17 July 2025

Hamilton City Council – IAF Reservoir

Ruakiwi Road, Hamilton

GEOTECHNICAL DESIGN REPORT

Hamilton City Council

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Version control

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1.0 INTRODUCTION

CMW Geosciences (CMW) was engaged by Hamilton City Council (HCC) to undertake a geotechnical investigation at a site located at Lake Domain along Ruakiwi Road, Hamilton. The site has been identified as the preferred location for a new 25 megalitre water reservoir and associated booster pump station, as part of the Reservoirs and Pump Station Project supported by the Government's Infrastructure Acceleration Fund (IAF), which aims to enable infrastructure that supports central city housing development.

This project is essential to securing long-term water supply capacity for Hamilton's growing population. It will improve network efficiency, support firefighting requirements, and provide critical resilience for future residential and commercial development.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter referenced HAM2023-0099AD VO4, Rev 2 dated 12 November 2024.

The purpose of this report is to provide sufficient technical information in relation to geotechnical aspects to support the Notice of Requirement for an Alteration to Designation. It also presents geotechnical investigation data, results of geotechnical analyses and recommendations to support a Building Consent application for the proposed IAF reservoir.

2.0 SITE DESCRIPTION

The site is located near the existing reservoir at Lake Domain along Ruakiwi Road as shown in Figure 2.1.

Details of the site are as follows:

- The proposed reservoir and valve chamber will be constructed next to the existing reservoir over rolling hill topography that falls gently from RL68m towards the South/South-West to RL56m at approximately 1V:11H (1 Vertically : 11 Horizontally), and then at approximately 1V:2.5H (1 Vertically :2.5 Horizontally) to RL38m at the Rotoroa / Hamilton Lake margin (refer Figure 2.2).
- Historical aerial photographs[1] show the presence of a building onsite since the 1940s, which has recently been demolished (2020-2021).

Figure 2.1: Site Location Plan (HCC Viewer – 2023 aerial photo) with Cross Section Locations



Figure 2.2: Site Contour Plan (HCC Viewer – 2023 aerial photo and 2019 Moturiki Datum contours)



[1] Retrolens website, Sourced from http://retrolens.nz and licensed by LINZ CC-BY 3.0, Survey SN266, run 831, photo 38 taken 14/06/1943.

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3.0 PROPOSED DEVELOPMENT

The proposed project plans and typical sections (Hamilton IAF Reservoir, ref.148023.33, S100-01 to P103-06, rev A, dated 13/12/2024 and preliminary design demands transmitted on 11/03/2025) provided by Holmes and presented in ***Appendix A***, show a water reservoir and a valve chamber adjacent to the existing reservoir, and uphill from the Hamilton Lake.

Brief details for the proposed water reservoir are as follows:

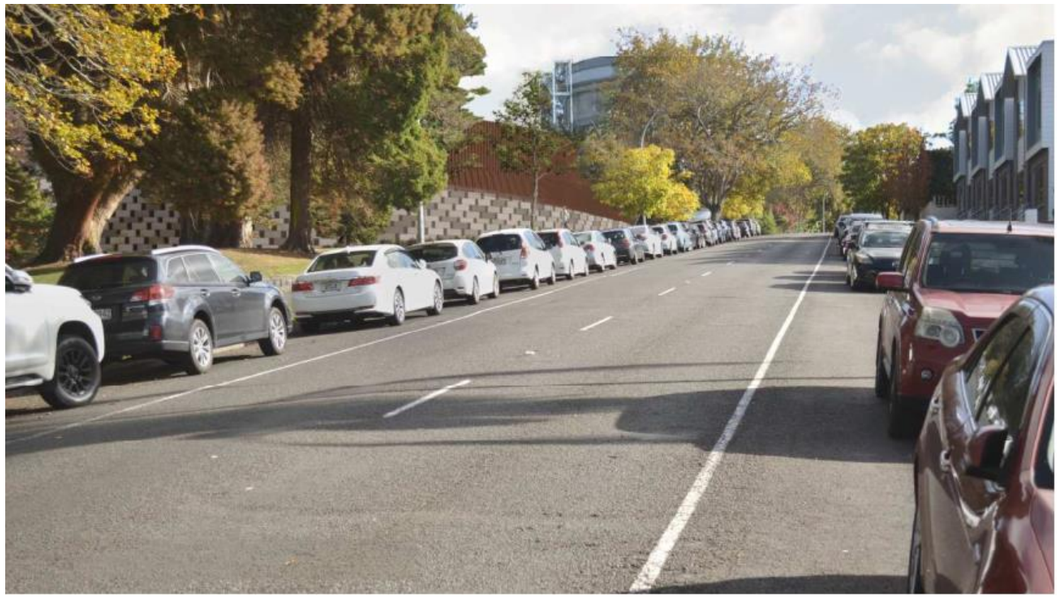
- The outer diameter of the new reservoir is 62.65m with a water storage height 9.85m providing a storage volume of approximately 25,000m^3,
- The reservoir will be built partially in cut and partially in fill. Up to 3.0m cuts below ground level are proposed on the northeastern side and up to 3.0m of fill is proposed on the southwestern side with a foundation level at RL60.5m,
- The new structure is located approximately 37m South of the existing reservoir,
- Working loads:
  - An applied unfactored working load of 100kPa is applied over the reservoir footprint (water load and permanent load due to the slab),
  - An l unfactored working load of 50kPa is applied over a 1.5m circular ring beam around the external perimeter of the reservoir,
  - An unfactored working load of 50kPa is applied for each of the forty-four 3.0 x 3.0m internal column foundations supporting the roof.
- Seismic case
  - At ULS, due to overturning moments, an additional 80kPa load is applied to the 1.5m circular ring beam around the external perimeter of the reservoir,
  - At SLS2, the additional load on the 1.5m circular ring beam around the external perimeter of the reservoir is 50 kPa,

Brief details for the proposed valve chamber are as follows:

- The new valve chamber is 28m in length by 14m in width,
- The building is partially buried with a finished foundation level at RL58.35 m (base foundation level at RL57.95m approximately 6.55m below existing ground level),
- The new structure is located between the existing and the new reservoir,
- A permanent widespread applied load of 20 kPa is applied over the whole footprint due to the slab,
- An unfactored working load of 80kPa is applied on a 1m-wide strip footing around the external boundaries of the chamber.

Both structures will be a IL4 (importance level 4) structures with a 100-year design life. Foundation pressures are respectively limited to 110 kPa and 115 kPa for ULS static and seismic cases. Total and differential settlements are respectively limited to 150mm and 100mm.

Figure 3.1: 3D rendering of the proposed project



4.0 INVESTIGATIONS

4.1 Desktop Study

The following geotechnical reports were reviewed during preparation of this design report:

- CMW Geosciences, 2023. Geotechnical Assessment Report for Hamilton City Council – Reservoir Optioneering, ref. HAM2023-0099AC Rev 0, dated 28 November 2023.
- CMW Geosciences, 2024. Geotechnical Interpretative Report for Hamilton City Council – IAF Reservoir, ref. HAM2023-0099AE Rev 0, dated 29 May 2024.
- CMW Geosciences, 2025. Geotechnical Factual Report for Hamilton City Council – IAF Reservoir and Pump Station, ref. HAM2023-0099AH Rev 0, dated 8 April 2025.
- CMW Geosciences, 2025. Site Specific Seismic Hazard Assessment for Hamilton City Council – IAF Reservoir, ref. HAM2023-0099AG Rev 2, dated 28 February 2025.

4.2 Preliminary Investigation Phase (2023-2024)

The scope of fieldwork completed during the preliminary phase is presented below:

Table 4.1: Investigation Summary – Preliminary Phases (phase 1 and 2)

Phase	Test ID	Test Type	Ground Surface Elevation (RL m)	Depth (m)	Samples
1	CPT01	Cone Penetration Test	63.0	18.3	N
1	CPT02	Cone Penetration Test	61.7	20.0	N
2	CPT03	Cone Penetration Test	62.5	22.6	N
2	CPT04	Cone Penetration Test	37.8	15.6	N
2	sCPT01	Seismic Cone Penetration Test	65.2	21.5	N
2	sCPT02	Seismic Cone Penetration Test	61.1	13.9	N
2	sCPT03	Seismic Cone Penetration Test	61.8	21.3	N
2	sCPT04	Seismic Cone Penetration Test	58.4	28.5	N
2	BH24-01	Machine Borehole	65.5	30.0	Y
2	BH24-02	Machine Borehole	61.1	30.0	Y
2	BH24-03	Machine Borehole	62.4	30.0	Y
2	BH24-04	Machine Borehole	58.3	30.0	Y
2	HA24-01	Hand-Auger	68.0	5.0	Y
2	HA24-02	Hand-Auger	61.3	5.0	Y
2	HA24-03	Hand-Auger	59.7	4.2	Y
2	HA24-04	Hand-Auger	62.0D	5.0	Y
2	HA24-05	Hand-Auger	58.1	5.0	Y
2	HA24-06	Hand-Auger	37.9	4.1	Y

4.3 Design Phase Investigation

The fieldwork completed specifically for this detailed design phase is presented below:

Table 4.2: Investigation Summary – Design Phase (phase 3)

Phase	Test ID	Test Type	Ground Surface Elevation (RL m)	Depth (m)	Samples
3	CPT05	Cone Penetration Test	61.3	20.1	N
3	CPT06	Cone Penetration Test	60.2	20.1	N
3	CPT07	Cone Penetration Test	60.4	26.9	N
3	CPT08	Cone Penetration Test	58.1	26.6	N
3	sCPT05	Seismic Cone Penetration Test	63.1	29.3	N
3	sCPT06	Seismic Cone Penetration Test	59.9	25.6	N
3	BH24-05	Machine Borehole	63.1	16.5	Y
3	BH24-06	Machine Borehole	60.0	16.5	Y
3	HA24-07	Hand-Auger	64.5	2.0	Y
3	HA24-08	Hand-Auger	64.0	2.0	Y
3	HA24-09	Hand-Auger	63.4	5.0	Y
3	HA24-10	Hand-Auger	63.2	5.0	Y
3	HA24-11	Hand-Auger	62.8	5.0	Y
3	HA24-12	Hand-Auger	59.4	5.0	Y
3	HA24-13	Hand-Auger	58.2	5.0	Y

The approximate locations of the respective investigation sites referred to above are shown on the Geotechnical Investigation Plan as ***Drawing 01*** presented in ***Appendix B***. Engineering logs are presented in ***Appendix C***.

4.4 Laboratory Testing

At the preliminary design phase, laboratory index testing was conducted on layers that had previously been identified as liquefiable in the CMW's Geotechnical Assessment Report ref. HAM2023-0099AC Rev 0. Testing was scheduled by CMW and carried out by Construction Sciences. Test certificates are presented in ***Appendix D*** .

FACTUAL

Table 4.3: Laboratory Testing Summary

Test ID/ Location	Depth (m bgl)	Type of Test	Test Method
BH24-02	1.5-2.0	Particle size distribution	NZS4407.3.8.1 (Wet sieve)
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
	3.0-3.5	Particle size distribution	NZS4407.3.8.1 (Wet sieve)
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
	5.2-5.5	Particle size distribution	NZS4407.3.8.1 (Wet sieve)
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
BH24-03	4.9-5.2	Particle size distribution	NZS4407.3.8.1 (Wet sieve)
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
BH24-03	7.0-7.5	Particle size distribution	NZS4407.3.8.1 (Wet sieve)
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
BH24-04	4.5-5.0	Particle size distribution	NZS4407.3.8.1 (Wet sieve)
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)

Additional laboratory testing was conducted specifically for this reporting scope on layers that had previously been identified in CMW's Geotechnical Interpretive Report ref. HAM2023-0099AE Rev0 as being susceptible to shrink/swell and static settlements. Testing was scheduled by CMW and carried out by WSP. Test certificates are presented in ***Appendix D.***

Table 4.4: Laboratory Testing Summary

Test ID/ Location	Depth (m bgl)	Type of Test	Test Method
BH24-01	7.0-8.0	Particle size distribution	NZS4407.3.8.1 (Wet sieve)
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
BH24-05	1.0-1.5	Linear shrinkage	NZS4402:1986 Test2.6
		Shrink/Swell index	AS 1789.7.1.1.-2003
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
		Consolidation (Oedometer test)	NZS4402:1986 Test 7.1
	4.0-4.5	Linear shrinkage	NZS4402:1986 Test2.6
		Shrink/Swell index	AS 1789.7.1.1.-2003
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
		Consolidation (Oedometer test)	NZS4402:1986 Test 7.1
	5.0-5.5	Linear shrinkage	NZS4402:1986 Test2.6
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
	5.5-6.0	Linear shrinkage	NZS4402:1986 Test2.6
	5.5-6.5	Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
	6.0-6.5	Consolidation (Oedometer test)	NZS4402:1986 Test 7.1
	11.4-11.5	Consolidation (Oedometer test)	NZS4402:1986 Test 7.1
	16.4-16.5	Consolidation (Oedometer test)	NZS4402:1986 Test 7.1
BH24-06	1.0-1.5	Linear shrinkage	NZS4402:1986 Test2.6
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
	1.7-2.2	Linear shrinkage	NZS4402:1986 Test2.6
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
	6.0-6.5	Linear shrinkage	NZS4402:1986 Test2.6
		Shrink/Swell index	AS 1789.7.1.1.-2003
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
	7.5-8.0	Linear shrinkage	NZS4402:1986 Test2.6
		Shrink/Swell index	AS 1789.7.1.1.-2003
		Atterberg limits	NZS4402.2.1 to 4 (Casagrande)
		Consolidation (Oedometer test)	NZS4402:1986 Test 7.1
	12.0-12.4	Consolidation (Oedometer test)	NZS4402:1986 Test 7.1
		Triaxial test	BS EN ISO 17892-9:2018
	16.4-16.5	Consolidation (Oedometer test)	NZS4402:1986 Test 7.1

4.5 Groundwater Measurements

Given the layered soil profile, based ongeotechnical experience, the presence of a perched groundwater table during and following periods of rainfall had been anticipated during our preliminary study. Groundwater monitoring piezometers were installed to various depths using 50mm uPVC, gravel and bentonite plug fitted with a toby cover during the preliminary stage (phase 2). A barometer was also installed to correct for atmospheric pressure. Results of groundwater monitoring undertaken following the investigation is presented in ***Appendix E.***

FACTUAL

5.0 GEOLOGY

5.1 Published Geology

Published geological maps[2] depict the regional geology for the area as comprising reworked non-welded ignimbrite sequences of sandy, gravelly, and pumiceous deposits of the Walton Subgroup across the rolling hills as illustrated in Figure 5.1. The published geology is typically overlain by Hamilton Ashes and Karapiro Formation. The low-lying terraces near the lake (beyond the proposed reservoir location) are anticipated to be underlain by alluvial soils (Holocene-aged recent swamp deposits) overlying the Walton Subgroups units at depth.

5.2 Geomorphology

Geomorphology of the site was mapped during a site walkover and in conjunction with examination of aerial photographs, digital elevation models, and hill-shades. A geomorphology plan is presented in Figure 5.2.

The geomorphology was found to reflect the underlying geology and associated slope processes. The dominant structure is the low rolling hill formed by the Walton Subgroup sequence. The site is bounded by the alluvial low-lying terraces associated with the Waikato River to the East and Hamilton Lake to the West. No instability was noted on-site, although steeper slopes have been observed adjacent to Hamilton Lake.

5.3 Active Faults

As indicated in CMW SSSHA report ref. HAM2023-0099AG Rev2 dated 28 February 2025, the closest active known fault to the site is the Kututaruhe fault, 3km from the site. The location of faults within 45 km from the site are presented in Figure 5.3.

Figure 5.1: Regional Geology (GNS Science Web Geology Map[3])

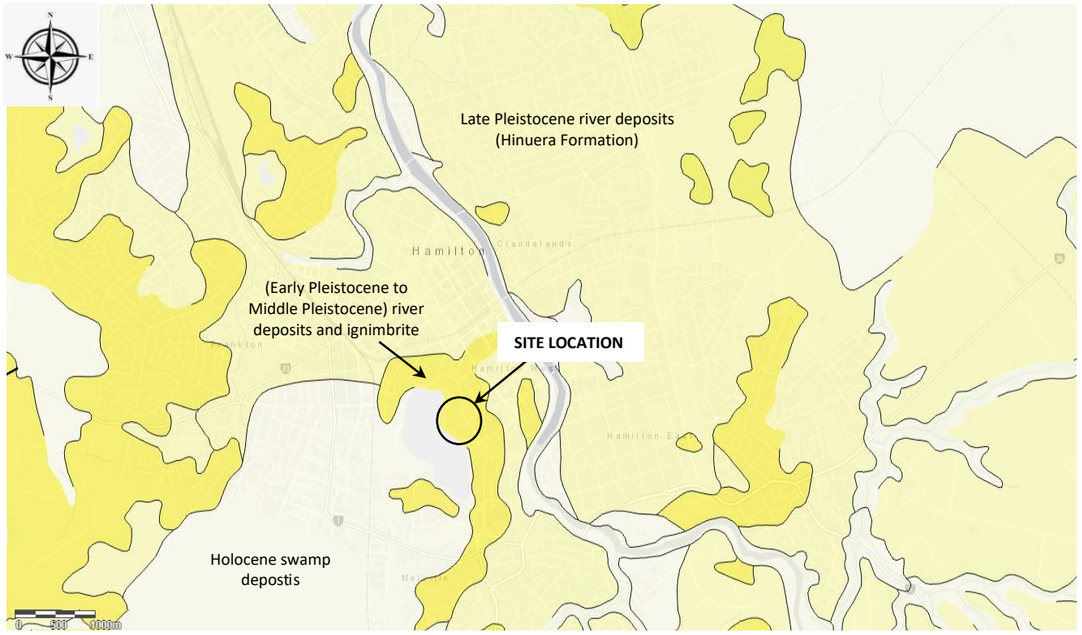
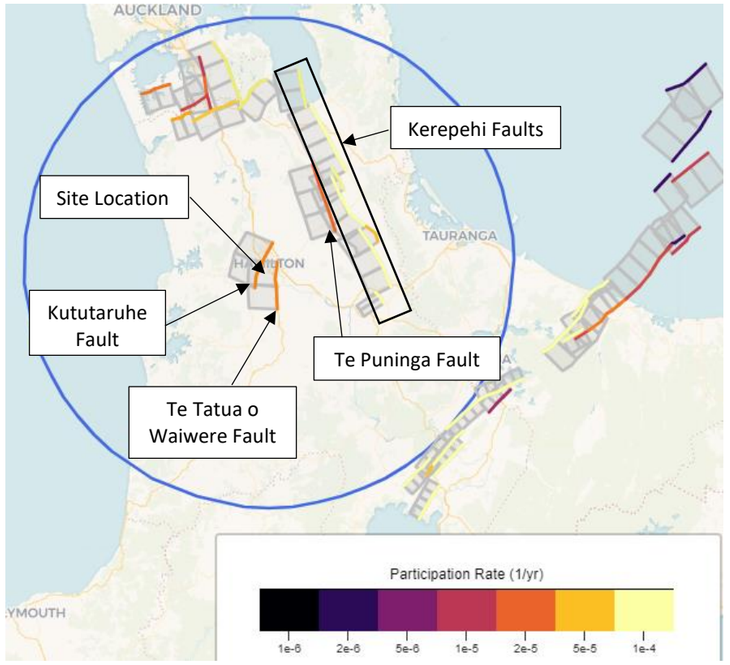


Figure 5.2: Geomorphology Plan



Figure 5.3: Crustal faults nearby the subject site, with a 100km radius of the site shown in blue. Source: nshm.gns.cri.nz



[2] Edbrooke, S.W. (compiler) 2005: Geology of the Waikato area. Institute of Geological & Nuclear Sciences 1:250,000 geological map.

INTERPRETIVE

6.0 GROUND MODEL

6.1 Stratigraphic Units

Our interpretation of the stratigraphic layers along the two cross sections running in the N-S and E-W directions through the site (refer Figure 3.1) are presented in geological sections in Figures 6.1 and 6.2 opposite.

Table 6.1: Ground Model

Geological Unit	Depth to Base (m bgl)		Thickness (m)	
Hilltop	**Min**	**Max**	**Min**	**Max**
Topsoil/(Uncontrolled) Fill	0.2	2.0	0.2	2.0
Stiff Clay with Sandy Bands [Hamilton Ashes]	1.5	6.0	1.0	5.5
Stiff Silty Clay with Sandy Bands [Hamilton Ashes]	5.0	9.5	1.1	4.0
Medium Dense Silty Sands/Firm to Stiff Sandy Silts with Very Stiff Clay Bands [Karapiro Formation]	9.5	17.0	3.0	11.0
Stiff Weathered Non-welded Ignimbrite [Walton Subgroup]	12.5	22.0	2.3	9.2
Very Dense Non-welded Ignimbrite [Walton Subgroup]	13.9	30.0	-	-

Geological Unit	Depth to Base (m bgl)		Thickness (m)	
Lakeside	**Min**	**Max**	**Min**	**Max**
Topsoil/Fill	0.20	0.5	0.2	0.5
Loose Sands and Soft Silts/ Clays [Swamp Deposits – Hinuera Formation]	>5.0	8.3	>4.8	7.8
Stiff Weathered Non-welded Ignimbrite [Walton Subgroup]	15.0		6.7	
Very Dense Non-welded Ignimbrite [Walton Subgroup]	>15.6		-	

Figure 6.1: Cross-Section (East to West)

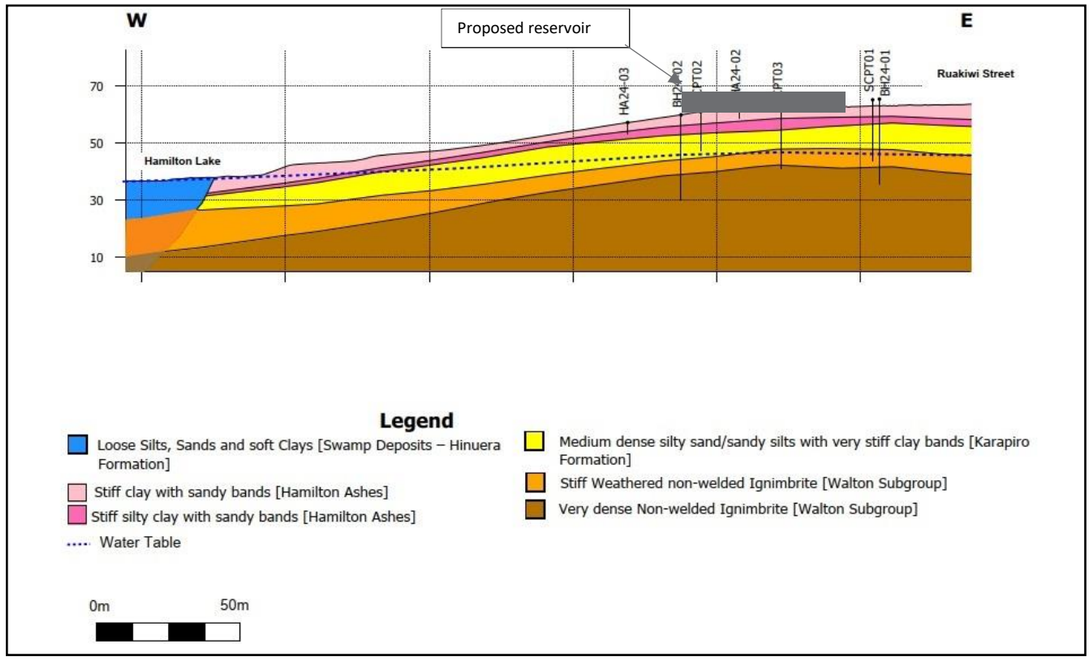
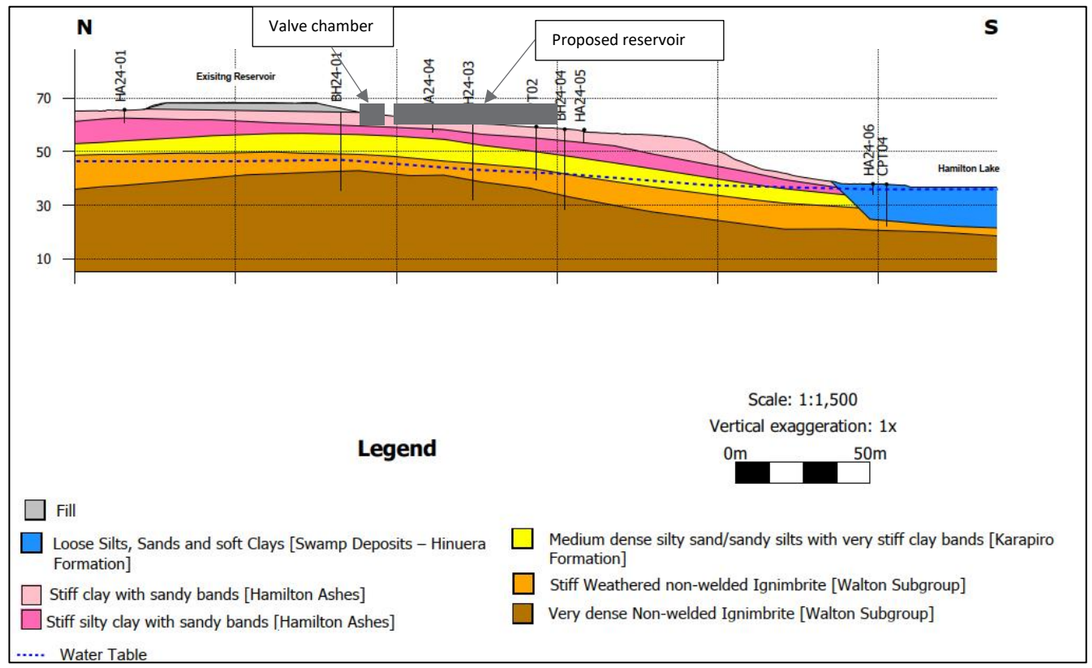


Figure 6.2: Cross-Section North to South



INTERPRETIVE

6.2 Laboratory test results

The results of the preliminary stage laboratory testing are summarised below.

Table 6.2: Laboratory Testing Summary

Test ID/ Location	Depth (m bgl)	Type of Test	Results
BH24-02	1.5-2.0	Particle size distribution	Fines content (Ø=75µm) =96%
		Atterberg limits	LL:81, PL:44, PI:37
	3.0-3.5	Particle size distribution	Fines content (Ø=75µm) =85%
		Atterberg limits	LL:72, PL:35, PI:37
	5.2-5.5	Particle size distribution	Fines content (Ø=75µm) =60%
		Atterberg limits	LL:64, PL:46, PI:18
BH24-03	4.9-5.2	Particle size distribution	Fines content (Ø=75µm) =62%
		Atterberg limits	LL:111, PL:52, PI:59
BH24-03	7.0-7.5	Particle size distribution	Fines content (Ø=75µm) =90%
		Atterberg limits	LL:79, PL:52, PI:27
BH24-04	4.5-5.0	Particle size distribution	Fines content (Ø=75µm) =98%
		Atterberg limits	LL:99, PL:52, PI:47

The results of the additional laboratory testing conducted for the detailed design phase are summarised below.

Table 6.3: Laboratory Testing Summary

Test ID/ Location	Depth (m bgl)	Type of Test	Results
BH24-01	7.0-8.0	Particle size distribution	Fines content (Ø=75µm) =41%
		Atterberg limits	LL:76, PL:37, PI:39
BH24-05	1.0-1.5	Linear shrinkage	23%
		Shrink/Swell index	I_{ss} = 5.7
		Atterberg limits	LL:108, PL:46, PI:62
		Consolidation (Oedometer test)	e_0=1.84, C_c=0.277, C_s=0.016
	4.0-4.5	Linear shrinkage	18%
		Shrink/Swell index	I_{ss} = 6.1
		Atterberg limits	LL:113, PL:56, PI:57
		Consolidation (Oedometer test)	e_0=2.22, Cc=0.284, Cs=0.023
	5.0-5.5	Linear shrinkage	7%
		Atterberg limits	LL:49, PL:32, PI:17
	5.5-6.0	Linear shrinkage	24%
	5.5-6.5	Atterberg limits	LL:130, PL:73, PI:57
	6.0-6.5	Consolidation (Oedometer test)	e_0=2.00, C_c=0.174, C_s=0.017
	11.4-11.5	Consolidation (Oedometer test)	e_0=1.36, C_c=0.141, C_s=0.003
	16.4-16.5	Consolidation (Oedometer test)	e_0=1.30, C_c=0.198, C_s=0.009
BH24-06	1.0-1.5	Linear shrinkage	23%
		Atterberg limits	LL:106, PL:44, PI:62
	1.7-2.2	Linear shrinkage	25%
		Atterberg limits	LL:110, PL:48, PI:62
	6.0-6.5	Linear shrinkage	16%
		Shrink/Swell index	I_{ss} = 2.2
		Atterberg limits	LL:64, PL:41, PI:23
	7.5-8.0	Linear shrinkage	18%
		Shrink/Swell index	I_{ss} = 3.5
		Atterberg limits	LL:96, PL:55, PI:41
		Consolidation (Oedometer test)	e_0=1.33, C_c=0.149, C_s=0.009
	12.0-12.4	Consolidation (Oedometer test)	e_0=1.02, C_c=0.133, C_s=0.006
		Triaxial test	c'=34 kPa, Φ'=30°
	16.4-16.5	Consolidation (Oedometer test)	e_0=2.03, C_c=0.359, C_s=0.020

6.3 Groundwater Tables

During the preliminary stage investigations completed in late summer conditions (March-May 2024), regional groundwater was encountered at depths ranging from 15.3m to 23.7m below existing ground levels. During the design stage investigations completed in early summer conditions (December 2024), regional groundwater was encountered at depths ranging from 13.7m to 16.1m below existing ground levels. A perched groundwater table has been observed locally during investigations at CPT07, BH24-05, BH24-06 at depths ranging from 2.7m to 3.1m below ground level.A summary of the perched water tables and regional groundwater table measured between March 2024 and February 2025 is summarised below:

Table 6.4: Groundwater monitoring summary (March 2024- February 2025)

Piezometer	Elevation (RL m)	Screen Depth (m bgl)	Minimum Measured Level (m bgl)	Maximum Elevation (RL m)	Maximum Measured Level (m bgl)	Minimum Elevation (RL m)
BH01	65.5	0.5-3.5	3.4	62.1	dry	dry
		16.5-29.6	18.7	46.8	19.6	45.9
BH02	59.9	1.0-3.0	0.8	59.1	dry	dry
		4.5-5.5	1.7	58.2	dry	dry
BH03	61.7	3.0-6.0	5.9	55.8	dry	dry
		19.0-28.0	17.2	44.5	18.1	43.6
BH04	58.3	1.0-3.5	0.8	57.5	dry	dry
		20.0-26.0	15.3	43.0	16.3	42.0

Perched groundwater tables:

- Perched water tables develop intermittently within the sandy lenses of the Hamilton Ashes after rainfall events as shown on the groundwater monitoring plots presented in ***Appendix E:*** BH01 (0.5-3.5m bgl), BH02 (1.0-3.1m bgl), BH02 (4.5-5.5m bgl), BH03 (3.0-6.0m bgl), BH04 (1.0-3.0m bgl).
- Perched water tables are also discontinuous i.e. were not encountered at all investigation locations.

Regional groundwater table:

- The regional groundwater table has been measured between 15m and 16m bgl at the site during the monitoring period as presented in ***Appendix E***: BH01 (16.5-30.0m bgl), BH03 (19.0-28.0m bgl), BH04 (20-24m bgl). A seasonal fluctuation of 1.0m can be anticipated at the site based on groundwater level measurements at Borehole 69 – Station 163 available on Waikato Regional Council's database.
- General groundwater flow appears to be oriented towards the South-West /Hamilton Lake.
- Interpreted regional groundwater table at 15m bgl has been used in the geotechnical assessments and has been presented in ***Appendix B***.

6.4 Recommended Geotechnical Parameters

Table 6.5: Geotechnical Design Parameters

Unit Description	Typical Thickness (m)	CPT q_c (MPa)	γ (kN/m3)	c´ (kPa)	ϕ´ (deg)	S_u (kPa)	E (MPa)
Topsoil/(Uncontrolled) Fill	0.5	1.0-3.0	16	-	-	-	-
Loose Sands and Soft to Firm Silts/ Clays [Swamp Deposits – Hinuera Formation]	8.0	0.5-1.0	16	4	20	50	-
Stiff to Very Stiff Clay with Sandy Bands [Hamilton Ashes]	4.2	1.0-2.0	16	3	28	110	25
Firm to Very Stiff Silty Clay with Sandy Bands [Hamilton Ashes]	3.0	0.5-2.5	16	2	26	75	30
Medium Dense Silty Sands/Firm to Stiff Sandy Silts with Very Stiff Clay Bands [Karapiro Formation]*	7.0	2.0-6.5	16	10	30	-	70
Stiff to Very Stiff Weathered Non-welded Ignimbrite [Walton Subgroup]*	5.0	1.0-2.5	17	3	28	130	35
Dense Non-welded Ignimbrite [Walton Subgroup]*	>5.0	>10.0	17	10	32	-	>150

Notes:
* Units not encountered in HA24-01 to HA24-04.
γ = soil unit weight (typical published values for similar soil types)
c´ = effective cohesion (conservative industry accepted value)
ϕ´ = effective friction angle (conservative industry accepted value)
S_u = undrained shear strength (average value determined from vane shear testing / CPT correlations)
E = Youngs modulus (average value determined from CPT correlations)

Figure 6.3: Perched Groundwater Table Monitoring

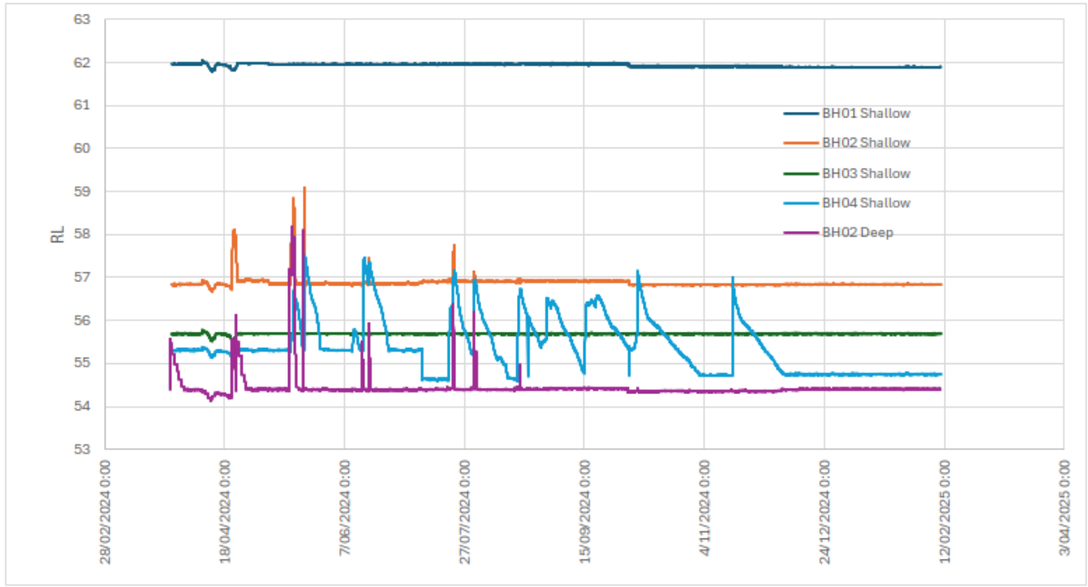
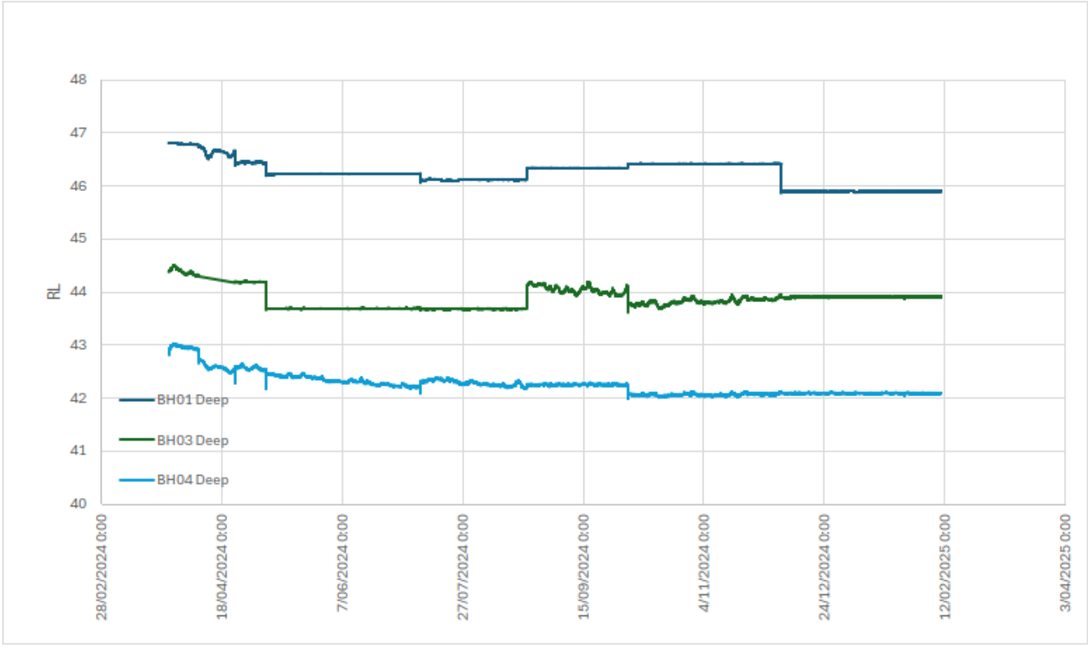


Figure 6.4: Regional Groundwater Table Monitoring



7.0 GEOHAZARDS ASSESSMENT

A full Geotechnical Risk Register including geohazards assessment and Safety in Design is presented in ***Appendix K*** and contains references to the assessment methods used. The table below is a summary of critical geohazards to this project and is based on information available to date. The Geotechnical Risk Register is a live document that will be updated as the project progresses. Where relevant, specific assessment details can be found in the respective design calculation packages in the appendices as noted.

Table 7.1: Geohazard Assessment Summary

Geohazard Assessment Summary											
Item	Geotechnical Hazard	Methodology / References	Area Assessed	Assessment Outcome	Existing Risk of Damage to Land / Structures			Mitigation Measure	Residual Risk of Damage to Land / Structures		
					Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
1	Seismicity	NZGS and MBIE (2021) Earthquake Geotechnical Engineering Practice in New Zealand, Module 1: Overview of the Guidelines Structural design actions - Part 0: General principles, NZS1170.0:2002 Structural design actions - Part 5: Earthquake actions - New Zealand, NZS1170.5:2004	Entire Site	Site subsoil class = Class D. A Site-Specific Seismic Hazard Assessment based on NZS1170.0 (2002) and TS1170.5 (2024) has been conducted to define the earthquake magnitude and peak ground acceleration for the proposed IL4 structures with a 100-year design life: ULS M=6.91 PGA = 0.33g SLS2 M=6.85 PGA=0.23g SLS M=6.59 PGA=0.03g Refer **CMW SSSHA Report ref. HAM2023-0099AG Rev2 dated 28 February 2025 – summary presented in *Appendix F***	2	5	10	Mitigation not required	2	5	10
2	Liquefaction	MfE and MBIE (2017), Planning and engineering guidance for potentially liquefaction-prone land NZGS and MBIE (2021) Earthquake Geotechnical Engineering Practice in NZ, Module 1: Overview of the Guidelines NZGS and MBIE (2021) Earthquake Geotechnical Engineering Practice in NZ, Module 3: Identification, assessment and mitigation of liquefaction hazards Robertson, P. K. (2015) Comparing CPT and Vs Liquefaction Triggering Methods, J. Geotech. Geoenviron. Eng.	Entire Site	Perched groundwater table is intermittent and discontinuous resulting in non-saturated superficial soils. Regional groundwater table Is encountered at depths greater than 15 m bgl. Shallow soils (>10m bgl on average) are tested as cohesive and plastic. Liquefaction occurs in discontinuous lenses (less than 0.5m thick) with >10m thick non-liquefied crust. Resulting liquefaction induced settlements <5mm. Damage to the structure due to liquefaction induced settlements is unlikely. **Refer *Appendix G* for adopted methodology, calculation summary and output.**	1	5	5	Mitigation not required	1	5	5
3	Coseismic Displacement/ Lateral Spread	NZGS and MBIE (2021) Earthquake Geotechnical Engineering Practice in NZ, Module 3: Identification, assessment and mitigation of liquefaction hazards	Entire Site	Damage to the structure due to lateral spread is anticipated. While surperficial liquefaction is unlikely, lateral spread anticipated to be 80mm or less for ULS PGA=0.33g **Refer *Appendix G and H* for adopted methodology, calculation summary and output.**	2	4	8	Structure is to be designed to withstand 80mm lateral displacement to limit damages.	1	4	4
4	Cyclic Softening	NZGS and MBIE (2021) Earthquake Geotechnical Engineering Practice in NZ, Module 3: Identification, assessment and mitigation of liquefaction hazards	Walton Subgroup Area	Cyclic softening is anticipated in the fine-grained soil bands in Karapiro Formation and weathered ignimbrites (upper layers of Walton subgroup) 15m to 17m below ground level. These layers have been assessed as discontinuous. This	1	5	5	Mitigation not required	1	5	5

INTERPRETIVE

Geohazard Assessment Summary											
Item	Geotechnical Hazard	Methodology / References	Area Assessed	Assessment Outcome	Existing Risk of Damage to Land / Structures			Mitigation Measure	Residual Risk of Damage to Land / Structures		
					Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
				hazard has been assessed as part of global stability and bearing capacity. Damage to the structure due to cyclic softening induced settlements is unlikely.							
5	Global Instability	Waikato Local Authority (2018) Regional Infrastructure Technical Specifications	Entire Site	Slope stability analysis results show that the proposed landforms achieve the target factors of safety for prevailing and transient scenarios. **Refer *Appendix H* for adopted methodology, calculation summary and output.**	1	5	5	Mitigation not required	1	5	5
6	Expansive Soils	MBIE (2021) Acceptable Solutions and Verification Methods For New Zealand Building Code Clause B1 Structure, Amendment 20 NZS 3604:2011 AS 2870-2011	Entire Site	Damage to the structure due to surface movements due to shrinking clays is anticipated. Atterberg limit tests (NZS 4402:1998 Test 2.2) conducted on all Hamilton ashes samples have shown a Liquid Limit (LL) >50% (except for one sample where 49% is reported). For all samples with a LL>50, the linear shrinkage is between 16% and 24%, and the shrink swell index, I_{ss}, as per AS 2870-2011, is between 2.2 (M) to 6.1 (H2). According to MBIE (2019, these soils would be classified as M to H, moderate to high Relative expansion. Characteristic surface movement (y_s) assessed in accordance with AS2870-2011 are anticipated to be between 27 mm and 75 mm. Halloysite (predominant in Hamilton ashes deposits) can undergo significant shrinkage and cracking when dehydrated, however its swelling potential is limited. **Refer *Appendix D* for summary and tests results output.**	4	3	12	Based on experience, swelling of clays from the Hamilton Ashes Formation has not been documented. Based on the laboratory results, specific foundation design by structural engineer in accordance with NZBC B1/AS1 is to be designed to withstand up to 75mm surface movements (shrinkage).	1	3	3
7	Sensitive Soils	NZGS Field Description of Soil and Rock (NZGS, 2005)	Transitional greyish-brown ash layer below the Hamilton ashes	Volcanic Ashes (Hamilton and Kauroa Ashes) are known to contain a more sensitive transitional greyish-brown ash layer, which, if exposed at finished level or during earthworks, is susceptible to rapid strength loss and softening with disturbed.	4	2	8	Sensitive ashes will require careful consideration by the contractor (i.e. planned movement of construction equipment and using a subgrade improvement layer, accounting for weather conditions). Over-excavation of these deposits to a depth of 1m and capping with engineered filling is a prudent remediation measure.	1	2	2
8	Uncontrolled Fill	N/A	In proximity to the existing reservoir	Uncontrolled fill comprising clayey material is present to depths of 0.6 to 2.0 m (encountered at BH24-01, sCPT01, HA24-07, HA24-08, HA24-09 and HA24-11) in proximity to the existing reservoir.	4	3	12	Uncontrolled fill is to be excavated and replaced when it is located within the reservoir and the valve chamber's footprint. Contamination testing if also recommended if this material needs to be worked with.	1	3	3
9	Bearing Capacity	MBIE (2021) Acceptable Solutions and Verification Methods For New Zealand Building Code Clause B1 Structure, Amendment 20, B1/VM4	Entire Site	Bearing capacity assessment shows preliminary geotechnical ultimate bearing capacity (GUBC) of 500kPa for static and ULS seismic conditions. **Refer *Appendix I* for adopted methodology, calculation summary and output.**	1	5	5	Mitigation not required, except removal of soft spots on the subgrade.	1	5	5

INTERPRETIVE

Geohazard Assessment Summary											
Item	Geotechnical Hazard	Methodology / References	Area Assessed	Assessment Outcome	Existing Risk of Damage to Land / Structures			Mitigation Measure	Residual Risk of Damage to Land / Structures		
					Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
10	Load Induced Settlement	N/A	Entire Site	Calculated load induced settlements are beyond acceptable limits for the structure. Load compensation due to 3m of excavation has been considered in the static settlement calculations. Differential settlements have been assessed carefully based on laboratory tests. For the Reservoir, primary settlements of 10mm to 250mm are predicted. Post-construction settlements of 10mm to 100mm are predicted. Total post construction differential settlements are estimated to be 10mm to 255mm. For the valve chamber, proposed loads are less than the current effective overburden pressure, no static settlement is expected. **Refer *Appendix J* for adopted methodology, calculation summary and output.**	2	5	10	Differential settlements over 100mm after the construction of the slab and walls are considered excessive for the project based on input from Holmes and WSP. Hence, specific mitigation measures will be required. Considering the current construction programme, we propose the following remediation options: - Surcharging, with monitoring of the settlements to adjust the estimated consolidation values, is considered to be an effective and cheap option. - Ground improvement in the form of Rigid Inclusions can also be an effective mitigation measure.	1	5	5
11	Lateral seismic loads	MBIE (2017) Earthquake geotechnical engineering practice, Module 6: Earthquake resistant retaining wall design", NZGS	Valve chamber	Damage to the structure including the perimetric walls of the underground valve chamber is anticipated due to lateral seismic loads. The seismic loads have been considered following a pseudo-static approach. The additional equivalent earth loading, ΔPe, is assessed to be between 130kN/m (Hamilton Ashes clays) and 180kN/m (GAP65) depending on the material used to backfill the area behind the valve chamber underground level wall.	2	5	10	Specific wall design by structural engineer should account for up to 130kN/m (Hamilton Ash clays) and 180kN/m (GAP65) of equivalent loading depending on the material used to backfill the area behind the valve chamber underground peripheralwall.	1	5	5
11	Groundwater Impacts	Waikato Regional Plan (2012), Section 3	Entire Site	Regional groundwater is not anticipated to be encountered during construction/ earthworks. However, an intermittent and discontinuous perched groundwater table is present on-site. Depending on rainfall inputs to which it is highly responsive, this perched groundwater table may be encountered during earthworks.	1	4	4	Subsoil drains need to be installed as necessary.	1	4	4
12	Excavatability	N/A	Entire Site	Excavatability may pose a construction risk, as within the deeper cuts, Hamilton ashes at the perched groundwater level may present high moisture contents, sometimes approaching their liquid limit.	2	4	8	Soils with high moisture content can be successfully earthworked in dry summer conditions but may require specific attention to excavation, conditioning, blending and compaction methodologies. There may be a need to carefully control moisture levels and consider appropriate haul routes to enable successful compaction. The addition of lime and/or cement to engineered filling in concentrations greater than 3% requires the approval of the Geotechnical Engineer.	1	4	4
13	Temporary Cut/ Fill Batter Stability	N/A	Entire Site	Cut / fill batter stability should be assessed when details are available.	2	4	8	Cut / fill batter stability should be assessed when details are available and appropriate recommendations	1	4	4

INTERPRETIVE

Geohazard Assessment Summary											
Item	Geotechnical Hazard	Methodology / References	Area Assessed	Assessment Outcome	Existing Risk of Damage to Land / Structures			Mitigation Measure	Residual Risk of Damage to Land / Structures		
					Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
								about slope limits should be provided for temporary cases. In general, temporary batters of 1(V):2.5(H) are acceptable within the volcanic ashes. The crest of the batter should be at least 5m away from any existing structure, assuming the temporary cut depth = 5m.			
14	Soil heaving induced by excavation	N/A	Entire Site	Based on our laboratory tests results, clays from the Hamilton ashes formation are near-normally consolidated, therefore excavation-Induced Stress Relief is unlikely to cause clays to expand.	1	2	2	Mitigation not required	1	2	2

INTERPRETIVE

8.0 RECOMMENDATIONS

8.1 Earthworks

All cut and fill activities must be carried out in general accordance with the requirements of NZS 4431:2022[4] and the RITS requirements under the guidance of a Chartered Professional Geotechnical Engineer.

A summary of the key project specific construction risks, as presented in the Project Risk Register in ***Appendix K,*** are as follows:

Table 8.1: Key Construction Risks

Item	Mitigation Measures
Excavatability	Given the stiffness of the soil units that will be encountered, excavation is expected to be readily achieved with normal earthworks plant. Soils with high moisture content can be successfully earthworked in dry summer conditions but may require specific attention to excavation, conditioning, blending and compaction methodologies.
Problematic Soils (Transitional greyish-brown ash layer below the Hamilton ashes)	Sensitive ashes which lose strength with trafficking and construction activities might pose challenges during construction and will require careful consideration by the contractor (i.e. planned movement of construction equipment and using a subgrade improvement layer, accounting for weather conditions). Over-excavation of these deposits to a depth of 1m and capping with engineered filling is a prudent remediation measure.
Temporary discontinuous perched groundwater table	Within the deeper cuts, Hamilton ashes at the perched groundwater level may present high moisture contents, sometimes approaching the liquid limit. Soils with high moisture content can be successfully earthworked in dry summer conditions but may require specific attention to excavation, conditioning, blending and compaction methodologies.

The temporary stability of the works should be assessed as per above comments. All works are to be completed in accordance with the requirements of current safety legislation and WorkSafe NZ.

Earthworks recommendations are detailed in the CMW geotechnical earthworks specification presented in ***Appendix L***.

8.2 Static Settlement Mitigation

8.2.1 Mitigation Options

To minimise post construction static ground settlements to less than 150mm and differential settlement to less than 100mm, a range of options may be considered, including the following:

- Construction of a temporary surcharge or pre-load fill embankment above design finished ground level, to over-consolidate the compressible soils and minimise post construction static settlements (preferred option). This is considered to be an effective and cheap option.
- Ground improvement in the form of Rigid Inclusions can also be used to reduce the post construction static settlements as an alternative solution. Preliminary design indicates 300mm diameter unreinforced rigid inclusions with minimum 30kPa UCS at 8% to 12% area replacement ratio to a depth of 11m will be required. This solution, if selected, will require detailed design.

8.2.2 Pre-Load Design

It is expected that pre-loading or surcharging, without cutting surficial compressible soils, is likely to be the preferred ground improvement technique for this project to reduce post-construction static settlements to acceptable magnitudes.

Pre-load embankment heights were estimated using the method described in Mesri et al (1994)[5] based on achieving 90% primary consolidation (t_{90}) during pre-load with post-construction settlements being limited to 150 mm. The pre-load material density is assumed to be 16 kN/m³ with 110kPa long term loading from project.

Resulting pre-load embankment heights are presented in ***Appendix J*** and range from 4.5m to 6.5m above design ground levels, depending on soft soil thickness and proposed fill depths. Embankment extents have been designed to consider protected trees.

8.2.3 Settlement Monitoring

Settlement estimates and preload heights are based on a limited amount of laboratory test data and back analysis of settlement monitoring data. As there will inevitably be some variation in soil composition and resulting settlement profiles from one location to the next, it is imperative that settlement monitoring is undertaken during construction to back analyse consolidation settlement parameters and progressively refine the pre-load design.

Due to material composition and depth variability, it is recommended that regular settlement monitoring plates would be required, as shown on ***Appendix J***. All plates must be installed at original ground level to capture the full magnitude of settlement.

It is recommended that fill embankments are temporarily terminated at least 5m inside the project footprint. Surface settlement monitoring points should be established prior to filling at the temporary embankment crest, toe, 2m from the toe and 5m from the toe to determine edge effects. This will provide confidence to place the remaining fill out to the whole footprint without impacting protected trees.

8.3 Foundations

Table 8.2: Anticipated Foundation Details

Item	Methodology	Value	Comment
Geotechnical Ultimate Bearing Capacity (GUBC) for Shallow Foundations	-	350 kPa(*)	Available within natural cut areas in static and seismic scenarios. Reservoir diameter to measure no greater than 65m in plan.
Expansive Soil Site Class	AS2870	H1 (high)	Specific foundation design by structural engineer in accordance with NZBC B1/AS1 is to be designed to withstand up to 75mm surface movements (shrinkage).
Strength Reduction Factors	B1/VM4[6]	0.8	Load combinations involving earthquake overstrength
		0.5	All other load combinations
Seismic Site Class(es)	NZS1170	D	Based on the ground conditions and the results of a specific

[4] Standards New Zealand (2022) Engineered fill construction for lightweight structures, NZS 4431:2022
[5] Mesri, G., Lo, D. O. K. and Feng, T. W. 1994. Settlement of embankments on soft clays. Keynote Lecture, Settlement '94, Texas A&M University, College Station, Texas, Geotechnical Special Publication 40, v. 1, 8-56.
[6] Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure,* B1/VM4, Amendment 19

	study completed across the Waikato Basin (Jeong and Wotherspoon, 2019)[7], the seismic site subsoil category is assessed as being Class D (deep soil site).
Note (*): higher bearing capacities are available for smaller footings. These will need to be assessed on a case-by-case basis, load induced settlements may be higher.	

8.4 Safety in Design

Our SiD risk assessment is presented in ***Appendix K***. This risk assessment must be communicated with all affected parties involved with the project and dealt with through specific on-site risk assessment plans.

9.0 FURTHER WORK

The following further work is recommended:

- Plan review: Review of building consent application plans and structural loads to ensure the design meets the intent of this report.
- Surcharging and settlement monitoring will have to be carried out to ensure post-construction settlements are within acceptable limits.
- Construction observations will be required during earthworks (e.g. subgrade check, compaction control of engineered fill, placement of geofabric).
- Validation of ground model during earthworks will be required.

10.0 CLOSURE

Additional important information regarding the use of your CMW report is provided in the *'Using your CMW Report'* document attached to this report.

This report has been prepared for use by Hamilton City Council in relation to the IAF Reservoir at Lake Domain along Ruakiwi Road, Hamilton in accordance with the scope, proposed uses and limitations described in the report. Should you have further questions relating to the use of your report please do not hesitate to contact us.

Where a party other than Hamilton City Council seeks to rely upon or otherwise use this report, the consent of CMW should be sought prior to any such use. CMW can then advise whether the report and its contents are suitable for the intended use by the other party.

[7] Jeong S and Wotherspoon (2019) Development of a Waikato Basin T0 and depth mofdel by the H/V spectral ratio method, 2019 Pacific Conference on Earthquake engineering and annual NZSEE Conference

APPENDIX A
Supplied Drawings

189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Holmes

Project 148023.33

WORK IN PROGRESS 05/03/2025

drawing index

S000-01 drawing index
S000-12 general arrangement 3D views
S001-01 general arrangement site plan
S101-01 reservoir floor plan
S101-02 reservoir roof plan
S101-11 reservoir floor reinforcing plan
S101-12 reservoir roof reinforcing plan
S102-01 reservoir typical sections
S103-01 reservoir concrete details
S103-02 reservoir concrete details
S105-01 reservoir precast panel details
S105-02 reservoir precast panel details
S201-01 valve chamber floor and roof plans
S202-01 valve chamber typical sections

WORK IN PROGRESS 05/03/2025

All dimensions to be verified on site before making any shop drawings or commencing any work.

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Rev	Date	Appd	Reason
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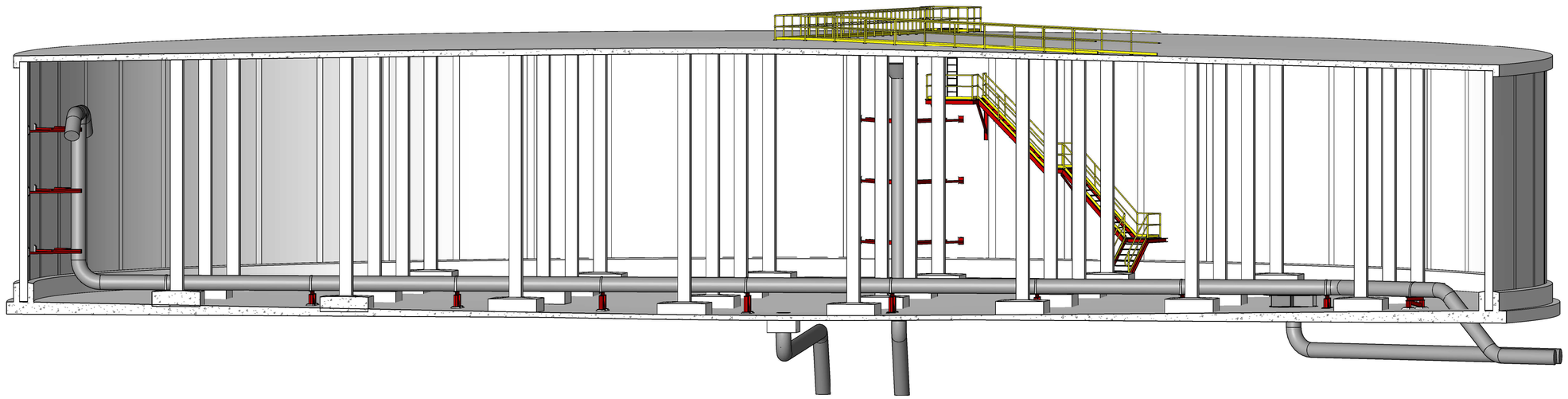
Holmes

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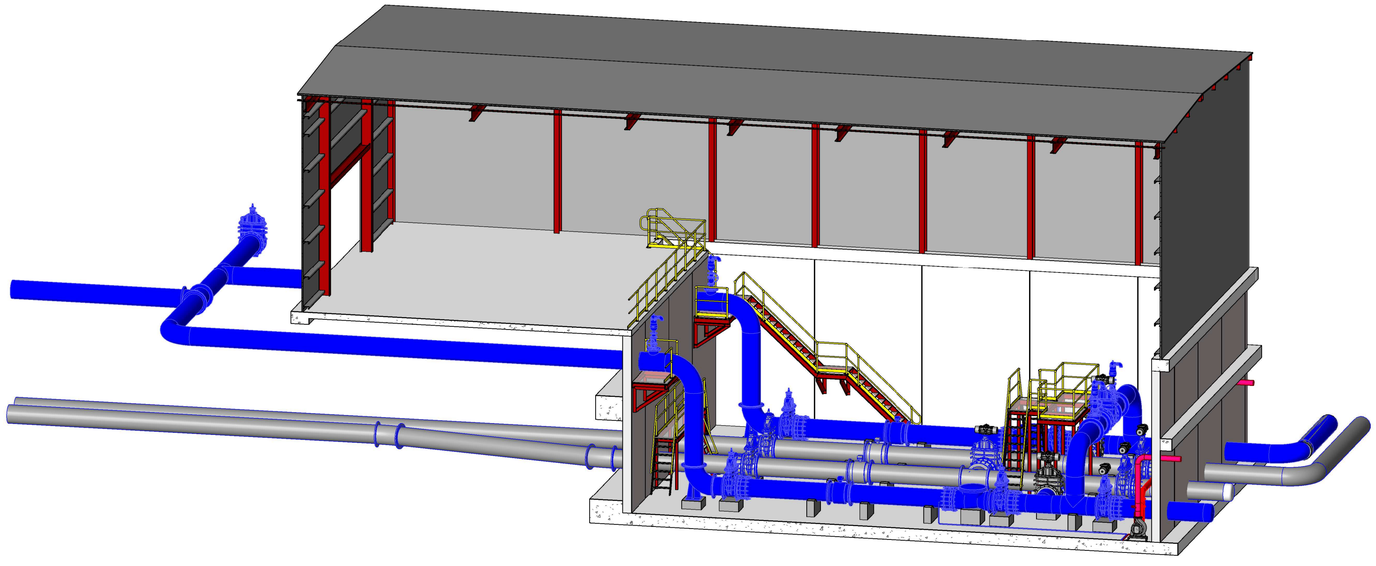
189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Sheet Title: drawing index

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Scale:
Filename: 189378_CB_STR_CB10_Holmes_202
Job Number: 148023.33
Sheet Number: S000-01



1 / - reservior 3D view
n.t.s.



2 / - valve chamber 3D view
n.t.s.

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189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Sheet Title
general arrangement
3D views

Drawn AJW Scale n.t.s
Filename 189378_CB_STR_CB10_Holmes_202
Job Number 148023.33 Sheet Number S000-12

N

notes:

1. Refer to S000 series for all general notes.

existing ruakiwi reservoir

designation boundary

Clarance Street

VH

V1

VA

V2

valve chamber

R1

Ruakiwi Road

stage two
reservoir outline

designation boundary

N 698130.114
E 445277.961

28° 01' 11"

118° 01' 11"

stage one
reservoir

RA

1 / - site plan
1 : 500

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189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Sheet Title
general arrangement
site plan

Drawn AJW Scale 1:500

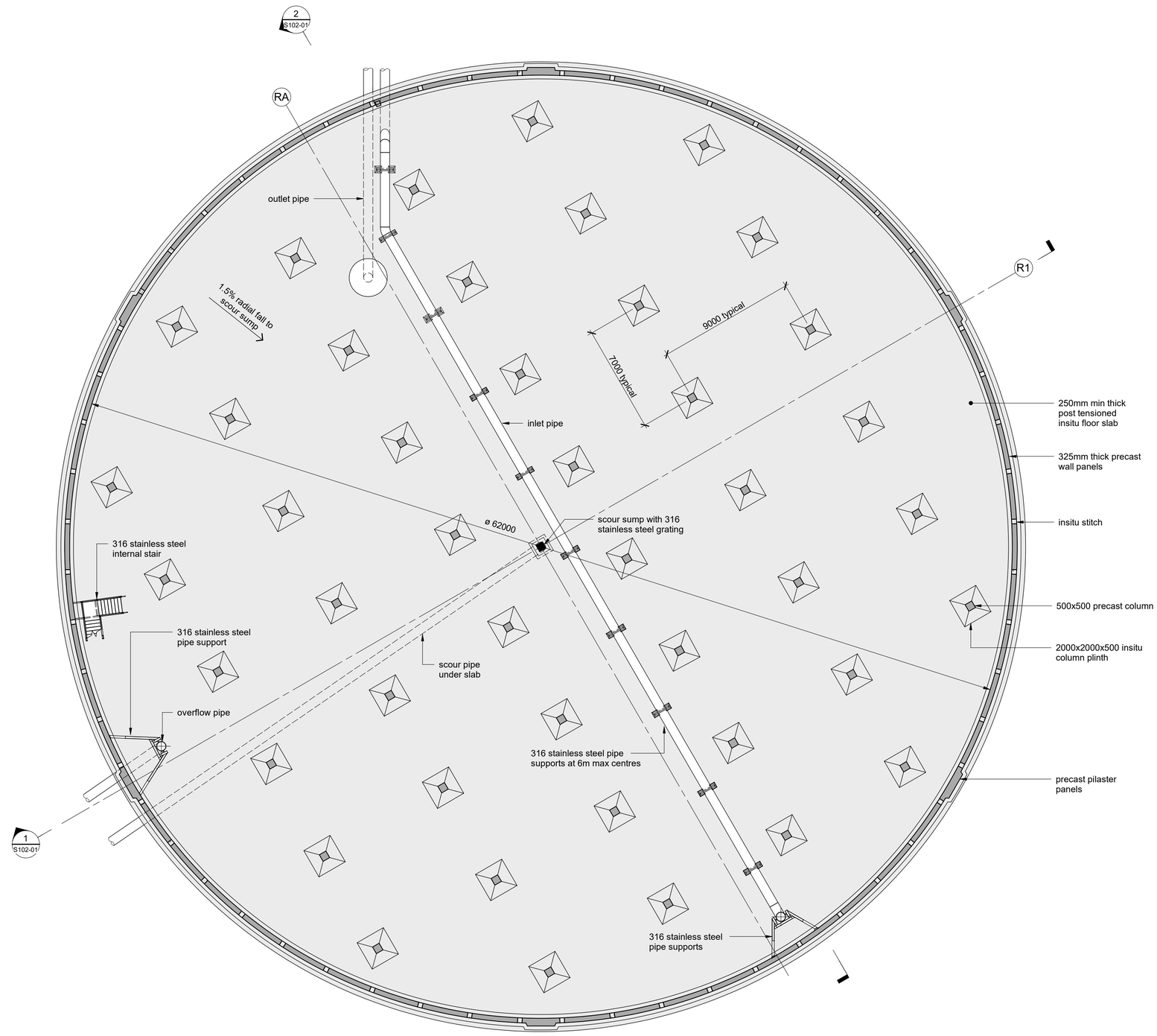
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Job Number 148023.33

Sheet Number S001-01

notes:

1. Refer to S000 series for all general notes.



1 / - reservoir floor plan
1 : 150

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Sheet Title: reservoir floor plan

Drawn: AJW | Scale: 1:150

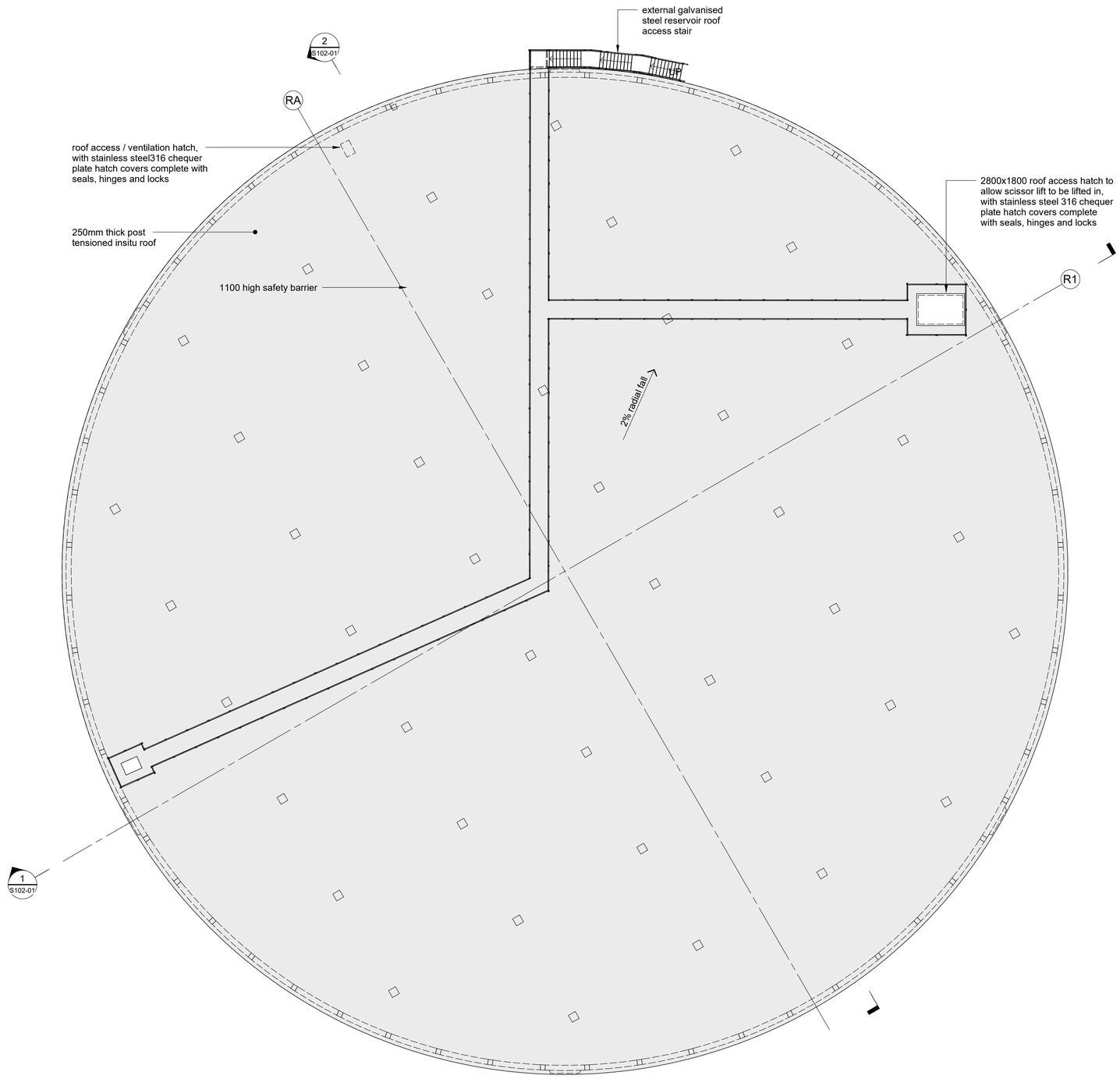
Filename: 189378_CB_STR_CB10_Holmes_202

Job Number: 148023.33 | Sheet Number: S101-01

WORK IN PROGRESS 05/03/2025

notes:

1. Refer to S000 series for all general notes.



1 / - reservoir roof plan
1 : 150

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189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Sheet Title: reservoir roof plan

Drawn: AJW | Scale: 1:150

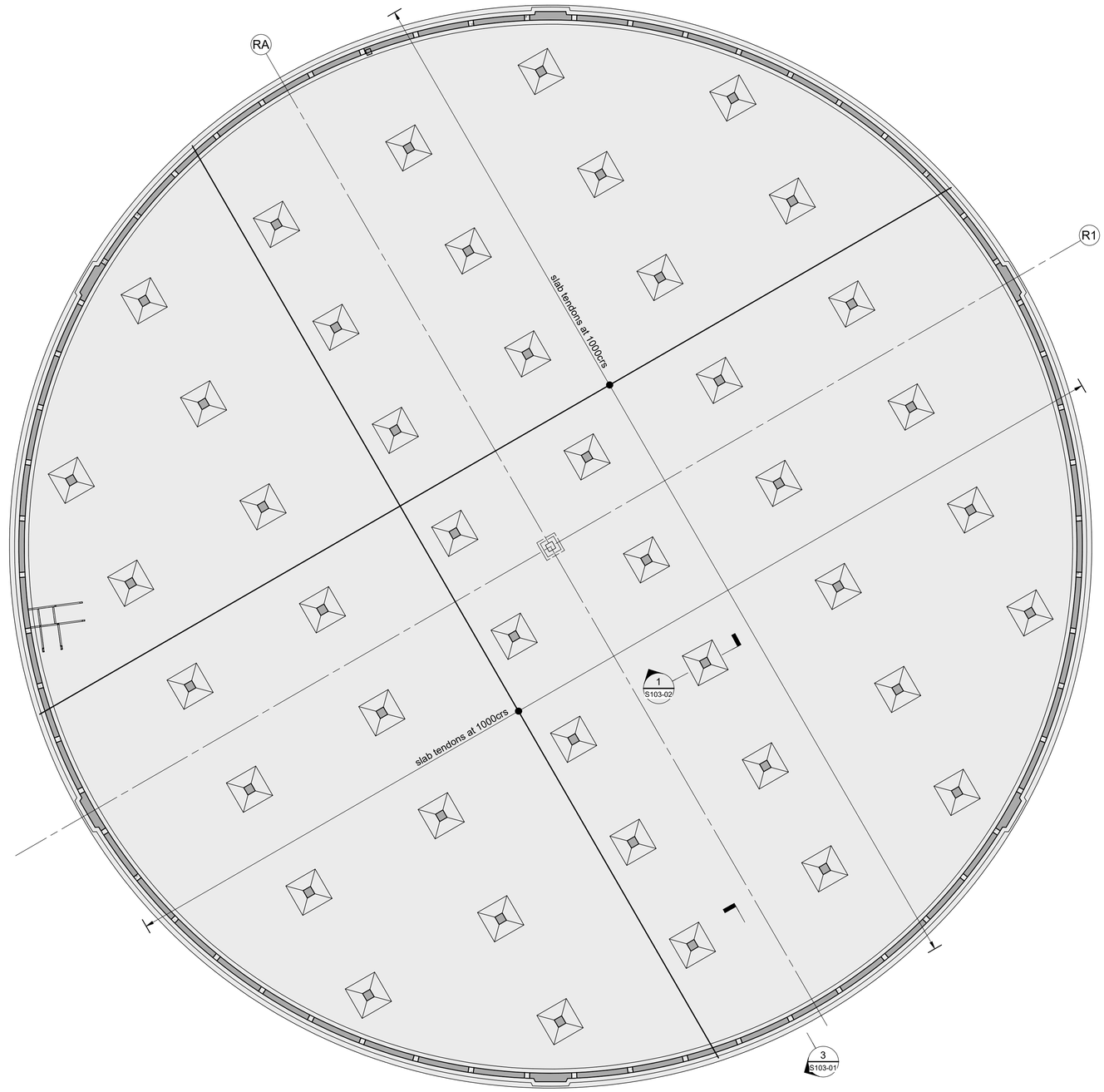
Filename: 189378_CB_STR_CB10_Holmes_202

Job Number: 148023.33 | Sheet Number: S101-02

WORK IN PROGRESS 05/03/2025

notes:

1. Refer to S000 series for all general notes.



1 / - reservoir floor plan
1 : 150

WORK IN PROGRESS 05/03/2025

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-			

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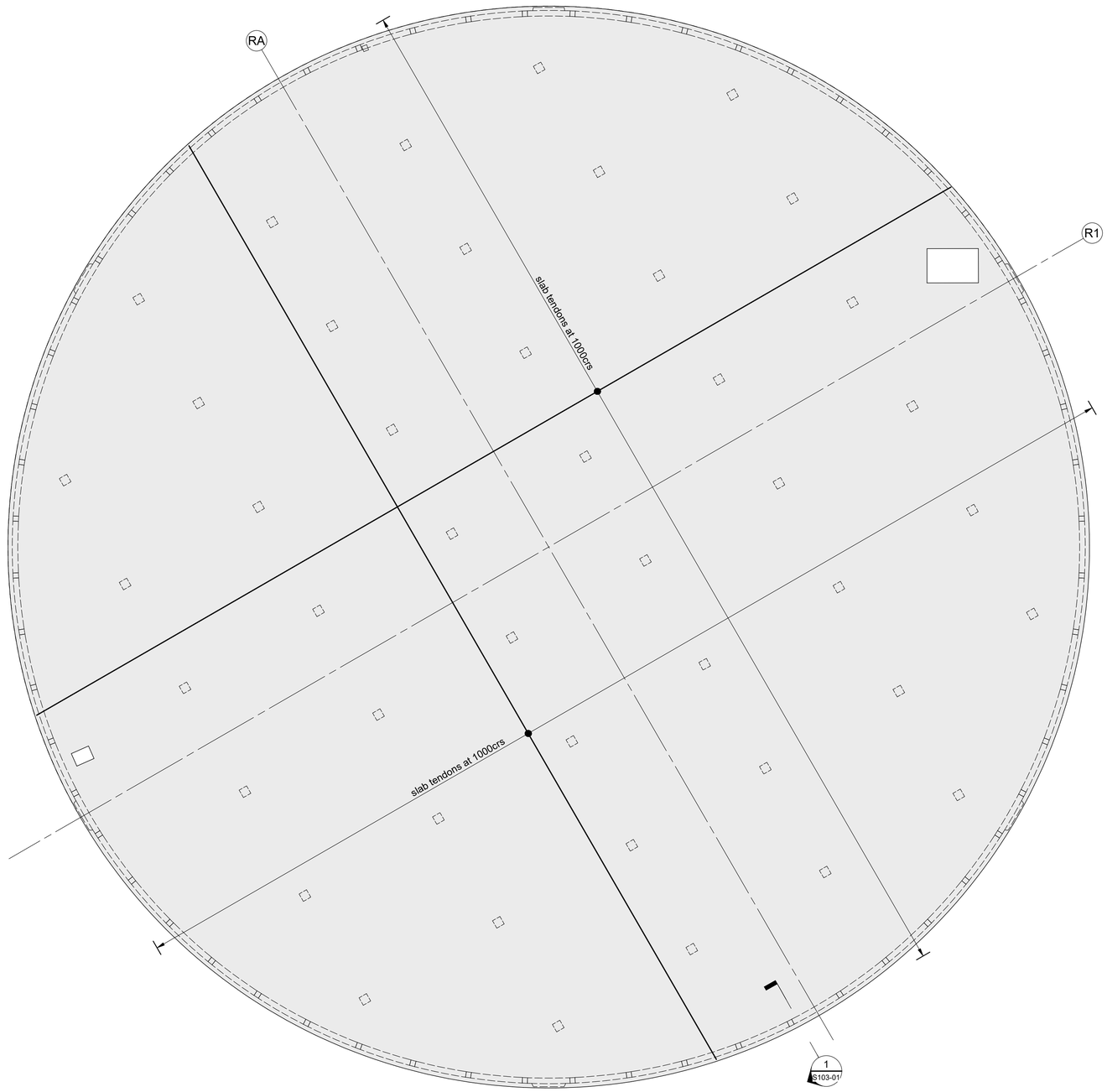
189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Sheet Title
reservoir
floor reinforcing plan

Drawn AJW Scale 1:150
Filename 189378_CB_STR_CB10_Holmes_202
Job Number 148023.33
Sheet Number S101-11

notes:

1. Refer to S000 series for all general notes.



1 / - reservoir roof plan
1 : 150

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189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

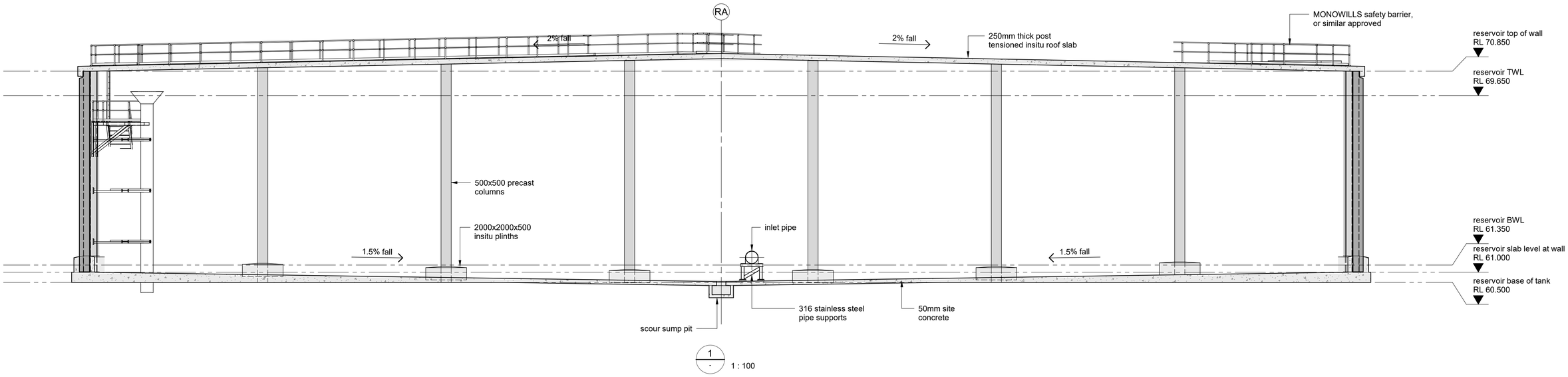
Sheet Title
reservoir
roof reinforcing plan

Drawn AJW Scale 1:150
Filename 189378_CB_STR_CB10_Holmes_202
Job Number 148023.33 Sheet Number S101-12

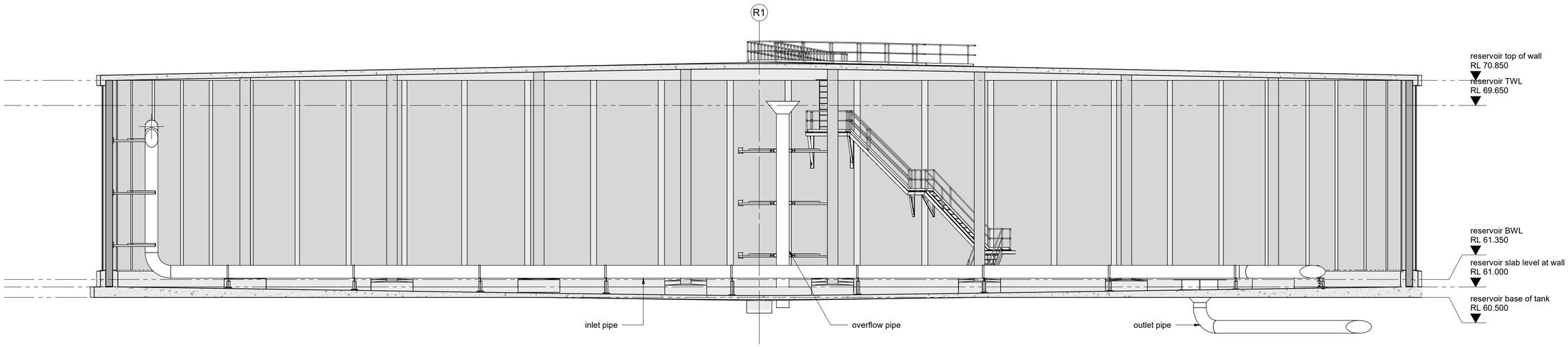
WORK IN PROGRESS 05/03/2025

notes:

1. Refer to S000 series for all general notes.



1 / - 1 : 100



2 / - 1 : 100

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189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Sheet Title: reservoir typical sections

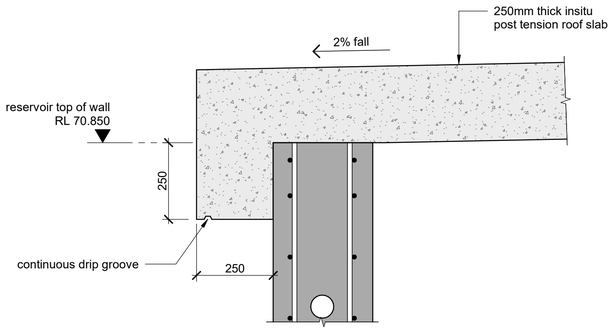
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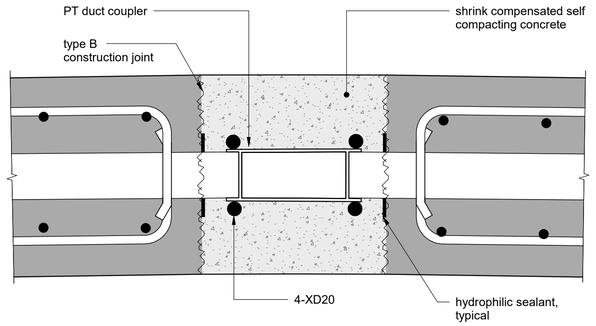
Job Number: 148023.33 Sheet Number: S102-01

notes:

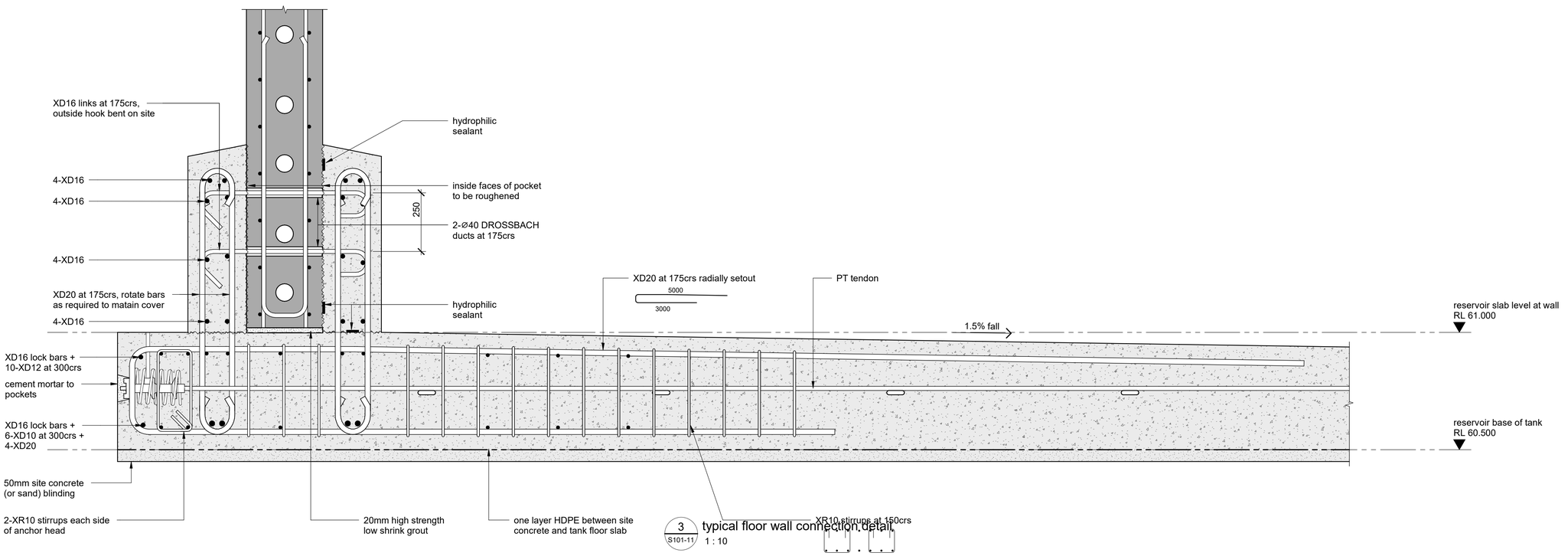
1. Refer to S000 series for all general notes.



