	0.0	
28	0.22	0.05	0.003	0	0.0	0.0	
29	-0.89	0.00	0.002	0	0.0	0.0	
30	-2.00	0.08	0.002	0	0.1	0.0	
31	-4.00	0.04	0.001	0	0.2	0.0	
32	-6.00	0.05	0.001	0	0.3	0.0	
33	-8.00	0.04	0.001	0	0.4	0.0	
34	-10.00	0.04	0.001	0	0.5	0.0	
35	-12.00	0.03	0.001	0	0.5	0.0	
36	-14.00	0.02	0.001	0	0.6	0.0	
37	-16.00	0.01	0.001	0	0.6	0.0	
38	-18.00	0.00	0.001	0	0.6	0.0	
39	-20.00	-0.00	0.001	0	0.6	0.0	
40	-22.00	-0.01	0.000	0	0.6	0.0	
41	-24.00	-0.01	0.000	0	0.6	0.0	
42	-26.00	-0.01	0.000	0	0.6	0.0	
43	-28.00	-0.01	0.000	0	0.5	0.0	
44	-30.00	-0.52	0.000	0	-0.0	0.0	

At elev. 9.25 Prop force = 40.9 kN/m run
 At elev. 1.85 The prop is slack

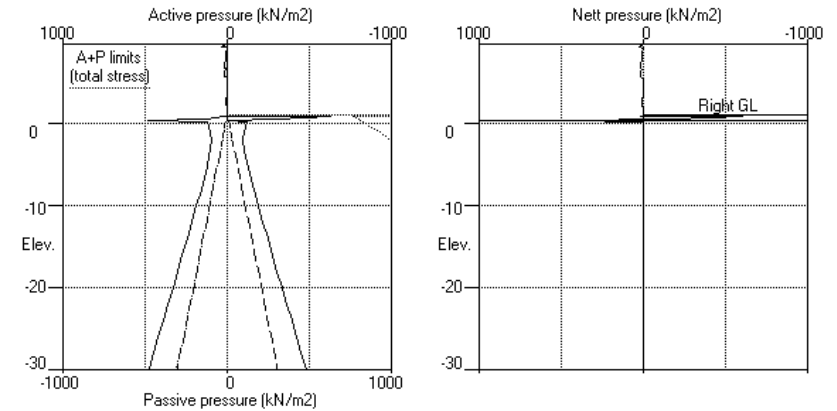
LEFT side									
Node	Y	Water	Vertic	Effective stresses	Active	Passive	Earth	Total earth	Adjusted soil
LEFT side									
Node	Y	Water	Vertic	Effective stresses	Active	Passive	Earth	Total earth	Adjusted soil
RIGHT side									
Node	Y	Water	Vertic	Effective stresses	Active	Passive	Earth	Total earth	Adjusted soil
RIGHT side									
Node	Y	Water	Vertic	Effective stresses	Active	Passive	Earth	Total earth	Adjusted soil

Units: kN,m

Stage No.7 Fill to elev. 1.10 on RIGHT side



Stage No.7 Fill to elev. 1.10 on RIGHT side



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 Data filename/Run ID: Whenuapai-PumpStation-Section_1v4dat
 Whenuapai pump station
 Section 1 - wet well - sheet pile STU1800 (v5)

Sheet No.
 Job No. 1013050
 Made by : op
 Date: 4-05-2022
 Checked :

Run ID: Whenuapai-PumpStation-Section_1v4dat
 Whenuapai pump station
 Section 1 - wet well - sheet pile STU1800 (v5)

Sheet No.
 Date: 4-05-2022
 Checked :

Pump station
 Wet wells

(continued)

Stage No.8 Apply water pressure profile no.1

Units: kN,m
 Stage No. 8 Apply water pressure profile no.1

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
 Factor of safety on soil strength

FoS for toe elev. = 0.35 Toe elev. for FoS = 1.500

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	Factor of Safety	Moment of equilb. at elev.	Toe elev. Penetr	Wall Direction of failure
8	9.75	1.10			More than one prop.	No FoS calc.	

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
 Analysis options

Length of wall perpendicular to section = 20.00m
 2-D finite element model. Active limit arching not modelled.
 Soil deformations are elastic until the active or passive limit is reached
 Open Tension Crack analysis - No
 All soil moduli were factored to take account of
 3-D effects due to the finite length of wall:
 Modulus factors - Left side = 1.06
 Right side = 1.02

Rigid boundaries: Left side 30.00 from wall Rough boundary
 Right side 30.00 from wall Rough boundary
 Lower rigid boundary at elevation -30.00 Rough boundary

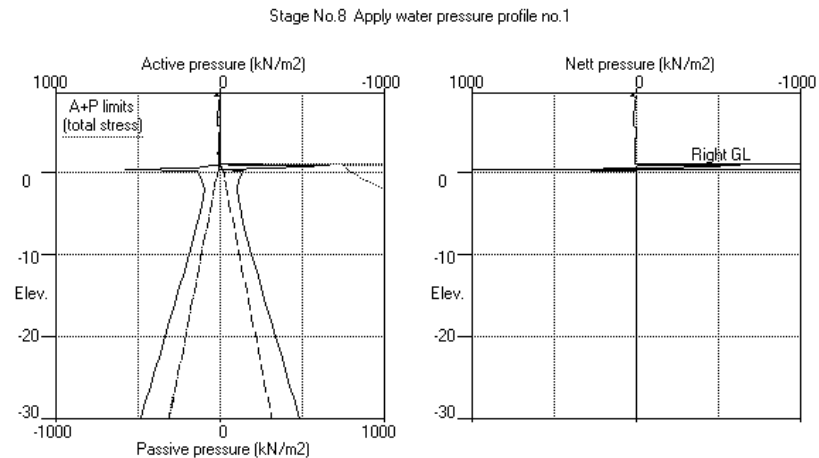
Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	9.75	0.00	0.012	-1.85E-03	0.0	-0.0	
2	9.35	37.72	0.013	-1.85E-03	7.5	0.3	
		9.02	0.013	-1.85E-03	7.5	0.3	
3	9.25	4.30	0.013	-1.85E-03	8.2	1.1	-48.0
		4.30	0.013	-1.85E-03	-39.7	1.1	
4	8.75	7.08	0.014	-1.79E-03	-36.9	-18.0	
5	8.25	10.87	0.015	-1.58E-03	-32.4	-35.3	
6	7.75	14.29	0.016	-1.26E-03	-26.1	-49.6	
7	7.30	17.20	0.016	-8.80E-04	-19.0	-59.9	
8	6.85	20.02	0.016	-4.41E-04	-10.7	-66.6	
		13.71	0.016	-4.41E-04	-10.7	-66.6	
9	6.58	15.38	0.017	-1.54E-04	-6.7	-69.0	
10	6.30	17.03	0.017	1.41E-04	-2.2	-70.3	
11	6.03	18.68	0.016	4.39E-04	2.7	-70.2	
12	5.75	20.31	0.016	7.34E-04	8.1	-68.7	
		4.34	0.016	7.34E-04	8.1	-68.7	
13	5.38	4.80	0.016	1.12E-03	9.8	-65.6	
14	5.00	5.27	0.015	1.49E-03	11.7	-61.8	
15	4.50	5.89	0.015	1.94E-03	14.5	-55.3	
16	4.00	6.51	0.013	2.33E-03	17.6	-47.2	
17	3.50	7.83	0.012	2.66E-03	21.1	-37.5	
18	3.00	10.71	0.011	2.90E-03	25.8	-25.8	
19	2.63	12.87	0.010	3.02E-03	30.2	-15.4	
20	2.25	15.04	0.009	3.08E-03	35.4	-3.0	
		8.67	0.009	3.08E-03	35.4	-3.0	
21	1.85	9.17	0.007	3.05E-03	39.0	11.8	-6.5
		9.17	0.007	3.05E-03	32.5	11.8	
22	1.48	9.63	0.006	2.94E-03	36.1	24.5	
23	1.10	10.10	0.005	2.76E-03	39.8	38.7	
		-243.71	0.005	2.76E-03	39.8	38.7	

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
24	0.95	-66.96	0.005	2.67E-03	16.5	42.0	
25	0.85	-6.66	0.004	2.60E-03	12.8	43.3	
		-624.93	0.004	2.60E-03	12.8	43.3	
26	0.60	-168.39	0.004	2.47E-03	-86.4	26.9	
27	0.35	572.78	0.003	2.42E-03	-35.8	0.0	
28	0.22	0.10	0.003	0	-0.0	0.0	
29	-0.89	0.00	0.003	0	0.0	0.0	
30	-2.00	0.08	0.002	0	0.1	0.0	
31	-4.00	0.04	0.002	0	0.2	0.0	
32	-6.00	0.05	0.001	0	0.3	0.0	
33	-8.00	0.04	0.001	0	0.4	0.0	
34	-10.00	0.04	0.001	0	0.5	0.0	
35	-12.00	0.03	0.001	0	0.5	0.0	
36	-14.00	0.02	0.001	0	0.6	0.0	
37	-16.00	0.01	0.001	0	0.6	0.0	
38	-18.00	0.00	0.001	0	0.6	0.0	
39	-20.00	-0.00	0.001	0	0.6	0.0	
40	-22.00	-0.01	0.000	0	0.6	0.0	
41	-24.00	-0.01	0.000	0	0.6	0.0	
42	-26.00	-0.01	0.000	0	0.6	0.0	
43	-28.00	-0.01	0.000	0	0.5	0.0	
44	-30.00	-0.52	0.000	0	-0.0	0.0	
At elev.	9.25				Prop force =	48.0 kN/m run	
At elev.	1.85				Prop force =	6.5 kN/m run	

LEFT side							
Node	Y	Water	Vertic	Effective stresses Active	Effective stresses Passive	Earth	Adjusted soil
LEFT side							
Node	Y	Water	Vertic	Effective stresses Active	Effective stresses Passive	Earth	Adjusted soil
RIGHT side							
Node	Y	Water	Vertic	Effective stresses Active	Effective stresses Passive	Earth	Adjusted soil
RIGHT side							
Node	Y	Water	Vertic	Effective stresses Active	Effective stresses Passive	Earth	Adjusted soil

Units: kN,m

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength



TONKIN and TAYLOR GROUP LTD.
Program: WALLAP Version 6.07 Revision A55.B74.R58
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Data filename/Run ID: Whenuapai-PumpStation-Section_1v4dat
Whenuapai pump station
Section 1 - wet well - sheet pile STU1800 (v5)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.06
Right side = 1.02

Rigid boundaries: Left side 30.00 from wall Rough boundary
Right side 30.00 from wall Rough boundary
Lower rigid boundary at elevation -30.00 Rough boundary

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement		Bending moment		Shear force	
		maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	9.75	0.012	0.000	0.0	-0.0	0.0	0.0
2	9.35	0.013	0.000	0.3	0.0	7.5	-1.4
3	9.25	0.013	0.000	1.1	-0.1	8.2	-39.7
4	8.75	0.014	0.000	1.2	-18.0	2.9	-36.9
5	8.25	0.015	0.000	3.7	-35.3	7.1	-32.4
6	7.75	0.016	0.000	8.0	-49.6	8.4	-26.1
7	7.30	0.016	0.000	11.7	-59.9	9.1	-19.0
8	6.85	0.016	0.000	16.2	-66.6	11.1	-10.7
9	6.58	0.017	0.000	18.9	-69.0	9.1	-6.7
10	6.30	0.017	0.000	21.2	-70.3	8.5	-2.2
11	6.03	0.016	0.000	23.5	-70.2	9.0	0.0
12	5.75	0.016	0.000	26.2	-68.7	10.9	0.0
13	5.38	0.016	0.000	26.6	-65.6	10.9	-4.2
14	5.00	0.015	0.000	23.0	-61.8	11.7	-11.0
15	4.50	0.015	0.000	16.4	-55.3	14.5	-12.7
16	4.00	0.013	0.000	10.3	-47.2	17.6	-10.7
17	3.50	0.012	0.000	5.8	-37.5	21.1	-6.8
18	3.00	0.011	0.000	3.5	-25.8	25.8	-1.6
19	2.63	0.010	0.000	3.7	-15.4	30.2	0.0
20	2.25	0.009	0.000	7.1	-4.1	35.4	0.0
21	1.85	0.007	0.000	11.8	0.0	39.0	-1.2
22	1.48	0.006	0.000	24.5	0.0	36.1	-4.8
23	1.10	0.005	0.000	38.7	0.0	39.8	-5.2
24	0.95	0.005	0.000	42.0	0.0	29.6	-5.0
25	0.85	0.004	0.000	43.3	0.0	30.9	-4.9
26	0.60	0.004	0.000	26.9	0.0	0.0	-86.4
27	0.35	0.003	0.000	0.0	0.0	0.0	-35.8
28	0.22	0.003	0.000	0.0	0.0	0.0	-0.0
29	-0.89	0.003	0.000	0.0	0.0	0.0	0.0
30	-2.00	0.002	0.000	0.0	0.0	0.1	0.0
31	-4.00	0.002	0.000	0.0	0.0	0.2	0.0
32	-6.00	0.001	0.000	0.0	0.0	0.3	0.0
33	-8.00	0.001	0.000	0.0	0.0	0.4	0.0
34	-10.00	0.001	0.000	0.0	0.0	0.5	0.0
35	-12.00	0.001	0.000	0.0	0.0	0.5	0.0
36	-14.00	0.001	0.000	0.0	0.0	0.6	0.0
37	-16.00	0.001	0.000	0.0	0.0	0.6	0.0
38	-18.00	0.001	0.000	0.0	0.0	0.6	0.0
39	-20.00	0.001	0.000	0.0	0.0	0.6	0.0

Run ID: Whenuapai-PumpStation-Section_1v4dat
Whenuapai pump station
Section 1 - wet well - sheet pile STU1800 (v5)

Sheet No.
Date: 4-05-2022
Checked :

Pump station
Wet wells

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement		Bending moment		Shear force	
		maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
40	-22.00	0.001	0.000	0.0	0.0	0.6	0.0
41	-24.00	0.000	0.000	0.0	0.0	0.6	0.0
42	-26.00	0.000	0.000	0.0	0.0	0.6	0.0
43	-28.00	0.000	0.000	0.0	0.0	0.5	0.0
44	-30.00	0.000	0.000	0.0	0.0	0.0	-0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment				Shear force			
	maximum kN.m/m	elev. m	minimum kN.m/m	elev. m	maximum kN/m	elev. m	minimum kN/m	elev. m
1	3.1	5.38	-2.0	7.75	3.7	5.75	-1.7	8.75
2	26.6	5.38	0.0	9.75	11.1	6.85	-12.7	4.50
3	No calculation at this stage							
4	22.0	0.85	-35.9	6.85	12.0	0.85	-44.1	0.60
5	33.6	0.85	-56.3	6.30	30.9	0.85	-67.1	0.60
6	No calculation at this stage							
7	33.7	0.85	-56.3	6.30	30.7	0.85	-67.3	0.60
8	43.3	0.85	-70.3	6.30	39.8	1.10	-86.4	0.60

Maximum and minimum displacement at each stage

Stage no.	Displacement				Stage description
	maximum m	elev. m	minimum m	elev. m	
1	0.001	9.75	0.000	9.75	Apply surcharge no.1 at elev. 9.75
2	0.007	9.75	0.000	9.75	Excav. to elev. 8.25 on RIGHT side
3	No calculation at this stage				Install prop no.1 at elev. 9.25
4	0.011	7.75	0.000	9.75	Excav. to elev. 0.85 on RIGHT side
5	0.014	6.58	0.000	9.75	Apply water pressure profile no.2
6	No calculation at this stage				Install prop no.2 at elev. 1.85
7	0.014	6.58	0.000	9.75	Fill to elev. 1.10 on RIGHT side
8	0.017	6.30	0.000	9.75	Apply water pressure profile no.1

Prop forces at each stage (horizontal components)

Stage no.	Anchor no. 1		Anchor no. 2	
	at elev. 9.25 kN/m run	kN/prop	at elev. 1.85 kN/m run	kN/prop
4	29.38	117.54	---	---
5	40.88	163.50	---	---
7	40.85	163.42	slack	slack
8	47.95	191.80	6.46	25.84

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 Whenuapai pump station
 Section 2 - emergency storage tanks - STU1800 (v5)

 Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types			
		Left side		Right side	
1	10.00	1 Engineered hardfill		1 Engineered hardfill	
2	9.60	2 Tauranga Group soils		2 Tauranga Group soils	
3	7.50	3 ECBF residual soils		3 ECBF residual soils	
4	6.00	4 ECBF Weathered rock		4 ECBF Weathered rock	
5	2.50	5 ECBF UW rock		5 ECBF UW rock	

SOIL PROPERTIES

-- Soil type --	Bulk density	Young's Modulus	At rest coeff.	Consol state.	Active limit	Passive limit	Cohesion
No. Description (Datum elev.)	kN/m3	Eh, kN/m2 (dEh/dy)	Ko (dKo/dy)	NC/OC (Nu)	Ka (Kac)	Kp (Kpc)	kN/m2 (dc/dy)
1 Engineered hardfill	20.00	50000	0.254	OC (0.300)	0.189 (0.000)	7.061 (0.000)	
2 Tauranga Group soils	17.00	10000	0.531	OC (0.350)	0.320 (1.278)	3.485 (4.674)	1.000d
3 ECBF residual soils	18.00	20000	0.500	OC (0.350)	0.294 (1.222)	3.878 (4.985)	5.000d
4 ECBF Weathered rock	21.00	85000	0.426	OC (0.350)	0.237 (1.089)	5.153 (5.931)	25.00d
5 ECBF UW rock	22.00	400000	0.357	OC (0.250)	0.189 (0.966)	7.061 (7.223)	100.0d
6 Concrete	24.00	500000	0.000	OC (0.490)	1.000 (0.851)	1.000 (2.233)	500.0u

Additional soil parameters associated with Ka and Kp

--- parameters for Ka ---			--- parameters for Kp ---		
Soil	Wall	Back-	Soil	Wall	Back-
friction angle	adhesion coeff.	fill angle	friction angle	adhesion coeff.	fill angle
1 Engineered hardfill	40.00	0.434	0.00	40.00	0.280
2 Tauranga Group soils	28.00	0.469	0.00	28.00	0.306
3 ECBF residual soils	30.00	0.464	0.00	30.00	0.302
4 ECBF Weathered rock	35.00	0.450	0.00	35.00	0.292
5 ECBF UW rock	40.00	0.434	0.00	40.00	0.280
6 Concrete	0.00	-0.736	0.00	0.00	0.265

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3
 Left side Right side
 Initial water table elevation 7.75 7.75

Automatic water pressure balancing at toe of wall : Yes

Left side				Right side			
Water press.	Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Point no.	Elev. m	Piezo elev. m
profile	no.						
	1	9.25	9.25	0.0	1	3.45	3.45
	2	7.75	7.75	0.0	1	3.45	3.45

WALL PROPERTIES

Type of structure = Fully Embedded Wall
 Elevation of toe of wall = 3.10
 Maximum finite element length = 0.40 m
 Youngs modulus of wall E = 2.0000E+08 kN/m2
 Moment of inertia of wall I = 3.2400E-04 m4/m run
 (Sumitomo SX18) E.I = 64800 kN.m2/m run
 Yield Moment of wall = Not defined

Pump station
Storage tanks

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin -ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	9.50	4.00	0.001257	2.100E+08	11.00	0.00	0	Anchor	n/a	R
2	4.60	4.00	0.001257	2.100E+08	11.00	0.00	0	Anchor	n/a	R

SURCHARGE LOADS

Surch -arge no.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2	Equiv. soil type	Partial factor/ Category
1	10.00	0.50(L)	25.00	3.50	15.00	= N/A N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 10.00
2	Excavate to elevation 8.50 on RIGHT side
3	Install strut or anchor no.1 at elevation 9.50
4	Apply water pressure profile no.2
5	Excavate to elevation 3.60 on RIGHT side
6	Install strut or anchor no.2 at elevation 4.60
7	Fill to elevation 3.70 on RIGHT side with soil type 6
8	Apply water pressure profile no.1

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
 Method of analysis - Strength Factor method
 Factor on soil strength for calculating wall depth = 1.50

Parameters for undrained strata:
 Minimum equivalent fluid density = 5.00 kN/m3
 Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:
 Method - 2-D finite element model
 Open Tension Crack analysis? - No
 Active limit arching modelled? - No
 Non-linear Modulus Parameter (L) = 6.900 m

Boundary conditions:
 Length of wall (normal to plane of analysis) = 20.00 m

Width of excavation on Left side of wall = 20.00 m
 Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 30.00 m
 Distance to rigid boundary on Right side = 30.00 m
 Elevation of rigid lower boundary = -30.00

Lower rigid boundary at elevation -30.00 - Rough
 Rigid boundary on Left side - Rough
 Rigid boundary on Right side - Rough
 Wall / soil interface - Smooth

OUTPUT OPTIONS

Stage no.	Stage description	Displacement Bending mom. Shear force	Output options Active, Passive pressures	Graph. output
1	Apply surcharge no.1 at elev. 10.00	Yes	Yes	Yes
2	Excav. to elev. 8.50 on RIGHT side	Yes	Yes	Yes
3	Install prop no.1 at elev. 9.50	Yes	Yes	Yes
4	Apply water pressure profile no.2	Yes	Yes	Yes
5	Excav. to elev. 3.60 on RIGHT side	Yes	Yes	Yes
6	Install prop no.2 at elev. 4.60	Yes	Yes	Yes
7	Fill to elev. 3.70 on RIGHT side	Yes	Yes	Yes
8	Apply water pressure profile no.1	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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Data filename/Run ID: Whenuapai-PumpStation-Section_2v4dat
Whenuapai pump station
Section 2 - emergency storage tanks - STU1800 (v5)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Pump station
Storage tanks

Units: kN,m

Stage No. 1 Apply surcharge no.1 at elevation 10.00

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 3.10 Factor of Safety at elev.	Toe elev. for FoS = 1.500 Wall Penetr. -ation failure	Direction of failure
1	10.00	10.00	Cant.	Conditions not suitable for FoS calc.		

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m

2-D finite element model. Active limit arching not modelled.

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

All soil moduli were factored to take account of

3-D effects due to the finite length of wall:

Modulus factors - Left side = 1.03

Right side = 1.03

Rigid boundaries: Left side 30.00 from wall Rough boundary
Right side 30.00 from wall Rough boundary
Lower rigid boundary at elevation -30.00 Rough boundary

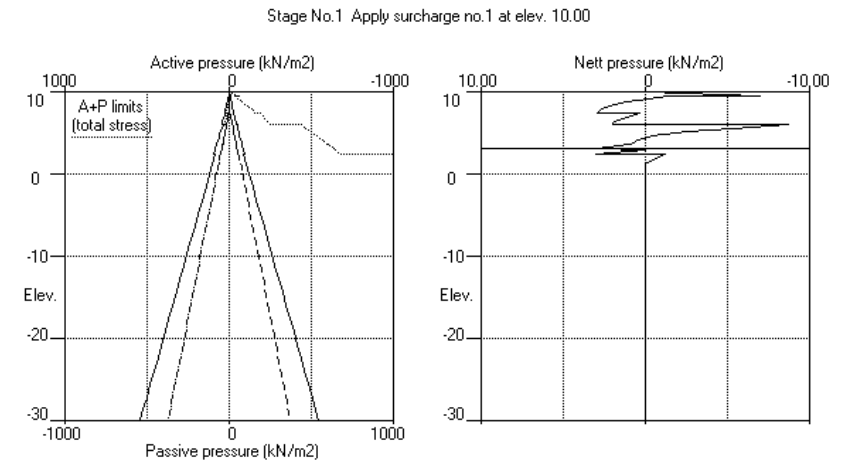
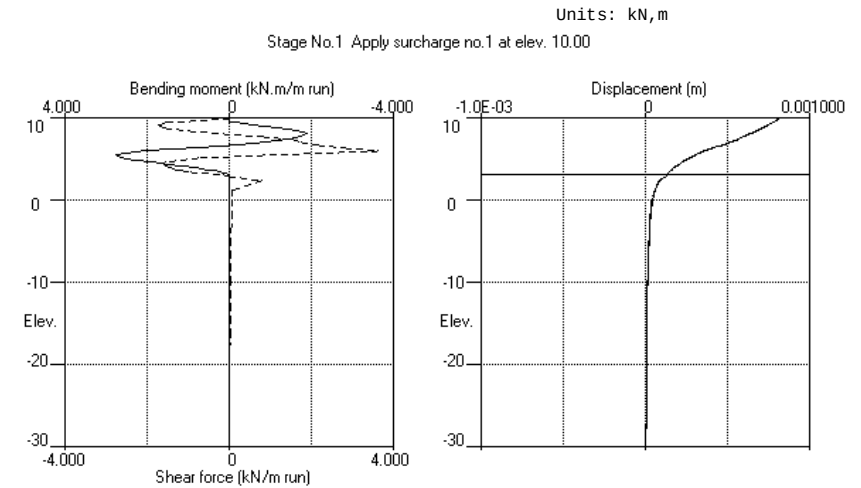
Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	0.00	0.001	8.78E-05	0.0	0.0	
2	9.60	-6.95	0.001	8.78E-05	-1.4	0.0	
		-1.75	0.001	8.78E-05	-1.4	0.0	
3	9.50	-1.38	0.001	8.79E-05	-1.5	-0.1	
4	9.25	-0.16	0.001	8.91E-05	-1.7	-0.5	
5	8.88	1.14	0.001	9.41E-05	-1.6	-1.2	
6	8.50	1.95	0.001	1.02E-04	-1.0	-1.7	
7	8.13	2.46	0.001	1.12E-04	-0.1	-1.9	
8	7.75	2.77	0.001	1.23E-04	0.8	-1.8	
9	7.50	2.94	0.001	1.29E-04	1.5	-1.5	
		0.38	0.001	1.29E-04	1.5	-1.5	
10	7.15	0.85	0.001	1.35E-04	1.8	-0.9	
11	6.80	1.43	0.000	1.38E-04	2.2	-0.2	
12	6.40	1.94	0.000	1.37E-04	2.8	0.7	
13	6.00	2.02	0.000	1.28E-04	3.6	2.0	
		-8.68	0.000	1.28E-04	3.6	2.0	
14	5.60	-5.33	0.000	1.13E-04	0.8	2.8	
15	5.20	-2.61	0.000	9.69E-05	-0.8	2.7	
16	4.90	-1.14	0.000	8.53E-05	-1.3	2.3	
17	4.60	-0.38	0.000	7.56E-05	-1.6	1.9	
18	4.38	0.11	0.000	6.97E-05	-1.6	1.5	
19	4.15	0.41	0.000	6.51E-05	-1.5	1.2	
20	3.93	0.67	0.000	6.17E-05	-1.4	0.8	
21	3.70	0.84	0.000	5.93E-05	-1.2	0.5	
22	3.60	1.05	0.000	5.86E-05	-1.1	0.4	
23	3.45	1.54	0.000	5.79E-05	-0.9	0.2	
24	3.10	3.03	0.000	5.72E-05	-0.2	-0.0	
25	3.00	0.05	0.000	0	0.0	0.0	
26	2.50	3.09	0.000	0	0.8	0.0	
		-1.17	0.000	0	0.8	0.0	

Stage No.1 Apply surcharge no.1 at elevation 10.00

(continued)

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
27	1.25	-0.01	0.000	0	0.1	0.0	
28	0.00	0.01	0.000	0	0.1	0.0	
29	-1.60	-0.01	0.000	0	0.1	0.0	
30	-3.20	-0.01	0.000	0	0.1	0.0	
31	-4.80	-0.01	0.000	0	0.0	0.0	
32	-6.40	-0.00	0.000	0	0.0	0.0	
33	-8.00	-0.00	0.000	0	0.0	0.0	
34	-9.60	-0.00	0.000	0	0.0	0.0	
35	-11.20	-0.00	0.000	0	0.0	0.0	
36	-12.80	-0.00	0.000	0	0.0	0.0	
37	-14.40	-0.00	0.000	0	0.0	0.0	
38	-16.00	-0.00	0.000	0	0.0	0.0	
39	-17.60	-0.00	0.000	0	0.0	0.0	
40	-19.20	-0.00	0.000	0	0.0	0.0	
41	-20.80	-0.00	0.000	0	0.0	0.0	
42	-22.40	-0.00	0.000	0	0.0	0.0	
43	-24.00	-0.00	0.000	0	0.0	0.0	
44	-25.60	-0.00	0.000	0	0.0	0.0	
45	-27.20	-0.00	0.000	0	0.0	0.0	
46	-28.80	-0.00	0.000	0	0.0	0.0	
47	-30.00	-0.01	0.000	0	0.0	0.0	

LEFT side							Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth		
Effective stresses								
LEFT side								
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth	Adjusted soil
Effective stresses								
RIGHT side								
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth	Adjusted soil
Effective stresses								
RIGHT side								
Node	Y	Water	Vertic	Active	Passive	Earth	Total earth	Adjusted soil
Effective stresses								



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 Section 2 - emergency storage tanks - STU1800 (v5)

Sheet No.
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Run ID: Whenuapai-PumpStation-Section_2v4dat
 Whenuapai pump station
 Section 2 - emergency storage tanks - STU1800 (v5)

Sheet No.
 Date: 4-05-2022
 Checked :

Pump station
 Storage tanks

(continued)

Stage No.2 Excavate to elevation 8.50 on RIGHT side

Units: kN,m
 Stage No. 2 Excavate to elevation 8.50 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
 Factor of safety on soil strength

		FoS for toe		Toe elev. for			
		elev. = 3.10		FoS = 1.500			
Stage	Ground level	Prop	Factor	Moment	Toe	Wall	Direction
No.	Act.	Pass.	Elev.	of	elev.	Penetr	of
				Safety	at elev.	-ation	failure
2	10.00	8.50	Cant.	2.978	3.80	6.02	2.48
							L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
 Analysis options

Length of wall perpendicular to section = 20.00m
 2-D finite element model. Active limit arching not modelled.
 Soil deformations are elastic until the active or passive limit is reached
 Open Tension Crack analysis - No
 All soil moduli were factored to take account of
 3-D effects due to the finite length of wall:
 Modulus factors - Left side = 1.03
 Right side = 1.03

Rigid boundaries: Left side 30.00 from wall Rough boundary
 Right side 30.00 from wall Rough boundary
 Lower rigid boundary at elevation -30.00 Rough boundary

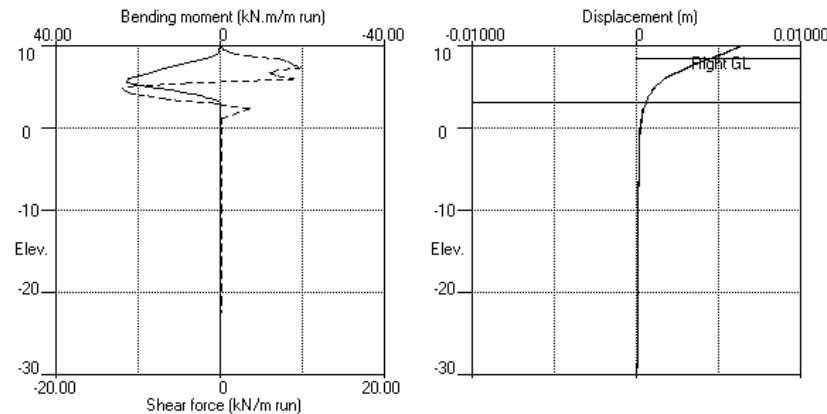
Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	10.00	0.00	0.006	1.30E-03	0.0	0.0	
2	9.60	1.85	0.006	1.30E-03	0.4	0.3	
3	9.50	2.70	0.006	1.30E-03	0.6	0.3	
4	9.25	4.77	0.005	1.30E-03	1.5	0.6	
5	8.88	7.58	0.005	1.30E-03	3.8	1.6	
6	8.50	10.23	0.004	1.28E-03	7.2	3.7	
		5.55	0.004	1.28E-03	7.2	3.7	
7	8.13	0.05	0.004	1.25E-03	8.2	6.8	
8	7.75	3.02	0.003	1.20E-03	8.8	9.9	
9	7.50	4.53	0.003	1.16E-03	9.8	12.2	
		-10.82	0.003	1.16E-03	9.8	12.2	
10	7.15	-5.53	0.003	1.09E-03	6.9	14.9	
11	6.80	0.24	0.002	1.00E-03	6.0	17.0	
12	6.40	4.95	0.002	8.93E-04	7.0	19.4	
13	6.00	4.85	0.002	7.63E-04	9.0	22.6	
		-41.82	0.002	7.63E-04	9.0	22.6	
14	5.60	-23.66	0.001	6.23E-04	-4.1	22.8	
15	5.20	-8.34	0.001	4.94E-04	-10.5	19.3	
16	4.90	-1.15	0.001	4.13E-04	-12.0	15.7	
17	4.60	2.17	0.001	3.48E-04	-11.8	12.1	
18	4.38	3.95	0.001	3.11E-04	-11.1	9.5	
19	4.15	4.98	0.001	2.82E-04	-10.1	7.1	
20	3.93	5.78	0.001	2.61E-04	-8.9	4.9	
21	3.70	6.44	0.001	2.47E-04	-7.5	3.1	
22	3.60	7.07	0.001	2.43E-04	-6.9	2.3	
23	3.45	9.32	0.001	2.39E-04	-5.6	1.4	
24	3.10	17.74	0.001	2.35E-04	-0.9	-0.0	
25	3.00	0.06	0.001	0	0.0	0.0	
26	2.50	14.48	0.000	0	3.6	0.0	
		-5.71	0.000	0	3.6	0.0	

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
27	1.25	-0.00	0.000	0	0.1	0.0	
28	0.00	0.03	0.000	0	0.1	0.0	
29	-1.60	-0.00	0.000	0	0.1	0.0	
30	-3.20	-0.00	0.000	0	0.1	0.0	
31	-4.80	-0.00	0.000	0	0.1	0.0	
32	-6.40	-0.00	0.000	0	0.1	0.0	
33	-8.00	-0.00	0.000	0	0.1	0.0	
34	-9.60	-0.00	0.000	0	0.1	0.0	
35	-11.20	-0.00	0.000	0	0.1	0.0	
36	-12.80	-0.00	0.000	0	0.1	0.0	
37	-14.40	-0.00	0.000	0	0.1	0.0	
38	-16.00	-0.00	0.000	0	0.1	0.0	
39	-17.60	-0.00	0.000	0	0.1	0.0	
40	-19.20	-0.00	0.000	0	0.1	0.0	
41	-20.80	-0.00	0.000	0	0.1	0.0	
42	-22.40	-0.00	0.000	0	0.1	0.0	
43	-24.00	-0.00	0.000	0	0.1	0.0	
44	-25.60	-0.00	0.000	0	0.1	0.0	
45	-27.20	-0.01	0.000	0	0.0	0.0	
46	-28.80	-0.00	0.000	0	0.0	0.0	
47	-30.00	-0.05	0.000	0	0.0	0.0	

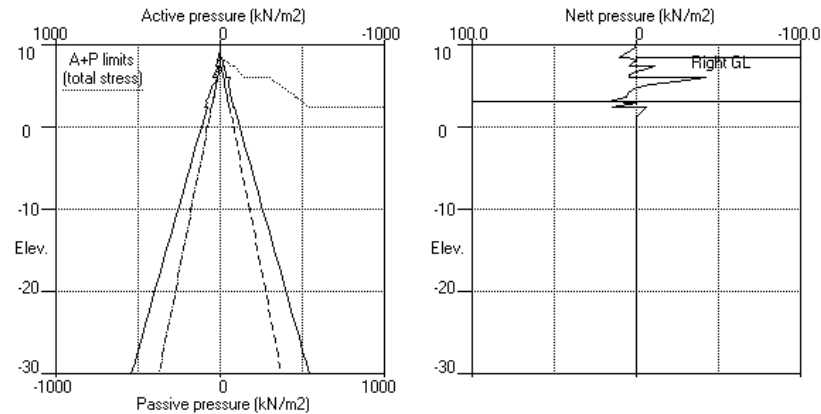
		LEFT side					Total earth	Adjusted soil
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth		
		LEFT side					Total earth	Adjusted soil
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth		
		RIGHT side					Total earth	Adjusted soil
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth		
		RIGHT side					Total earth	Adjusted soil
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth		

Units: kN,m

Stage No.2 Excav. to elev. 8.50 on RIGHT side



Stage No.2 Excav. to elev. 8.50 on RIGHT side



Units: kN,m

Stage No. 4 Apply water pressure profile no.2

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 3.10 Factor of Safety	Moment of equilib. at elev. n/a	Toe elev. for FoS = 1.500 Toe elev. 7.52	Wall Penetr. -ation 0.98	Direction of failure L to R
4	10.00	8.50	9.50	9.158	n/a	7.52	0.98	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m

2-D finite element model. Active limit arching not modelled.

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

All soil moduli were factored to take account of

3-D effects due to the finite length of wall:

Modulus factors - Left side = 1.03

Right side = 1.03

Rigid boundaries: Left side 30.00 from wall

Right side 30.00 from wall

Lower rigid boundary at elevation -30.00

Rough boundary

Rough boundary

Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	0.00	0.006	1.29E-03	0.0	0.0	
2	9.60	1.94	0.006	1.29E-03	0.4	0.3	
		1.87	0.006	1.29E-03	0.4	0.3	
3	9.50	2.70	0.006	1.29E-03	0.6	0.3	-0.1
		2.70	0.006	1.29E-03	0.5	0.3	
4	9.25	4.77	0.005	1.29E-03	1.4	0.5	
5	8.88	7.58	0.005	1.28E-03	3.7	1.5	
6	8.50	10.18	0.004	1.27E-03	7.1	3.5	
		5.56	0.004	1.27E-03	7.1	3.5	
7	8.13	0.00	0.004	1.24E-03	8.1	6.6	
8	7.75	2.93	0.004	1.19E-03	8.6	9.6	
9	7.50	4.58	0.003	1.15E-03	9.6	11.9	
		-10.87	0.003	1.15E-03	9.6	11.9	
10	7.15	-5.44	0.003	1.08E-03	6.7	14.6	
11	6.80	0.48	0.002	1.00E-03	5.9	16.6	
12	6.40	5.39	0.002	8.92E-04	7.0	19.0	
13	6.00	5.58	0.002	7.64E-04	9.2	22.2	
		-42.32	0.002	7.64E-04	9.2	22.2	
14	5.60	-24.06	0.001	6.26E-04	-4.0	22.5	
15	5.20	-8.59	0.001	4.98E-04	-10.6	19.0	
16	4.90	-1.25	0.001	4.18E-04	-12.1	15.4	
17	4.60	2.25	0.001	3.55E-04	-11.9	11.8	
18	4.38	4.20	0.001	3.19E-04	-11.2	9.1	
19	4.15	5.40	0.001	2.91E-04	-10.1	6.7	
20	3.93	6.40	0.001	2.72E-04	-8.8	4.6	
21	3.70	7.26	0.001	2.59E-04	-7.2	2.8	
22	3.60	8.02	0.001	2.55E-04	-6.5	2.1	
23	3.45	10.25	0.001	2.51E-04	-5.1	1.2	
24	3.10	14.71	0.001	2.48E-04	-0.7	-0.0	

Sheet No.
Date: 4-05-2022
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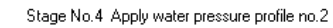
Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Stage No.4 Apply water pressure profile no.2

(continued)

At elev. 9.50 Prop force = 0.1 kN/m run

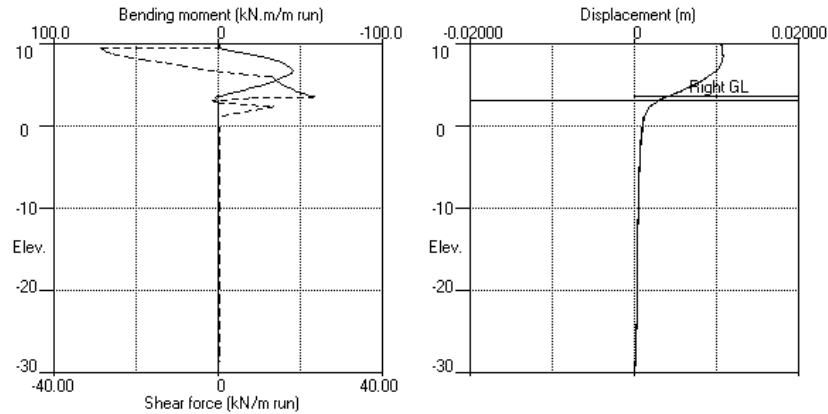
Stage No.4 Apply water pressure profile no.2



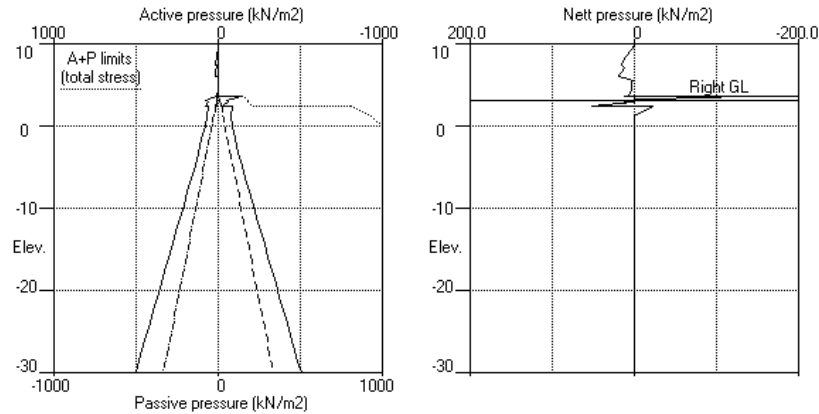
		<u>LEFT side</u>							
<u>Node</u>	<u>Y</u>	<u>Water</u>	<u>Vertic</u>	<u>Effective stresses</u>	<u>Active</u>	<u>Passive</u>	<u>Earth</u>	<u>Total earth</u>	<u>Adjusted soil</u>
		<u>LEFT side</u>							
<u>Node</u>	<u>Y</u>	<u>Water</u>	<u>Vertic</u>	<u>Effective stresses</u>	<u>Active</u>	<u>Passive</u>	<u>Earth</u>	<u>Total earth</u>	<u>Adjusted soil</u>
		<u>RIGHT side</u>							
<u>Node</u>	<u>Y</u>	<u>Water</u>	<u>Vertic</u>	<u>Effective stresses</u>	<u>Active</u>	<u>Passive</u>	<u>Earth</u>	<u>Total earth</u>	<u>Adjusted soil</u>
		<u>RIGHT side</u>							
<u>Node</u>	<u>Y</u>	<u>Water</u>	<u>Vertic</u>	<u>Effective stresses</u>	<u>Active</u>	<u>Passive</u>	<u>Earth</u>	<u>Total earth</u>	<u>Adjusted soil</u>

Units: kN,m

Stage No.5 Excav. to elev. 3.60 on RIGHT side



Stage No.5 Excav. to elev. 3.60 on RIGHT side



Units: kN,m

Stage No. 7 Fill to elevation 3.70 on RIGHT side with soil type 6

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Prop. Pass.	FoS for toe elev. = 3.10	Toe elev. for FoS = 1.500	Direction of failure
7	10.00	3.70	Factor of Safety at elev. More than one prop.	No FoS calc.	

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.03
Right side = 1.01

Rigid boundaries: Left side 30.00 from wall
Right side 30.00 from wall
Lower rigid boundary at elevation -30.00
Rough boundary
Rough boundary
Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	0.00	0.011	-2.00E-04	0.0	-0.0	
2	9.60	1.85	0.011	-2.01E-04	0.4	0.3	
3	9.50	2.70	0.011	-2.01E-04	0.6	0.3	-29.4
		2.70	0.011	-2.01E-04	-28.8	0.3	
4	9.25	4.77	0.011	-1.89E-04	-27.9	-6.8	
5	8.88	7.58	0.011	-1.21E-04	-25.6	-16.8	
6	8.50	10.08	0.011	1.85E-06	-22.2	-25.7	
7	8.13	12.39	0.011	1.72E-04	-18.0	-33.1	
8	7.75	14.58	0.011	3.80E-04	-13.0	-39.0	
9	7.50	16.22	0.011	5.36E-04	-9.1	-41.7	
		10.01	0.011	5.36E-04	-9.1	-41.7	
10	7.15	12.22	0.010	7.68E-04	-5.2	-44.3	
11	6.80	14.40	0.010	1.01E-03	-0.6	-45.4	
12	6.40	16.86	0.010	1.28E-03	5.7	-44.4	
13	6.00	19.30	0.009	1.55E-03	12.9	-40.7	
		2.40	0.009	1.55E-03	12.9	-40.7	
14	5.60	2.95	0.008	1.78E-03	14.0	-35.5	
15	5.20	3.50	0.008	1.98E-03	15.3	-29.8	
16	4.90	3.94	0.007	2.11E-03	16.4	-25.0	
17	4.60	4.40	0.006	2.21E-03	17.6	-19.9	0.0
18	4.38	4.76	0.006	2.28E-03	18.7	-15.8	
19	4.15	5.12	0.005	2.32E-03	19.8	-11.5	
20	3.93	6.09	0.005	2.35E-03	21.1	-6.9	
21	3.70	7.47	0.004	2.37E-03	22.6	-2.0	
		5.94	0.004	2.37E-03	22.6	-2.0	
22	3.60	12.41	0.004	2.37E-03	23.5	0.3	
		-136.26	0.004	2.37E-03	23.5	0.3	
23	3.45	-77.68	0.004	2.37E-03	7.5	2.3	
24	3.10	26.93	0.003	2.36E-03	-1.4	-0.0	

(continued)
 Stage No.7 Fill to elevation 3.70 on RIGHT side with soil type 6

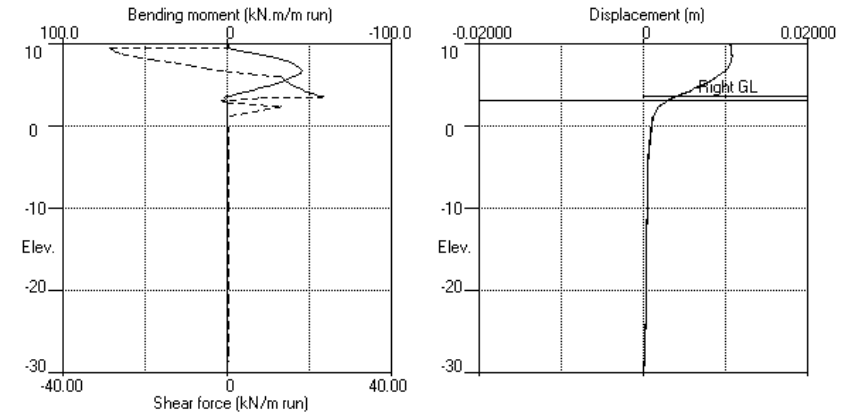
Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
25	3.00	1.05	0.003	0	-0.0	0.0	
26	2.50	51.78	0.002	0	13.2	0.0	
		-20.98	0.002	0	13.2	0.0	
27	1.25	0.00	0.001	0	0.1	0.0	
28	0.00	0.04	0.001	0	0.1	0.0	
29	-1.60	0.01	0.001	0	0.1	0.0	
30	-3.20	0.02	0.001	0	0.2	0.0	
31	-4.80	0.02	0.001	0	0.2	0.0	
32	-6.40	0.02	0.001	0	0.2	0.0	
33	-8.00	0.01	0.000	0	0.2	0.0	
34	-9.60	0.01	0.000	0	0.3	0.0	
35	-11.20	0.01	0.000	0	0.3	0.0	
36	-12.80	0.00	0.000	0	0.3	0.0	
37	-14.40	0.00	0.000	0	0.3	0.0	
38	-16.00	-0.00	0.000	0	0.3	0.0	
39	-17.60	-0.00	0.000	0	0.3	0.0	
40	-19.20	-0.00	0.000	0	0.3	0.0	
41	-20.80	-0.00	0.000	0	0.3	0.0	
42	-22.40	-0.01	0.000	0	0.3	0.0	
43	-24.00	-0.01	0.000	0	0.2	0.0	
44	-25.60	-0.01	0.000	0	0.2	0.0	
45	-27.20	-0.04	0.000	0	0.2	0.0	
46	-28.60	-0.00	0.000	0	0.2	0.0	
47	-30.00	-0.24	0.000	0	-0.0	0.0	

At elev. 9.50 Prop force = 29.4 kN/m run
 At elev. 4.60 The prop is slack

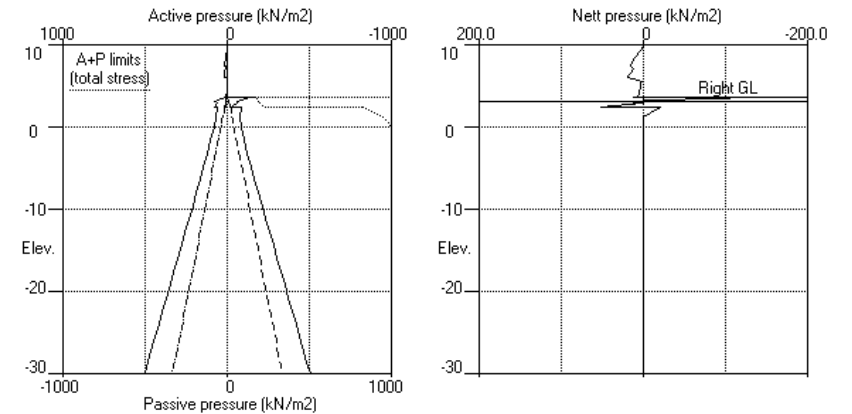
LEFT side							
Effective stresses						Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	
LEFT side							
Effective stresses						Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	
RIGHT side							
Effective stresses						Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	
RIGHT side							
Effective stresses						Total earth	Adjusted soil
Node	Y	Water	Vertic	Active	Passive	Earth	

Units: kN,m

Stage No.7 Fill to elev. 3.70 on RIGHT side



Stage No.7 Fill to elev. 3.70 on RIGHT side



TONKIN and TAYLOR GROUP LTD.
Program: WALLAP Version 6.07 Revision A55.B74.R58
Licensed from GEOSOLVE
Data filename/Run ID: Whenuapai-PumpStation-Section_2v4dat
Whenuapai pump station
Section 2 - emergency storage tanks - STU1800 (v5)

Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m
Stage No. 8 Apply water pressure profile no.1

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Prop Elev.	FoS for toe elev. = 3.10	Moment of equil.	Toe elev. for FoS = 1.500	Wall Penetr	Direction of failure
8	10.00	3.70	More than one prop.	No	FoS calc.		