1 / S101-12 typical roof wall connection detail
1 : 10



2 typical wall insitu stitch detail
1 : 5



3 / S101-11 typical floor wall connection detail
1 : 10

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-			

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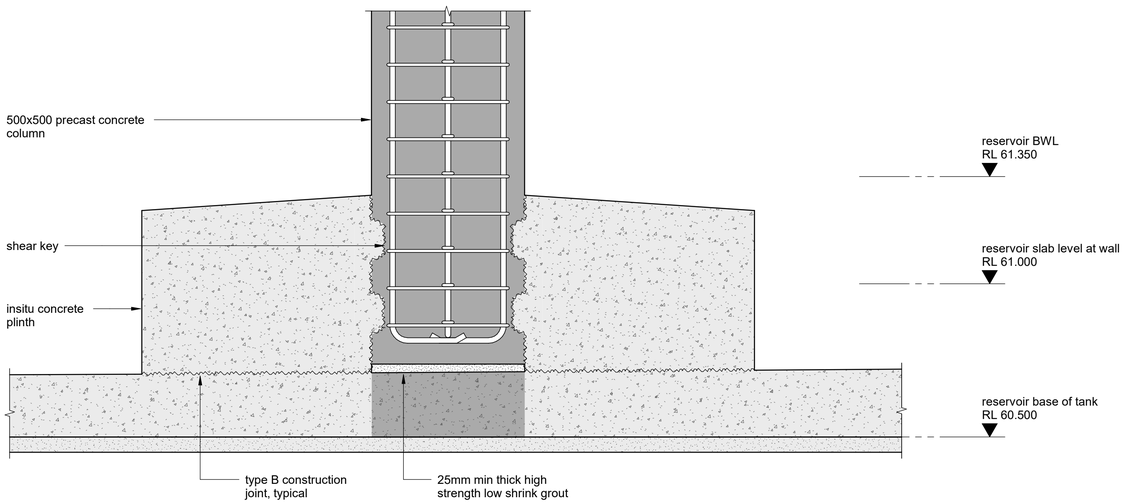
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189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Sheet Title
reservoir
concrete details

Drawn AJW Scale 1:5, 1:10
Filename 189378_CB_STR_CB10_Holmes_202
Job Number 148023.33
Sheet Number S103-01



1 / S101-11 typical column and plinth detail
1 : 10

notes:

1. Refer to S000 series for all general notes.

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189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Sheet Title: reservoir concrete details

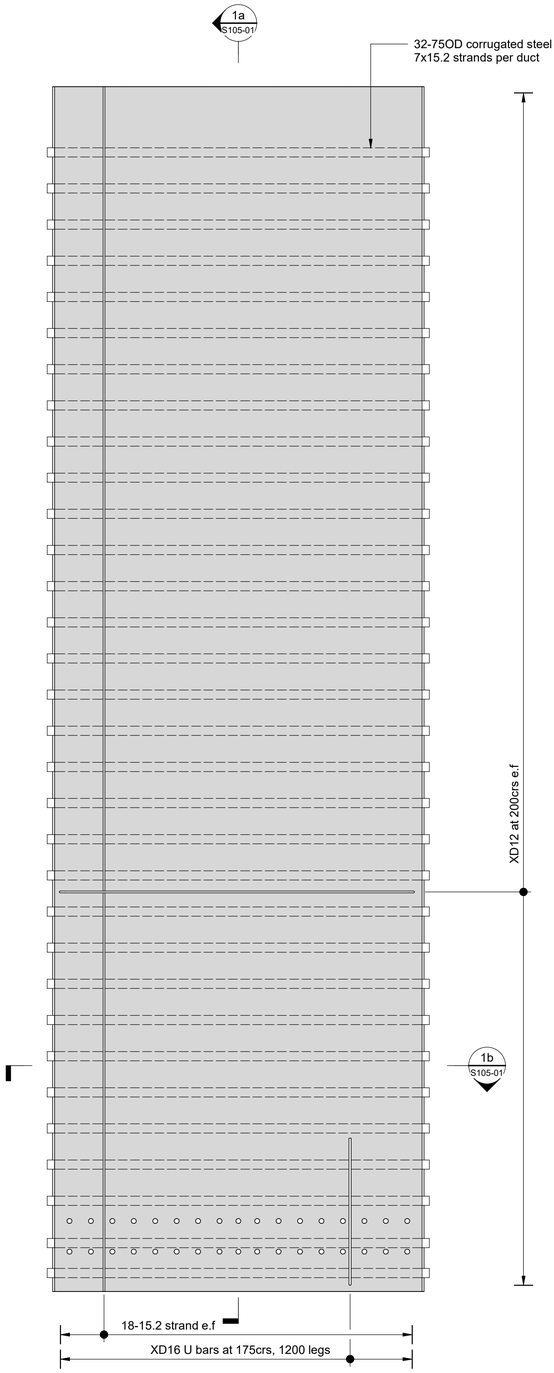
Drawn: AJW Scale: 1:10

Filename: 189378_CB_STR_CB10_Holmes_202

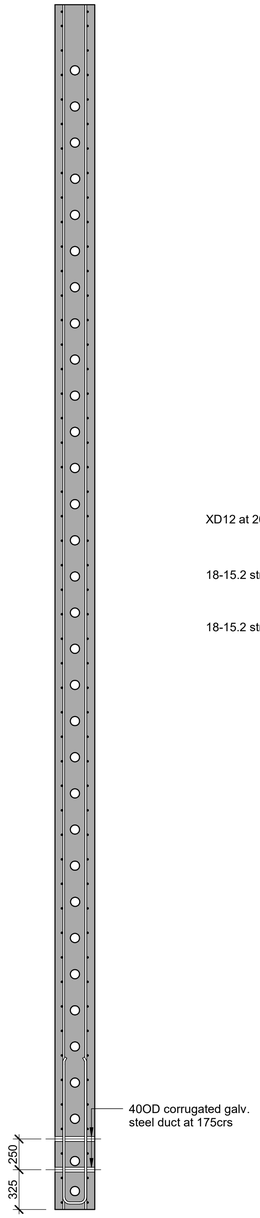
Job Number: 148023.33 Sheet Number: S103-02

notes:

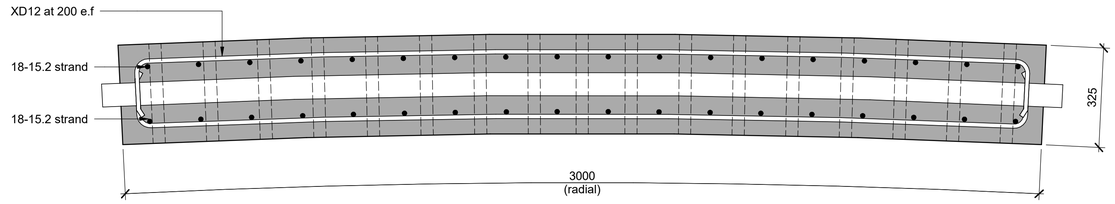
1. Refer to S000 series for all general notes.



1 — typical panel inside elevation (54 of)
1 : 25



1a
1 : 25



1b
1 : 10

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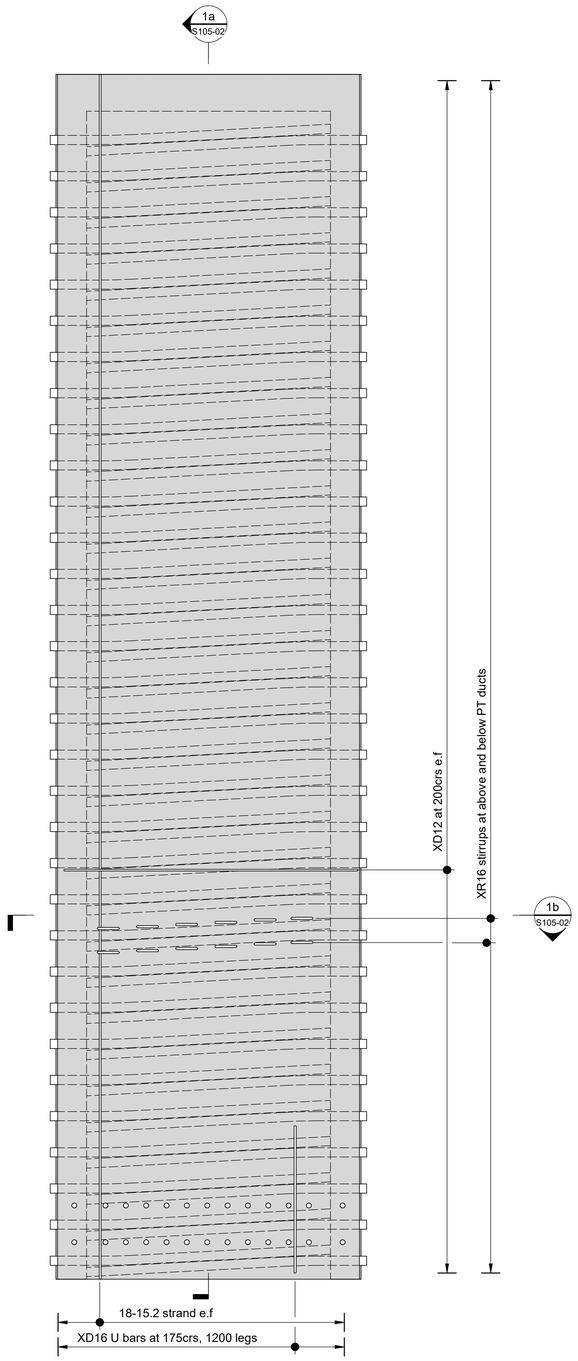
189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Sheet Title: reservoir precast panel details

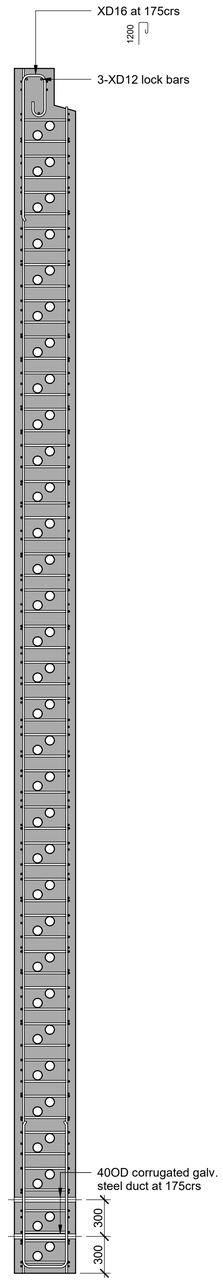
Drawn: AJW
Scale: 1:10, 1:25
Filename: 189378_CB_STR_CB10_Holmes_202
Job Number: 148023.33
Sheet Number: S105-01

notes:

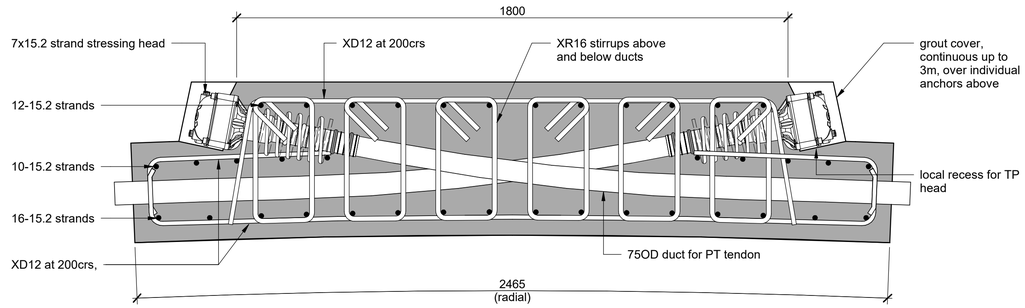
1. Refer to S000 series for all general notes.



1 / - typical pilasiter inside elevation (6 of)
1 : 25



1a / - 1 : 25



1b / - 1 : 10

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-			

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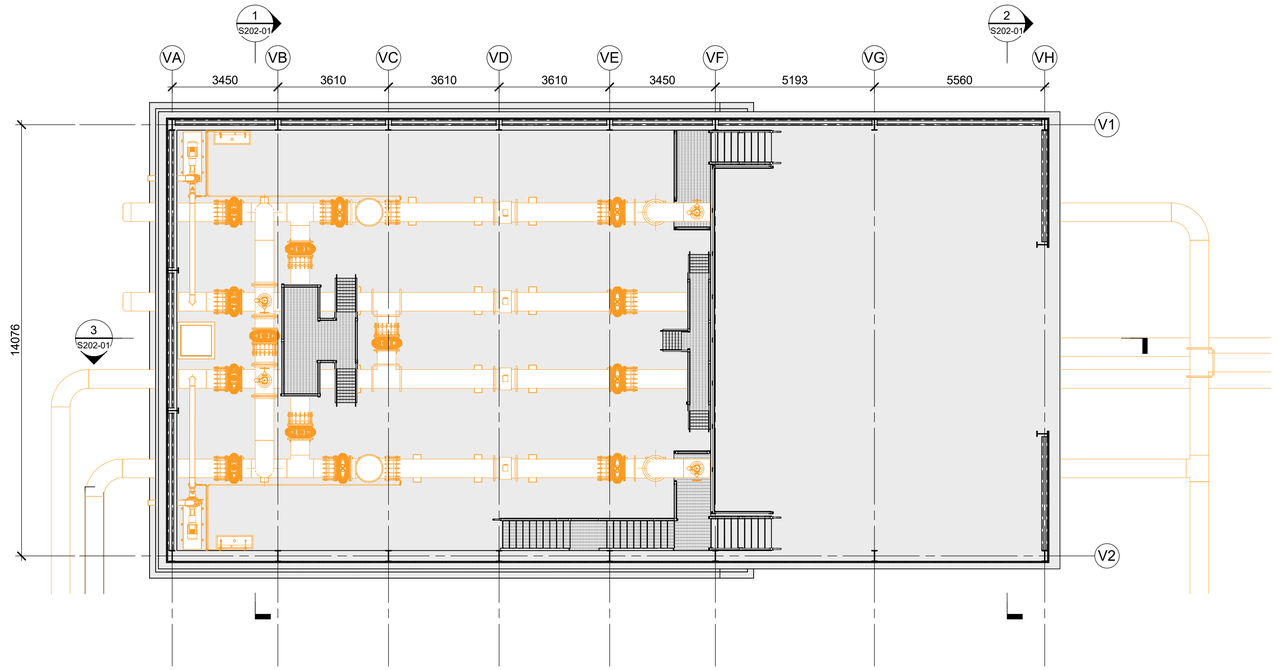
189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Sheet Title: reservoir precast panel details

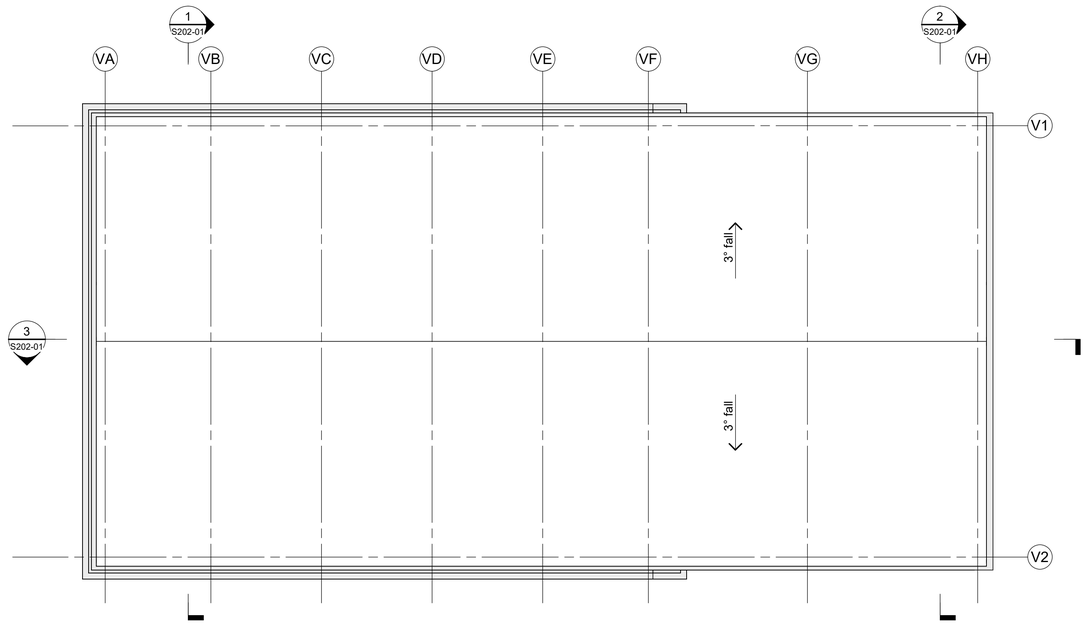
Drawn: AJW
Scale: 1:10, 1:25
Filename: 189378_CB_STR_CB10_Holmes_202
Job Number: 148023.33
Sheet Number: S105-02

notes:

1. Refer to S000 series for all general notes.



1 / - valve chamber floor plan
1 : 100



2 / - valve chamber roof plan
1 : 100

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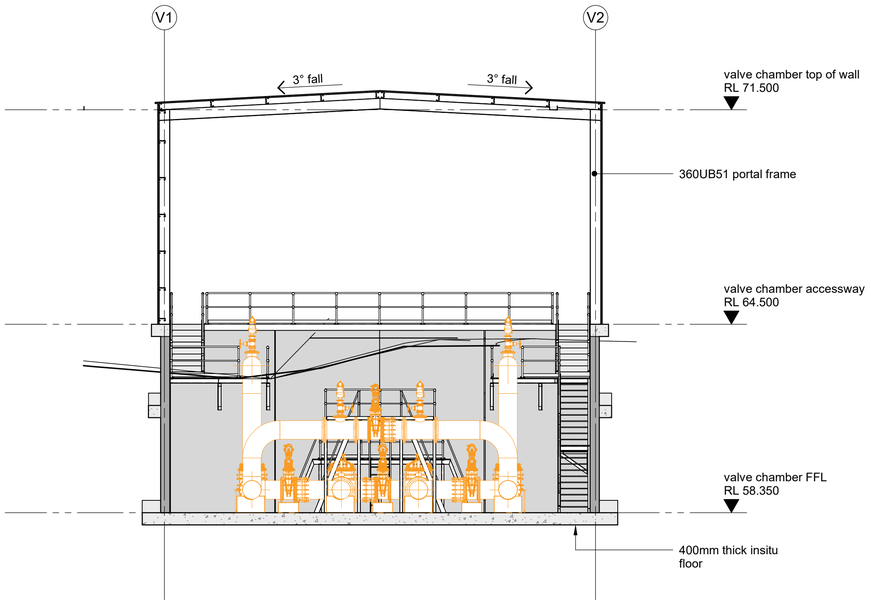
189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Sheet Title
valve chamber
floor and roof plans

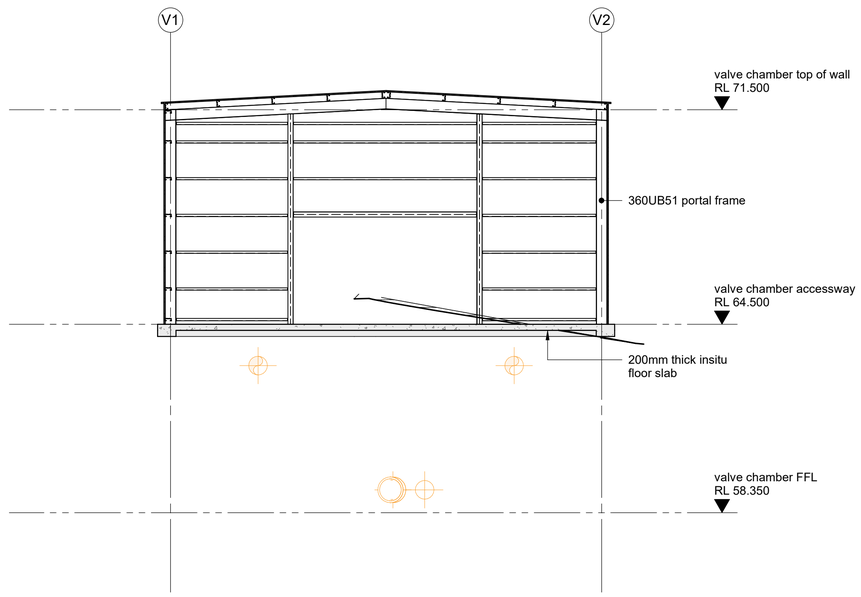
Drawn AJW Scale 1:100
Filename 189378_CB_STR_CB10_Holmes_202
Job Number 148023.33 Sheet Number S201-01

notes:

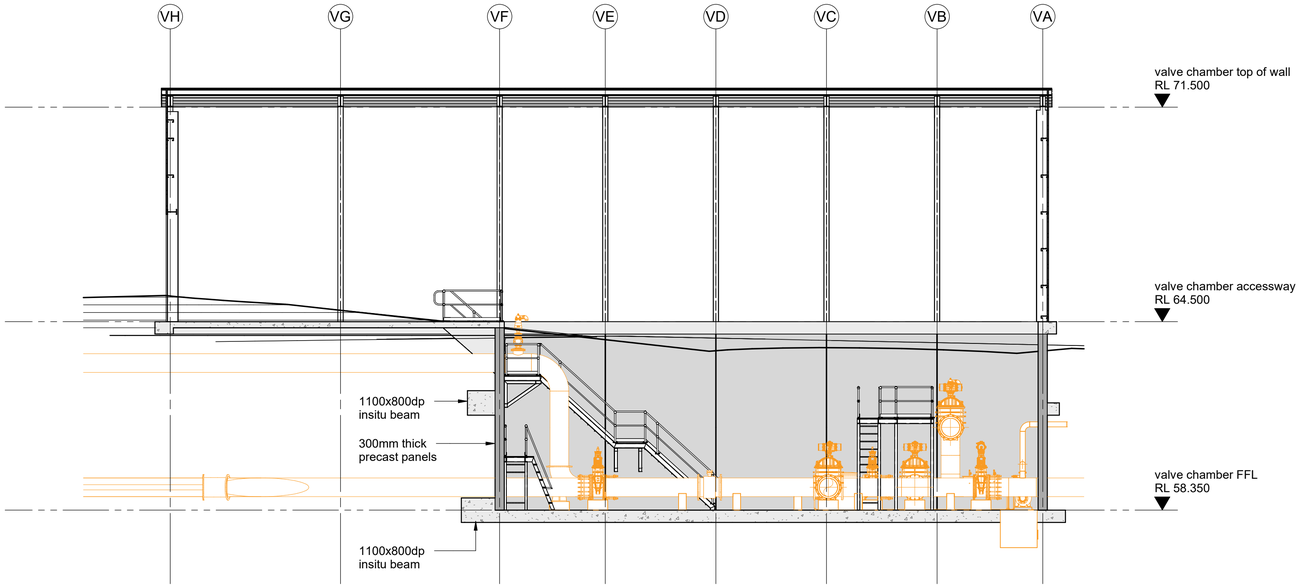
1. Refer to S000 series for all general notes.



1 S201-01 1 : 100



2 S201-01 1 : 100



3 S201-01 1 : 100

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-			

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189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Sheet Title: valve chamber typical sections

Drawn: AJW Scale: 1:100

Filename: 189378_CB_STR_CB10_Holmes_202

Job Number: 148023.33 Sheet Number: S202-01

PROJECT: IAF RESEVOIR - RUAKIWI RESERVOIR

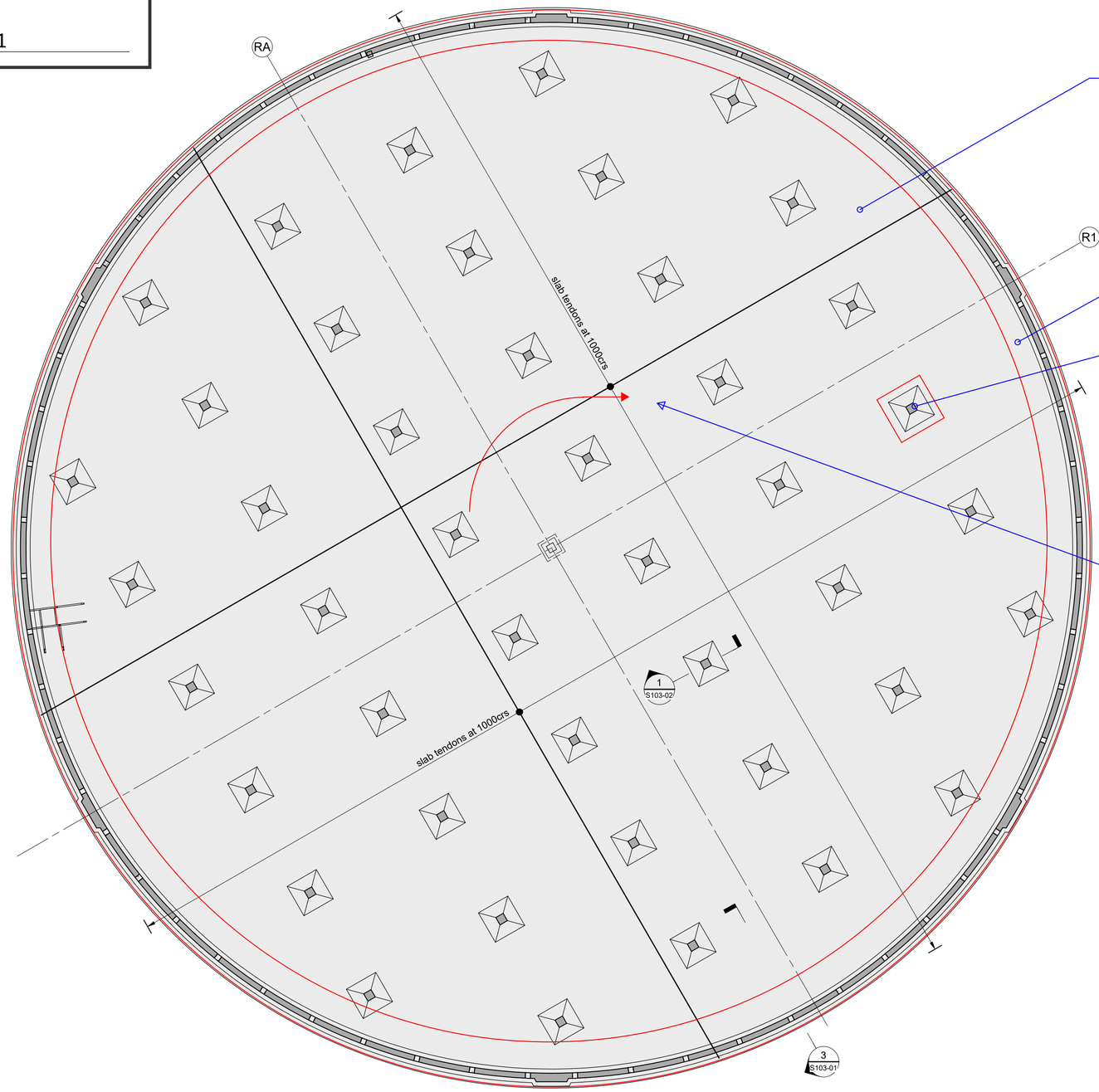
JOB NO: 148023.33 DATE: 11/03/2025

SSK: Prelim Found. Dem. 1 REV: 1

Preliminary design demands on the foundation of the Reservoir. For geotechnical design purposes. Pressures exclude demands due to earth retaining loads - likely small compared to structure seismic loads

notes:

1. Refer to S000 series for all general notes.



100kPa loading (water + permanent structure) (over whole footprint)

1.5m wide strip - addition permanent load of 50kPa

3.0*3.0m column foundations - addition permanent load of 50kPa

ULS seismic overturn moment induces 80kPa pressure to 1.5m wide wall strip (SLS2 case = 50kPa)

Individual cases

CASE	TYP Floor	Column Pad	Wall
PERMANENT (incl water)(Flp + G)	100kPa	150kPa	150kPa
SLS2 seismic	-	-	50kPa
ULS seismic	-	-	80kPa

SLS combinations

CASE	TYP Floor	Column Pad	Wall
1.0 (Flp + G)	100kPa	150kPa	150kPa
Flp + G + SLS2 EQ	100kPa	150kPa	200kPa

ULS combinations

CASE	TYP Floor	Column Pad	Wall
1.2 (Flp + G)	120kPa	180kPa	180kPa
Flp + G + ULS EQ	100kPa	150kPa	230kPa

1 / - reservoir floor plan

1 : 150

WORK IN PROGRESS 05/03/2025

All dimensions to be verified on site before making any shop drawings or commencing any work.

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-			

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189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

Sheet Title: reservoir floor reinforcing plan

Drawn: AJW Scale: 1:150

Filename: 189378_CB_STR_CB10_Holmes_202

Job Number: 148023.33 Sheet Number: S101-11

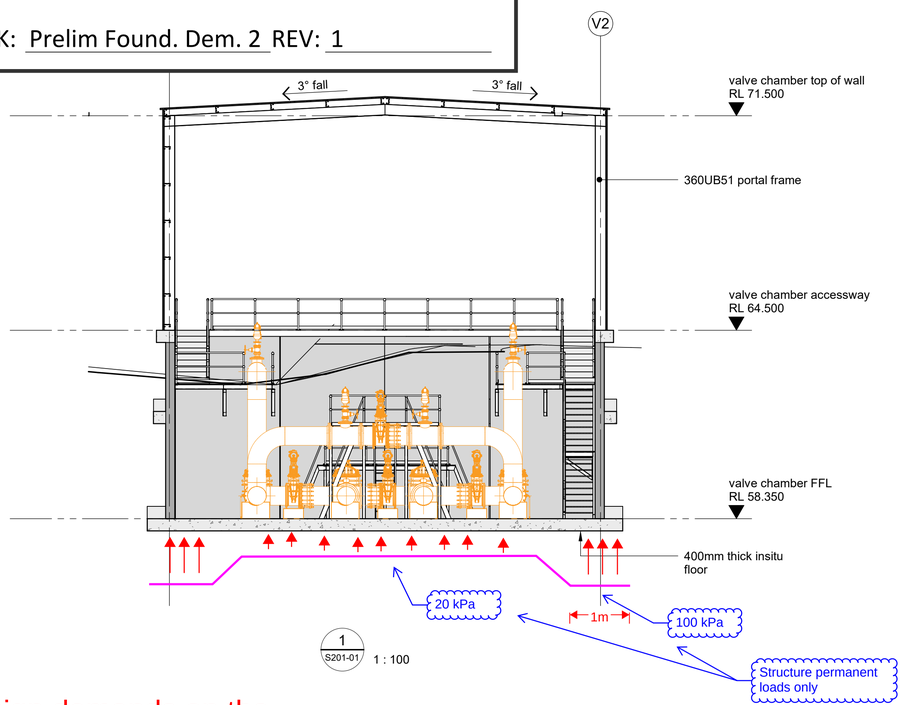
PROJECT: IAF RESEVOIR - RUAKIWI RESERVOIR

JOB NO: 148023.33 DATE: 11/03/2025

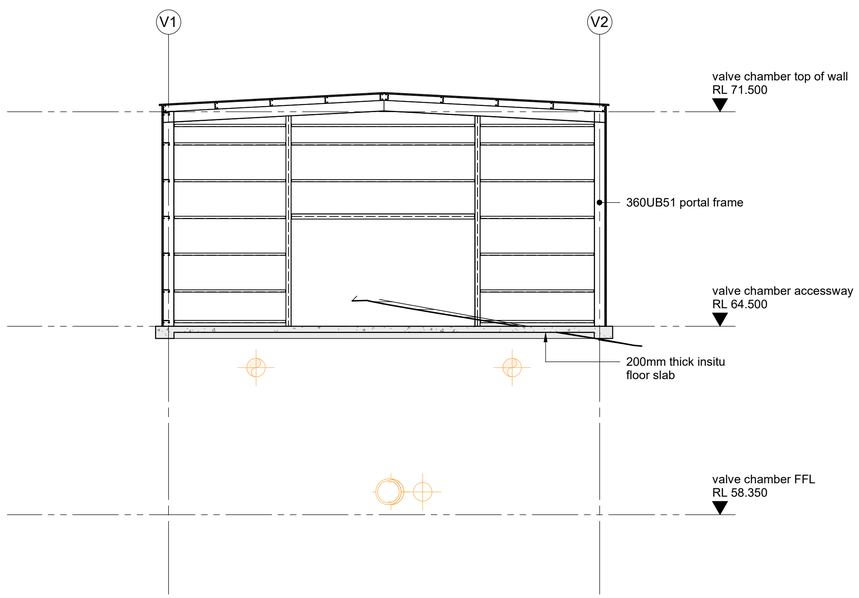
SSK: Prelim Found. Dem. 2 REV: 1

notes:

1. Refer to S000 series for all general notes.



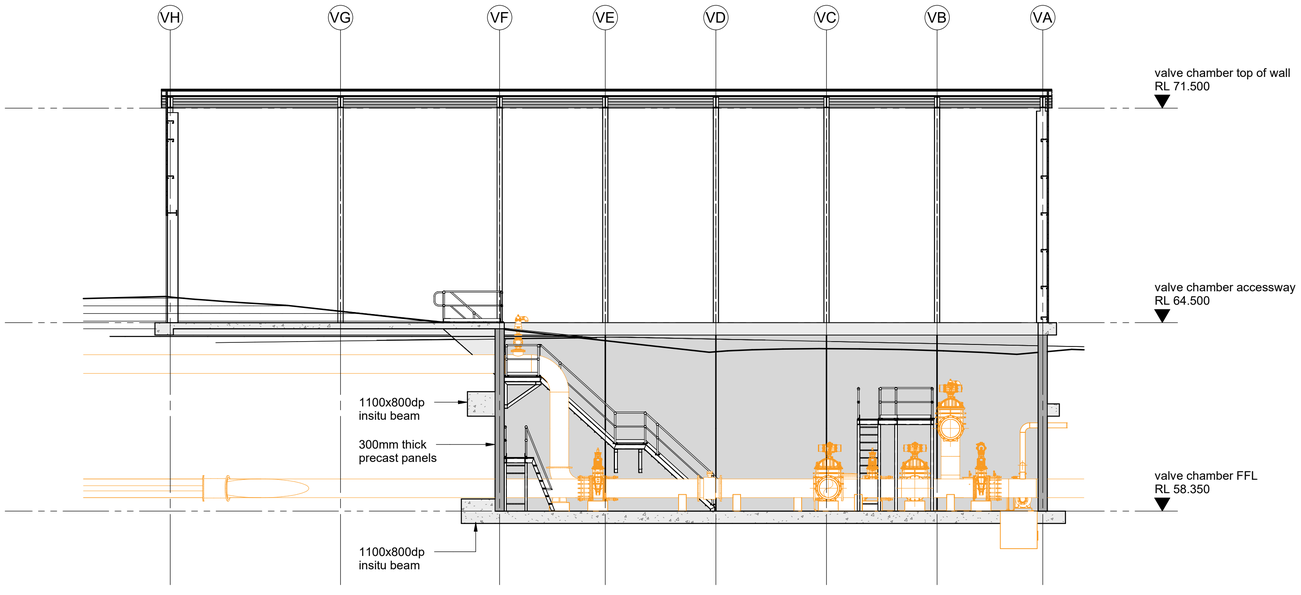
1 S201-01 1 : 100



2 S201-01 1 : 100

Preliminary design demands on the foundation of the Reservoir. For geotechnical design purposes.

Seismic pressures to be confirmed. Heavily dependent on final earth pressures applied to the structure



3 S201-01 1 : 100

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189378 - RUAKIWI INFRASTRUCTURE ACCELERATION FUND RESERVOIR AND PUMP STATION

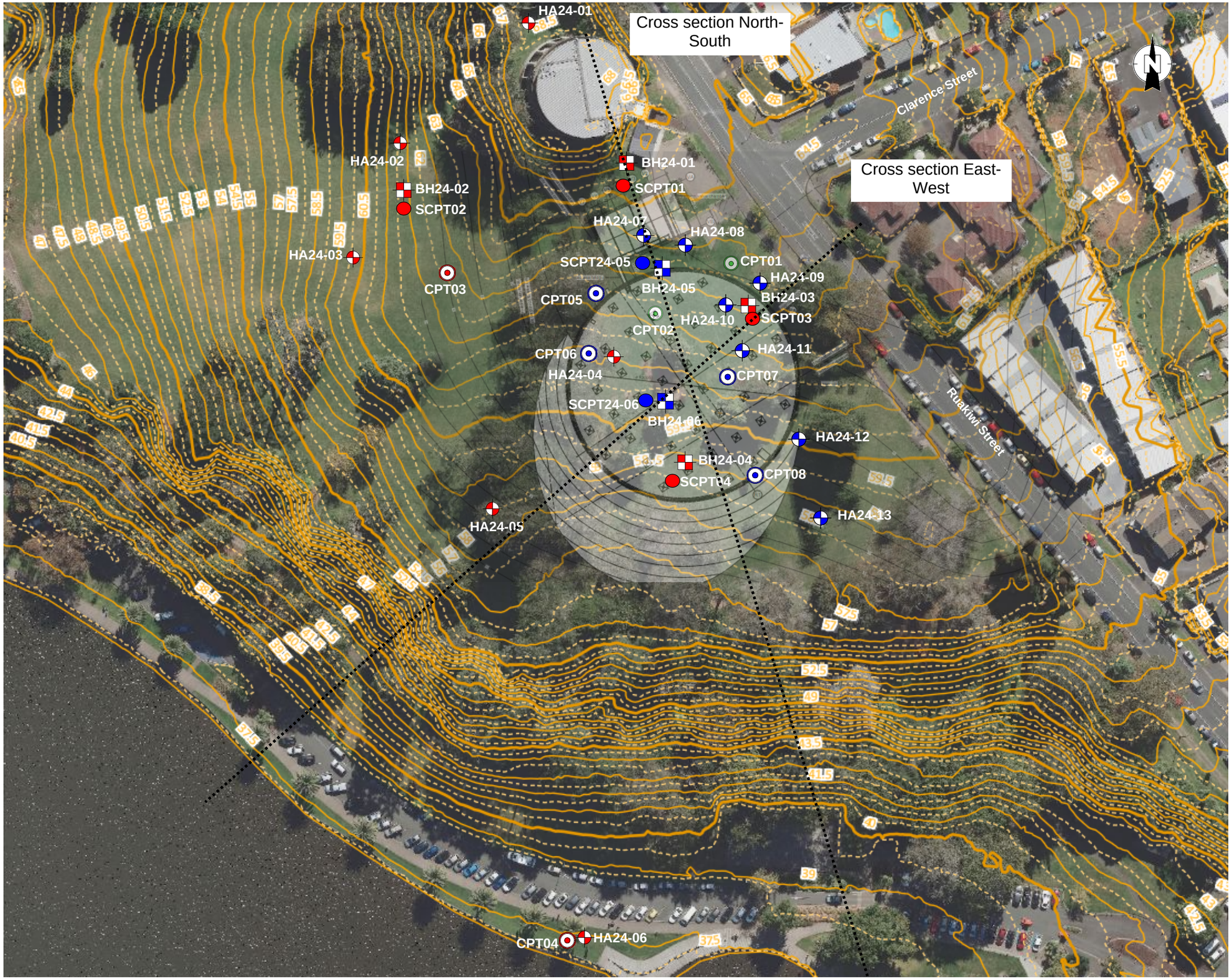
Sheet Title: valve chamber typical sections

Drawn: AJW Scale: 1:100

Filename: 189378_CB_STR_CB10_Holmes_202

Job Number: 148023.33 Sheet Number: S202-01

APPENDIX B
CMW Drawings



Legend

- Cone Penetrometer (CPT) (Phase 1)
- Machine Boreholes (Phase 2)
- Cone Penetrometer (CPT) (Phase 2)
- Seismic CPT (Phase 2)
- Hand Augers (Phase 2)
- Machine Boreholes (Phase 3)
- Cone Penetrometer (CPT) (Phase 3)
- Seismic CPT (Phase 3)
- Hand Augers (Phase 3)

0 — 50m

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CLIENT: HAMILTON CITY COUNCIL		DRAWN: PM	HAM2023-0099
PROJECT: IAF RESERVOIR		CHECKED: HNB	DRAWING: 01
		REVISION: 02	SCALE: NA
TITLE: GEOTECHNICAL SITE PLAN		DATE: 08/04/2025	SHEET: A3 L

APPENDIX C

Machine Borehole, Hand Auger and CPT Logs

BOREHOLE LOG - BH24-01

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 19/03/2024
Borehole Location: Refer to Site Plan
Logged by: PM/ MM
Checked by: MM
Scale: 1:25
Sheet 1 of 6
Position: 445256.5mE; 698193.1mN
Projection: Mt Eden 2000
Elevation: 65.49m
Datum: Moturiki 1953
Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		0.5	Peak = 68kPa Residual = 25kPa	65.5			OL: Organic SILT: dark brown. No plasticity (Topsoil)						
				65.4			SW: Fine to coarse SAND: with trace fine gravel; greyish brown. Well graded. Subangular. (Fill)						
				65.2			CH: Silty CLAY: dark brown mottled brownish orange. High plasticity. (Fill)						
		1.0	Peak = 50kPa Residual = 12kPa		1					100			
		1.5	SPT = (1,2,2) N* = 4										
				63.7			OL: Organic SILT: dark brown. No plasticity (Topsoil)						
		2.0	Peak = 75kPa Residual = 20kPa	63.5	2		CH: CLAY: dark brown. High plasticity. (Hamilton Ash)						
				63.5			CH: CLAY: yellowish brown mottled brown. High plasticity. (Hamilton Ash)						
		2.6	Peak = 60kPa Residual = 12kPa				*... from 2.65m to 3.95m, Becoming light brown*		St to VSt	84			
		3.0	SPT = (2,2,3) N* = 5		3								
					4		*... at 3.95m, Becoming yellowish brown*			77			
		4.5	SPT = (1,3,5) N* = 8										
				60.6			CH: CLAY: with trace silt and fine to coarse sand; brown mottled black. High plasticity. Manganese inclusions (Hamilton Ash)						
					5								

Termination Reason: Target Depth Reached.
Shear Vane No: 3434
DCP No:

Remarks: Groundwater encountered at 17.6m. Nested shallow piezometer installed to 3.5m depth, deep piezometer to 29.6m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-01

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 19/03/2024
Borehole Location: Refer to Site Plan
Logged by: PM/ MM
Checked by: MM
Scale: 1:25
Sheet 2 of 6
Position: 445256.5mE; 698193.1mN
Projection: Mt Eden 2000
Elevation: 65.49m
Datum: Moturiki 1953
Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		6.0	SPT = (0,0,2) N* = 2		6		... at 5.30m, Becoming greyish brown		F to St	78		5 10 15	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
							... at 6.45m, Becoming light greyish brown						
				58.7			... from 6.69m to 8.94m, Becoming dark brown mottled yellowish brown speckled black streaked gray			88			
		7.5	SPT = (1,2,3) N* = 5		7		ML: Clayey SILT: with some fine to coarse sand; yellowish brown mottled grey speckled black. Low plasticity. Manganese inclusions. (Walton Subgroup)	M	St				
					8								
				57.3			ML: Clayey SILT: with minor fine to coarse sand with trace fine pumiceous gravel; reddish brown mottled yellowish brown speckled black streaked grey. Low plasticity. (Walton Subgroup)			81			
		9.0	SPT = (4,4,4) N* = 8		9								
							... at 9.45m, race fine gravel with some fine to coarse sand			77			
					10								

Termination Reason: Target Depth Reached.
Shear Vane No: 3434
DCP No:

Remarks: Groundwater encountered at 17.6m. Nested shallow piezometer installed to 3.5m depth, deep piezometer to 29.6m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-01

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 19/03/2024
Borehole Location: Refer to Site Plan
Logged by: PM/ MM
Checked by: MM
Scale: 1:25

Position: 445256.5mE; 698193.1mN
Projection: Mt Eden 2000
Elevation: 65.49m
Datum: Moturiki 1953
Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		10.5	SPT = (4,4,5) N* = 9		11		... at 11.30m, Becoming yellowish brown speckled white and black mottled brown		VSt to H	79		5 10 15	
		12.0	SPT = (8,9,9) N* = 18	53.0	12		ML: SILT: with minor fine to coarse sand; yellowish brown mottled brown streaked black speckled grey. Low plasticity. (Walton Subgroup)			74	SNC		
		13.5	SPT = (4,3,2) N* = 5	52.1	13		ML: Clayey SILT : with minor fine to coarse sand; light greyish brown mottled brown. Low plasticity. (Walton Subgroup)		St				
		15.0	SPT = (5,4,9) N* = 13	51.5	14		ML: SILT: with trace fine to coarse sand; light grey mottled black streaked yellow. Low plasticity. (Walton Subgroup)			87			
					15								

Termination Reason: Target Depth Reached.
Shear Vane No: 3434
DCP No:

Remarks: Groundwater encountered at 17.6m. Nested shallow piezometer installed to 3.5m depth, deep piezometer to 29.6m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-01

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 19/03/2024
Borehole Location: Refer to Site Plan
Logged by: PM/ MM
Checked by: MM
Scale: 1:25

Position: 445256.5mE; 698193.1mN
Projection: Mt Eden 2000
Elevation: 65.49m
Datum: Moturiki 1953
Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
				50.0			ML: Clayey SILT: with trace fine to coarse sand; light pinkish grey streaked yellowish brown mottled black. Low plasticity. (Walton Subgroup)			93			
				49.5	16		ML: Clayey SILT: with trace fine sand; light greyish brown. Low plasticity. (Walton Subgroup)		H				
		16.5	SPT = (0,6,9) N* = 15										
				48.5	17		SW: Silty fine to coarse SAND: with trace fine pumiceous gravel; light greyish brown. Well graded, sub angular. (Non-welded Ignimbrite)			80			
	19-03-2024												
		18.0	SPT = (15,25,20) N* = 45		18		... from 18.37m to 19.50m, Becoming light brown		VD				
										78			
		19.5	SPT = (16,27,23) N* = 50		19								
							... at 19.90m, Becoming light grey						
					20								

Termination Reason: Target Depth Reached.
Shear Vane No: 3434
DCP No:

Remarks: Groundwater encountered at 17.6m. Nested shallow piezometer installed to 3.5m depth, deep piezometer to 29.6m depth.

BOREHOLE LOG - BH24-01

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 19/03/2024
Borehole Location: Refer to Site Plan
Logged by: PM/ MM
Checked by: MM
Scale: 1:25
Sheet 5 of 6
Position: 445256.5mE; 698193.1mN
Projection: Mt Eden 2000
Elevation: 65.49m
Datum: Moturiki 1953
Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		21.0	SPT = (14,21,29) N* = 50		21			M to W		71		5 10 15	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
		22.5	SPT = (11,15,20) N* = 35		22					69			
		24.0	SPT = (10,15,32) N* = 47		23		... at 22.95m, containing trace fine to medium pumiceous gravel and becoming light brownish grey		D	68			
					24					69			
					25								

Termination Reason: Target Depth Reached.
Shear Vane No: 3434
DCP No:

Remarks: Groundwater encountered at 17.6m. Nested shallow piezometer installed to 3.5m depth, deep piezometer to 29.6m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-01

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 19/03/2024
Borehole Location: Refer to Site Plan

Logged by: PM/MM Checked by: MM Scale: 1:25 Sheet 6 of 6

Position: 445256.5mE; 698193.1mN Projection: Mt Eden 2000
Elevation: 65.49m Datum: Moturiki 1953 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15	Structure & Other Observations
		25.5	SPT = (11,24,26) N* = 50		26					63			
		27.0	SPT = (12,15,35) N* = 50		27			W					
		28.5	SPT = (14,23,27) N* = 50		28				VD	68			
					29			S		69			
		30.0	SPT = (20,32,18/75mm) N* = 50+		30		... at 29.70m, containing some fine to coarse pumiceous gravel Borehole terminated at 30.0 m						

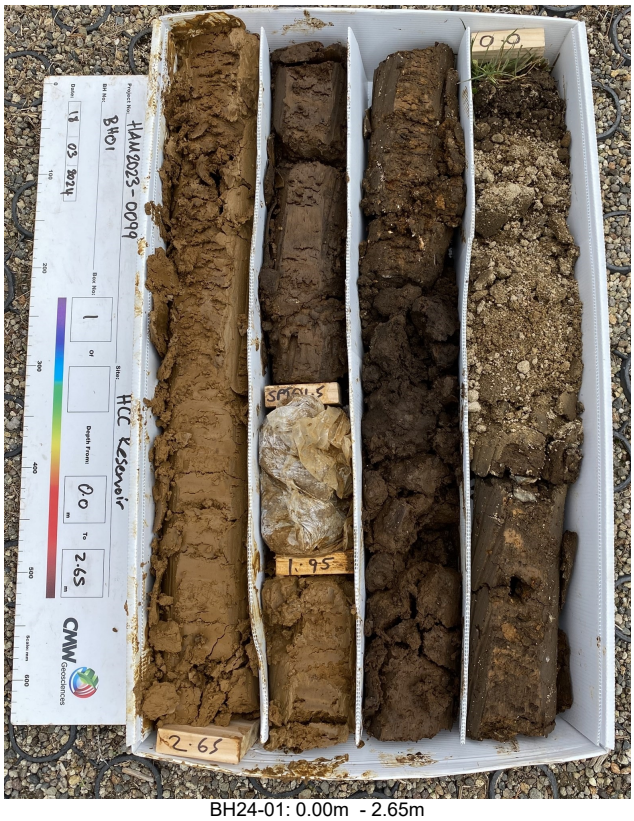
Termination Reason: Target Depth Reached.
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 17.6m. Nested shallow piezometer installed to 3.5m depth, deep piezometer to 29.6m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - BH24-01

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:19/03/2024



BH24-01: 0.00m - 2.65m



BH24-01: 2.65m - 5.40m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

PHOTOGRAPH SHEET - BH24-01

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:19/03/2024



BH24-01: 5.40m - 7.95m



BH24-01: 7.95m - 10.45m

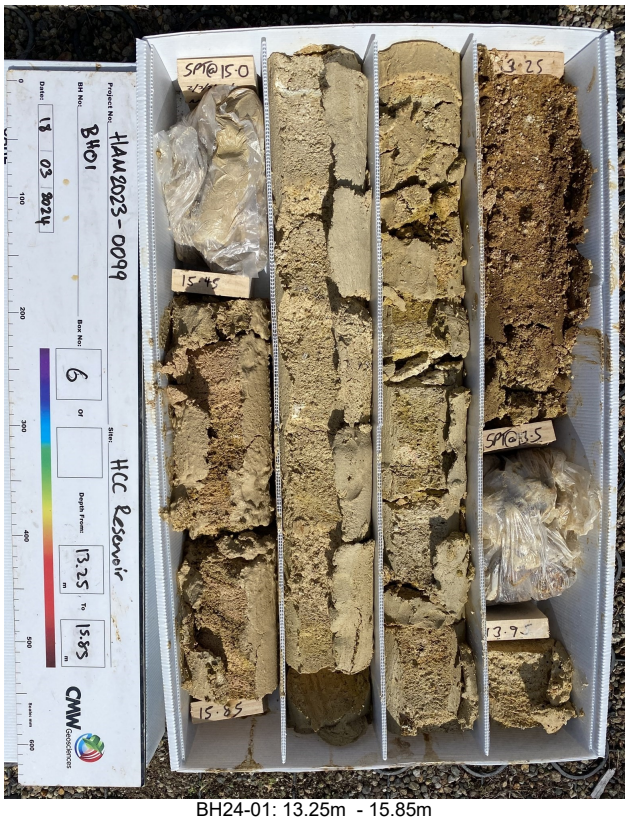
This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

PHOTOGRAPH SHEET - BH24-01

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:19/03/2024



BH24-01: 10.45m - 13.25m



BH24-01: 13.25m - 15.85m

PHOTOGRAPH SHEET - BH24-01

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:19/03/2024



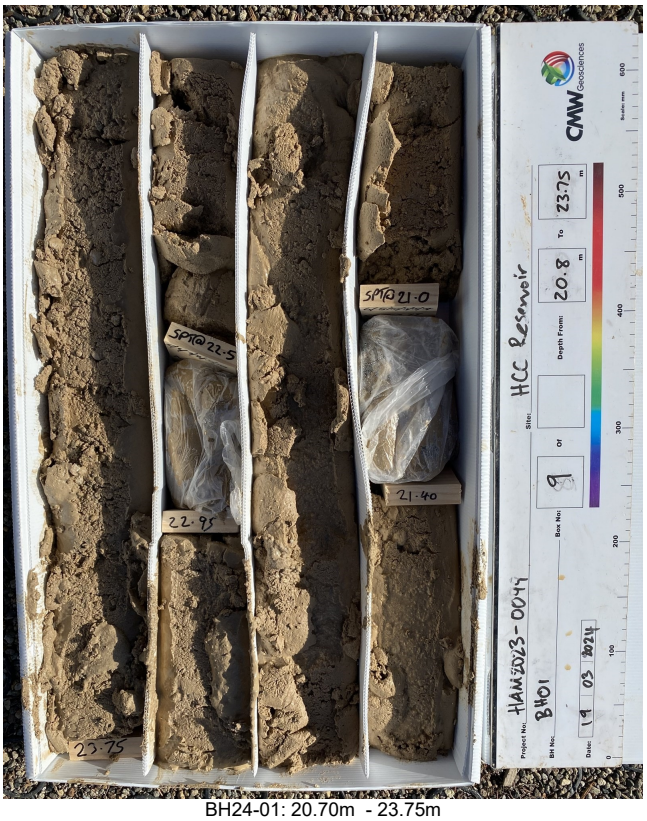
BH24-01: 15.85m - 18.00m



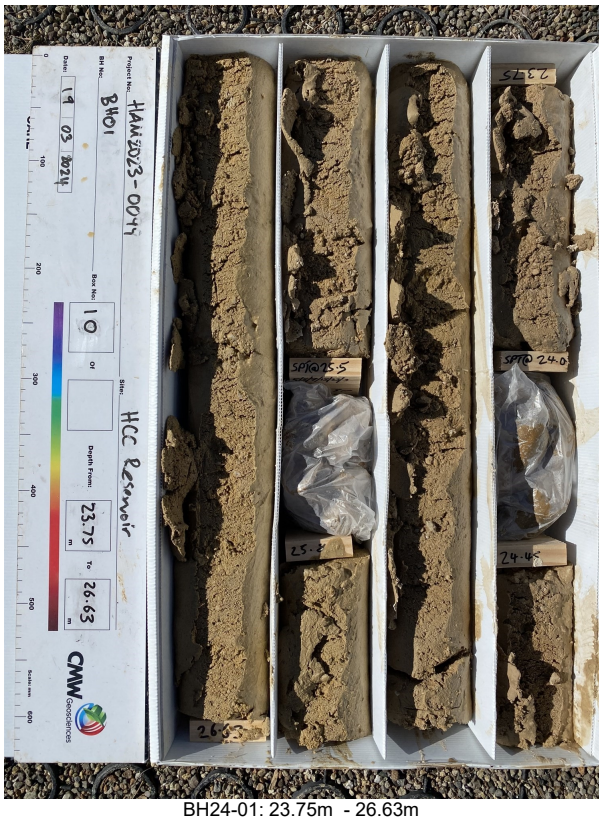
BH24-01: 18.00m - 20.70m

PHOTOGRAPH SHEET - BH24-01

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:19/03/2024



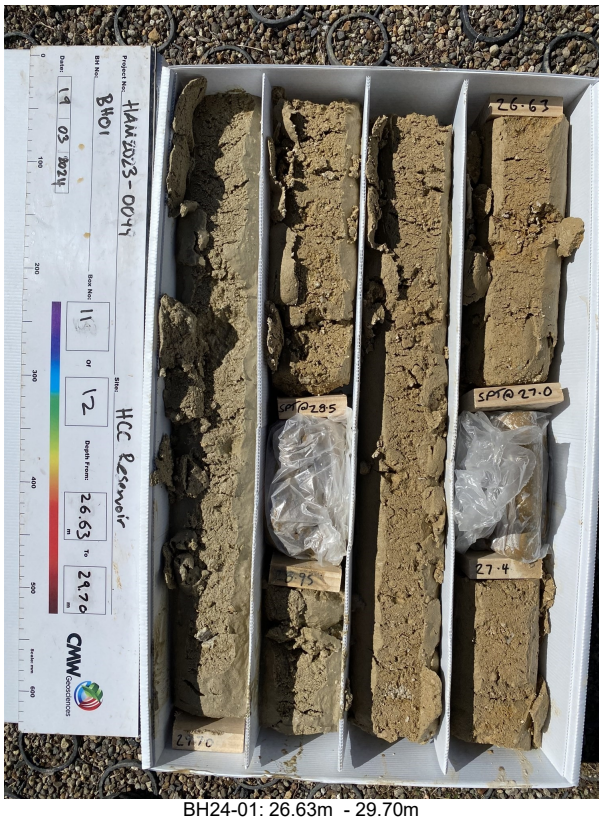
BH24-01: 20.70m - 23.75m



BH24-01: 23.75m - 26.63m

PHOTOGRAPH SHEET - BH24-01

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:19/03/2024



BH24-01: 26.63m - 29.70m



BH24-01: 29.70m - 30.37m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

BOREHOLE LOG - BH24-02

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 19/03/2024 - 20/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 1 of 6

Position: 445187.5mE; 698182.5mN Projection: Mt Eden 2000
Elevation: 59.92m Datum: Moturiki 1953 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		0.6		59.9			OL: Organic SILT: dark brown. No plasticity. (Topsoil)						
		0.7	Peak = 19kPa Residual = 12kPa	59.5			CH: CLAY: dark brown. High plasticity. (Hamilton Ash)						
		1.5	SPT = (2,5,7) N* = 12	59.1	1		CH: CLAY: brown streaked grey. High plasticity. (Hamilton Ash)		H	100			
		2.9	Peak = 50kPa Residual = 6kPa	58.0	2		CH: CLAY: brownish orange mottled black. High plasticity. (Hamilton Ash)		F	71			
		3.0	SPT = (0,0,1) N* = 1		3								
				56.5			CH: CLAY: Light yellowish brown mottled black. High plasticity. Manganese inclusions. (Hamilton Ash)			71			
		4.5	SPT = (3,4,2) N* = 6	56.1	4		CH: CLAY: reddish brown mottled black. High plasticity. Manganese inclusions (Hamilton Ash) *... from 4.00m to 4.05m, with some manganese inclusions. ... at 4.05m, Becoming brownish grey mottled black streaked orange.*						
				55.0	5		CH: CLAY: with minor fine to coarse sand; light yellowish brown. High plasticity. (Hamilton Ash)						
				54.9									

Termination Reason: Target Depth Reached.
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 23.7m. Nested Shallow piezometer installed to 3.0m, deep piezometer to 5.5m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-02

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 19/03/2024 - 20/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 2 of 6

Position: 445187.5mE; 698182.5mN Projection: Mt Eden 2000
Elevation: 59.92m Datum: Moturiki 1953 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
				54.5			ML: Clayey SILT: with minor fine to coarse sand; light brown speckled black. Low plasticity. (Hamilton Ash)						
							CH: CLAY : with trace fine to coarse sand; light brown streaked brown speckled black. High plasticity. (Hamilton Ash)		VSt	73			
							... at 5.87m, Becoming brown.						
		6.0	SPT = (3,3,5) N* = 8		6								
				53.5			ML: SILT: with some fine to coarse sand with minor fine pumiceous gravel; light yellowish brown mottled white streaked pink speckled black. Low plasticity. (Walton Subgroup)						
							... from 6.91m to 7.20m, Becoming brownish orange.			70			
					7								
		7.5	SPT = (4,6,5) N* = 11					M					
					8								
							... at 8.20m, Becoming grey.		MD	67			
		9.0	SPT = (6,5,7) N* = 12		9								
				50.2			ML: Sandy SILT: light brownish grey mottled white streaked brown speckled black. Low plasticity. (Walton Subgroup)			55			
					10								

Termination Reason: Target Depth Reached.
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 23.7m. Nested Shallow piezometer installed to 3.0m, deep piezometer to 5.5m depth.

BOREHOLE LOG - BH24-02

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 19/03/2024 - 20/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 3 of 6

Position: 445187.5mE; 698182.5mN Projection: Mt Eden 2000
Elevation: 59.92m Datum: Moturiki 1953 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		10.5	SPT = (7,7,8) N* = 15		11		... at 11.07m, Becoming yellowish brown.		H	75		5 10 15	
				48.6			ML: SILT: with minor fine to coarse sand; light grey mottled black streaked orange. Low plasticity. Dilatant. (Walton Subgroup)						
		12.0	SPT = (1,0,0) N* = 0		12					70	SNC		
		13.5	SPT = (1,0,0) N* = 0		13		... at 13.50m, Becoming light brown.		S				
					14		... at 13.95m, Becoming speckled white.			73			
		15.0	SPT = (1,8,18) N* = 26		15								

Termination Reason: Target Depth Reached.
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 23.7m. Nested Shallow piezometer installed to 3.0m, deep piezometer to 5.5m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-02

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 19/03/2024 - 20/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 4 of 6
Position: 445187.5mE; 698182.5mN Projection: Mt Eden 2000
Elevation: 59.92m Datum: Moturiki 1953 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
				44.5			SW: Fine to medium SAND: with some silt; light reddish brown streaked brownish orange speckled black. Well graded. Subangular gravel. (Non-welded Ignimbrite)		H	73			
		16.5	SPT = (18,25,25) N* = 50	43.4	16		SW: Silty fine to coarse SAND: with trace fine pumiceous gravel; light yellowish brown. Well graded. Angular gravel. (Non-welded Ignimbrite)			70			
					17		*... at 17.80m, containing minor pumiceous gravel.*						
		18.0	SPT = (13,15,15) N* = 30		18								
				41.5			SW: Fine to coarse SAND: with some silt and with minor fine gravel; light yellowish brown speckled grey. Well graded. Angular gravel. (Non-welded Ignimbrite)			70			
		19.5	SPT = (15,14,18) N* = 32		19								
					20								

Dynamic Cone Penetrometer (Blows/100mm): 5 10 15

Structure & Other Observations: Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks

Termination Reason: Target Depth Reached.
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 23.7m. Nested Shallow piezometer installed to 3.0m, deep piezometer to 5.5m depth.

BOREHOLE LOG - BH24-02

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 19/03/2024 - 20/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 5 of 6

Position: 445187.5mE; 698182.5mN Projection: Mt Eden 2000
Elevation: 59.92m Datum: Moturiki 1953 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
	20-03-2024	21.0	SPT = (12,19,29) N* = 48		21			M to W	D to VD	73		5 10 15	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
		22.5	SPT = (14,20,28) N* = 48		22					70			
					23		... at 22.95m, Containing trace fine pumice gravel and streaked brownish orange.			70			
		24.0	SPT = (19,30,20) N* = 50		24					70			
					25								

Termination Reason: Target Depth Reached.
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 23.7m. Nested Shallow piezometer installed to 3.0m, deep piezometer to 5.5m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-02

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 19/03/2024 - 20/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 6 of 6

Position: 445187.5mE; 698182.5mN Projection: Mt Eden 2000
Elevation: 59.92m Datum: Moturiki 1953 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		25.5	SPT = (12,24,) N* = 50+										
					26		... at 25.90m, Containing minor fine to medium gravel.			72			
		27.0	SPT = (16,35,15/75mm) N* = 50+		27			W					
					28					80			
		28.5	SPT = (15,19,21) N* = 40										
				31.0	29		SP: Fine SAND: with some silt Light yellowish grey Poorly graded. Subangular.to Subrounded. (Non-welded Ignimbrite)			74			
							... at 29.10m, Becoming grey.						
							... at 29.48m, Becoming streaked light yellow.	W to S					
							... at 29.85m, Becoming grey mottled black and streaked orange.						
		30.0	SPT = (24,20,29) N* = 49		30		... at 29.90m, brownish orange mottled black and streaked dark brown.						
							Borehole terminated at 30.0 m						

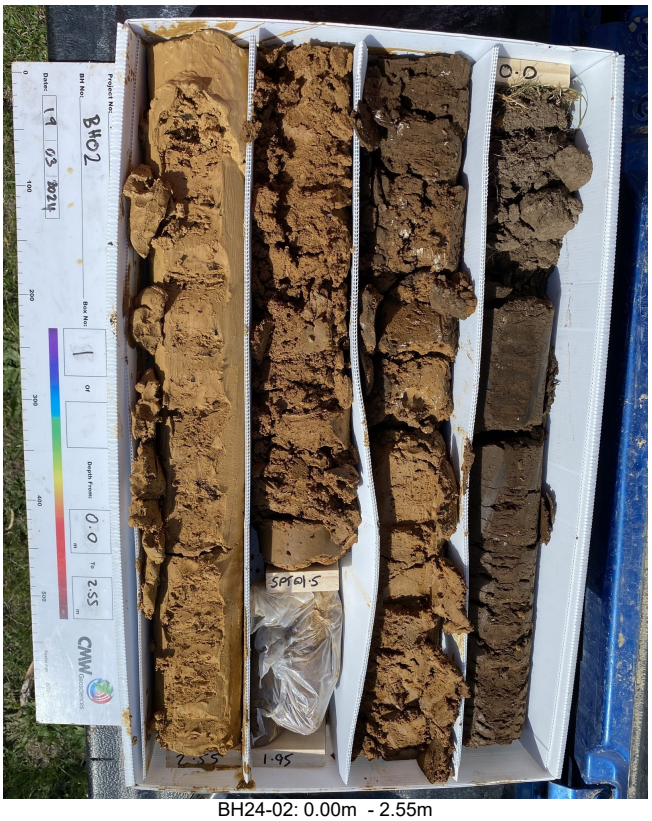
Termination Reason: Target Depth Reached.
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 23.7m. Nested Shallow piezometer installed to 3.0m, deep piezometer to 5.5m depth.

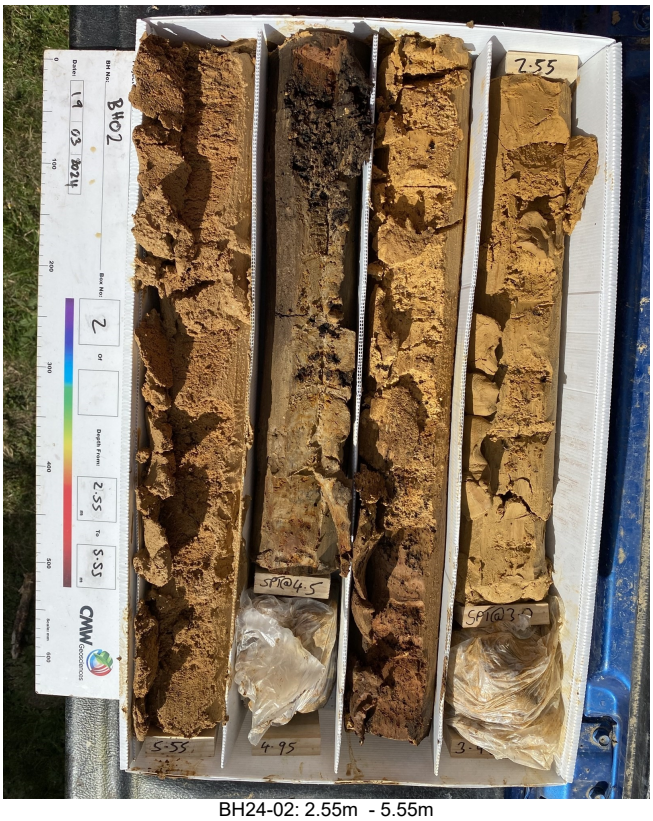
This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - BH24-02

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:19/03/2024 - 20/03/2024



BH24-02: 0.00m - 2.55m



BH24-02: 2.55m - 5.55m

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PHOTOGRAPH SHEET - BH24-02

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:19/03/2024 - 20/03/2024



BH24-02: 5.55m - 8.55m



BH24-02: 8.55m - 11.75m

PHOTOGRAPH SHEET - BH24-02

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:19/03/2024 - 20/03/2024



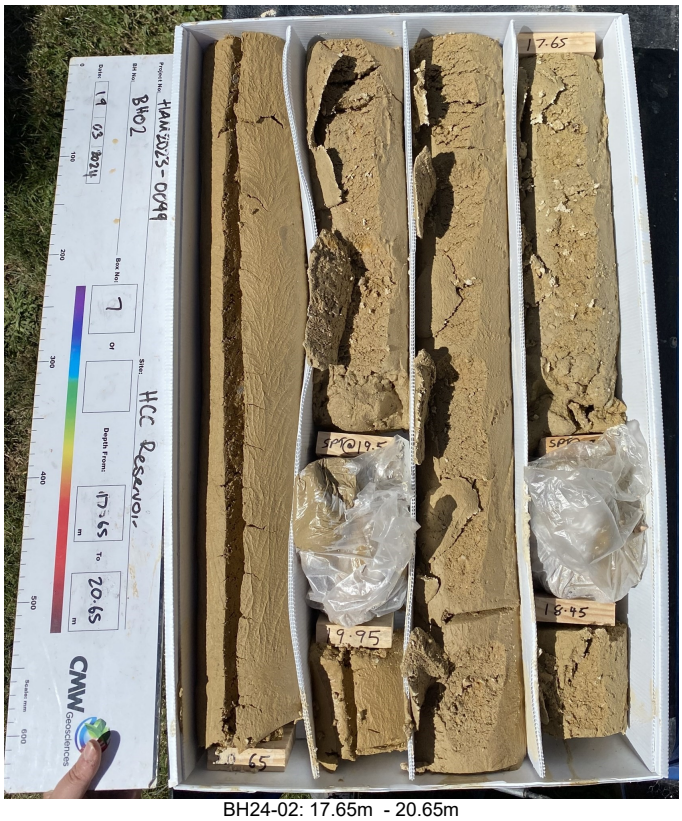
BH24-02: 11.75m - 14.70m



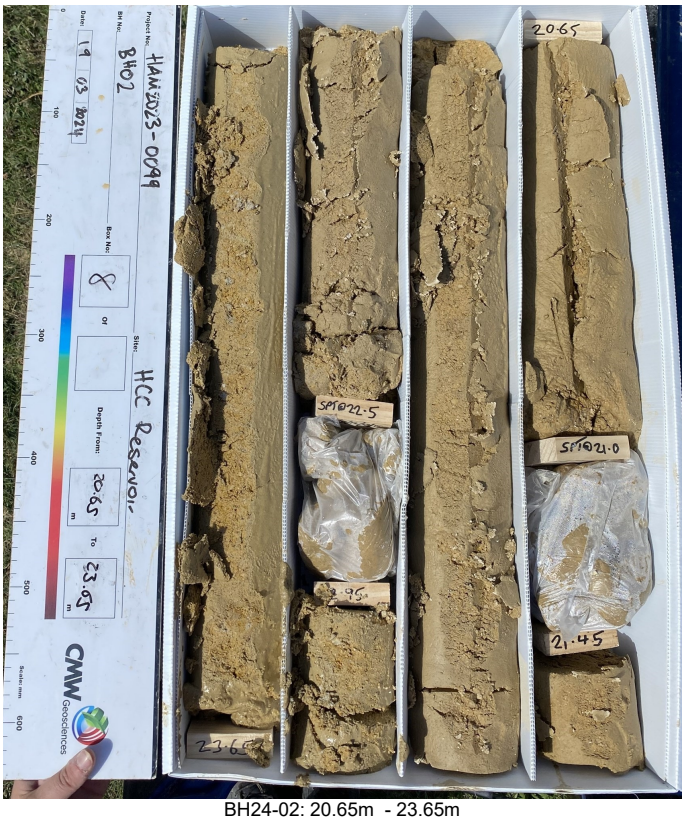
BH24-02: 14.70m - 17.65m

PHOTOGRAPH SHEET - BH24-02

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:19/03/2024 - 20/03/2024



BH24-02: 17.65m - 20.65m



BH24-02: 20.65m - 23.65m

PHOTOGRAPH SHEET - BH24-02

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:19/03/2024 - 20/03/2024



BH24-02: 23.65m - 26.50m



BH24-02: 26.50m - 29.35m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

PHOTOGRAPH SHEET - BH24-02

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:19/03/2024 - 20/03/2024



BH24-02: 29.35m - 30.45m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

BOREHOLE LOG - BH24-03

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 21/03/2024 - 22/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 1 of 6

Position: 445282.5mE; 698145.3mN Projection: Mt Eden 2000
Elevation: 61.69m Datum: Moturiki 1953 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
				61.7			OL: Organic SILT: dark brown. No plasticity (Topsoil)						
				61.3			CH: CLAY: dark brown. High plasticity. (Hamilton Ash)						
		0.6	Peak = 48kPa Residual = 12kPa										
							... at 0.70m, Becoming brown			117			
		1.0	Peak = 25kPa Residual = 22kPa		1								
		1.3					... from 1.20m to 1.40m, Becoming light yellowish brown						
		1.4											
		1.5	SPT = (2,3,3) N* = 6										
					2		... at 1.95m, Becoming light yellowish brown			87			
		2.8	Peak = 50kPa Residual = 12kPa						St to VSt				
		3.0	SPT = (2,3,2) N* = 5		3								
		3.4	Peak = 38kPa Residual = 12kPa	58.2			CH: CLAY: light brown mottled black. High plasticity. (Hamilton Ash)			71			
					4		... at 4.10m, Becoming light brown						
		4.5	SPT = (1,2,1) N* = 3										
				56.7	5		CH: Silty CLAY: light brown speckled black. High plasticity. (Hamilton Ash)						

Termination Reason: Target Depth Reached.
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 19.4m. Nested shallow piezometer installed to 6.0m depth, deep piezometer to 28.0m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-03

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 21/03/2024 - 22/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 2 of 6

Position: 445282.5mE; 698145.3mN Projection: Mt Eden 2000
Elevation: 61.69m Datum: Moturiki 1953 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		5.9	Peak = 25kPa Residual = 12kPa										
		6.0	SPT = (0,0,0) N* = 0		6								
				55.2			ML: Clayey SILT: light yellowish brown mottled black. Low plasticity. (Walton Subgroup)		S	71			
					7					73			
		7.4	Peak = 15kPa Residual = 10kPa					M					
		7.5	SPT = (0,0,1) N* = 1										
				53.6	8		ML: Sandy SILT: with minor fine gravel; reddish brown mottled grey speckled black. Low plasticity. (Walton Subgroup)			78			
		9.0	SPT = (2,1,3) N* = 4		9				St to VSt	69			
					10								

Termination Reason: Target Depth Reached.
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 19.4m. Nested shallow piezometer installed to 6.0m depth, deep piezometer to 28.0m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-03

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 21/03/2024 - 22/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 3 of 6

Position: 445282.5mE; 698145.3mN Projection: Mt Eden 2000
Elevation: 61.69m Datum: Moturiki 1953 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		10.5	SPT = (2,2,4) N* = 6	50.3	11		Soil: soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)			76		5 10 15	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
		12.0	SPT = (6,6,8) N* = 14		12		SW: fine to coarse SAND: with some silt and with trace fine pumiceous gravel; brown streaked brownish orange mottled white bands of dark brown. Well graded. Angular. (Walton Subgroup)		MD	69	SNC		
		13.5	SPT = (7,8,10) N* = 18		13		*... from 11.95m to 12.88m, Becoming light brown*						
		15.0	SPT = (8,7,9) N* = 16	46.9	14		SW: Fine to Coarse SAND: with minor silt with trace fine gravel; light yellowish brown speckled black. Well graded. Angular. (Walton Subgroup)			71			
					15								

Termination Reason: Target Depth Reached.
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 19.4m. Nested shallow piezometer installed to 6.0m depth, deep piezometer to 28.0m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-03

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 21/03/2024 - 22/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 4 of 6

Position: 445282.5mE; 698145.3mN Projection: Mt Eden 2000
Elevation: 61.69m Datum: Moturiki 1953 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
				46.3			ML: SILT: with some fine to coarse sand; light brownish grey mottled white speckled black. Low plasticity. (Walton Subgroup)						
							... at 15.55m, Becoming brown						
				45.8	16		ML: SILT: with minor fine to medium sand; light yellowish brown mottled white streaked light brown speckled black. Low plasticity. (Walton Subgroup)		H	71			
		16.5	SPT = (5,6,4) N* = 10										
				44.7	17		ML: SILT: with trace medium sand; light greyish pink streaked orange speckled black. Low plasticity. (Walton Subgroup)		VSt	72			
							... at 17.32m, Becoming light grey						
		18.0	SPT = (1,3,5) N* = 8		18								
				43.2			SW: Fine to Coarse SAND: with some silt and with trace fine to medium gravel; grey mottled white. Well graded. Angular. (Non-welded Ignimbrite)			73			
	22-03-2024				19								
		19.5	SPT = (12,13,19) N* = 32										
							... at 19.95m, with minor fine to medium gravel						
					20								

Termination Reason: Target Depth Reached.
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 19.4m. Nested shallow piezometer installed to 6.0m depth, deep piezometer to 28.0m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-03

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 21/03/2024 - 22/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 5 of 6

Position: 445282.5mE; 698145.3mN Projection: Mt Eden 2000
Elevation: 61.69m Datum: Moturiki 1953 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		21.0	SPT = (14,24,26) N* = 50		21					60		5 10 15	
		22.5	SPT = (8,15,22) N* = 37		22			M to W	D to VD	60			
		24.0	SPT = (10,14,28) N* = 42		23		*... from 23.05m to 24.00m, Becoming light brownish grey*			69			
					24					69			
					25								

Termination Reason: Target Depth Reached.
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 19.4m. Nested shallow piezometer installed to 6.0m depth, deep piezometer to 28.0m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-03

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 21/03/2024 - 22/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 6 of 6
Position: 445282.5mE; 698145.3mN Projection: Mt Eden 2000
Elevation: 61.69m Datum: Moturiki 1953 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		25.5	SPT = (14,15,18) N* = 33		26					60		5 10 15	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
		27.0	SPT = (19,23,27) N* = 50		27					65			
		28.5	SPT = (25,50,) N* = 50+		28		... at 28.80m, Becoming light brown			73			
				31.9	29		SP: Fine to medium SAND : with minor silt; grey streaked greyish brown. Poorly graded. Subangular to subrounded. (Non-welded Ignimbrite)	W					
		30.0	SPT = (31,50,) N* = 50+		30		Borehole terminated at 30.0 m						

Termination Reason: Target Depth Reached.
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 19.4m. Nested shallow piezometer installed to 6.0m depth, deep piezometer to 28.0m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - BH24-03

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:21/03/2024 - 22/03/2024



BH24-03: 0.00m - 2.25m



BH24-03: 2.25m - 4.95m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

PHOTOGRAPH SHEET - BH24-03

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:21/03/2024 - 22/03/2024



BH24-03: 4.95m - 7.95m



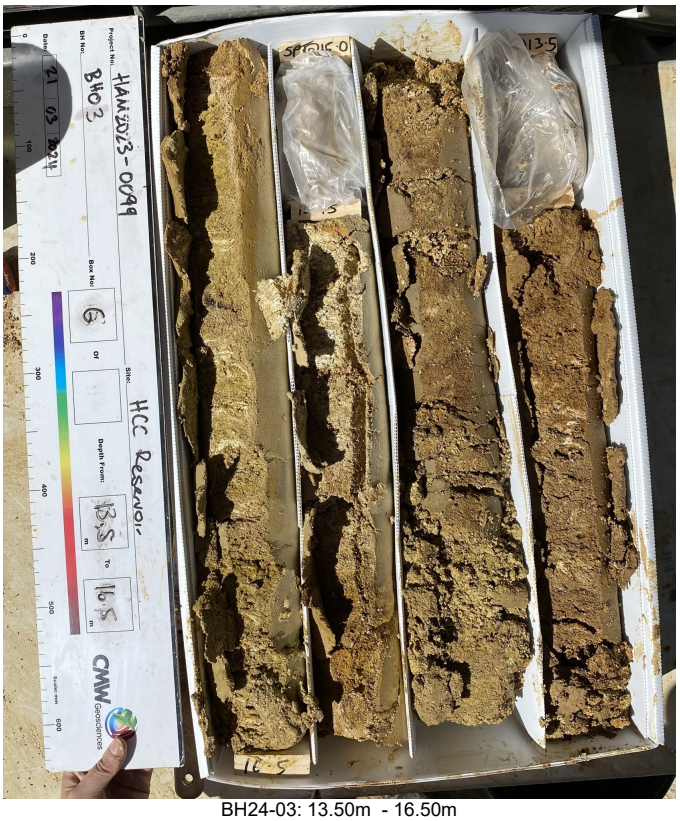
BH24-03: 7.95m - 10.50m

PHOTOGRAPH SHEET - BH24-03

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:21/03/2024 - 22/03/2024



BH24-03: 10.50m - 13.50m



BH24-03: 13.50m - 16.50m

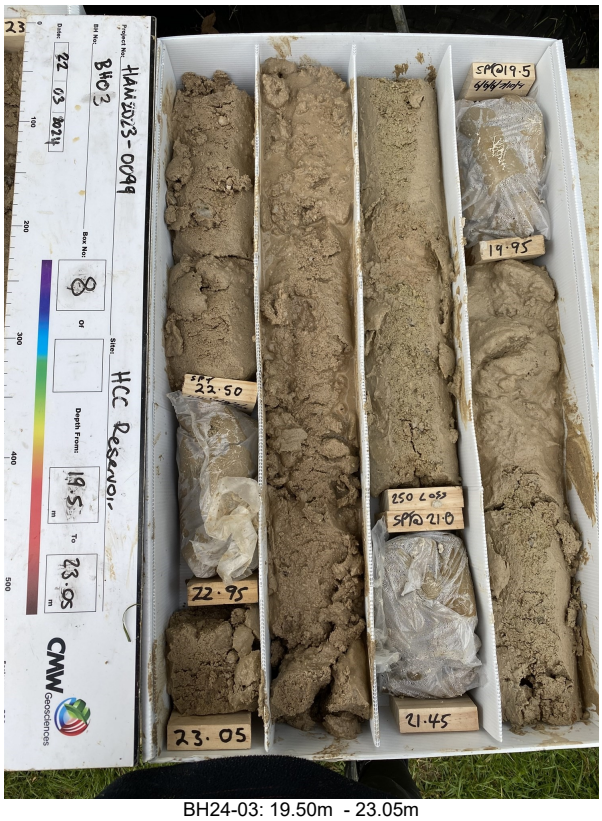
This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

PHOTOGRAPH SHEET - BH24-03

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:21/03/2024 - 22/03/2024



BH24-03: 16.50m - 19.50m



BH24-03: 19.50m - 23.05m

PHOTOGRAPH SHEET - BH24-03

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:21/03/2024 - 22/03/2024



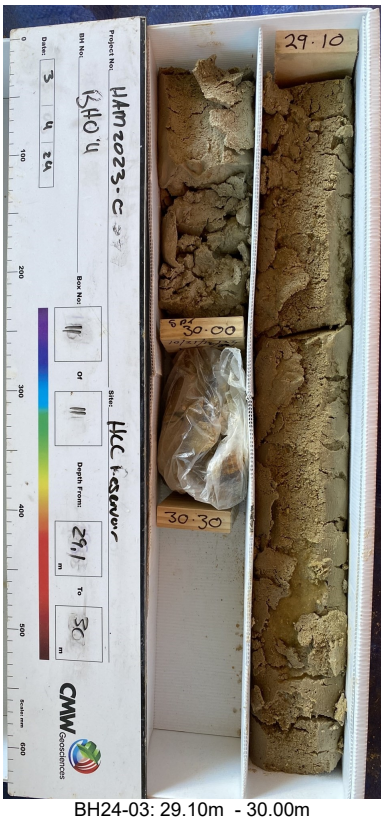
BH24-03: 23.05m - 26.05m



BH24-03: 26.05m - 29.10m

PHOTOGRAPH SHEET - BH24-03

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:21/03/2024 - 22/03/2024



BH24-03: 29.10m - 30.00m

BOREHOLE LOG - BH24-04

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 22/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 1 of 6

Position: 445276.5mE; 698110.4mN Projection: Mt Eden 2000 Angle from horizontal: 90°
Elevation: 58.31m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
				58.3			OL: Organic SILT: dark brown. No plasticity. (Topsoil)						
		0.6	Peak = 62kPa Residual = 12kPa	57.9			CH: CLAY: light brown. High plasticity. (Hamilton Ash)						
		1.2	Peak = 25kPa Residual = 12kPa	57.4	1		CH: Silty CLAY: light yellowish brown. High plasticity. (Hamilton Ash)			72			
		1.8	SPT = (2,3,3) N* = 6		2			M	St to VSt	80			
		2.6	Peak = 38kPa Residual = 12kPa										
		3.0 3.0	Peak = 38kPa Residual = 12kPa SPT = (1,2,2) N* = 4		3					80			
		3.5	Peak = 25kPa Residual = 12kPa	54.4			CH: CLAY: light yellowish brown. High plasticity. (Hamilton Ash)						
		4.0	Peak = 38kPa Residual = 12kPa		4								
		4.5	SPT = (3,3,4) N* = 7	53.9			CH: CLAY: with trace fine sand; light greyish brown. High plasticity. (Hamilton Ash)						
				53.4	5		CH: Silty CLAY: light brown mottled black. High plasticity. (Hamilton Ash)						

Termination Reason: Target Depth Reached
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 15.3m. Nested shallow piezometer installed to 3.5m depth, deep piezometer to 26.0m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-04

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 22/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 2 of 6

Position: 445276.5mE; 698110.4mN Projection: Mt Eden 2000 Angle from horizontal: 90°
Elevation: 58.31m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		5.5	Peak = 25kPa Residual = 12kPa							67			
		6.0 6.0	Peak = 38kPa Residual = 12kPa SPT = (0,0,1) N* = 1		6				S				
							... at 6.75m, Becoming brown.			73			
				51.2	7		SW: Fine to coarse SAND: with some silt; reddish brown mottled grey streaked orange and speckled black. Well graded. Angular. (Walton Subgroup)						
		7.5	SPT = (4,4,4) N* = 8						VSt		SNC		
				50.4	8		SW: Fine to coarse SAND : with some silt and trace fine gravel; greyish brown mottled white streaked pink and specked black. Well graded. Sub angular. (Walton Subgroup)			72			
		9.0	SPT = (4,4,4) N* = 8		9				L to MD				
				48.9			SW: Fine to coarse SAND: with trace silt and fine gravel; brown streaked dark brown. Well graded. Sub angular. (Walton Subgroup)	W		73			
				48.5	10		SW: Fine to coarse SAND: with some silt and trace fine gravel; brown mottled white streaked brownish orange and speckled black. Well graded. Sub angular. (Walton Subgroup)						

Termination Reason: Target Depth Reached
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 15.3m. Nested shallow piezometer installed to 3.5m depth, deep piezometer to 26.0m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-04

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 22/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 3 of 6
Position: 445276.5mE; 698110.4mN Projection: Mt Eden 2000 Angle from horizontal: 90°
Elevation: 58.31m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Depth	Type & Results	RL (m)	Depth (m)	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15	Structure & Other Observations
10.5	SPT = (7,6,6) N* = 12		11	... at 10.95m, Becoming light brownish grey mottled white, streaked pink and speckled black.			73			
		46.9		SW: Fine to coarse SAND: with some silt and minor fine to medium gravel; brown mottled grey. Well graded. Sub angular. (Walton Subgroup)						
		46.6		... from 11.60m to 11.65m, Becoming dark brown. ... from 11.65m to 11.75m, Becoming brownish orange. SW: Fine to coarse SAND: with some silt and trace fine gravel; light brownish grey mottled white streaked pink and speckled black. Well graded. Sub angular. (Walton Subgroup)						
12.0	SPT = (6,6,6) N* = 12		12	... from 12.45m to 13.00m, Becoming brown.			69			
			13	... from 13.00m to 13.50m, Becoming brownish yellow mottled white and speckled black.		MD				
13.5	SPT = (7,7,7) N* = 14			... from 13.50m to 14.30m, Becoming greyish brown mottled white and speckled black.			67			
			14	... from 14.30m to 15.00m, Becoming yellowish brown speckled black.						
15.0	SPT = (4,6,7) N* = 13		15							

Termination Reason: Target Depth Reached
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 15.3m. Nested shallow piezometer installed to 3.5m depth, deep piezometer to 26.0m depth.

BOREHOLE LOG - BH24-04

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 22/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 4 of 6
Position: 445276.5mE; 698110.4mN Projection: Mt Eden 2000 Angle from horizontal: 90°
Elevation: 58.31m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
	25-03-2024			42.9	16		SW: Silty fine to coarse SAND: brown speckled white. Well graded. Sub angular. (Walton Subgroup)	M		73		5 10 15	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
		16.5	SPT = (3,5,6) N* = 11	41.4	17		ML: SILT: with some fine to medium sand; light yellowish brown mottled white and speckled black. Low plasticity. (Walton Subgroup)		H	73			
		18.0	SPT = (0,0,0) N* = 0	40.5	18		ML: SILT: with trace medium sand; light pink speckled black. Low plasticity. (Non-welded Ignimbrite)		VS	73			
							... from 18.40m to 19.20m, Becoming light yellowish brown streaked pink.						
					19		*... at 19.20m, Becoming light pink mottled white and speckled black.*						
		19.5	SPT = (0,0,0) N* = 0	38.8			No Recovery:						
					20								

Termination Reason: Target Depth Reached
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 15.3m. Nested shallow piezometer installed to 3.5m depth, deep piezometer to 26.0m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-04

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 22/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 5 of 6

Position: 445276.5mE; 698110.4mN Projection: Mt Eden 2000 Angle from horizontal: 90°
Elevation: 58.31m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
										0	X	5 10 15	
		21.0	SPT = (0,0,0) N* = 0	37.3	21		ML: SILT: with trace medium sand; light greyish pink mottled white and streaked light yellow. Low plasticity. (Non-welded Ignimbrite)			53			
		22.5	SPT = (0,0,2) N* = 2		22								
					23				S to F	68			
		24.0	SPT = (0,0,0) N* = 0		24								
					25		*... at 25.00m, with minor fine to medium sand.*			70			

Termination Reason: Target Depth Reached
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 15.3m. Nested shallow piezometer installed to 3.5m depth, deep piezometer to 26.0m depth.

BOREHOLE LOG - BH24-04

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 22/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 6 of 6
Position: 445276.5mE; 698110.4mN Projection: Mt Eden 2000 Angle from horizontal: 90°
Elevation: 58.31m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		25.5	SPT = (0,0,0) N* = 0									5 10 15	
				32.4	26		SW: Silty fine to coarse SAND: with trace fine gravel; grey mottled white. Well graded. Angular. (Non-welded Ignimbrite)			69			
		27.0	SPT = (10,10,14) N* = 24		27			W	D to VD	69	SNC		
		28.5	SPT = (12,14,20) N* = 34		28								
					29					67			
		30.0	SPT = (17,26,24) N* = 50		30		Borehole terminated at 30.0 m						

Termination Reason: Target Depth Reached
Shear Vane No: 3434 DCP No:

Remarks: Groundwater encountered at 15.3m. Nested shallow piezometer installed to 3.5m depth, deep piezometer to 26.0m depth.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - BH24-04

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:22/03/2024



BH24-04: 0.00m - 3.00m



BH24-04: 3.00m - 6.00m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

PHOTOGRAPH SHEET - BH24-04

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:22/03/2024



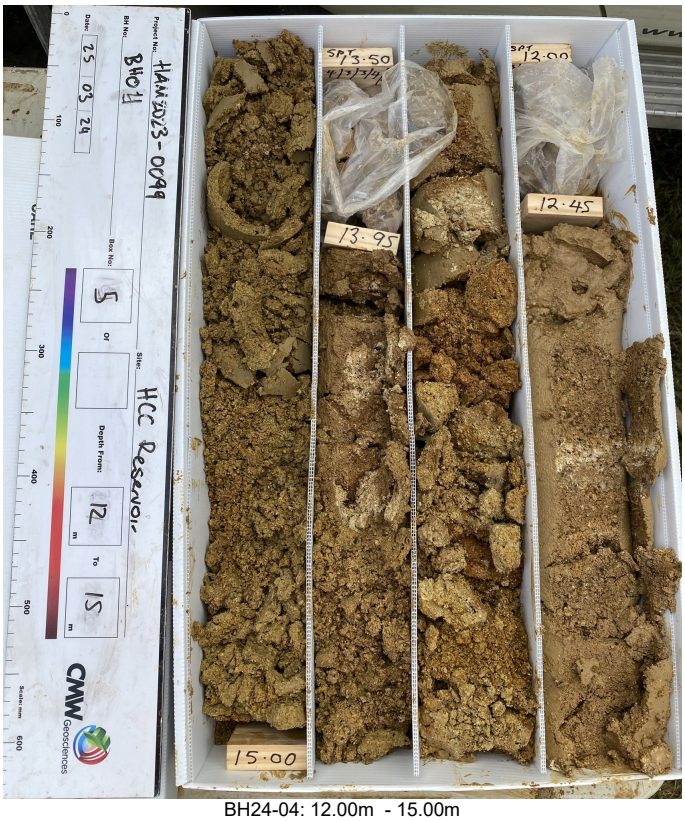
BH24-04: 6.00m - 9.00m



BH24-04: 9.00m - 12.00m

PHOTOGRAPH SHEET - BH24-04

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:22/03/2024



BH24-04: 12.00m - 15.00m



BH24-04: 15.00m - 18.00m

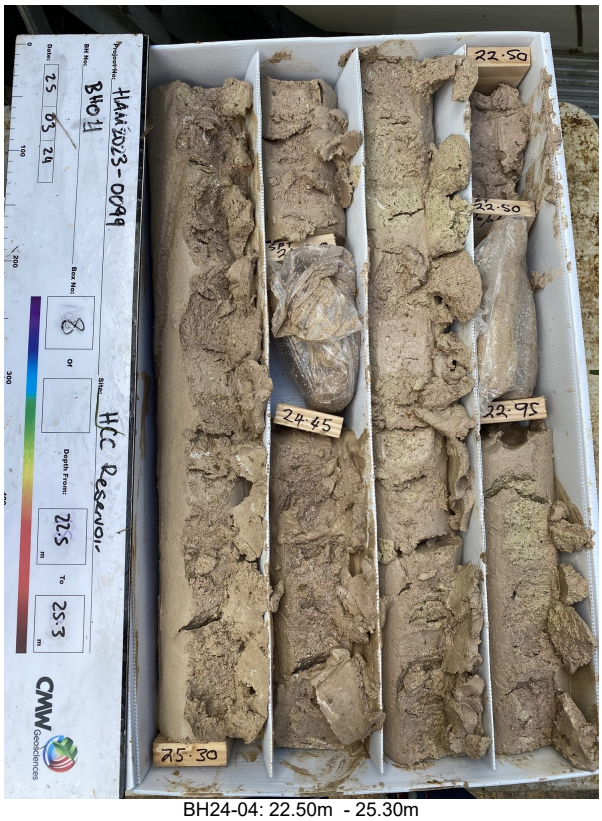
This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

PHOTOGRAPH SHEET - BH24-04

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:22/03/2024



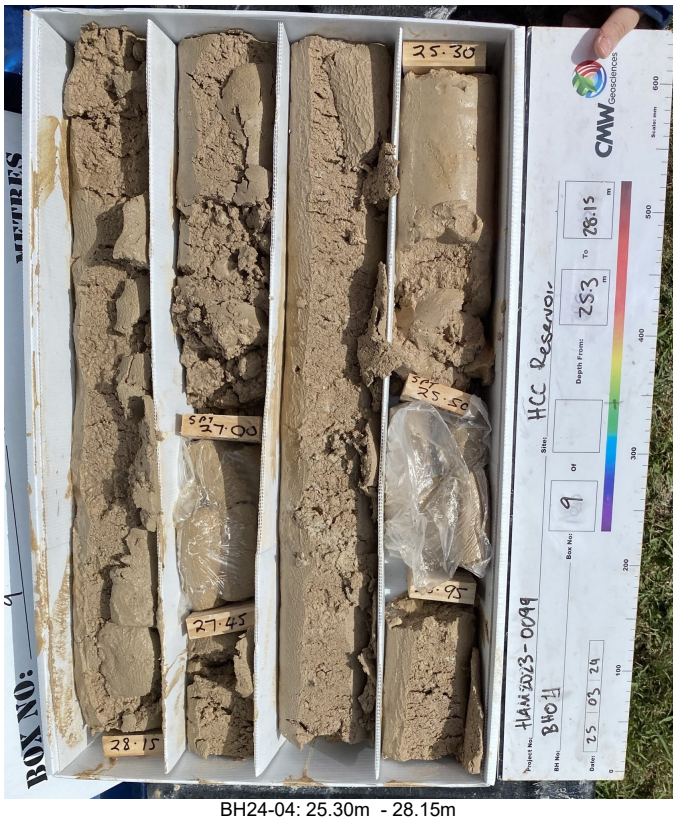
BH24-04: 18.00m - 22.50m



BH24-04: 22.50m - 25.30m

PHOTOGRAPH SHEET - BH24-04

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:22/03/2024



BH24-04: 25.30m - 28.15m



BH24-04: 28.15m - 30.41m

HAND AUGER BOREHOLE LOG - HA24-01

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 12/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 1 of 1
Position: 445405.1mE; 698424.9mN Projection: Mt Eden 2000
Elevation: 67.5 m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. No plasticity. (Topsoil)			
	0.6	Peak = 169kPa Residual = 77kPa				CH: CLAY: brown. High plasticity. moderately sensitive. (Hamilton Ash)	D	VSt	
	1.0	Peak = 197kPa		1		CH: CLAY: dark brown mottled black. High plasticity. Roots. (Hamilton Ash)			
	1.4	Peak = UTP							
	1.6	Peak = UTP				CH: Silty CLAY: brownish orange. High plasticity. (Hamilton Ash)		VSt to H	
	1.9	Peak = UTP		2					
	2.2	Peak = UTP				CH: Silty CLAY: brown. Hight plasticity. Moderately sensitive. (Hamilton Ash)			
	2.6	Peak = 183kPa Residual = 77kPa							
	3.0	Peak = 155kPa Residual = 49kPa		3		CH: Silty CLAY: light brown. High plasticity. Moderately sensitive. (Hamilton Ash)	M		
	3.5	Peak = 155kPa Residual = 63kPa							
	3.9	Peak = 169kPa Residual = 68kPa		4				VSt	
	4.5	Peak = 127kPa Residual = 56kPa							
	4.9	Peak = 141kPa Residual = 73kPa							
				5		Borehole terminated at 5.0 m			

Termination Reason: Target depth reached.
Shear Vane No: 2532 DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA24-02

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 12/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 1 of 1
Position: 445213.7mE; 698117.8mN Projection: Mt Eden 2000
Elevation: 65.5 m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. No plasticity. (Topsoil)			
	0.3	Peak = 127kPa Residual = 42kPa				CH: Silty CLAY: brown. High plasticity. Moderately sensitive. (Hamilton Ash)		VSt	
	0.7	Peak = UTP				CH: CLAY: brownish orange. High plasiticy. (Hamilton Ash)		H	
	1.0	Peak = UTP		1					
	1.2	Peak = 155kPa Residual = 35kPa				MH: Silty CLAY: light greyish brown. High plasticity. Sensitive. (Hamilton Ash)			
	1.6	Peak = 169kPa Residual = 56kPa				CH: CLAY: brown. High plasticity. Moderately sensitive. (Hamilton Ash)			
	2.0	Peak = 127kPa Residual = 42kPa		2			M		
	2.4	Peak = 183kPa Residual = 56kPa							
	2.8	Peak = 127kPa Residual = 35kPa							
				3				VSt	
	3.2	Peak = 148kPa Residual = 56kPa							
	3.6	Peak = 155kPa Residual = 54kPa							
				4		CH: Silty CLAY: Light brownish orange. High plasticity. (Hamilton Ash)			
	4.4	Peak = 120kPa Residual = 42kPa					M to W		
	4.9	Peak = 127kPa Residual = 45kPa							
				5		Borehole terminated at 5.0 m			

Termination Reason: Target depth reached.
Shear Vane No: 2532 DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA24-03

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 13/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 1 of 1
Position: 445168.9mE; 698199.9mN Projection: Mt Eden 2000
Elevation: 60.0 m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. No plasticity. (Topsoil)			
	0.3	Peak = UTP				CH: Silty CLAY: with minor fine to coarse sand; brown. High plasticity. Moderately sensitive. (Hamilton Ash)			
	0.7	Peak = 193kPa Residual = 59kPa						VSt to H	
	1.0	Peak = 178kPa Residual = 80kPa		1					
	1.2	Peak = UTP				CH: CLAY: brownish orange. High plasticity. (Hamilton Ash)			
	1.6	Peak = UTP							
						... at 1.70m, becoming streaked grey			
	2.0	Peak = UTP		2		CH: Silty CLAY: brown mottled black. High plasticity. (Walton Subgroup)	M		
	2.3	Peak = UTP				CH: CLAY: brownish orange. High plasticity. (Walton Subgroup)			
						CH: CLAY: with minor fine to coarse sand; brownish orange. High plasticity. (Walton Subgroup)		H	
	2.7	Peak = UTP							
	2.9	Peak = UTP				CH: Sandy CLAY: light yellowish brown. High plasticity. Manganese inclusions. (Walton Subgroup)			
				3					
	3.3	Peak = UTP				CH: Silty CLAY: with some fine to coarse sand; grey mottled pink. High plasticity. Manganese inclusions. (Walton Subgroup)			
	3.7	Peak = UTP							
									4
									5
				4		SW: Fine to Coarse SAND: Light brown. Well graded, sub angular. (Walton Subgroup)		MD to D	8
									8
						Borehole terminated at 4.2 m			10
									10
									12
									12
									9
									7
									8
									7
				5					

Termination Reason: Refusal on hard ground.
Shear Vane No: 2993 DCP No: 26
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA24-04

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 14/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 1 of 1
Position: 445273.1mE; 698221.7mN Projection: Mt Eden 2000
Elevation: 60.2 m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. No plasticity. (Topsoil)			
	0.4	Peak = 138kPa Residual = 42kPa				CH: CLAY: dark brown. High plasticity. Moderately sensitive. (Hamilton Ash)			
	0.8	Peak = UTP					D		
	1.0	Peak = UTP		1					
	1.5	Peak = UTP							
						... from 1.70m to 2.00m, becoming brown			
	2.0	Peak = UTP		2		CH: Silty CLAY: brownish orange. High plasticity. Moderately sensitive. (Hamilton Ash)		VSt to H	
						... at 2.30m, becoming light brown			
	2.4	Peak = UTP							
	2.8	Peak = 197kPa		3					
	3.4	Peak = 183kPa Residual = 68kPa					M		
						ML: Clayey SILT: brownish orange. Low plasticity. Manganese inclusions. (Walton Subgroup)		VSt	
	3.9	Peak = 197kPa							
	4.0	Peak = UTP		4		CH: CLAY: Light brown. High plasticity. Moderately sensitive. (Walton Subgroup)			
	4.4	Peak = 99kPa Residual = 42kPa						VSt to H	
	4.8	Peak = 127kPa Residual = 49kPa							
				5		Borehole terminated at 5.0 m			

Termination Reason: Target depth reached.
Shear Vane No: 2532 DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA24-05

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 13/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 1 of 1
Position: 445254.3mE; 698114.8mN Projection: Mt Eden 2000
Elevation: 58.5 m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
	0.3	Peak = 148kPa Residual = 37kPa				OL: Organic SILT: dark brown. No plasticity. (Topsoil)			
						CH: CLAY: dark brown. High plasticity. Moderately sensitive. (Hamilton Ash)			
	0.6	Peak = UTP				*... at 0.50m, becoming brownish orange*		VSt to H	
	1.0	Peak = UTP		1			D		
	1.3	Peak = UTP				CH: CLAY: dark brownish black. High plasticity. (Hamilton Ash)			
	1.7	Peak = UTP							
	1.9	Peak = UTP				CH: CLAY: brown. High plasticity. (Hamilton Ash)			
				2				H	
	2.5	Peak = UTP							
	2.9	Peak = 148kPa Residual = 44kPa				CH: Silty CLAY: brown. High plasticity. Moderately sensitive. (Hamilton Ash)			
				3					
	3.4	Peak = 148kPa Residual = 59kPa				*... at 3.50m, becoming brownish orange*	M		
	3.8	Peak = 104kPa Residual = 59kPa						VSt	
				4					
	4.5	Peak = 163kPa Residual = 44kPa							
	4.9	Peak = 148kPa Residual = 52kPa							
				5		Borehole terminated at 5.0 m			

Termination Reason: Target depth reached.
Shear Vane No: 2993 DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA24-06

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 14/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 1 of 1
Position: 445251.8mE; 697993.4mN Projection: Mt Eden 2000
Elevation: 37.7 m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
				0		OL: Organic SILT: dark brown. No plasticity. (Topsoil)			4, 6
	0.3	Peak = 141kPa Residual = 42kPa				ML: SILT: dark brown. Low plasticity. Moderately sensitive to insensitive. (Recent Alluvium)	M	St to VSt	2, 1, 1, 1, 1, 1, 1
	0.7	Peak = 127kPa Residual = 28kPa							
	1.1	Peak = 113kPa Residual = 28kPa		1			W		3, 3, 3, 3, 3
14-03-2024	1.5	Peak = 70kPa Residual = 28kPa							1, 2, 1, 1, 2
	1.9	Peak = 42kPa Residual = 28kPa		2				F to St	3, 3, 3, 3, 3, 3
	2.5	Peak = 85kPa Residual = 28kPa							
				3		SP: Fine to medium SAND : dark grey. Poorly graded, sub rounded. (Recent Alluvium)	S	L to MD	2, 2, 2, 2, 4, 3, 3, 3, 2, 2, 2, 2, 4, 5, 5
				4		Borehole terminated at 4.1 m			5, 5, 5, 5, 5, 5, 6, 4
				5					

Termination Reason: No Retrieval.
Shear Vane No: 2532 DCP No: 18b
Remarks: Groundwater encountered at 1.7m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA24-01

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Site Location: 139 Clarence Street, Hamilton Lake
Project No.: HAM2023-0099A
Date: 02/05/2024
Borehole Location: Refer to site plan Logged by: AN Checked by: MM Scale: 1:25 Sheet 1 of 1

Position: 445394.2mE; 698228.9mN Projection: Mount Eden 2000
Elevation: 55.0 m Datum: Moturiki 1953 Survey Source: Site Plan

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
	0.3	Peak = 107kPa Residual = 46kPa				OL: Organic SILT: dark brown. Low plasticity. (Topsoil)			
						ML: Clayey SILT: brown. Low plasticity, Insensitive to moderately sensitive, (Hamilton Ash)			
	0.6	Peak = 74kPa Residual = 46kPa				*... from 0.50m to 0.70m, Becoming sticky.*			
						... at 0.70m, Becoming brown.			
	0.9	Peak = 126kPa Residual = 67kPa		1				St to VSt	
	1.2	Peak = 169kPa Residual = 86kPa							
	1.5	Peak = 184kPa Residual = 104kPa							
	1.8	Peak = 199kPa Residual = 141kPa				CH: Silty CLAY: brown. Low plasticity. Insensitive. (Hamilton Ash)			
	2.0	Peak = >200kPa Residual = 123kPa		2			M		
	2.5	Peak = 172kPa Residual = 86kPa				CH: CLAY: with some silt. Orange brown. High plasticity. Moderately sensitive. (Hamilton Ash)			
	3.0	Peak = 199kPa Residual = 58kPa		3				VSt to H	
	3.5	Peak = >200kPa							
	4.0	Peak = >200kPa		4					
	4.5	Peak = 196kPa Residual = 64kPa					M to W		
	5.0	Peak = >200kPa Residual = 61kPa		5		Borehole terminated at 5.0 m			

Termination Reason: Target Depth Reached
Shear Vane No: 3399 DCP No:
Remarks: No groundwater encountered at the time of investigation.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA24-02

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Site Location: 139 Clarence Street, Hamilton Lake
Project No.: HAM2023-0099A
Date: 02/05/2024
Borehole Location: Refer to site plan Logged by: AN Checked by: MM Scale: 1:25 Sheet 1 of 1

Position: 445403.2mE; 698183.6mN Projection: Mount Eden 2000
Elevation: 53.0 m Datum: Moturiki 1953 Survey Source: Site Plan

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. Low plasticity. (Topsoil)			
						... from 0.00m to 0.50m, Containing layer of polythene and some fine gravel, dark brown with orange brown and black (Fill).			
	0.6	Peak = 64kPa Residual = 28kPa				MH: Clayey SILT: brown mottled dark brown. Low plasticity, Moderately sensitive, (Hamilton Ash)	M to W	St to VSt	
	0.9	Peak = 187kPa Residual = 64kPa							
				1		*... from 1.00m to 1.90m, Becoming sticky and brown.*			
	1.2	Peak = >200kPa							
	1.5	Peak = 169kPa Residual = 77kPa							
	1.8	Peak = >200kPa							
	2.0	Peak = 196kPa Residual = 77kPa		2		CH: Silty CLAY: orange brown. Low plasticity. Moderately sensitive. (Hamilton Ash)			
	2.5	Peak = >200kPa							
	3.0	Peak = 166kPa Residual = 77kPa		3		CH: CLAY: with some silt. Orange brown. High plasticity. Insensitive to sensitive. (Hamilton Ash)	M	VSt to H	
	3.5	Peak = >200kPa Residual = 126kPa							
	4.0	Peak = >200kPa		4					
	4.5	Peak = >200kPa Residual = 43kPa							
	5.0	Peak = >200kPa		5		Borehole terminated at 5.0 m			

Termination Reason: Target Depth Reached
Shear Vane No: 3399 DCP No:
Remarks: No groundwater encountered at the time of investigation.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA24-03

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Site Location: 139 Clarence Street, Hamilton Lake
Project No.: HAM2023-0099A
Date: 02/05/2024
Borehole Location: Refer to site plan Logged by: AN Checked by: MM Scale: 1:25 Sheet 1 of 1

Position: 445391.1mE; 698208.6mN Projection: Mount Eden 2000
Elevation: 55.0 m Datum: Moturiki 1953 Survey Source: Site Plan

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. Low plasticity. (Topsoil)			
						MH: Clayey SILT: brown. Low plasticity, Insensitive to moderately sensitive, (Hamilton Ash)			
	0.6	Peak = 153kPa Residual = 74kPa						VSt	
	0.9	Peak = 199kPa Residual = 92kPa		1					
	1.2	Peak = 153kPa Residual = 83kPa							
						CH: Silty CLAY: light brown with orange brown. Low plasticity. Insensitive to moderately sensitive. (Hamilton Ash)			
	1.5	Peak = 141kPa Residual = 67kPa							
	1.8	Peak = 144kPa Residual = 77kPa							
	2.0	Peak = 156kPa Residual = 77kPa		2			M		
						... at 2.00m, Becoming light brown mottled orange brown and dark brown.			
						... at 2.40m, Becoming light orange brown.			
	2.5	Peak = >200kPa						VSt to H	
						CH: CLAY: with some silt. Brown. High plasticity. Moderately sensitive. (Hamilton Ash)			
	3.0	Peak = 141kPa Residual = 46kPa		3					
	3.5	Peak = 153kPa Residual = 69kPa							
						... at 3.90m, Becoming light brown with orange brown.			
	4.0	Peak = 184kPa Residual = 49kPa		4					
	4.5	Peak = 156kPa Residual = 58kPa					M to W	VSt	
	5.0	Peak = 150kPa Residual = 49kPa		5		Borehole terminated at 5.0 m			

Termination Reason: Target Depth Reached
Shear Vane No: 3399 DCP No:
Remarks: No groundwater encountered at the time of investigation.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA24-04

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Site Location: 139 Clarence Street, Hamilton Lake
Project No.: HAM2023-0099A
Date: 03/05/2024
Borehole Location: Refer to site plan Logged by: AN Checked by: MM Scale: 1:25 Sheet 1 of 1

Position: 445251.8mE; 697993.4mN Projection: Mount Eden 2000
Elevation: 52.2 m Datum: Moturiki 1953 Survey Source: Site Plan

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
	0.6	Peak = >200kPa				GP: Asphalt: overlying fine to medium gravel with minor fine to coarse SAND (Uncontrolled Fill)			
	0.9	Peak = 166kPa Residual = 77kPa				MH: Clayey SILT: brown. Low plasticity, Moderately sensitive, (Uncontrolled Fill)			
	1.2	Peak = 104kPa Residual = 37kPa		1		CH: Silty CLAY: orange brown with reddish brown. High plasticity. Moderately sensitive. (Uncontrolled Fill)			
	1.5	Peak = >200kPa				... at 1.20m, Becoming reddish brown and containing minor to some coarse sand.	M		
	1.8	Peak = >200kPa				... at 1.80m, Becoming orange brown streaked light brown and white.			
	2.0	Peak = >200kPa		2		... at 2.00m, Becoming reddish brown streaked orange brown and white. Containing trace fine gravel and some coarse sand.			
	2.5	Peak = >200kPa						VSt to H	
	3.0	Peak = UTP		3		SC: Sandy CLAY: medium to coarse grained. Orange brown mottled dark brown, reddish brown and white. Low plasticity. (Uncontrolled Fill)			
	3.5	Peak = >200kPa					M to W		
	4.0	Peak = >200kPa		4					
	4.5	Peak = >200kPa				CH: CLAY: with minor coarse sand. Light brown. High plasticity. (Uncontrolled Fill) ... at 4.50m, Becoming light brown streaked brown.			
	5.0	Peak = UTP		5		Borehole terminated at 5.0 m			

Termination Reason: Target Depth Reached
Shear Vane No: 3399 DCP No:
Remarks: No groundwater encountered at the time of investigation.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA24-05

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Site Location: 139 Clarence Street, Hamilton Lake
Project No.: HAM2023-0099A
Date: 03/05/2024
Borehole Location: Refer to site plan Logged by: WD Checked by: MM Scale: 1:25 Sheet 1 of 1

Position: 445213.7mE; 698117.8mN Projection: Mount Eden 2000
Elevation: 56.0 m Datum: Moturiki 1953 Survey Source: Site Plan

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: Dark brown. Low plasticity. (Topsoil)			
						CH: Silty CLAY: Dark brown. High plasticity, Moderately sensitive, (Hamilton Ash)		F to St	
	0.5	Peak = 50kPa Residual = 23kPa							
	1.0	Peak = 175kPa		1		CH: Silty CLAY: Dark brown. High plasticity. (Hamilton Ash)			
	1.3	Peak = UTP							
	1.6	Peak = 175kPa							
	1.9	Peak = UTP		2			M		
						CH: CLAY: with some silt. Brown. High plasticity. Insensitive. (Hamilton Ash)			
	2.3	Peak = 175kPa							
						... at 2.40m, Becoming orange brown.			
	2.6	Peak = 175kPa							
	2.9	Peak = UTP		3				VSt to H	
						... at 3.10m, Becoming light orange brown.			
	3.3	Peak = 175kPa							
	3.6	Peak = 173kPa Residual = 98kPa							
	3.9	Peak = 138kPa Residual = 55kPa		4					
						CH: CLAY: with some silt. Light orange brown. High plasticity. Moderately sensitive. (Hamilton Ash)			
	4.3	Peak = 145kPa Residual = 58kPa							
						... at 4.40m, Becoming light greyish brown.			
	4.6	Peak = 125kPa Residual = 55kPa					M to W		
	4.9	Peak = 150kPa Residual = 55kPa							
				5		Borehole terminated at 5.0 m			

Termination Reason: Target Depth Reached
Shear Vane No: 3434 DCP No:
Remarks: No groundwater encountered at the time of investigation.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA24-06

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 14/03/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: MM Scale: 1:25 Sheet 1 of 1

Position: 445251.8mE; 697993.4mN Projection: Mt Eden 2000
Elevation: 37.7 m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
				0		OL: Organic SILT: dark brown. No plasticity. (Topsoil)			4, 6
	0.3	Peak = 141kPa Residual = 42kPa				ML: SILT: dark brown. Low plasticity. Moderately sensitive to insensitive. (Recent Alluvium)	M	St to VSt	2, 1, 1, 1, 1, 1, 1
	0.7	Peak = 127kPa Residual = 28kPa							
	1.1	Peak = 113kPa Residual = 28kPa		1			W		3, 3, 3, 3, 3
14-03-2024	1.5	Peak = 70kPa Residual = 28kPa							1, 2, 1, 1, 2
	1.9	Peak = 42kPa Residual = 28kPa		2				F to St	3, 3, 3, 3, 3, 3
	2.5	Peak = 85kPa Residual = 28kPa							
				3		SP: Fine to medium SAND : dark grey. Poorly graded, sub rounded. (Recent Alluvium)	S	L to MD	2, 2, 2, 2, 4, 3, 3, 3, 2, 2, 2, 2, 4, 5, 5
				4		Borehole terminated at 4.1 m			5, 5, 5, 5, 5, 5, 6, 4
				5					

Termination Reason: No Retrieval.
Shear Vane No: 2532 DCP No: 18b
Remarks: Groundwater encountered at 1.7m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-05

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 06/12/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: AS Scale: 1:25 Sheet 1 of 4

CMW Geosciences
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Position: 445263.9mE; 698168.9mN Projection: Mt Eden 2000
Elevation: 63.1m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
				63.1	0		OL: Organic SILT: dark brown. No plasticity. (Topsoil)					5 10 15	
				62.8			CH: CLAY: dark brown. High plasticity. (Hamilton Ash)		VSt	100			
					1								1.0-1.5m: push tube sample taken.
		1.5	SPT = SPT: N* = 6 (1, 1 / 1, 2, 1, 2)	61.6			CH: CLAY: brownish orange. High plasticity. (Hamilton Ash)						
					2					70			
							... at 2.70m, Becoming light brown.						
	06-12-2024	3.0	SPT = SPT: = 5 (0, 0 / 1, 1, 1, 2)		3				St				
					4					73			4.0-4.5m: push tube sample taken.
							... at 4.40m, Becoming mottled black.						
		5.0	SPT = SPT: = 4 (0, 1 / 0, 1, 1, 2)	58.1	5		CH: Silty CLAY: grey mottled black. High plasticity. (Hamilton Ash)						

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:

Remarks: Groundwater dipped at 3.03m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-05

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 06/12/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: AS Scale: 1:25 Sheet 2 of 4

CMW Geosciences
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Position: 445263.9mE; 698168.9mN Projection: Mt Eden 2000
Elevation: 63.1m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
				57.6			CH: CLAY: with trace fine to coarse sand; Brownish orange mottled black. High plasticity. Manganese. (Hamilton Ash)		St	100		5 10 15	
				57.5			CH: CLAY: dark brown mottled black. High plasticity. (Hamilton Ash)						
		6.0	SPT = SPT: = 1 (0, 0 / 0, 0, 0, 1)		6								
							... at 6.50m, Becoming light brown.			70			
					7								
		7.5	SPT = SPT: = 0 (0, 0 / 0, 0, 0, 0)				... at 7.40m, Becoming speckled white.	M			SNC		
							... at 7.70m, Becoming brown mottled black		F				
					8					70			
				54.3			CH: Silty CLAY: light brown mottled black. High plasticity. (Hamilton Ash)						
		9.0	SPT = SPT: = 0 (0, 0 / 0, 0, 0, 0)		9								
				53.7			CH: Silty CLAY: with some fine sand; reddish brown mottled black and speckled white. High plasticity. (Walton Subgroup)			67			
					10								

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:

Remarks: Groundwater dipped at 3.03m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-05

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 06/12/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: AS Scale: 1:25 Sheet 3 of 4

CMW Geosciences
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Position: 445263.9mE; 698168.9mN Projection: Mt Eden 2000
Elevation: 63.1m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		10.5	SPT = SPT: = 12 (2, 2 / 3, 3, 3, 3)	52.6			SC: Clayey fine to coarse SAND: with some fine gravel; reddish brown mottled black and speckled white. Well graded. Sub angular. (Walton Subgroup)						
					11				MD	100			11.0-11.5m: Push Tube sample taken
		12.0	SPT = SPT: = 11 (2, 2 / 2, 2, 3, 4)		12								
					13		*... at 13.00m, Becoming orange brown streaked red, mottled black and speckled white.*		MD	34			
		13.5	SPT = SPT: = 11 (2, 2 / 3, 2, 3, 3)										
					14					52			
		15.0	SPT = SPT: = 11 (2, 4 / 3, 3, 3, 2)		15								

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:

Remarks: Groundwater dipped at 3.03m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-05

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 06/12/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: AS Scale: 1:25 Sheet 4 of 4

CMW Geosciences
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Position: 445263.9mE; 698168.9mN Projection: Mt Eden 2000
Elevation: 63.1m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
					16					56		5 10 15	16.0-16.5m: push tube sample taken.
							Borehole terminated at 16.5 m						
					17								
					18								
					19								
					20								

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:
Remarks: Groundwater dipped at 3.03m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

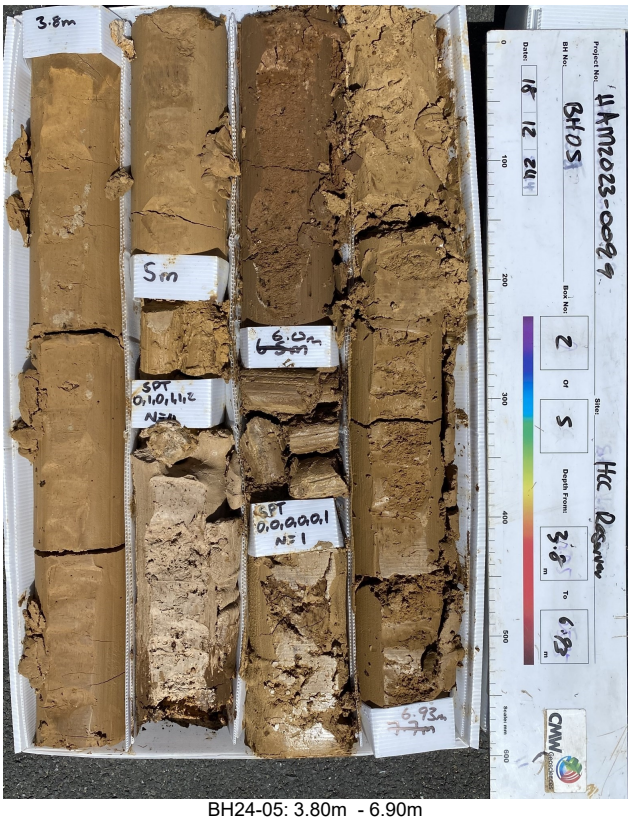
PHOTOGRAPH SHEET - BH24-05

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:06/12/2024

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BH24-05: 0.00m - 3.80m



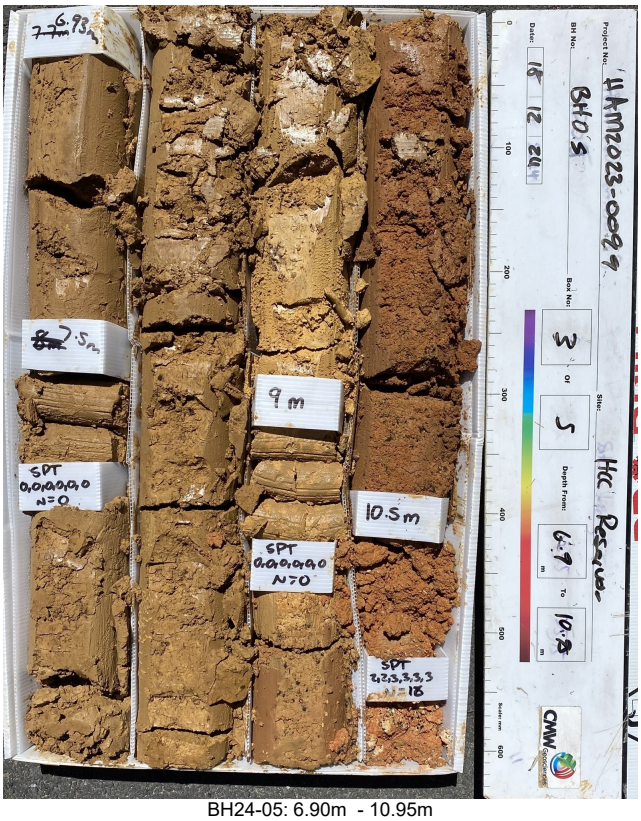
BH24-05: 3.80m - 6.90m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

PHOTOGRAPH SHEET - BH24-05

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:06/12/2024

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BH24-05: 6.90m - 10.95m



BH24-05: 10.95m - 15.00m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

PHOTOGRAPH SHEET - BH24-05

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:06/12/2024

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BH24-05: 15.00m - 16.00m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

BOREHOLE LOG - BH24-06

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 06/12/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: AS Scale: 1:25 Sheet 1 of 4

CMW Geosciences
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Position: 445269.4mE; 698130.8mN Projection: Mt Eden 2000
Elevation: 60.0m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
				60.0	0		OL: Organic SILT: dark brown. No Plasticity. (Topsoil)					5 10 15	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
				59.9			CH: CLAY: dark brown. High plasticity. (Hamilton Ash)						
							... from 0.30m to 0.40m, Becoming brownish orange.						
							... from 0.40m to 0.80m, Becoming brown mottled black.			73			
					1								
		1.5	SPT = SPT: = 7 (1, 1 / 2, 1, 2, 2)										
							... from 1.80m to 2.00m, Becoming light brown streaked grey.						
					2		*... at 2.00m, Becoming light brown.*			100			
	06-12-2024								F				
		3.0	SPT = SPT: = 3 (0, 1 / 0, 1, 1, 1)		3								
										88			
					4								
		4.5	SPT = SPT: = 2 (0, 0 / 0, 0, 1, 1)										
					5		*... at 5.00m, Becoming streaked grey.*						

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:

Remarks: Groundwater dipped at 3.07m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-06

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 06/12/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: AS Scale: 1:25 Sheet 2 of 4

CMW Geosciences
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Position: 445269.4mE; 698130.8mN Projection: Mt Eden 2000
Elevation: 60.0m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15	Structure & Other Observations
					6					100			6.0-6.5m: push tube sample taken.
		6.5	SPT = SPT: = 2 (1, 0 / 1, 0, 0, 1)	53.5			CH: CLAY: with minor manganese and with trace fine sand; brown mottled black. High plasticity. (Hamilton Ash)						
					7			M	F	100	SNC		7.5-8.0m: push tube sample taken.
		8.0	SPT = SPT: = 6 (1, 2 / 2, 1, 1, 2)	52.0	8		SC: Clayey fine to coarse SAND: with some fine gravel; reddish brown mottled grey and speckled black. Well graded. Sub angular. (Walton Subgroup)			99			
		9.0	SPT = SPT: = 8 (2, 1 / 2, 2, 2, 2)		9					70			
					10								

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:

Remarks: Groundwater dipped at 3.07m.

BOREHOLE LOG - BH24-06

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 06/12/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: AS Scale: 1:25 Sheet 3 of 4

CMW Geosciences
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Position: 445269.4mE; 698130.8mN Projection: Mt Eden 2000
Elevation: 60.0m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		10.5	SPT = SPT: = 10 (2, 3 / 2, 3, 2, 3)	49.5	11		SW: Fine to coarse SAND: with some clay and trace gravel; light brown mottled grey and speckled black. Well graded. Sub angular. (Walton Subgroup)	M to W	L	86		5 10 15	
							... from 11.30m to 11.40m, Becoming light brown mottled white and speckled black.						
		12.4	SPT = SPT: = 19 (3, 3 / 3, 5, 5, 6)	47.6	12		SW: Fine to coarse SAND: with some clay and trace gravel; light brown mottled grey and speckled black. Well graded. Sub angular. (Walton Subgroup)						12.0-12.4m: Push Tube sample taken.
		13.5	SPT = SPT: = 12 (3, 3 / 2, 3, 4, 3)		13				MD	87			
					14		*... from 14.30m to 14.35m, Becoming dark reddish brown.*			81			
				45.5			CH: Silty CLAY: with some sand; light yellowish brown mottled black and speckled white. High plasticity. (Walton Subgroup)						
		15.0	SPT = SPT: = 20 (2, 4 / 4, 5, 5, 6)		15								

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:

Remarks: Groundwater dipped at 3.07m.

BOREHOLE LOG - BH24-06

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 06/12/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: AS Scale: 1:25 Sheet 4 of 4

CMW Geosciences
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Position: 445269.4mE; 698130.8mN Projection: Mt Eden 2000
Elevation: 60.0m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
				44.5			CH: Silty CLAY: light greyish pink mottled white speckled black. High plasticity. (Walton Subgroup)		St to VSt	56		5 10 15	
					16								16.0-16.5m: push tube sample taken.
							Borehole terminated at 16.5 m						
					17								
					18								
					19								
					20								

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:
Remarks: Groundwater dipped at 3.07m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - BH24-06

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:06/12/2024

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BH24-06: 0.00m - 3.00m



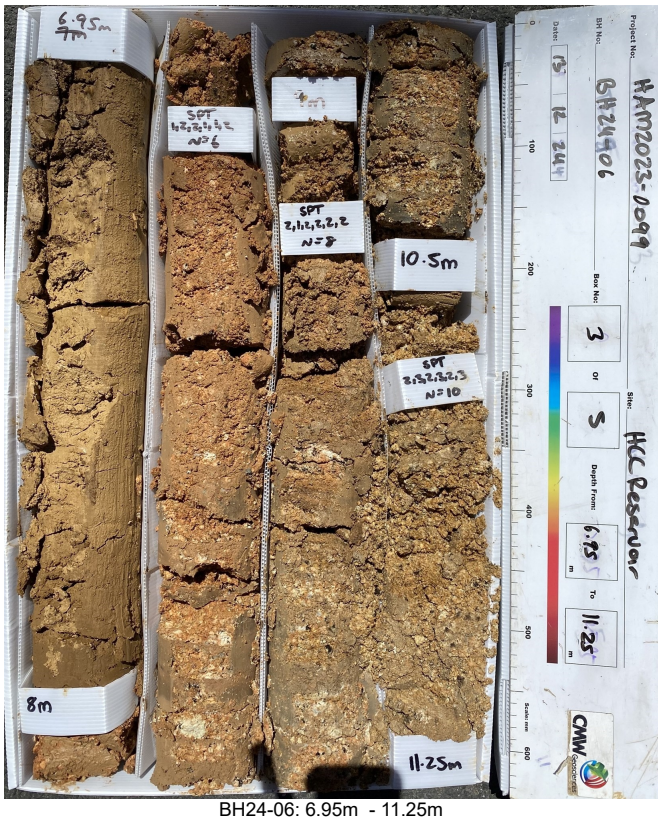
BH24-06: 3.00m - 6.95m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

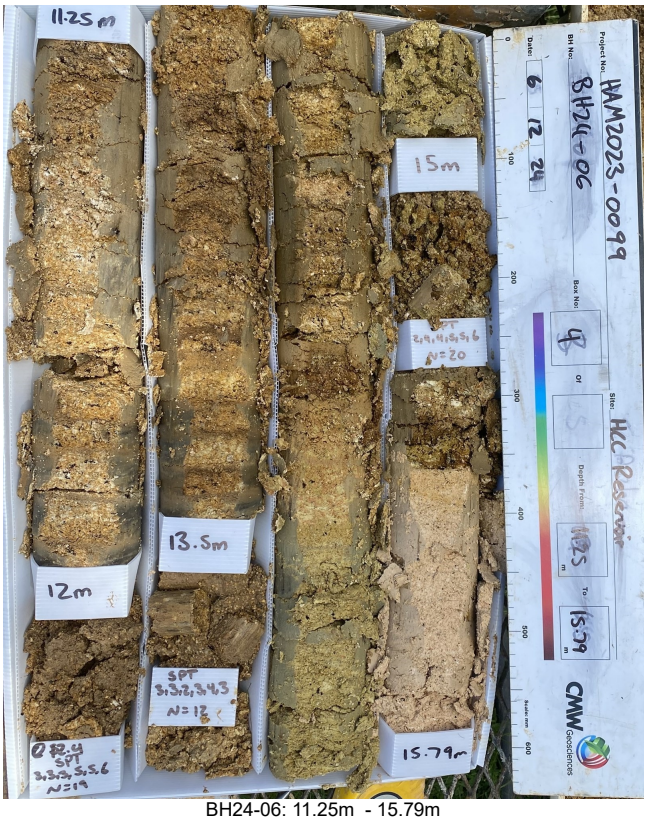
PHOTOGRAPH SHEET - BH24-06

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:06/12/2024

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BH24-06: 6.95m - 11.25m



BH24-06: 11.25m - 15.79m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

PHOTOGRAPH SHEET - BH24-06

Client: Hamilton City Council
Project: Reservoir Site Options
Location: 18 Ruakiwi Street
Project ID: HAM2023-0099
Date:06/12/2024

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BH24-06: 15.79m - 16.00m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

HAND AUGER BOREHOLE LOG - HA24-07

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 05/12/2024
Borehole Location: Refer to Site Plan Logged by: WD Checked by: AS Scale: 1:25 Sheet 1 of 1

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Position: 445259.0mE; 698181.7mN Projection: Mt Eden 2000
Elevation: 64.5m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			64.5			OL: Organic SILT: with some fine gravel and some clay. Brown. Low plasticity. (Uncontrolled Fill)	D		
			63.7			CH: CLAY: with some fine gravel and some fine sand. Orange brown with brown. Medium plasticity. (Uncontrolled Fill)			
	0.9	Peak = 106kPa Residual = 32kPa	63.6	1		CH: CLAY: dark brown mottled black. High plasticity. Insensitive to moderately sensitive. (Hamilton Ash)			
						... at 1.10m, becoming brown.	M	VSt	
	1.3	Peak = 136kPa Residual = 68kPa							
	1.6	Peak = 142kPa Residual = 68kPa							
	1.9	Peak = 159kPa Residual = 59kPa		2		Borehole terminated at 2.0 m			
				3					
				4					
				5					

Termination Reason: Target depth reached.
Shear Vane No: 2955 DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

HAND AUGER BOREHOLE LOG - HA24-08

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 05/12/2024

CMW Geosciences
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Borehole Location: Refer to Site Plan | Logged by: PM | Checked by: AS | Scale: 1:25 | Sheet 1 of 1

Position: 445266.0mE; 698174.6mN | Projection: Mt Eden 2000
Elevation: 64.0m | Datum: Moturiki 1953 | Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			64.0			OL: Organic SILT: with some gravel; dark brown. No plasticity. (Topsoil)			
			63.6			CH: CLAY: with some organics; dark brown mottled orange. High plasticity. (Uncontrolled Fill)			
	0.5	Peak = UTP							
	1.0	Peak = UTP		1			M		
			62.8			CH: CLAY: dark brown. High plasticity. (Hamilton Ash)		H	
	1.3	Peak = UTP							
	1.7	Peak = UTP							
	2.0	Peak = UTP		2		Borehole terminated at 2.0 m			
				3					
				4					
				5					

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

HAND AUGER BOREHOLE LOG - HA24-09

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 05/12/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: AS Scale: 1:25 Sheet 1 of 1

CMW Geosciences
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Position: 445284.4mE; 698170.1mN Projection: Mt Eden 2000
Elevation: 63.4m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			63.4			OL: Organic SILT: with some gravel; dark brown. No plasticity. (Uncontrolled Fill)			
	0.9	Peak = 178kPa Residual = 74kPa	62.6	1		CH: CLAY: dark brown. High plasticity. Moderately sensitive. (Hamilton Ash)		VSt	
						... at 1.00m, Becoming brown.			
	1.2	Peak = 178kPa Residual = 83kPa	62.1						
	1.4	Peak = UTP				CH: Silty CLAY: light brown. High plasticity. Moderately sensitive. (Hamilton Ash)			
	1.7	Peak = UTP							
	2.0	Peak = UTP		2					
	2.3	Peak = UTP					M		
	2.6	Peak = UTP						VSt to H	
	3.0	Peak = 178kPa Residual = 104kPa		3					
	3.5	Peak = 178kPa Residual = 59kPa				... at 3.50m, Becoming greyish brown.			
						... at 3.80m, Becoming streaked brownish orange mottled black.			
	4.0	Peak = UTP	59.4	4		CH: Silty CLAY : with trace fine sand and some mica; light brownish grey streaked brownish orange. High plasticity. (Hamilton Ash)			
						... at 4.30m, Becoming reddish brown.			
	4.5	Peak = UTP				... at 4.50m, Becoming light brownish grey.		H	
						... at 4.70m, Becoming streaked brownish orange.	M to W		
	5.0	Peak = UTP		5		Borehole terminated at 5.0 m			

Termination Reason: Target Depth Reached
Shear Vane No: 2993 DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

HAND AUGER BOREHOLE LOG - HA24-10

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 05/12/2024
Borehole Location: Refer to Site Plan Logged by: WD Checked by: AS Scale: 1:25 Sheet 1 of 1

CMW Geosciences
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Position: 445280.1mE; 698166.7mN Projection: Mt Eden 2000
Elevation: 63.2m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			63.2			OL: Organic SILT: with some fine gravel. Dark brown mottled black and orange brown. No plasticity. (Topsoil)	D		
	0.3	Peak = 136kPa Residual = 44kPa	62.9			CH: CLAY: dark brown. High plasticity. Insensitive to moderately sensitive. (Hamilton Ash)			
						... at 0.40m, becoming brown.			
	0.6	Peak = 162kPa Residual = 85kPa							
						... at 0.80m, becoming orange brown.			
	0.9	Peak = 165kPa Residual = 88kPa		1				St to VSt	
	1.3	Peak = 177kPa Residual = 94kPa							
						... at 1.50m, becoming light orange brown.			
	1.6	Peak = 74kPa Residual = 29kPa							
	1.9	Peak = 162kPa Residual = 38kPa		2			M		
	2.3	Peak = 177kPa Residual = 94kPa							
	2.6	Peak = 177kPa Residual = 112kPa							
						... at 2.80m, becoming light greyish brown.		VSt to H	
	2.9	Peak = 147kPa Residual = 71kPa		3					
						... from 3.10m to 3.20m, containing minor fine sand and trace mica fragments.			
	3.3	Peak = 206kPa	59.9			CH: CLAY: with some silt. Light brownish grey. High plasticity. (Hamilton Ash)			
						... at 3.50m, becoming brown.			
	3.6	Peak = 153kPa Residual = 47kPa							
	3.9	Peak = 85kPa Residual = 35kPa	59.3				M to W		
				4		CH: Silty CLAY: greyish brown. High plasticity. (Hamilton Ash)			
						... at 4.00m, becoming light yellowish grey.			
	4.3	Peak = 94kPa Residual = 59kPa							
						... at 4.50m, becoming light orange grey.	W	St	
	4.6	Peak = 85kPa Residual = 53kPa							
						... at 4.70m, becoming light orange brown.			
	4.9	Peak = 88kPa Residual = 50kPa							
				5		Borehole terminated at 5.0 m			

Termination Reason: Target depth reached.
Shear Vane No: 2955 DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

HAND AUGER BOREHOLE LOG - HA24-11

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 05/12/2024
Borehole Location: Refer to Site Plan Logged by: WD Checked by: AS Scale: 1:25 Sheet 1 of 1

CMW Geosciences
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Position: 445288.4mE; 698157.6mN Projection: Mt Eden 2000
Elevation: 62.8m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			62.8			OL: Organic SILT: with some fine gravel. Brown mottled orange brown. No plasticity. (Topsoil)			
			62.5			CH: CLAY: with minor fine sand. dark brown streaked orange brown. High plasticity. (Uncontrolled Fill)	D	VSt	
	0.5	Peak = 153kPa							
			62.2			CH: CLAY: dark brown. High plasticity. Insensitive to sensitive. (Hamilton Ash)			
	0.7	Peak = 74kPa Residual = 15kPa				... at 0.80m, becoming brown.			
	1.0	Peak = 97kPa Residual = 32kPa		1		... at 1.00m, becoming orange brown.			
	1.3	Peak = 192kPa Residual = 53kPa							
	1.6	Peak = 192kPa Residual = 68kPa				... at 1.50m, becoming light orange brown.			
	1.9	Peak = 183kPa Residual = 97kPa		2		... at 2.00m, becoming light orange grey.	M	St to VSt	
	2.3	Peak = 156kPa Residual = 71kPa							
	2.6	Peak = 162kPa Residual = 77kPa							
	2.9	Peak = 162kPa Residual = 71kPa		3					
	3.3	Peak = 118kPa Residual = 59kPa							
	3.6	Peak = 112kPa Residual = 50kPa				... at 3.60m, becoming greyish brown.			
						... at 3.70m, poor recovery.			
	3.9	Peak = 97kPa Residual = 56kPa				... at 3.90m, becoming light greyish brown with trace mica.			
			58.8	4		CH: CLAY: with some silt and minor mica. Light brownish grey. High plasticity. Insensitive to moderately sensitive. (Walton Subgroup)			
						... at 4.00m, becoming light brownish grey with minor mica.			
	4.3	Peak = 206kPa				... at 4.30m, becoming light grey mottled black.		VSt to H	
						... at 4.50m, becoming dark reddish brown.			
	4.6	Peak = 106kPa Residual = 41kPa				... at 4.60m, becoming light brown.			
						... at 4.80m, becoming light brown streaked light yellowish brown.		St	
	4.9	Peak = 85kPa Residual = 50kPa		5		Borehole terminated at 5.0 m			

Termination Reason: Target depth reached.
Shear Vane No: 2955 DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

HAND AUGER BOREHOLE LOG - HA24-12

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 05/12/2024
Borehole Location: Refer to Site Plan Logged by: PM Checked by: AS Scale: 1:25 Sheet 1 of 1

CMW Geosciences
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Position: 445306.1mE; 698115.1mN Projection: Mt Eden 2000
Elevation: 59.4m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			59.4			OL: Organic SILT: dark brown. No plasticity. (Topsoil)			
			59.0			CH: CLAY: dark brown mottled black. High plasticity. Moderately sensitive. (Hamilton Ash)			
	0.5	Peak = 172kPa Residual = 63kPa							
	0.7	Peak = >219kPa							
						... at 0.80m, becoming brown.			
				1					
			58.2			CH: Silty CLAY: brown streaked brownish orange. High plasticity. Moderately sensitive. (Hamilton Ash)			
	1.3	Peak = UTP							
	1.7	Peak = UTP							
						... at 1.80m, becoming mottled black.			
						... at 1.90m, becoming brown.			
	2.0	Peak = UTP		2					
						... at 2.10m, becoming light brown.		VSt to H	
	2.4	Peak = 138kPa Residual = 47kPa					M		
	2.7	Peak = 141kPa Residual = 63kPa							
			56.6			CH: CLAY: light brown. High plasticity. Moderately sensitive. (Hamilton Ash)			
	2.9	Peak = 156kPa Residual = 63kPa		3					
	3.5	Peak = UTP							
	4.0	Peak = 94kPa Residual = 31kPa		4				St	
			55.0			CH: Silty CLAY: with minor mica; brownish orange streaked grey and mottled white. High plasticity. (Walton Subgroup)			
	4.5	Peak = >219kPa						H	
						... from 4.80m to 5.00m, becoming brownish grey.			
	5.0	Peak = >219kPa		5		Borehole terminated at 5.0 m			

Termination Reason: Target depth reached.
Shear Vane No: 2993 DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

HAND AUGER BOREHOLE LOG - HA24-13

Client: Hamilton City Council
Project: Reservoir Site Options
Site Location: 18 Ruakiwi Street
Project No.: HAM2023-0099
Date: 06/12/2024
Borehole Location: Refer to Site Plan Logged by: WD Checked by: AS Scale: 1:25 Sheet 1 of 1

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Position: 445311.5mE; 698095.4mN Projection: Mt Eden 2000
Elevation: 58.2m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			58.2			OL: Organic SILT: dark brown. No plasticity. (Topsoil)			
	0.3	Peak = 134kPa Residual = 41kPa	57.9			CH: CLAY: dark brown. High plasticity. Insensitive to sensitive. (Hamilton Ash)	D		
						... at 0.40m, becoming brown.			
	0.6	Peak = 200kPa Residual = 47kPa							
						... at 0.70m, becoming dark brown.			
	0.9	Peak = UTP							
				1		*... at 0.90m, becoming brown.*			
						... at 1.20m, becoming orange brown.		VSt to H	
	1.3	Peak = 194kPa Residual = 88kPa							
	1.6	Peak = 219kPa Peak = >219kPa					M		
	1.9	Peak = 219kPa Peak = >219kPa							
				2		*... at 2.00m, becoming light orange brown.*			
	2.3	Peak = 172kPa Residual = 47kPa							
	2.6	Peak = 84kPa Residual = 44kPa							
						... from 2.70m to 3.00m, poor recovery.			
	2.9	Peak = 150kPa Residual = 69kPa							
				3		*... at 3.00m, becoming light orange grey.*			
	3.3	Peak = 94kPa Residual = 47kPa							
	3.6	Peak = 100kPa Residual = 41kPa				*... at 3.60m, becoming light greyish brown.*	M to W	St to VSt	
	3.9	Peak = 125kPa Residual = 41kPa							
				4					
	4.3	Peak = 109kPa Residual = 47kPa				*... at 4.30m, becoming greyish brown.*			
	4.6	Peak = 109kPa Residual = 47kPa							
						... at 4.80m, becoming light brown streaked light grey.			
	4.9	Peak = 106kPa Residual = 56kPa				*... at 4.95m, becoming light grey streaked light orange brown. Containing trace mica.*			
				5		Borehole terminated at 5.0 m			

Termination Reason: Target depth reached.
Shear Vane No: 2993 DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

BOREHOLE LOG - BH24-07

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Site Location: 139 Clarence Street, Hamilton Lake
Project No.: HAM2023-0099A
Date: 07/12/2024
Borehole Location: Refer to Site Plan Logged by: WD Checked by: AS Scale: 1:25 Sheet 1 of 4

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Position: 445389.2mE; 698218.8mN Projection: Mount Eden 2000
Elevation: 54.8m Datum: Moturiki 1953 Survey Source: Site Plan

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
				54.8			GP: Fine to medium GRAVEL: dark grey. Angular. Poorly graded. (Uncontrolled Fill)						
				54.7			CH: CLAY: with some gravel. Brownish grey. High plasticity. (Uncontrolled Fill)						
				54.5			CH: CLAY: orange brown. High plasticity. (Hamilton Ash)						
							... at 0.60m, becoming orange grey.			97			
					1		... at 1.20m, contains trace mica.						
		1.5	SPT = SPT: = 6 (1, 1 / 1, 2, 1, 2)							98			
					2				F				
		3.0	SPT = SPT: = 2 (0, 1 / 0, 1, 0, 1)		3		... at 3.20m, becoming light orange grey.			100			
				50.8	4		CH: Silty CLAY: with trace fine sand and trace mica. Light orange brown. High plasticity. (Hamilton Ash)						
		4.5	SPT = SPT: = 5 (1, 1 / 1, 1, 2, 1)										
				49.8	5		CH: CLAY: with some fine to medium sand and minor fine gravel. Reddish brown. High plasticity. Gravel: white and grey, subrounded to subangular. (Walton Subgroup)						

Dynamic Cone Penetrometer (Blows/100mm): 5 10 15

Structure & Other Observations: Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:
Remarks: Groundwater encountered at 10.5m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-07

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Site Location: 139 Clarence Street, Hamilton Lake
Project No.: HAM2023-0099A
Date: 07/12/2024
Borehole Location: Refer to Site Plan Logged by: WD Checked by: AS Scale: 1:25 Sheet 2 of 4

CMW Geosciences
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Position: 445389.2mE; 698218.8mN Projection: Mount Eden 2000
Elevation: 54.8m Datum: Moturiki 1953 Survey Source: Site Plan

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		6.0	SPT = SPT: = 5 (1, 1 / 1, 1, 1, 2)		6					93			
				48.3			SW: Clayey Gravelly Fine to coarse SAND: dark red mottled white and black. Well graded. Subangular. Gravel: white and black, subangular. (Walton Subgroup)						
		7.5	SPT = SPT: = 8 (1, 2 / 2, 2, 2, 2)		7			M		95	SNC		
					8		... at 7.80m, becoming light pink and white mottled black.						
							... at 8.30m, becoming brown with orange brown mottled white and black, containing some clay.		L	100			
		9.0	SPT = SPT: = 8 (1, 2 / 2, 2, 2, 2)		9								
							... at 9.70m, becoming light orange brown streaked yellowish brown, contains minor fine gravel.			97			
					10								

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:
Remarks: Groundwater encountered at 10.5m

BOREHOLE LOG - BH24-07

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Site Location: 139 Clarence Street, Hamilton Lake
Project No.: HAM2023-0099A
Date: 07/12/2024
Borehole Location: Refer to Site Plan Logged by: WD Checked by: AS Scale: 1:25 Sheet 3 of 4

CMW Geosciences
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Position: 445389.2mE; 698218.8mN Projection: Mount Eden 2000
Elevation: 54.8m Datum: Moturiki 1953 Survey Source: Site Plan

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
					11		*... from 10.10m to 10.15m, becoming white with light brownish grey mottled black.*					5 10 15	
		10.5	SPT = SPT: = 6 (0, 1 / 1, 2, 1, 2)				*... at 11.00m, becoming light brownish grey mottled white and black.* ... *from 11.10m to 11.25m, becoming white with light yellowish grey mottled black.* ... *at 11.25m, becoming orange brown streaked white mottled black.*			90			
		12.0	SPT = SPT: = 1 (0, 0 / 0, 0, 0, 1)		12		*... at 11.80m, becoming dark yellowish grey mottled black.*						
				42.7			ML: Clayey SILT: with trace fine to medium sand. Light pinkish grey mottled black. Low plasticity. Sensitive. (Non-welded Ignimbrite)						
		13.5	SPT = SPT: = 1 (0, 0 / 1, 0, 0, 0)		13				F	97			
					14								
				40.4			CH: CLAY: with some fine sand. Dark grey. High plasticity. (Non-welded Ignimbrite)			82			
				40.2			SW: Clayey Gravelly Fine to coarse SAND: light brownish grey streaked yellowish grey. Well graded. Subangular. Gravel: fine to coarse, white, subangular. (Non-welded Ignimbrite)						
					15								