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.03
Right side = 1.01

Rigid boundaries: Left side 30.00 from wall Rough boundary
Right side 30.00 from wall Rough boundary
Lower rigid boundary at elevation -30.00 Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	10.00	0.00	0.011	-2.44E-04	0.0	-0.0	-31.0
2	9.60	1.85	0.011	-2.45E-04	0.4	0.3	
3	9.50	2.70	0.011	-2.46E-04	0.6	0.3	
		2.70	0.011	-2.46E-04	-30.4	0.3	
4	9.25	4.77	0.011	-2.32E-04	-29.5	-7.2	
5	8.88	7.85	0.011	-1.60E-04	-27.1	-17.8	
6	8.50	10.62	0.011	-3.03E-05	-23.6	-27.3	
7	8.13	13.20	0.011	1.50E-04	-19.2	-35.1	
8	7.75	15.66	0.011	3.71E-04	-13.8	-41.3	
9	7.50	17.25	0.011	5.36E-04	-9.6	-44.3	-0.9
		11.07	0.011	5.36E-04	-9.6	-44.3	
10	7.15	13.21	0.011	7.83E-04	-5.4	-47.0	
11	6.80	15.31	0.010	1.03E-03	-0.4	-48.0	
12	6.40	17.68	0.010	1.33E-03	6.2	-46.9	
13	6.00	20.03	0.009	1.61E-03	13.7	-43.0	
		3.43	0.009	1.61E-03	13.7	-43.0	
14	5.60	3.86	0.009	1.85E-03	15.2	-37.4	
15	5.20	4.28	0.008	2.06E-03	16.8	-31.1	
16	4.90	4.60	0.007	2.20E-03	18.2	-25.8	
17	4.60	4.91	0.006	2.30E-03	19.6	-20.2	
		4.91	0.006	2.30E-03	18.6	-20.2	
18	4.38	5.15	0.006	2.37E-03	19.8	-15.8	
19	4.15	5.39	0.005	2.41E-03	21.0	-11.3	
20	3.93	6.14	0.005	2.44E-03	22.3	-6.4	
21	3.70	7.40	0.004	2.46E-03	23.8	-1.2	1.0
		-37.21	0.004	2.46E-03	23.8	-1.2	
22	3.60	5.86	0.004	2.46E-03	22.2	1.0	
		-137.40	0.004	2.46E-03	22.2	1.0	2.8
23	3.45	-77.77	0.004	2.45E-03	6.1	2.8	

Run ID. Whenuapai-PumpStation-Section_2v4dat
Whenuapai pump station
Section 2 - emergency storage tanks - STU1800 (v5)

Sheet No.
Date: 4-05-2022
Checked :

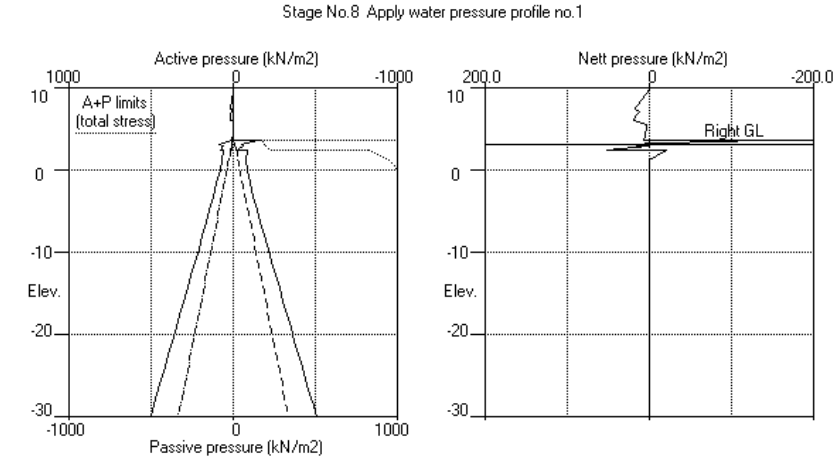
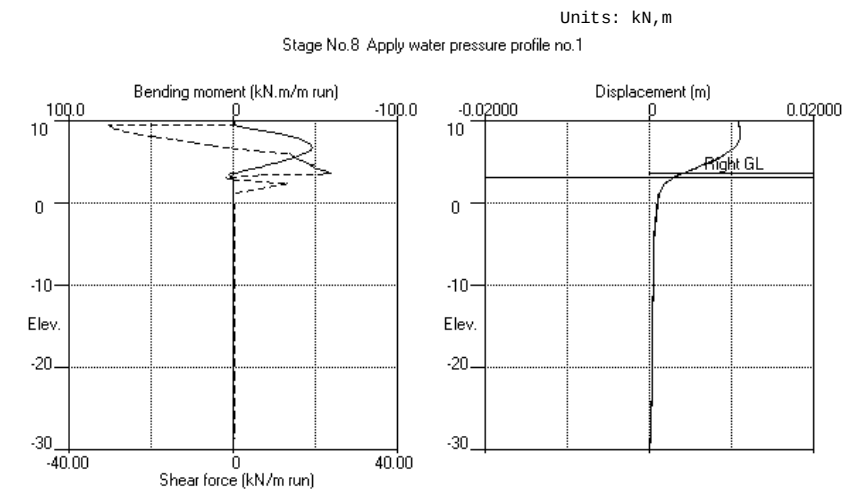
Pump station
Storage tanks

Stage No.8 Apply water pressure profile no.1

(continued)

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
24	3.10	33.11	0.003	2.44E-03	-1.7	-0.0	31.0 kN/m run
25	3.00	1.05	0.003	0	-0.0	0.0	
26	2.50	51.78	0.002	0	13.2	0.0	
		-20.98	0.002	0	13.2	0.0	
27	1.25	0.00	0.001	0	0.1	0.0	
28	0.00	0.04	0.001	0	0.1	0.0	
29	-1.60	0.01	0.001	0	0.1	0.0	
30	-3.20	0.02	0.001	0	0.2	0.0	
31	-4.80	0.02	0.001	0	0.2	0.0	
32	-6.40	0.02	0.001	0	0.2	0.0	
33	-8.00	0.01	0.000	0	0.2	0.0	
34	-9.60	0.01	0.000	0	0.3	0.0	
35	-11.20	0.01	0.000	0	0.3	0.0	
36	-12.80	0.00	0.000	0	0.3	0.0	
37	-14.40	0.00	0.000	0	0.3	0.0	
38	-16.00	-0.00	0.000	0	0.3	0.0	0.9 kN/m run
39	-17.60	-0.00	0.000	0	0.3	0.0	
40	-19.20	-0.00	0.000	0	0.3	0.0	
41	-20.80	-0.00	0.000	0	0.3	0.0	
42	-22.40	-0.01	0.000	0	0.3	0.0	
43	-24.00	-0.01	0.000	0	0.3	0.0	
44	-25.60	-0.01	0.000	0	0.2	0.0	
45	-27.20	-0.04	0.000	0	0.2	0.0	
46	-28.80	-0.00	0.000	0	0.2	0.0	
47	-30.00	-0.24	0.000	0	0.0	0.0	
At elev.	9.50				Prop force =	31.0 kN/m run	
At elev.	4.60				Prop force =	0.9 kN/m run	

LEFT side							
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth	Adjusted soil
LEFT side							
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth	Adjusted soil
RIGHT side							
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth	Adjusted soil
RIGHT side							
Node	Y	Water	Vertic	Effective stresses Active	Passive	Earth	Adjusted soil



Units: kN,m

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

<u>Stage</u> <u>No.</u>	<u>Ground level</u> <u>Act.</u>	<u>Prop</u> <u>Pass.</u>	<u>Prop</u> <u>Elev.</u>	<u>FoS for toe</u> <u>elev. = 3.10</u>		<u>Toe elev. for</u> <u>FoS = 1.500</u>		<u>Direction</u> <u>of</u> <u>failure</u>
				<u>Factor</u> <u>of</u> <u>Safety at elev.</u>	<u>Moment</u> <u>equilib.</u>	<u>Toe</u> <u>elev.</u>	<u>Wall</u> <u>Penetr</u> <u>-ation</u>	
1	10.00	10.00	Cant.	Conditions not suitable for FoS calc.				
2	10.00	8.50	Cant.	2.978	3.80	6.02	2.48	L to R
3	10.00	8.50		No analysis at this stage				
4	10.00	8.50	9.50	9.158	n/a	7.52	0.98	L to R
5	10.00	3.60	9.50	1.285	n/a	***	***	L to R
6	10.00	3.60		No analysis at this stage				
All remaining stages have more than one prop - FoS calculation n/a								

Legend: *** Result not found

TONKIN and TAYLOR GROUP LTD.
Program: WALLAP Version 6.07 Revision A55.B74.R5B
Licensed from GEOSOLVE
Data filename/Run ID: Whenuapai-PumpStation-Section_2v4dat
Whenuapai pump station
Section 2 - emergency storage tanks - STU1800 (v5)
Sheet No.
Job No. 1013050
Made by : op
Date: 4-05-2022
Checked :

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Active limit arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.03
Right side = 1.01

Rigid boundaries: Left side 30.00 from wall Rough boundary
Right side 30.00 from wall Rough boundary
Lower rigid boundary at elevation -30.00 Rough boundary

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement		Bending moment		Shear force	
		maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	10.00	0.011	0.000	0.0	-0.0	0.0	0.0
2	9.60	0.011	0.000	0.3	0.0	0.4	-1.4
3	9.50	0.011	0.000	0.3	-0.1	0.6	-30.4
4	9.25	0.011	0.000	0.6	-7.2	1.5	-29.5
5	8.88	0.011	0.000	1.6	-17.8	3.8	-27.1
6	8.50	0.011	0.000	3.7	-27.3	7.2	-23.6
7	8.13	0.011	0.000	6.8	-35.1	8.2	-19.2
8	7.75	0.011	0.000	9.9	-41.3	8.8	-13.8
9	7.50	0.011	0.000	12.2	-44.3	9.8	-9.6
10	7.15	0.011	0.000	14.9	-47.0	6.9	-5.4
11	6.80	0.010	0.000	17.0	-48.0	6.0	-0.6
12	6.40	0.010	0.000	19.4	-46.9	7.0	0.0
13	6.00	0.009	0.000	22.6	-43.0	13.7	0.0
14	5.60	0.009	0.000	22.8	-37.4	15.2	-4.1
15	5.20	0.008	0.000	19.3	-31.1	16.8	-10.6
16	4.90	0.007	0.000	15.7	-25.8	18.2	-12.1
17	4.60	0.006	0.000	12.1	-20.2	19.6	-11.9
18	4.38	0.006	0.000	9.5	-15.8	19.8	-11.2
19	4.15	0.005	0.000	7.1	-11.5	21.0	-10.1
20	3.93	0.005	0.000	4.9	-6.9	22.3	-8.9
21	3.70	0.004	0.000	3.1	-2.0	23.8	-7.5
22	3.60	0.004	0.000	2.3	0.0	23.5	-6.9
23	3.45	0.004	0.000	2.8	0.0	7.5	-5.6
24	3.10	0.003	0.000	0.0	-0.0	0.0	-1.7
25	3.00	0.003	0.000	0.0	0.0	0.0	-0.0
26	2.50	0.002	0.000	0.0	0.0	13.4	0.0
27	1.25	0.001	0.000	0.0	0.0	0.1	0.0
28	0.00	0.001	0.000	0.0	0.0	0.1	0.0
29	-1.60	0.001	0.000	0.0	0.0	0.1	0.0
30	-3.20	0.001	0.000	0.0	0.0	0.2	0.0
31	-4.80	0.001	0.000	0.0	0.0	0.2	0.0
32	-6.40	0.001	0.000	0.0	0.0	0.2	0.0
33	-8.00	0.000	0.000	0.0	0.0	0.2	0.0
34	-9.60	0.000	0.000	0.0	0.0	0.3	0.0
35	-11.20	0.000	0.000	0.0	0.0	0.3	0.0
36	-12.80	0.000	0.000	0.0	0.0	0.3	0.0
37	-14.40	0.000	0.000	0.0	0.0	0.3	0.0
38	-16.00	0.000	0.000	0.0	0.0	0.3	0.0
39	-17.60	0.000	0.000	0.0	0.0	0.3	0.0

Run ID. Whenuapai-PumpStation-Section_2v4dat
Whenuapai pump station
Section 2 - emergency storage tanks - STU1800 (v5)
Sheet No.
Date: 4-05-2022
Checked :

Pump station
Storage tanks

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement		Bending moment		Shear force	
		maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
40	-19.20	0.000	0.000	0.0	0.0	0.3	0.0
41	-20.80	0.000	0.000	0.0	0.0	0.3	0.0
42	-22.40	0.000	0.000	0.0	0.0	0.3	0.0
43	-24.00	0.000	0.000	0.0	0.0	0.3	0.0
44	-25.60	0.000	0.000	0.0	0.0	0.2	0.0
45	-27.20	0.000	0.000	0.0	0.0	0.2	0.0
46	-28.80	0.000	0.000	0.0	0.0	0.2	0.0
47	-30.00	0.000	0.000	0.0	0.0	0.0	-0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment				Shear force			
	maximum	elev.	minimum	elev.	maximum	elev.	minimum	elev.
	kN.m/m		kN.m/m		kN/m		kN/m	
1	2.8	5.60	-1.9	8.13	3.6	6.00	-1.7	9.25
2	22.8	5.60	-0.0	3.10	9.8	7.50	-12.0	4.90
3	No calculation at this stage							
4	22.5	5.60	-0.0	3.10	9.6	7.50	-12.1	4.90
5	2.3	3.45	-45.3	6.80	23.4	3.60	-28.8	9.50
6	No calculation at this stage							
7	2.3	3.45	-45.4	6.80	23.5	3.60	-28.8	9.50
8	2.8	3.45	-48.0	6.80	23.8	3.70	-30.4	9.50

Maximum and minimum displacement at each stage

Stage no.	Displacement				Stage description
	maximum	elev.	minimum	elev.	
	m		m		
1	0.001	10.00	0.000	10.00	Apply surcharge no.1 at elev. 10.00
2	0.006	10.00	0.000	10.00	Excav. to elev. 8.50 on RIGHT side
3	No calculation at this stage				Install prop no.1 at elev. 9.50
4	0.006	10.00	0.000	10.00	Apply water pressure profile no.2
5	0.011	8.50	0.000	10.00	Excav. to elev. 3.60 on RIGHT side
6	No calculation at this stage				Install prop no.2 at elev. 4.60
7	0.011	8.50	0.000	10.00	Fill to elev. 3.70 on RIGHT side
8	0.011	8.50	0.000	10.00	Apply water pressure profile no.1

Prop forces at each stage (horizontal components)

Stage no.	Anchor no. 1		Anchor no. 2	
	at elev. 9.50	at elev. 4.60	at elev. 9.50	at elev. 4.60
	kN/m run	kN/prop	kN/m run	kN/prop
4	0.15	0.58	---	---
5	29.38	117.54	---	---
7	29.40	117.59	slack	slack
8	30.99	123.95	0.93	3.74

Appendix F Construction methodology

CONSTRUCTION METHODOLOGY

17 February 2022

To: Byron de Villiers

From: Charlie Schorr-Kon, Raj Pushpagadan, Kevin Conolly and Mike Harker

Revision 3

Whenuapai Redhills Package 1 (WRP1) - Interim Pump Station and Associated Pipelines

1. Introduction

This memorandum sets out the Brian Perry Civil construction methodology proposed for the WRP1 project. This methodology statement includes assumed construction areas needed to safely deliver construction of the proposed infrastructure and sets out the methods to be adopted and key constraints as they are understood at the completion of the detailed design stage.

Some key assumptions are noted below. If these assumptions need to be changed in future, this may impact the construction approach adopted and the access and temporary works requirements noted in this memorandum.

Key assumptions:

- The Oyster Capital works (Spedding Road Extension road formation) are assumed not to be in place at the time of construction. This means that a temporary access road and staging bridge are required to be installed to support the pipeline and pipe bridge construction.
- Brian Perry Civil will be constructing a pipe bridge to carry the rising main across the Stinton Creek.
- Brian Perry Civil will be constructing a temporary access road along the rising main and gravity main alignments. The access road for the Spedding Road rising main will be cut to the proposed Spedding Road Extension subgrade level and hardfill placed to form temporary construction access. This temporary access will be left in place after construction along the rising main alignment but will be removed from the gravity main alignment once construction is completed.
- Trenchless options will be considered for the Brigham Creek Road crossing, but an open cut option is also be presented as a back up option.
- Pipeline installation assumes open cut methodology for the majority of the gravity and rising main alignments, with trenchless options presented where noted at the Brigham Creek Road crossing and at the Tamiro Road stormwater pond embankment only.

One of the principal project risks at the time of writing is uncertainty over the timing of the construction of the proposed Spedding Road Extension and Sinton Stream culvert (by others). The above noted assumptions may need to be amended if the road and culvert is constructed prior to Brian Perry Civil taking possession of the site.

2. Project Overview

WRP1 is to be constructed to convey flows from the vicinity of Whenuapai Village pump station diverted by means of a DN375/475 gravity sewer to the proposed interim Slaughterhouse PS.

The interim Slaughterhouse PS will discharge to a single DN500 PE rising main, conveying flow to a location close to the intersection of Spedding and Mamari Road where it will discharge into a pressure

break chamber at the upstream end of the Massey Connector tunnel. The pressure break chamber and Massey Connector tunnel form part of Whenuapai-Redhills Wastewater Servicing Package 2 (WRP2) which is outside the scope of this memorandum.

The downstream battery limit for the WRP1 project is to terminate the pipeline adjacent to the pressure break chamber. Once WRP 2 is completed (not part of this scope), flows from the Massey Connector will gravitate to the Hobsonville PS via the WRP2 system. From Hobsonville PS, the flows will ultimately be pumped to Rosedale WWTP.

The project scope of work for WRP1 consists of the construction of three key elements:

1. Gravity Main – transferring flow from the location of the existing Whenuapai Village PS to the interim Slaughterhouse pump station.
2. Interim Slaughterhouse PS – discharging flow to the WRP2 pressure break chamber.
3. Spedding Road Rising Main – carrying flow from the Interim Slaughterhouse PS, the pipeline will terminate adjacent to the proposed pressure break chamber.

Refer to Figure 1 for an overview of the project site.

3. Contractor areas, land occupation and use

The project will commence with establishment of the contractor facilities and yards on site, there are three proposed establishment areas that that will be required to facilitate construction. Landowner discussions are currently underway and have not yet been concluded at the time of writing this memo. The overall proposed site plan is shown below in Figure 1.



Figure 1 – Overall Site Plan (not to scale)

The site extends from the existing Whenuapai Village Pump Station site in Tamiro Road, at the upstream extent of the site in the north, to the existing Spedding Road at the downstream end of the WRP1 system in the south as shown above in Figure 1.

Site establishment would commence at Contractor Area Hub (CA Hub) location shown in Figure 2 below, with establishment of the main yard and site compound, which would include office space, workshop facilities, light vehicle parking, as well as spoil stockpiling area and materials storage yard space. Establishment of the CA Hub would commence with construction of the road crossing, vegetation clearing, erosion and sedimentation controls, topsoil stripping/metalling and temporary traffic management (TTM) established for safe site access from Brigham Creek Road (SAP1) through the new road crossing.

The smaller yards at Contractor Area North (CA North) and Contractor Area South (CA South) would also be established following the CA Hub mobilisation, following the same methodology of vegetation clearance as required, with topsoil stripping/metalling, erosion, and sediment controls (ESC) established, as well as TTM for site access.

As noted, TTM would be established within Spedding Road at SAP2 to provide safe access to the southern end of the Spedding Road rising main site and at SAP5 to provide safe access to CA South via an existing driveway crossing. TTM would also be established at Brigham Creek Road both at SAP1 and SAP3 to provide safe access to CA Hub and CA North respectively. Both site access locations (SAP1 and SAP3) have existing driveway crossings which would be utilised and extended to provide safe site access.

Following the establishment of TTM and sediment controls, vegetation and topsoil stripping and hardstanding of the contractor areas would commence. Spoil stockpiling areas would also be established with appropriate bunding, sedimentation and runoff management.

Once the yard at CA South was established, work would commence on the earthworks associated with the temporary access road along the Spedding Road extension, following the rising main alignment. The stripping and hardstanding of the temporary access road along the gravity main to the north would also be undertaken once the earthworks were completed for the rising main site.

3.1 Contractor Area Hub

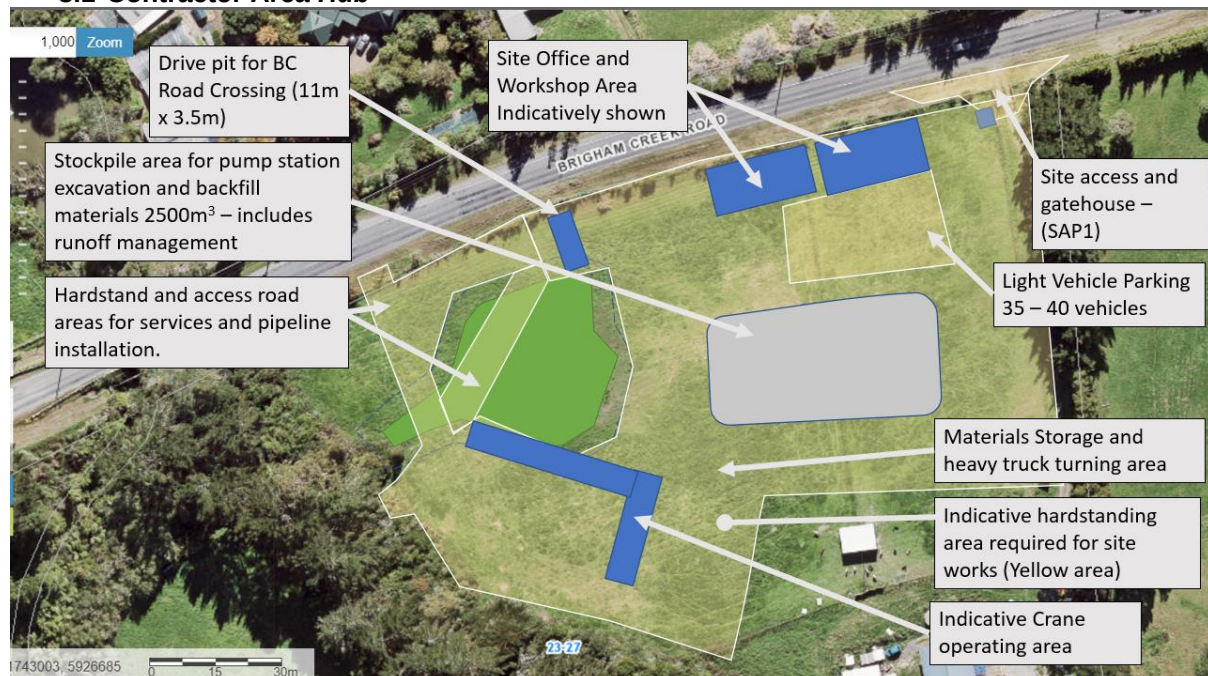


Figure 2 – Contractor Area Hub (CA Hub) – Approximate Layout

The Contractor Area Hub would be the first area to be established, the contractor yard space is located on Oyster Capital land. In the order of 10,000m² would be required for hardstand, consisting of a topsoil strip (300mm-400mm), placement of geofabric and compacted GAP65. A stockpile area,

light vehicle parking (more than 35-40 vehicles) and main office area would be constructed at project mobilisation. Standard motion activated security lighting is to be used on site outside of operational hours.

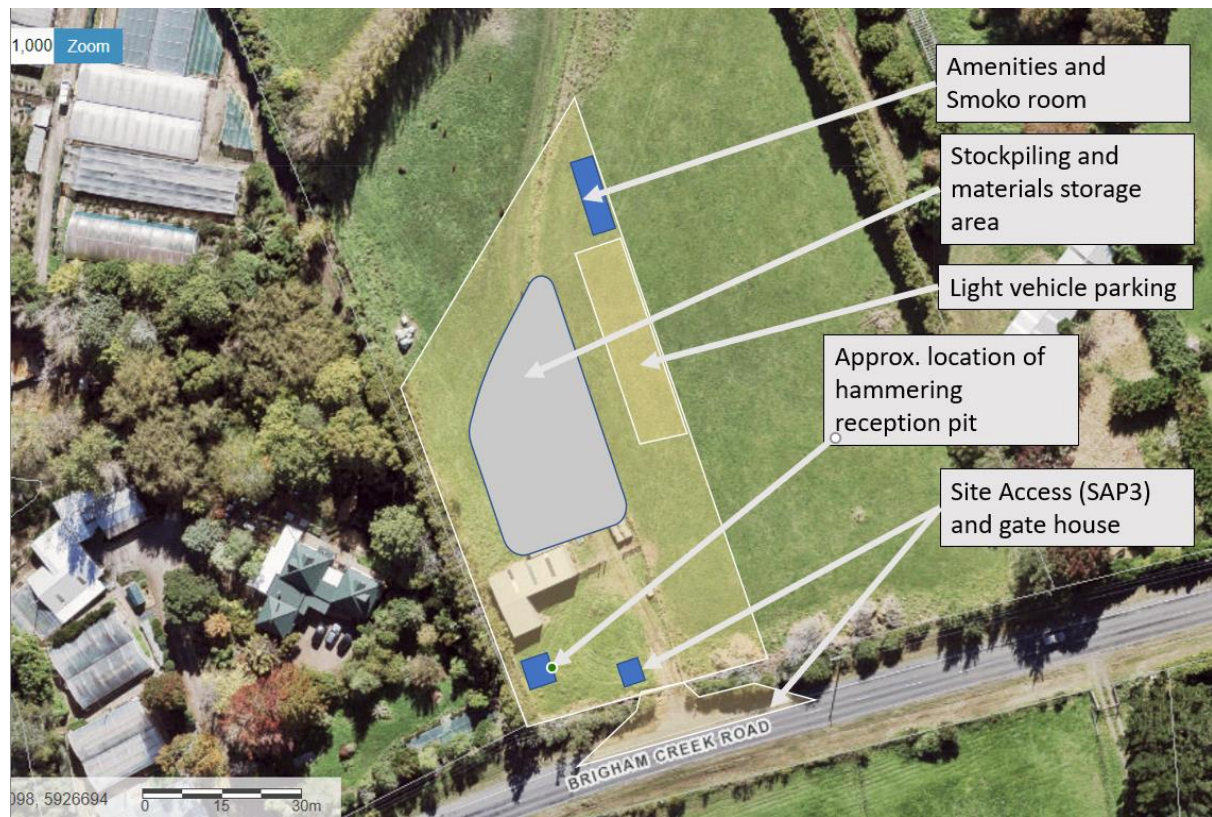


Figure 3 – Contractor Area North (CA North) – Approximate Layout

The Contractor Area North (CA North) compound would be constructed prior to the gravity main construction getting underway. This would consist of approximately 5000m² of metalled area, requiring its own bunded stockpiling area, materials storage, light vehicle parking (less than 20 vehicles) and amenities, to remove the need for construction staff to cross Brigham Creek Road to access facilities. Standard motion activated security lighting is to be used on site outside of operational hours.

Landowner discussions are ongoing at the time of writing. If the suggested site shown in Figure 3 is not available, an alternative location has been identified - as shown in Figure 1, to the northwest, accessed from Whenuapai Drive.