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:
Remarks: Groundwater encountered at 10.5m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - BH24-07

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Site Location: 139 Clarence Street, Hamilton Lake
Project No.: HAM2023-0099A
Date: 07/12/2024
Borehole Location: Refer to Site Plan Logged by: WD Checked by: AS Scale: 1:25 Sheet 4 of 4

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Position: 445389.2mE; 698218.8mN Projection: Mount Eden 2000
Elevation: 54.8m Datum: Moturiki 1953 Survey Source: Site Plan

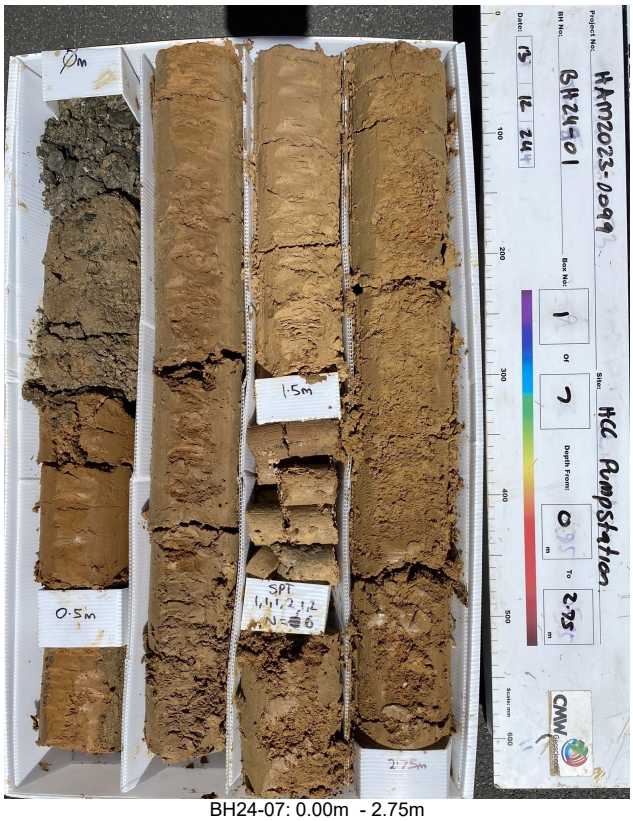
Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15	Structure & Other Observations
							... at 15.30m, containing pocket of pumiceous gravel. ... from 15.30m to 15.60m, becoming yellowish grey streaked dark yellowish grey.		MD				
		16.0	SPT = SPT: = 26 (3, 4 / 5, 6, 7, 8)		16								
				38.2			SW: Gravelly Fine to coarse SAND: with minor silt. Yellowish grey mottled white. Well graded. Subangular. Gravel: fine to coarse, white , subangular, pumiceous. (Non-welded Ignimbrite)		D	91			
					17								
		18.0	SPT = SPT: = 48 (5, 10 / 11, 11, 12, 14)		18		... at 17.90m, becoming light pinkish grey, contains large pumice cobble.						
				36.3			SP: Silty Fine to medium SAND: light grey streaked yellowish brown. Poorly graded. Subangular. Pumiceous. (Non-welded Ignimbrite)			89			
					19								
				35.7			ML: Fine Sandy SILT: light grey streaked yellowish grey. Low plasticity. Dilatant. (Non-welded Ignimbrite)		MD				
		19.5	SPT = SPT: = 26 (4, 4 / 6, 8, 7, 5)	35.3			... from 19.45m to 19.50m, band of fine to medium sand with some clay: dark reddish brown, subangular, highly iron stained. CH: CLAY: with trace fine sand. Greyish brown with orange brown. High plasticity. (Non-welded Ignimbrite)			90			
					20		Borehole terminated at 20.0 m						

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:
Remarks: Groundwater encountered at 10.5m

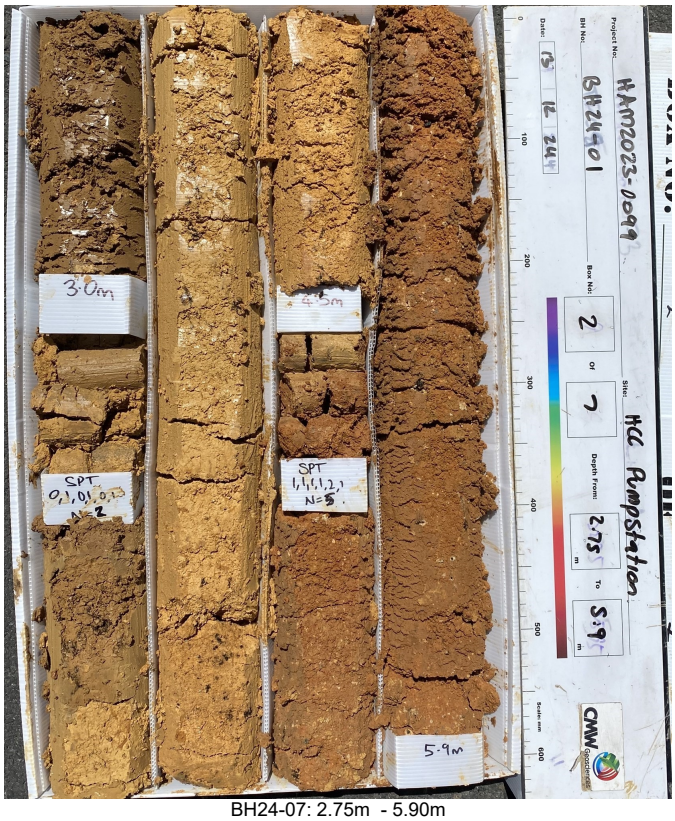
PHOTOGRAPH SHEET - BH24-07

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Location: 139 Clarence Street, Hamilton Lake
Project ID: HAM2023-0099A
Date:07/12/2024

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BH24-07: 0.00m - 2.75m



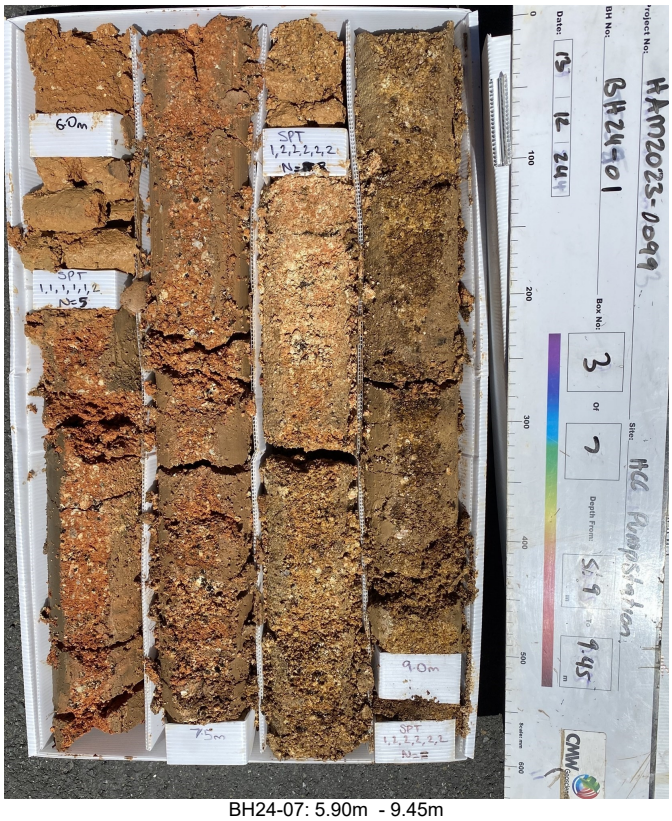
BH24-07: 2.75m - 5.90m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

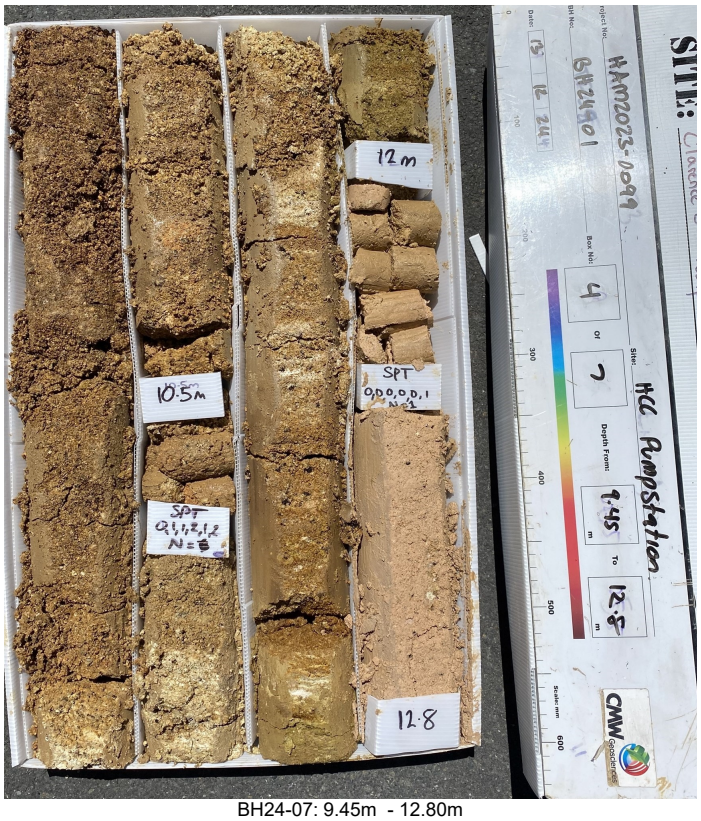
PHOTOGRAPH SHEET - BH24-07

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Location: 139 Clarence Street, Hamilton Lake
Project ID: HAM2023-0099A
Date:07/12/2024

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BH24-07: 5.90m - 9.45m



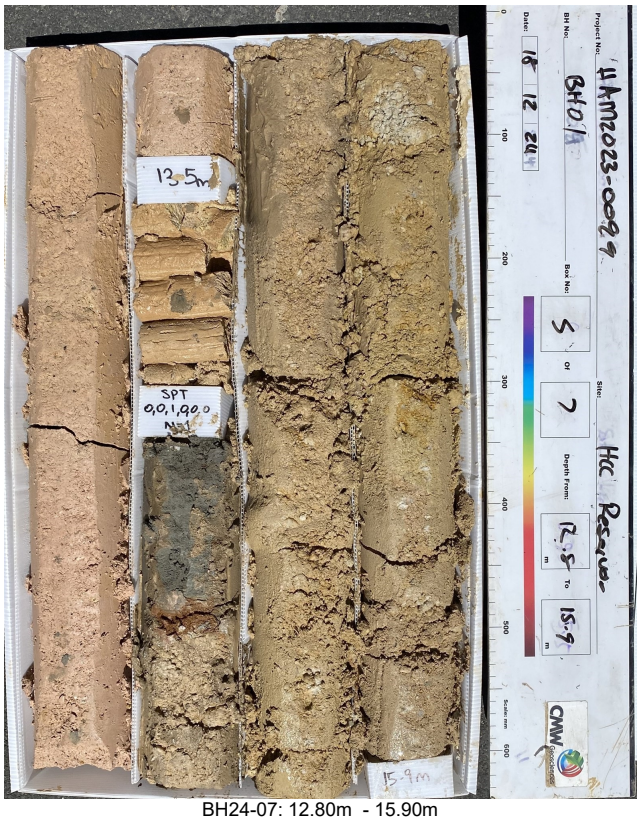
BH24-07: 9.45m - 12.80m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

PHOTOGRAPH SHEET - BH24-07

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Location: 139 Clarence Street, Hamilton Lake
Project ID: HAM2023-0099A
Date:07/12/2024

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BH24-07: 12.80m - 15.90m



BH24-07: 15.90m - 19.35m

This borehole report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

PHOTOGRAPH SHEET - BH24-07

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Location: 139 Clarence Street, Hamilton Lake
Project ID: HAM2023-0099A
Date:07/12/2024

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BH24-07: 19.35m - 20.00m

HAND AUGER BOREHOLE LOG - HA24-06

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Site Location: 139 Clarence Street, Hamilton Lake
Project No.: HAM2023-0099A
Date: 07/12/2024
Borehole Location: Refer to Site Plan Logged by: WD Checked by: AS Scale: 1:25 Sheet 1 of 1

CMW Geosciences
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Position: 445405.8mE; 698206.5mN Projection: Mount Eden 2000
Elevation: 53.1m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			53.1			ASPHALT: dark grey.			
			53.1			(Fill)			
						... from 0.00m to 0.30m, saturated from water pooling.	S		
						GW: Fine to coarse GRAVEL: dark grey. Well graded. Angular.			
						(Uncontrolled Fill)			
	0.3	Peak = 150kPa	52.8			CH: CLAY: dark greyish brown streaked orange brown. High plasticity.			
						(Uncontrolled Fill)			
			52.5			CH: CLAY: dark orange brown. High plasticity. Moderately sensitive.			
	0.7	Peak = 156kPa Residual = 63kPa				(Hamilton Ash)			
				1		*... at 1.00m, becoming orange brown.*			
	1.3	Peak = 219kPa							
	1.6	Peak = 216kPa Residual = 78kPa				*... at 1.70m, becoming light orange brown.*			
	1.9	Peak = 206kPa Residual = 84kPa							
				2		*... at 2.00m, containing trace mica.*		VSt to H	
						... at 2.20m, becoming mottled black.	M		
	2.3	Peak = 219kPa				*... at 2.30m, becoming reddish brown.*			
						... at 2.50m, becoming dark orange brown.			
	2.6	Peak = 213kPa Residual = 50kPa							
						... at 2.75m, becoming light reddish brown mottled white and black, contains some fine pumiceous gravel.			
	2.9	Peak = UTP							
				3		*... from 3.10m to 3.20m, becoming white mottled pink and black.*			
	3.3	Peak = 219kPa				*... at 3.30m, becoming greyish brown mottled white, pink and black.*			
			49.7			CH: Fine to coarse Sandy CLAY: with minor fine gravel. Brown mottled white. High plasticity. Gravel: white, subrounded.			
	3.6	Peak = 219kPa				(Walton Subgroup)			
						... at 3.70m, becoming dark brown.			
	3.9	Peak = 219kPa							
						... at 3.95m, becoming light orange brown mottled white and black.			
			49.1	4		SW: Clayey Fine to coarse SAND: with minor fine gravel. Brown. Well graded. Subangular. Gravel: white, subrounded.		MD	4
						(Walton Subgroup)			5
						Borehole terminated at 4.2 m			4
									5
									5
									5
									4
				5					4

Termination Reason: Target depth reached.
Shear Vane No: 2993 DCP No: 17B
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

HAND AUGER BOREHOLE LOG - HA24-07

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Site Location: 139 Clarence Street, Hamilton Lake
Project No.: HAM2023-0099A
Date: 06/12/2024
Borehole Location: Refer to Site Plan Logged by: WD Checked by: AS Scale: 1:25 Sheet 1 of 1

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Position: 445409.4mE; 698197.7mN Projection: Mount Eden 2000
Elevation: 52.3m Datum: Moturiki 1953 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			52.3			CONCRETE: grey and white.			
			52.2			(Fill)			
						CH: CLAY: dark brown mottled orange brown. High plasticity. (Uncontrolled Fill)			
	0.3	Peak = 169kPa						VSt	
			51.9			CH: CLAY: dark brown. High plasticity. Moderately sensitive. (Hamilton Ash)			
						... at 0.50m, becoming brown.			
	0.6	Peak = 138kPa Residual = 44kPa							
	0.9	Peak = 119kPa Residual = 31kPa				... at 0.90m, becoming orange brown.			
				1					
	1.3	Peak = 156kPa Residual = 53kPa							
						... at 1.40m, becoming greyish brown.	M		
	1.6	Peak = 147kPa Residual = 59kPa							
	1.9	Peak = 109kPa Residual = 47kPa							
				2		... at 2.00m, becoming light brownish grey, contains trace mica.			
						... at 2.20m, becoming light brownish grey streaked light grey.		VSt to H	
	2.3	Peak = 213kPa Residual = 69kPa							
						... at 2.40m, becoming orange brown.			
						... at 2.50m, becoming light orange brown.			
	2.6	Peak = 219kPa							
						... at 2.70m, becoming light orange grey streaked dark orange brown.			
	2.9	Peak = 153kPa Residual = 34kPa	49.4			CH: Silty CLAY: with trace mica. Light orange brown. High plasticity. Moderately sensitive to sensitive. (Walton Subgroup)			
				3					
	3.3	Peak = 156kPa Residual = 44kPa							
						... at 3.40m, becoming light pinkish grey.			
	3.6	Peak = 138kPa Residual = 53kPa							
	3.9	Peak = 219kPa					M to W		
				4					
			48.1			CH: Fine to coarse Sandy CLAY: reddish brown streaked brown mottled grey and black. High plasticity. (Walton Subgroup)			
	4.3	Peak = UTP							
	4.6	Peak = UTP						H	
	4.9	Peak = UTP							
				5		Borehole terminated at 5.0 m			

Termination Reason: Target Depth Reached
Shear Vane No: 2993 DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

HAND AUGER BOREHOLE LOG - HA24-08

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Site Location: 139 Clarence Street, Hamilton Lake
Project No.: HAM2023-0099A
Date: 07/12/2024
Borehole Location: Refer to Site Plan

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Scale: 1:25 Sheet 1 of 1

Position: 445409.8mE; 698192.1mN Projection: Mount Eden 2000
Elevation: 51.9m Datum: Moturiki 1953 Survey Source: Hand-held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			51.9			ASPHALT: grey.			
			51.9			(Fill)			
			51.8			GP: Fine to medium GRAVEL: with some clay. Dark grey. Poorly graded. Angular. (Uncontrolled Fill)			
	0.3	Peak = 188kPa				CH: CLAY: orange brown streaked dark brown. High plasticity. (Uncontrolled Fill)		VSt	
			51.5			OL: Organic SILT: brown. No plasticity. (Topsoil)			
	0.6	Peak = 219kPa	51.3			CH: CLAY: brown. High plasticity. Moderately sensitive. (Hamilton Ash)			
						... at 0.70m, becoming orange brown.			
	0.9	Peak = 197kPa Residual = 72kPa		1			M		
						... at 1.20m, becoming light orange brown streaked light grey, containing trace mica.			
	1.3	Peak = 203kPa Residual = 72kPa	50.6			CH: CLAY: with some mica and trace fine sand. Light grey streaked light orange brown. High plasticity. Moderately sensitive. (Walton Subgroup)		VSt to H	
	1.6	Peak = 219kPa				*... at 1.50m, becoming light brownish grey, containing trace mica and no sand.*			
			50.1			CH: CLAY: dark yellowish brown. High plasticity. Moderately sensitive. (Walton Subgroup)			
	1.9	Peak = 203kPa Residual = 78kPa		2		Borehole terminated at 2.0 m			
				3					
				4					
				5					

Termination Reason: Target depth reached.
Shear Vane No: 2993 DCP No:
Remarks: Groundwater not encountered.

HAND AUGER BOREHOLE LOG - HA24-09

Client: Hamilton City Council
Project: Hamilton Reservoir pump station
Site Location: 139 Clarence Street, Hamilton Lake
Project No.: HAM2023-0099A
Date: 06/12/2024
Borehole Location: Refer to Site Plan Logged by: WD Checked by: AS Scale: 1:25 Sheet 1 of 1

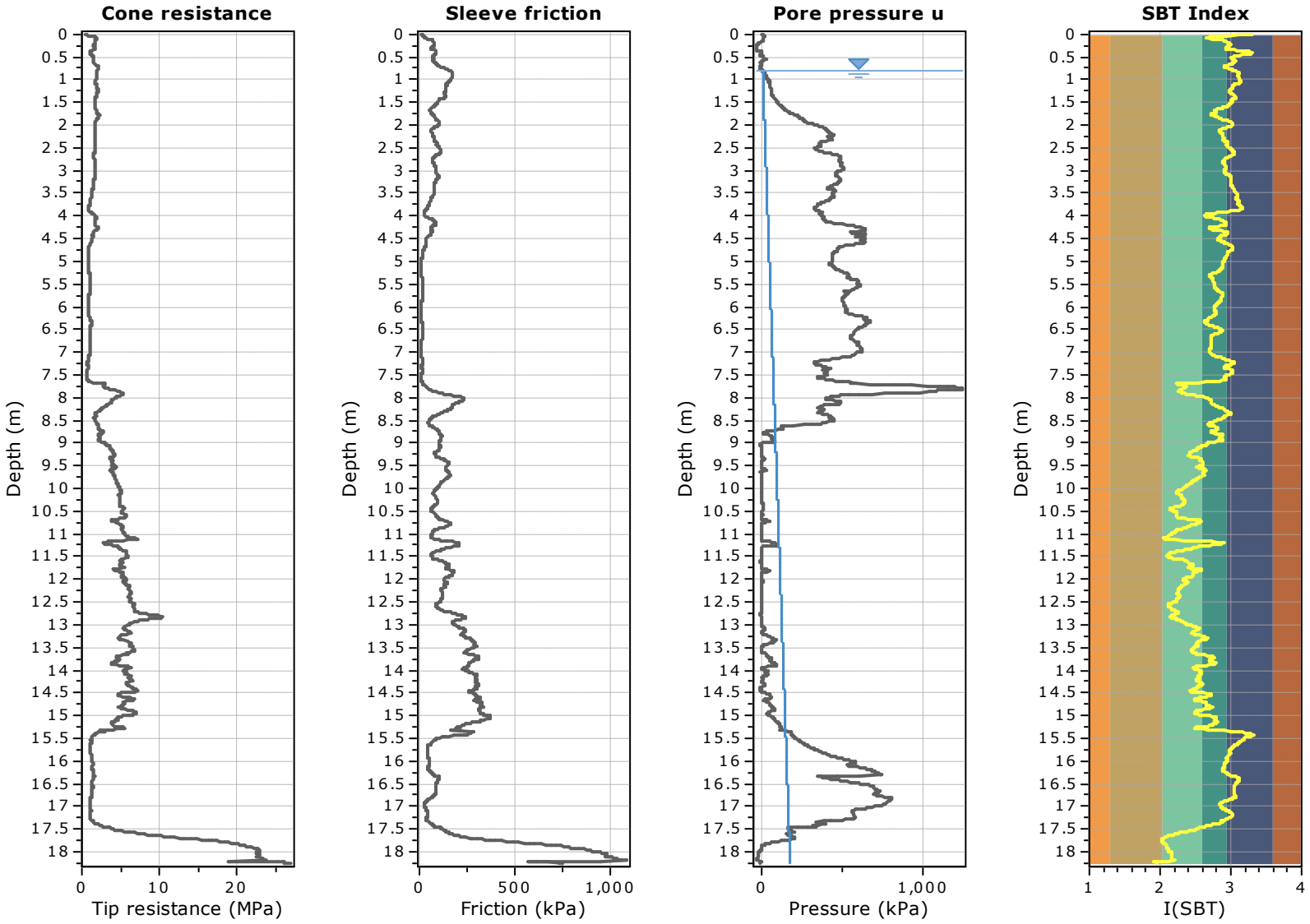
CMW Geosciences
Great People | Practical Solutions

Position: 44510.4mE; 698187.9mN Projection: Mount Eden 2000
Elevation: 51.8m Datum: Moturiki 1953 Survey Source: Hand Held GPS

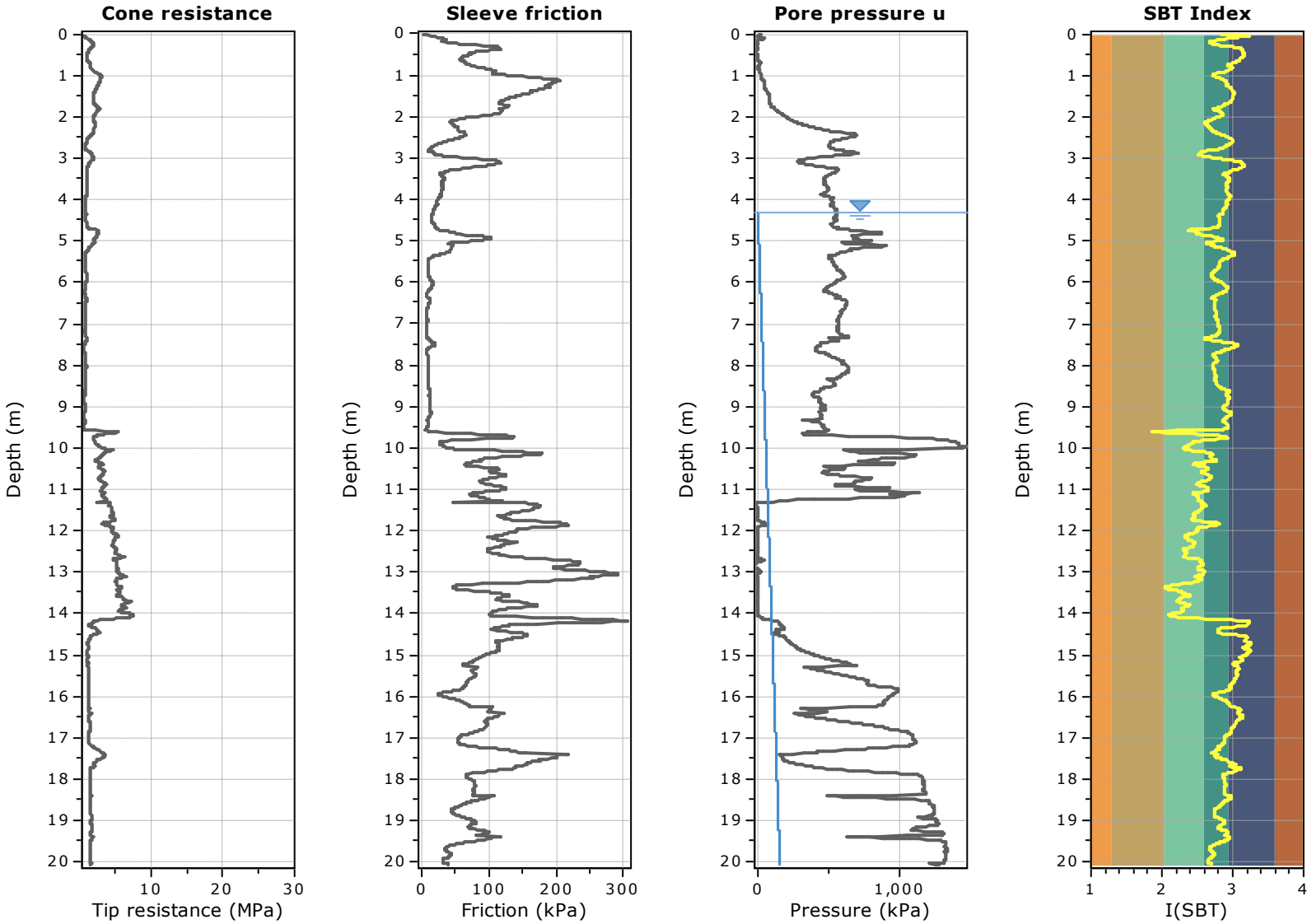
Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			51.8			ASPHALT: black.			
			51.7			(Fill)			
						GW: Fine to coarse GRAVEL: dark grey. Angular. Well graded.			
			51.6			(Uncontrolled Fill)			
	0.3	Peak = 109kPa				CH: CLAY: with some fine to medium gravel. Dark brown mottled orange brown. High plasticity. (Uncontrolled Fill)			
	0.7	Peak = 178kPa Residual = 38kPa	51.1			CH: CLAY: with trace mica. Brown. High plasticity. Moderately sensitive. (Walton Subgroup)			
						... at 0.80m, becoming light brown.			
	1.0	Peak = 131kPa Residual = 50kPa		1		*... at 1.00m, becoming orange brown.*		VSt	
	1.3	Peak = 125kPa Residual = 38kPa				*... at 1.30m, becoming brown.*			
	1.6	Peak = 156kPa Residual = 75kPa							
	1.9	Peak = 181kPa Residual = 69kPa							
			49.8	2		CH: Silty CLAY: with trace mica. Light orange brown. High plasticity. Moderately sensitive. (Walton Subgroup)			
						... at 2.00m, poor recovery.	M		
	2.3	Peak = 97kPa Residual = 31kPa							
	2.6	Peak = 109kPa Residual = 44kPa							
						... at 2.80m, becoming greyish brown streaked dark grey.			
	2.9	Peak = 138kPa Residual = 56kPa		3				St to VSt	
						... at 3.10m, becoming cream streaked pinkish grey.			
	3.3	Peak = 125kPa Residual = 34kPa							
						... at 3.40m, becoming pinkish brown streaked white.			
	3.6	Peak = 128kPa Residual = 31kPa							
	3.9	Peak = 125kPa Residual = 38kPa		4					
						... at 4.20m, becoming orange brown streaked reddish and yellowish brown mottled white and black, with trace fine sand.			
	4.3	Peak = UTP						H	
						Borehole terminated at 4.4 m			
				5					

Termination Reason: Target Depth Reached
Shear Vane No: 2993 DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.


Cone resistance
Depth (m)
Tip resistance (MPa)
Sleeve friction
Friction (kPa)
Pore pressure u
Pressure (kPa)
SBT Index
I(SBT)

CPT: CPT02
Total depth: 20.07 m, Date: 26/10/2023
Surface Elevation: 61.70 m, Est. GWL: 4.30 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



CPT: CPT03

Total depth: 22.59 m, Date: 11/03/2025

Surface Elevation: 0.00 m, Est. GWL: 2.30 m

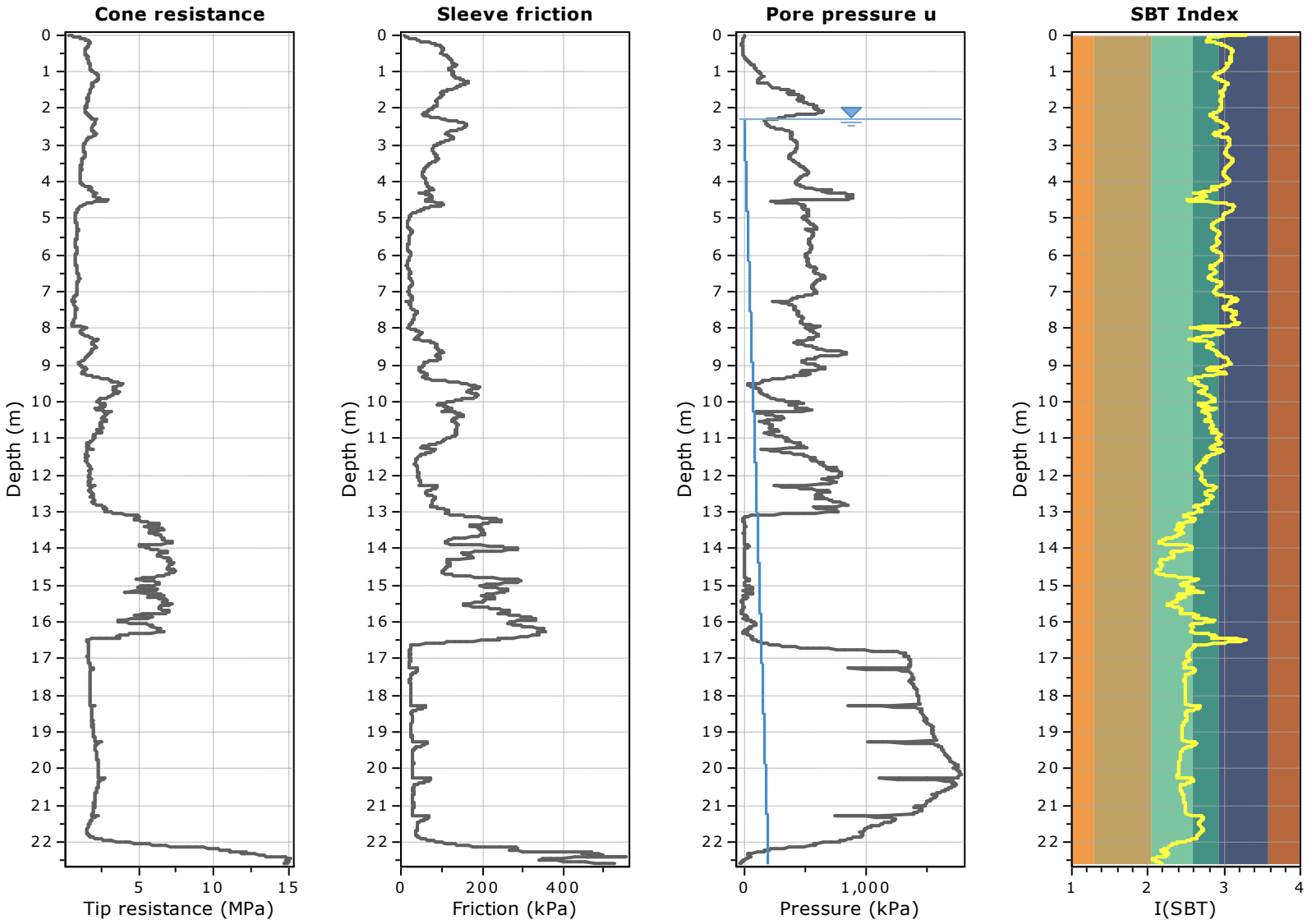
Coords: X:0.00, Y:0.00

Cone Type:

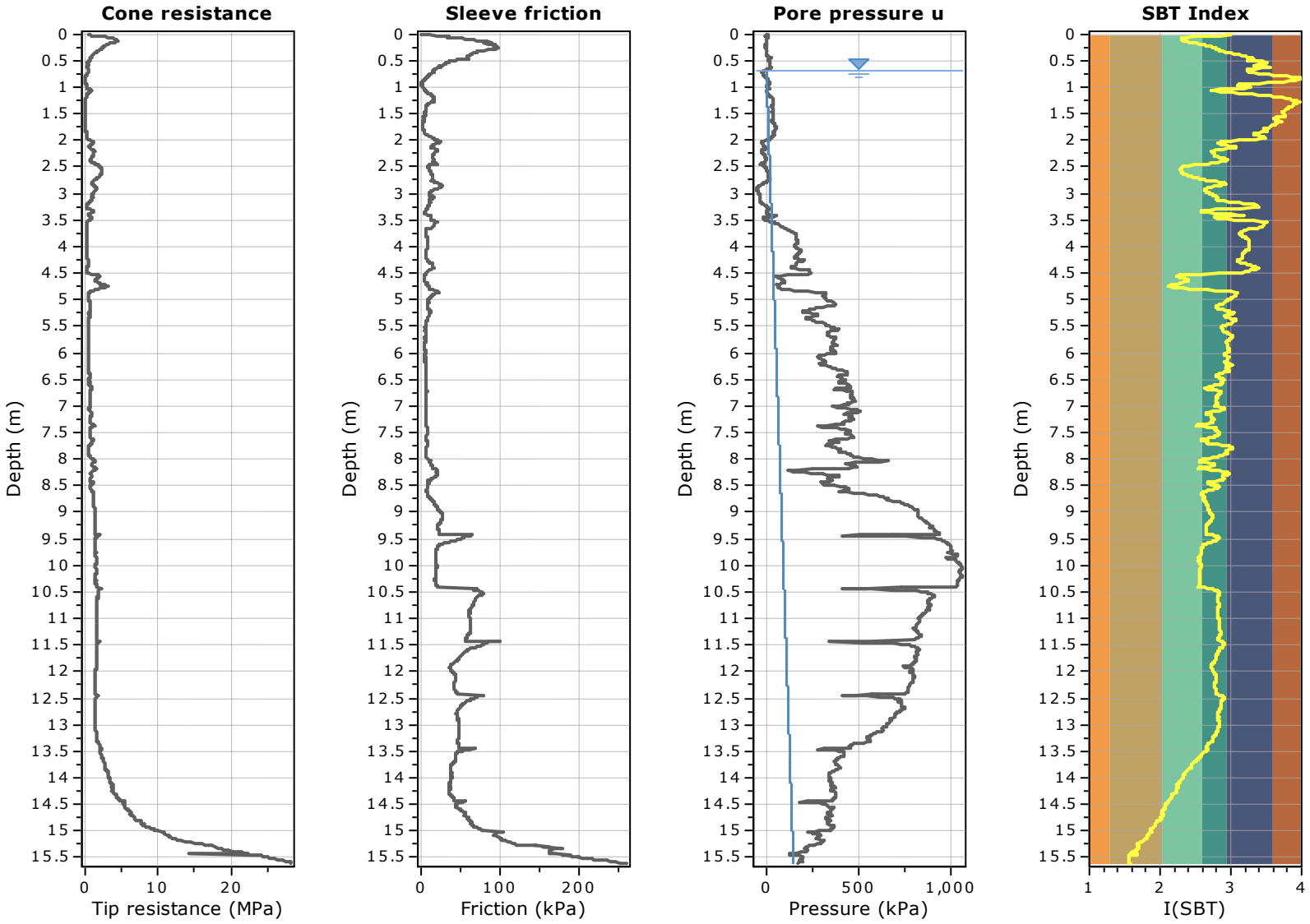
Cone Operator:

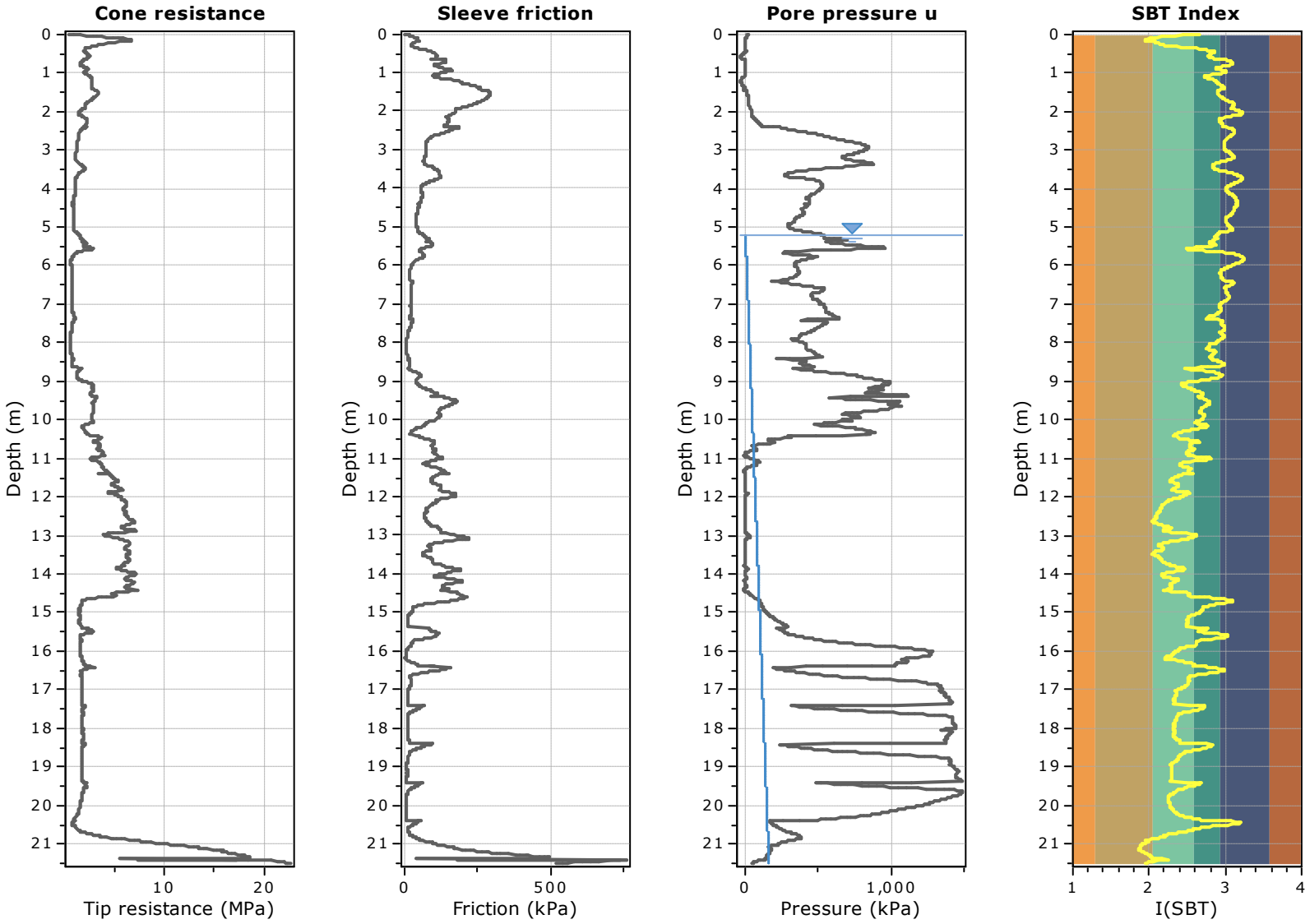
Project: HCC IAF Reservoir Optioneering

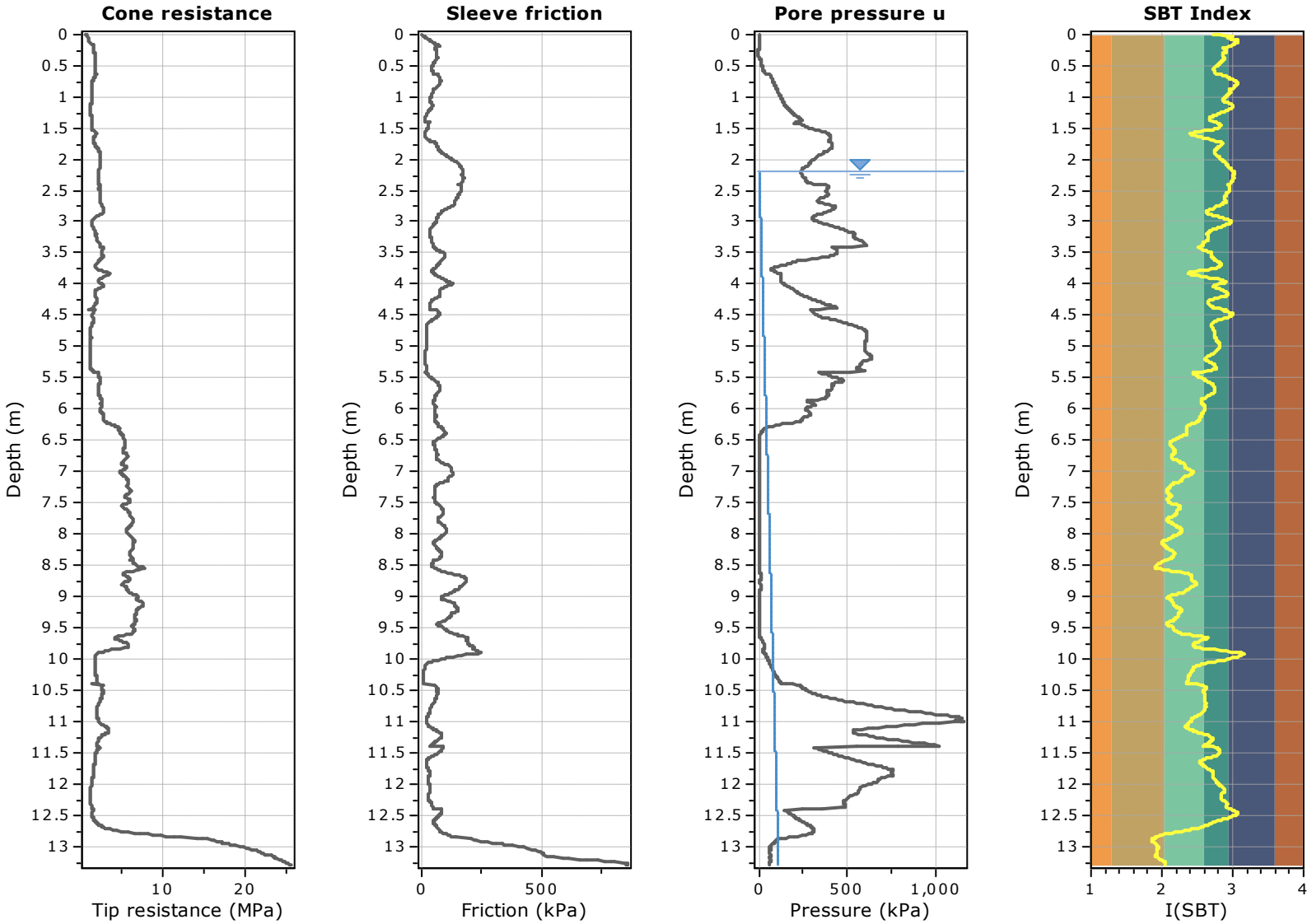
Location: Ruakiwi Rd, Hamilton Lake



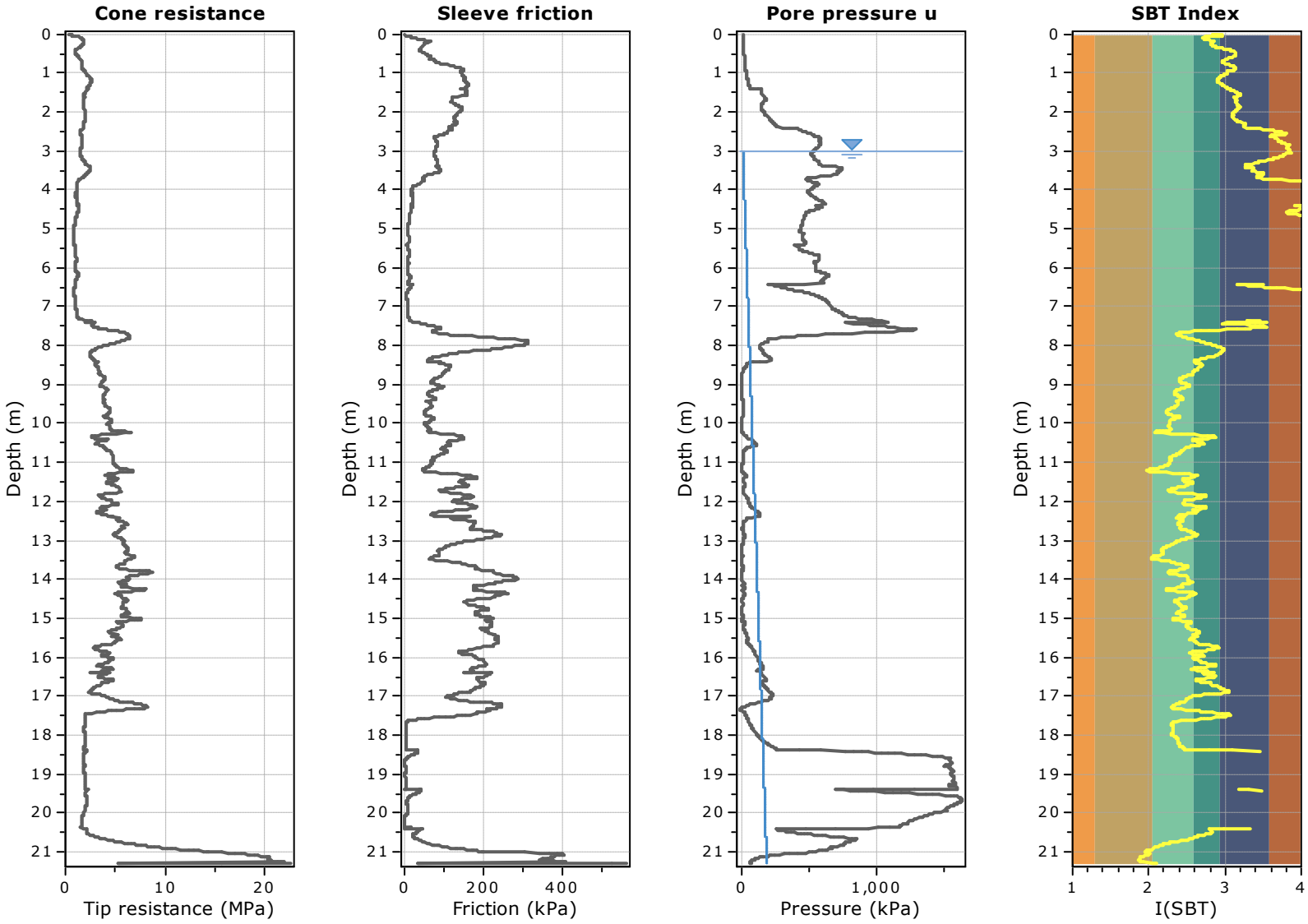
Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

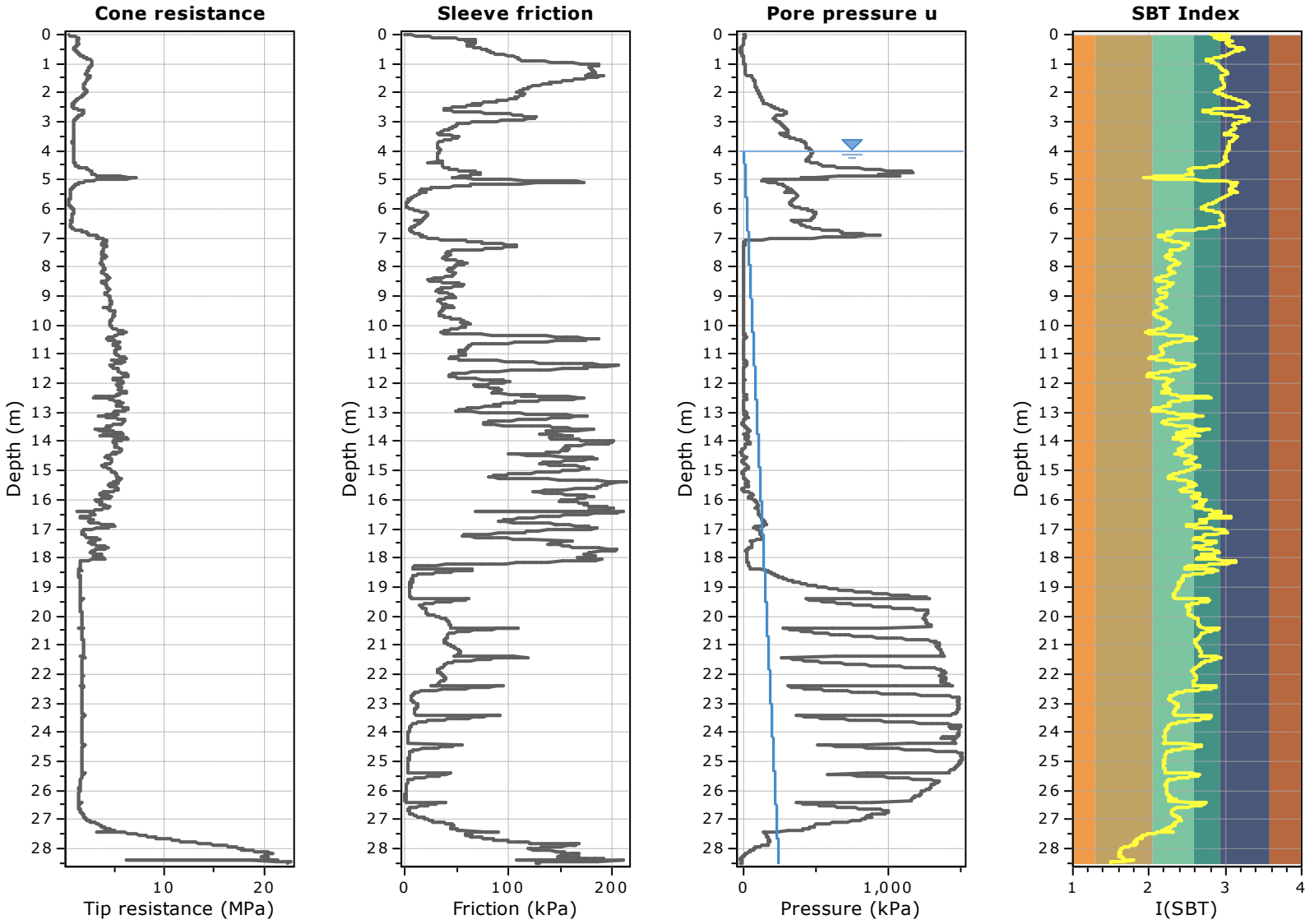


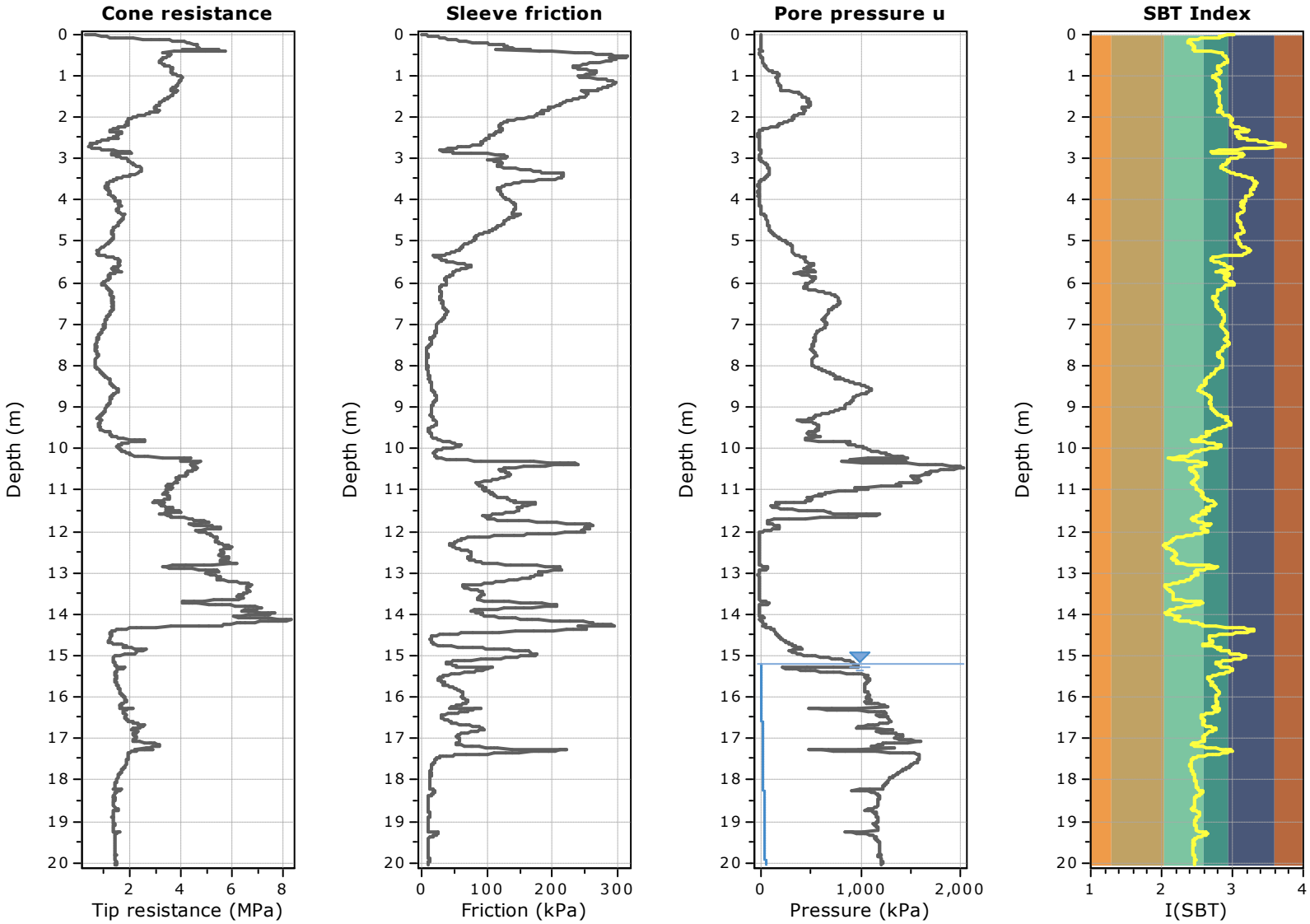

Cone resistance
Depth (m)
Tip resistance (MPa)
Sleeve friction
Friction (kPa)
Pore pressure u
Pressure (kPa)
SBT Index
I(SBT)

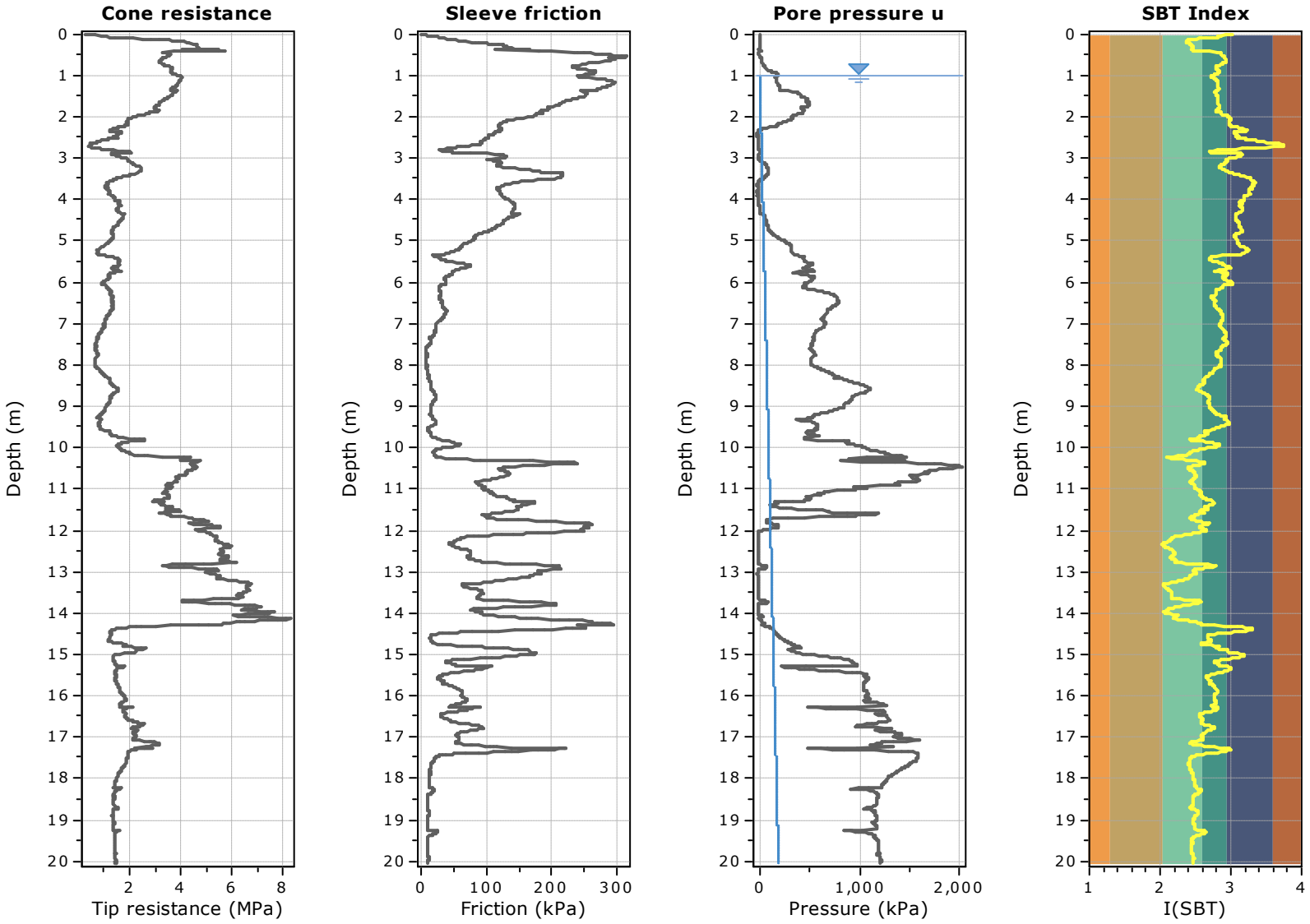

Cone resistance
Depth (m)
Tip resistance (MPa)
Sleeve friction
Friction (kPa)
Pore pressure u
Pressure (kPa)
SBT Index
I(SBT)

CPT: sCPT03
Total depth: 21.30 m, Date: 11/03/2025
Surface Elevation: 0.00 m, Est. GWL: 3.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

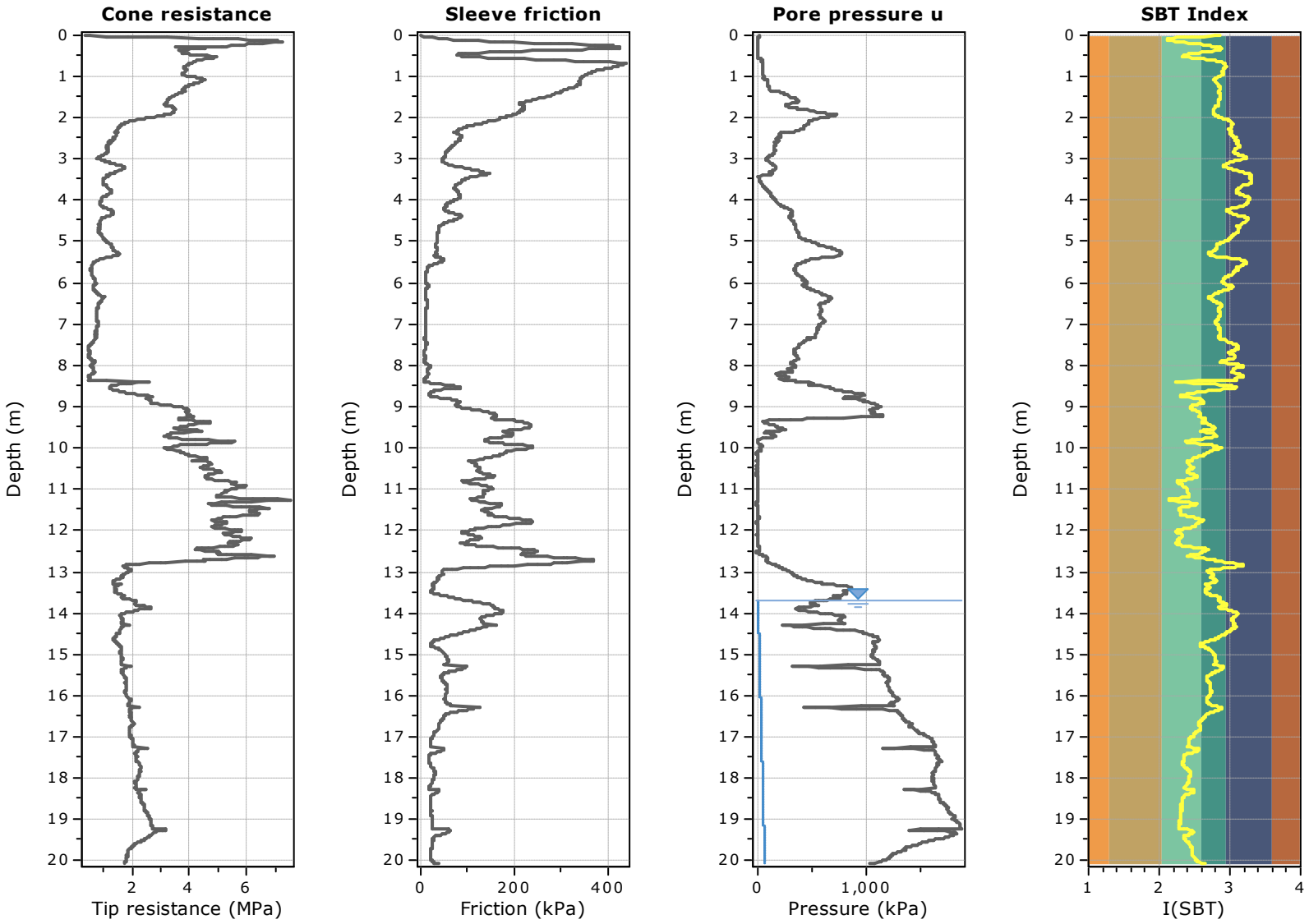


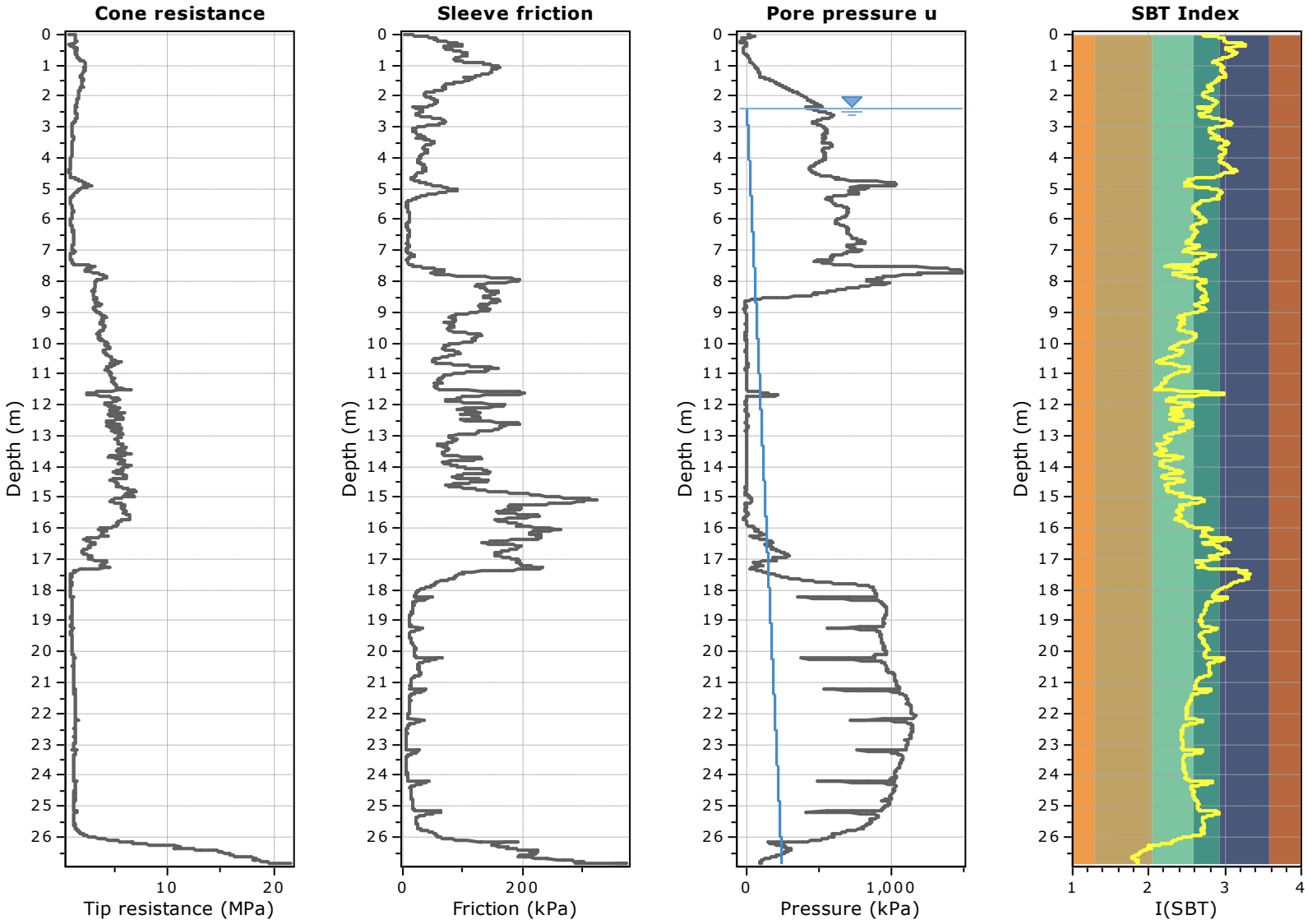

Cone resistance
Depth (m)
Tip resistance (MPa)
Sleeve friction
Friction (kPa)
Pore pressure u
Pressure (kPa)
SBT Index
I(SBT)

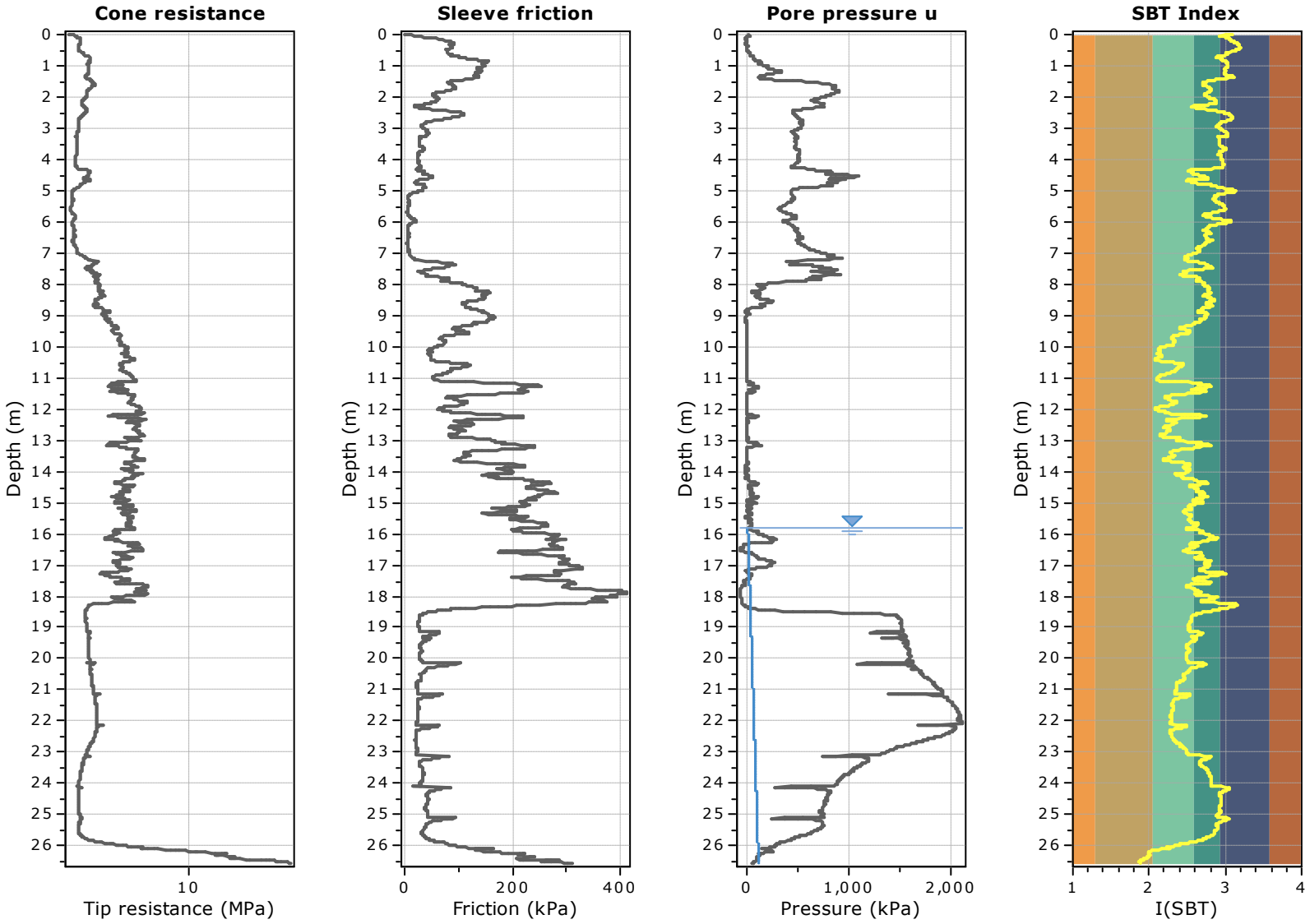

Cone resistance
Depth (m)
Tip resistance (MPa)
Sleeve friction
Friction (kPa)
Pore pressure u
Pressure (kPa)
SBT Index
I(SBT)

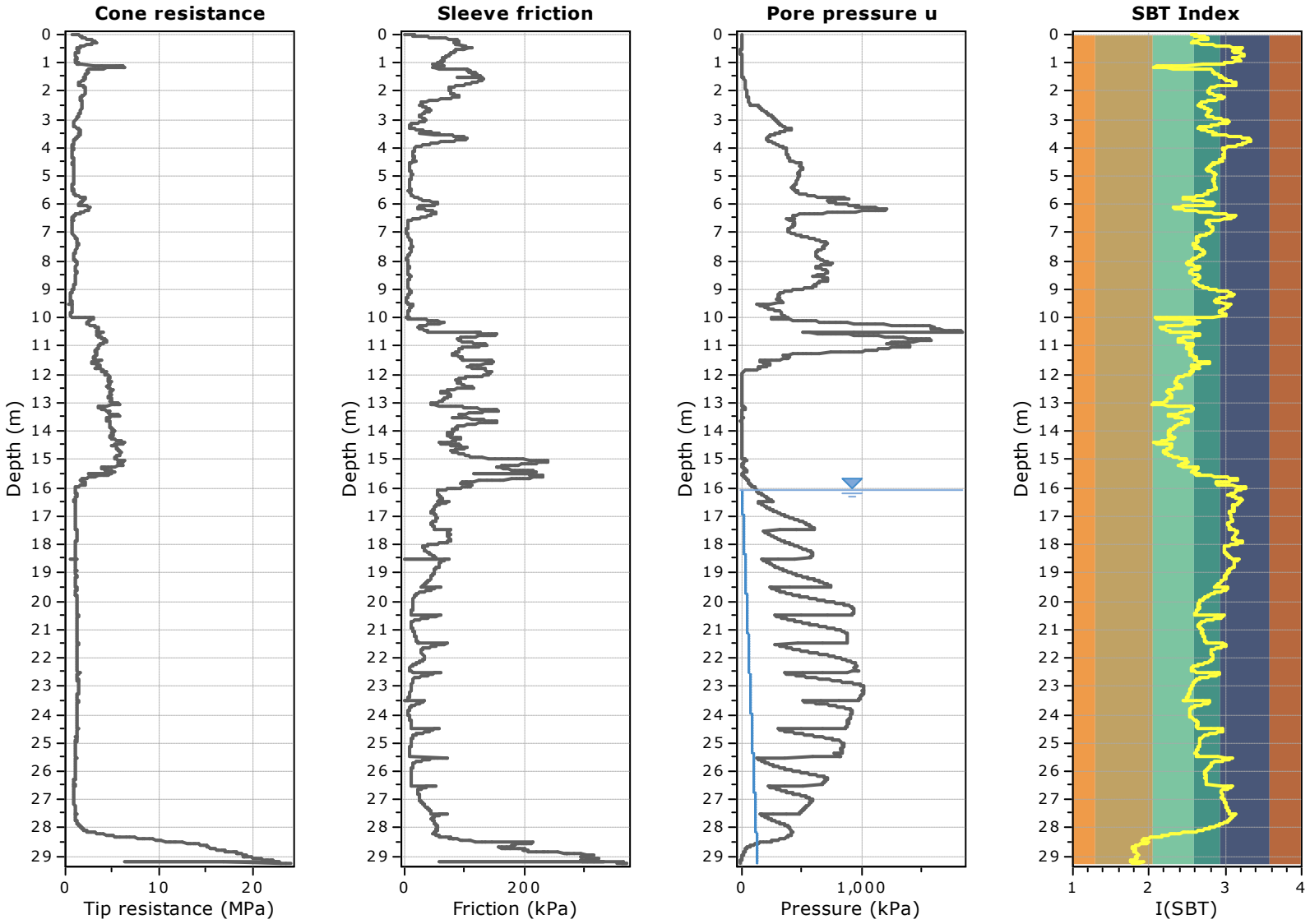

Cone resistance
Depth (m)
Tip resistance (MPa)
Sleeve friction
Friction (kPa)
Pore pressure u
Pressure (kPa)
SBT Index
I(SBT)

CPT: CPT06
Total depth: 20.06 m, Date: 11/03/2025
Surface Elevation: 0.00 m, Est. GWL: 13.70 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

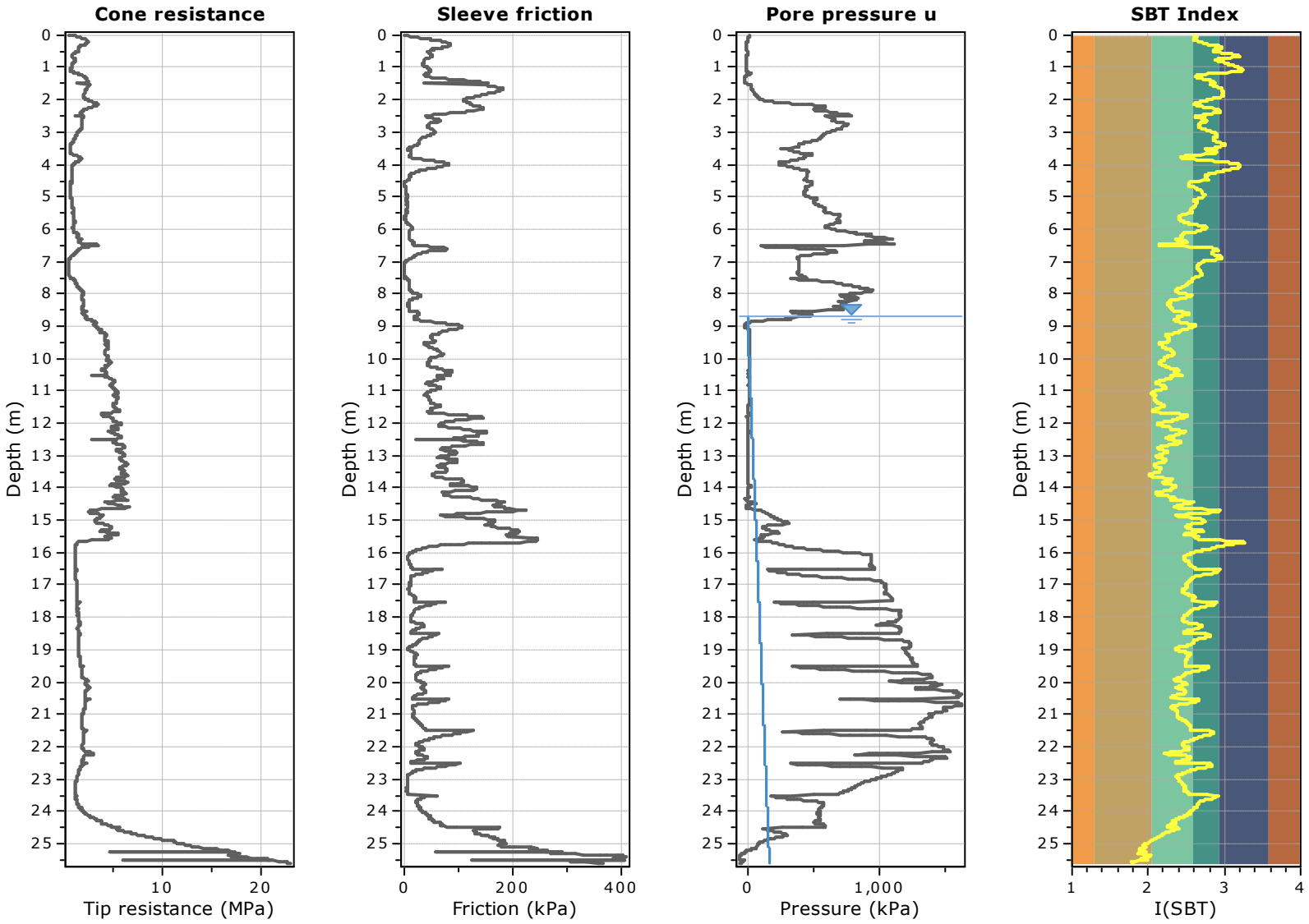



Cone resistance
Depth (m)
Tip resistance (MPa)
Sleeve friction
Friction (kPa)
Pore pressure u
Pressure (kPa)
SBT Index
I(SBT)


Cone resistance
Depth (m)
Tip resistance (MPa)
Sleeve friction
Friction (kPa)
Pore pressure u
Pressure (kPa)
SBT Index
I(SBT)


Cone resistance
Depth (m)
Tip resistance (MPa)
Sleeve friction
Friction (kPa)
Pore pressure u
Pressure (kPa)
SBT Index
I(SBT)

CPT: sCPT06
Total depth: 25.61 m, Date: 11/03/2025
Surface Elevation: 0.00 m, Est. GWL: 8.70 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Eijkelkamp GeoPoint
SoilSolutions

Rijkstraatweg 22F
2171 AL Sassenheim
The Netherlands

T +31 71 301 9251
E info@eijkelkamp-geopoint.com
I eijkelkamp-geopoint.com

Cone Calibration Certificate

General

Certificate number	**GS-2449-001**
Instrument Type	Digital Compression Cone
Model	DC10-CFIIPTT
Serial number	2449
Client	GDS

Calibration Instrument

Manufacturer	Hottinger Baldwin Messtechnik GmbH
NMi certificate	3824907.00501

Calibration Conditions

Ambient temperature	25.4	°C
Atmospheric pressure	1017	mBar

Cone Specifications

Cone base area	1000	mm2
Nominal load Tip Resistance	100	kN
Friction sleeve area	15000	mm2
Nominal load Local Friction	22.5	kN
Nominal load Pore Pressure	5000	kPa
Nom. Temperature Range	50	°C
Nominal Inclination	15	°
Temperature compensation (all channels)	0...+40	°C
Max. overload (all channels)	100	%
Cone area ratio (a)	0.74	
Friction area ratio (b)	1.00	

Standard and method of calibration NEN-EN ISO 22476-1 Class 1

Results The probe complies with the requirements of the above mentioned standard and indicated calibration class.