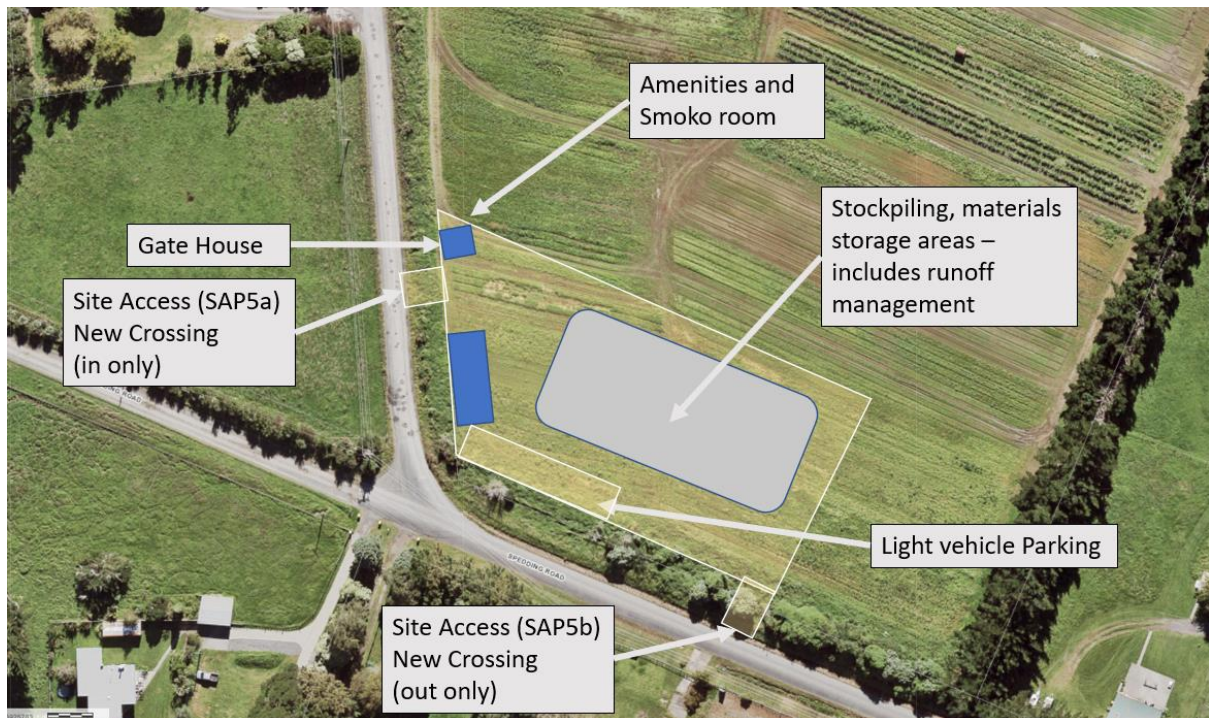


Figure 4 – Contractor Area South (CA South) – Approximate Layout

The Contractor Area South (CA South) would be constructed after the CA Hub was completed and would need to be in place prior to the commencement of earthworks for the Spedding Road rising main temporary access road. CA South would be similar in area to the Contractor Area North (5,000m²), constructed using the same method and materials. Light vehicle parking would be for less than 20 vehicles. Standard motion activated security lighting is to be used on site outside of operational hours.

It is currently proposed that the CA South is located at the property of 32 Mamari Road as shown in Figure 4. A new road crossing would need to be constructed accessing Mamari Road. A back up location has been identified at 13 Spedding Road if the primary location is not available, as shown in Figure 1.

4. Construction Phasing of the Works (overview)

The construction programme for the WRP1 works would run for 18-20 months including a period of 4.5 months for completion of contract documentation at commencement. The critical path for the construction would run through the pump station construction. Refer to the high-level indicative programme attached in Appendix C.

It is suggested that the three separate work fronts be operational in parallel to meet the programme. The independent work fronts would be the rising main, pump station and the gravity main, all operational (as needed) from project commencement, or as resourcing demands permit.

Approximate phasing of the works would be as follows:

Team 1 Establish Contractor Area Hub. The construction of the CA Hub area is assumed to take approximately 6-8 weeks. Pump station works can get underway once the CA Hub area is constructed. Pump station construction duration is likely to be in the order of 16 months from commencement on site until pre-commissioning completion (Hot commissioning can only take place once the pump station is connected to WRP2 and the Whenuapai Village pump station).

Team 2 Establish CA South yard area. The construction of the CA Hub area is assumed to take approximately 4-5 weeks.

Commence of the earthworks on Spedding Road rising main follows CA South construction. The rising main works are estimated to take in the order of 14 months.

Team 3 Establish CA North. Commence installation of gravity main temporary access road once CA North is established. The gravity main works are estimated to take in the order of 14 months.

5. Rising Main Construction Approach

5.1 Rising Main Overview

The Spedding Road Rising Main consists of 1487m long, 500OD PE100 SDR 13.6 rising main, which conveys flow from the proposed Interim Slaughterhouse Pumping Station (Refer Section 7) to the break pressure chamber at the head of the Northern Interceptor Stage 2 tunnel. The break pressure chamber is the downstream extent of this contract and is to be constructed under the Whenuapai Redhills Package 2 contract. The overview of the rising main is shown in Figure 5 below.

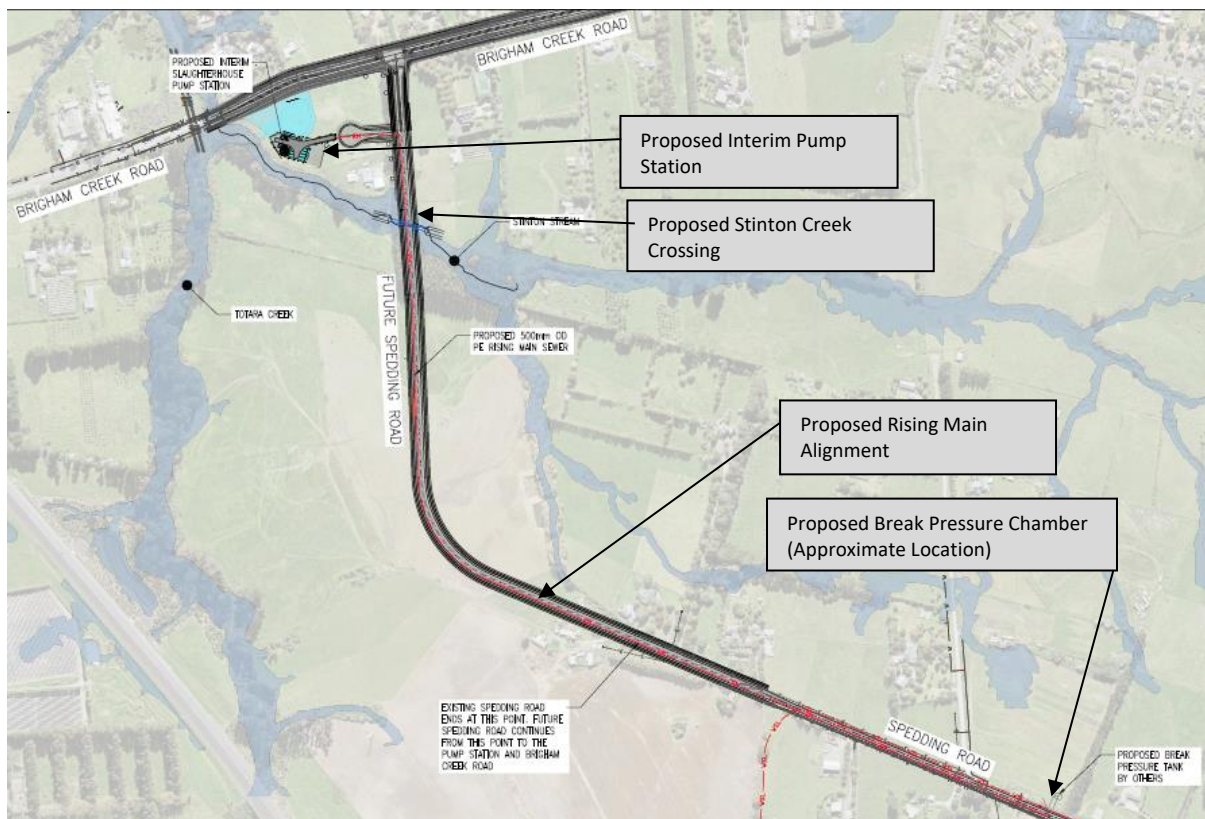


Figure 5 – Rising Main Overview

Three options have been considered for the installation of the rising main.

Option 1 – Open cut rising main and pipe bridge (Discussed in detail within this report)

Option 1 considers that the full length of the rising main is to be installed by open cut method, as per the design intent. The pipeline is intended to run underground for its full length except where it passes through a proposed 30m pipe bridge crossing at Stinton Creek.

Option 2 – No pipe bridge and majority of line installed via trenchless method

Option 2 considers that most of the pipeline length is installed via trenchless method. The upstream section of the pipeline from the outlet of the proposed interim pump station outlet to the Spedding Road Extension alignment is assumed to be installed via open cut. From CH145 the pipeline would be installed via trenchless method, under Stinton Creek and onto the BPT.

Option 3 considers that the pipeline from the outlet of the proposed interim pump station to the pipe bridge is installed via open cut method. The pipe bridge over Stinton Creek is included in this option. From the downstream end of the pipe bridge (CH245m) approximately 150m of pipeline would be open cut, then from there, the pipeline is installed via trenchless method to the BPT.

Options 2 and 3 are not discussed further in this method statement.

Temporary works are required for establishing a trafficable access road along the pipeline alignment and for installing a temporary staging bridge over the Stinton Creek adjacent to where the pipe bridge is to be installed. We have assumed that the temporary access road is 6m wide and follows the pipeline alignment at approximately 1.2 – 1.5m cover. Refer to Figure 6 below for an indicative cross section of the access road.



Figure 6 –Temp Access Road Indicative Cross Section

The access road area once constructed (including batter slopes is approximately 16,300m²), the earthworks volume to construct the temporary access road will be in the order of 10,000m³, details can be found in Appendix B. Sediment and erosion controls would be put in place prior to earthworks commencing and would then be removed once the temporary access road was removed at commencement of the construction period.

The Stinton Stream crossing for the rising main is to consist of a permanent culvert proposed as part of the Oyster Capital extension of Spedding Road (Refer to Appendix F for culvert design and installation information).

It should be noted that detailed design of the temporary works will be provided at engineering plan approval stage.

An overview of the pipeline installation process is detailed below as a list of activities.

- Installation of silt controls outside of earthwork footprint.

- Set up dewatering locations for disposal of ground water, encountered during excavation for the new rising main.
- Construct sediment ponds, that can treat the water, that has been pumped out of the trench before it is discharged into waterways.
- Or set up sediment tanks, that can be moved along as excavation proceeds. These tanks can treat the dirty water before discharging into existing waterways.

Earthworks.

- Establish the laydown area for the stockpile of excavated material and the stockpiling of bedding and backfill material at CA South.
- To minimise truck movements, the removal of excavated material will be carried out by truck and trailers from the existing Spedding Road to the local clean-fill tip site.
- As the new haul road is excavated, it will be covered with a layer of 400mm hard fill over a geofabric membrane, with the metal material compacted as per the temporary works specification.
- At each shift end, all exposed ground within the temporary access road site will be covered to prevent sediment laden run off.

Set up of Welding Area.

- Build an area for the delivery of PE pipework within the CA South compound.
- Make the area large enough to enable the pipe strings to be welded together.
- Area to be stripped of topsoil and use this material for bunds which would then be covered with geofabric to temporarily stabilise.
- Place geofabric over exposed area and place a compacted layer of hard fill.
- Unloaded PE pipes and stack packs of pipe onto timber dunnage to prevent damage to the pipe material and enable inspection.
- Construct an area for the welding machine and pipe rollers to feed pipes to welding area.

PE Pipe Welding

- Pipe string welding and weld testing as required to meet Watercare specifications.
- Welding will be limited to three pipes per pipe string, welding information is written beside each weld joint.
- Ends of pipe strings to be sealed off as they are completed and stacked in area to be ready for transporting to work area.
- The pipe strings will be moved to site on wheeled trollies.

Excavation

- All excavated material from the trench works will be taken to a stockpile area within SA South and removed by truck and trailers to clean-fill.
- The trench will be benched as required or if needed shoring will be installed, along the alignment, depending on the available space at the specific site location.

Pipeline Installation

- As excavation continues, take shear vane readings at the base of the trench, to confirm the competence of the cut level.
- Place geofabric and compact bedding as per specifications.
- Install the first pipe string, with a dead-end plate at chainage 145.
- This will enable progressive testing of the pipeline during construction.
- At the end of pipe string, excavate for a wider welding pit, for connection of next pipe string.
- Place and compact bedding over the first pipe string and record clegg tests along pipe string.
- Place and compact GAP 65 in layers and record clegg result along pipeline.

Installation of scour chambers

- Excavate for new scour chamber, bench existing ground or install shoring
- Take a shear vane reading, at the base of the excavation, to confirm the competence of the cut level.
- Place and compact bedding and place site concrete to enable manhole to be installed.
- Connect scour pipework to main pipeline and install scour manhole.
- Construct concrete corbel, with waterproofing detail around scour pipework
- Bring manhole to full height and place compacted hardfill around manhole.

Installation of air valve chambers

- Install air valve tee onto existing pipeline and connect pipe onto tee junction.
- Backfill and compact bedding around pipe and tee junction
- Install concrete pads for manhole riser and install riser.
- Complete CCTV inspection at air valve junction back, going back towards chainage 245. Record in the QA file.
- Continue to perform air test as pipeline is install. Record tests in QA file.
- Place air valve onto tee junction and complete manhole lid and casting.
- Install vent pipe and vent to be locate off road reserve.

Pipeline Installation

- Continue with above pipeline installation process, until the pipeline reaches chainage 1138m.
- Locate the existing Massey North Branch Sewer Rising main and confirm the level of the existing rising main. Confirm the amount of separation between the top of Massey rising main and the invert of the new sewer rising main.
- New rising main will pass over the top of the existing rising main, with the correct amount of separation.
- Continue with pipeline construction to the new pressure break chamber location at approximate chainage CH1500m.

5.5 Rising main connection into brake pressure chamber

The rising main connection into the break pressure chamber is being designed as part of the Whenuapai Redhills Package 2 project. Based on the assumption that the Package 1 rising main will be installed prior to the break pressure chamber, the pipeline will be terminated at the contract battery limit at a flange location in the proximity of the break pressure chamber within Spedding Road. The existing Massey North rising main diversion into the new break pressure chamber will be completed once the Package 2 project has been completed and commissioned.

6. Gravity Main Construction Approach

6.1 Gravity Main Overview

The gravity main consists of a 670m long gravity pipeline comprised of 99m of 475mm diameter RRJ uPVC and the remaining length (571m) in 375mm diameter RRJ uPVC.

The gravity main conveys flow from the existing Whenuapai Village pump station located in Tamiro Road to the proposed Interim Slaughterhouse Pump Station (Refer Section 7). The gravity main is designed at a constant gradient of 0.5%, with 13 manholes. Refer to Figure 8 for overview.

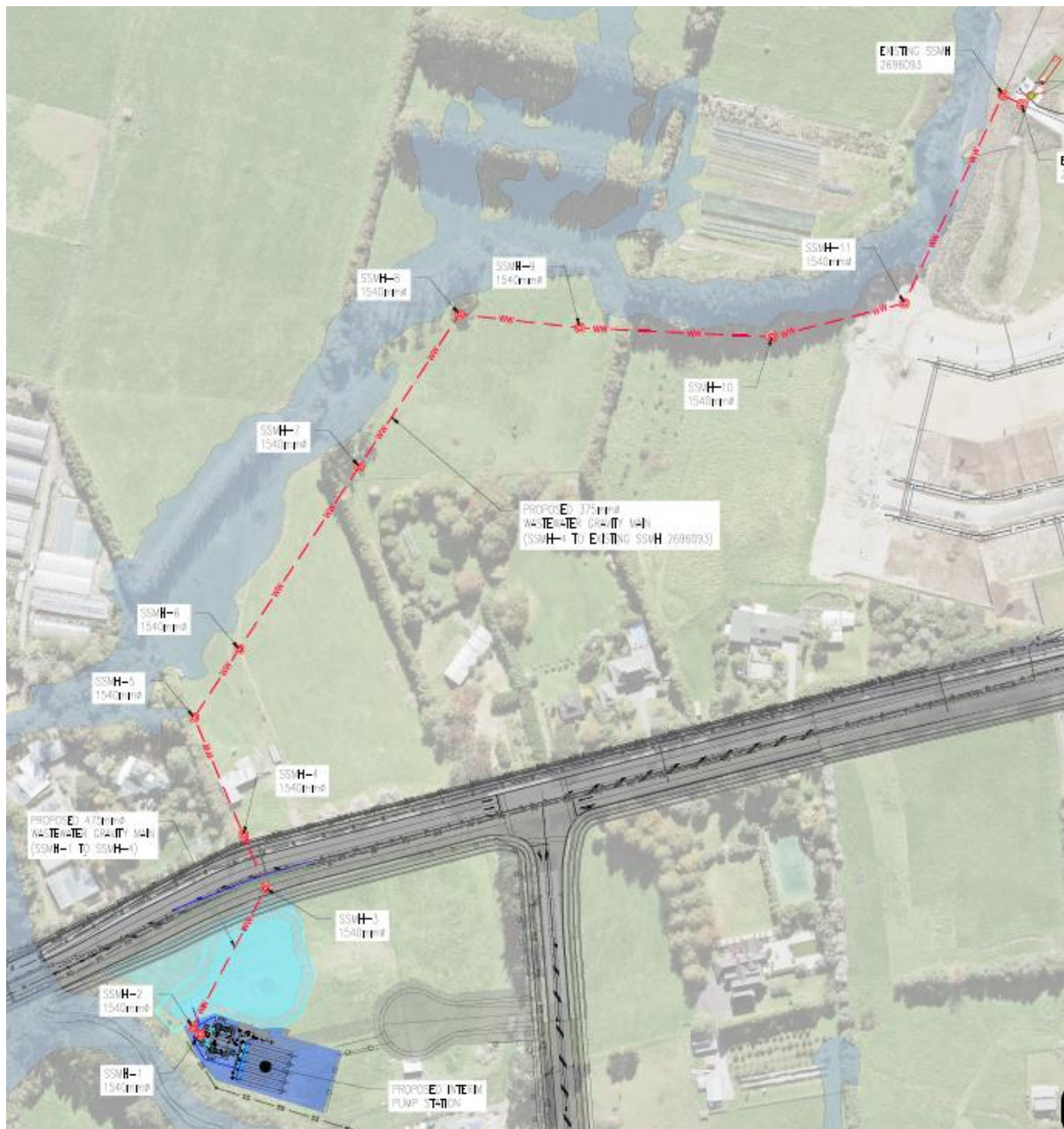


Figure 7 – Gravity Main Overview

6.2 Gravity Main Construction Access

Similar to the rising main, the gravity main will require a construction access road along the full alignment. The topography of the gravity main alignment is generally much flatter than the rising main alignment, which means that the volume of earthworks required for the temporary access will be significantly less than that required for the rising main.

Typically, a 6m wide and require approximately 300 - 400mm of GAP65 over a layer of geotextile. The approximate area of the gravity main access road will be 4,300m² and will require the removal of approximately 1,720m³ of topsoil to be stockpiled for the duration of the pipeline installation. The stockpile area would most likely be adjacent to the CA North yard area.

The access road would be removed after construction and topsoil replaced, stabilised and seeded to replace the grass areas and remediate the site after construction.

6.3 Gravity Main Construction Process

The pipe material for the gravity main is rubber ring jointed uPVC (375 and 475mm diameter). The gravity pipeline will commence with installation of the Brigham Creek Road crossing. The reason for this is that the crossing is proposed to be installed by pipe-hammering a casing beneath the road corridor, this will set the level for the pipeline at the Brigham Creek Road location. Once the pipeline is constructed beneath Brigham Creek Road (Refer to 6.3.1), chambers SSMH3 and SSMH4 would be constructed either side of Brigham Creek Road.

The SSMH4 chamber would be constructed on the southern side of Brigham Creek Road and the pipeline would be constructed back to the pump station moving downstream. Once the pump station connection is completed, the pipeline installation team will move to the northern side of Brigham Creek Road and install the pipeline from SSMH5 to the location of SSMH11 moving sequentially along the pipeline in an upstream direction. The excavation for SSMH11 would be constructed and the last section of the pipeline would be installed trenchlessly through to a reception pit adjacent to the Whenuapai Village pump station.

Pipeline spoil would be stockpiled at the CA North Yard for disposal to clean fill. Some suitable material would be retained for back filling of the pipe and chambers as allowed by the specification.

6.3.1 Brigham Creek Road Crossing (Trenchless Option - preferred)

To construct the pipe between chambers SSMH4 and SSMH5, trenchless methods are proposed. However, the ground conditions do present some risk as fibrous organics and wood were identified in the geotechnical borehole logs.

The trenchless approach would be executed by constructing two shafts, one either side of Brigham Creek Road (BCR), at the approximate locations shown in Figure 8 below. The reception shaft would be on the northern side of BCR and drive shaft pit on southern side, so the hammering machinery would be working in an upstream direction.

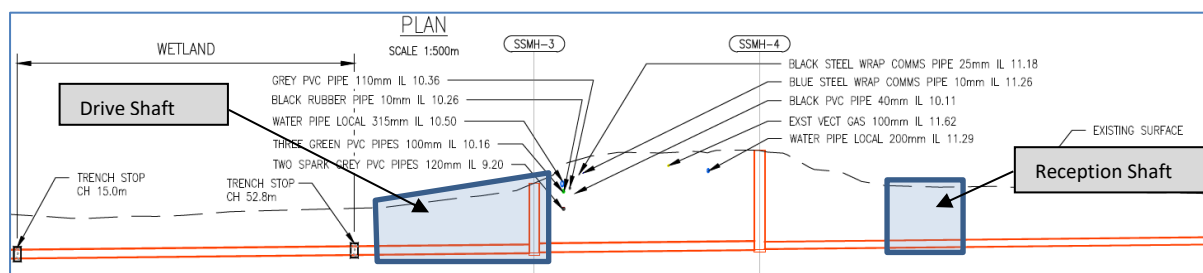


Figure 8 – Pipe Hammering (Approx) Set Up for Brigham Creek Road Crossing

A sheet pile excavation would need to be constructed for the launch shaft, concrete would be placed on the shaft floor and guide rail bed would then be installed on the slab. The hammer would then be installed on the guide bed and the first casing placed. A hole would be cut in the sheet piles to suit the casing diameter then hammering of the casing pipe (800mm – 1000mm) would commence. As the hammering progresses, casing pipe sections would be welded into the string as each length is hammered into place. The reception shaft would be excavated, and a trench shield used to support the excavation.

Dewatering sump pumps will be set up in the drive and reception pits as necessary to manage ground water ingress. The water will be appropriately treated prior to discharge to the environment. It should be assumed that the drive and reception pits will be in place for >30 days, in case of delay. A detailed proposal of the water treatment system will be provided at engineering plan approval stage.

It should be noted that the casing pipe will pass within 800mm underneath the southern cross cable (international fibre). In discussion with Chorus, they noted that it would be their preference to pothole the southern cross cable (trench parallel with the cable alignment and about 0.5m to the south of the cable in the crossing location). To enable the site team to see if the casing is approaching the cable.

If ground conditions permit keep sheet piles short in the reception pit rather than cutting an entry hole. Once the casing is in place remove the spoil out of the casing pipe.

Install sewer pipe and grout in place, using spiders to hold pipe at correct grade. Grout pipe in place once grade is confirmed. Complete by constructing chambers, back filling shafts and removing sheet piles.



Figure 9 – Indicative pipe hammering set up.

The pipe hammering operation will produce some noise in the vicinity of the drive pit. The hammering operation would likely be in operation for 1 – 2 weeks, with the hammering operating during normal site hours (i.e. 7:30am – 6pm).

6.3.2 Brigham Creek Road Crossing (Open Cut Option)

The option to open cutting across Brigham Creek Road would only be used if the trenchless option failed due to poor ground conditions or underground obstructions. Where the pipe needed to be open cut through Brigham Creek Road the work would be proposed to be completed in half of the road at a time. The road pavement would need to be temporarily widened to enable traffic to be offset, in a stop/go set up.

Work would start from the southern side of the road, with existing services being marked out and hydro-excavation executed to expose the existing services in the southern berm area. A temporary

pavement would be constructed on the northern side of Brigham Creek Road and traffic moved over to enable the excavation to be constructed on the southern side of the road. As services were identified in conjunction with the asset owners we would work to identify and protect the services.

Excavation would commence from the road centreline in a southerly direction, installing short sections of shoring as the excavation progressed. Sheet piles would be pushed into the ground with the excavator between the services, as the trench is excavated around the services, timber lagging would be placed in the gaps between sheet piles to shore the excavation. This would be continued to cut level between and on either side of the services.

Once the trench was large enough and properly shored the sections of pipe could be laid and tested. Once the pipe was tested, the trench could be progressively back filled, and the shoring carefully removed from around the services. If required self-compacting flowable fill could be used to backfill around the existing services.

The first section of trench shoring would be left in place at the centreline of the road to keep the excavation open for the pipe connection from the North. Temporary pavement would then be constructed on the southern berm of the road (over the top of the newly constructed pipe). The traffic flow would then be moved over to the southern side of the road and work would commence on the southern side of the road once traffic flow was relocated.

Refer to staging plan in Appendix E for further information on the methodology proposed for open cut through Brigham Creek Road. Note that this is not the preferred method as there are more significant community impacts than the trenchless method noted in Section 6.3.1.

6.3.3 The Tamiro Road Stormwater Pond Embankment

Construct 2.5m manhole (SSMH11) to accommodate the pilot drilling rig. SSMH12 is an existing manhole, which would need to be removed and enlarged to a minimum of 2.0m diameter. An over-pumping operation would be required to enable SSMH12 to be replaced.

Within SSMH11, a concrete slab would be constructed at 1m below the upstream pipe invert. The chamber should be back grouted, to provide a good base for the pipe auguring. A hole would need to be cored into the chamber where the upstream pipe would penetrate the chamber. Once the rig is installed within the chamber a series of rods would be pushed through at the correct gradient to the reception chamber at SSMH12.

Once the pilot rods were in place at the correct gradient and location. The lead auger casing would be attached and driven through. Muck and drill fluid would be removed from the drive pit. Once the casings were in place the pipe would be pushed through to drive the casings out to the reception pit. Once the final pipe was in place, the chamber corbels would be cast in situ around the pipe.

7. Interim Slaughterhouse Pumping Station Construction Approach

7.1 Pump Station Overview

The proposed Interim Slaughterhouse Pump Station site is in a greenfield area adjacent to Brigham Creek Road. The pump station site is situated between the Stinton Stream to the southwest and a wetland area to the north. The pump station inlet chamber depth is determined by the storage and wet well volume requirements. The wet wells are in the order of 8.65m deep to invert which will require an excavated depth of approximately 9.5m. The storage tanks are a maximum of approximately 5.3m to invert which will require an excavation depth of approximately 6.0m.

7.2 Pump Station Construction Access

Because of the proximity to the Stinton Stream and the wetland area, construction access will be constrained to the northern and western sides of the site. The wetland area is shown with a 10.0m offset area, which we would hope to utilise for construction, with silt protection in place. We have shown the likely areas of hardstanding that would be constructed for the pump station.

The construction process would commence with installation of sediment controls and preparing a hardstand area with appropriate runoff treatment, prior to discharge to the environment. Construction of the hardstand area would involve the stripping of topsoil to 400mm, placement of geofabric and GAP65 compacted in place. The topsoil that is removed would be locally stockpiled and once the works were completed, the hardstand areas would be removed and replaced with the native topsoil, which would be stabilised and seeded at completion.

7.3 Inlet Chambers, Wet Wells and Deep Piping

We have developed an approximate staging plan for construction of the pump station (Appendix D), which commences with the deep structures and works progressively to the surface structures and civil works.

Extensive temporary works will be required to facilitate the construction of the underground chambers and connecting pipes. Sheet piled excavations are proposed for the inlet works and wet wells and associated deep piping. The below image is extracted from the staging plan for the inlet works and wet wells showing the installation of the deep structures and piping.

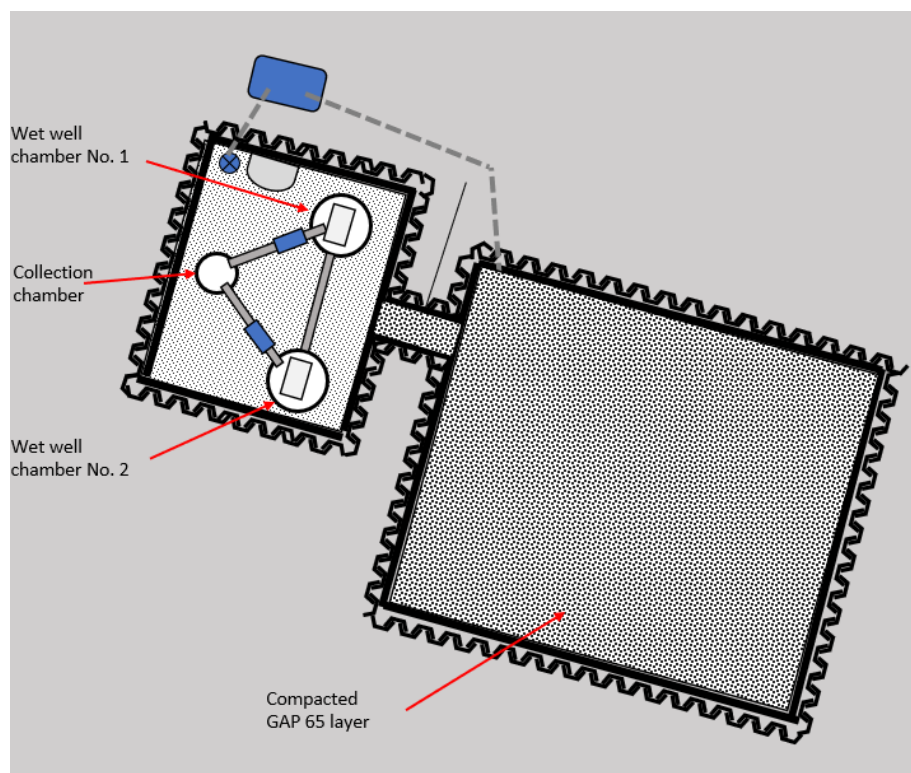


Figure 10 – temporary works for installation of pump station inlet structures

The excavation for the inlet chamber, wet wells and interconnecting deep pipelines would be in the order of 140m² in plan area and require the excavation of approximately 1,400m³ of material. The material is proposed to be stockpiled locally to the pump station site within the Contractor Area Hub yard stockpiling area, while it is carted off site for disposal at clean fill site, while retaining the necessary material on site for backfilling. Dewatering facilities and water treatment would be used during the excavations being in place to manage ground water. Dewatering discharge rates and treatment requirements will be determined during the preparation of temporary works and sediment and erosion controls design.

7.4 Storage Tanks and Connections

The storage tanks will require a separate sheet piled excavation to be constructed adjacent to the excavation for the pump station wet wells and inlet works. The footprint area of the second sheet piled excavation would be in the order of 600m² in plan area and require the excavation of approximately 3,900m³ of material. The material is proposed to be stockpiled locally to the pump station site within

the Contractor Area Hub yard stockpiling area, while it is carted off site for disposal at clean fill site, while retaining the necessary suitable material on site for backfilling. As noted above dewatering will be in place during the works to manage groundwater. Any ground water discharged from the site will be treated prior to discharge, using a sedimentation pond or alternatively a 'silt-buster' sediment removal system.

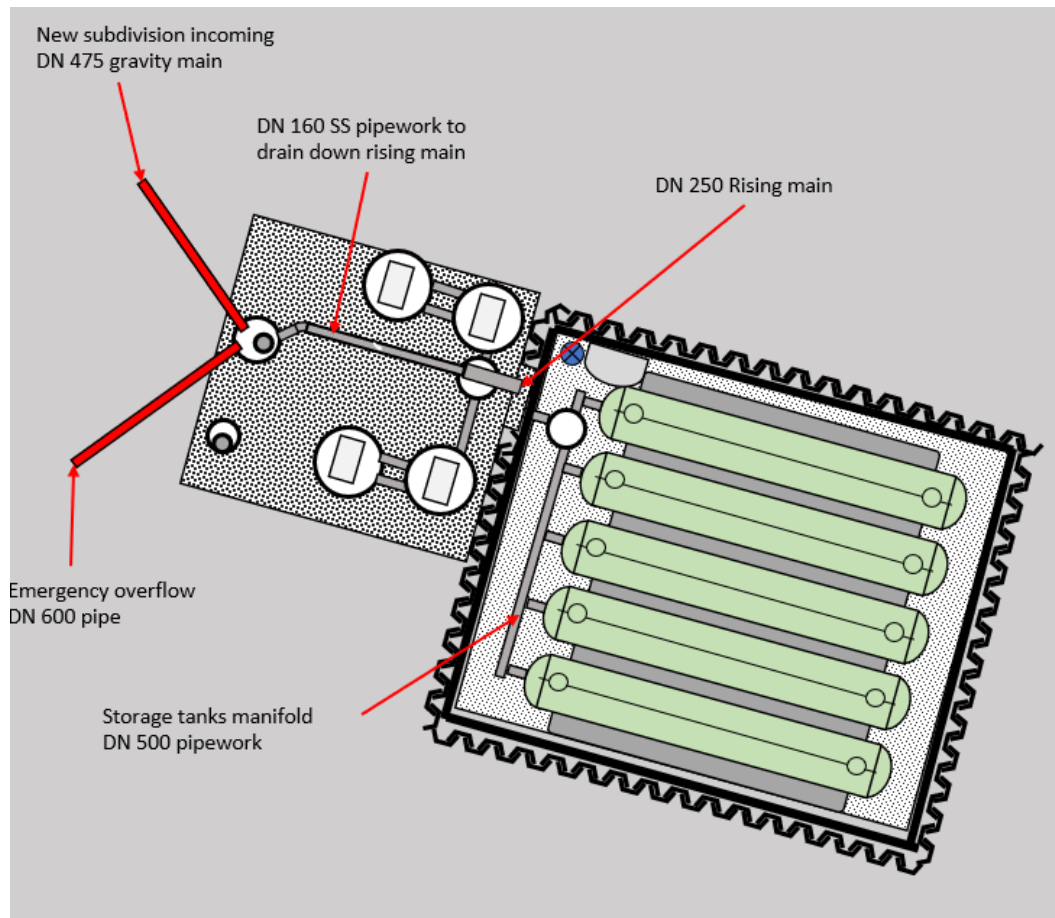


Figure 11 – temporary works for installation of storage tanks

Once the structural works are completed the excavations would be backfilled in accordance with the specification in compacted layers.

7.5 Emergency Overflow

The pump station emergency overflow outfall would require careful construction in the Stinton Stream. Vegetation would be cleared around the emergency outfall area to enable construction. The vegetation clearance would be out to 2.0m beyond the footprint of the infrastructure shown on the drawings, including the rip-rap, headwall and pipeline. The outfall would be excavated with foundations and riprap installed, followed by the placement of the precast headwall and casting of an apron slab.

8. Limitations

This memorandum is prepared for the exclusive use of Watercare Services Limited (Client) under the Enterprise Model by Brian Perry Civil (Construction Partner). The information used in the preparation of this memorandum has been received from the Client and has not been independently verified.

Brian Perry Civil accepts no liability in connection with either:

- Unverified information provided to Brian Perry Civil, that has been relied upon in preparation of this memorandum.
- Reliance of third parties on the use of the information contained in this report.

Appendix A – Project Drawings (Detailed Design – when available)

Appendix B – Rising Main Earthworks Conceptual Design

Appendix C – Indicative Project Programme

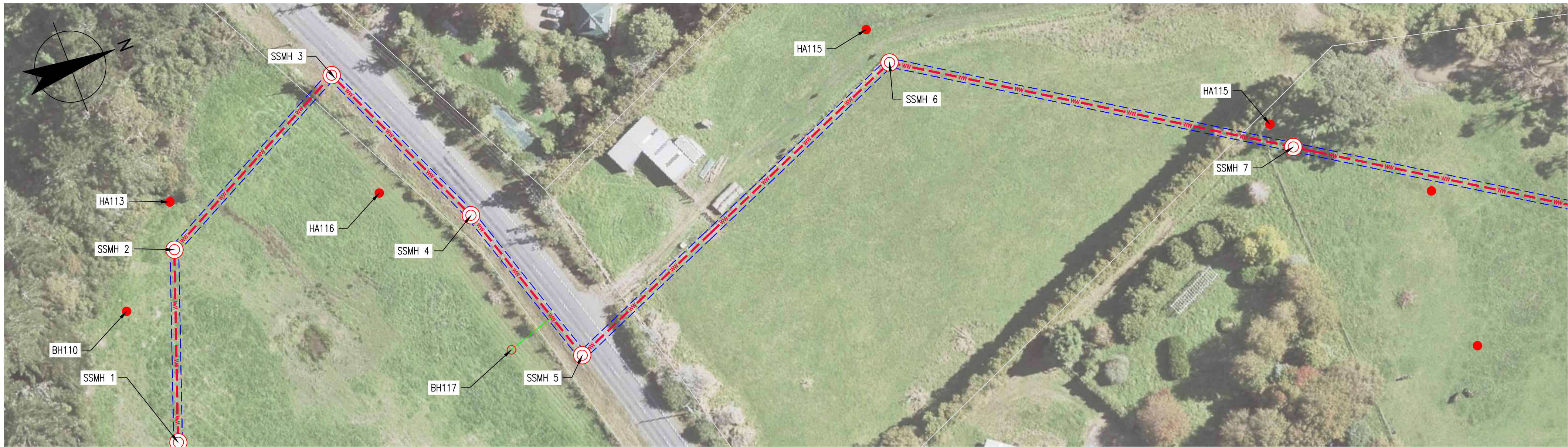
Appendix D – Pump Station Construction Staging Plans

Appendix E – Open Cut Crossing of Brigham Creek Road - Construction Staging Plans

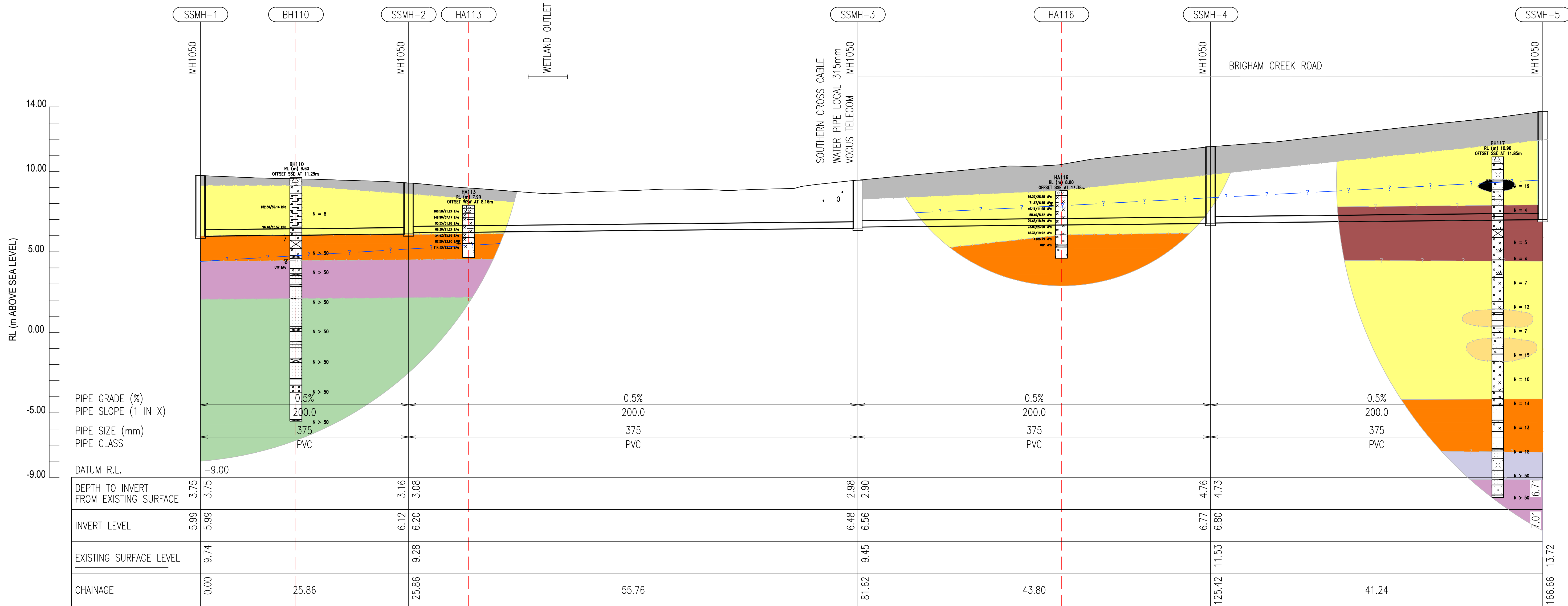
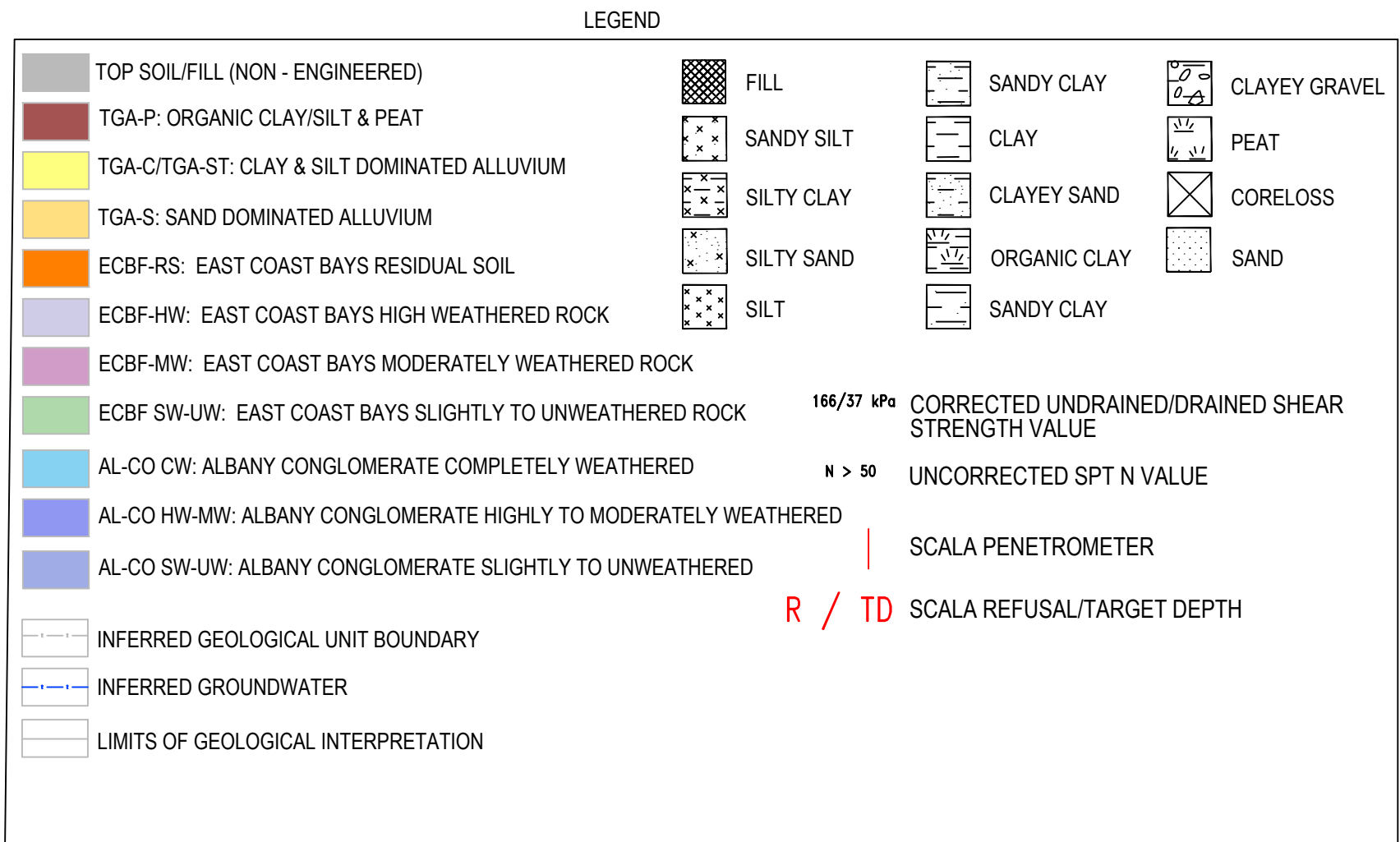
Appendix F – Oyster Capital Culvert Diversion Details

Appendix G Geological long section from GIR

Appendix D – Geological long sections

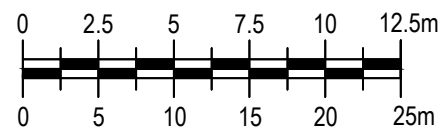


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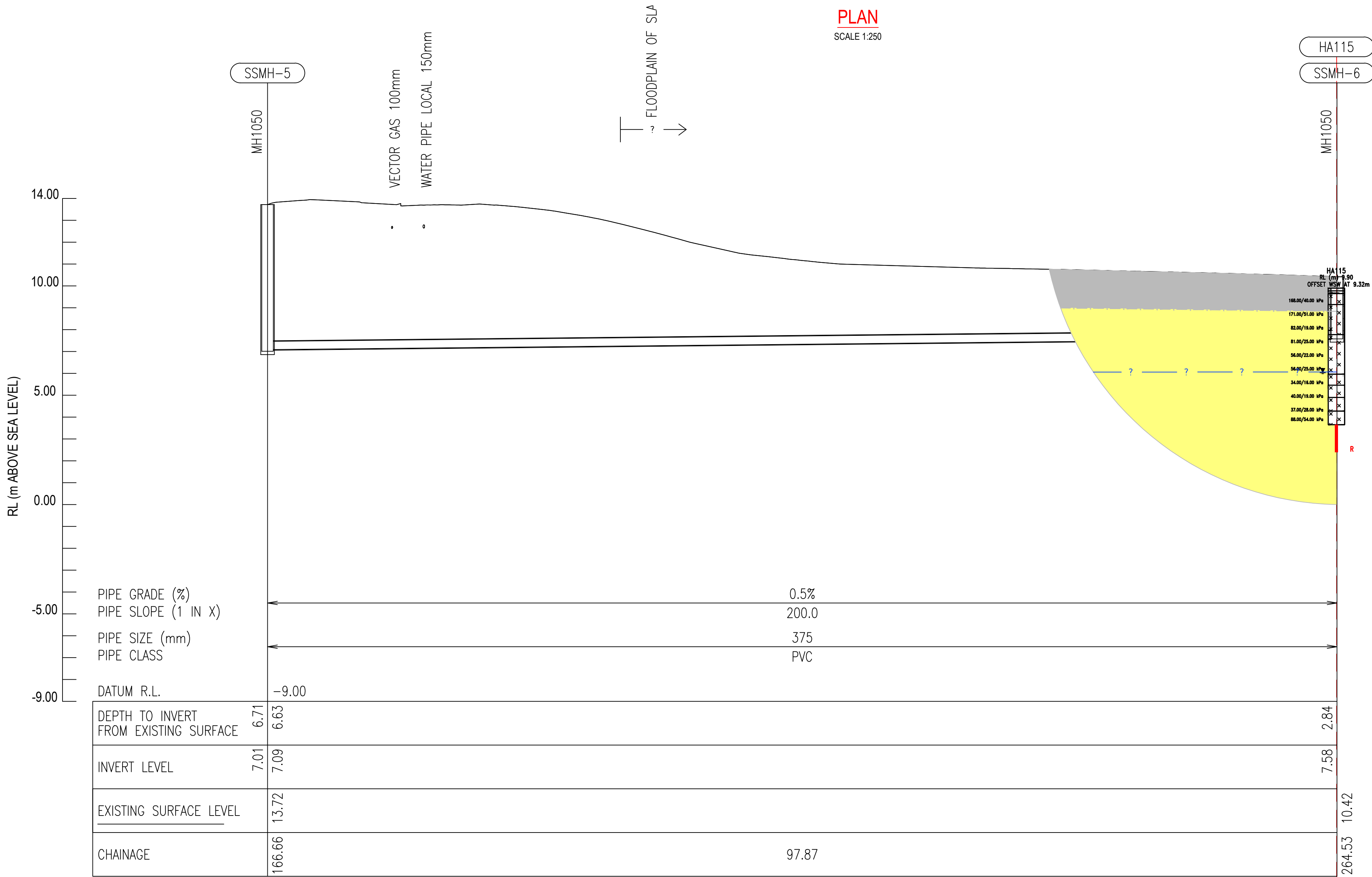
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	INFERRED GROUNDWATER						
	LIMITS OF GEOLOGICAL INTERPRETATION						



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0 5 10 15 20 25m



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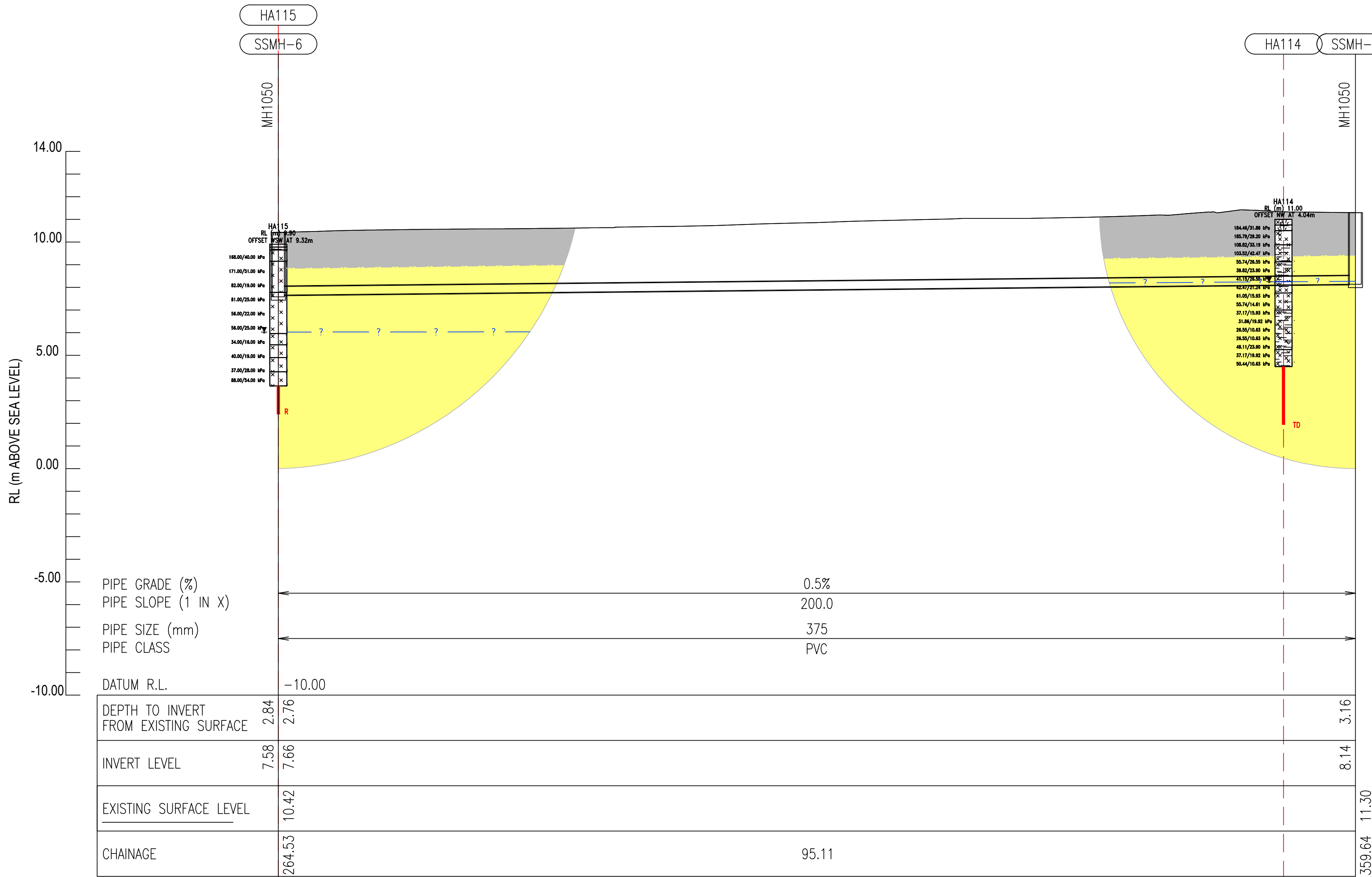
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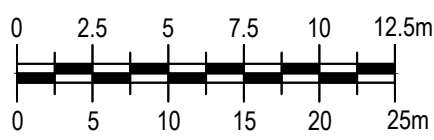