Maximum uncertainty transducer	qc	35 or 1%	kPa
	fs	5 or 1%	kPa
	u2	10 or 0.5%	kPa
	I	0.5	°

Relative uncertainty applies to the measured value not the measuring range.

Calibrated by	A.Verhart
Calibration date	28-08-2024
Signature	
QA Manager	R. Mosterd
Date	
Signature	

Expiration date according to NEN-EN ISO 22476-1 28-02-2025

Remarks:
This calibration is compliant with Eijkelkamp GeoPoint SoilSolutions BV internal quality system, internal calibration procedures and meets the requirements of NEN2649, NEN-EN-ISO 22476-1, NORSOK G-001, ISSMFE and ASTM using calibration equipment traceable to (Inter-)National Standards. The calibration results only relate to the probe identified in this certificate. This new certificate replaces all previously issued certificates for this probe.This certificate may not be reproduced other than in full and except with permission of Eijkelkamp GeoPoint SoilSolutions BV. Calibration certificates without signature are not valid.

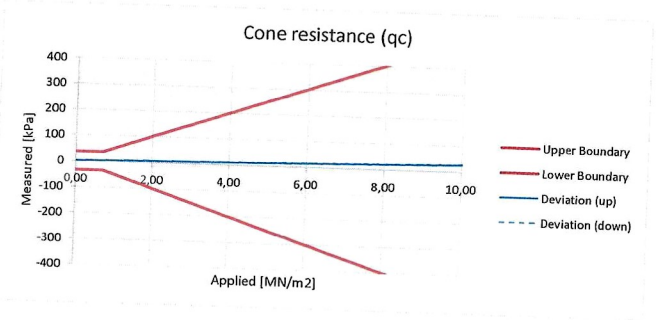
Eijkelkamp GeoPoint
SoilSolutions

CLASS 1 - CALIBRATION REPORT

Cone Nr: 2449 digital
α-factor: 0,74 @10bar

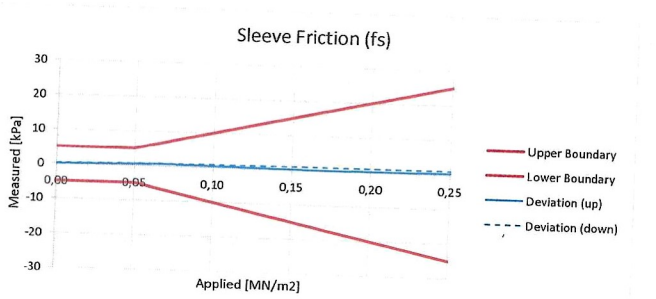
Cone resistance (qc)

Applied/Ref [kN]	Measured (up) [kN]	Deviation (up) [kPa]	Measured (down) [kN]	Deviation (down) [kPa]
0,0	0,000	0,0	0,001	0,5
1,0	1,003	2,5	1,003	2,5
2,0	2,006	5,5	2,003	3,0
3,0	3,007	7,1	3,007	6,9
5,0	5,011	11,0	5,013	13,0
7,5	7,519	18,8	7,521	20,5
10,0	10,027	26,5	10,028	28,0
17,5	17,543	42,7	17,555	54,7
25,0	25,059	59,0	25,082	81,5
37,5	37,559	59,0	37,570	70,3
50,0	50,059	59,0	50,059	59,0
100,0	100,010	10,0	100,010	10,1



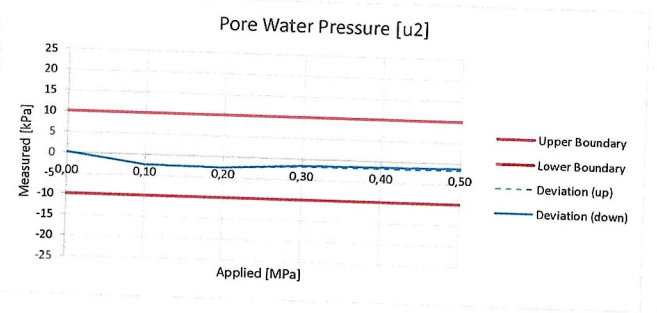
Sleeve Friction (fs)

Applied/Ref [kN]	Measured (up) [kN]	Deviation (up) [kPa]	Measured (down) [kN]	Deviation (down) [kPa]
0,0	0,000	0,00	0,003	0,17
1,0	1,008	0,50	1,010	0,67
2,5	2,501	0,03	2,515	0,97
3,8	3,754	0,27	3,764	0,90
5,0	5,008	0,50	5,013	0,83
7,5	7,511	0,73	7,529	1,90
10,0	10,015	0,97	10,045	2,97
15,0	15,020	1,32	15,047	3,13
20,0	20,025	1,67	20,050	3,30
22,5	22,501	0,07	22,501	0,07



Pore Water Pressure [u2]

Applied/Ref [kPa]	Measured (up) [kPa]	Deviation (up) [kPa]	Measured (down) [kPa]	Deviation (down) [kPa]
0,0	0,0	0,0	0,1	0,1
100,0	97,5	-2,5	97,6	-2,5
200,0	197,3	-2,7	197,4	-2,7
300,0	298,1	-1,9	298,3	-1,7
500,0	498,3	-1,7	498,8	-1,3
750,0	748,7	-1,3	749,2	-0,8
1000,0	999,1	-0,9	999,6	-0,4
1750,0	1749,7	-0,3	1750,9	0,9
2500,0	2500,3	0,3	2502,3	2,3
3750,0	3750,8	0,8	3751,8	1,8
5000,0	5001,2	1,2	5001,2	1,2



APPENDIX D

Laboratory Tests Results

Construction Sciences

Construction Sciences NZ Limited
ABN: 93 485 645

Address:
Unit 3, 9 Mohuia Crescent Elsdon
Porirua NZ 5022

Laboratory: **Wellington Laboratory**
Phone: 64 27 364 3488
Fax:
Email: wellington@constructionsciences.net

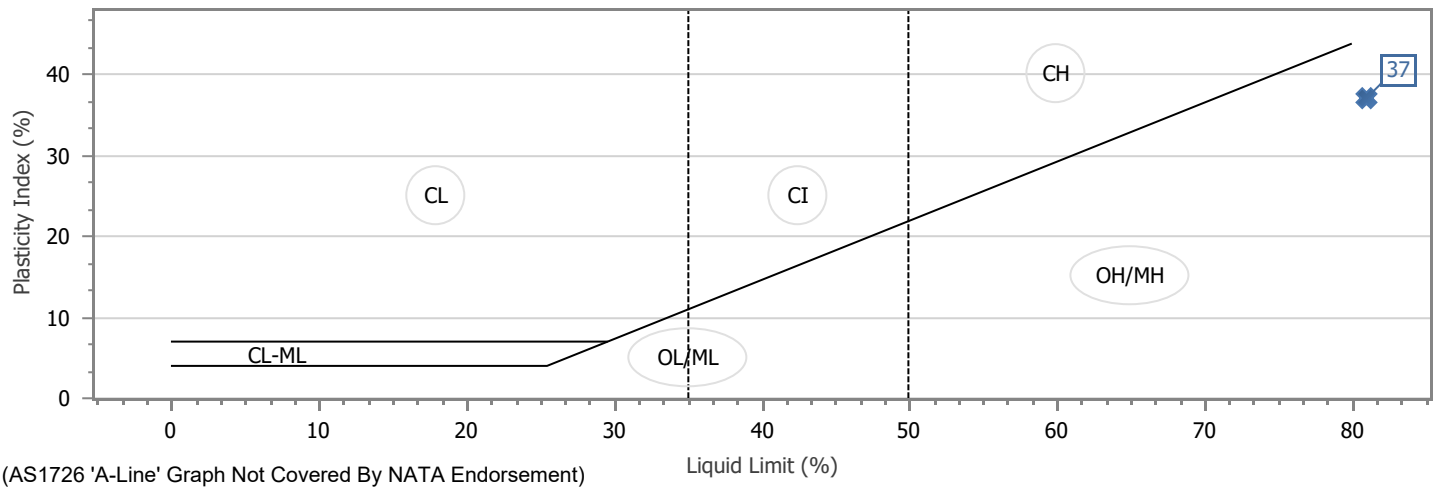
ATTERBERG LIMITS REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/28469-1
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	
Location:	Upper North Island	Internal Test Request:	1232/T/18056
Component:	HAM2023-0099	Client Reference/s:	PO# HAM130000
Area Description:		Report Date / Page:	24/04/2024 Page 5 of 6

Test Procedures:	NZS4402.2.2, NZS4402.2.4, NZS4402.2.3, NZS4402.2.1		
Sample Number	1232/S/114441	Sample Location	
Sampling Method	Tested As Received	Location	BH24-02 (1.5-2.0 m)
Date Sampled	11/04/2024		
Sampled By	Unknown		
Date Tested	24/04/2024		
Drying / Prep Method	Oven Dried / Wet Sieved (passing 0.425mm)	Material Source	-
LL Water Type	Potable	Material Type	Insitu
LL Device Type	Cassagrande	Specification	No Specification
Client Reference	Bag 1	Prep Mat > 53mm (%)	-
Material Description	-		

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit		**81**	
Plastic Limit		**44**	
Plasticity Index		**37**	
Linear Shrinkage			
Linear Shrinkage Observations:			

Atterberg Limits 'A-Line' Graph



(AS1726 'A-Line' Graph Not Covered By NATA Endorsement)

Remarks

ACCREDITED
IANZ
TESTING LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

Accreditation Number: 1232

Approved Signatory: Karl Rutherford
Form ID: W11Rep Rev 2

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ABN: 93 485 645

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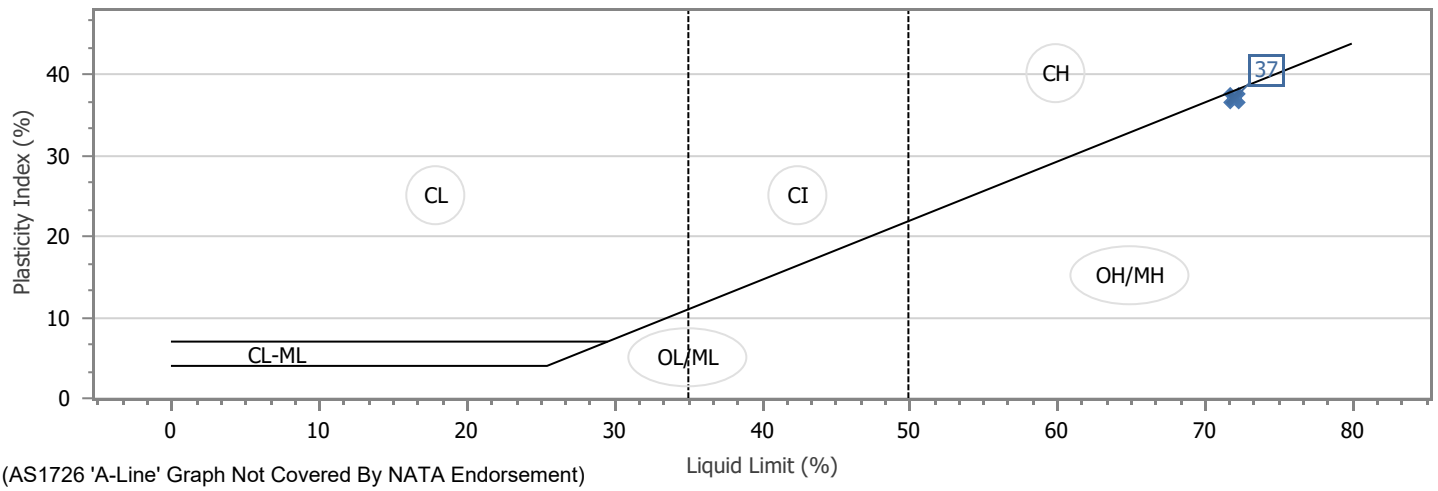
ATTERBERG LIMITS REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/28469-1
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	
Location:	Upper North Island	Internal Test Request:	1232/T/18056
Component:	HAM2023-0099	Client Reference/s:	PO# HAM130000
Area Description:		Report Date / Page:	24/04/2024 Page 6 of 6

Test Procedures:	NZS4402.2.2, NZS4402.2.4, NZS4402.2.3, NZS4402.2.1		
Sample Number	1232/S/114442	Sample Location	
Sampling Method	Tested As Received	Location	BH24-02 (3.0-3.5m)
Date Sampled	11/04/2024		
Sampled By	Unknown		
Date Tested	24/04/2024		
Drying / Prep Method	Air Dried / Wet Sieved (passing 0.425mm)	Material Source	-
LL Water Type	Potable	Material Type	Insitu
LL Device Type	Cassagrande	Specification	No Specification
Client Reference	Bag 2	Prep Mat > 53mm (%)	-
Material Description	-		

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit		**72**	
Plastic Limit		**35**	
Plasticity Index		**37**	
Linear Shrinkage			
Linear Shrinkage Observations:			

Atterberg Limits 'A-Line' Graph



(AS1726 'A-Line' Graph Not Covered By NATA Endorsement)

Remarks

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IANZ
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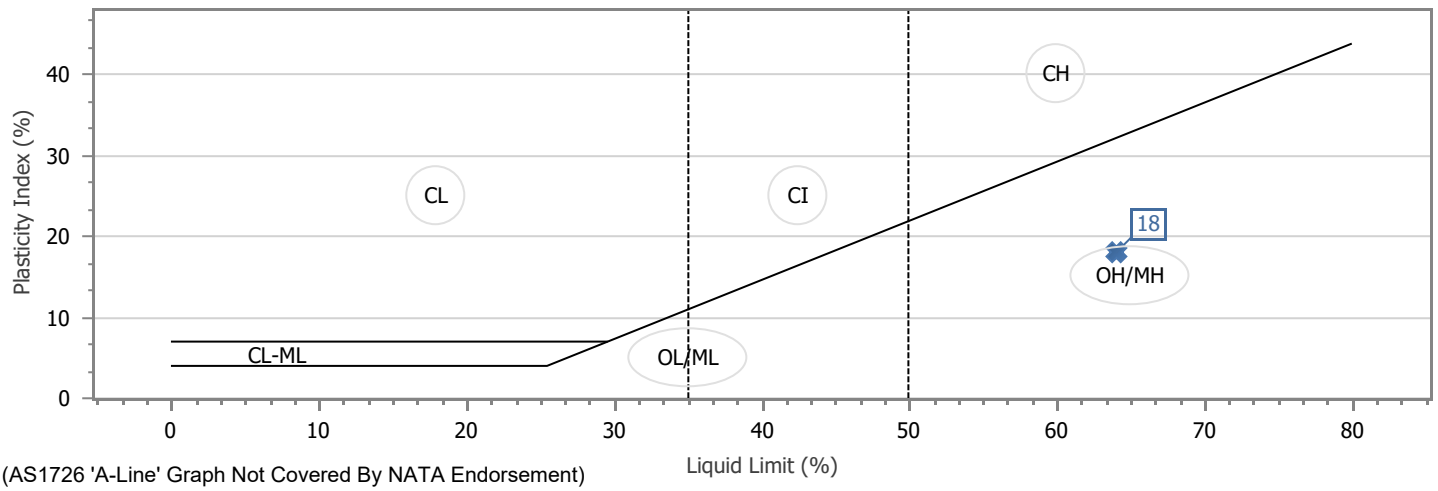
ATTERBERG LIMITS REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/28577-2
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	BH02 Bag 3
Location:	Upper North Island	Internal Test Request:	1232/T/18056
Supplied To:	CMW Geotechnical NZ Limited	Client Reference/s:	PO# HAM130000
Area Description:		Report Date / Page:	8/05/2024 Page 1 of 2

Test Procedures:	NZS4402.2.2, NZS4402.2.4, NZS4402.2.3, NZS4402.2.1		
Sample Number	1232/S/114672	Sample Location	
Sampling Method	Tested As Received	Location	HAM2023-0099
Date Sampled	11/04/2024		5.5-5.5m
Sampled By	Client Sampled		
Date Tested	7/05/2024		
Drying / Prep Method	Air Dried / Wet Sieved (whole sample)	Material Source	Insitu
LL Water Type		Material Type	Insitu
LL Device Type	Cassagrande	Specification	No Specification
Client Reference	-	Prep Mat > 53mm (%)	-
Material Description	-		

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit		**64**	
Plastic Limit		**46**	
Plasticity Index		**18**	
Linear Shrinkage			
Linear Shrinkage Observations:			

Atterberg Limits 'A-Line' Graph



(AS1726 'A-Line' Graph Not Covered By NATA Endorsement)

Remarks: Re-Issued Report Replaces Report No 1232/R/28577-1 (reason: Material passing 75um. Not accredited)

Verifed By: Karl Rutherford
Form ID: W11Rep Rev 2

Construction Sciences

Construction Sciences NZ Limited
ABN: 93 485 645

Address:
Unit 3, 9 Mohuia Crescent Elsdon
Porirua NZ 5022

Laboratory: **Wellington Laboratory**
Phone: 64 27 364 3488
Fax:
Email: wellington@constructionsciences.net

ATTERBERG LIMITS REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/28577-2
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	BH03 Bag 5
Location:	Upper North Island	Internal Test Request:	1232/T/18056
Supplied To:	CMW Geotechnical NZ Limited	Client Reference/s:	PO# HAM130000
Area Description:		Report Date / Page:	8/05/2024 Page 2 of 2

Test Procedures: NZS4402.2.2, NZS4402.2.4, NZS4402.2.3, NZS4402.2.1

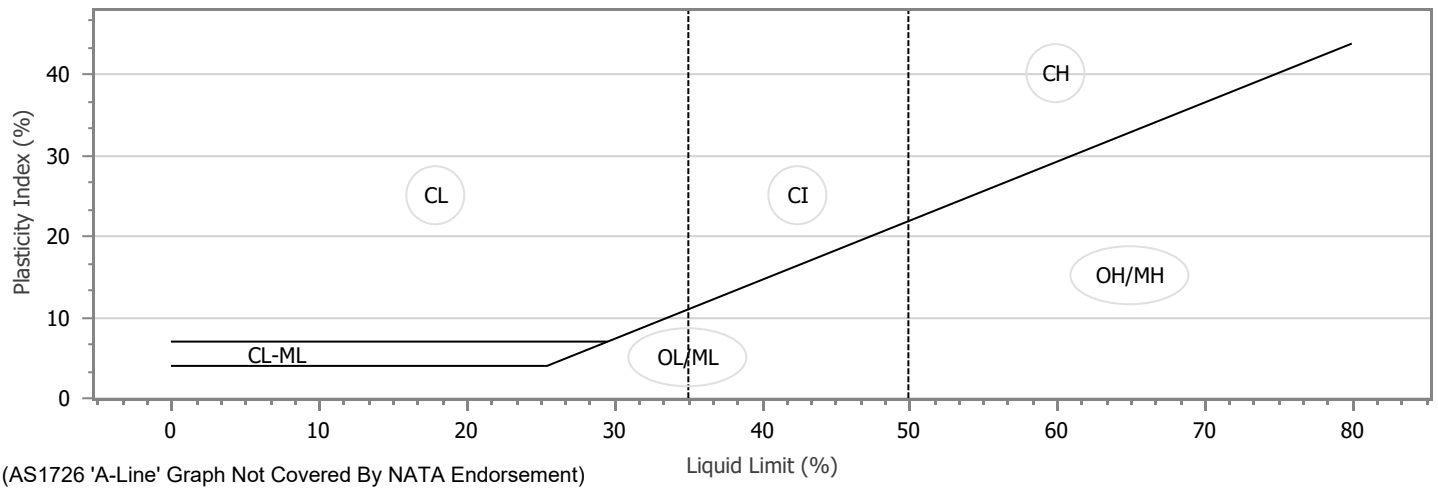
Sample Number	1232/S/114674	Sample Location	
Sampling Method	Tested As Received	Location	HAM2023-0099
Date Sampled	11/04/2024		4.9-5.2m
Sampled By	Client Sampled		
Date Tested	7/05/2024		
Drying / Prep Method	Oven Dried / Wet Sieved (whole sample)	Material Source	Insitu
LL Water Type		Material Type	Insitu
LL Device Type	Cassagrande	Specification	No Specification
Client Reference	-	Prep Mat > 53mm (%)	-

Material Description: -

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit		**111**	
Plastic Limit		**52**	
Plasticity Index		**59**	
Linear Shrinkage			

Linear Shrinkage Observations:

Atterberg Limits 'A-Line' Graph



(AS1726 'A-Line' Graph Not Covered By NATA Endorsement)

Remarks: Re-Issued Report Replaces Report No 1232/R/28577-1 (reason: Material passing 75um. Not accredited)

Verifed By: Karl Rutherford
Form ID: W11Rep Rev 2

Construction Sciences

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ABN: 93 485 645

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Unit 3, 9 Mohuia Crescent Elsdon
Porirua NZ 5022

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Email: wellington@constructionsciences.net

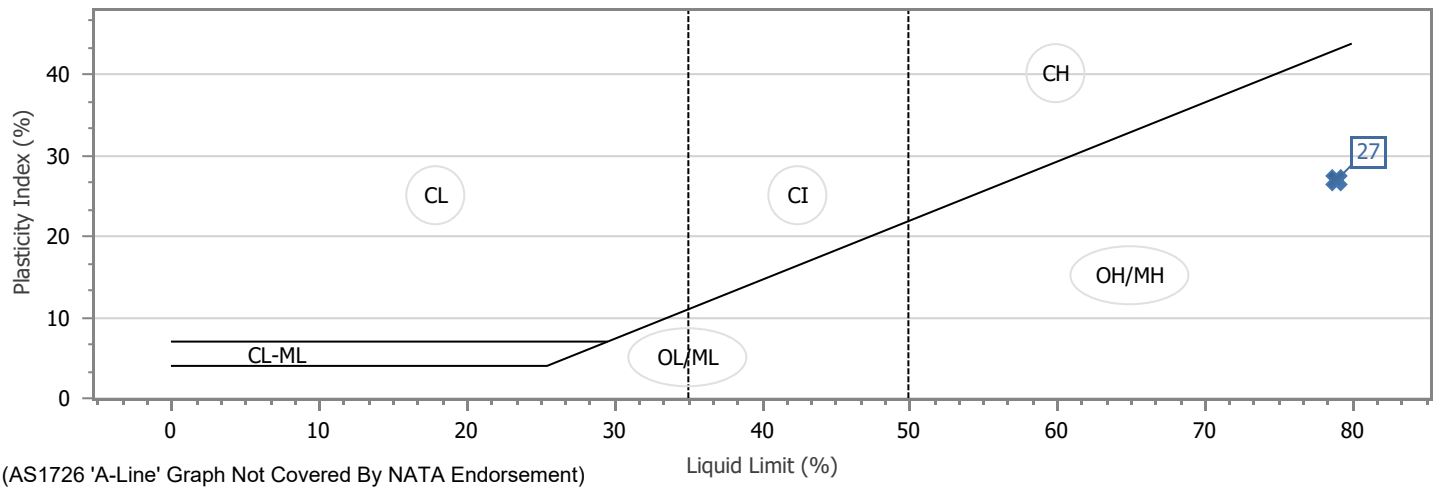
ATTERBERG LIMITS REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/28469-1
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	
Location:	Upper North Island	Internal Test Request:	1232/T/18056
Component:	HAM2023-0099	Client Reference/s:	PO# HAM130000
Area Description:		Report Date / Page:	24/04/2024 Page 4 of 6

Test Procedures:	NZS4402.2.2, NZS4402.2.4, NZS4402.2.3, NZS4402.2.1		
Sample Number	1232/S/114440	Sample Location	
Sampling Method	Tested As Received	Location	BH24-03 (7.0-7.5m)
Date Sampled	11/04/2024		
Sampled By	Unknown		
Date Tested	24/04/2024		
Drying / Prep Method	Oven Dried / Wet Sieved (passing 0.425mm)	Material Source	-
LL Water Type	Potable	Material Type	Insitu
LL Device Type	Cassagrande	Specification	No Specification
Client Reference	Bag 6	Prep Mat > 53mm (%)	-
Material Description	-		

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit		**79**	
Plastic Limit		**52**	
Plasticity Index		**27**	
Linear Shrinkage			
Linear Shrinkage Observations:			

Atterberg Limits 'A-Line' Graph



(AS1726 'A-Line' Graph Not Covered By NATA Endorsement)

Remarks

ACCREDITED
IANZ
TESTING LABORATORY

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Accreditation Number: 1232

Approved Signatory: Karl Rutherford
Form ID: W11Rep Rev 2

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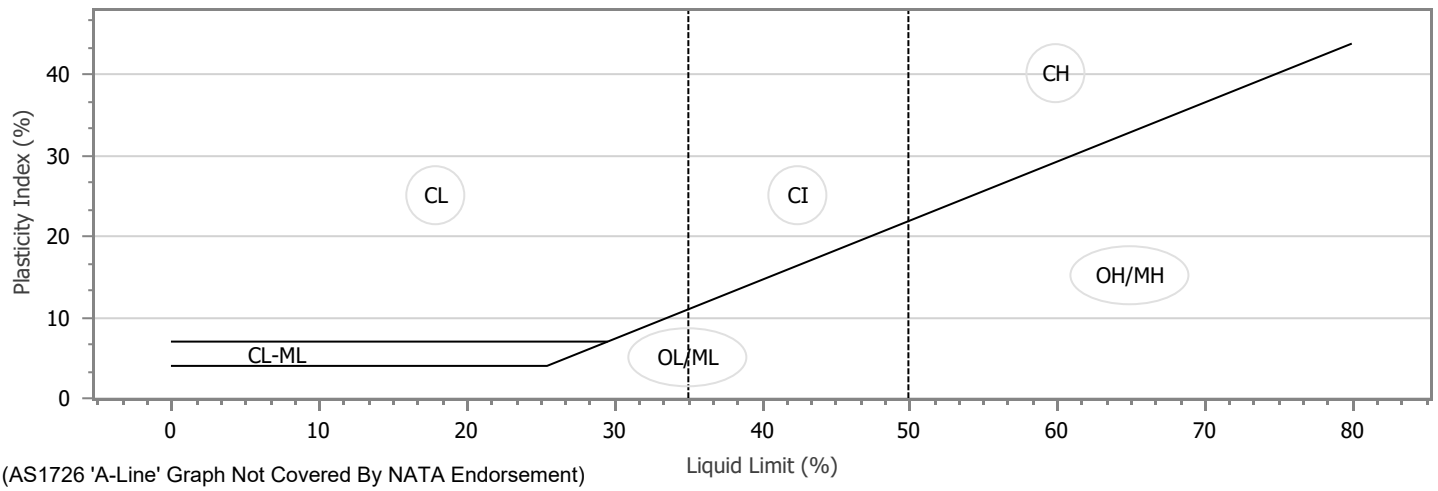
ATTERBERG LIMITS REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/28469-1
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	
Location:	Upper North Island	Internal Test Request:	1232/T/18056
Component:	HAM2023-0099	Client Reference/s:	PO# HAM130000
Area Description:		Report Date / Page:	24/04/2024 Page 1 of 6

Test Procedures:	NZS4402.2.2, NZS4402.2.4, NZS4402.2.3, NZS4402.2.1		
Sample Number	1232/S/114437	Sample Location	
Sampling Method	Tested As Received	Location	BH24-04 (4.5-5.0 m)
Date Sampled	11/04/2024		
Sampled By	Unknown		
Date Tested	24/04/2024		
Drying / Prep Method	Oven Dried / Wet Sieved (passing 0.425mm)	Material Source	-
LL Water Type	Potable	Material Type	Insitu
LL Device Type	Cassagrande	Specification	No Specification
Client Reference	Bag 4	Prep Mat > 53mm (%)	-
Material Description	-		

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit		**99**	
Plastic Limit		**52**	
Plasticity Index		**47**	
Linear Shrinkage			
Linear Shrinkage Observations:			

Atterberg Limits 'A-Line' Graph



(AS1726 'A-Line' Graph Not Covered By NATA Endorsement)

Remarks

ACCREDITED
IANZ
TESTING LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

Accreditation Number: 1232

Approved Signatory: Karl Rutherford
Form ID: W11Rep Rev 2

Construction Sciences
a kiwa company

Construction Sciences NZ Limited
ABN: 093 485 645

Address:
Unit 3, 9 Mohuia Crescent Elsdon
Porirua NZ 5022

Laboratory: **Wellington Laboratory**
Phone: 64 27 364 3488
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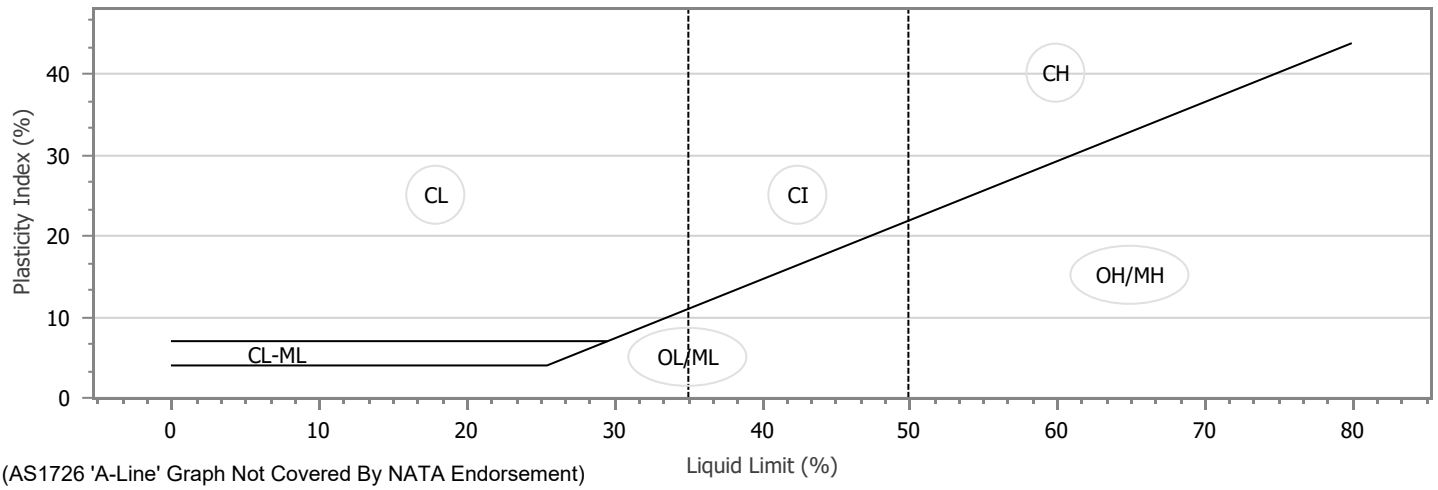
ATTERBERG LIMITS REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/25-59-2
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	
Location:	Upper North Island	Internal Test Request:	1232/T/25-29
Supplied To:	CMW Geotechnical NZ Limited	Client Reference/s:	HAM136470
Area Description:		Report Date / Page:	27/02/2025 Page 1 of 2

Test Procedures:	NZS4402.2.2, NZS4402.2.4, NZS4402.2.3, NZS4407.3.1		
Sample Number	1232/S/25-261	Sample Location	
Sampling Method		Location	PS-BH24-01
Date Sampled	25/02/2025		Ash formation
Sampled By	Client Sampled		
Date Tested	27/02/2025		
Drying / Prep Method	Oven Dried / Wet Sieved (whole sample)	Material Source	Insitu
LL Water Type	Potable	Material Type	Insitu
LL Device Type	Cassagrande	Specification	-
Client Reference	1	Prep Mat > 53mm (%)	-
Material Description	-		

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit		**110**	
Plastic Limit		**73**	
Plasticity Index		**37**	
Linear Shrinkage			
Linear Shrinkage Observations:			

Atterberg Limits 'A-Line' Graph



(AS1726 'A-Line' Graph Not Covered By NATA Endorsement)

Remarks	Not Endorsed - Fraction tested over the 75um Re-Issued Report Replaces Report No 1232/R/25-59-1 (reason: LS Removed)

Verifed By: Karl Rutherford
Form ID: W11Rep Rev 2

Construction Sciences
a kiwa company

Construction Sciences NZ Limited
ABN: 093 485 645

Address:
Unit 3, 9 Mohuia Crescent Elsdon
Porirua NZ 5022

Laboratory: **Wellington Laboratory**
Phone: 64 27 364 3488
Fax:
Email: wellington@constructionsciences.net

ATTERBERG LIMITS REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/25-59-2
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	
Location:	Upper North Island	Internal Test Request:	1232/T/25-29
Supplied To:	CMW Geotechnical NZ Limited	Client Reference/s:	HAM136470
Area Description:		Report Date / Page:	27/02/2025 Page 2 of 2

Test Procedures:	NZS4402.2.2, NZS4402.2.4, NZS4402.2.3		
Sample Number	1232/S/25-262	Sample Location	
Sampling Method		Location	PS-BH24-02
Date Sampled	25/02/2025		Karapiro formation
Sampled By	Client Sampled		
Date Tested	27/02/2025		
Drying / Prep Method	- / - (whole sample)	Material Source	Insitu
LL Water Type		Material Type	Insitu
LL Device Type	Cassagrande	Specification	-
Client Reference	2	Prep Mat > 53mm (%)	-
Material Description	-		

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit		**Not applicable**	
Plastic Limit		**Non-Plastic**	
Plasticity Index		**Non Plastic**	
Linear Shrinkage			
Linear Shrinkage Observations:			

Remarks	Not Endorsed - Fraction tested over the 75um Re-Issued Report Replaces Report No 1232/R/25-59-1 (reason: LS Removed)



Verifed By: Karl Rutherford
Form ID: W11Rep Rev 2

PLASTICITY INDEX FOR SOILS
TEST REPORT

Project :	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Contractor :	-
Sampled by :	Client
Date sampled :	Not Stated
Date received :	19/12/24
Sampling method :	Borehole
Sample condition :	As received

Project No :	2-68014.00
Lab Ref No :	HA14114_PI
Client Ref No :	HAM2023-0099

Test Results

Sample Lab Ref No :	HA14114_1_PI	HA14114_2_PI	HA14114_5_PI	HA14114_6_PI	HA14114_9_PI
Borehole :	BH24-05	BH24-05	BH24-06	BH24-06	BH24-05
Sample Depth (m) :	1.0-1.5	4.0-4.5	6.0-6.5	7.5-8.0	5.0-5.5
Soil Fraction Tested :	-425µm	-425µm	-425µm	-425µm	-425µm
Natural Water Content (%) :	53.3	76.2	51.3	59.6	40.5
Liquid Limit :	108	113	64	96	49
Plastic Limit :	46	56	41	55	32
Plasticity Index :	62	57	23	41	17

Sample Description :		
	HA14114_1_PI	CLAY
	HA14114_2_PI	CLAY
	HA14114_5_PI	CLAY
	HA14114_6_PI	CLAY
	HA14114_9_PI	CLAY

Test Methods		Notes
Water Content	NZS 4402 : 1986, Test 2.1	Soil fraction tested as shown.
Liquid Limit	NZS 4402 : 1986, Test 2.2	
Plastic Limit	NZS 4402 : 1986, Test 2.3	
Plasticity Index	NZS 4402 : 1986, Test 2.4	

Date tested : 28-31/01/25
Date reported : 10/02/25

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full
All information supplied by Client

Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/25

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

WSP
Hamilton (Fox St)
Quality Management Systems Certified to ISO 9001

4 Fox Street
Private Bag 3057, Waikato Mail Centre, 3240,
Hamilton, New Zealand

Telephone 07 856 2870
Website www.wsp.com/nz

PLASTICITY INDEX FOR SOILS
TEST REPORT

Project :	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Contractor :	-
Sampled by :	Client
Date sampled :	Not Stated
Date received :	19/12/24
Sampling method :	Borehole
Sample condition :	As received

Project No :	2-68014.00
Lab Ref No :	HA14114_PI
Client Ref No :	HAM2023-0099

Test Results

Sample Lab Ref No :	HA14114_10_PI	HA14114_11_PI	HA14114_12_PI	HA14114_13_PI
Borehole :	BH24-05	BH24-06	BH24-06	BH24-01
Sample Depth (m) :	5.5-6.5	1.0-1.5	1.7-2.2	7.0-8.0
Soil Fraction Tested :	-425µm	-425µm	-425µm	-425µm
Natural Water Content (%) :	99.6	44.5	54.6	35.0
Liquid Limit :	130	106	110	76
Plastic Limit :	73	44	48	37
Plasticity Index :	**57**	**62**	**62**	**39**

Sample Description :		
	HA14114_10_PI	CLAY
	HA14114_11_PI	CLAY
	HA14114_12_PI	CLAY
	HA14114_13_PI	SAND

Test Methods		Notes
Water Content	NZS 4402 : 1986, Test 2.1	Soil fraction tested as shown.
Liquid Limit	NZS 4402 : 1986, Test 2.2	
Plastic Limit	NZS 4402 : 1986, Test 2.3	
Plasticity Index	NZS 4402 : 1986, Test 2.4	

Date tested : 28-31/01/25
Date reported : 10/02/25

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full
All information supplied by Client

Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/25

ACCREDITED IANZ TESTING LABORATORY

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WSP
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Construction Sciences

Construction Sciences NZ Limited
ABN: 93 485 645

Address:
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Porirua NZ 5022

Laboratory: **Wellington Laboratory**
Phone: 64 27 364 3488
Fax:
Email: wellington@constructionsciences.net

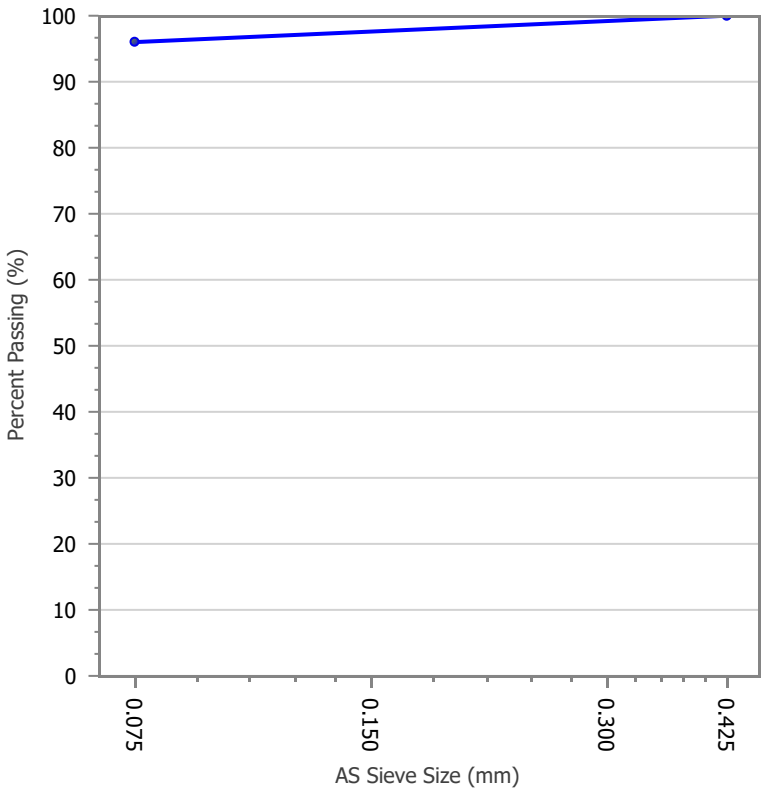
PARTICLE SIZE DISTRIBUTION REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/28510-1
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	HAM2023-0099
Location:	Upper North Island	Internal Test Request:	1232/T/18056
Supplied To:	CMW Geotechnical NZ Limited	Client Reference/s:	PO# HAM130000
Area Description:		Report Date / Page:	2/05/2024 Page 5 of 6

Test Procedures:	NZS4407.3.8.1		
Sample Number	1232/S/114441	Location	BH02 Bag 1
Sampling Method	Tested As Received		1.5-2m
Date Sampled	11/04/2024 12:00		
Sampled By	Unknown		
Date Tested	2/05/2024	Material Source	-
Prep / Drying Method	Washed / Oven	Material Type	Insitu
Prep > 53mm (%)	-	Specification	No Specification

AS Sieve (mm)	Specification Minimum (%)	**Percent Passing (%)**	Specification Maximum (%)
0.425		**100**	
0.075		**96**	

PARTICLE SIZE DISTRIBUTION GRAPH



Remarks

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

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Accreditation Number: 1232

Approved Signatory: Karl Rutherford
Form ID: W9Rep Rev 3

Construction Sciences

Construction Sciences NZ Limited
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Address:
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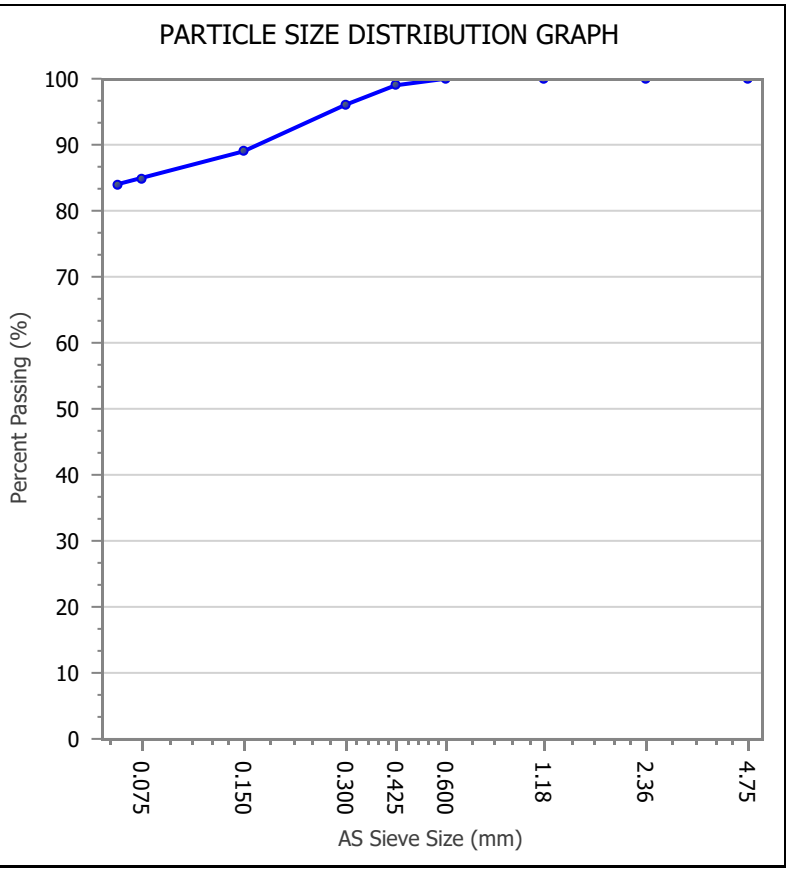
Laboratory: **Wellington Laboratory**
Phone: 64 27 364 3488
Fax:
Email: wellington@constructionsciences.net

PARTICLE SIZE DISTRIBUTION REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/28575-1
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	BH02 Bag 2
Location:	Upper North Island	Internal Test Request:	1232/T/18056
Supplied To:	CMW Geotechnical NZ Limited	Client Reference/s:	PO# HAM130000
Area Description:		Report Date / Page:	8/05/2024 Page 2 of 3

Test Procedures:	NZS4407.3.8.1		
Sample Number	1232/S/114673	Location	HAM2023-0099
Sampling Method	Tested As Received		3-3.5m
Date Sampled	11/04/2024 12:00		
Sampled By	Client Sampled		
Date Tested	7/05/2024	Material Source	Insitu
Prep / Drying Method	Washed / Oven	Material Type	Insitu
Prep > 53mm (%)	-	Specification	No Specification

AS Sieve (mm)	Specification Minimum (%)	**Percent Passing (%)**	Specification Maximum (%)
4.75		**100**	
2.36		**100**	
1.18		**100**	
0.600		**100**	
0.425		**99**	
0.300		**96**	
0.150		**89**	
0.075		**85**	
0.0630		**84**	



Remarks

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Accreditation Number: 1232

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Form ID: W9Rep Rev 3

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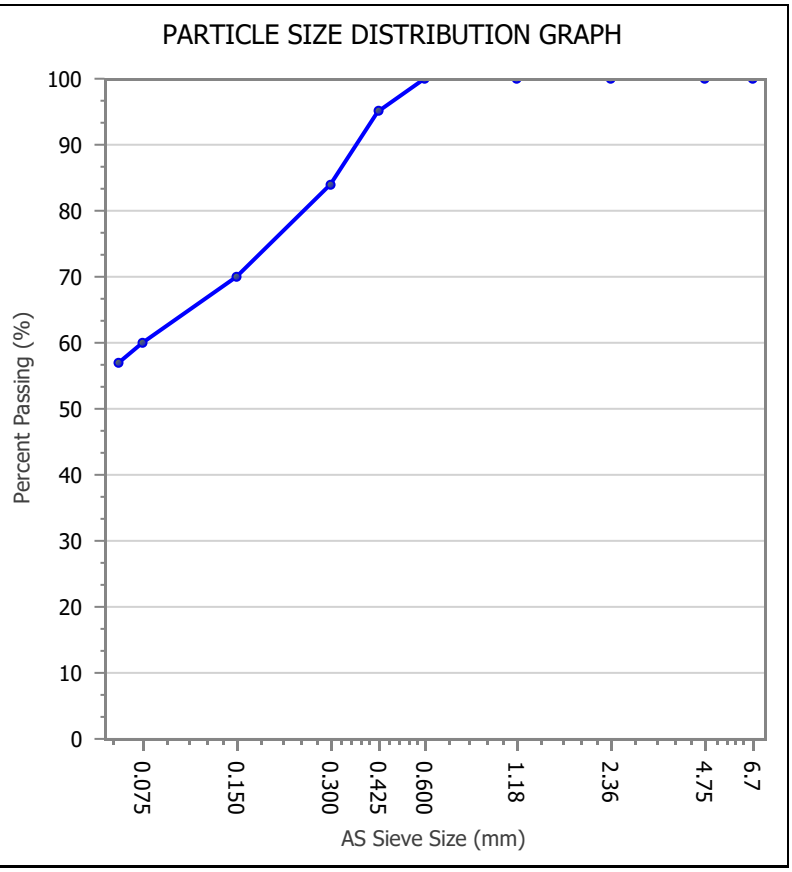
Laboratory: **Wellington Laboratory**
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Fax:
Email: wellington@constructionsciences.net

PARTICLE SIZE DISTRIBUTION REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/28575-1
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	BH02 Bag 3
Location:	Upper North Island	Internal Test Request:	1232/T/18056
Supplied To:	CMW Geotechnical NZ Limited	Client Reference/s:	PO# HAM130000
Area Description:		Report Date / Page:	8/05/2024 Page 1 of 3

Test Procedures:	NZS4407.3.8.1		
Sample Number	1232/S/114672	Location	HAM2023-0099
Sampling Method	Tested As Received		5.5-5.5m
Date Sampled	11/04/2024 12:00		
Sampled By	Client Sampled		
Date Tested	6/05/2024	Material Source	Insitu
Prep / Drying Method	Washed / Oven	Material Type	Insitu
Prep > 53mm (%)	-	Specification	No Specification

AS Sieve (mm)	Specification Minimum (%)	**Percent Passing (%)**	Specification Maximum (%)
6.7		**100**	
4.75		**100**	
2.36		**100**	
1.18		**100**	
0.600		**100**	
0.425		**95**	
0.300		**84**	
0.150		**70**	
0.075		**60**	
0.0630		**57**	



Remarks

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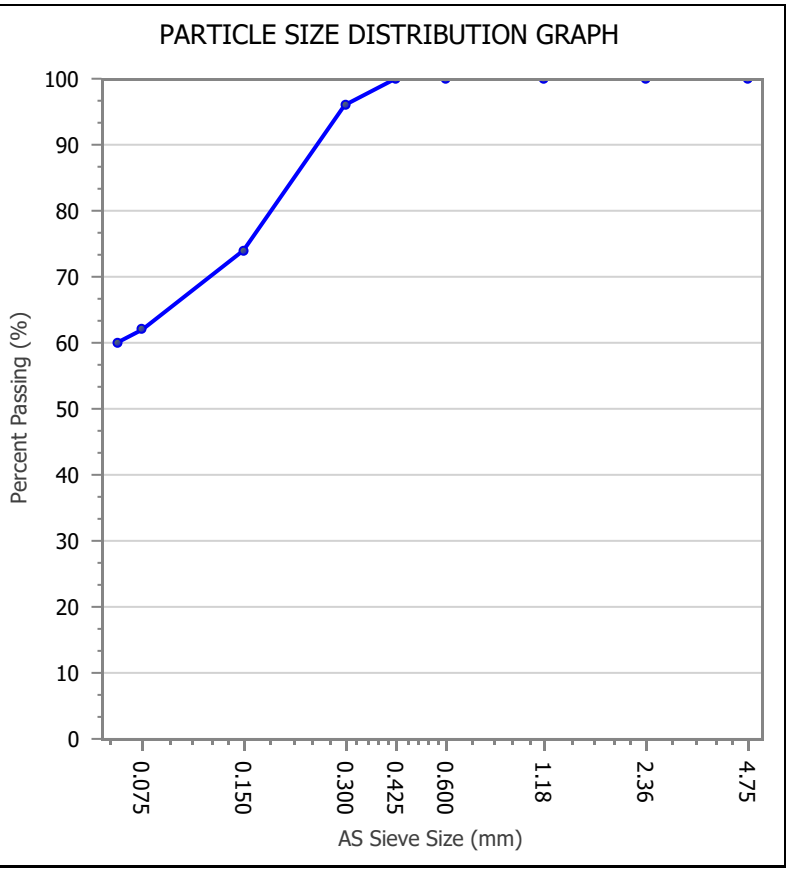
Laboratory: **Wellington Laboratory**
Phone: 64 27 364 3488
Fax:
Email: wellington@constructionsciences.net

PARTICLE SIZE DISTRIBUTION REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/28575-1
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	BH03 Bag 5
Location:	Upper North Island	Internal Test Request:	1232/T/18056
Supplied To:	CMW Geotechnical NZ Limited	Client Reference/s:	PO# HAM130000
Area Description:		Report Date / Page:	8/05/2024 Page 3 of 3

Test Procedures:	NZS4407.3.8.1		
Sample Number	1232/S/114674	Location	HAM2023-0099
Sampling Method	Tested As Received		4.9-5.2m
Date Sampled	11/04/2024 12:00		
Sampled By	Client Sampled		
Date Tested	7/05/2024	Material Source	Insitu
Prep / Drying Method	Washed / Oven	Material Type	Insitu
Prep > 53mm (%)	-	Specification	No Specification

AS Sieve (mm)	Specification Minimum (%)	**Percent Passing (%)**	Specification Maximum (%)
4.75		**100**	
2.36		**100**	
1.18		**100**	
0.600		**100**	
0.425		**100**	
0.300		**96**	
0.150		**74**	
0.075		**62**	
0.0630		**60**	



Remarks

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Accreditation Number: 1232

Approved Signatory: Karl Rutherford
Form ID: W9Rep Rev 3

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Porirua NZ 5022

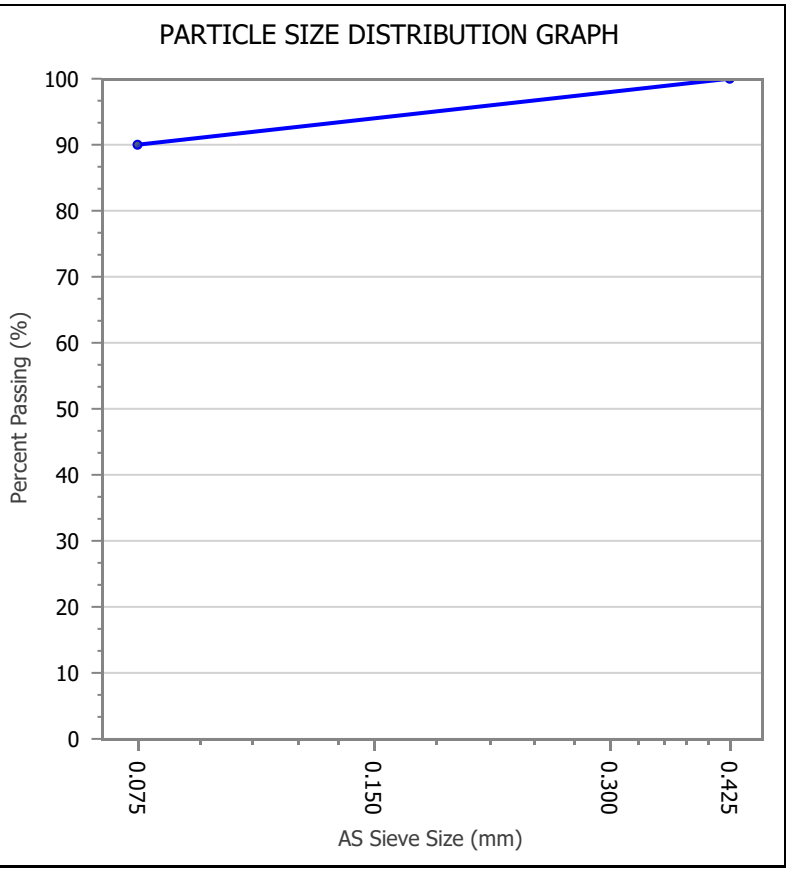
Laboratory: **Wellington Laboratory**
Phone: 64 27 364 3488
Fax:
Email: wellington@constructionsciences.net

PARTICLE SIZE DISTRIBUTION REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/28510-1
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	HAM2023-0099
Location:	Upper North Island	Internal Test Request:	1232/T/18056
Supplied To:	CMW Geotechnical NZ Limited	Client Reference/s:	PO# HAM130000
Area Description:		Report Date / Page:	2/05/2024 Page 4 of 6

Test Procedures:	NZS4407.3.8.1		
Sample Number	1232/S/114440	Location	BH03 Bag 6
Sampling Method	Tested As Received		7-7.5m
Date Sampled	11/04/2024 12:00		
Sampled By	Unknown		
Date Tested	2/05/2024	Material Source	-
Prep / Drying Method	Washed / Oven	Material Type	Insitu
Prep > 53mm (%)	-	Specification	No Specification

AS Sieve (mm)	Specification Minimum (%)	**Percent Passing (%)**	Specification Maximum (%)
0.425		**100**	
0.075		**90**	



Remarks

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

Accreditation Number: 1232

Approved Signatory: Karl Rutherford
Form ID: W9Rep Rev 3

Construction Sciences

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ABN: 93 485 645

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Laboratory: **Wellington Laboratory**
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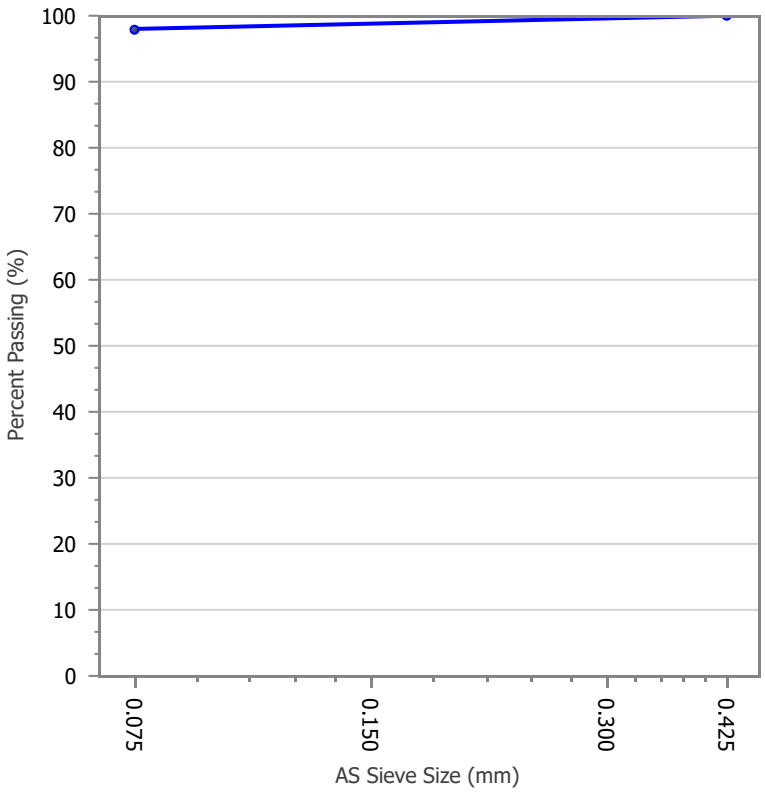
PARTICLE SIZE DISTRIBUTION REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/28510-1
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	HAM2023-0099
Location:	Upper North Island	Internal Test Request:	1232/T/18056
Supplied To:	CMW Geotechnical NZ Limited	Client Reference/s:	PO# HAM130000
Area Description:		Report Date / Page:	2/05/2024 Page 1 of 6

Test Procedures:	NZS4407.3.8.1		
Sample Number	1232/S/114437	Location	BH04 Bag 4
Sampling Method	Tested As Received		4.5-5m
Date Sampled	11/04/2024 12:00		
Sampled By	Unknown		
Date Tested	2/05/2024	Material Source	-
Prep / Drying Method	Washed / Oven	Material Type	Insitu
Prep > 53mm (%)	-	Specification	No Specification

AS Sieve (mm)	Specification Minimum (%)	**Percent Passing (%)**	Specification Maximum (%)
0.425		**100**	
0.075		**98**	

PARTICLE SIZE DISTRIBUTION GRAPH



Remarks

ACCREDITED
IANZ
TESTING LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

Accreditation Number: 1232

Approved Signatory: Karl Rutherford
Form ID: W9Rep Rev 3

Construction Sciences
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Porirua NZ 5022

Laboratory: Wellington Laboratory
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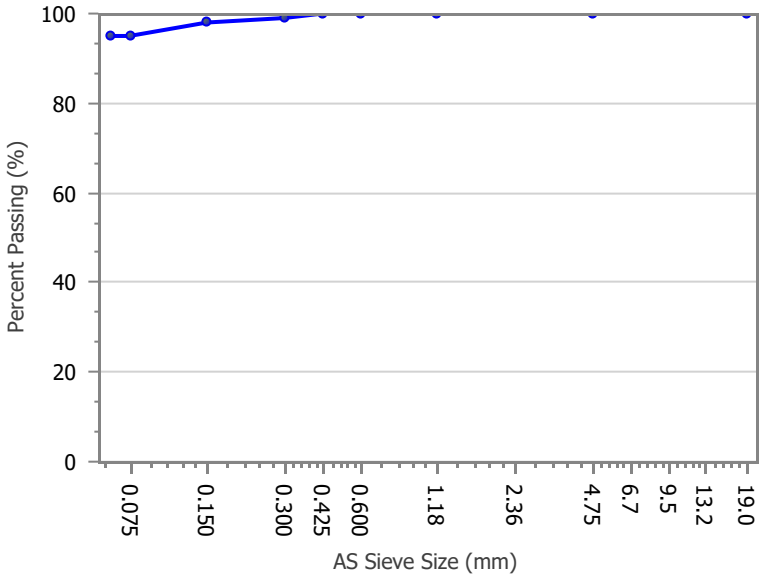
QUALITY OF MATERIALS REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/25-58-4
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	
Location:	Upper North Island	Internal Test Request:	1232/T/25-29
Supplied To:	CMW Geotechnical NZ Limited	Client Reference/s:	HAM136470
Area Description:		Report Date / Page:	27/02/2025 Page 1 of 2

Test Procedures	NZS4402.2.8.1, NZS4402.2.2, NZS4402.2.3, NZS4407.3.1, NZS4402.2.4		
Sample Number	1232/S/25-261	Location	PS-BH24-01
Sampling Method			Ash formation
Date Sampled	25/02/2025		
Sampled By	Client Sampled		
Date Tested	26/02/2025	Material Source	Insitu
PSD Preparation	Washed	Material Type	Insitu
Atterberg Preparation	Wet Sieved / Oven Dried	Prep Material > 53.0mm (%)	
Material Description	-		

AS Sieve (mm)	Specification Minimum (%)	**Percent Passing (%)**	Specification Maximum (%)
19.0		**100**	
4.75		**100**	
1.18		**100**	
0.600		**100**	
0.425		**100**	
0.300		**99**	
0.150		**98**	
0.075		**95**	
0.0630		**95**	

PARTICLE SIZE DISTRIBUTION GRAPH



Test Result	Specification Minimum (%)	**Result**	Specification Maximum (%)	Test Result	Specification Minimum (%)	**Result**	Specification Maximum (%)
Liquid Limit (%)		**110**		0.075/0.425 Fines Ratio		**0.96**	
Plastic Limit (%)		**73**		PI x 0.425 Ratio (%)		**3692.6**	
Plastic Index		**37**		LS x 0.425 Ratio (%)		**-**	
Linear Shrinkage (%)				Shrinkage Observations			

Remarks	Re-Issued Report Replaces Report No 1232/R/25-58-3 (reason: Plastic limit, Liquid Limit and Plastic index Not Endorsed - Fraction tested over the 75um seive)

ACCREDITED IANZ TESTING LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

Accreditation Number: 1232

Approved Signatory: Karl Rutherford
Form ID: W85Rep Rev 3

Construction Sciences
a kiwa company

Construction Sciences NZ Limited
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Laboratory: Wellington Laboratory
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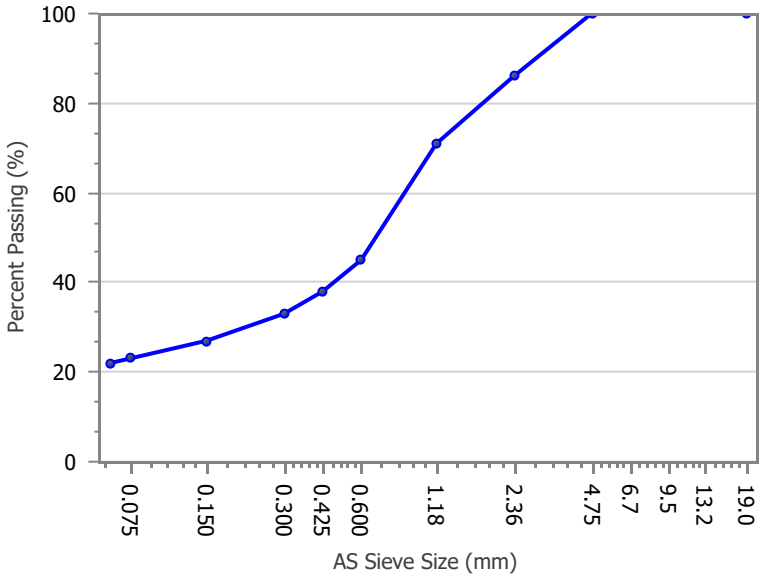
QUALITY OF MATERIALS REPORT

Client:	CMW Geotechnical NZ Ltd	Report Number:	1232/R/25-58-4
Client Address:	116 Cameron Road, Tauranga	Project Number:	1232/P/118
Project:	Materials Testing - Hamilton	Lot Number:	
Location:	Upper North Island	Internal Test Request:	1232/T/25-29
Supplied To:	CMW Geotechnical NZ Limited	Client Reference/s:	HAM136470
Area Description:		Report Date / Page:	27/02/2025 Page 2 of 2

Test Procedures	NZS4402.2.8.1, NZS4402.2.2, NZS4402.2.3, NZS4402.2.4		
Sample Number	1232/S/25-262	Location	PS-BH24-02
Sampling Method			Karapiro formation
Date Sampled	25/02/2025		
Sampled By	Client Sampled		
Date Tested	26/02/2025	Material Source	Insitu
PSD Preparation	Washed	Material Type	Insitu
Atterberg Preparation	- / -	Prep Material > 53.0mm (%)	
Material Description	-		

AS Sieve (mm)	Specification Minimum (%)	Percent Passing (%)	Specification Maximum (%)
19.0		**100**	
4.75		**100**	
2.36		**86**	
1.18		**71**	
0.600		**45**	
0.425		**38**	
0.300		**33**	
0.150		**27**	
0.075		**23**	
0.0630		**22**	

PARTICLE SIZE DISTRIBUTION GRAPH



Test Result	Specification Minimum (%)	Result	Specification Maximum (%)	Test Result	Specification Minimum (%)	Result	Specification Maximum (%)
Liquid Limit (%)		**Not applicable**		0.075/0.425 Fines Ratio		**0.61**	
Plastic Limit (%)		**Non-Plastic**		PI x 0.425 Ratio (%)		**-**	
Plastic Index		**Non Plastic**		LS x 0.425 Ratio (%)		**-**	
Linear Shrinkage (%)				Shrinkage Observations			

Remarks	Re-Issued Report Replaces Report No 1232/R/25-58-3 (reason: Plastic limit, Liquid Limit and Plastic index Not Endorsed - Fraction tested over the 75um seive)

ACCREDITED IANZ TESTING LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

Accreditation Number: 1232

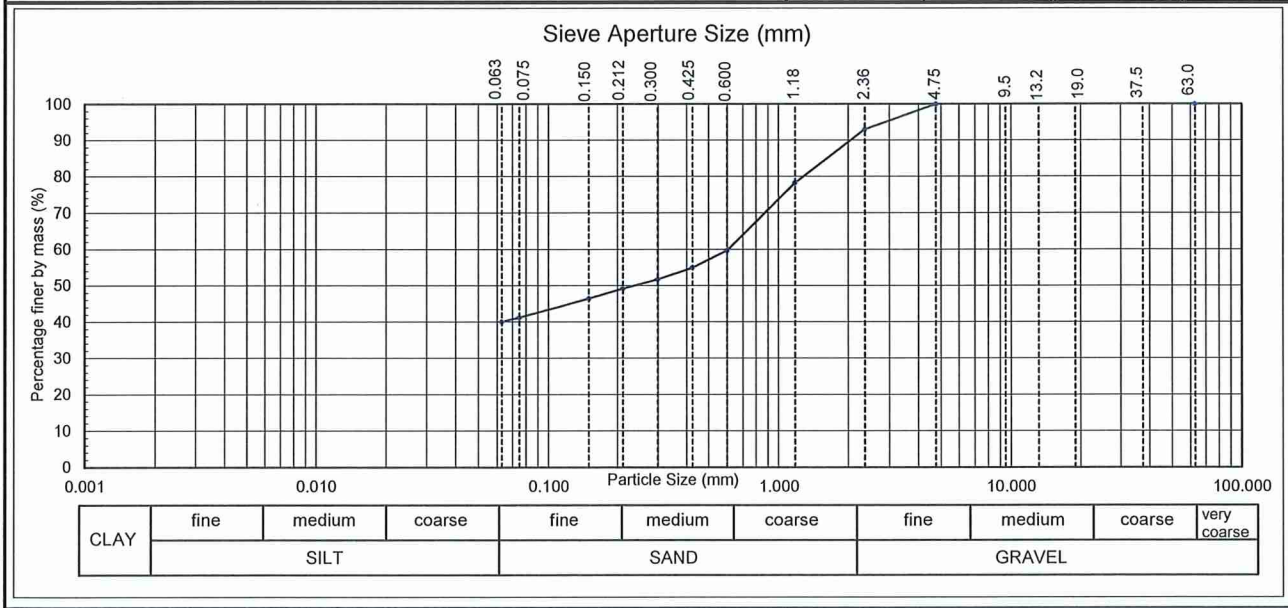
Approved Signatory: Karl Rutherford
Form ID: W85Rep Rev 3

PARTICLE SIZE ANALYSIS (WET SIEVE METHOD)
TEST REPORT

Project :	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Consultant :	-
Borehole No:	BH24-01
Depth :	7.00-8.00m
Sample Ref No. :	-
Sampled by :	Client
Date sampled :	Not Stated
Sampling method :	Borehole
Sample condition :	As received
Sample description :	Sandy SILT/CLAY, minor gravel
Water Content (as received):	35.0 %

Project No:	2-68014.00
Lab Ref No:	HA14114_13_PSD
Client Ref:	HAM2023-0099

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	100	0.300	52	--	--	--	--
37.5	--	2.36	93	0.212	49	--	--	--	--
19.0	--	1.18	78	0.150	46	--	--	--	--
13.2	--	0.600	60	0.075	41	--	--	--	--
9.5	--	0.425	55	0.063	40	--	--	--	--
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					--	--		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.1 (Wet Sieve Method)	All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

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Date Tested: 03/02/25

Date Reported: 10/02/25

Approved Signatory

Designation : *Senior Civil Engineering Technician*

Date : 10/02/25

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LINEAR SHRINKAGE FOR SOILS
TEST REPORT

Project :	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Contractor :	-
Sampled by :	Client
Date sampled :	Not Stated
Date received :	19/12/24
Sampling method :	Borehole
Sample condition :	As received

Project No :	2-68014.00
Lab Ref No :	HA14114_LS
Client Ref No :	HAM2023-0099

Test Results

Sample Lab Ref No :	HA14114_1_LS	HA14114_2_LS	HA14114_5_LS	HA14114_6_LS	HA14114_9_LS
Location ID :	BH24-05	BH24-05	BH24-06	BH24-06	BH24-05
Sample Depth (m) :	1.0-1.5	4.0-4.5	6.0-6.5	7.5-8.0	5.0-5.5
Soil Fraction Tested :	-425µm	-425µm	-425µm	-425µm	-425µm
Sample History :	Natural	Natural	Natural	Natural	Natural
Water Content as Rec'd (%) :	53.2	76.6	50.8	59.1	40.0
Water Content at LS test (%) :	109.4	114.5	63.2	93.9	48.2
Linear Shrinkage (%) :	23	18	16	18	7

Test Methods		Notes
Water Content	NZS 4402 : 1986, Test 2.1	Sample description is not IANZ endorsed.
Linear Shrinkage	NZS 4402 : 1986, Test 2.6	

Date tested : 28/01-05/02/25
Date reported : 10/02/25

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All information supplied by Client

Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/25

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LINEAR SHRINKAGE FOR SOILS
TEST REPORT

Project :	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Contractor :	-
Sampled by :	Client
Date sampled :	Not Stated
Date received :	19/12/24
Sampling method :	Borehole
Sample condition :	As received

Project No :	2-68014.00
Lab Ref No :	HA14114_LS
Client Ref No :	HAM2023-0099

Test Results

Sample Lab Ref No :	HA14114_10_LS	HA14114_11_LS	HA14114_12_LS
Location ID :	BH24-05	BH24-06	BH24-06
Sample Depth (m) :	5.5-6.0	1.0-1.5	1.7-2.2
Soil Fraction Tested :	-425µm	-425µm	-425µm
Sample History :	Natural	Natural	Natural
Water Content as Rec'd (%) :	100.2	45.2	54.4
Water Content at LS test (%) :	127.9	102.8	110.2
Linear Shrinkage (%) :	24	23	25

Test Methods		Notes
Water Content	NZS 4402 : 1986, Test 2.1	Sample description is not IANZ endorsed.
Linear Shrinkage	NZS 4402 : 1986, Test 2.6	

Date tested : 28/01-05/02/25
Date reported : 10/02/25

Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/25

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
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All information supplied by Client

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SHRINK-SWELL INDEX TEST REPORT

Project :	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Contractor :	-
Sampled by :	Client
Date sampled :	Not Stated
Sampling method :	Borehole
Sample description :	CLAY
Sample condition :	As received
Sample ID:	BH24-05
Depth (m):	1.0-1.5

Project No :	2-68014.00
Lab Ref No :	HA14114_1_SHSW
Client Ref No :	HAM2023-0099

Test Results

Moisture content (As received) (%) :	53.6
Moisture content of core shrinkage sample (%) :	54.3
Moisture content of swell sample (%) :	56.8
Estimated percentage of inert inclusions in the soil specimen (%):	N/A
Extent of soil crumbling and cracking during shrinkage:	cracks forming on side of specimen
Total Shrinkage ε_{sw} (%) :	10.3
Swelling Strain ε_{sw} (%) :	0.011
Shrink Swell Index (Iss):	5.7

Test Methods		Notes
Shrink-Swell Index	AS 1289.7.1.1 -2003	
Water Content	NZS 4402:1986 Test 2.1	

Date tested : 29/01-07/02/25
Date reported : 10/02/25

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SHRINK-SWELL INDEX TEST REPORT

Project :	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Contractor :	-
Sampled by :	Client
Date sampled :	Not Stated
Sampling method :	Borehole
Sample description :	CLAY
Sample condition :	As received
Sample ID:	BH24-05
Depth (m):	4.5-5.0

Project No :	2-68014.00
Lab Ref No :	HA14114_2_SHSW
Client Ref No :	HAM2023-0099

Test Results

Moisture content (As received) (%) :	82.0
Moisture content of core shrinkage sample (%) :	82.2
Moisture content of swell sample (%) :	84.6
Estimated percentage of inert inclusions in the soil specimen (%):	N/A
Extent of soil crumbling and cracking during shrinkage:	cracks forming on side of specimen
Total Shrinkage ε_{sw} (%) :	10.9
Swelling Strain ε_{sw} (%) :	-0.011
Shrink Swell Index (Iss):	6.1

Test Methods		Notes
Shrink-Swell Index	AS 1289.7.1.1 -2003	
Water Content	NZS 4402:1986 Test 2.1	

Date tested : 29/01-07/02/25
Date reported : 10/02/25

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SHRINK-SWELL INDEX TEST REPORT

Project :	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Contractor :	-
Sampled by :	Client
Date sampled :	Not Stated
Sampling method :	Borehole
Sample description :	CLAY
Sample condition :	As received
Sample ID:	BH24-06
Depth (m):	6.0-6.5

Project No :	2-68014.00
Lab Ref No :	HA14114_5_SHSW
Client Ref No :	HAM2023-0099

Test Results

Moisture content (As received) (%) :	38.0
Moisture content of core shrinkage sample (%) :	43.4
Moisture content of swell sample (%) :	41.4
Estimated percentage of inert inclusions in the soil specimen (%):	N/A
Extent of soil crumbling and cracking during shrinkage:	N/A
Total Shrinkage ε_{sw} (%) :	4.0
Swelling Strain ε_{sw} (%) :	-0.011
Shrink Swell Index (Iss):	2.2

Test Methods		Notes
Shrink-Swell Index	AS 1289.7.1.1 -2003	
Water Content	NZS 4402:1986 Test 2.1	

Date tested : 29/01-07/02/25
Date reported : 10/02/25

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Date : 10/02/25

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SHRINK-SWELL INDEX TEST REPORT

Project :	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Contractor :	-
Sampled by :	Client
Date sampled :	Not Stated
Sampling method :	Borehole
Sample description :	CLAY
Sample condition :	As received
Sample ID:	BH24-06
Depth (m):	7.5-8.0

Project No :	2-68014.00
Lab Ref No :	HA14114_6_SHSW
Client Ref No :	HAM2023-0099

Test Results

Moisture content (As received) (%) :	43.9
Moisture content of core shrinkage sample (%) :	52.1
Moisture content of swell sample (%) :	48.4
Estimated percentage of inert inclusions in the soil specimen (%):	N/A
Extent of soil crumbling and cracking during shrinkage:	Some small cracks forming around specimen
Total Shrinkage ε_{sw} (%) :	6.4
Swelling Strain ε_{sw} (%) :	-0.216
Shrink Swell Index (Iss):	3.5

Test Methods		Notes
Shrink-Swell Index	AS 1289.7.1.1 -2003	
Water Content	NZS 4402:1986 Test 2.1	

Date tested : 29/01-07/02/25
Date reported : 10/02/25

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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
TEST RESULT REPORT

Project : HCC Reservoir
Location: HCC Reservoir
Client : CMW Geotechnical NZ Ltd
Sample Location ID: BH24-05 1.0-1.5 Specimen depth: 1.40-1.45m
Sampled by : Client
Date sampled: Not Stated
Sampling method : Pushtube
Sample condition : As Received
Sample description : CLAY, some silt; brown. Firm, moist, highly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_1_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: One

SOIL PROPERTIES

Specimen Dimensions:	
Diameter (mm):	50.01
Initial height (mm):	18.90
Final height (mm):	17.05
Initial mass of sample (g):	56.58

Note: ** Void ratio is not IANZ Accredited due to assumed Solid Density value.