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SCALA PENETROMETER
R / TD SCALA REFUSAL/TARGET DEPTH

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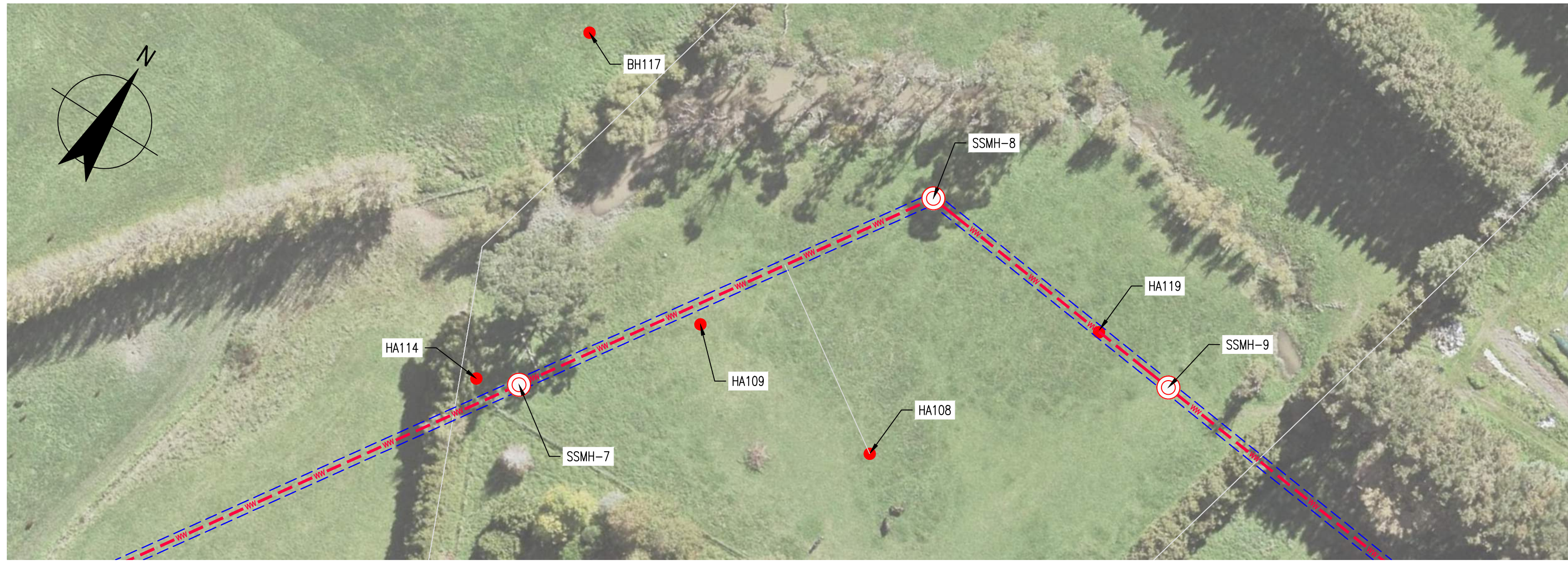
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TGA-S: SAND DOMINATED ALLUVIUM

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SILTY CLAY

SILTY SAND

SILT

SANDY CLAY

CLAY

CLAYEY SAND

ORGANIC CLAY

SANDY CLAY

CLAYEY GRAVEL

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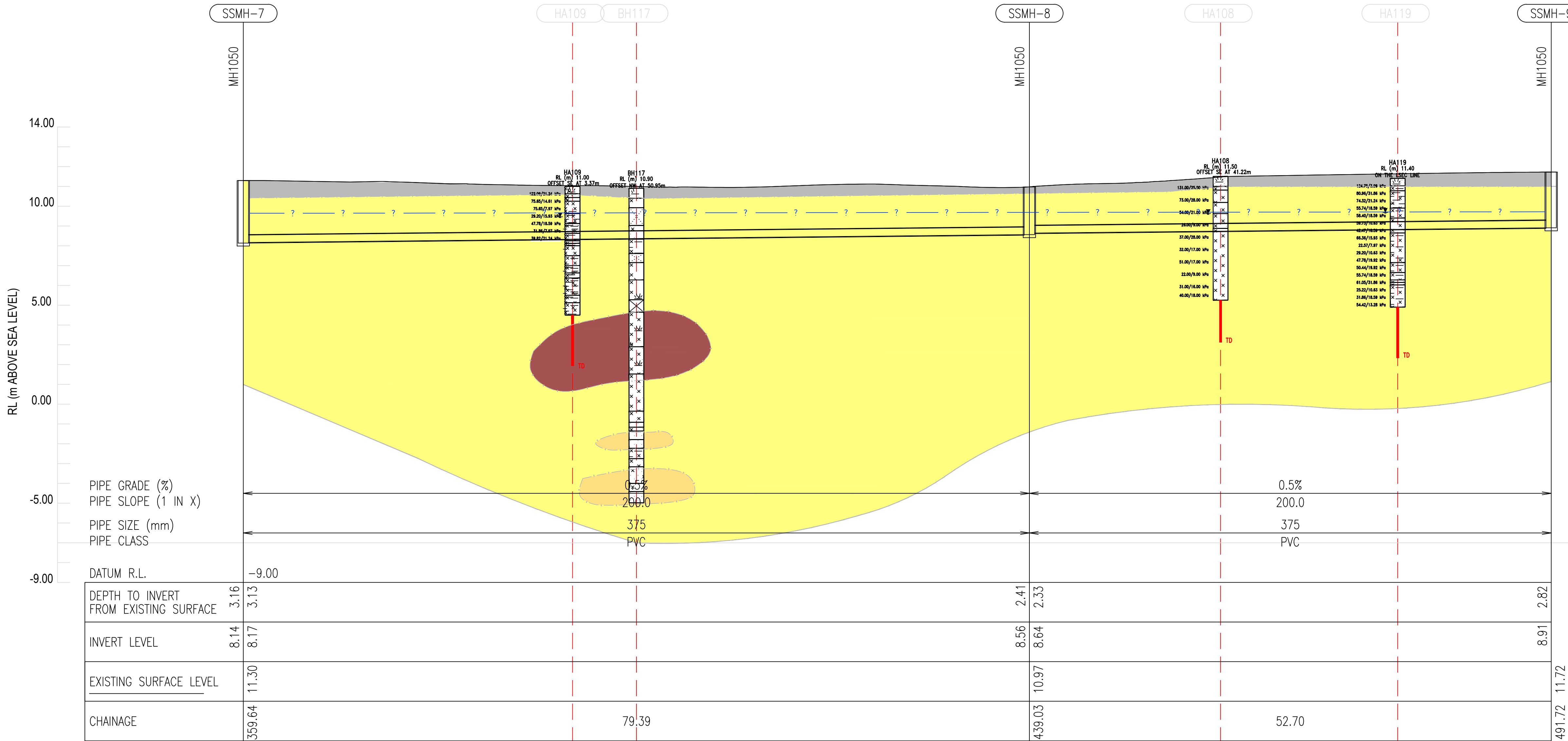
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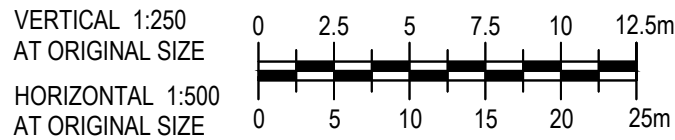
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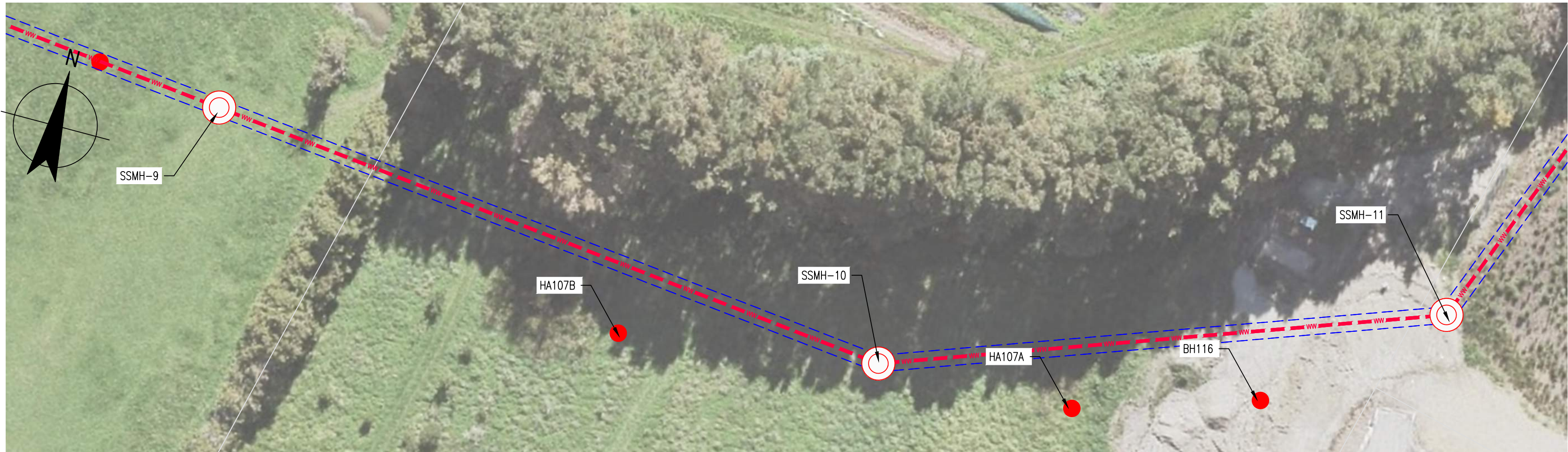
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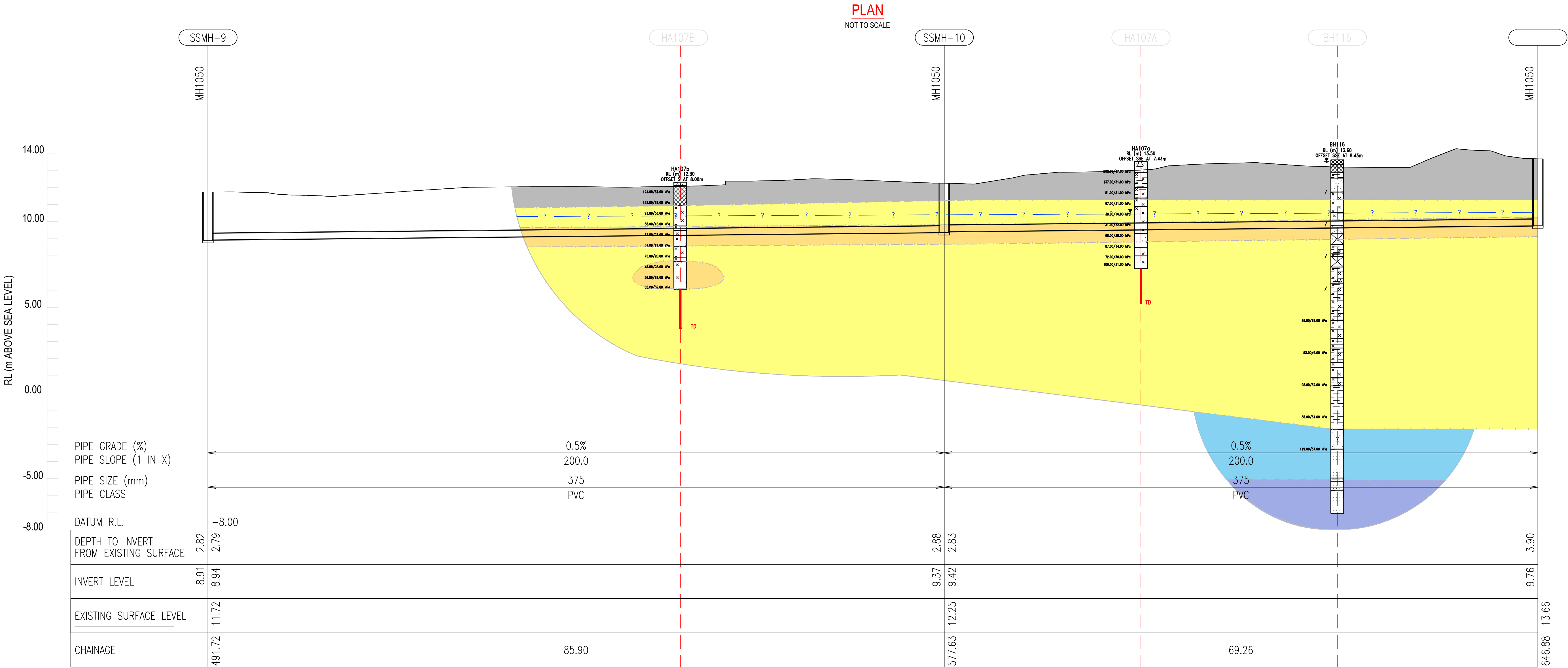
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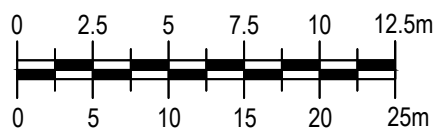


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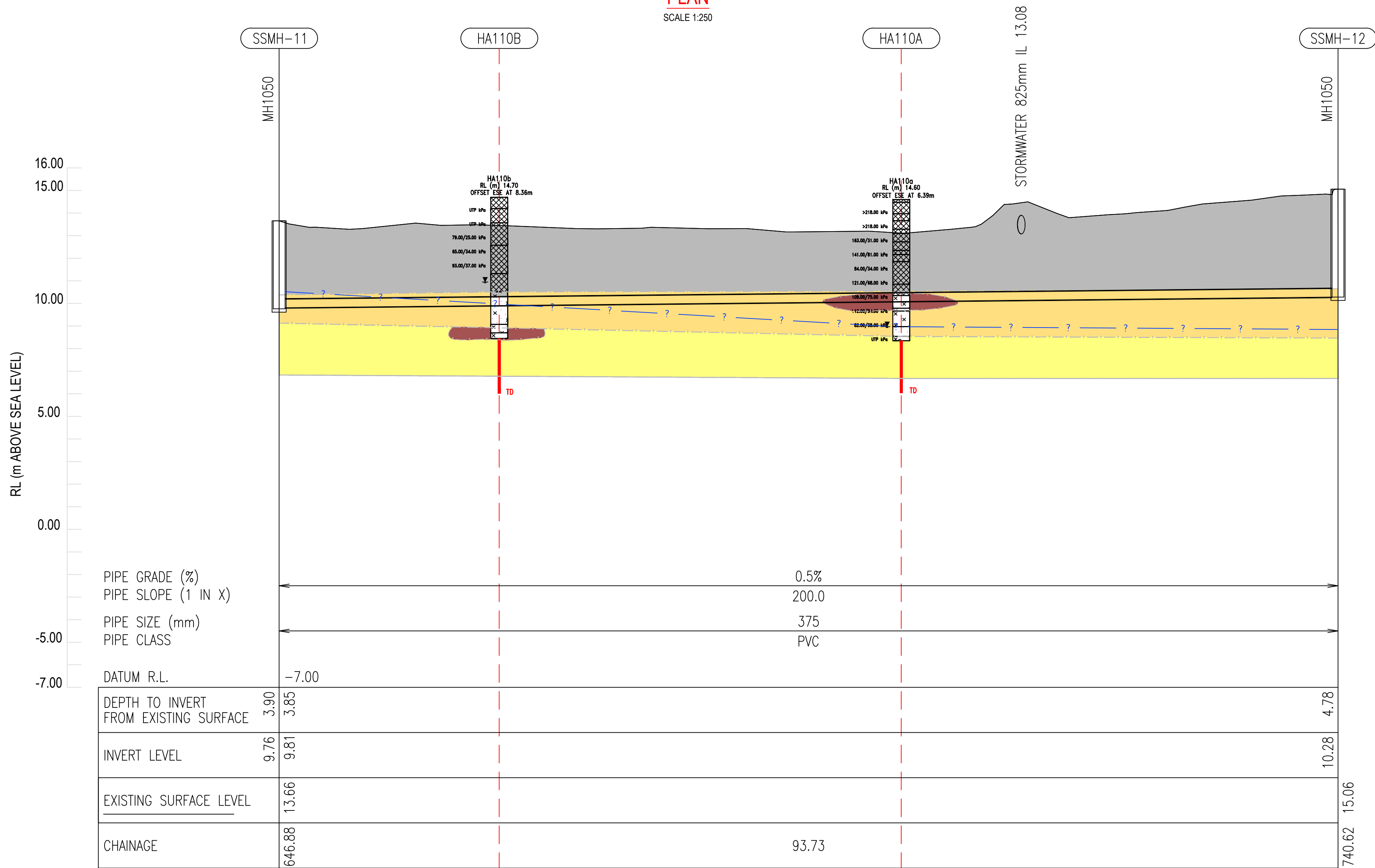
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	TGA-P: ORGANIC CLAYS/SILT & PEAT		SANDY SILT		CLAY		PEAT
	TGA-C/TGA-ST: CLAY & SILT DOMINATED ALLUVIUM		SILTY CLAY		CLAYEY SAND		CORELOSS
	TGA-S: SAND DOMINATED ALLUVIUM		SILTY SAND		ORGANIC CLAY		SAND
	ECBF-RS: EAST COAST BAYS RESIDUAL SOIL		SILT		SANDY CLAY		
	ECBF-HW: EAST COAST BAYS HIGH WEATHERED ROCK						
	ECBF-MW: EAST COAST BAYS MODERATELY WEATHERED ROCK						
	ECBF SW-UW: EAST COAST BAYS SLIGHTLY TO UNWEATHERED ROCK						
	AL-CO CW: ALBANY CONGLOMERATE COMPLETELY WEATHERED			166/37 kPa	CORRECTED UNDRAINED/DRAINED SHEAR STRENGTH VALUE		
	AL-CO HW-MW: ALBANY CONGLOMERATE HIGHLY TO MODERATELY WEATHERED			N > 50	UNCORRECTED SPT N VALUE		
	AL-CO SW-UW: ALBANY CONGLOMERATE SLIGHTLY TO UNWEATHERED				SCALA PENETROMETER		
				R / TD	SCALA REFUSAL/TARGET DEPTH		
	INFERRED GEOLOGICAL UNIT BOUNDARY						
	INFERRED GROUNDWATER						
	LIMITS OF GEOLOGICAL INTERPRETATION						

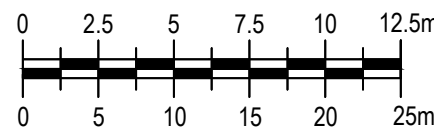
PLAN

SCALE 1:250



Rev	Description	Checked	Approved	Date
A	FOR INTERNAL GHD REVIEW			15.03.2021
Author	Drafting Check			
Designer	Design Check			

VERTICAL 1:250
AT ORIGINAL SIZE
HORIZONTAL 1:500
AT ORIGINAL SIZE



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12508391

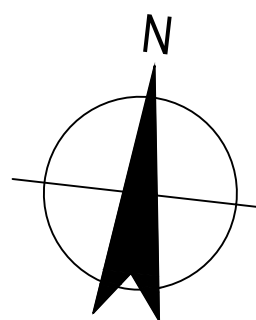
Client	WATERCARE
Project	WHENUAPAI REDHILLS
Status	

Drawing Title
GEOTECHNICAL LONG SECTION
SHEET 6 OF 6

Drawing No.
12508391-C106

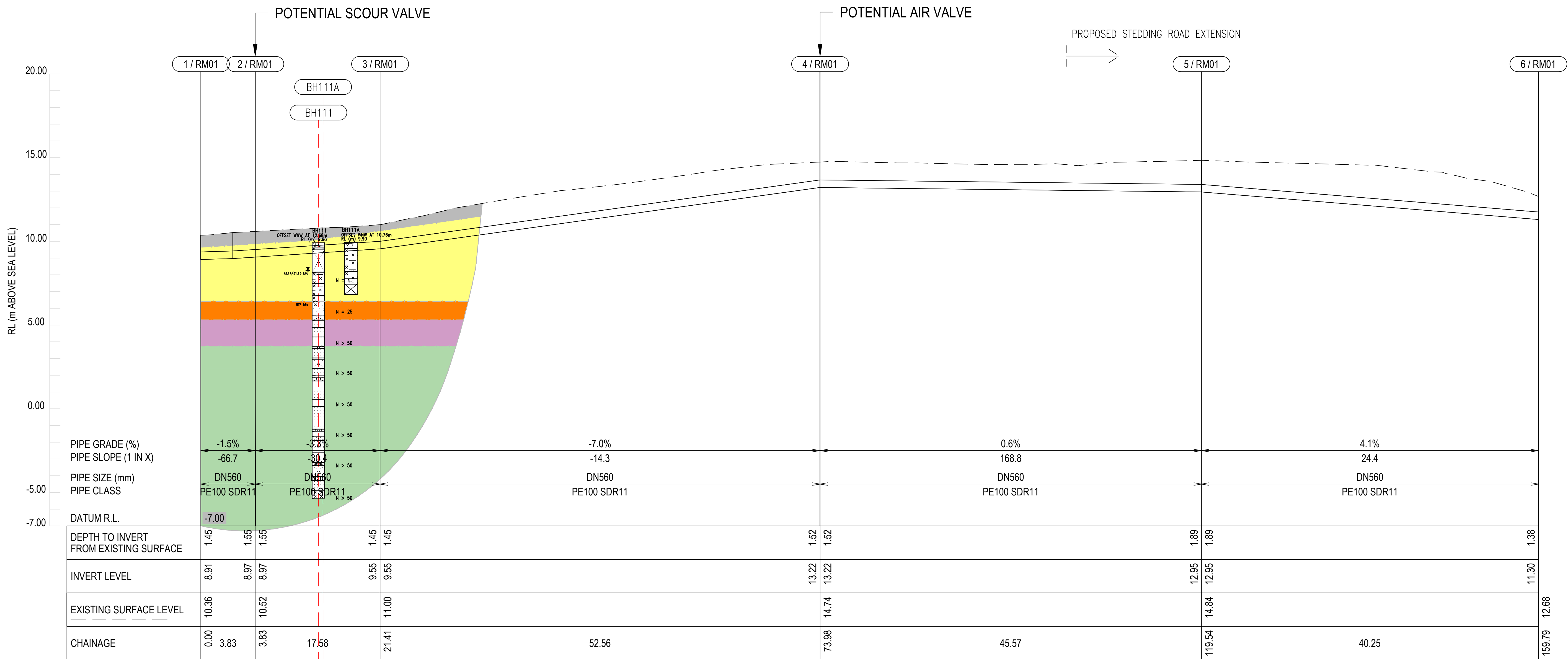
Size
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Rev
A



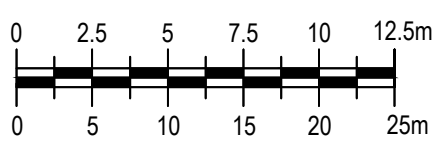
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NOT TO SCALE

LEGEND							
	TOP SOIL/FILL (NON - ENGINEERED)		FILL		SANDY CLAY		CLAYEY GRAVEL
	TGA-P: ORGANIC CLAY/SILT & PEAT		SANDY SILT		CLAY		PEAT
	TGA-C/TGA-ST: CLAY & SILT DOMINATED ALLUVIUM		SILTY CLAY		CLAYEY SAND		CORELOSS
	TGA-S: SAND DOMINATED ALLUVIUM		SILTY SAND		ORGANIC CLAY		SAND
	ECBF-RS: EAST COAST BAYS RESIDUAL SOIL		SILT		SANDY CLAY		
	ECBF-HW: EAST COAST BAYS HIGH WEATHERED ROCK						
	ECBF-MW: EAST COAST BAYS MODERATELY WEATHERED ROCK						
	ECBF SW-UW: EAST COAST BAYS SLIGHTLY TO UNWEATHERED ROCK			166/37 kPa	CORRECTED UNDRAINED/DRAINED SHEAR STRENGTH VALUE		
	AL-CO CW: ALBANY CONGLOMERATE COMPLETELY WEATHERED			N > 50	UNCORRECTED SPT N VALUE		
	AL-CO HW-MW: ALBANY CONGLOMERATE HIGHLY TO MODERATELY WEATHERED				SCALA PENETROMETER		
	AL-CO SW-UW: ALBANY CONGLOMERATE SLIGHTLY TO UNWEATHERED				SCALA REFUSAL/TARGET DEPTH		
				R / TD			
	INFERRED GEOLOGICAL UNIT BOUNDARY						
	INFERRED GROUNDWATER						
	LIMITS OF GEOLOGICAL INTERPRETATION						



Rev	Description	Checked	Approved	Date
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Author	Drafting Check			
Designer	Design Check			

VERTICAL 1:250
AT ORIGINAL SIZE
HORIZONTAL 1:500
AT ORIGINAL SIZE



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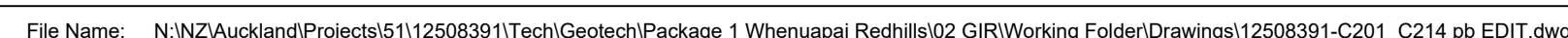
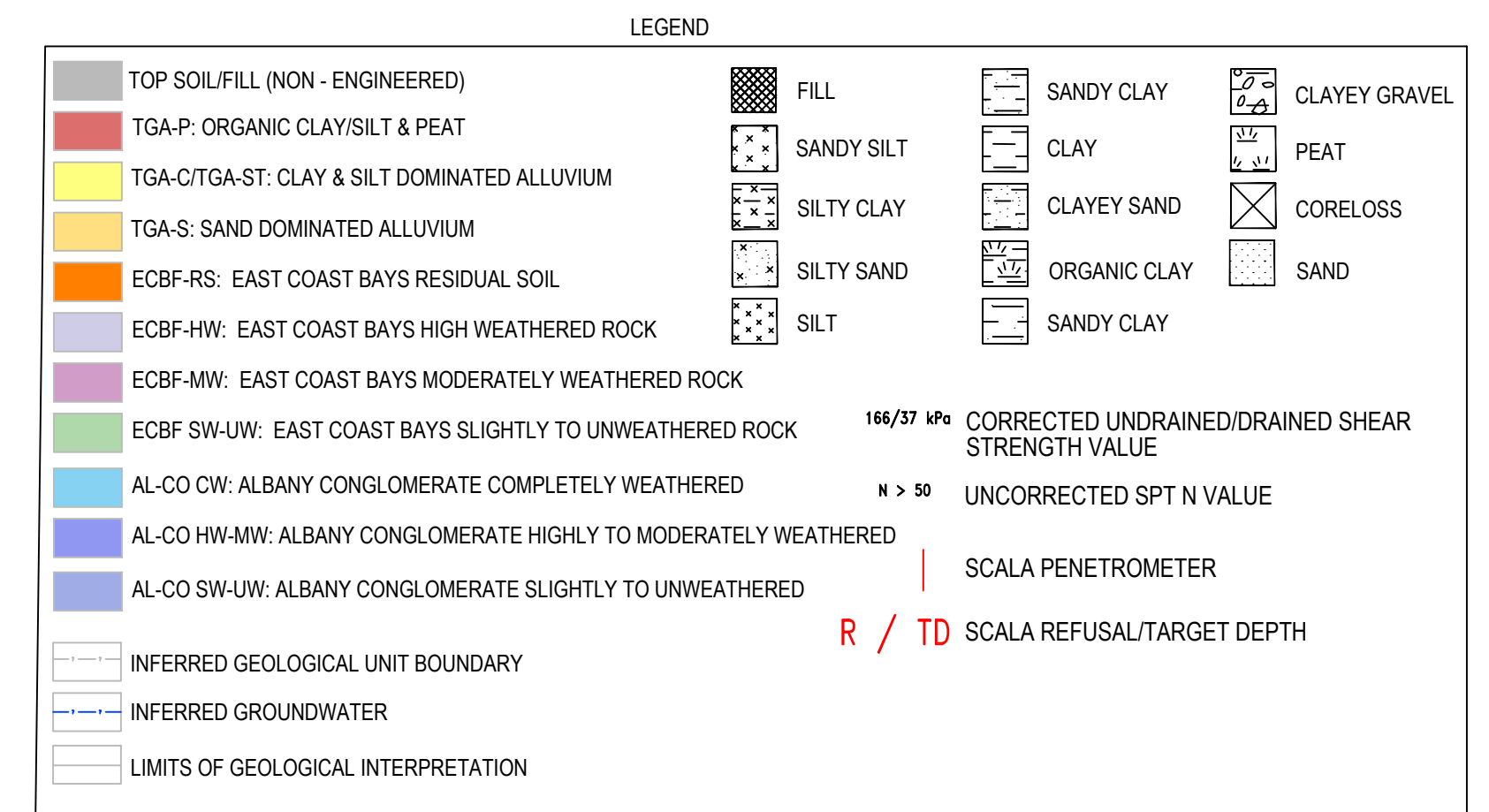
Project No.
12508391

Client	WATER CARE
Project	WHENUAPAI REDHILLS
Status	

Drawing Title	GEOTECHNICAL LONG SECTION SHEET 1 OF 14
Drawing No.	12508391-C201

Size
A1

Rev
A



LEGEND

TOP SOIL/FILL (NON - ENGINEERED)

TGA-P: ORGANIC CLAY/SILT & PEAT

TGA-S: SAND DOMINATED ALLUVIUM

ECBF-RS: EAST COAST BAYS RESIDUAL SOIL

ECBF-HW: EAST COAST BAYS HIGH WEATHERED ROCK

ECBF-MW: EAST COAST BAYS MODERATELY WEATHERED ROCK

ECBF-SW-UW: EAST COAST BAYS SLIGHTLY TO UNWEATHERED ROCK

AL-CO CW: ALBANY CONGLOMERATE COMPLETELY WEATHERED

AL-CO HW-MW: ALBANY CONGLOMERATE HIGHLY TO MODERATELY WEATHERED

AL-CO SW-UW: ALBANY CONGLOMERATE SLIGHTLY TO UNWEATHERED

INFERRED GEOLOGICAL UNIT BOUNDARY

INFERRED GROUNDWATER

LIMITS OF GEOLOGICAL INTERPRETATION

FILL

SANDY SILT

SILT

SANDY CLAY

CLAY

CLAYEY SAND

ORGANIC CLAY

SANDY CLAY

CLAYEY GRAVEL

PEAT

CORELOSS

SAND

100/27 kPa

N > 50

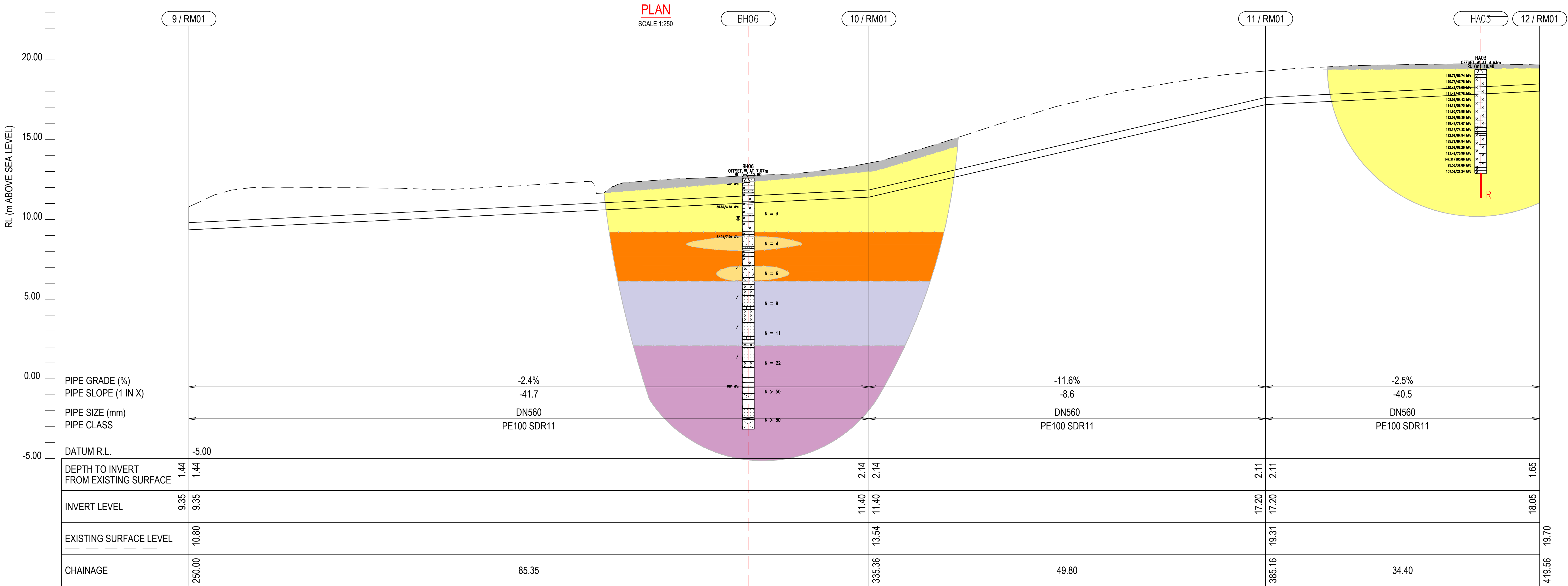
SCALA PENETROMETER

R / TD

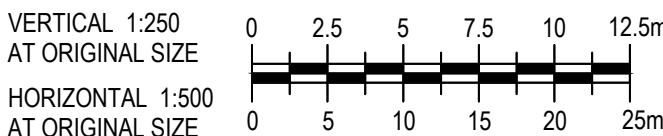
CORRECTED UNDRAINED/DRAINED SHEAR STRENGTH VALUE

UNCORRECTED SPT N VALUE

SCALA REFUSAL/TARGET DEPTH



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Project No.
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Client
WATER CARE

Project
WHENUAPAI REDHILLS

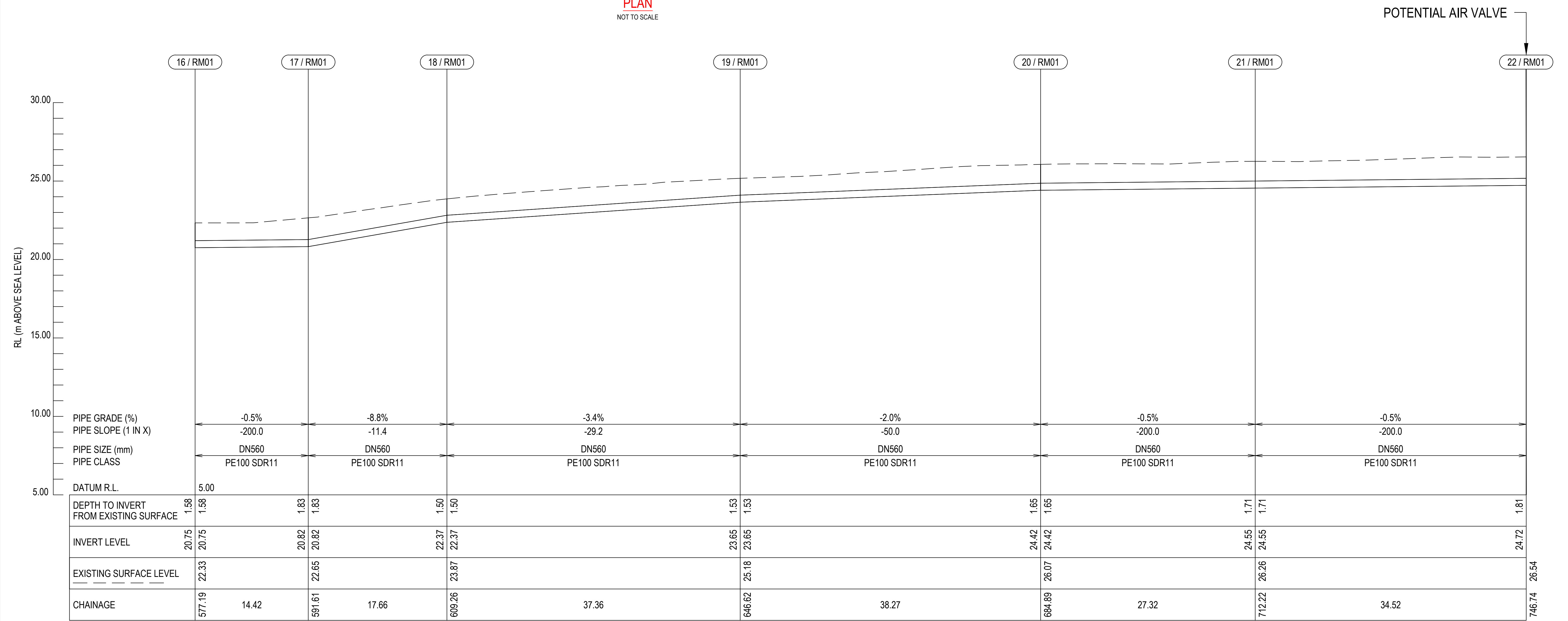
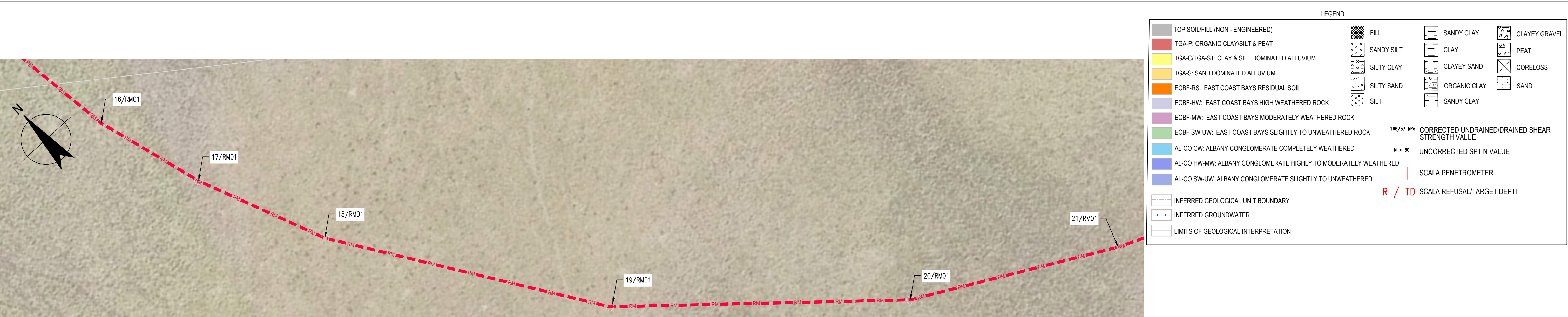
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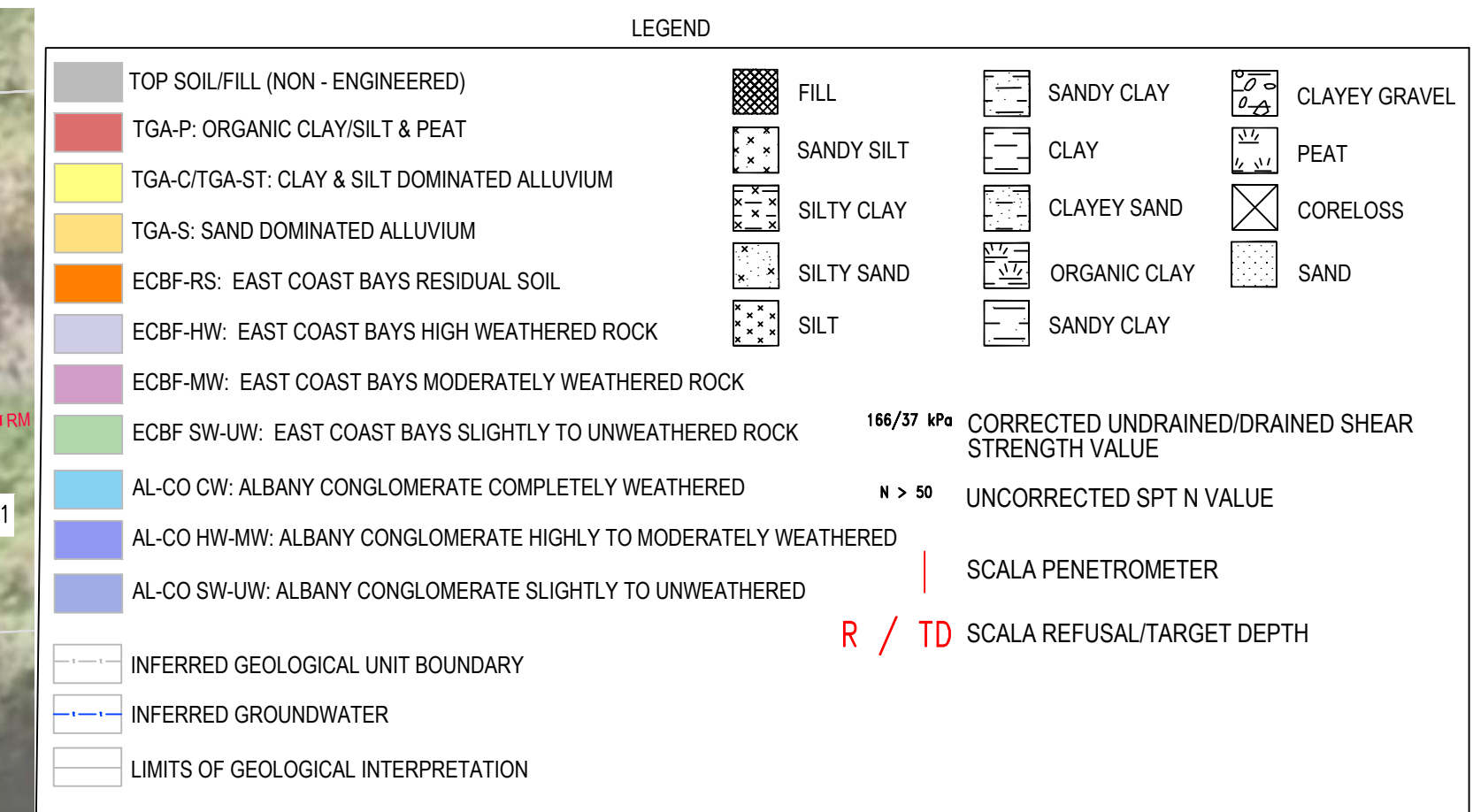
Drawing Title
GEOTECHNICAL LONG SECTION
SHEET 3 OF 14

Drawing No.
12508391-C203

Size
A1

Rev
A





RL (m ABOVE SEA LEVEL)

PIPE GRADE (%) -2.9%

PIPE SLOPE (1 IN X) -34.5

PIPE SIZE (mm) DN560

PIPE CLASS PE100 SDR11

DATUM R.L. 8.00

DEPTH TO INVERT FROM EXISTING SURFACE	2.26	2.26	1.51
INVERT LEVEL	24.10	24.10	27.00
EXISTING SURFACE LEVEL	26.36		28.51
CHAINAGE	912.22	100.00	1012.22

HA05

HA06

T.D.

OFFSET 2.40m

130.00/71.46 m/s

87.50/78.20 m/s

62.50/71.46 m/s

40.00/64.00 m/s

25.00/50.00 m/s

15.00/30.00 m/s

10.00/20.00 m/s

7.50/15.00 m/s

5.00/10.00 m/s

3.75/7.50 m/s

2.50/5.00 m/s

1.25/2.50 m/s

0.625/1.25 m/s

0.3125/0.625 m/s

0.15625/0.3125 m/s

0.078125/0.15625 m/s

0.0390625/0.078125 m/s

0.01953125/0.0390625 m/s

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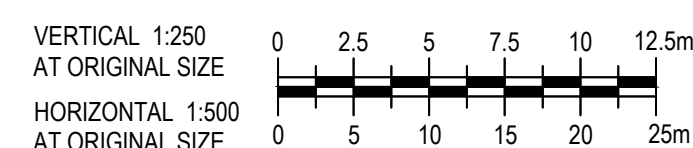
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Designer	Design Check			



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Project No.
12508391

Client WATER CARE

Project WHENUAPAI REDHILLS

Status

Drawing
Title

GEOTECHNICAL LONG SECTION
SHEET 7 OF 14

Drawing No.
12508391-C207

1

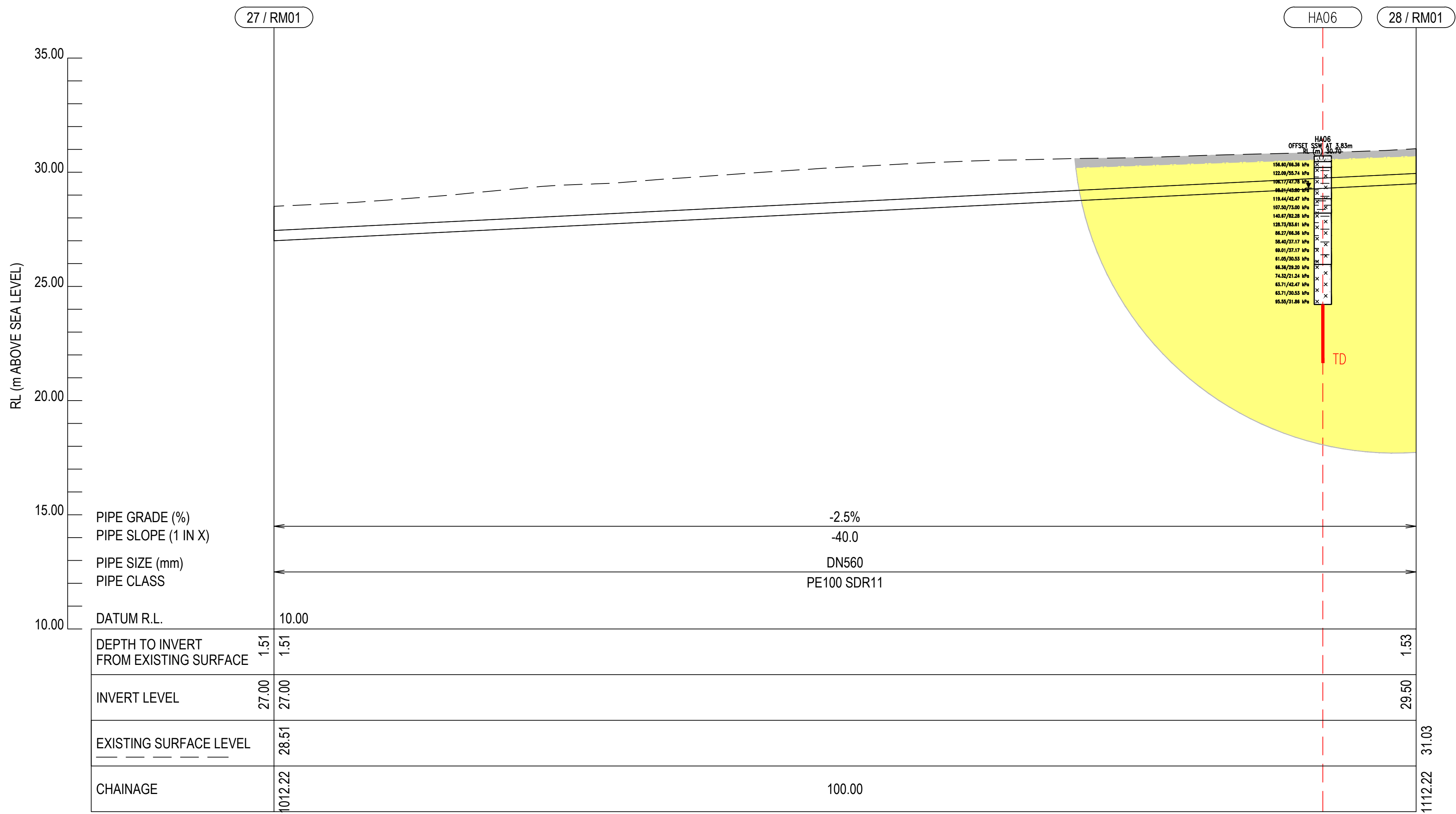
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PLAN
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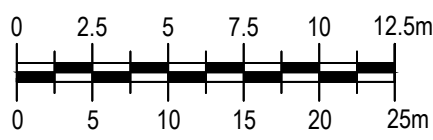
LEGEND							
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	TGA-P: ORGANIC CLAY/SILT & PEAT		SANDY SILT		CLAY		PEAT
	TGA-C/TGA-ST: CLAY & SILT DOMINATED ALLUVIUM		SILTY CLAY		CLAYEY SAND		CORELOSS
	TGA-S: SAND DOMINATED ALLUVIUM		SILTY SAND		ORGANIC CLAY		SAND
	ECBF-RS: EAST COAST BAYS RESIDUAL SOIL		SILT		SANDY CLAY		
	ECBF-HW: EAST COAST BAYS HIGH WEATHERED ROCK						
	ECBF-MW: EAST COAST BAYS MODERATELY WEATHERED ROCK						
	ECBF-SW-UW: EAST COAST BAYS SLIGHTLY TO UNWEATHERED ROCK						
	AL-CO CW: ALBANY CONGLOMERATE COMPLETELY WEATHERED						
	AL-CO HW-MW: ALBANY CONGLOMERATE HIGHLY TO MODERATELY WEATHERED						
	AL-CO SW-UW: ALBANY CONGLOMERATE SLIGHTLY TO UNWEATHERED						
	INFERRED GEOLOGICAL UNIT BOUNDARY						
	INFERRED GROUNDWATER						
	LIMITS OF GEOLOGICAL INTERPRETATION						

166/57 kPa	CORRECTED UNDRAINED/DRAINED SHEAR STRENGTH VALUE
N > 50	UNCORRECTED SPT N VALUE
	SCALA PENETROMETER
R / TD	SCALA REFUSAL/TARGET DEPTH



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Designer	Design Check			

VERTICAL 1:250
AT ORIGINAL SIZE
HORIZONTAL 1:500
AT ORIGINAL SIZE



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Project No.
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Client	WATER CARE
Project	WHENUAPAI REDHILLS
Status	