Initial Wet Density	pbi (t/m³)	1.52
Initial Dry Density	pdi (t/m³)	0.97
Final Dry Density	pdf (t/m³)	1.07
Initial Void Ratio	eo	1.84
Final Void Ratio	ef	1.57
Initial Degree of Saturation	Si (%)	86
Final Degree of Saturation	Sf (%)	100
Solid Particle Density (Assumed)	Gs (t/m³)	2.75
INITIAL Water Content	Wi (%)	57.6
FINAL Water Content	Wf (%)	58.6

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	**Void Ratio (e)	Intercept t90 (min)	Volume Compressibilty Mv=m²/MN	Coeff. of Consolidation Cv=m²/year	Coeff. of Permeability k=m/year	
0 - 50	50	1.769	1.462	0.52	27	1.4 x10 -1	
50 - 100	50	1.719	0.742	0.37	51	1.8 x10 -1	
100 - 200	100	1.638	0.875	0.30	41	1.2 x10 -1	
200 - 400	200	1.552	1.495	0.16	23	3.6 x10 -2	
400 - 50	-	1.566	-	-	-		
-	-	-	-	-	-		
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-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		

Test Methods:		Notes:
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	Load Increments applied at 24 hr intervals
		Root time fitting method was used for Cv calculations.

Date tested : 20-25/01/25
Date reported : 10/02/2025

Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/2025

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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
TEST RESULT REPORT

Project : HCC Reservoir
Location: HCC Reservoir
Client : CMW Geotechnical NZ Ltd
Sample Location ID: BH24-05 1.0-1.5 Specimen depth: 1.40-1.45m
Sampled by : Client
Date sampled: Not Stated
Sampling method : Pushtube
Sample condition : As Received
Sample description : CLAY, some silt; brown. Firm, moist, highly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_1_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: One

SOIL PROPERTIES

Specimen Dimensions:	
Diameter (mm):	50.01
Initial height (mm):	18.90
Final height (mm):	17.05
Initial mass of sample (g):	56.58

Note: ** Void ratio is not IANZ Accredited due to assumed Solid Density value.

Initial Wet Density	pbi (t/m³)	1.52
Initial Dry Density	pdi (t/m³)	0.97
Final Dry Density	pdf (t/m³)	1.07
Initial Void Ratio	eo	1.84
Final Void Ratio	ef	1.57
Initial Degree of Saturation	Si (%)	86
Final Degree of Saturation	Sf (%)	100
Solid Particle Density (Assumed)	Gs (t/m³)	2.75
INITIAL Water Content	Wi (%)	57.6
FINAL Water Content	Wf (%)	58.6

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	**Void Ratio (e)	Intercept t50 (min)	Volume Compressibilty Mv=m²/MN	Coeff. of Consolidation Cv=m²/year	Coeff. of Permeability k=m/year	Coeff. of Secondary Compr. (Csec)
0 - 50	50	1.769	0.420	0.52	22	1.1 x10 -1	0.00045
50 - 100	50	1.719	0.200	0.37	44	1.6 x10 -1	0.001
100 - 200	100	1.638	0.730	0.30	12	3.4 x10 -2	0.00097
200 - 400	200	1.552	1.000	0.16	8	1.3 x10 -2	0.0015
400 - 50	-	1.566	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
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-	-	-	-	-	-		-
-	-	-	-	-	-		-

Test Methods:		Notes:
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	Load Increments applied at 24 hr intervals
		Log time fitting method was used for Cv calculations.

Date tested : 20-25/01/25
Date reported : 10/02/2025

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Approved Signatory

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Date : 10/02/2025

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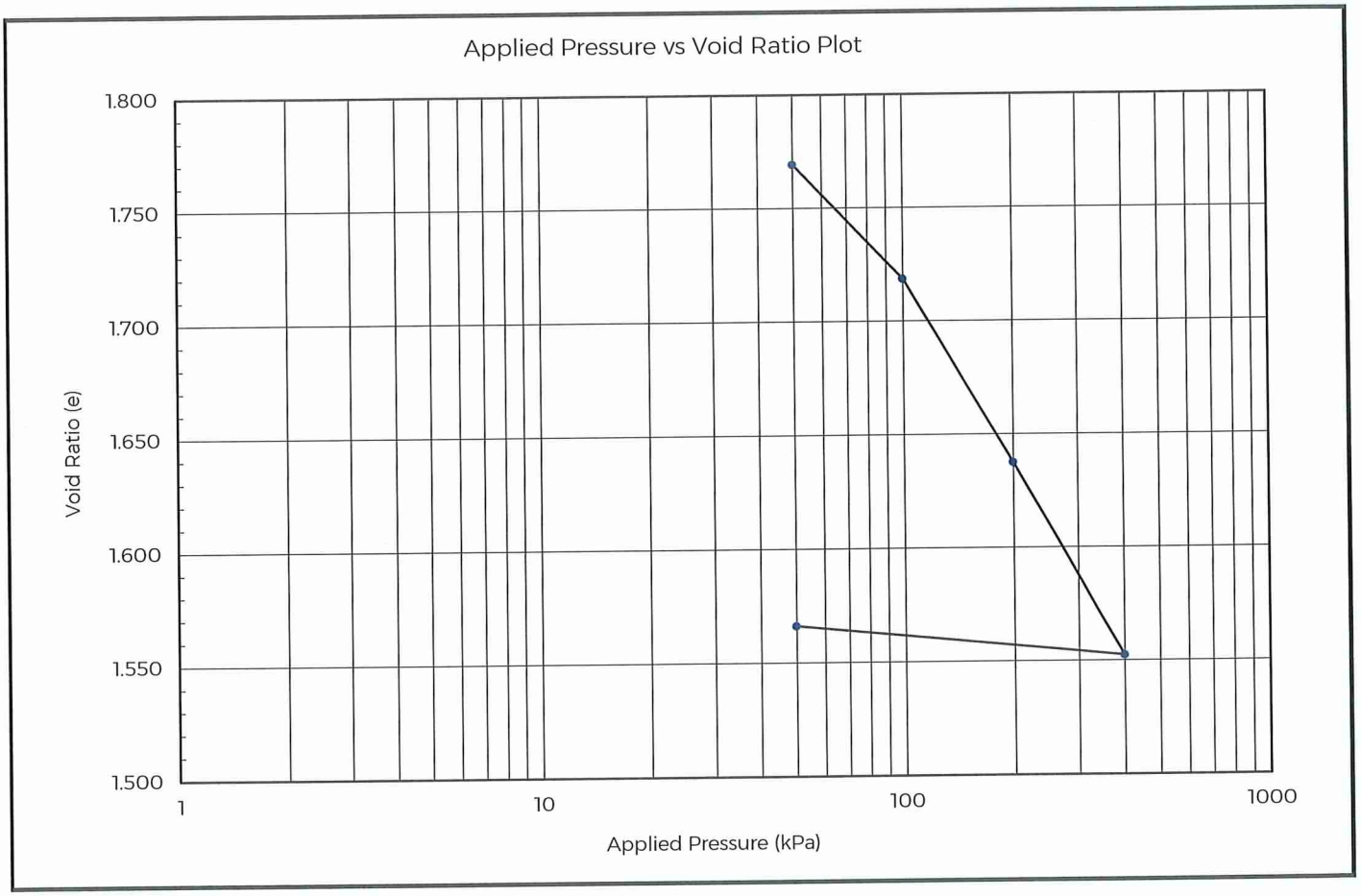
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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
Applied Pressure vs Void Ratio TEST REPORT

Project :	HCC Reservoir
Location:	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Sample Location ID:	BH24-05 1.0-1.5 Specimen depth: 1.40-1.45m
Sampled by :	Client
Date sampled:	Not Stated
Sampling method :	Pushtube
Sample condition :	As Received
Sample description :	CLAY, some silt; brown. Firm, moist, highly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_1_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: One



Test Method:		Notes:
One Dimensional Consolidation Test:	NZS 4402:1986 Test 7.1	Load Increments applied at 24 hr intervals Void ratio is not IANZ Accredited due to assumed Solid Density value.

Date tested : 20-25/01/25
Date reported : 10/02/2025

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Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/2025

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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
TEST RESULT REPORT

Project : HCC Reservoir
Location: HCC Reservoir
Client : CMW Geotechnical NZ Ltd
Sample Location ID: BH24-05 4.0-4.5 Specimen depth: 4.40-4.45m
Sampled by : Client
Date sampled: Not Stated
Sampling method : Pushtube
Sample condition : As Received
Sample description : Silty CLAY, light brown. Firm, wet, highly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_2_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Three

SOIL PROPERTIES

Specimen Dimensions:	
Diameter (mm):	49.88
Initial height (mm):	18.93
Final height (mm):	17.72
Initial mass of sample (g):	57.02

Note: ** Void ratio is not IANZ Accredited due to assumed Solid Density value.

Initial Wet Density	pbi (t/m³)	1.54
Initial Dry Density	pdi (t/m³)	0.85
Final Dry Density	pdf (t/m³)	0.91
Initial Void Ratio	eo	2.22
Final Void Ratio	ef	2.02
Initial Degree of Saturation	Si (%)	100
Final Degree of Saturation	Sf (%)	100
Solid Particle Density (Assumed)	Gs (t/m³)	2.75
INITIAL Water Content	Wi (%)	80.7
FINAL Water Content	Wf (%)	75.7

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	**Void Ratio (e)	Intercept t90 (min)	Volume Compressibilty Mv=m²/MN	Coeff. of Consolidation Cv=m²/year	Coeff. of Permeability k=m/year	
0 - 50	50	2.193	0.639	0.19	62	1.2 x10 -1	
50 - 100	50	2.169	1.855	0.15	21	3.1 x10 -2	
100 - 200	100	2.110	1.729	0.18	22	4.0 x10 -2	
200 - 400	200	1.998	3.911	0.18	9.5	1.7 x10 -2	
400 - 50	-	2.019	-	-	-		
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-	-	-	-	-	-		
-	-	-	-	-	-		
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-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		

Test Methods:		Notes:
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	Load Increments applied at 24 hr intervals
		Root time fitting method was used for Cv calculations.

Date tested : 20-25/01/25
Date reported : 10/02/2025

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Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/2025

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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
TEST RESULT REPORT

Project : HCC Reservoir
Location: HCC Reservoir
Client : CMW Geotechnical NZ Ltd
Sample Location ID: BH24-05 4.0-4.5 Specimen depth: 4.40-4.45m
Sampled by : Client
Date sampled: Not Stated
Sampling method : Pushtube
Sample condition : As Received
Sample description : Silty CLAY, light brown. Firm, wet, highly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_2_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Three

SOIL PROPERTIES

Specimen Dimensions:	
Diameter (mm):	49.88
Initial height (mm):	18.93
Final height (mm):	17.72
Initial mass of sample (g):	57.02

Note: ** Void ratio is not IANZ Accredited due to assumed Solid Density value.

Initial Wet Density	pbi (t/m³)	1.54
Initial Dry Density	pdi (t/m³)	0.85
Final Dry Density	pdf (t/m³)	0.91
Initial Void Ratio	eo	2.22
Final Void Ratio	ef	2.02
Initial Degree of Saturation	Si (%)	100
Final Degree of Saturation	Sf (%)	100
Solid Particle Density (Assumed)	Gs (t/m³)	2.75
INITIAL Water Content	Wi (%)	80.7
FINAL Water Content	Wf (%)	75.7

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	**Void Ratio (e)	Intercept t50 (min)	Volume Compressibilty Mv=m²/MN	Coeff. of Consolidation Cv=m²/year	Coeff. of Permeability k=m/year	Coeff. of Secondary Compr. (Csec)
0 - 50	50	2.193	-	-	-		-
50 - 100	50	2.169	0.610	0.15	15	2.2 x10 -2	0.00091
100 - 200	100	2.110	0.660	0.18	14	2.5 x10 -2	0.0014
200 - 400	200	1.998	1.290	0.18	6.7	1.2 x10 -2	0.0028
400 - 50	-	2.019	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
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Test Methods:		Notes:
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	Load Increments applied at 24 hr intervals
		Log time fitting method was used for Cv calculations.

Date tested : 20-25/01/25
Date reported : 10/02/2025

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Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/2025

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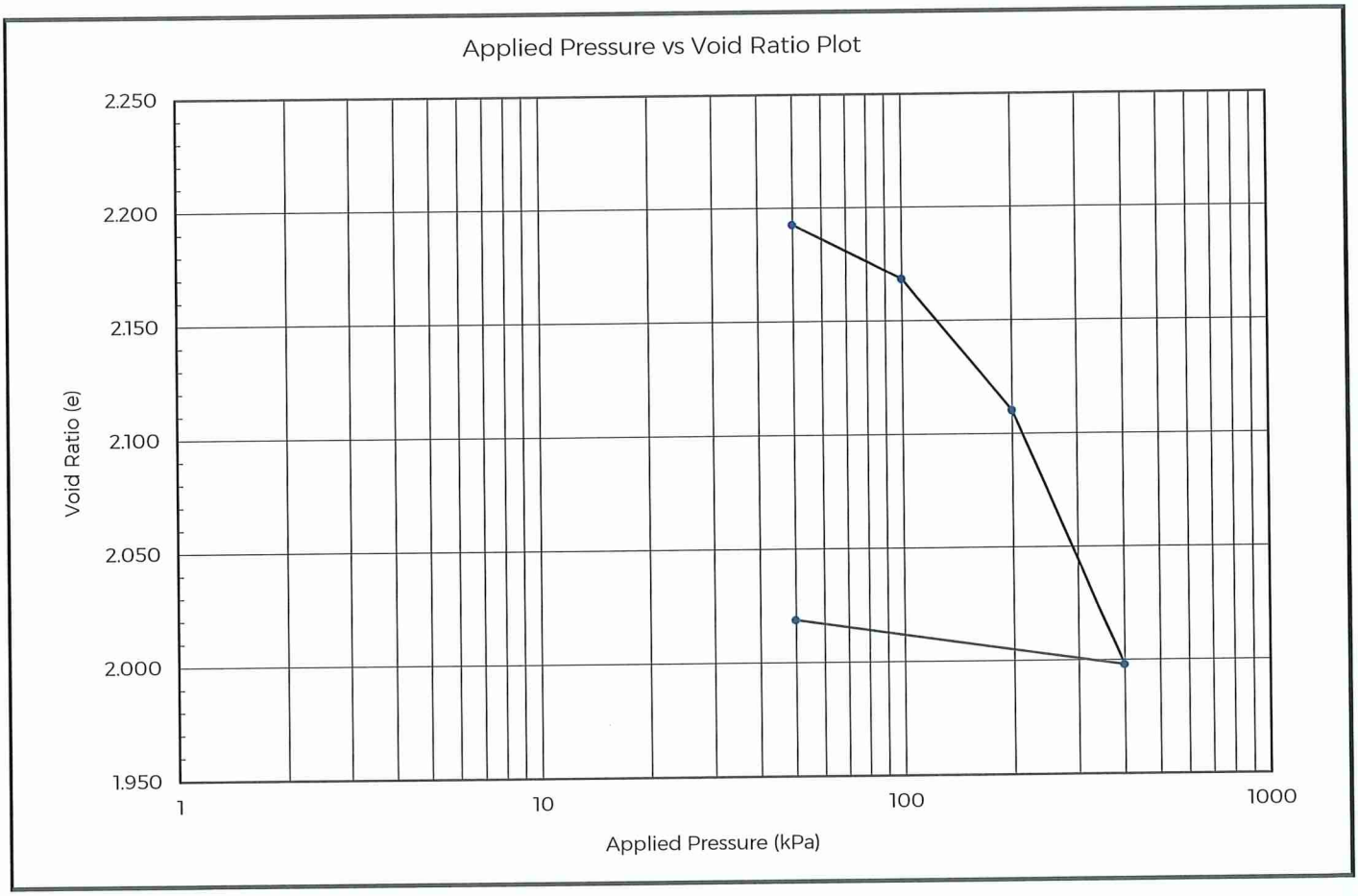
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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
Applied Pressure vs Void Ratio TEST REPORT

Project :	HCC Reservoir
Location:	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Sample Location ID:	BH24-05 4.0-4.5 Specimen depth: 4.40-4.45m
Sampled by :	Client
Date sampled:	Not Stated
Sampling method :	Pushtube
Sample condition :	As Received
Sample description :	Silty CLAY, light brown. Firm, wet, highly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_2_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Three



Test Method:		Notes:
One Dimensional Consolidation Test:	NZS 4402:1986 Test 7.1	Load Increments applied at 24 hr intervals Void ratio is not IANZ Accredited due to assumed Solid Density value.

Date tested : 20-25/01/25
Date reported : 10/02/2025

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Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/2025

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ONE DIMENSIONAL CONSOLIDATION PROPERTIES TEST RESULT REPORT

Project : HCC Reservoir
Location: HCC Reservoir
Client : CMW Geotechnical NZ Ltd
Sample Location ID: BH24-05 11.0-11.5 Specimen depth: 11.40-11.45m
Sampled by : Client
Date sampled: Not Stated
Sampling method : Pushtube
Sample condition : As Received
Sample description : Clayey SILT, minor fine to medium sand; orangish brown. Firm, moist, moderately to highly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_3_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Four

SOIL PROPERTIES

Specimen Dimensions:		
Diameter	(mm):	49.90
Initial height	(mm):	18.99
Final height	(mm):	17.63
Initial mass of sample (g):		59.24

Note: ** Void ratio is not IANZ Accredited due to assumed Solid Density value.

Initial Wet Density	pbi (t/m³)	1.60
Initial Dry Density	pdi (t/m³)	1.12
Final Dry Density	pdf (t/m³)	1.21
Initial Void Ratio	eo	1.36
Final Void Ratio	ef	1.19
Initial Degree of Saturation	Si (%)	82
Final Degree of Saturation	Sf (%)	100
Solid Particle Density (Assumed)	Gs (t/m³)	2.65
INITIAL Water Content	Wi (%)	41.8
FINAL Water Content	Wf (%)	44.8

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	**Void Ratio (e)	Intercept t90 (min)	Volume Compressibilty Mv=m²/MN	Coeff. of Consolidation Cv=m²/year	Coeff. of Permeability k=m/year	
0 - 50	50	1.311	0.652	0.38	61	2.3 x10 -1	
50 - 100	50	1.274	1.034	0.32	37	1.2 x10 -1	
100 - 200	100	1.232	1.443	0.18	26	4.7 x10 -2	
200 - 400	200	1.184	1.975	0.11	18	1.9 x10 -2	
400 - 50	-	1.187	-	-	-		
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-	-	-	-	-	-		
-	-	-	-	-	-		
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-	-	-	-	-	-		
-	-	-	-	-	-		

Test Methods:		Notes:
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	Load Increments applied at 24 hr intervals
		Root time fitting method was used for Cv calculations.

Date tested : 20-25/01/25
Date reported : 10/02/2025

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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
TEST RESULT REPORT

Project : HCC Reservoir
Location: HCC Reservoir
Client : CMW Geotechnical NZ Ltd
Sample Location ID: BH24-05 11.0-11.5 Specimen depth: 11.40-11.45m
Sampled by : Client
Date sampled: Not Stated
Sampling method : Pushtube
Sample condition : As Received
Sample description : Clayey SILT, minor fine to medium sand; orangish brown. Firm, moist, moderately to highly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_3_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Four

SOIL PROPERTIES

Specimen Dimensions:	
Diameter (mm):	49.90
Initial height (mm):	18.99
Final height (mm):	17.63
Initial mass of sample (g):	59.24

Note: ** Void ratio is not IANZ Accredited due to assumed Solid Density value.

Initial Wet Density	pbi (t/m³)	1.60
Initial Dry Density	pdi (t/m³)	1.12
Final Dry Density	pdf (t/m³)	1.21
Initial Void Ratio	eo	1.36
Final Void Ratio	ef	1.19
Initial Degree of Saturation	Si (%)	82
Final Degree of Saturation	Sf (%)	100
Solid Particle Density (Assumed)	Gs (t/m³)	2.65
INITIAL Water Content	Wi (%)	41.8
FINAL Water Content	Wf (%)	44.8

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	**Void Ratio (e)	Intercept t50 (min)	Volume Compressibilty Mv=m²/MN	Coeff. of Consolidation Cv=m²/year	Coeff. of Permeability k=m/year	Coeff. of Secondary Compr. (Csec)
0 - 50	50	1.311	-	-	-		-
50 - 100	50	1.274	-	-	-		-
100 - 200	100	1.232	0.420	0.18	21	3.8 x10 -2	0.0015
200 - 400	200	1.184	0.580	0.11	15	1.5 x10 -2	0.0023
400 - 50	-	1.187	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
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-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-

Test Methods:	
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1
Water Content	NZS 4402:1986 Test 2.1

Notes:
Sample is saturated during test.
Load Increments applied at 24 hr intervals
Log time fitting method was used for Cv calculations.

Date tested : 20-25/01/25
Date reported : 10/02/2025

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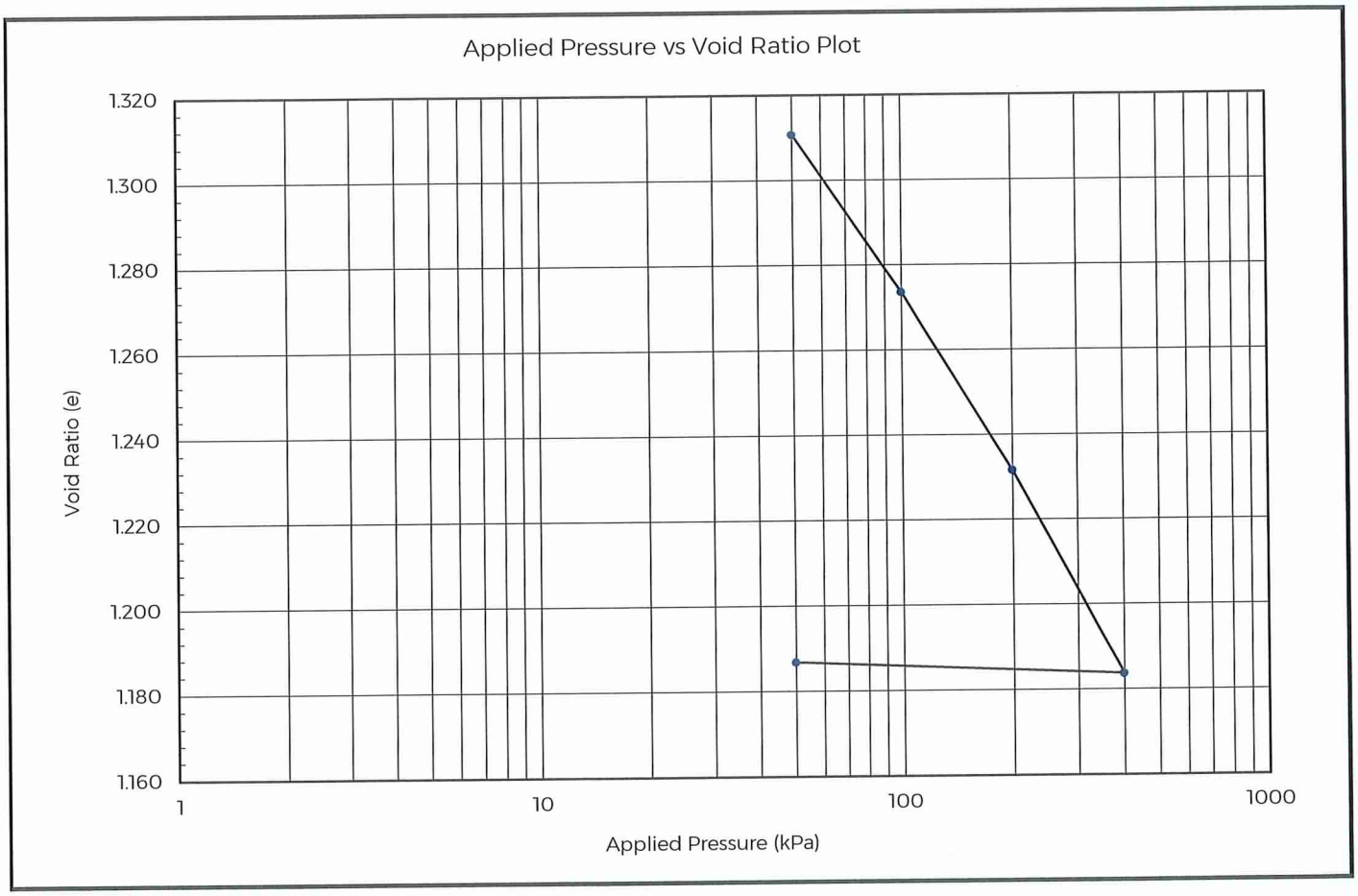
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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
Applied Pressure vs Void Ratio TEST REPORT

Project :	HCC Reservoir
Location:	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Sample Location ID:	BH24-05 11.0-11.5 Specimen depth: 11.40-11.45m
Sampled by :	Client
Date sampled:	Not Stated
Sampling method :	Pushtube
Sample condition :	As Received
Sample description :	Clayey SILT, minor fine to medium sand; orangish brown. Firm, moist, moderately to highly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_3_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Four



Test Method:		Notes:
One Dimensional Consolidation Test:	NZS 4402:1986 Test 7.1	Load Increments applied at 24 hr intervals Void ratio is not IANZ Accredited due to assumed Solid Density value.

Date tested : 20-25/01/25
Date reported : 10/02/2025

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ONE DIMENSIONAL CONSOLIDATION PROPERTIES TEST RESULT REPORT

Project : HCC Reservoir
Location: HCC Reservoir
Client : CMW Geotechnical NZ Ltd
Sample Location ID: BH24-05 16.0-16.5 Specimen depth: 16.40-16.45m
Sampled by : Client
Date sampled: Not Stated
Sampling method : Pushtube
Sample condition : As Received
Sample description : Fine to medium sandy SILT, minor clay; light yellowish brown. Firm, wet, slightly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_4_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Five

SOIL PROPERTIES

Specimen Dimensions:	
Diameter (mm):	49.94
Initial height (mm):	18.88
Final height (mm):	17.50
Initial mass of sample (g):	60.25

Note: ** Void ratio is not IANZ Accredited due to assumed Solid Density value.

Initial Wet Density	pbi (t/m³)	1.63
Initial Dry Density	pdi (t/m³)	1.15
Final Dry Density	pdf (t/m³)	1.24
Initial Void Ratio	eo	1.30
Final Void Ratio	ef	1.13
Initial Degree of Saturation	Si (%)	84
Final Degree of Saturation	Sf (%)	100
Solid Particle Density (Assumed)	Gs (t/m³)	2.65
INITIAL Water Content	Wi (%)	41.4
FINAL Water Content	Wf (%)	42.9

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	**Void Ratio (e)	Intercept t90 (min)	Volume Compressibilty Mv=m²/MN	Coeff. of Consolidation Cv=m²/year	Coeff. of Permeability k=m/year	
0 - 50	50	1.272	1.437	0.24	28	6.6 x10 -2	
50 - 100	50	1.243	3.479	0.26	11	2.8 x10 -2	
100 - 200	100	1.193	1.411	0.22	27	5.9 x10 -2	
200 - 400	200	1.124	1.597	0.16	23	3.5 x10 -2	
400 - 50	-	1.132	-	-	-		
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-	-	-	-	-	-		
-	-	-	-	-	-		

Test Methods:		Notes:
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	Load Increments applied at 24 hr intervals
		Root time fitting method was used for Cv calculations.

Date tested : 20-25/01/25
Date reported : 10/02/2025

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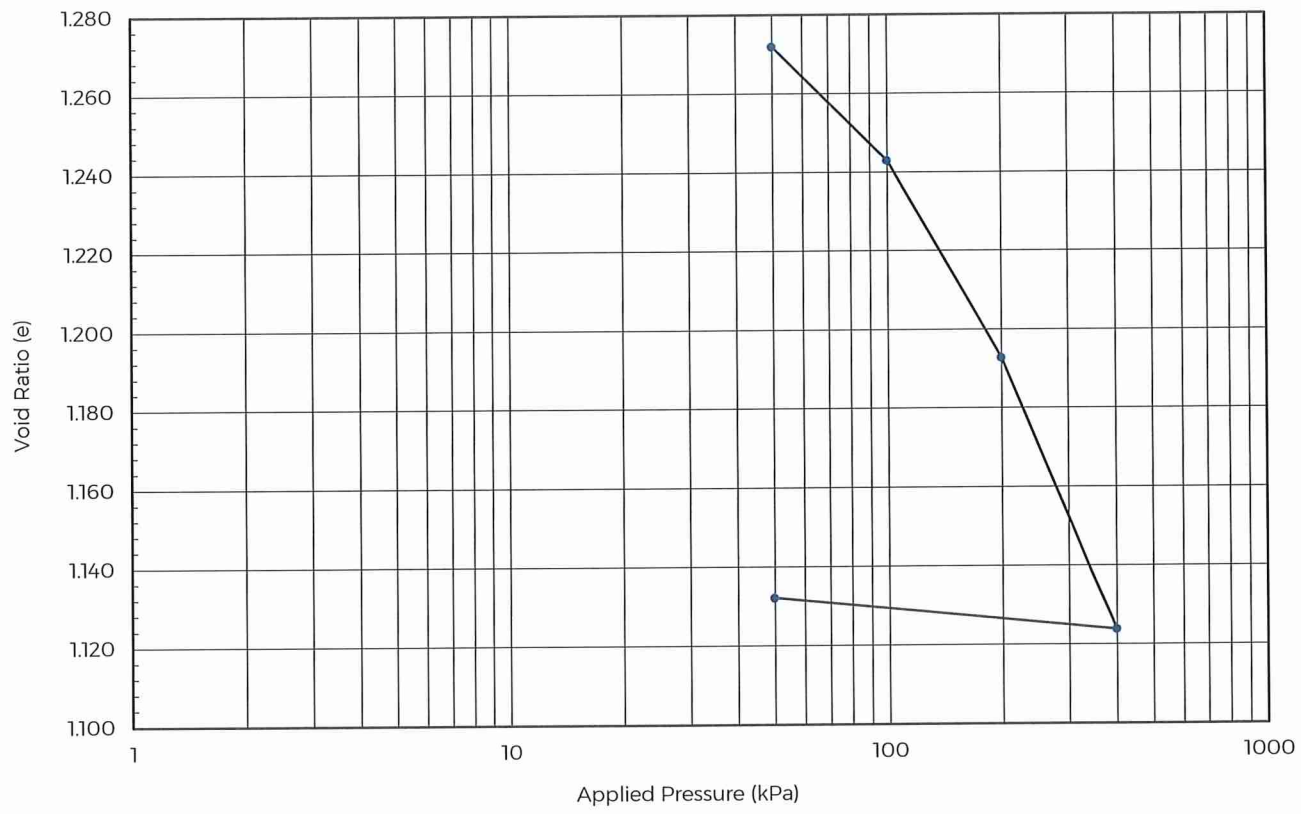
ONE DIMENSIONAL CONSOLIDATION PROPERTIES
Applied Pressure vs Void Ratio TEST REPORT

Project :	HCC Reservoir
Location:	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Sample Location ID:	BH24-05 16.0-16.5 Specimen depth: 16.40-16.45m
Sampled by :	Client
Date sampled:	Not Stated
Sampling method :	Pushtube
Sample condition :	As Received
Sample description :	Fine to medium sandy SILT, minor clay; light yellowish brown. Firm, wet, slightly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_4_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Five

Applied Pressure vs Void Ratio Plot



Test Method:		Notes:
One Dimensional Consolidation Test:	NZS 4402:1986 Test 7.1	Load Increments applied at 24 hr intervals Void ratio is not IANZ Accredited due to assumed Solid Density value.

Date tested : 20-25/01/25
Date reported : 10/02/2025

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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
TEST RESULT REPORT

Project : HCC Reservoir
Location: HCC Reservoir
Client : CMW Geotechnical NZ Ltd
Sample Location ID: BH24-06 6.0-6.5 Specimen depth: 6.40-6.45m
Sampled by : Client
Date sampled: Not Stated
Sampling method : Pushtube
Sample condition : As Received
Sample description : Clayey SILT, minor fine sand, brown. Firm, wet, moderatly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_5_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: One

SOIL PROPERTIES

Specimen Dimensions:	
Diameter (mm):	49.84
Initial height (mm):	19.74
Final height (mm):	18.97
Initial mass of sample (g):	59.86

Note: ** Void ratio is not IANZ Accredited due to assumed Solid Density value.

Initial Wet Density	pbi (t/m³)	1.55
Initial Dry Density	pdi (t/m³)	0.92
Final Dry Density	pdf (t/m³)	0.96
Initial Void Ratio	eo	2.00
Final Void Ratio	ef	1.88
Initial Degree of Saturation	Si (%)	96
Final Degree of Saturation	Sf (%)	100
Solid Particle Density (Assumed)	Gs (t/m³)	2.75
INITIAL Water Content	Wi (%)	69.3
FINAL Water Content	Wf (%)	68.7

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	**Void Ratio (e)	Intercept t90 (min)	Volume Compressibilty Mv=m²/MN	Coeff. of Consolidation Cv=m²/year	Coeff. of Permeability k=m/year	
0 - 50	50	1.986	0.768	0.06	56	3.5 x10 -2	
50 - 100	50	1.968	0.720	0.12	60	6.8 x10 -2	
100 - 200	100	1.931	1.387	0.13	31	3.8 x10 -2	
200 - 400	200	1.863	0.722	0.12	57	6.5 x10 -2	
400 - 50	-	1.878	-	-	-		
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-	-	-	-	-	-		

Test Methods:		Notes:
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	Load Increments applied at 24 hr intervals
		Root time fitting method was used for Cv calculations.

Date tested : 28/01-02/02/25
Date reported : 10/02/2025

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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
TEST RESULT REPORT

Project : HCC Reservoir
Location: HCC Reservoir
Client : CMW Geotechnical NZ Ltd
Sample Location ID: BH24-06 6.0-6.5 Specimen depth: 6.40-6.45m
Sampled by : Client
Date sampled: Not Stated
Sampling method : Pushtube
Sample condition : As Received
Sample description : Clayey SILT, minor fine sand, brown. Firm, wet, moderatly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_5_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: One

SOIL PROPERTIES

Specimen Dimensions:	
Diameter (mm):	49.84
Initial height (mm):	19.74
Final height (mm):	18.97
Initial mass of sample (g):	59.86

Note: ** Void ratio is not IANZ Accredited due to assumed Solid Density value.

Initial Wet Density	pbi (t/m³)	1.55
Initial Dry Density	pdi (t/m³)	0.92
Final Dry Density	pdf (t/m³)	0.96
Initial Void Ratio	eo	2.00
Final Void Ratio	ef	1.88
Initial Degree of Saturation	Si (%)	96
Final Degree of Saturation	Sf (%)	100
Solid Particle Density (Assumed)	Gs (t/m³)	2.75
INITIAL Water Content	Wi (%)	69.3
FINAL Water Content	Wf (%)	68.7

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	**Void Ratio (e)	Intercept t50 (min)	Volume Compressibilty Mv=m²/MN	Coeff. of Consolidation Cv=m²/year	Coeff. of Permeability k=m/year	Coeff. of Secondary Compr. (Csec)
0 - 50	50	1.986	-	-	-		-
50 - 100	50	1.968	-	-	-		-
100 - 200	100	1.931	0.380	0.13	26	3.2 x10 -2	0.00077
200 - 400	200	1.863	0.280	0.12	35	4.0 x10 -2	0.0021
400 - 50	-	1.878	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
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-	-	-	-	-	-		-
-	-	-	-	-	-		-

Test Methods:		Notes:
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	Load Increments applied at 24 hr intervals
		Log time fitting method was used for Cv calculations.

Date tested : 28/01-02/02/25
Date reported : 10/02/2025

Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/2025

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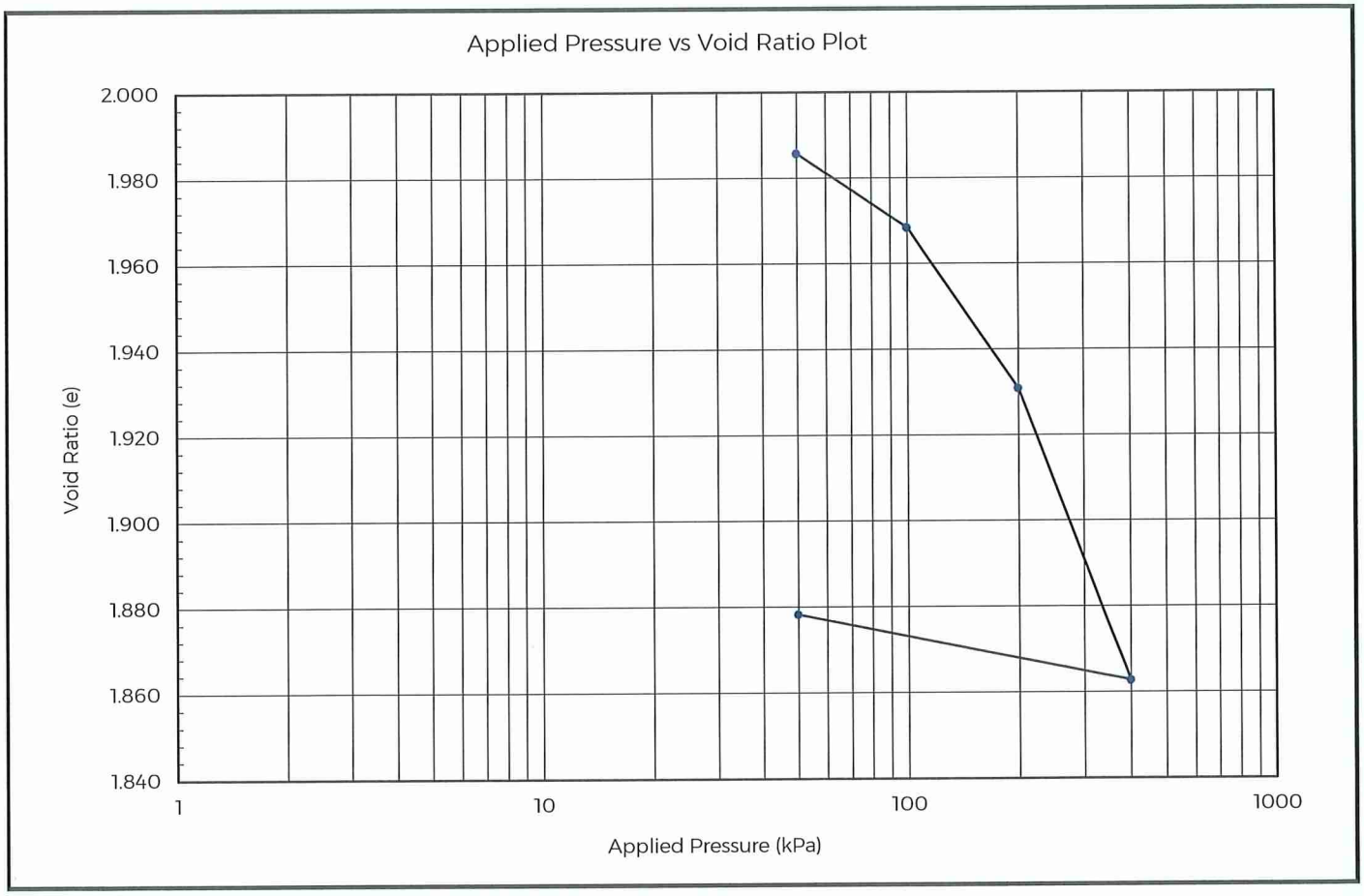
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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
Applied Pressure vs Void Ratio TEST REPORT

Project :	HCC Reservoir
Location:	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Sample Location ID:	BH24-06 6.0-6.5 Specimen depth: 6.40-6.45m
Sampled by :	Client
Date sampled:	Not Stated
Sampling method :	Pushtube
Sample condition :	As Received
Sample description :	Clayey SILT, minor fine sand, brown. Firm, wet, moderatly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_5_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: One



Test Method:		Notes:
One Dimensional Consolidation Test:	NZS 4402:1986 Test 7.1	Load Increments applied at 24 hr intervals Void ratio is not IANZ Accredited due to assumed Solid Density value.

Date tested : 28/01-02/02/25
Date reported : 10/02/2025

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Designation : *Senior Civil Engineering Technician*
Date : 10/02/2025

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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
TEST RESULT REPORT

Project : HCC Reservoir
Location: HCC Reservoir
Client : CMW Geotechnical NZ Ltd
Sample Location ID: BH24-06 7.5-8.0 Specimen depth: 7.90-7.95m
Sampled by : Client
Date sampled: Not Stated
Sampling method : Pushtube
Sample condition : As Received
Sample description : Clayey SILT, minor fine to medium sand, brown. Firm, moist, moderatly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_6_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Three

SOIL PROPERTIES

Specimen Dimensions:	
Diameter (mm):	49.84
Initial height (mm):	18.94
Final height (mm):	17.73
Initial mass of sample (g):	61.39

Note: ** Void ratio is not IANZ Accredited due to assumed Solid Density value.

Initial Wet Density	pbi (t/m³)	1.66
Initial Dry Density	pdi (t/m³)	1.18
Final Dry Density	pdf (t/m³)	1.26
Initial Void Ratio	eo	1.33
Final Void Ratio	ef	1.18
Initial Degree of Saturation	Si (%)	84
Final Degree of Saturation	Sf (%)	100
Solid Particle Density (Assumed)	Gs (t/m³)	2.75
INITIAL Water Content	Wi (%)	40.8
FINAL Water Content	Wf (%)	43.5

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	**Void Ratio (e)	Intercept t90 (min)	Volume Compressibilty Mv=m²/MN	Coeff. of Consolidation Cv=m²/year	Coeff. of Permeability k=m/year	
0 - 50	50	1.296	0.700	0.29	57	1.6 x10 -1	
50 - 100	50	1.262	1.382	0.30	28	8.1 x10 -2	
100 - 200	100	1.227	1.281	0.16	29	4.5 x10 -2	
200 - 400	200	1.172	1.210	0.12	30	3.6 x10 -2	
400 - 50	-	1.180	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		

Test Methods:		Notes:
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	Load Increments applied at 24 hr intervals
		Root time fitting method was used for Cv calculations.

Date tested : 28/01-02/02/25
Date reported : 10/02/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
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Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/2025

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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
TEST RESULT REPORT

Project : HCC Reservoir
Location: HCC Reservoir
Client : CMW Geotechnical NZ Ltd
Sample Location ID: BH24-06 7.5-8.0 Specimen depth: 7.90-7.95m
Sampled by : Client
Date sampled: Not Stated
Sampling method : Pushtube
Sample condition : As Received
Sample description : Clayey SILT, minor fine to medium sand, brown. Firm, moist, moderatly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_6_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Three

SOIL PROPERTIES

Specimen Dimensions:	
Diameter (mm):	49.84
Initial height (mm):	18.94
Final height (mm):	17.73
Initial mass of sample (g):	61.39

Note: ** Void ratio is not IANZ Accredited due to assumed Solid Density value.

Initial Wet Density	pbi (t/m³)	1.66
Initial Dry Density	pdi (t/m³)	1.18
Final Dry Density	pdf (t/m³)	1.26
Initial Void Ratio	eo	1.33
Final Void Ratio	ef	1.18
Initial Degree of Saturation	Si (%)	84
Final Degree of Saturation	Sf (%)	100
Solid Particle Density (Assumed)	Gs (t/m³)	2.75
INITIAL Water Content	Wi (%)	40.8
FINAL Water Content	Wf (%)	43.5

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	**Void Ratio (e)	Intercept t50 (min)	Volume Compressibilty Mv=m²/MN	Coeff. of Consolidation Cv=m²/year	Coeff. of Permeability k=m/year	Coeff. of Secondary Compr. (Csec)
0 - 50	50	1.296	-	-	-		-
50 - 100	50	1.262	-	-	-		-
100 - 200	100	1.227	-	-	-		-
200 - 400	200	1.172	0.310	0.12	27	3.3 x10 -2	0.0012
400 - 50	-	1.180	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-
-	-	-	-	-	-		-

Test Methods:		Notes:
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	Load Increments applied at 24 hr intervals
		Log time fitting method was used for Cv calculations.

Date tested : 28/01-02/02/25
Date reported : 10/02/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
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Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/2025

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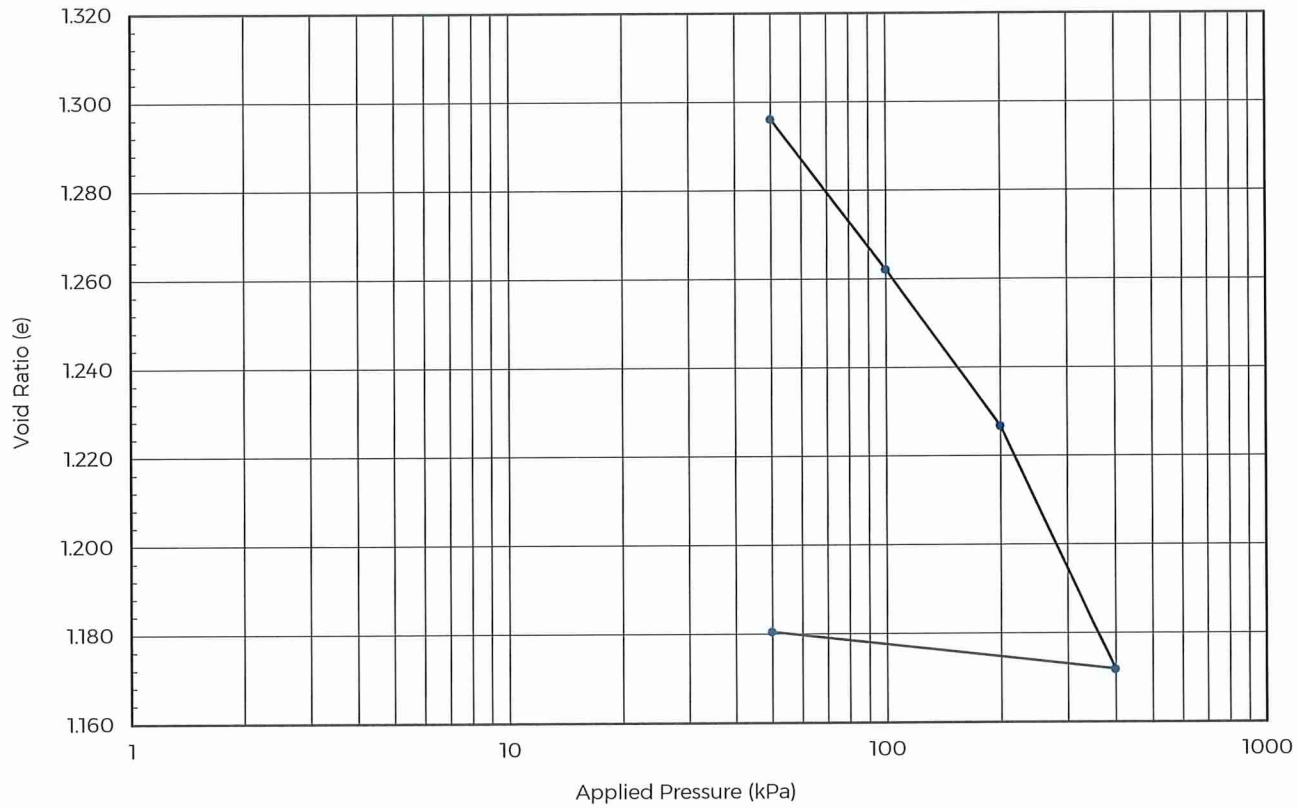
ONE DIMENSIONAL CONSOLIDATION PROPERTIES
Applied Pressure vs Void Ratio TEST REPORT

Project :	HCC Reservoir
Location:	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Sample Location ID:	BH24-06 7.5-8.0 Specimen depth: 7.90-7.95m
Sampled by :	Client
Date sampled:	Not Stated
Sampling method :	Pushtube
Sample condition :	As Received
Sample description :	Clayey SILT, minor fine to medium sand, brown. Firm, moist, moderatly plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_6_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Three

Applied Pressure vs Void Ratio Plot



Test Method:	Notes:
One Dimensional Consolidation Test: NZS 4402:1986 Test 7.1	Load Increments applied at 24 hr intervals Void ratio is not IANZ Accredited due to assumed Solid Density value.

Date tested : 28/01-02/02/25
Date reported : 10/02/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
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ONE DIMENSIONAL CONSOLIDATION PROPERTIES TEST RESULT REPORT

Project : HCC Reservoir
Location: HCC Reservoir
Client : CMW Geotechnical NZ Ltd
Sample Location ID: BH24-06 12.0-12.4 Specimen depth: 12.30-12.35m
Sampled by : Client
Date sampled: Not Stated
Sampling method : Pushtube
Sample condition : As Received
Sample description : Silty fine to coarse SAND, light brown. 'Medium Dense to Loose', Wet, well graded, non plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_7_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Four

SOIL PROPERTIES

Specimen Dimensions:	
Diameter (mm):	49.90
Initial height (mm):	19.88
Final height (mm):	18.73
Initial mass of sample (g):	67.22

Note: ** Void ratio is not IANZ Accredited due to assumed Solid Density value.

Initial Wet Density	pbi (t/m³)	1.73
Initial Dry Density	pdi (t/m³)	1.34
Final Dry Density	pdf (t/m³)	1.42
Initial Void Ratio	eo	1.02
Final Void Ratio	ef	0.90
Initial Degree of Saturation	Si (%)	78
Final Degree of Saturation	Sf (%)	100
Solid Particle Density (Assumed)	Gs (t/m³)	2.70
INITIAL Water Content	Wi (%)	29.4
FINAL Water Content	Wf (%)	33.6

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	**Void Ratio (e)	Intercept t90 (min)	Volume Compressibilty Mv=m²/MN	Coeff. of Consolidation Cv=m²/year	Coeff. of Permeability k=m/year	
0 - 50	50	1.010	0.685	0.10	64	6.6 x10 -2	
50 - 100	50	0.979	3.803	0.30	11	3.4 x10 -2	
100 - 200	100	0.943	1.348	0.19	31	5.7 x10 -2	
200 - 400	200	0.899	1.859	0.11	22	2.4 x10 -2	
400 - 50	-	0.904	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
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-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		

Test Methods:		Notes:
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	Load Increments applied at 24 hr intervals
		Root time fitting method was used for Cv calculations.

Date tested : 28/01-02/02/25
Date reported : 10/02/2025

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Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/2025

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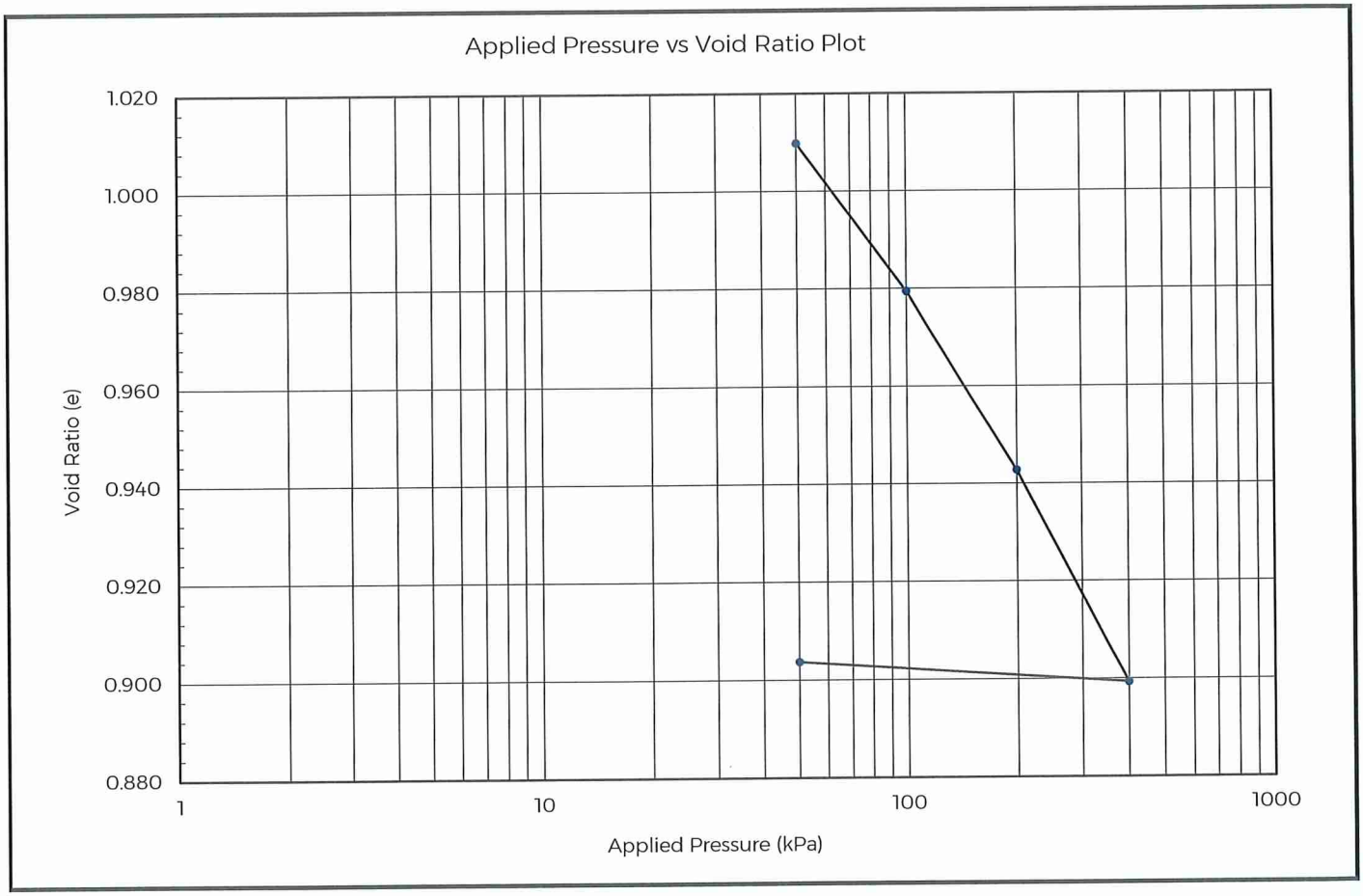
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ONE DIMENSIONAL CONSOLIDATION PROPERTIES
Applied Pressure vs Void Ratio TEST REPORT

Project :	HCC Reservoir
Location:	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Sample Location ID:	BH24-06 12.0-12.4 Specimen depth: 12.30-12.35m
Sampled by :	Client
Date sampled:	Not Stated
Sampling method :	Pushtube
Sample condition :	As Received
Sample description :	Silty fine to coarse SAND, light brown. 'Medium Dense to Loose', Wet, well graded, non plastic.

Project No:	2-68014.00
Lab Ref No:	HA14114_7_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Four



Test Method:		Notes:
One Dimensional Consolidation Test:	NZS 4402:1986 Test 7.1	Load Increments applied at 24 hr intervals Void ratio is not IANZ Accredited due to assumed Solid Density value.

Date tested : 28/01-02/02/25
Date reported : 10/02/2025

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Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/2025

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ONE DIMENSIONAL CONSOLIDATION PROPERTIES TEST RESULT REPORT

Project : HCC Reservoir
Location: HCC Reservoir
Client : CMW Geotechnical NZ Ltd
Sample Location ID: BH24-06 16.0-16.5 Specimen depth: 16.40-16.45m
Sampled by : Client
Date sampled: Not Stated
Sampling method : Pushtube
Sample condition : As Received
Sample description : SILT, minor clay, minor fine to medium sand, light brown. Soft, wet, slightly plastic

Project No:	2-68014.00
Lab Ref No:	HA14114_8_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Five

SOIL PROPERTIES

Specimen Dimensions:	
Diameter (mm):	49.76
Initial height (mm):	19.02
Final height (mm):	17.21
Initial mass of sample (g):	59.01

Note: ** Void ratio is not IANZ Accredited due to assumed Solid Density value.

Initial Wet Density	pbi (t/m³)	1.60
Initial Dry Density	pdi (t/m³)	0.91
Final Dry Density	pdf (t/m³)	1.00
Initial Void Ratio	eo	2.03
Final Void Ratio	ef	1.74
Initial Degree of Saturation	Si (%)	100
Final Degree of Saturation	Sf (%)	100
Solid Particle Density (Assumed)	Gs (t/m³)	2.75
INITIAL Water Content	Wi (%)	75.7
FINAL Water Content	Wf (%)	65.7

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	**Void Ratio (e)	Intercept t90 (min)	Volume Compressibilty Mv=m²/MN	Coeff. of Consolidation Cv=m²/year	Coeff. of Permeability k=m/year	
0 - 50	50	1.974	0.638	0.35	63	2.2 x10 -1	
50 - 100	50	1.937	1.217	0.25	32	7.9 x10 -2	
100 - 200	100	1.862	1.354	0.25	28	6.9 x10 -2	
200 - 400	200	1.721	1.297	0.25	28	6.7 x10 -2	
400 - 50	-	1.739	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		

Test Methods:		Notes:
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	Load Increments applied at 24 hr intervals
		Root time fitting method was used for Cv calculations.

Date tested : 28/01-02/02/25
Date reported : 10/02/2025

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Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/2025

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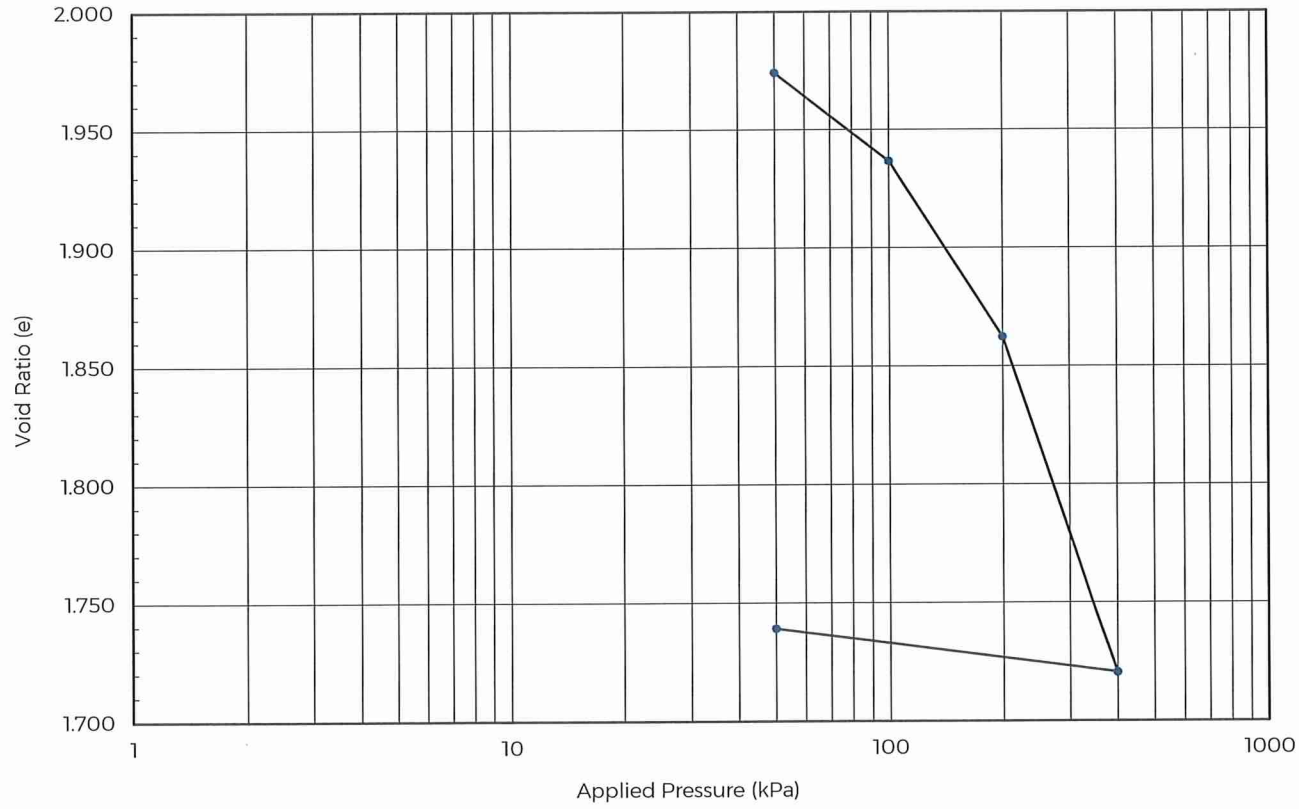
ONE DIMENSIONAL CONSOLIDATION PROPERTIES
Applied Pressure vs Void Ratio TEST REPORT

Project :	HCC Reservoir
Location:	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Sample Location ID:	BH24-06 16.0-16.5 Specimen depth: 16.40-16.45m
Sampled by :	Client
Date sampled:	Not Stated
Sampling method :	Pushtube
Sample condition :	As Received
Sample description :	SILT, minor clay, minor fine to medium sand, light brown. Soft, wet, slightly plastic

Project No:	2-68014.00
Lab Ref No:	HA14114_8_OED
Client Ref:	HAM2023-0099

OEDOMETER APPARATUS No: Five

Applied Pressure vs Void Ratio Plot



Test Method:		Notes:
One Dimensional Consolidation Test:	NZS 4402:1986 Test 7.1	Load Increments applied at 24 hr intervals Void ratio is not IANZ Accredited due to assumed Solid Density value.

Date tested : 28/01-02/02/25
Date reported : 10/02/2025

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Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 10/02/2025

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CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (CIU)
Test Report - Result Summary

Project:	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Borehole No:	BH24-06
Depth (m):	12.0-12.4
Sampled by:	Client
Date sampled:	Not Stated
Sampling Method:	Pushtube
Sample Description:	Silty fine to coarse SAND, light brown. 'Medium dense to loose', wet, well graded, non-plastic.
Sample Type :	Undisturbed
Comments:	Multistage Test.

Project No:	2-68014.00
Lab Ref No:	HA14114_6_CuTx
Client Ref:	HAM2023-0099

Initial Sample properties

Length (mm)	=	107.82
Diameter (mm)	=	54.63

Membrane Correction applied

Rate of strain (mm/min)	
Stage 1	0.04325
Stage 2	0.04332
Stage 3	0.04350

Saturation achieved using a minimum Back Pressure of 400 kPa

Specimen Stage No	Effective Confining Pressure (kPa)	INITIAL PROPERTIES Densities (Mg/m³) Bulk (Mg/m³)	Dry (Mg/m³)	Water Content (%)	Solid Particle Density (Mg/m³)	FINAL PROPERTIES Densities (Mg/m³) Bulk (Mg/m³)	Dry (Mg/m³)	Water Content (%)
1	150	1.92	1.49	28.8				
2	250				2.65			
3	350				(assumed)	1.97	1.56	26.1

Specimen Stage No	Effective Confining Pressure (kPa)	Void Ratio (e)	Deg of Saturation (Sr) Sr before Consolid. (%)	Sr after Consolid. (%)	Deviator Stress σ_1-σ_3 (kPa)	Pore Pressure μ (kPa)	Cumulative Strain (%)	Failure Criteria at Maximum Values
1	150	0.78	98	100	312.7	44	3.06	Dev. Stress
2	250				527.0	54	6.00	Dev. Stress
3	350				664.2	62	13.23	Dev. Stress

Specimen Stage No	Effective Confining Pressure (kPa)	Coefficient of Consolidation Cv (m^2/year)	Volume Compressibility Mv (m^2/MN)	Coefficient of Permeability k (m/s)	Final B Value
1	150	171	0.16	8.3 x 10 $^{-9}$	0.95
2	250	173	0.12	6.5 x 10 $^{-9}$	
3	350	349	0.10	1.1 x 10 $^{-8}$	

Due to the use of side filter drains, IANZ endorsement does not include the Cv, Mv and k values reported herein.

Mv,Cv & k calculated for the following conditions:-

L/D=2, RADIAL+ONE END Drainage

Side Filter Drains Used

(L/D= Sample Length/Diameter.)

TOTAL STRESS RESULT		
Intercept d	15.53	(kPa)
Beta β	25.16	(deg)
Cohesion c	18	(kPa)
Phi Ø	28	(deg)
Correl coeff.	0.9955	(r^2)

EFFECTIVE STRESS RESULT		
Intercept d'	29.40	(kPa)
Beta β'	26.31	(deg)
Cohesion c'	34	(kPa)
Phi Ø'	30	(deg)
Correl coeff.	0.9957	(r^2)

Test Method	Notes
Consolidated undrained triaxial test : BS EN ISO 17892-9:2018 Water Content : NZS4402 : 1986 Test 2.1	Cv and Mv have been rounded to 2 significant figures. Mg/m³ is equivalent to t/m³ Deviation from standard, rate of vertical strain for shear stage reported in mm/min vs. %/hr

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

This report may only be reproduced in full

All information supplied by Client

Date tested: 28/01-11/02/25

Date reported: 17/02/25

Approved Signatory: Date: 17/02/25

Designation: *Senior Civil Engineering Technician*

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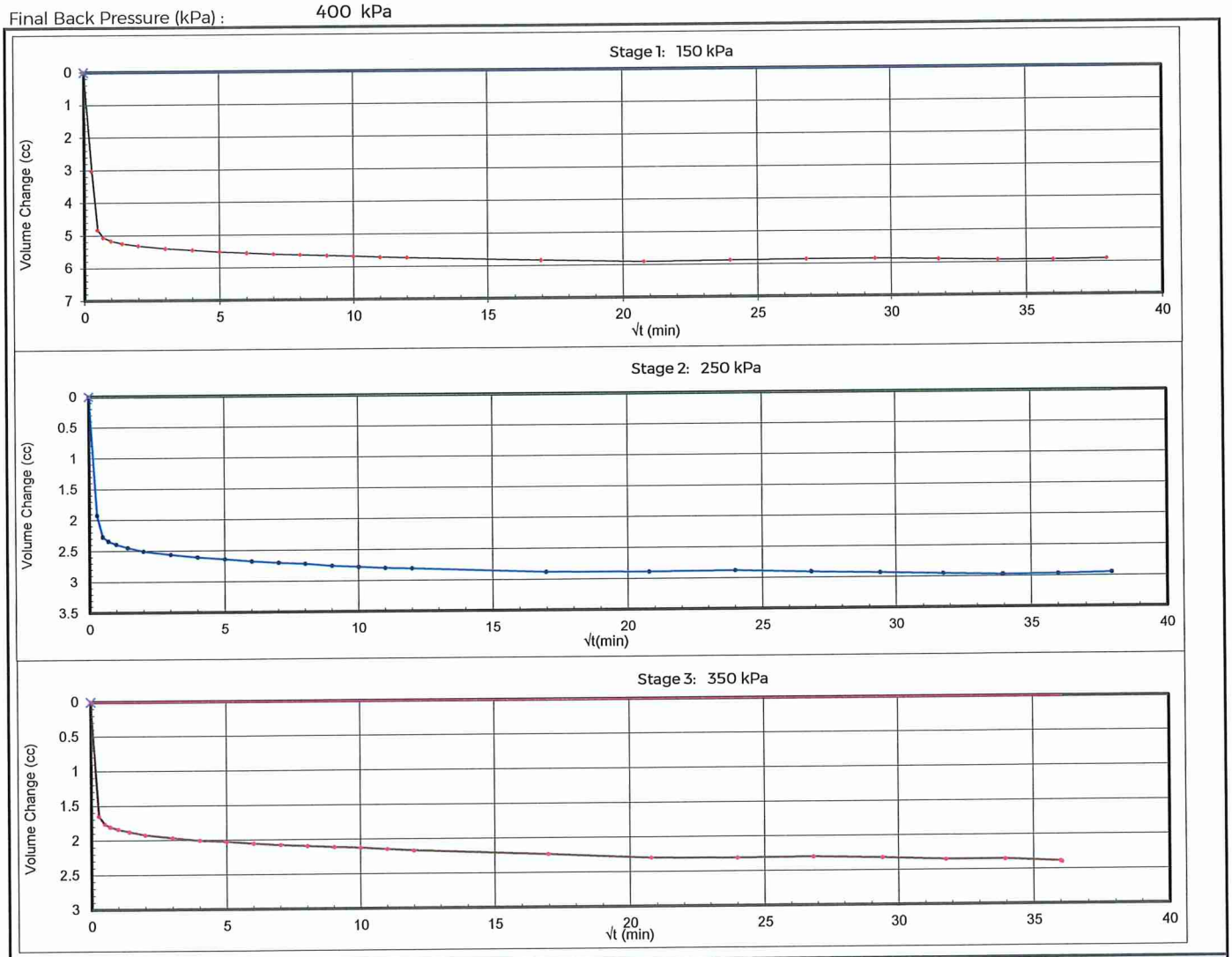
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (CIU)
Volume change *vs* √t Plot (Consolidation stage)

Project:	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Borehole No:	BH24-06
Depth (m):	12.0-12.4
Sampled by:	Client
Date sampled:	Not Stated
Sampling Method:	Pushtube
Sample Description:	Silty fine to coarse SAND, light brown. 'Medium dense to loose', wet, well graded, non-plastic.

Comments: Multistage Test.
Radial + One end drainage conditions during consolidation

Project No:	2-68014.00
Lab Ref No:	HA14114_6_CuTx
Client Ref:	HAM2023-0099

Final Back Pressure (kPa) : 400 kPa



Test Method
Consolidated undrained triaxial test : BS EN ISO 17892-9:2018
Water Content : NZS4402 : 1986 Test 2.1

Notes :

Test Results at end of consolidaiton			
Effective Stress (kPa)=	150 kPa	250 kPa	350 kPa
$t_{100\ (min)}$ =	0.361	0.355	0.176
Volumetric Strain (%)=	3.01	1.5	1.22
Vertical Strain (%)=	0.00	2.67	15.00
PWP Dissapation (U%)=	100	99	99.7
Estimated Strain to failure(%)=	5	5	5

Date tested : 28/01-11/02/25
Date reported : 17/02/25

Approved Signatory
Designation: *Senior Civil Engineering Technician*

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full
All information supplied by Client
Date: 17/02/25

ACCREDITED IANZ TESTING LABORATORY

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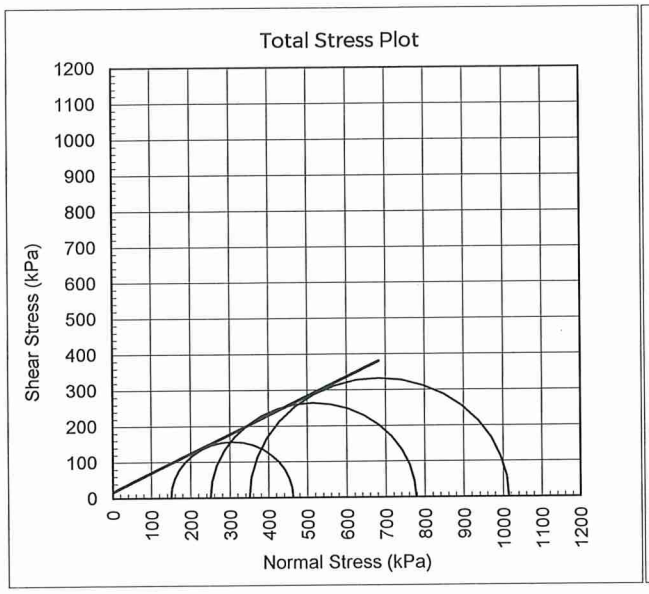
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (CIU)
Test Report - Mohr Coulomb Envelope Plot

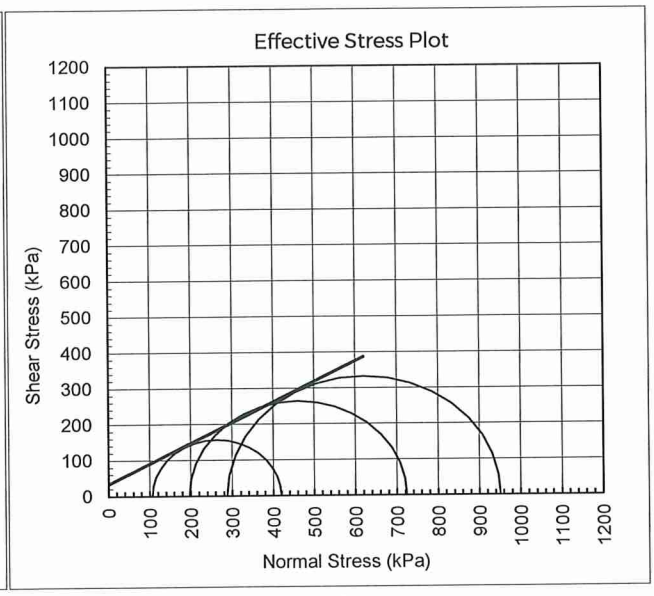
Project:	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Borehole No:	BH24-06
Depth (m):	12.0-12.4
Sampled by:	Client
Date sampled:	Not Stated
Sampling Method:	Pushtube
Sample Description:	Silty fine to coarse SAND, light brown. 'Medium dense to loose', wet, well graded, non-plastic.

Sample Type :	Undisturbed
Comments:	Multistage Test.

Project No:	2-68014.00
Lab Ref No:	HA14114_6_CuTx
Client Ref:	HAM2023-0099

Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT
Mohr-Coulomb envelope plots - Result at Maximum Stress
Back Pressure Saturated at 400 kPa





TOTAL STRESS RESULT		
Intercept d	15.53	(kPa)
Beta β	25.16	(deg)
Cohesion c	18	(kPa)
Phi Ø	28	(deg)
Correl coeff.	0.9955	(r^2)

EFFECTIVE STRESS RESULT		
Intercept d'	29.40	(kPa)
Beta β'	26.31	(deg)
Cohesion c'	34	(kPa)
Phi Ø'	30	(deg)
Correl coeff.	0.9957	(r^2)

Test Method	Notes
Consolidated undrained triaxial test : BS EN ISO 17892-9:2018 Water Content : NZS4402 : 1986 Test 2.1	Stage 1 : Dev. Stress Stage 2 : Dev. Stress Stage 3 : Dev. Stress

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full
All information supplied by Client

Date tested: 28/01-11/02/25
Date reported: 17/02/25

Approved Signatory: Date: 17/02/25

Designation: *Senior Civil Engineering Technician*

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Website www.wsp.com/nz

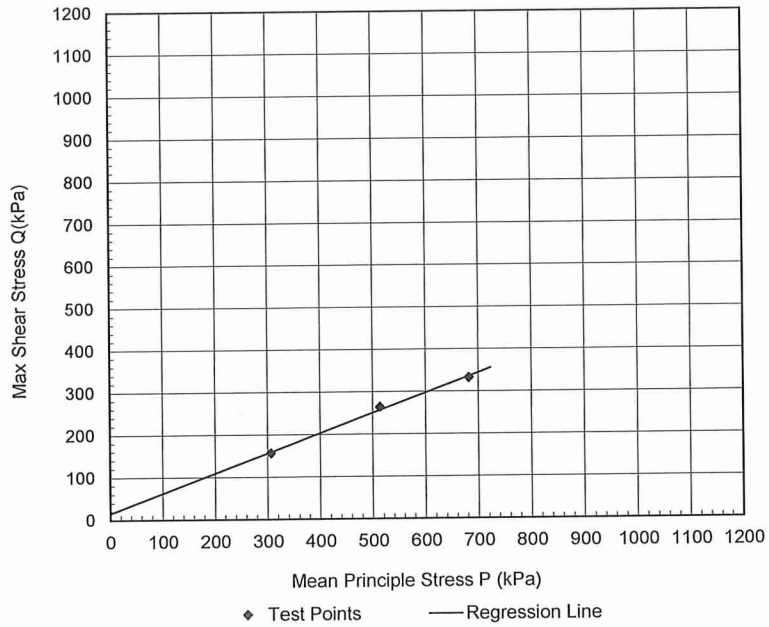
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (CIU)
Test Report - P vs Q Total Stress Plot

Project:	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Borehole No:	BH24-06
Depth (m):	12.0-12.4
Sampled by:	Client
Date sampled:	Not Stated
Sampling Method:	Pushtube
Sample Description:	Silty fine to coarse SAND, light brown. 'Medium dense to loose', wet, well graded, non-plastic.

Sample Type :	Undisturbed
Comments:	Multistage Test.

Project No:	2-68014.00
Lab Ref No:	HA14114_6_CuTx
Client Ref:	HAM2023-0099

Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT
P vs Q Total Stress Plot - Back Pressure saturated at 400 kPa



TOTAL STRESS RESULT			Correl coeff	0.9955	(r^2)
Intercept d	15.53	(kPa)	Cohesion c	18	(kPa)
Beta β	25.16	(deg)	Phi Ø	28	(deg)

Test Method	Notes
Consolidated undrained triaxial test : BS EN ISO 17892-9:2018 Water Content : NZS4402 : 1986 Test 2.1	Failure Criteria: (at Max. Values) Stage 1 : Dev. Stress Stage 2 : Dev. Stress Stage 3 : Dev. Stress

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

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All information supplied by Client

Date tested: 28/01-11/02/25

Date reported: 17/02/25

Approved Signatory:

Date: 17/02/25

Designation: *Senior Civil Engineering Technician*

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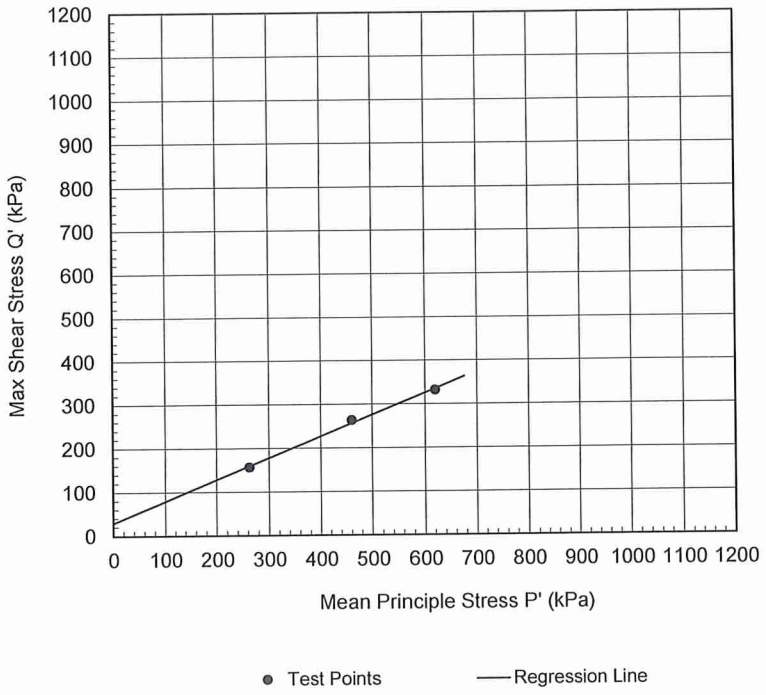
Telephone +64 7 856 2870
Website www.wsp.com/nz

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (CIU)
Test Report - P' vs Q' Effective Stress Plot

Project:	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Borehole No:	BH24-06
Depth (m):	12.0-12.4
Sampled by:	Client
Date sampled:	Not Stated
Sampling Method:	Pushtube
Sample Description:	Silty fine to coarse SAND, light brown. 'Medium dense to loose', wet, well graded, non-plastic.
Sample Type :	Undisturbed
Comments:	Multistage Test.

Project No:	2-68014.00
Lab Ref No:	HA14114_6_CuTx
Client Ref:	HAM2023-0099

Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT
P' vs Q' Effective Stress Plot - Back Pressure saturated at 400 kPa



EFFECTIVE STRESS RESULT			Correl coeff	0.9957	(r^2)
Intercept d'	29	(kPa)	Cohesion c'	34	(kPa)
Beta β'	26	(deg)	Phi Ø'	30	(deg)

Test Method	Notes
Consolidated undrained triaxial test : BS EN ISO 17892-9:2018	
Water Content : NZS4402 : 1986 Test 2.1	Failure Criteria: (at Max. Values) Stage 1 : Dev. Stress; Stage 2 : Dev. Stress; Stage 3 : Dev. Stress

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

This report may only be reproduced in full

All information supplied by Client

Date tested: 28/01-11/02/25

Date reported: 17/02/25

Approved Signatory: Date: 17/02/25

Designation: *Senior Civil Engineering Technician*

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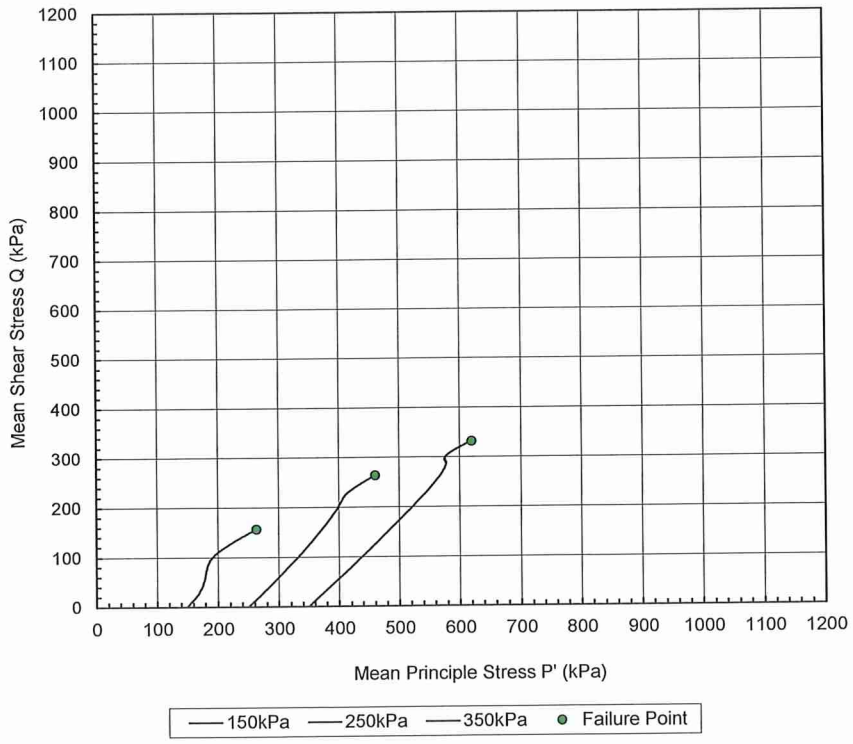
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (CIU)
Test Report - PvsQ Stress Path Plot

Project:	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Borehole No:	BH24-06
Depth (m):	12.0-12.4
Sampled by:	Client
Date sampled:	Not Stated
Sampling Method:	Pushtube
Sample Description:	Silty fine to coarse SAND, light brown. 'Medium dense to loose', wet, well graded, non-plastic.

Sample Type :	Undisturbed
Comments:	Multistage Test.

Project No:	2-68014.00
Lab Ref No:	HA14114_6_CuTx
Client Ref:	HAM2023-0099

Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT
P' vs Q Stress Path (Effective Stress Plot) - Back Pressure saturated at 400 kPa



Test Method	Notes
Consolidated undrained triaxial test : BS EN ISO 17892-9:2018 Water Content : NZS4402 : 1986 Test 2.1	Failure Criteria: (at Max. Values) Stage 1 : Dev. Stress Stage 2 : Dev. Stress Stage 3 : Dev. Stress

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full
All information supplied by Client

Date tested: 28/01-11/02/25
Date reported: 17/02/25

Approved Signatory:

Date: 17/02/25

Designation: *Senior Civil Engineering Technician*

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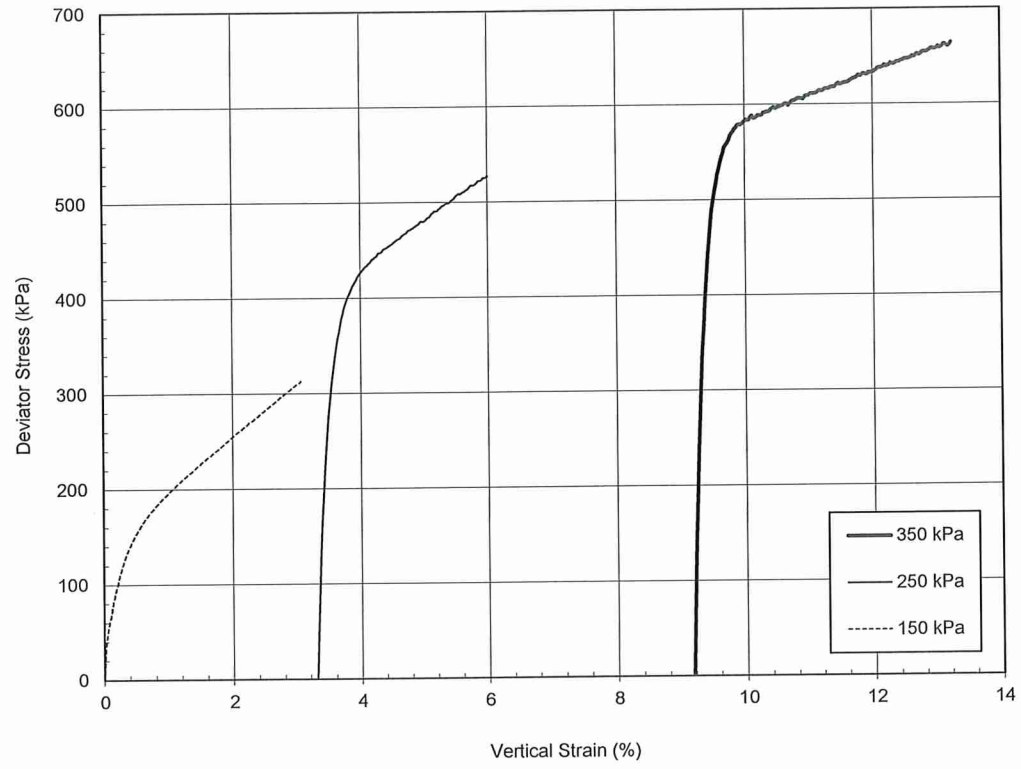
Telephone +64 7 856 2870
Website www.wsp.com/nz

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (CIU)
Test Report - Strain vs Deviator StressPlot

Project:	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Borehole No:	BH24-06
Depth (m):	12.0-12.4
Sampled by:	Client
Date sampled:	Not Stated
Sampling Method:	Pushtube
Sample Description:	Silty fine to coarse SAND, light brown. 'Medium dense to loose', wet, well graded, non-plastic.
Sample Type :	Undisturbed
Comments:	Multistage Test.

Project No:	2-68014.00
Lab Ref No:	HA14114_6_CuTx
Client Ref:	HAM2023-0099

Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT
Vertical Strain vs Deviator Stress Plot - Back Pressure saturated at 400 kPa



Test Method	Notes
Consolidated undrained triaxial test : BS EN ISO 17892-9:2018 Water Content : NZS4402 : 1986 Test 2.1	

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full
All information supplied by Client

Date tested: 28/01-11/02/25
Date reported: 17/02/25

Approved Signatory: Date: 17/02/25

Designation: *Senior Civil Engineering Technician*

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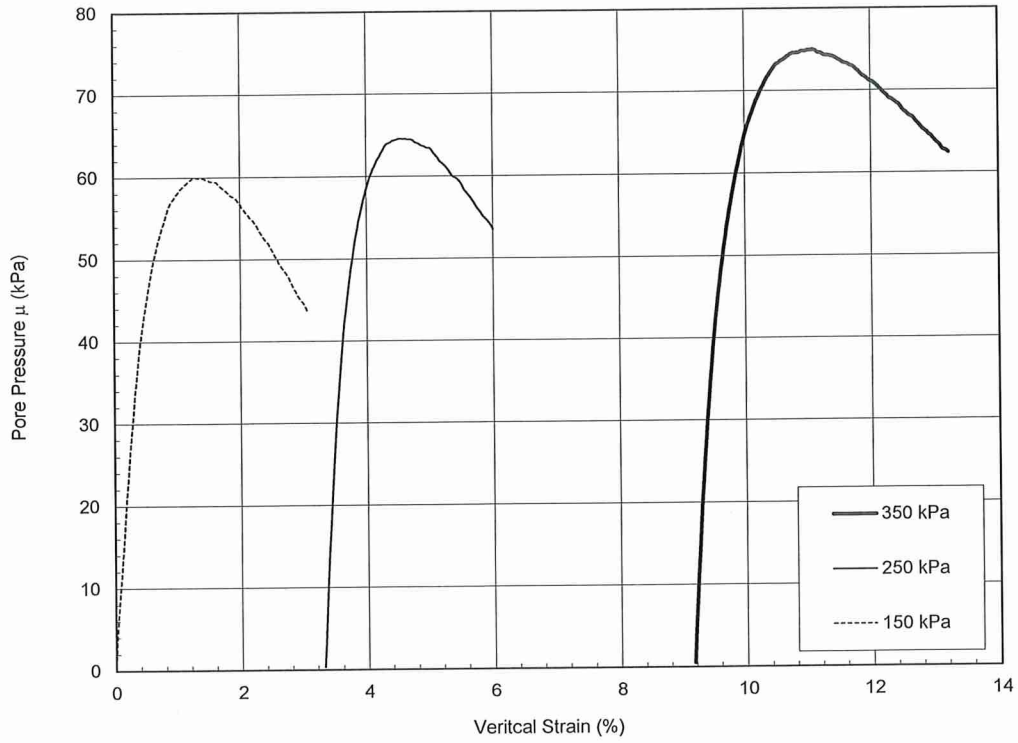
Telephone +64 7 856 2870
Website www.wsp.com/nz

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (CIU)
Test Report - Strain vs Pore Pressure Plot

Project:	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Borehole No:	BH24-06
Depth (m):	12.0-12.4
Sampled by:	Client
Date sampled:	Not Stated
Sampling Method:	Pushtube
Sample Description:	Silty fine to coarse SAND, light brown. 'Medium dense to loose', wet, well graded, non-plastic.
Sample Type :	Undisturbed
Comments:	Multistage Test.

Project No:	2-68014.00
Lab Ref No:	HA14114_6_CuTx
Client Ref:	HAM2023-0099

Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT
Vertical Strain vs Pore Pressure Plot - Back Pressure saturated at 400 kPa



Test Method	Notes
Consolidated undrained triaxial test : BS EN ISO 17892-9:2018 Water Content : NZS4402 : 1986 Test 2.1	

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full
All information supplied by Client

Date tested: 28/01-11/02/25
Date reported: 17/02/25

Approved Signatory:

Date: 17/02/25

Designation: *Senior Civil Engineering Technician*

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Website www.wsp.com/nz

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (CIU)
Test report - Photograph of Failure Type

Project:	HCC Reservoir
Location :	HCC Reservoir
Client :	CMW Geotechnical NZ Ltd
Borehole No:	BH24-06
Depth (m):	12.0-12.4
Sampled by:	Client
Date sampled:	Not Stated
Sampling Method:	Pushtube
Sample Description:	Silty fine to coarse SAND, light brown. 'Medium dense to loose', wet, well graded, non-plastic.
Sample Type :	Undisturbed
Comments:	Multistage Test.

Project No:	2-68014.00
Lab Ref No:	HA14114_6_CuTx
Client Ref:	HAM2023-0099

Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT
Photo of failure type



Test Method	Notes
Consolidated undrained triaxial test : BS EN ISO 17892-9:2018 Water Content : NZS4402 : 1986 Test 2.1	

Date tested: 28/01-11/02/25
Date reported: 17/02/25

Approved Signatory: Date: 17/02/25

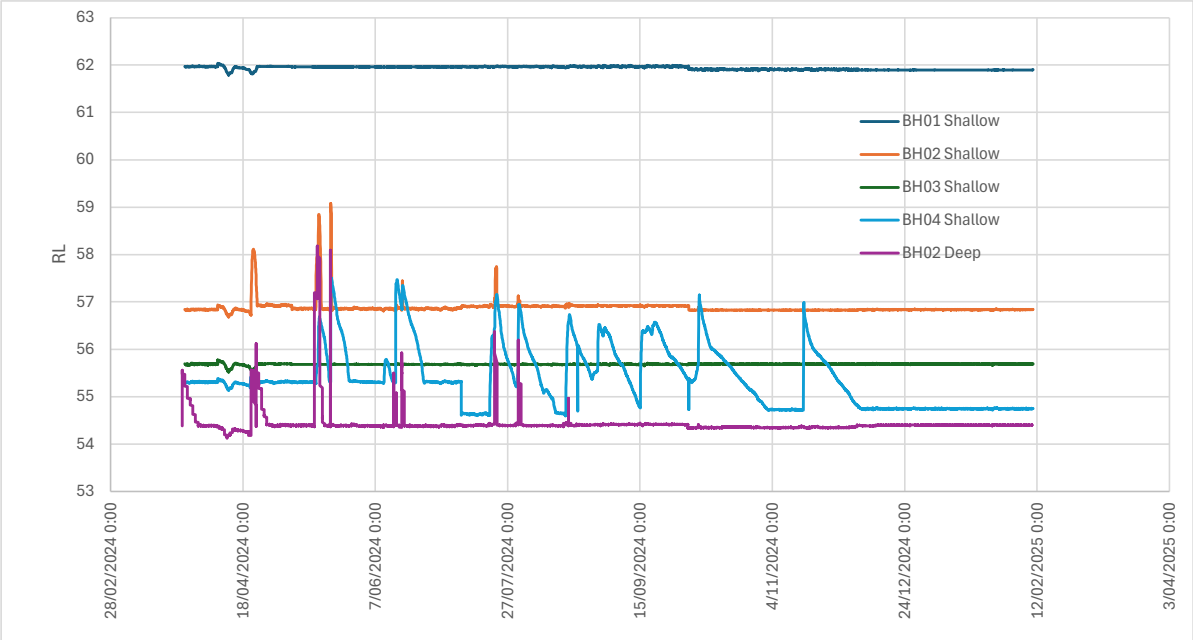
Designation: *Senior Civil Engineering Technician*

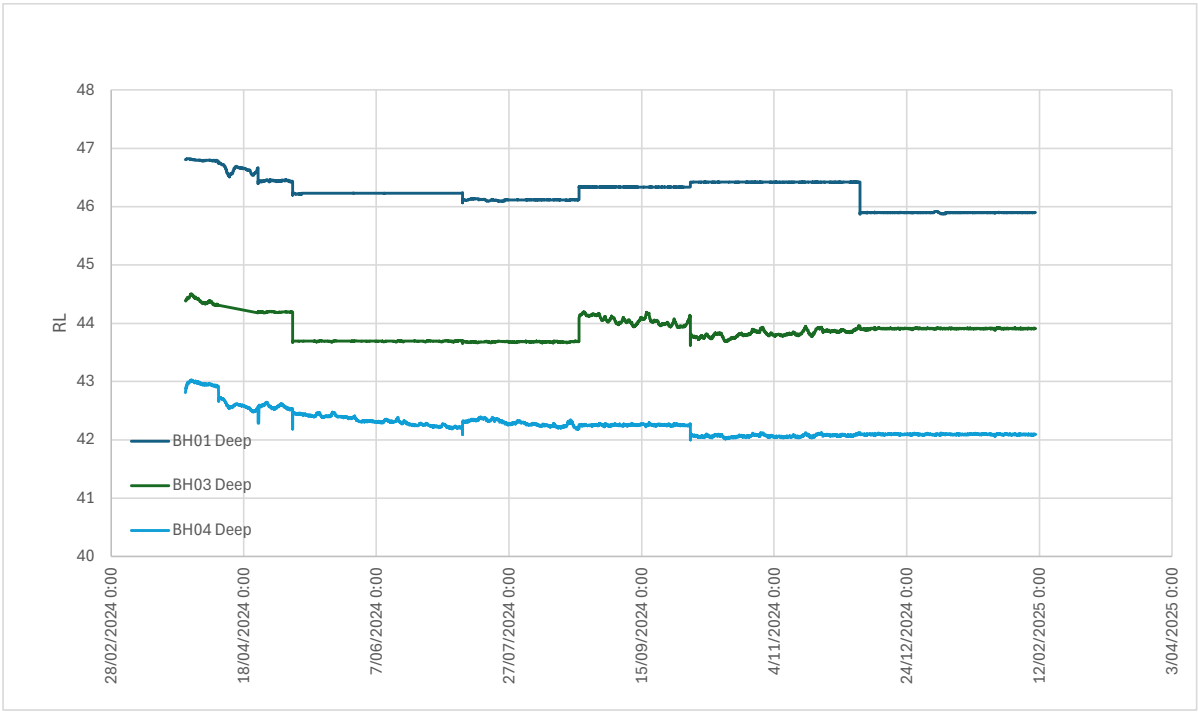
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APPENDIX E
Groundwater Monitoring


RL
63
62
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53
28/02/2024 0:00
18/04/2024 0:00
7/06/2024 0:00
27/07/2024 0:00
15/09/2024 0:00
4/11/2024 0:00
24/12/2024 0:00
12/02/2025 0:00
3/04/2025 0:00
BH01 Shallow
BH02 Shallow
BH03 Shallow
BH04 Shallow
BH02 Deep


RL
48
47
46
45
44
43
42
41
40
28/02/2024 0:00
18/04/2024 0:00
7/06/2024 0:00
27/07/2024 0:00
15/09/2024 0:00
4/11/2024 0:00
24/12/2024 0:00
12/02/2025 0:00
3/04/2025 0:00
BH01 Deep
BH03 Deep
BH04 Deep

APPENDIX F
Seismic Loads

The proposed IAF reservoir will be an importance level (IL) 4 structure with a design life of 100 years.

As per NZS 1170.0[8], the annual exceedance of probability and seismic loads for IL4 structures with a 100-years design life should be determined based on a site-specific seismic hazard analysis (SSSHA). The results of the SSSHA conducted by CMW Geosciences, ref. HAM2023-0099AG, Rev2 dated 28 February 2025 are summarized in the table below:

Table 9: Recommended Seismic Loads – Reservoir Site

Return Period	Mean Magnitude	PGA		
		Lower Bound V_{s30}	Mean V_{s30}	Upper Bound V_{s30}
1/25	6.59	0.03	0.03	0.03
1/50	6.69	0.05	0.05	0.05
1/500	6.82	0.17	0.17	0.17
1/1,000	6.85	0.23	0.23	0.23
1/2,500	6.91	0.33	0.33	0.32

[8] Standards New Zealand "Structural Design Actions, Part 0: General Principles", NZS 1170.0:2002.

APPENDIX G

Liquefaction Analysis Output

METHODOLOGY

In accordance with MBIE/NZGS guidance, the liquefaction susceptibility of the soils at this site was assessed with respect to geological age and compositional (soil fabric and density) criteria, based on the following staged analysis:

1) Liquefaction assessment with consideration of the soil microstructure:

- Only saturated soils below an assessed seasonal average groundwater level were modelled as being susceptible to liquefaction. Soils were modelled as saturated below the regional groundwater level shown on the Cross Sections North- South and East-West (***Drawings 02 and 03***) which is approximately at 15m bgl.
- A site-specific assessment was carried out using the seismic CPTs to account for soil microstructure in accordance with Robertson and Lontzetidis et al. Results suggest that soil microstructure is present and justifies the use of an average strength gain factor (K_{DR}) of 1.5 in the Hamilton Ashes and Walton Subgroup formations.

2) Lab-testing on targeted layers identified as potentially liquefiable during stage 1:

- Soils are also classified with respect to their grain size and plasticity to assess liquefaction susceptibility. For this project, a cut-off threshold soil behaviour type index value (I_c) of 2.6 was used to distinguish between liquefiable (I_c<2.6) and non-liquefiable (I_c>2.6) soils.
- Based on the laboratory test results, fines contents are more than 30% and Plasticity Index is more than 12%. Therefore, the Hamilton Ashes are considered as non-liquefiable (including the sandy layers).
- Specific liquefaction analyses were undertaken using the software package CLiq using the Boulanger and Idriss (2014) method. The cyclic stress ratio (CSR), being a function of the earthquake magnitude for the design return period event, was compared to the cyclic resistance ratio (CRR), being a function of the CPT cone resistance (q_c) and friction ratio (F_r).
- Free-field liquefaction induced settlements were determined in accordance with Zhang et al. (2002).

Results Summary

Results are summarised below and provided in the following Cliq analyses outputs.

Table 10: Liquefaction summary

CPT	Groundwater Depth (m bgl)	Cut (-) / Fill (+) (m)	SLS1 Settlement (mm)	SLS2 Settlement (mm)	Total ULS Settlement (mm)	Depth to Liquefied Layer (m bgl)*
CPT01	15.0	0	<5	<5	<5	N/A
CPT02	15.0	-1.2	<5	<5	<5	N/A
CPT03	15.0	0	<5	<5	<5	N/A
CPT04*	15.0	0	<5	65(*)	70(*)	2.2
sCPT01	15.0	0	<5	<5	<5	N/A
sCPT02	15.0	0	<5	<5	<5	N/A
sCPT03	15.0	-1.3	<5	<5	<5	N/A
sCPT04	15.0	2.1	<5	<5	<5	N/A
CPT05	15.0	0	<5	<5	<5	N/A
CPT06	15.0	0.3	<5	<5	<5	17.5
CPT07	15.0	0.1	<5	<5	<5	N/A
CPT08	15.0	2.4	<5	<5	<5	N/A
sCPT24-05	15.0	0	<5	<5	<5	N/A
sCPT24-06	15.0	0.6	<5	<5	<5	N/A

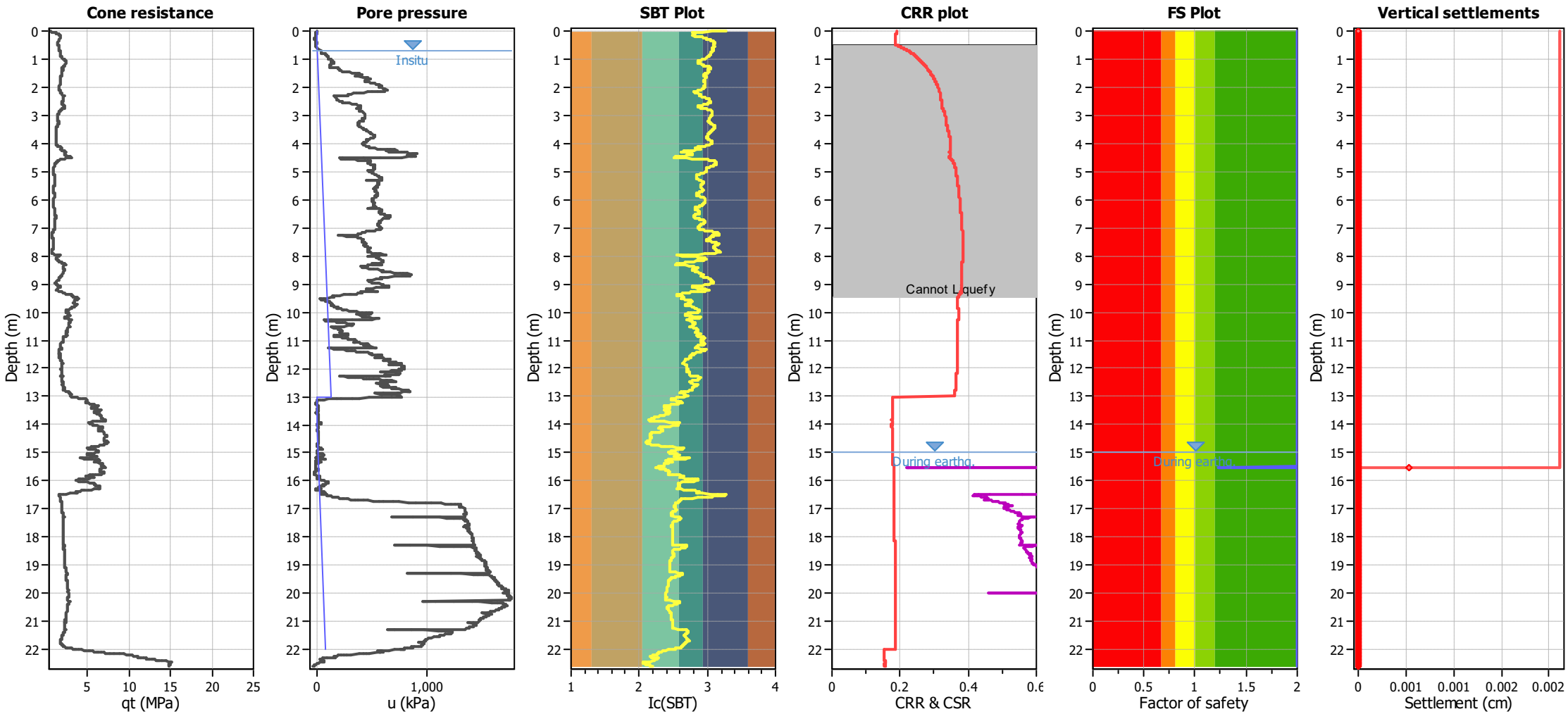
Note: All settlements and depths based on design elevation.

Total ULS settlements are based on the full depth of the CPT trace (limited to 20m) with a depth weighting factor applied.

(*) CPT04 is located outside of the reservoir project footprint and shall not be considered in terms of liquefaction settlement. The liquefaction assessment for this log is however used as input data in our slope stability assessment.

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

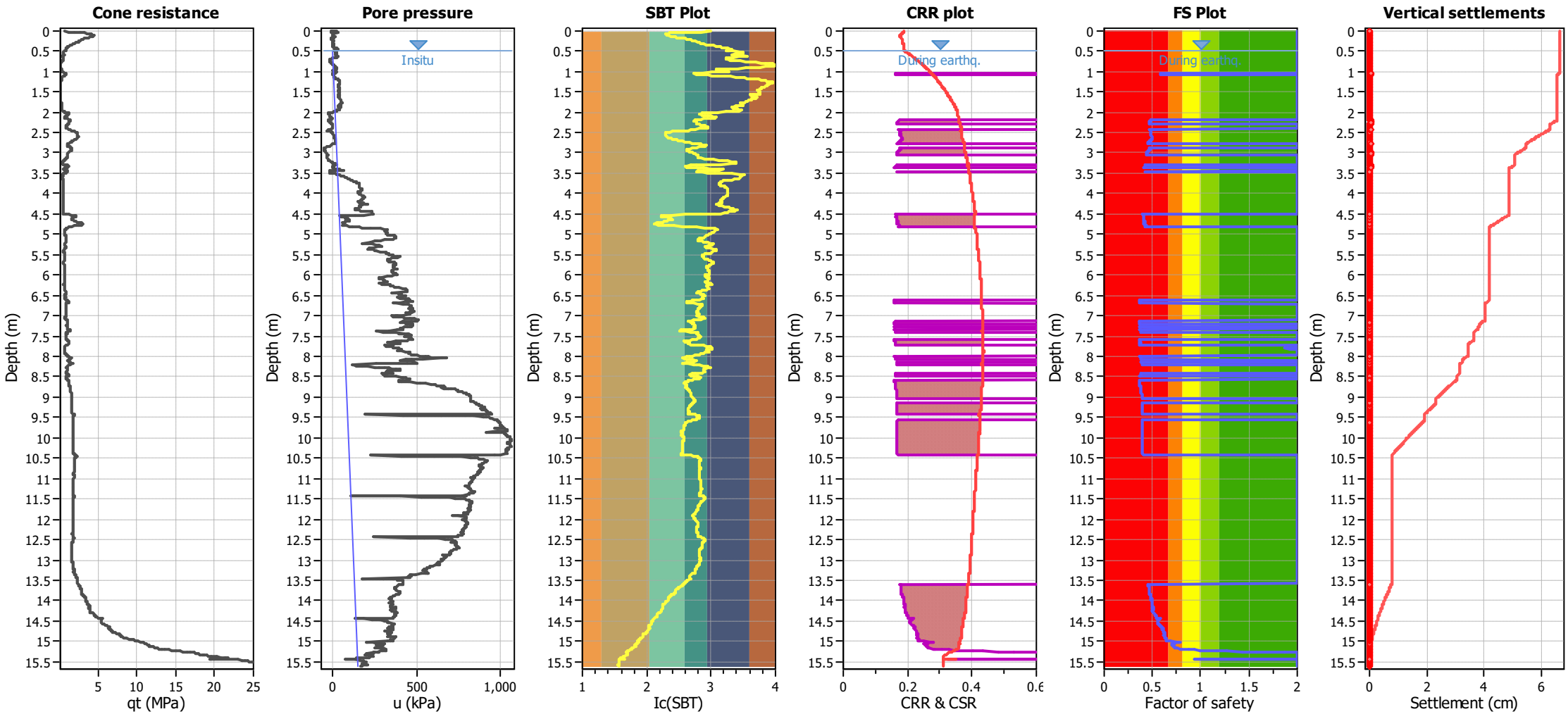
CPT: CPT03
Total depth: 22.59 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.70 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

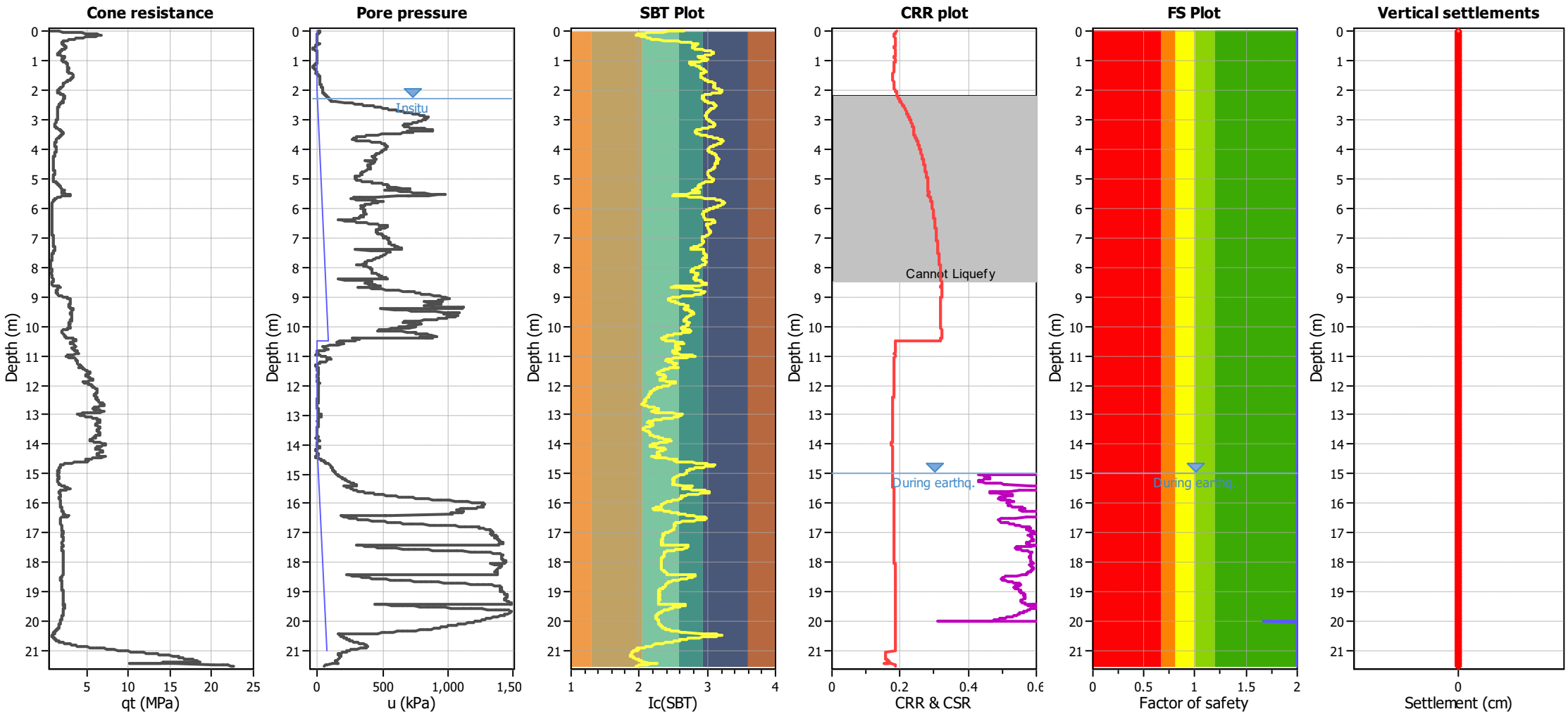
CPT: CPT04
Total depth: 15.61 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

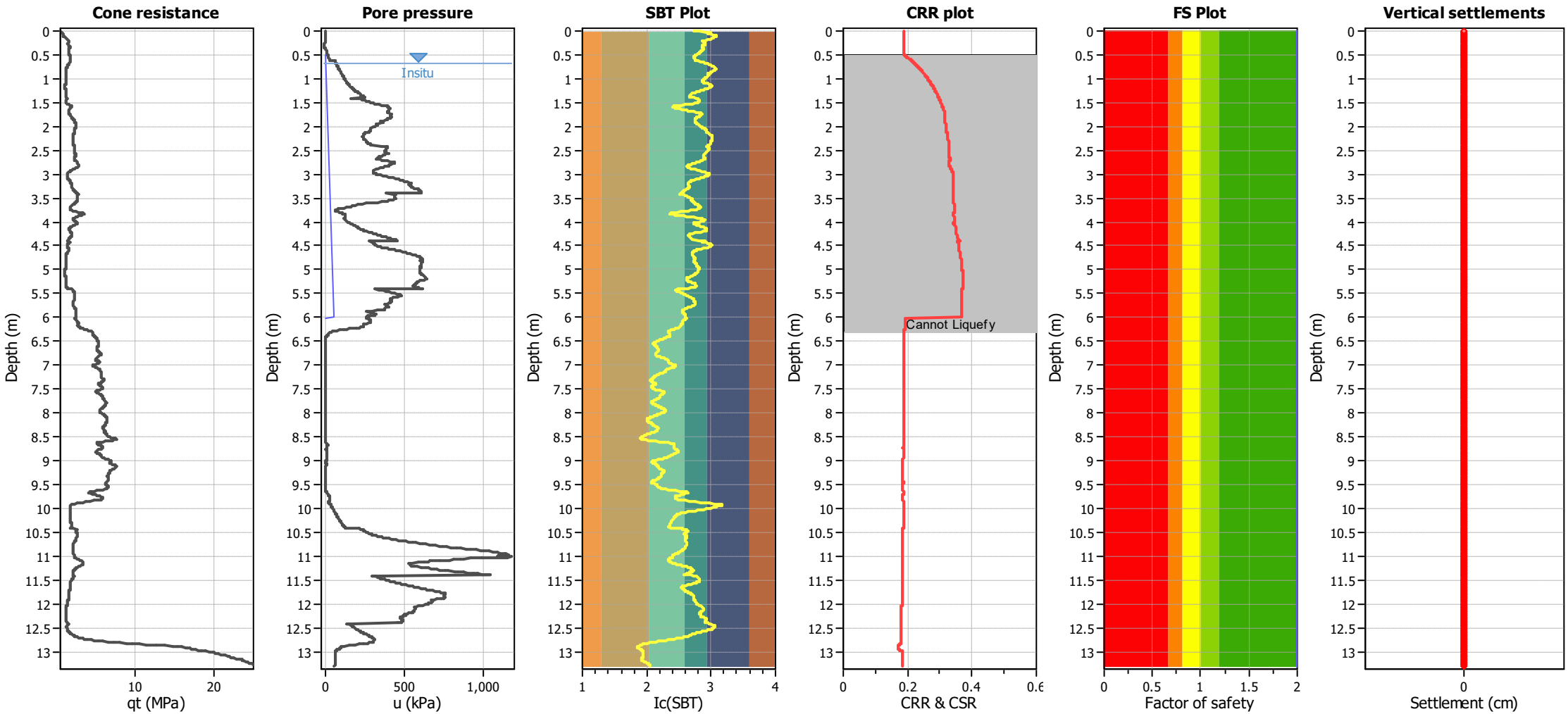
CPT: sCPT01
Total depth: 21.51 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.30 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

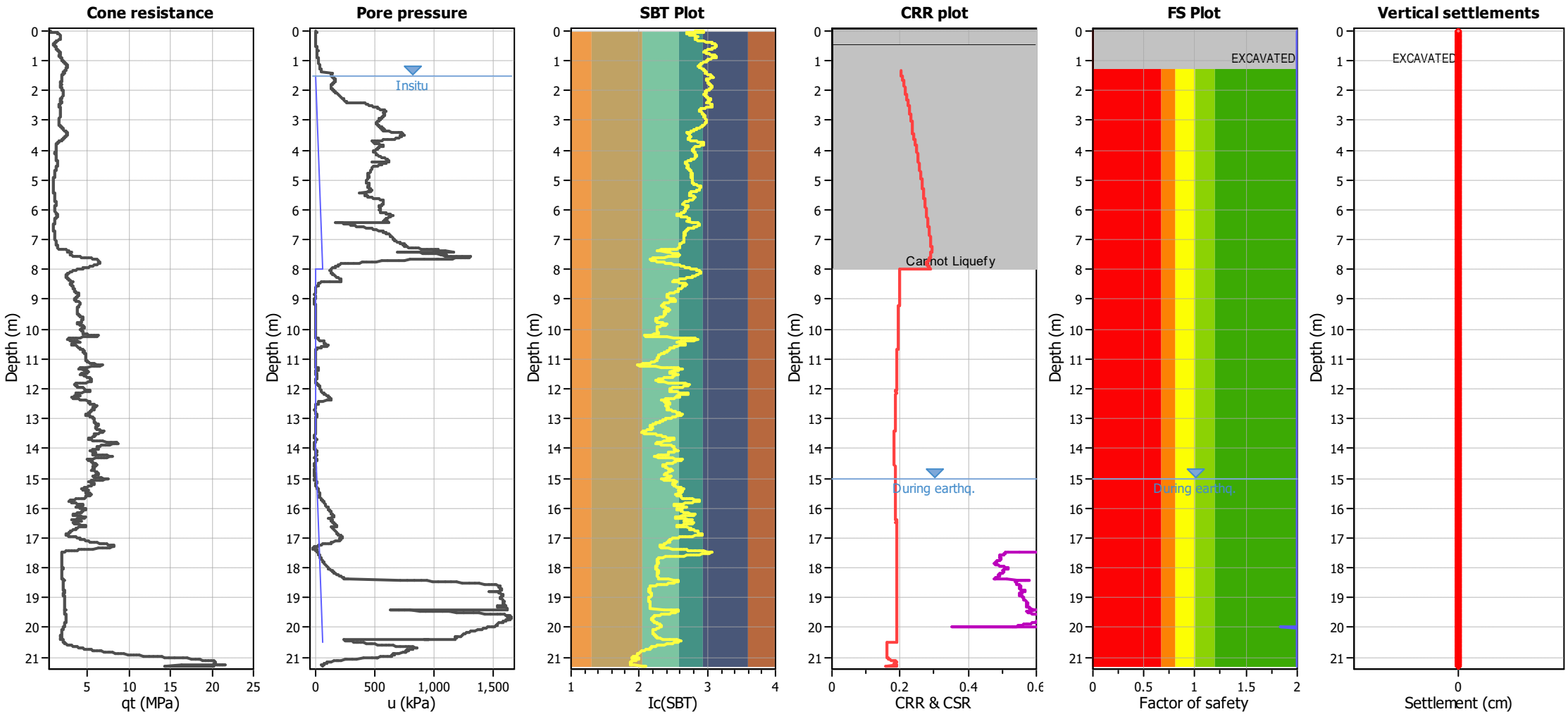
CPT: sCPT02
Total depth: 13.29 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.70 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

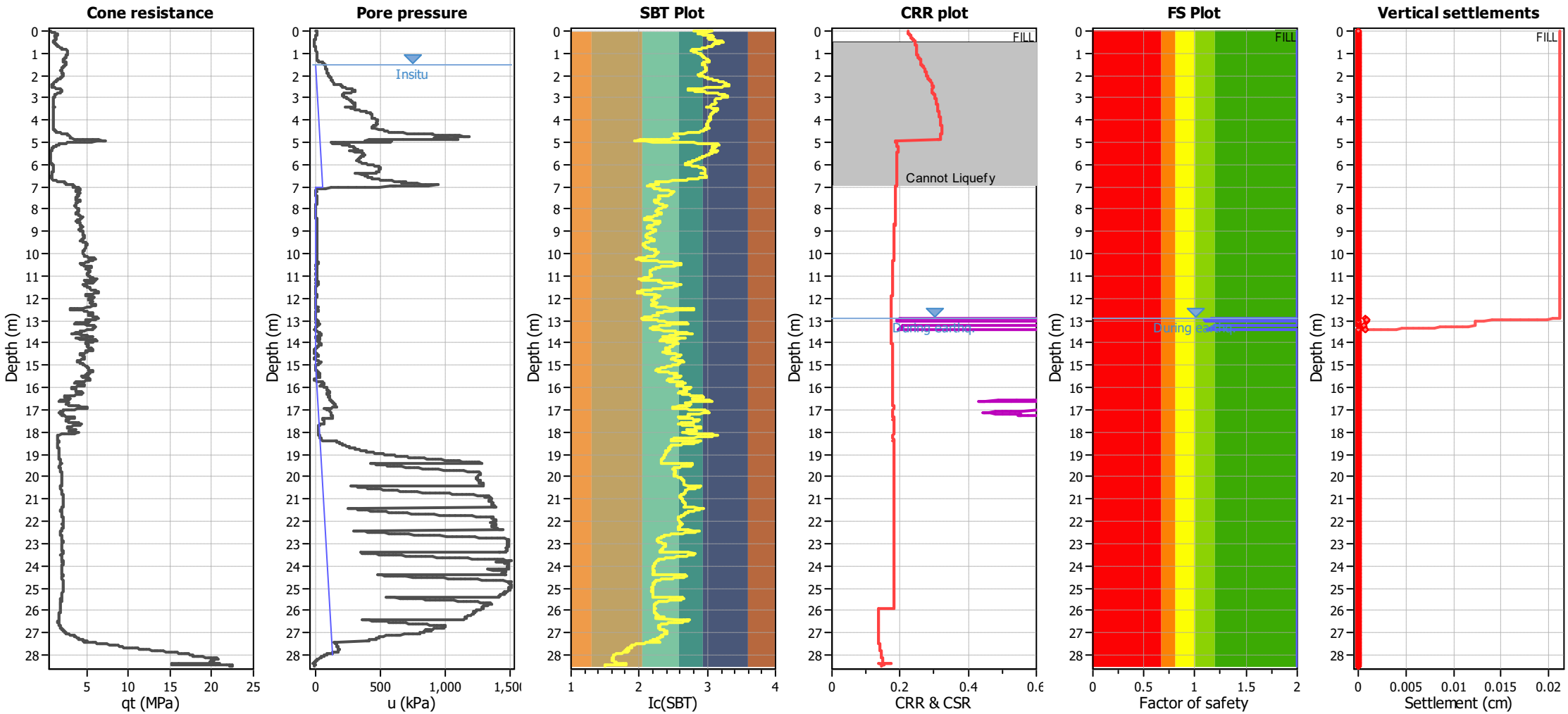
CPT: sCPT03
Total depth: 21.30 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.50 m	Excavation:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Excavation depth:	1.30 m	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	100.00 kPa	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

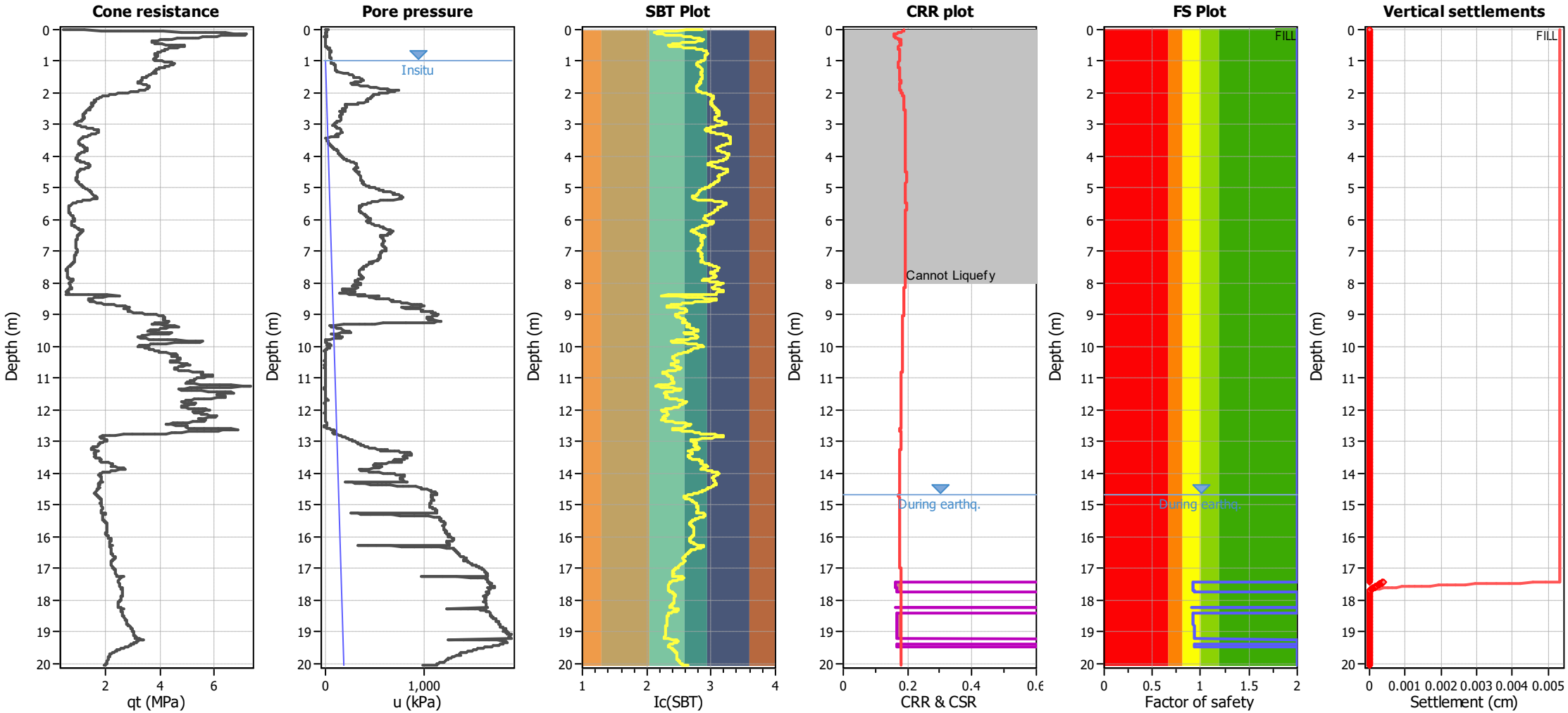
CPT: sCPT04
Total depth: 28.50 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.50 m	Use fill:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	2.10 m	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	18.00 kN/m^3	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

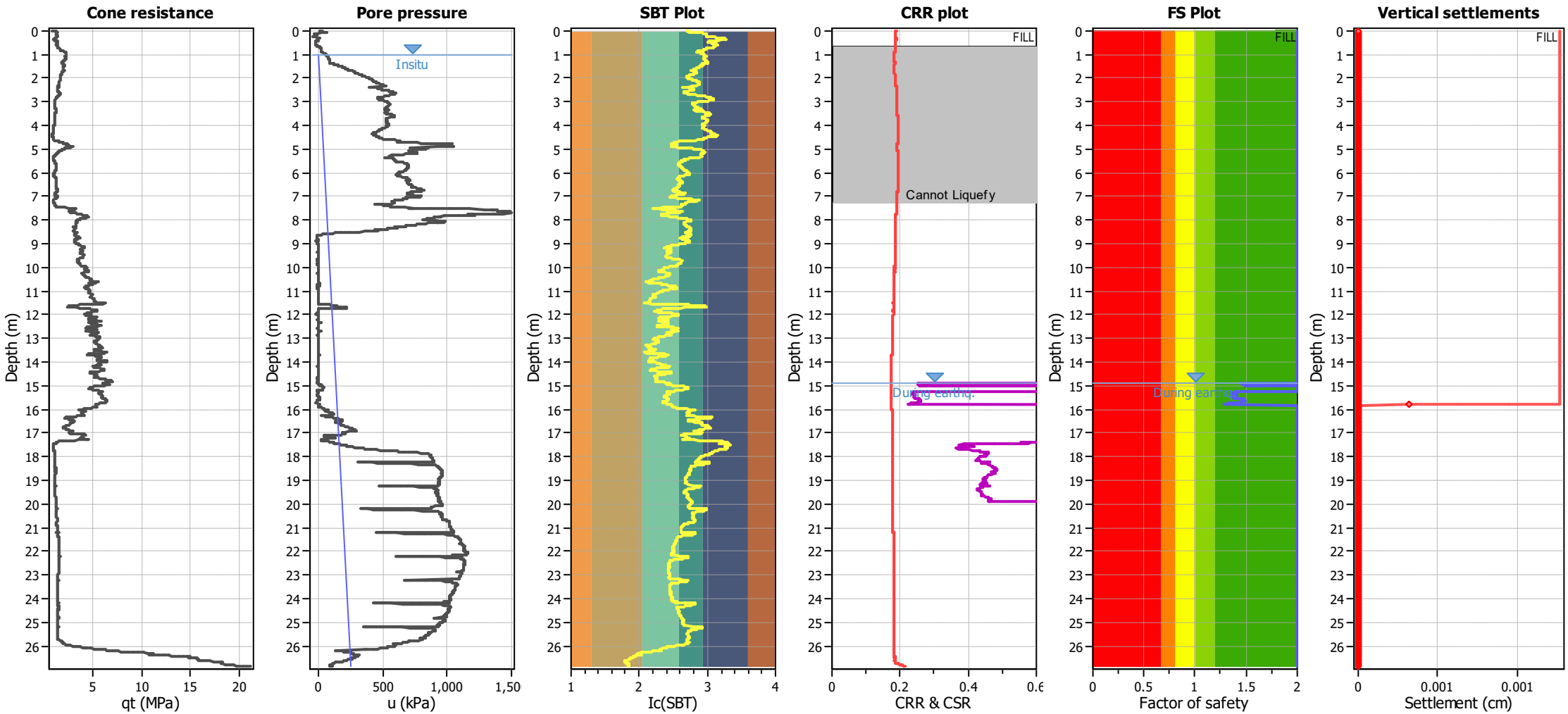
CPT: CPT06
Total depth: 20.06 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	0.30 m	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	18.00 kN/m^3	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

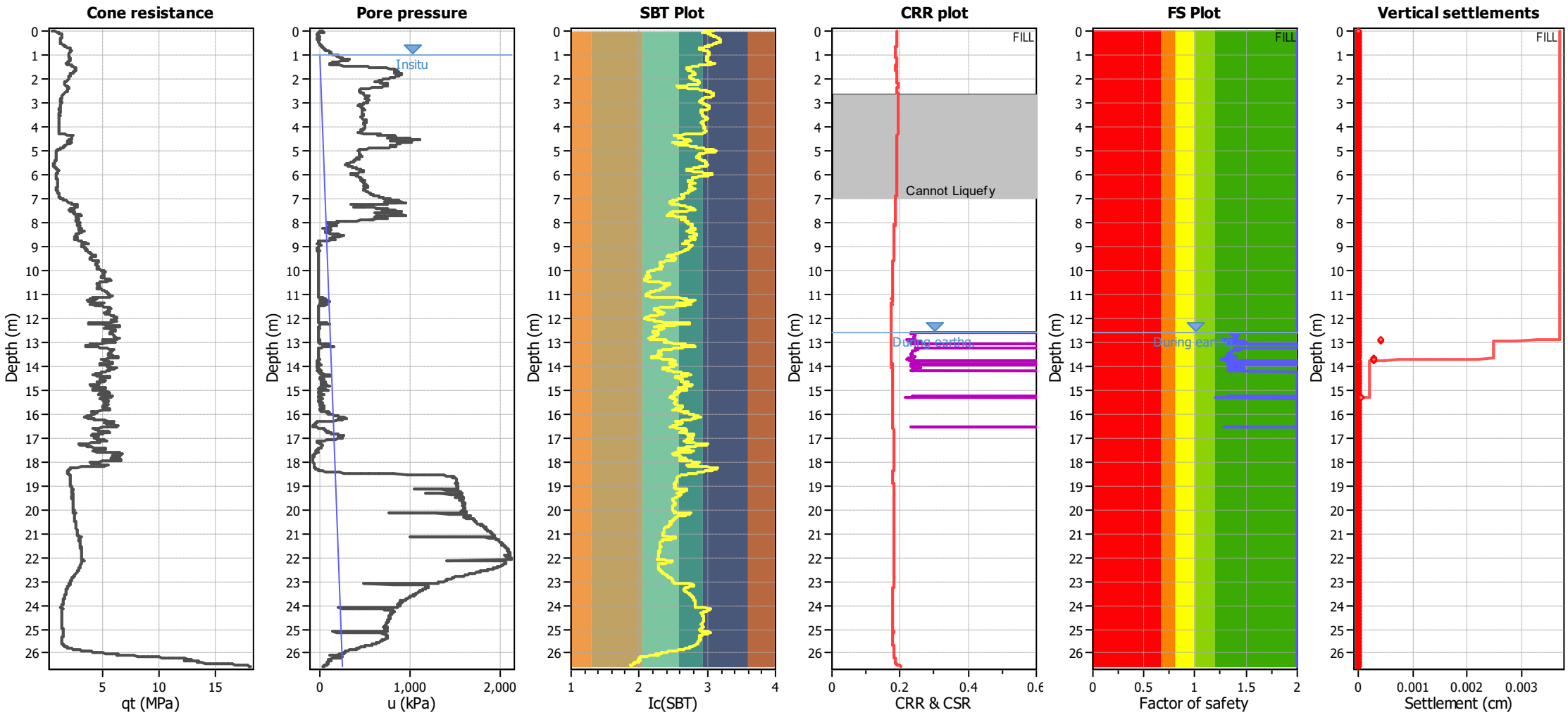
CPT: CPT07
Total depth: 26.86 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	0.10 m	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	18.00 kN/m^3	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

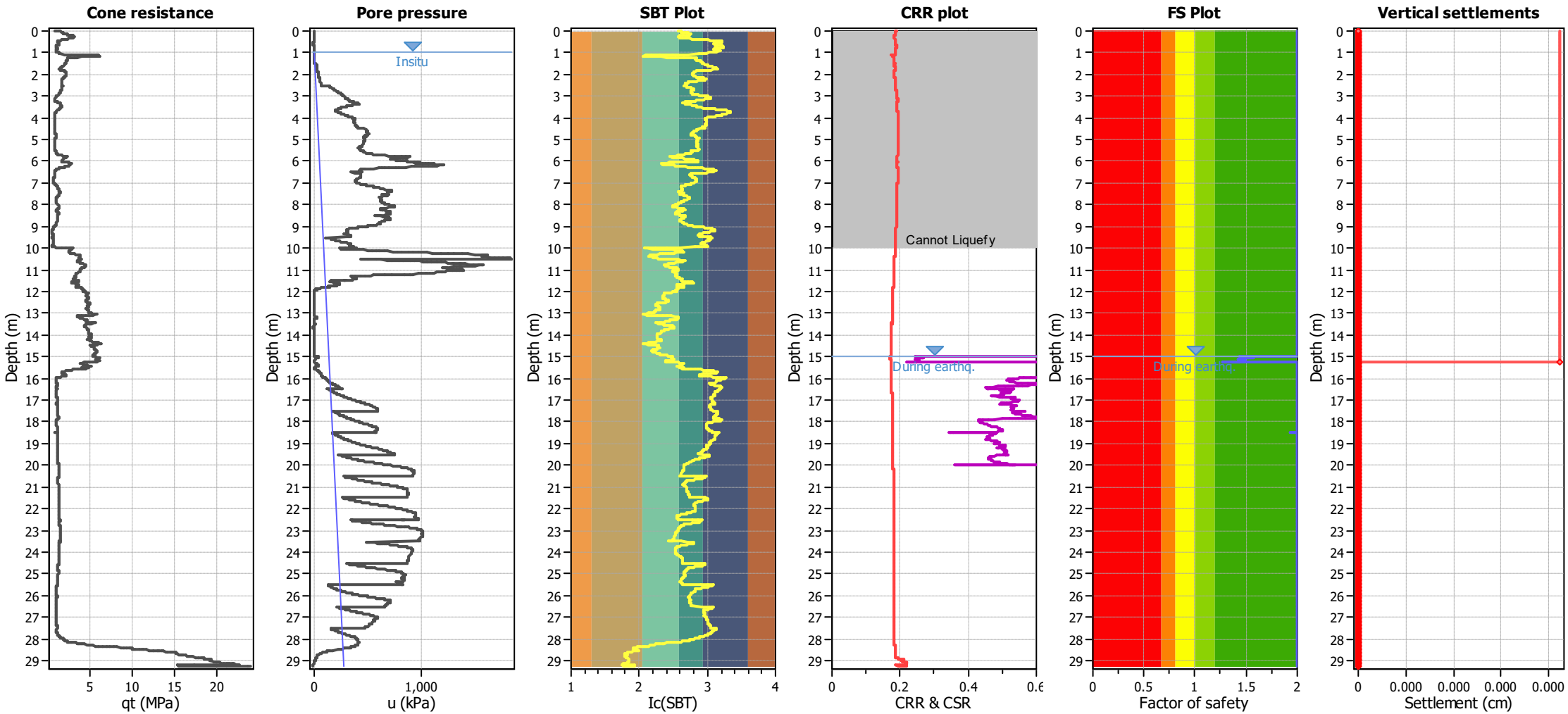
CPT: CPT08
Total depth: 26.56 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	2.40 m	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	18.00 kN/m^3	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

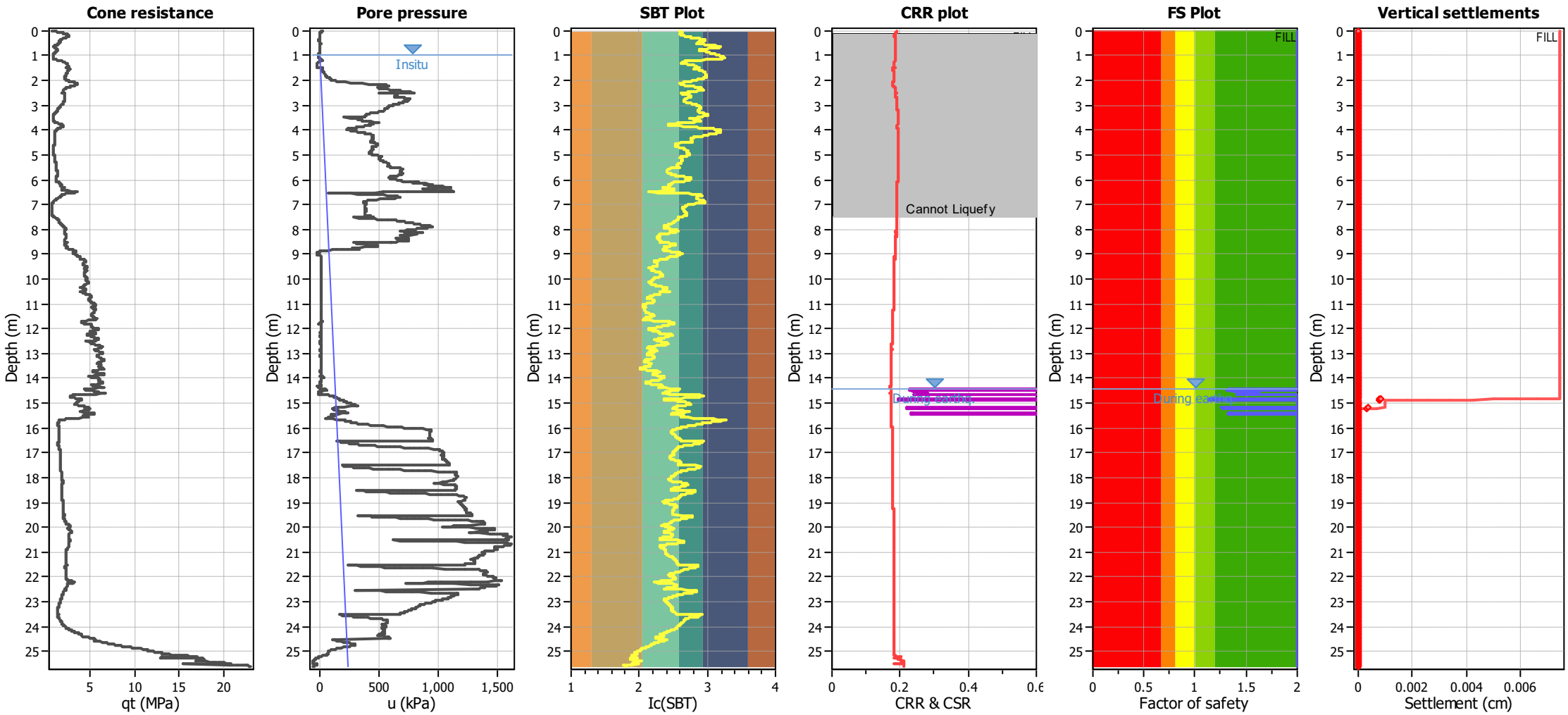
CPT: sCPT05
Total depth: 29.25 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

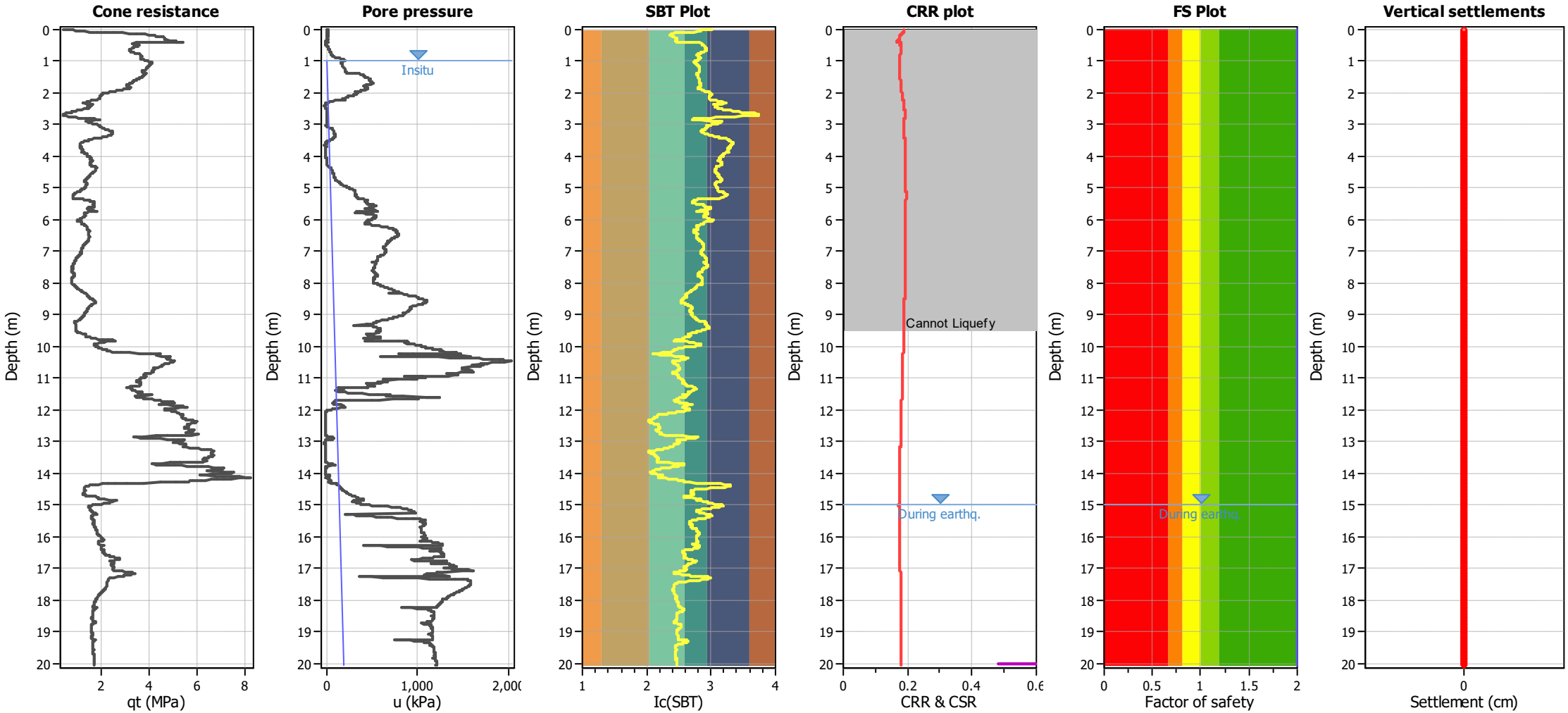
CPT: sCPT06
Total depth: 25.61 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	0.60 m	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	18.00 kN/m^3	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

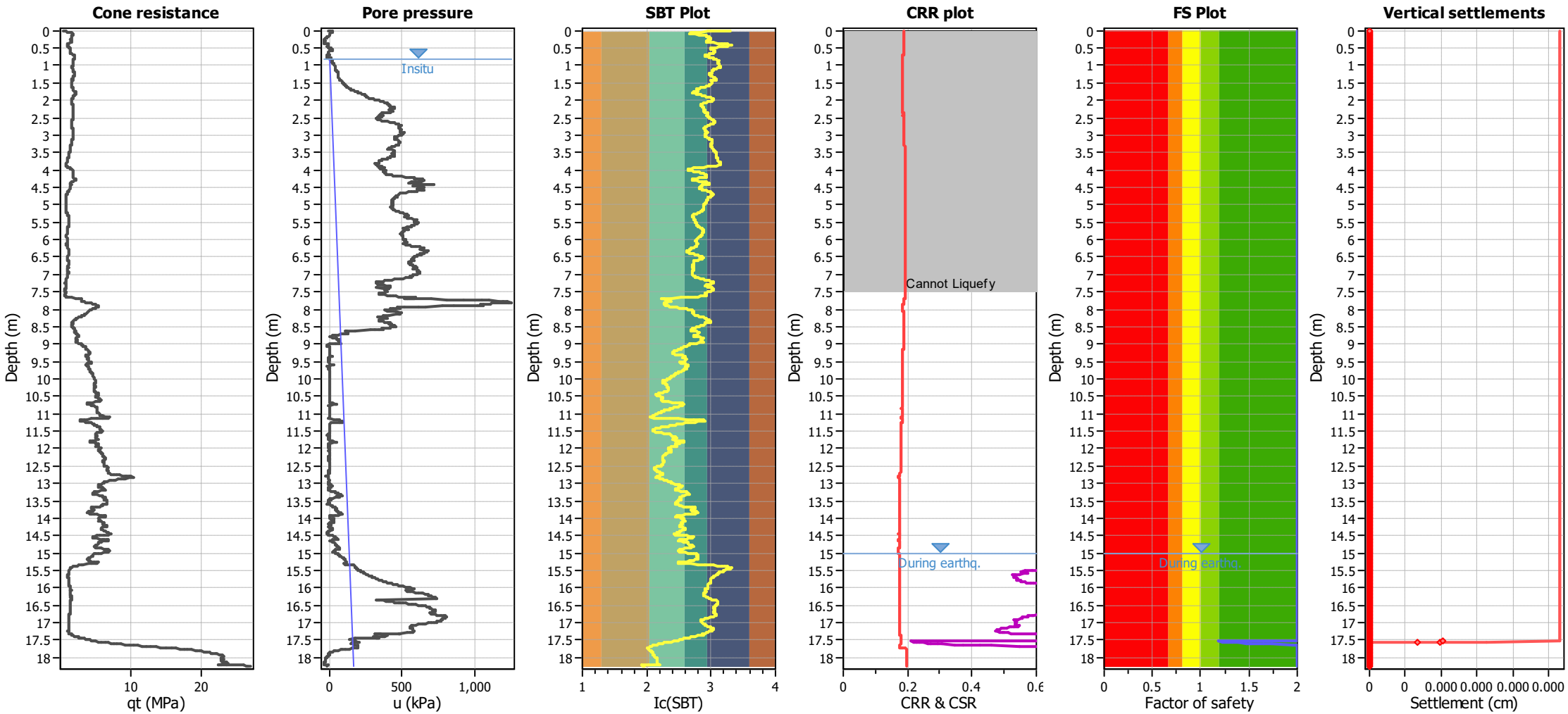
CPT: CPT05
Total depth: 20.05 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

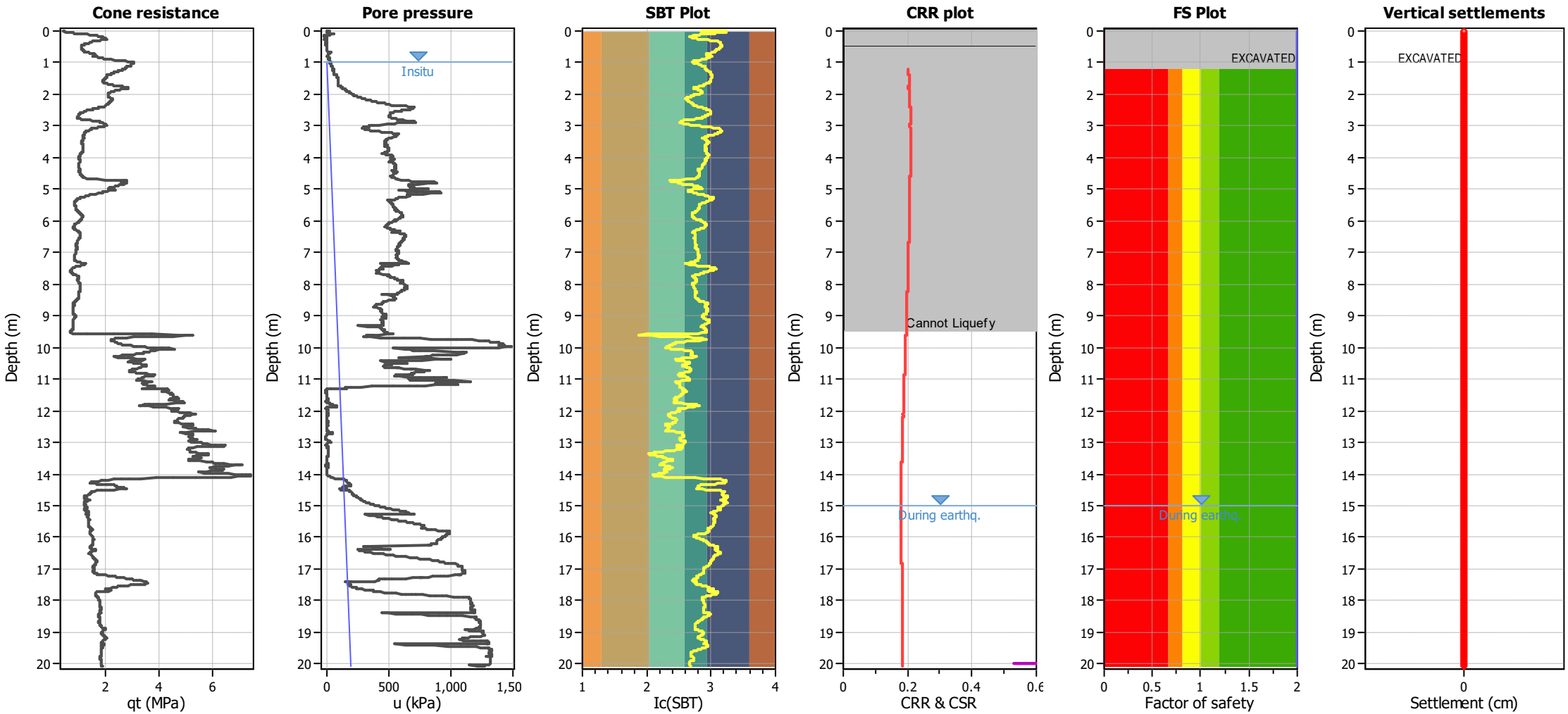
CPT: CPT01
Total depth: 18.25 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.80 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

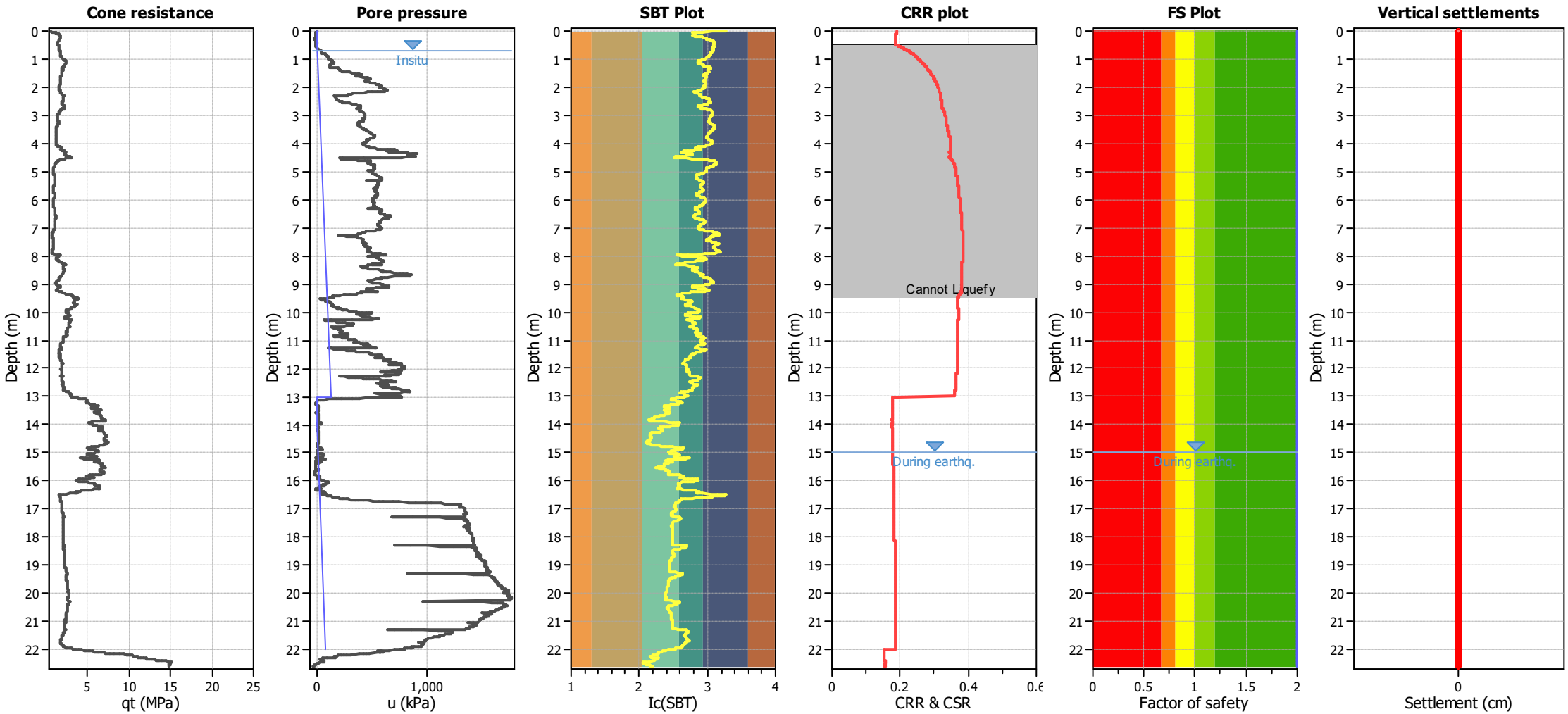
CPT: CPT02
Total depth: 20.07 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Excavation:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Excavation depth:	1.20 m	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	100.00 kPa	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