Drawing Title	GEOTECHNICAL LONG SECTION SHEET 8 OF 14
Drawing No.	12508391-C208

Size	A1
Rev	A

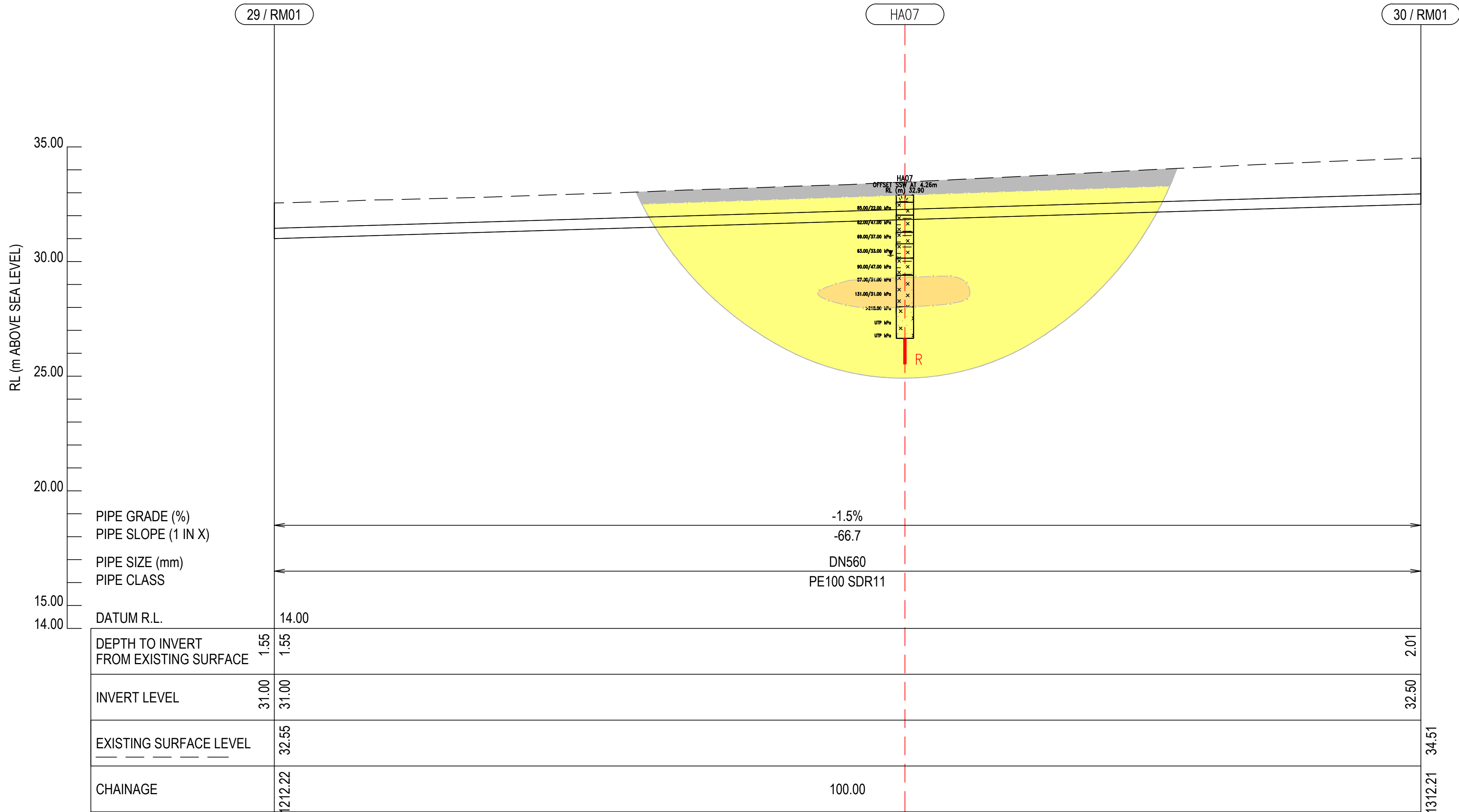


PLAN

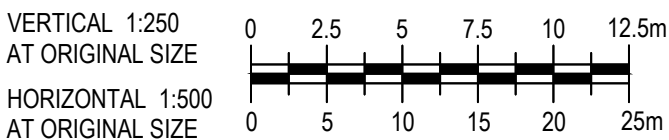
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LEGEND							
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	TGA-P: ORGANIC CLAY/SILT & PEAT		SANDY SILT		CLAY		PEAT
	TGA-C/TGA-ST: CLAY & SILT DOMINATED ALLUVIUM		SILTY CLAY		CLAYEY SAND		CORELOSS
	TGA-S: SAND DOMINATED ALLUVIUM		SILTY SAND		ORGANIC CLAY		SAND
	ECBF-RS: EAST COAST BAYS RESIDUAL SOIL		SILT		SANDY CLAY		
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	AL-CO HW-MW: ALBANY CONGLOMERATE HIGHLY TO MODERATELY WEATHERED						
	AL-CO SW-UW: ALBANY CONGLOMERATE SLIGHTLY TO UNWEATHERED						
	INFERRED GEOLOGICAL UNIT BOUNDARY						
	INFERRED GROUNDWATER						
	LIMITS OF GEOLOGICAL INTERPRETATION						

	166/37 kPa	CORRECTED UNDRAINED/DRAINED SHEAR STRENGTH VALUE
	N > 50	UNCORRECTED SPT N VALUE
		SCALA PENETROMETER
R / TD		SCALA REFUSAL/TARGET DEPTH



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Designer	Design Check			



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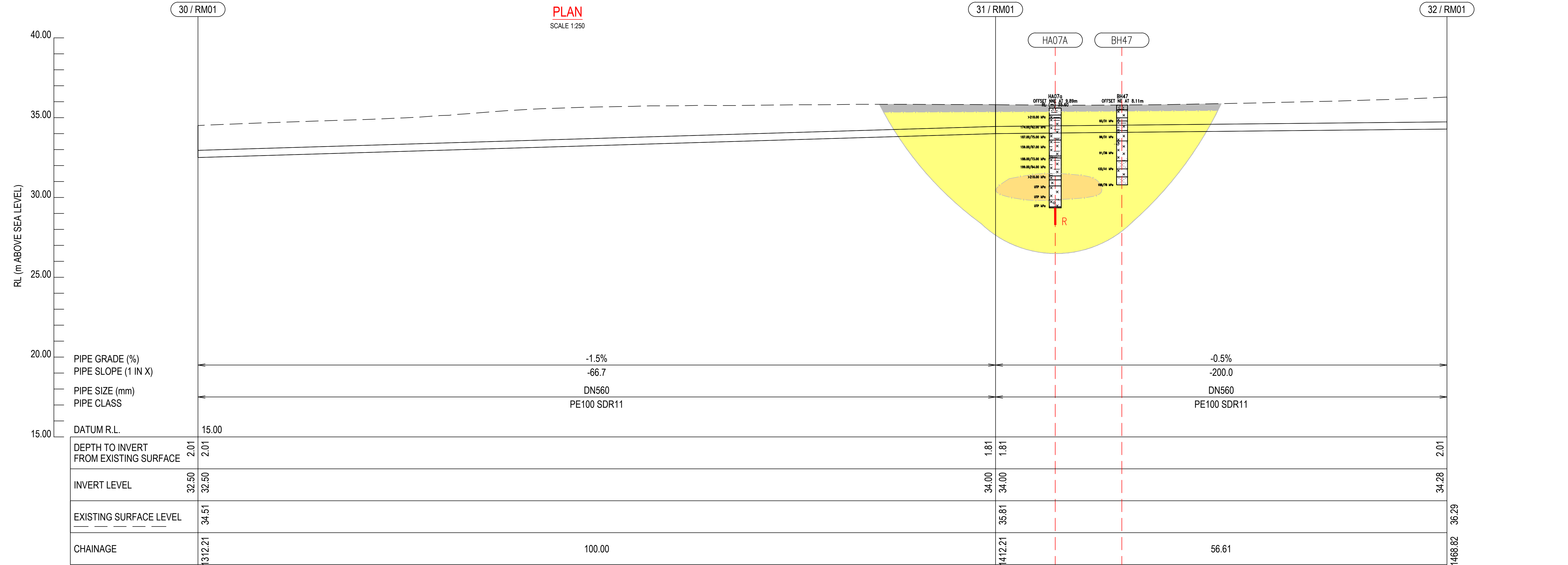
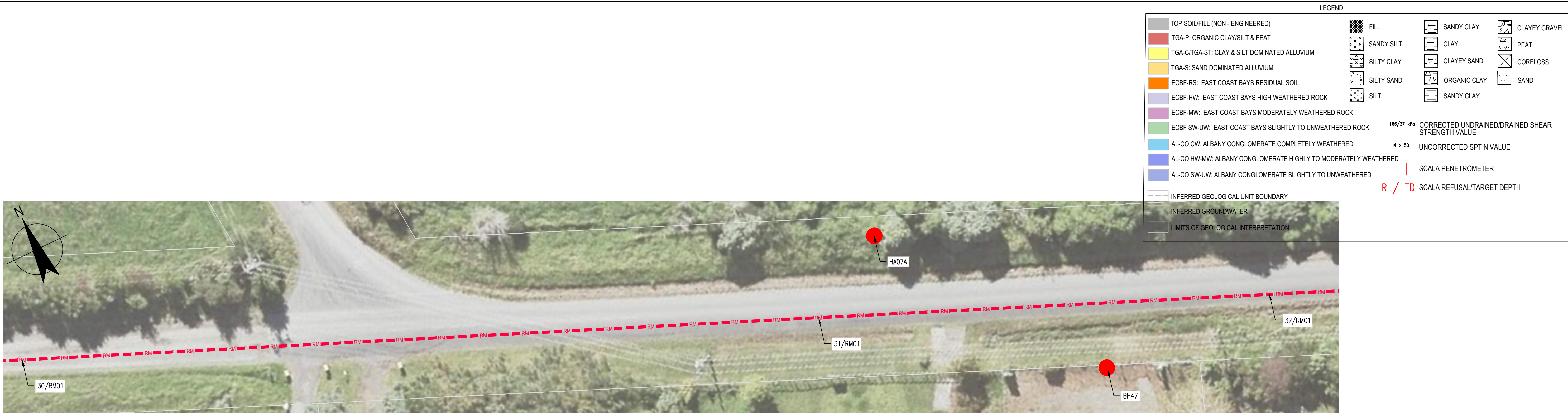
Project No.
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Client	WATER CARE
Project	WHENUAPAI REDHILLS
Status	

Drawing Title
**GEOTECHNICAL LONG SECTION
SHEET 10 OF 14**

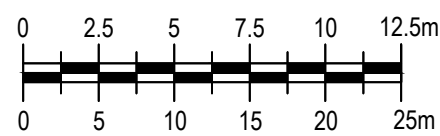
Drawing No.
12508391-C210

Size
A1
Rev
A



Rev	Description	Checked	Approved	Date
A	FOR INTERNAL GHD REVIEW			15.03.2021
Author	Designing			
Designer	Designing			

VERTICAL 1:250
AT ORIGINAL SIZE
HORIZONTAL 1:500
AT ORIGINAL SIZE



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Project No.
12508391

Client
WATER CARE
Project
WHENUAPAI REDHILLS

Status

Status
Code

Drawing
Title
GEOTECHNICAL LONG SECTION
SHEET 11 OF 14

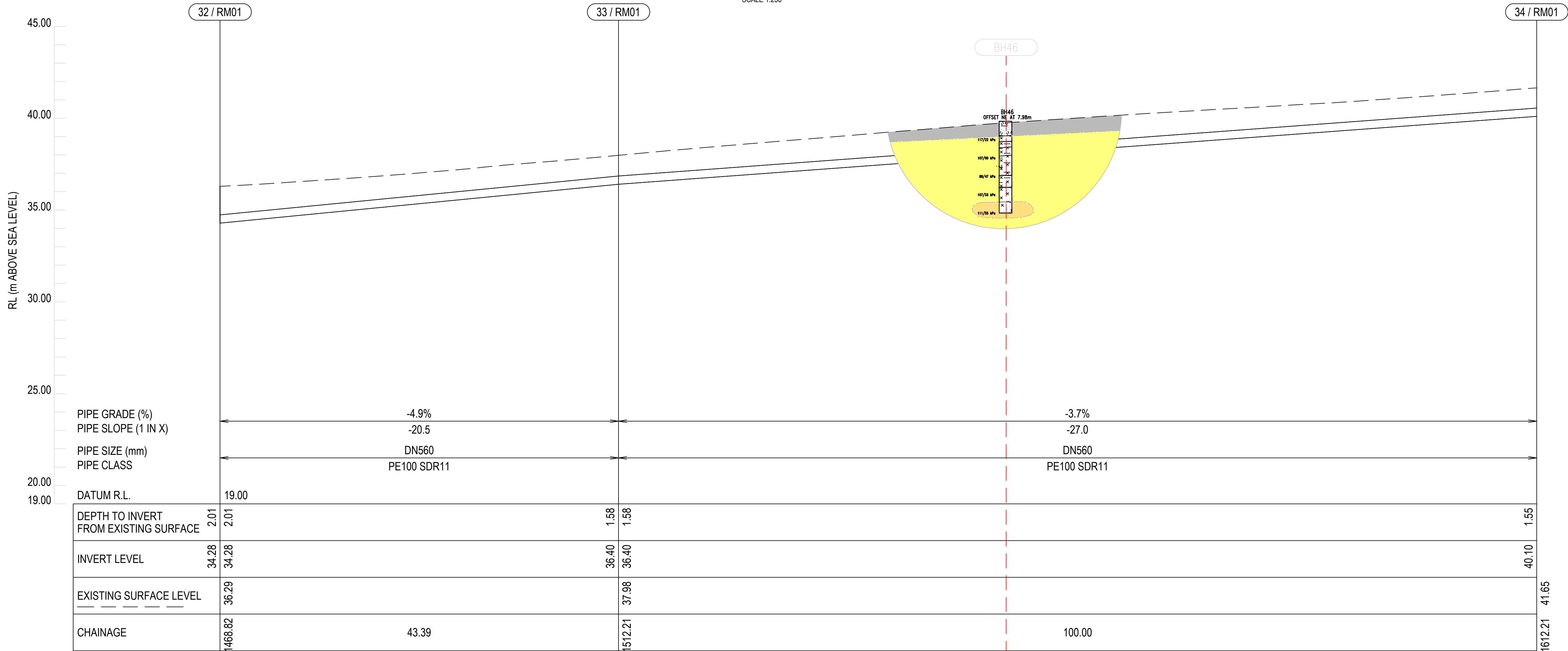
Drawing No.
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Size
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Rev
A



PLAN
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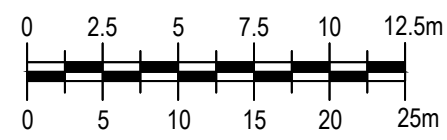


LEGEND			
TOP SOIL/FILL (NON - ENGINEERED)	FILL	SANDY CLAY	CLAYEY GRAVEL
TGA-P: ORGANIC CLAY/SILT & PEAT	SANDY SILT	CLAY	PEAT
TGA-C/TGA-ST: CLAY & SILT DOMINATED ALLUVIUM	SILTY CLAY	CLAYEY SAND	CORELOSS
TGA-S: SAND DOMINATED ALLUVIUM	SILTY SAND	ORGANIC CLAY	SAND
ECBF-RS: EAST COAST BAYS RESIDUAL SOIL	SILT	SANDY CLAY	
ECBF-HW: EAST COAST BAYS HIGH WEATHERED ROCK			
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AL-CO HW-MW: ALBANY CONGLOMERATE HIGHLY TO MODERATELY WEATHERED			
AL-CO SW-UW: ALBANY CONGLOMERATE SLIGHTLY TO UNWEATHERED			
INFERRED GEOLOGICAL UNIT BOUNDARY			
INFERRED GROUNDWATER			
LIMITS OF GEOLOGICAL INTERPRETATION			

166/37 kPa CORRECTED UNDRAINED/DRAINED SHEAR STRENGTH VALUE
N > 50 UNCORRECTED SPT N VALUE
SCALA PENETROMETER
R / TD SCALA REFUSAL/TARGET DEPTH

Rev	Description	Checked	Approved	Date
A	FOR INTERNAL GHD REVIEW			15.03.2021
Author	Drafting Check			
Designer	Design Check			

VERTICAL 1:250
AT ORIGINAL SIZE
HORIZONTAL 1:500
AT ORIGINAL SIZE



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Project No.

Client **WATER CARE**
Project **WHENUAPAI REDHILLS**

Status

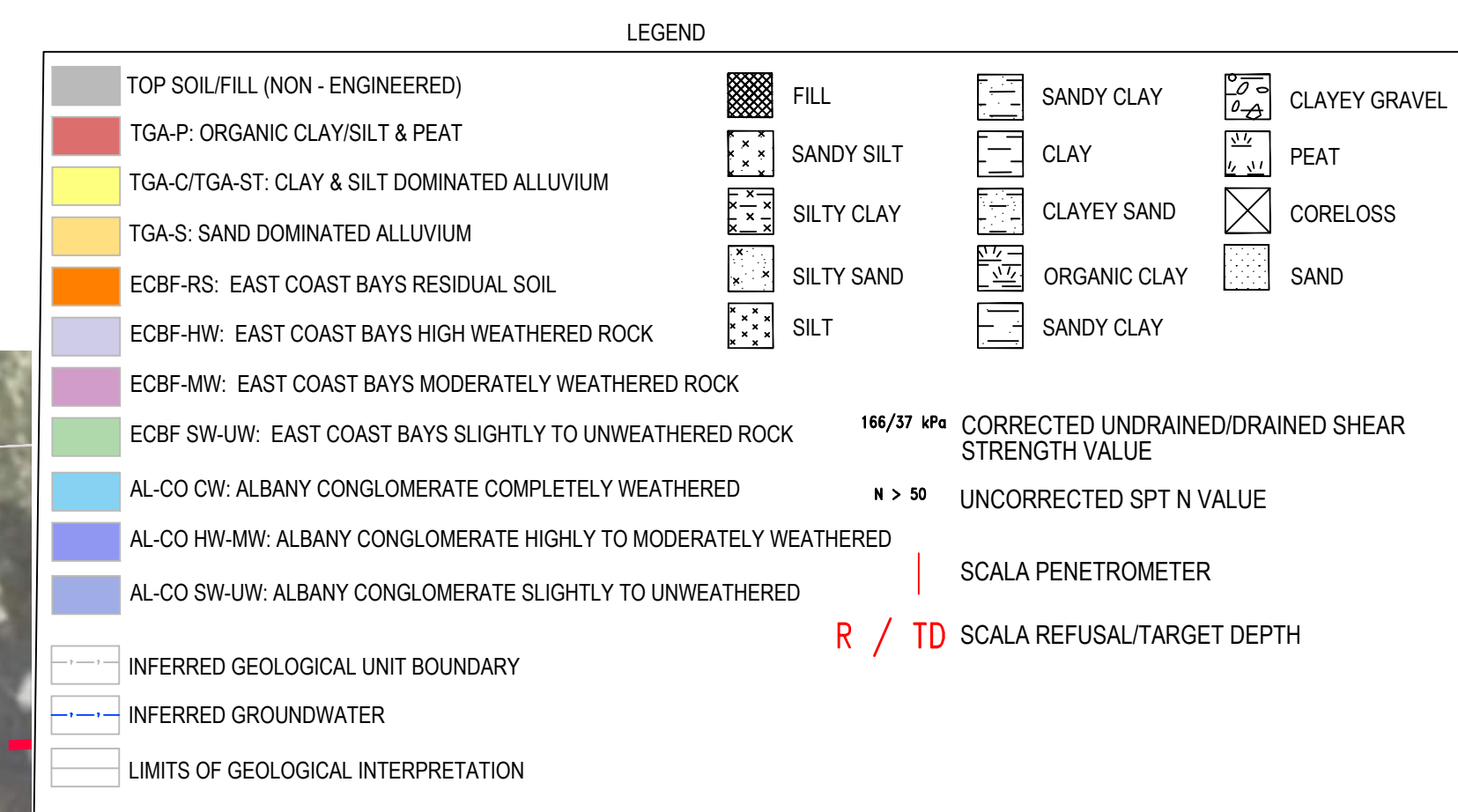
Drawing Title
**GEOTECHNICAL LONG SECTION
SHEET 12 OF 14**

Drawing No.
12508391-C212

Size
A1
Rev
A

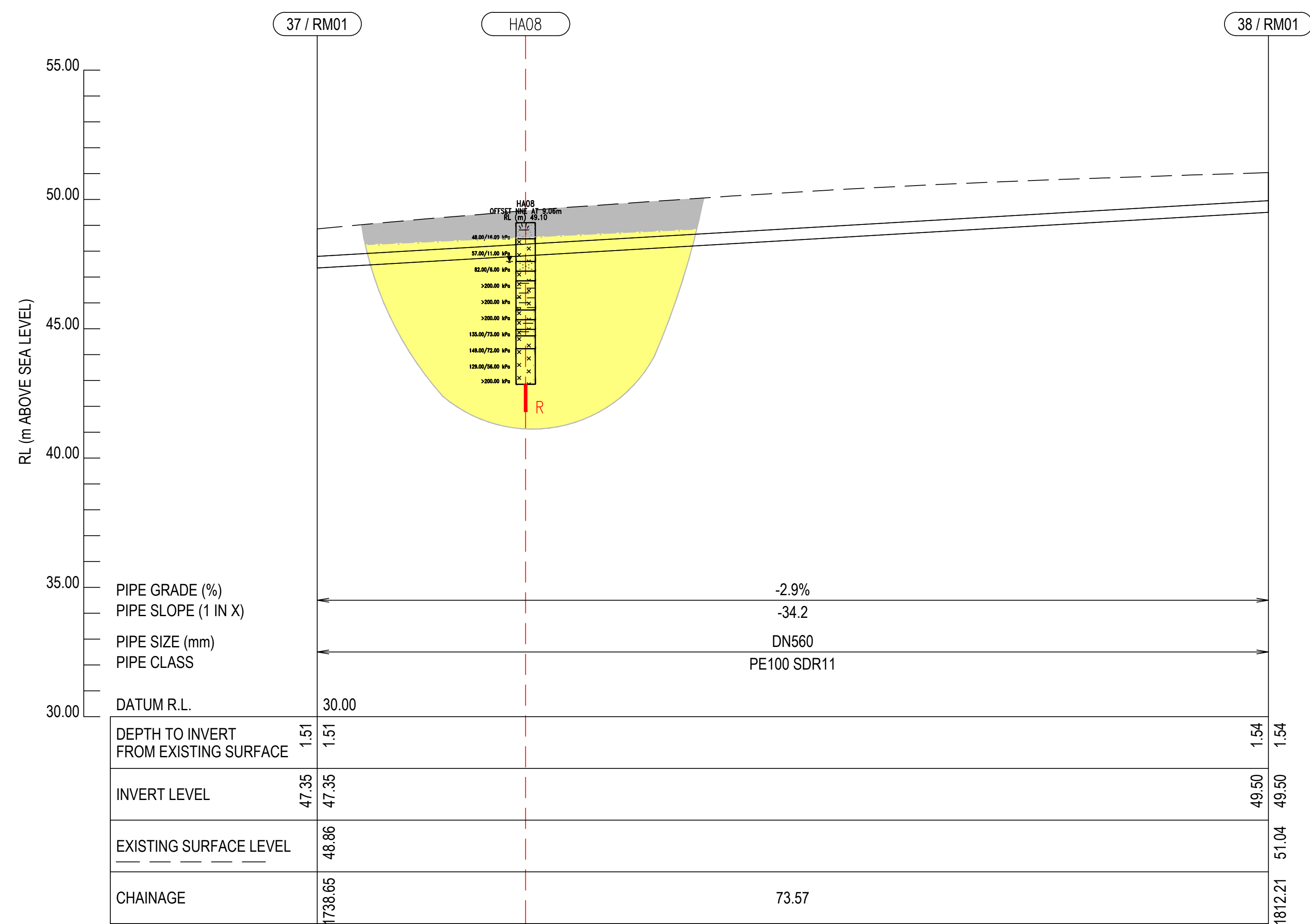
Plot Date: 23 March 2021 - 3:15 PM Plotted by: Paige Boyed

File Name: \\ghdnet\ghd\NZ\Auckland\Projects\5112508391\Tech\Geotech\Package 1 Whenuapai Redhills\02 GIR\Working Folder\Drawings\12508391-C201_C214 pb EDIT.dwg



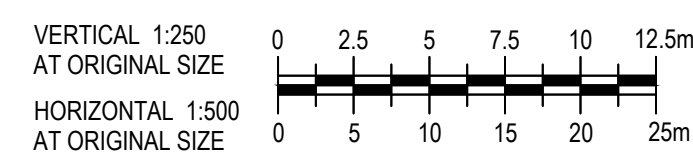


PLAN
SCALE 1:250



LEGEND							
	TOP SOIL/FILL (NON - ENGINEERED)		FILL		SANDY CLAY		CLAYEY GRAVEL
	TGA-P: ORGANIC CLAY/SILT & PEAT		SANDY SILT		CLAY		PEAT
	TGA-C/TGA-ST: CLAY & SILT DOMINATED ALLUVIUM		SILTY CLAY		CLAYEY SAND		CORELOSS
	TGA-S: SAND DOMINATED ALLUVIUM		SILTY SAND		ORGANIC CLAY		SAND
	ECBF-RS: EAST COAST BAYS RESIDUAL SOIL		SILT		SANDY CLAY		
	ECBF-HW: EAST COAST BAYS HIGH WEATHERED ROCK						
	ECBF-MW: EAST COAST BAYS MODERATELY WEATHERED ROCK						
	ECBF-SW-UW: EAST COAST BAYS SLIGHTLY TO UNWEATHERED ROCK			155/37 kPa	CORRECTED UNDRAINED/DRAINED SHEAR STRENGTH VALUE		
	AL-CO CW: ALBANY CONGLOMERATE COMPLETELY WEATHERED			n > 50	UNCORRECTED SPT N VALUE		
	AL-CO HW-MW: ALBANY CONGLOMERATE HIGHLY TO MODERATELY WEATHERED				SCALA PENETROMETER		
	AL-CO SW-UW: ALBANY CONGLOMERATE SLIGHTLY TO UNWEATHERED				SCALA REFUSAL/TARGET DEPTH		
				R / TD			
	INFERRED GEOLOGICAL UNIT BOUNDARY						
	INFERRED GROUNDWATER						
	LIMITS OF GEOLOGICAL INTERPRETATION						

A FOR INTERNAL GHD REVIEW				15.03.2021
Rev	Description	Checked	Approved	Date
Author	Drafting Check			
Designer	Design Check			



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Project No.
12508391

Client **WATER CARE**

Project **WHENUAPAI REDHILLS**

Status	
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Drawing Title	
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GEOTECHNICAL LONG SECTION
SHEET 14 OF 14

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Rev
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Drawing No.
12508391-C214