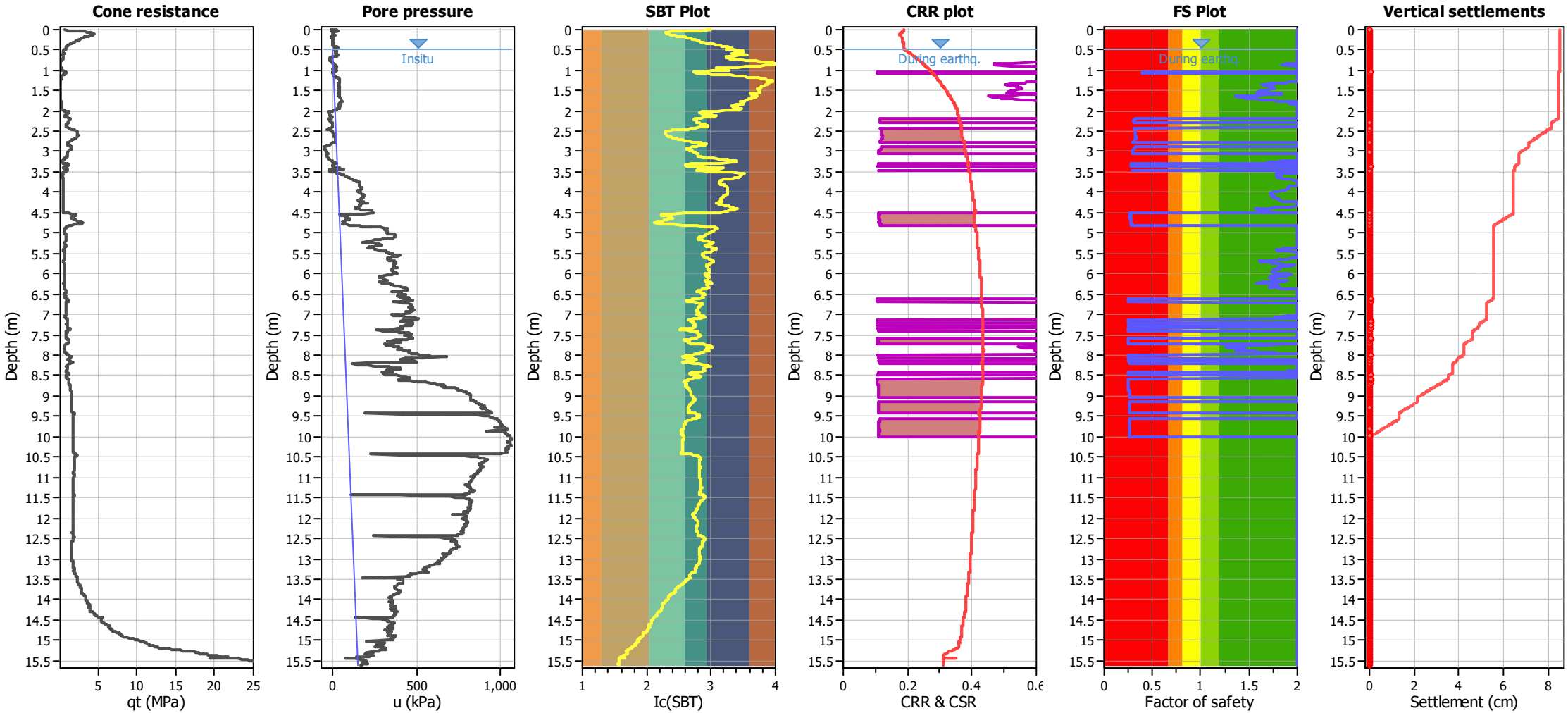
CPT: CPT03
Total depth: 22.59 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.70 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	10.00	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

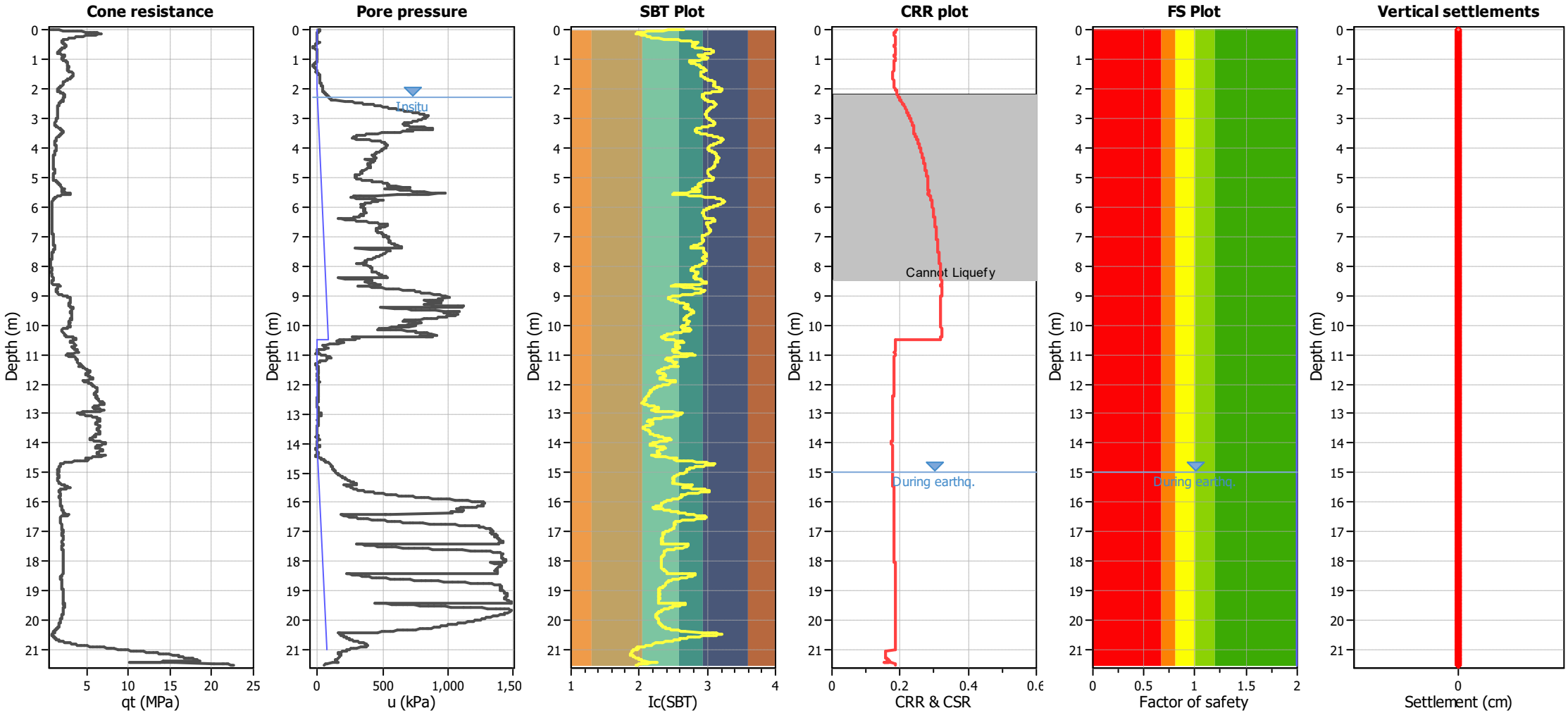
CPT: CPT04
Total depth: 15.61 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

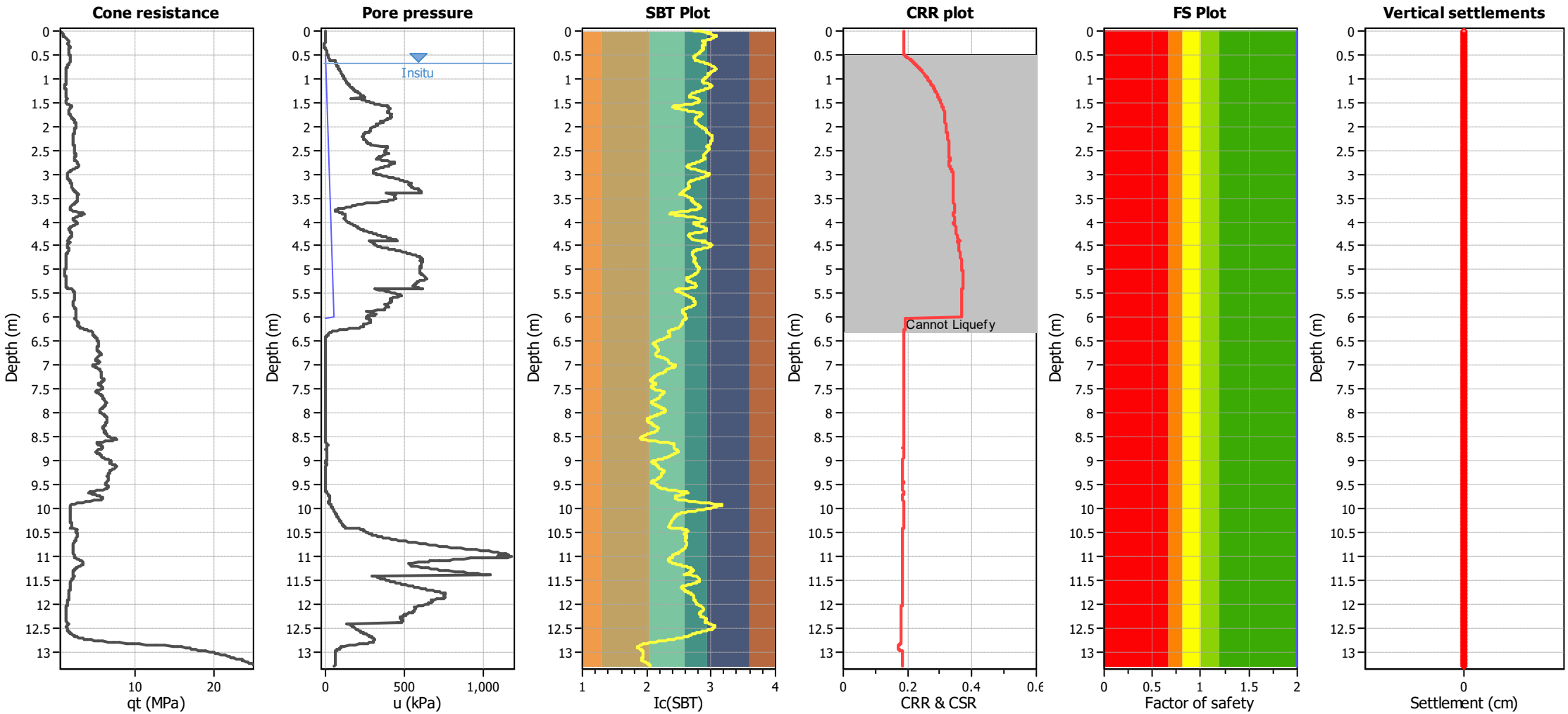
CPT: sCPT01
Total depth: 21.51 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.30 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	10.00	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

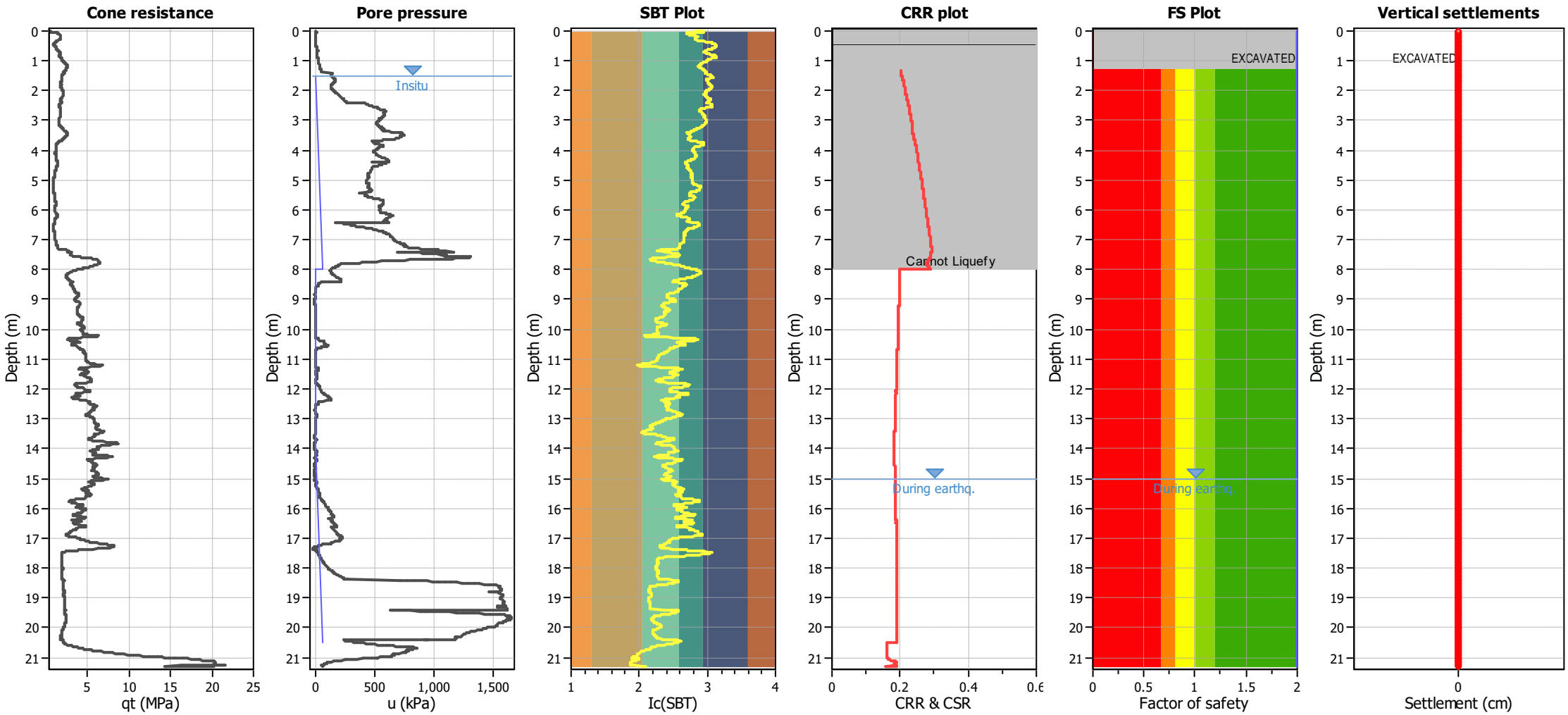
CPT: sCPT02
Total depth: 13.29 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.70 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	10.00	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

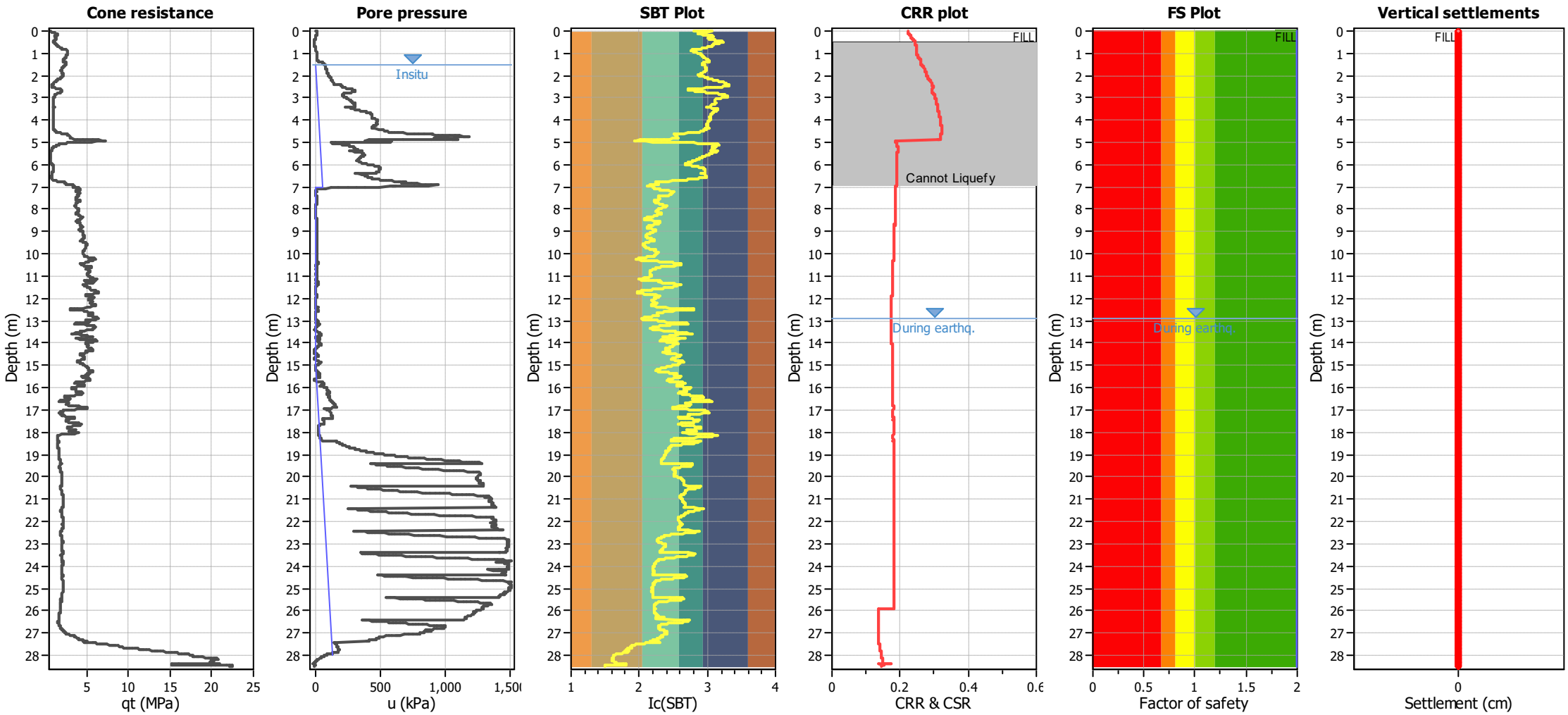
CPT: sCPT03
Total depth: 21.30 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.50 m	Excavation:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Excavation depth:	1.30 m	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	100.00 kPa	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	10.00	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

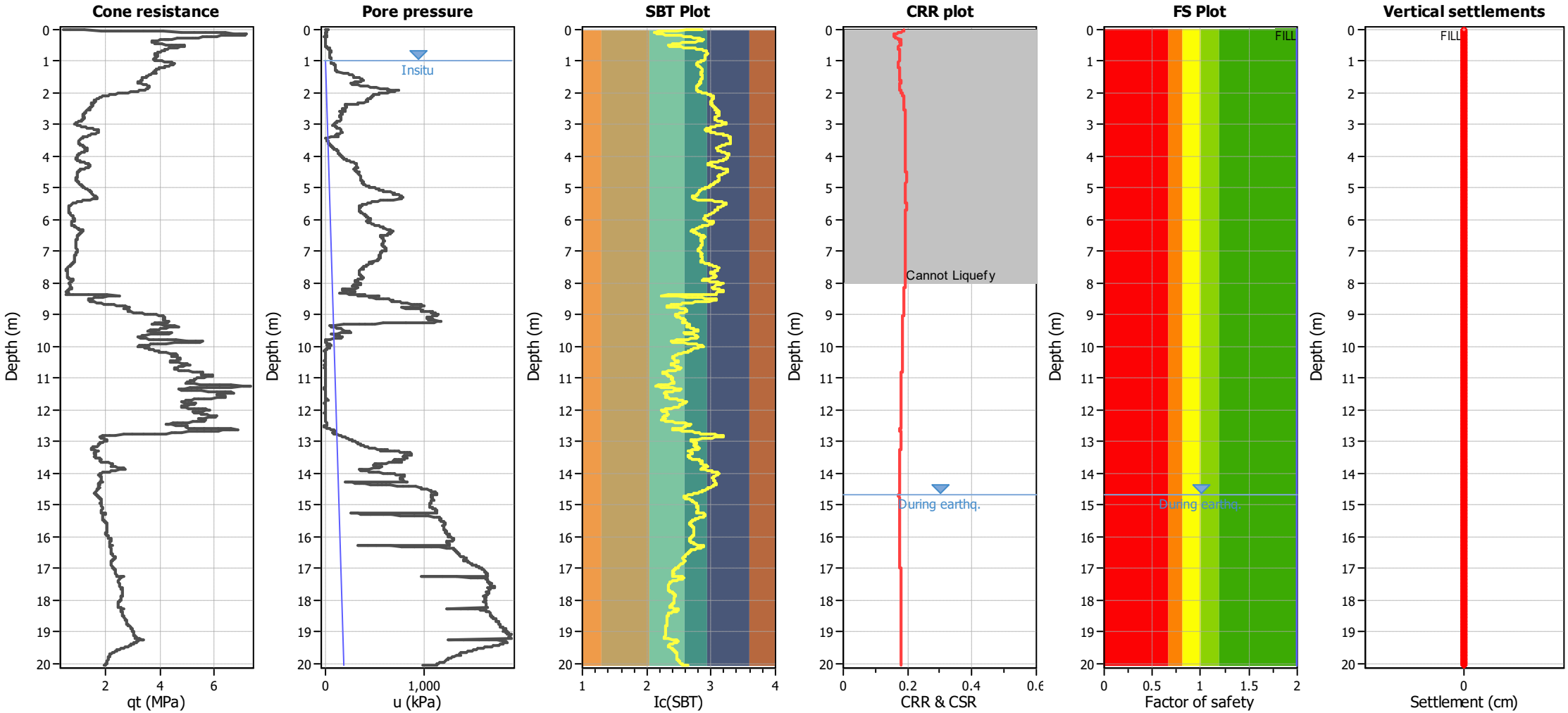
CPT: sCPT04
Total depth: 28.50 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.50 m	Use fill:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	2.10 m	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	18.00 kN/m^3	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	10.00	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: CPT06
Total depth: 20.06 m



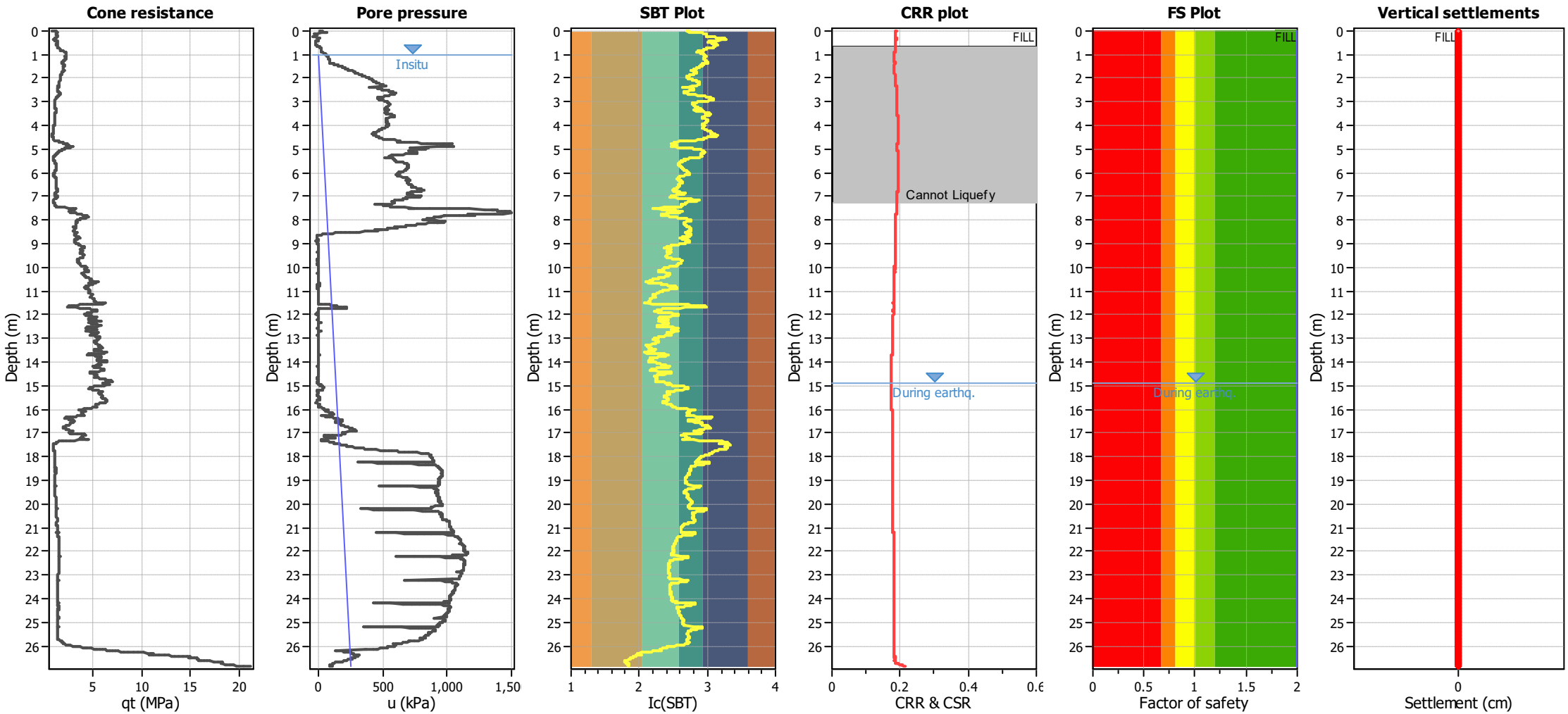
Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	0.30 m	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	18.00 kN/m^3	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	10.00	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering

Location: Ruakiwi Rd, Hamilton Lake

CPT: CPT07

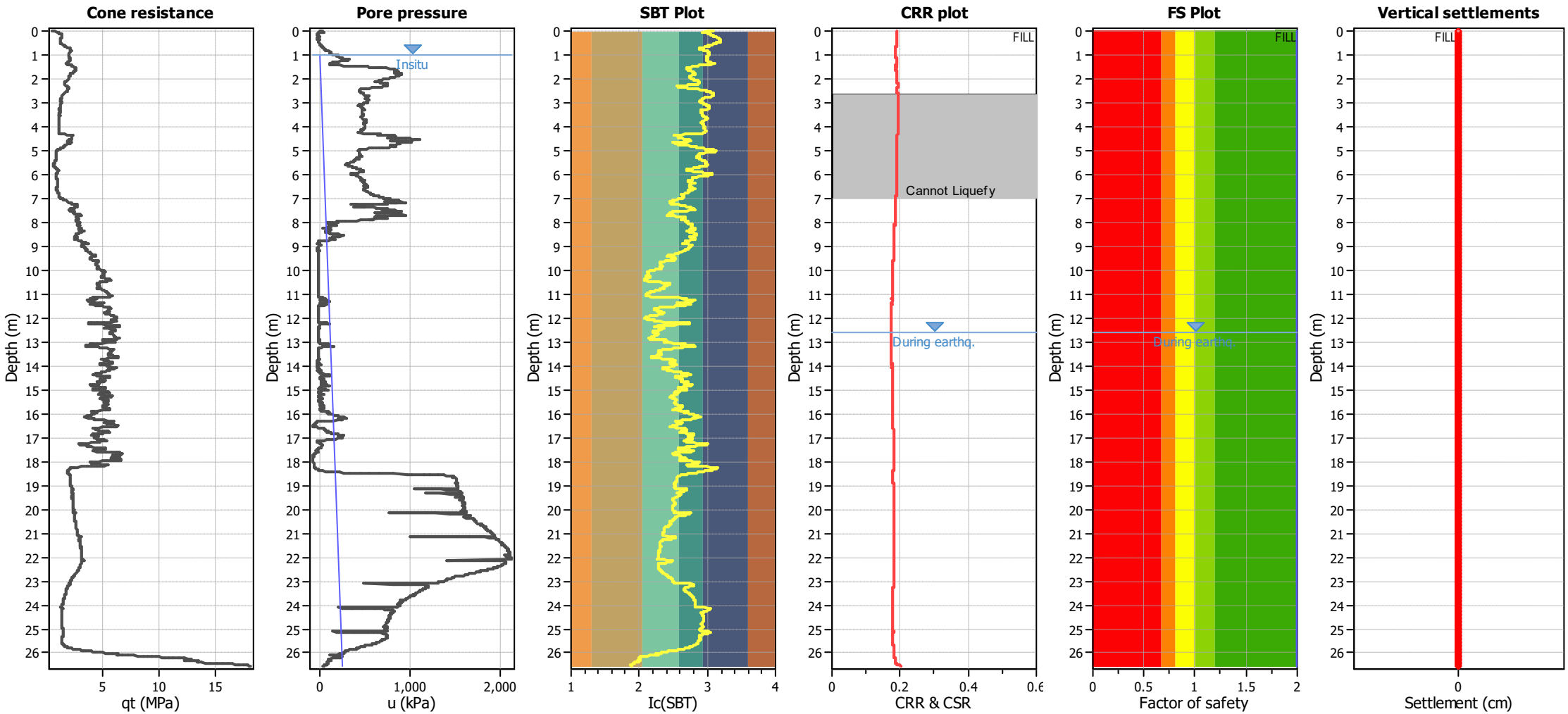
Total depth: 26.86 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	0.10 m	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	18.00 kN/m^3	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	10.00	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

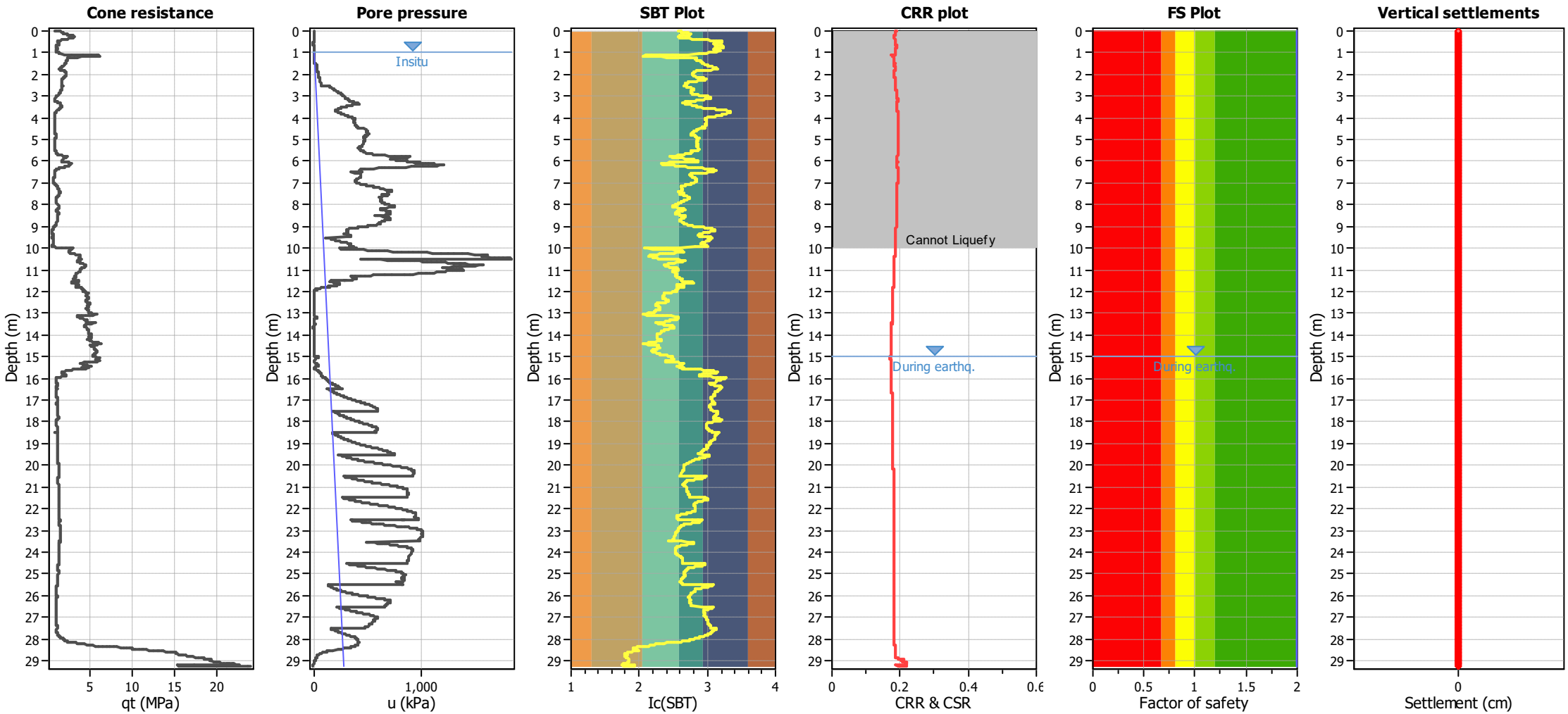
CPT: CPT08
Total depth: 26.56 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	2.40 m	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	18.00 kN/m^3	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	10.00	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

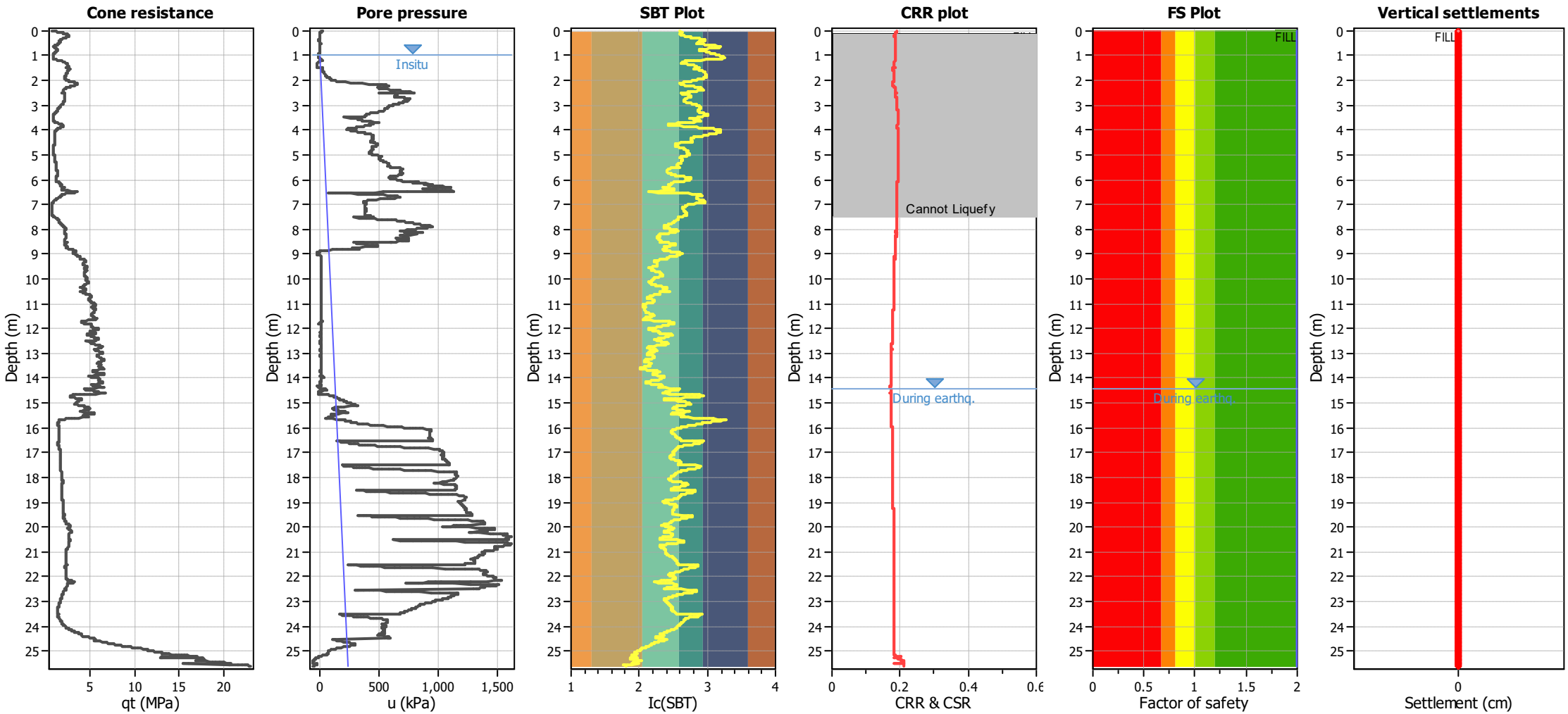
CPT: sCPT05
Total depth: 29.25 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	10.00	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

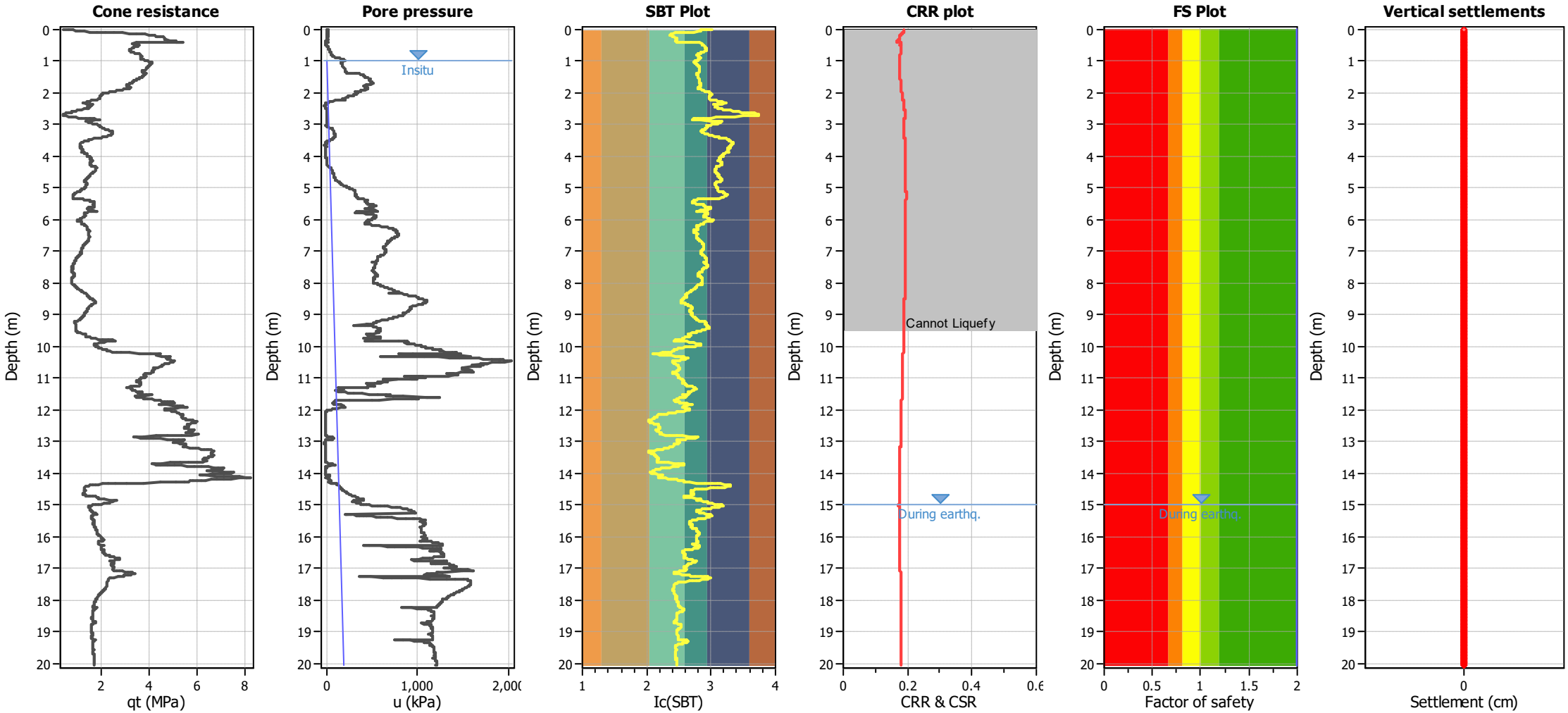
CPT: sCPT06
Total depth: 25.61 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	0.60 m		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	18.00 kN/m^3	Limit depth applied:	Yes
Earthquake magnitude M_w:	6.91	Ic cut-off value:	10.00	Trans. detect. applied:	No	Limit depth:	10.00 m
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

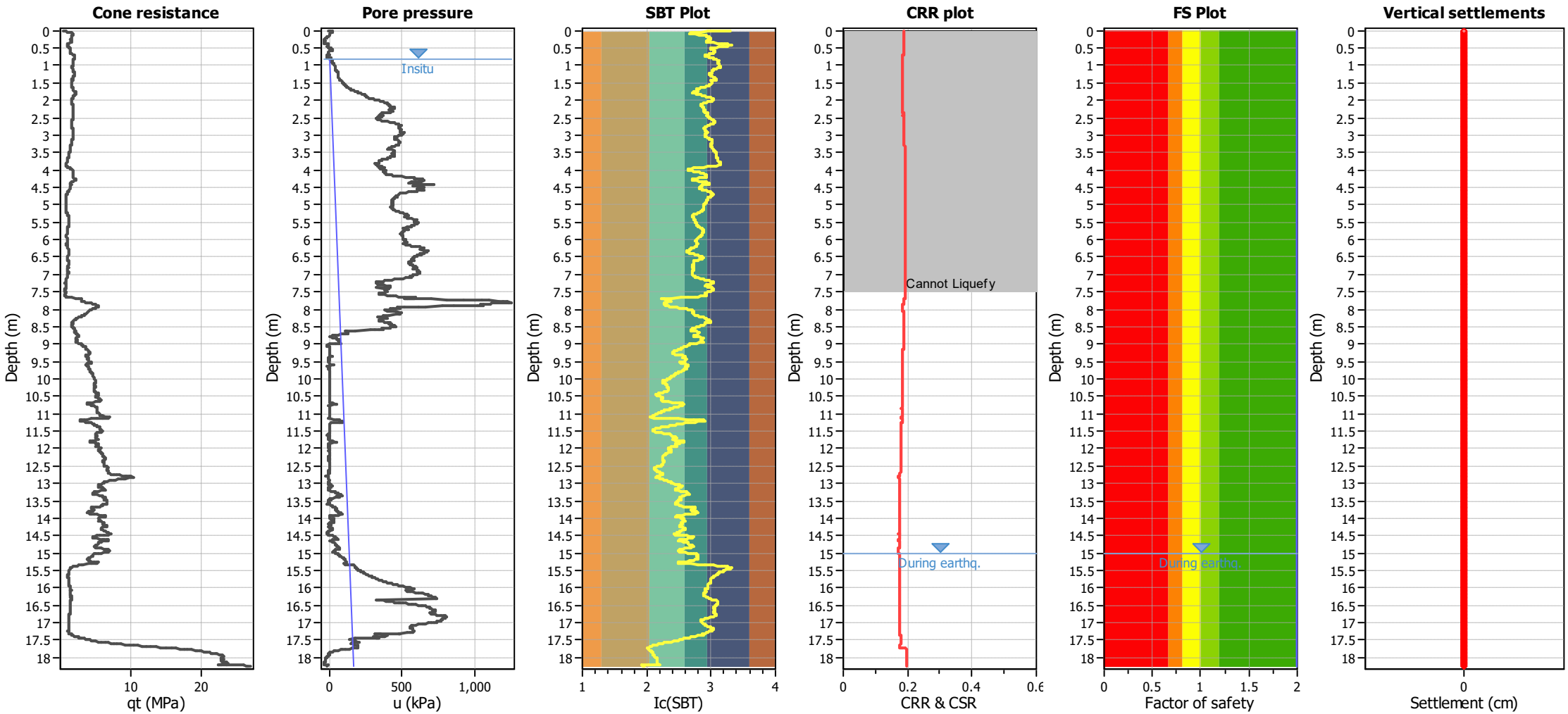
CPT: CPT05
Total depth: 20.05 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	10.00	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

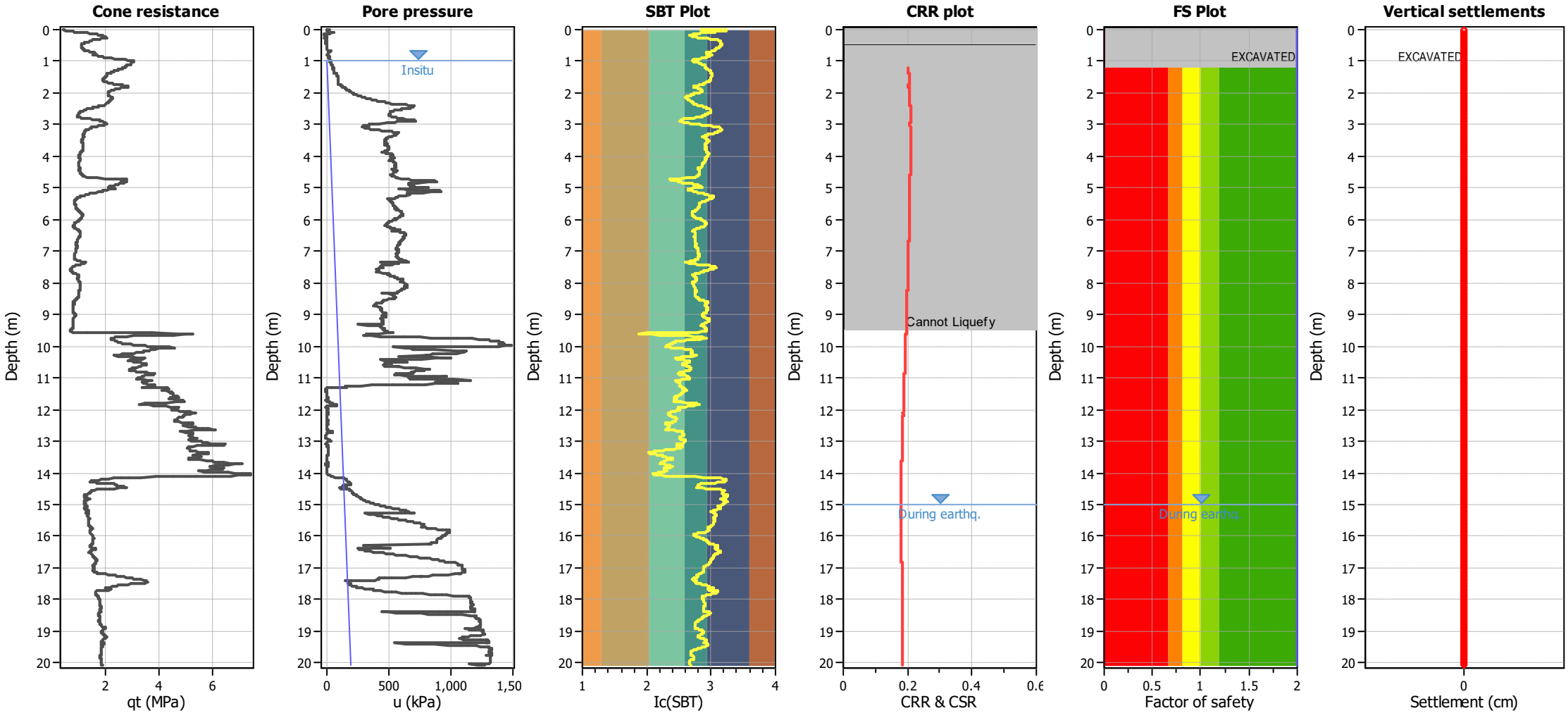
CPT: CPT01
Total depth: 18.25 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.80 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	10.00	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

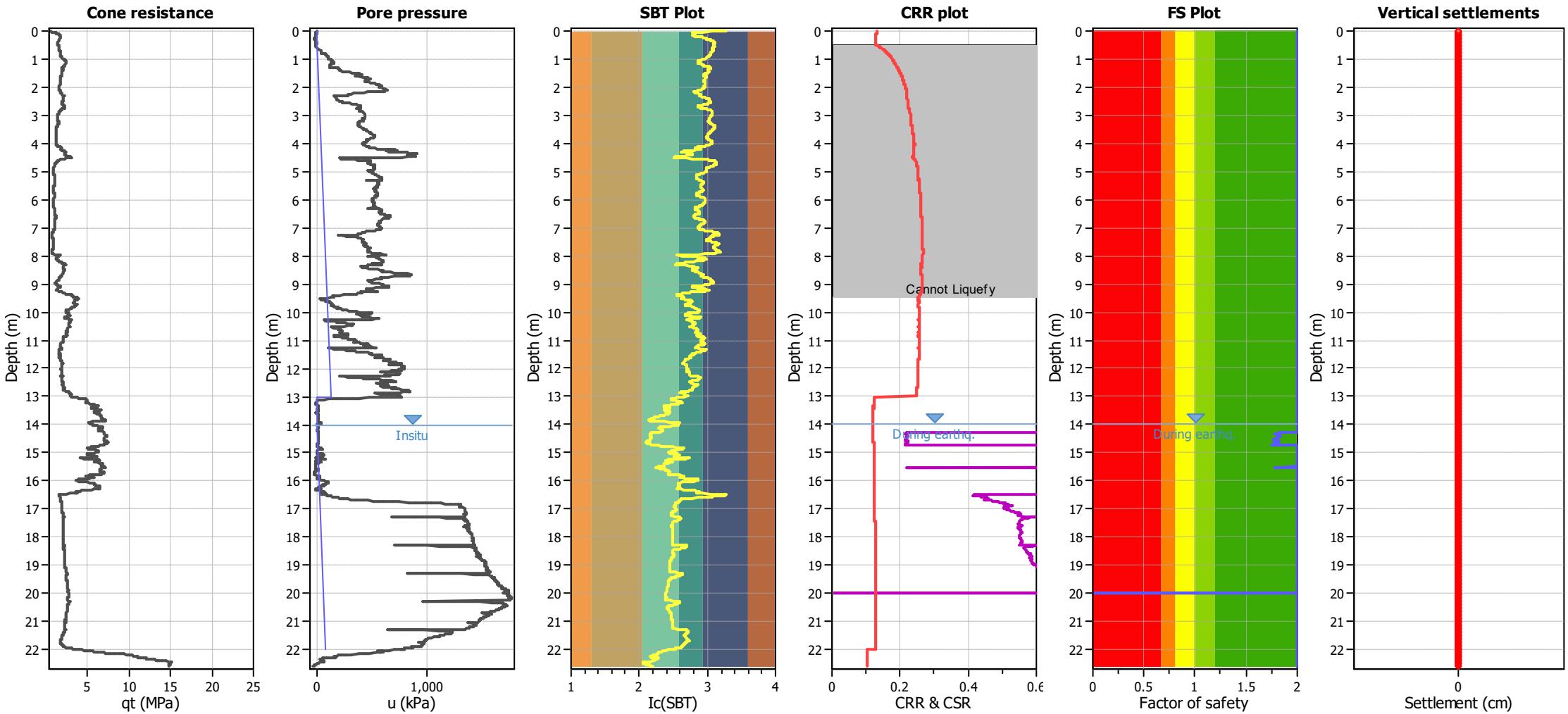
CPT: CPT02
Total depth: 20.07 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Excavation:	Yes	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Excavation depth:	1.20 m	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	100.00 kPa	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.91	Ic cut-off value:	10.00	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

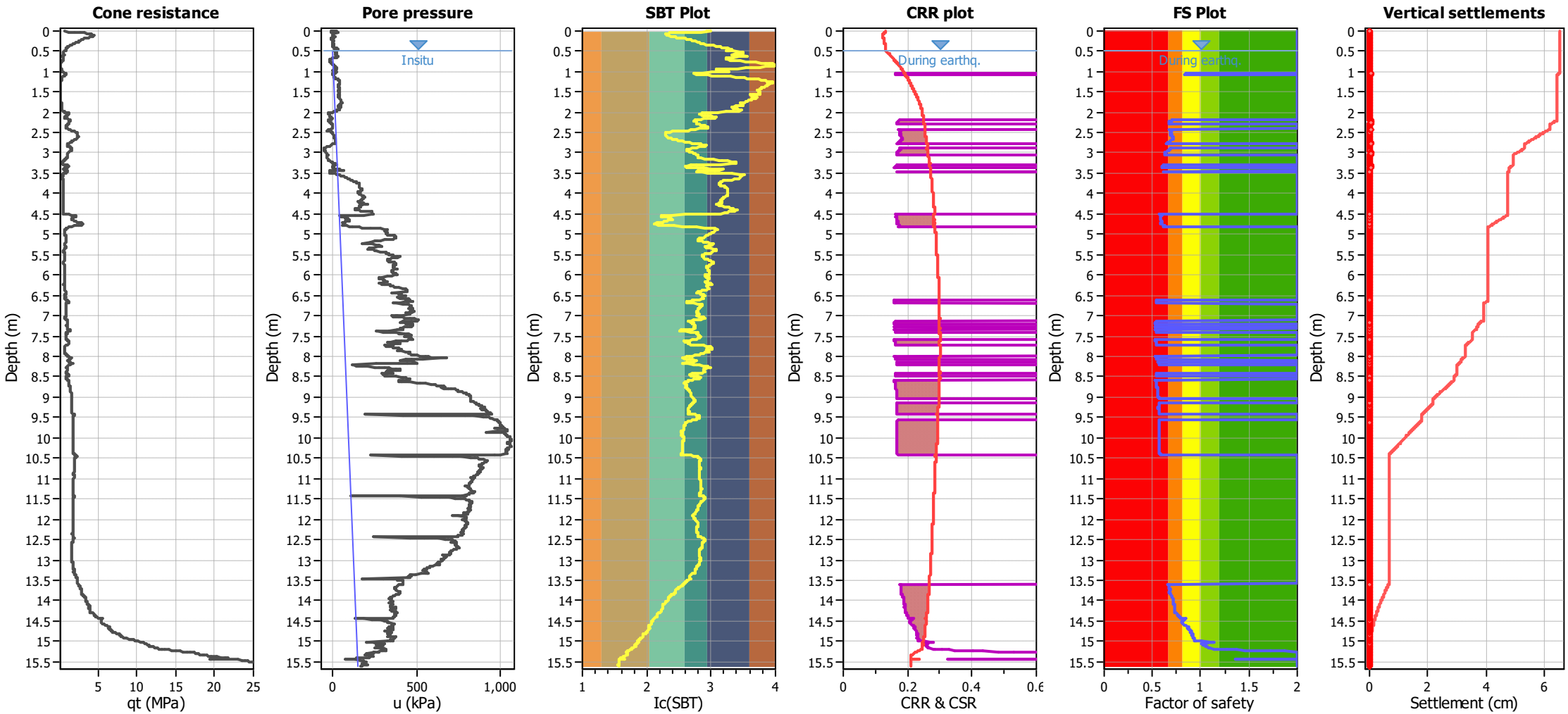
CPT: CPT03
Total depth: 22.59 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	14.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	14.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.85	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

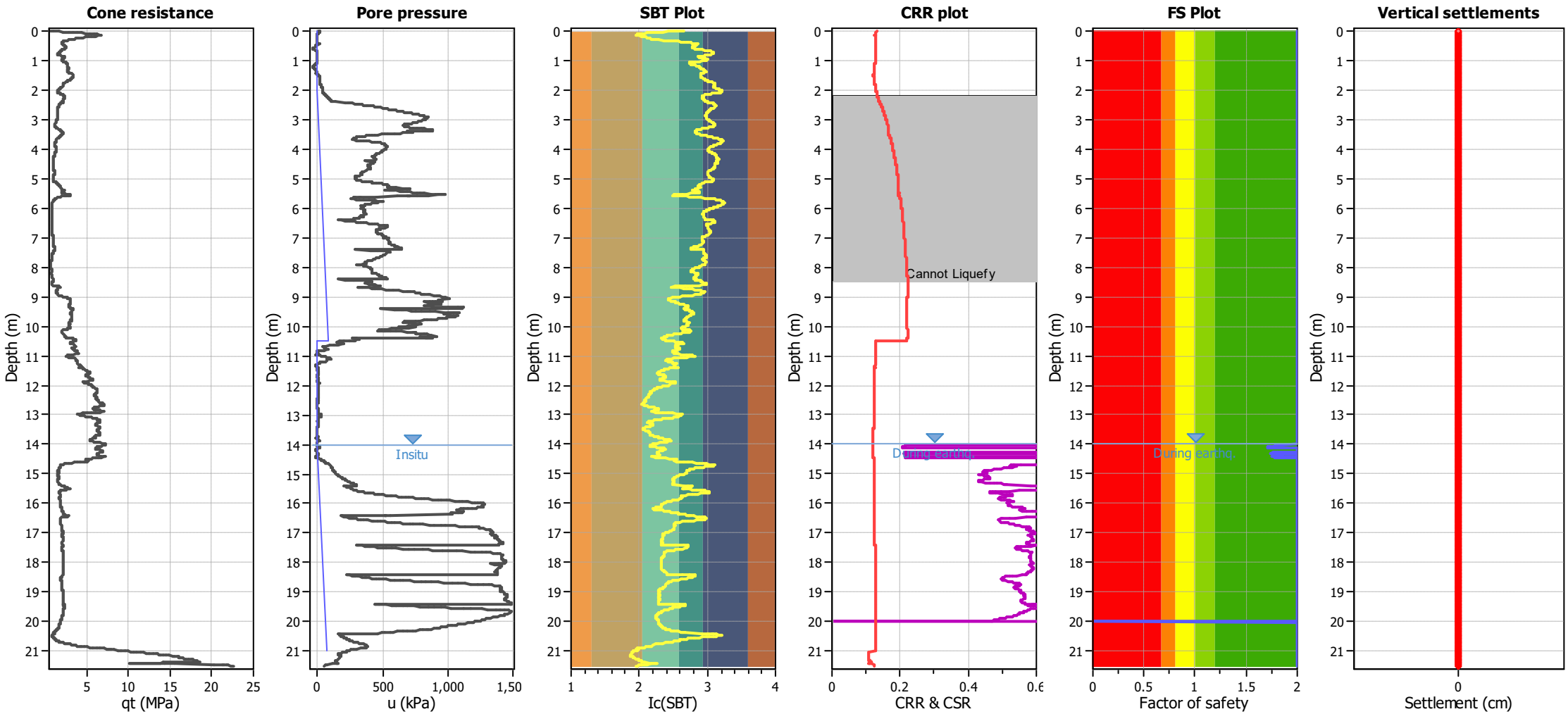
CPT: CPT04
Total depth: 15.61 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.85	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

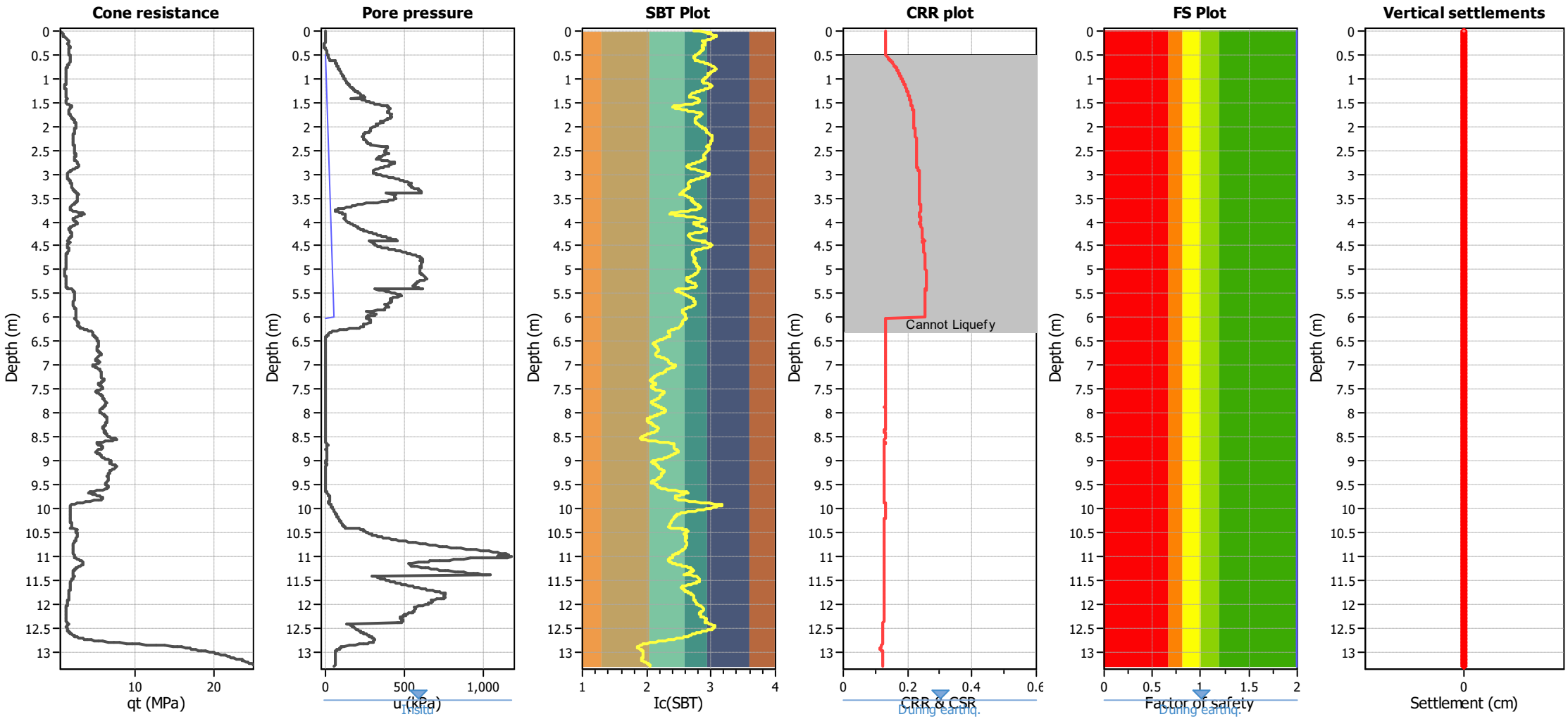
CPT: sCPT01
Total depth: 21.51 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	14.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	14.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.85	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

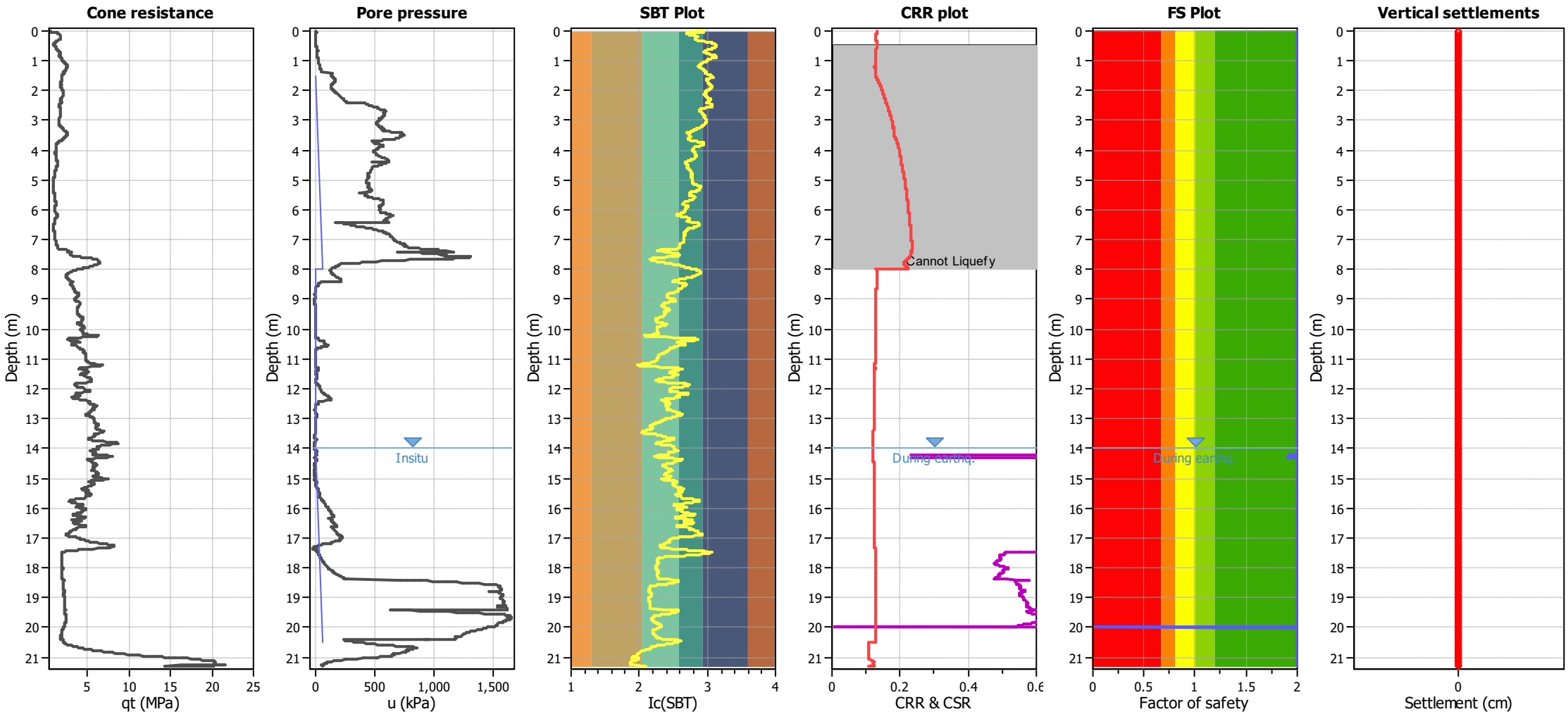
CPT: sCPT02
Total depth: 13.29 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	14.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	14.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.85	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: sCPT03
Total depth: 21.30 m



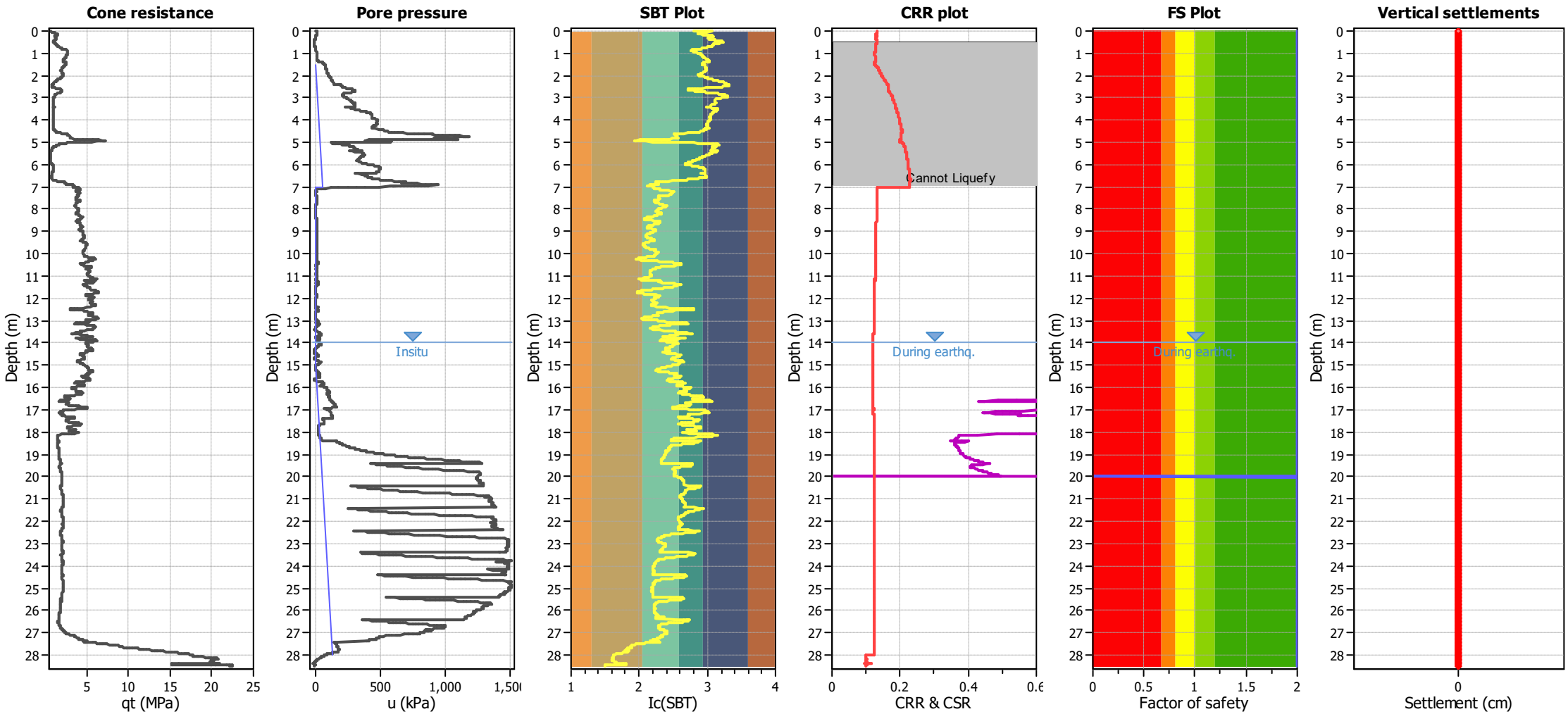
Analysis method:	B&I (2014)	G.W.T. (in-situ):	14.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	14.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.85	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering

Location: Ruakiwi Rd, Hamilton Lake

CPT: sCPT04

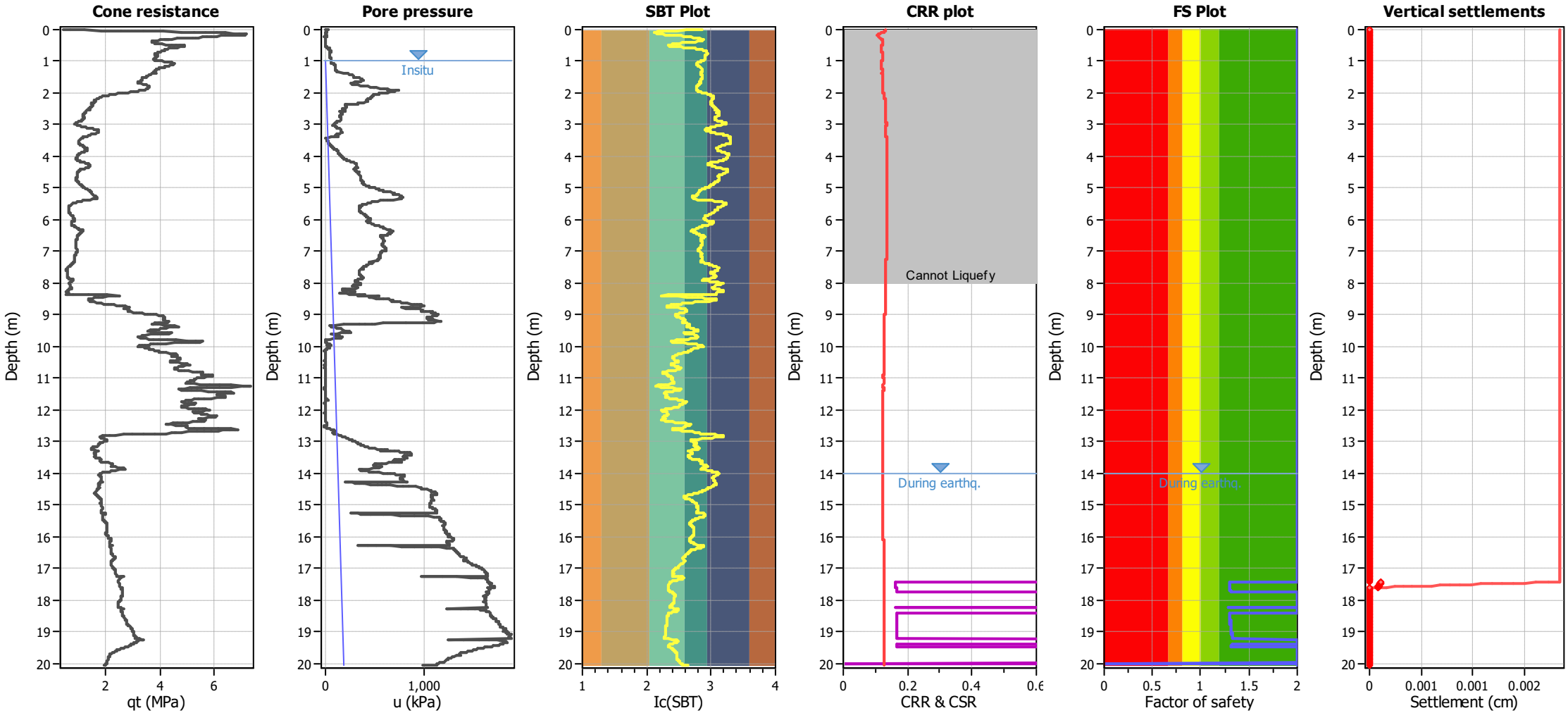
Total depth: 28.50 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	14.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	14.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.85	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

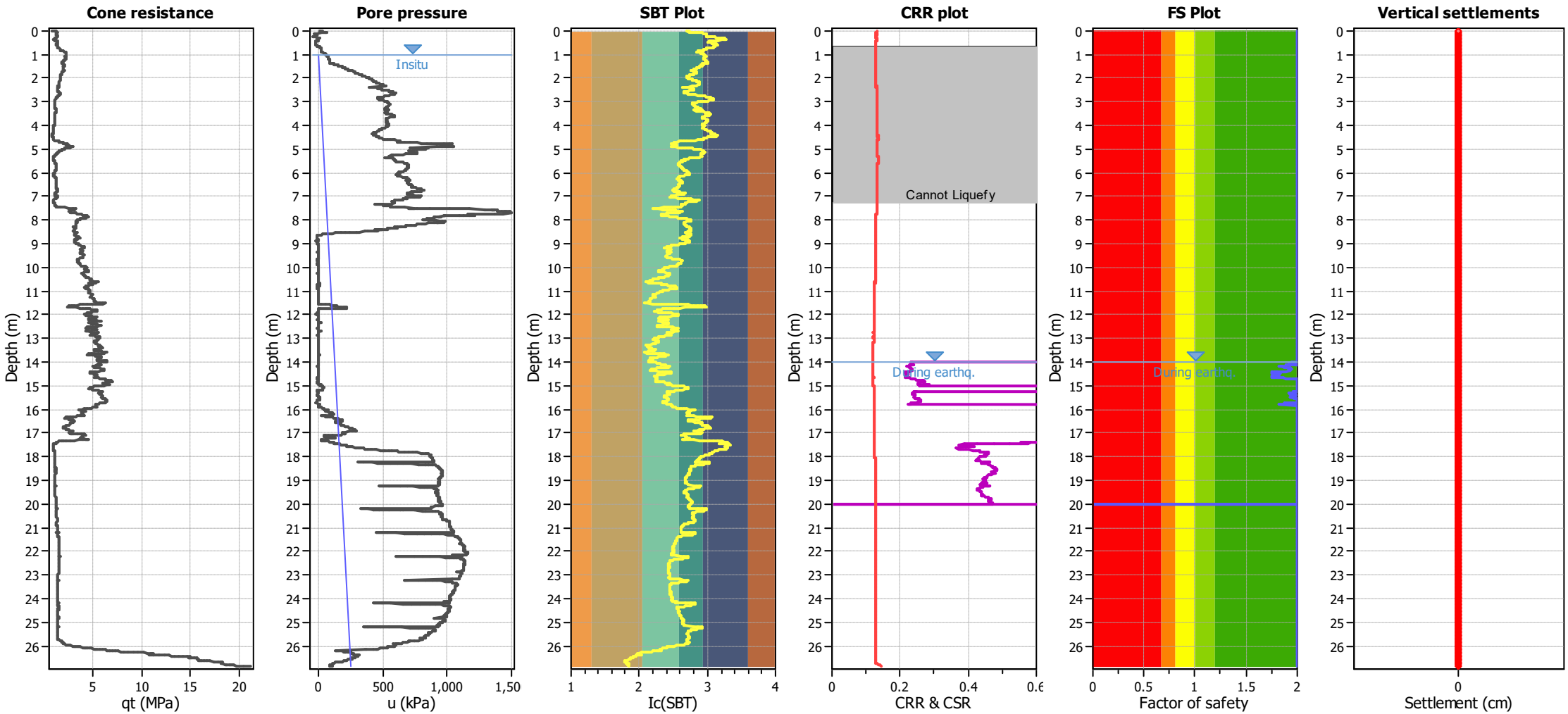
CPT: CPT06
Total depth: 20.06 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	14.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.85	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

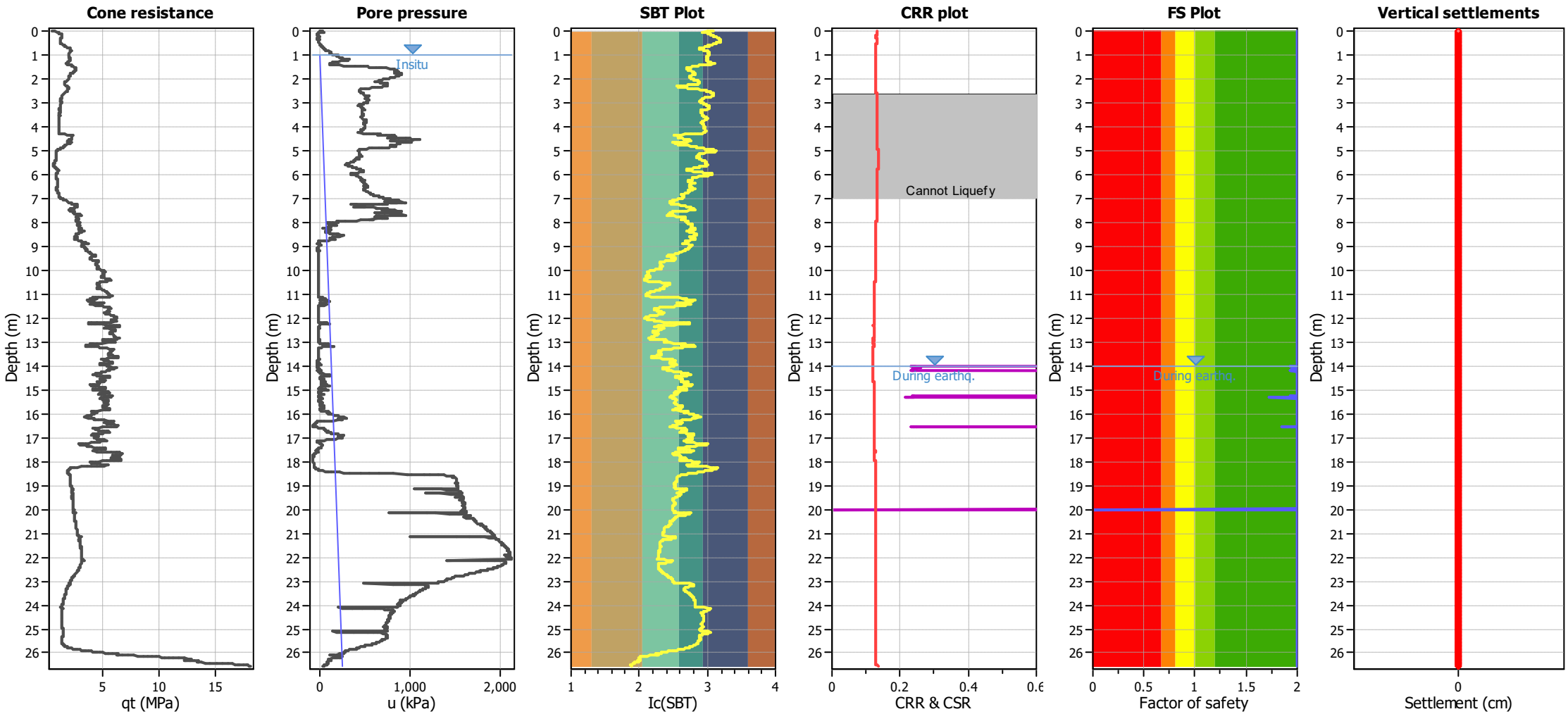
CPT: CPT07
Total depth: 26.86 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	14.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.85	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

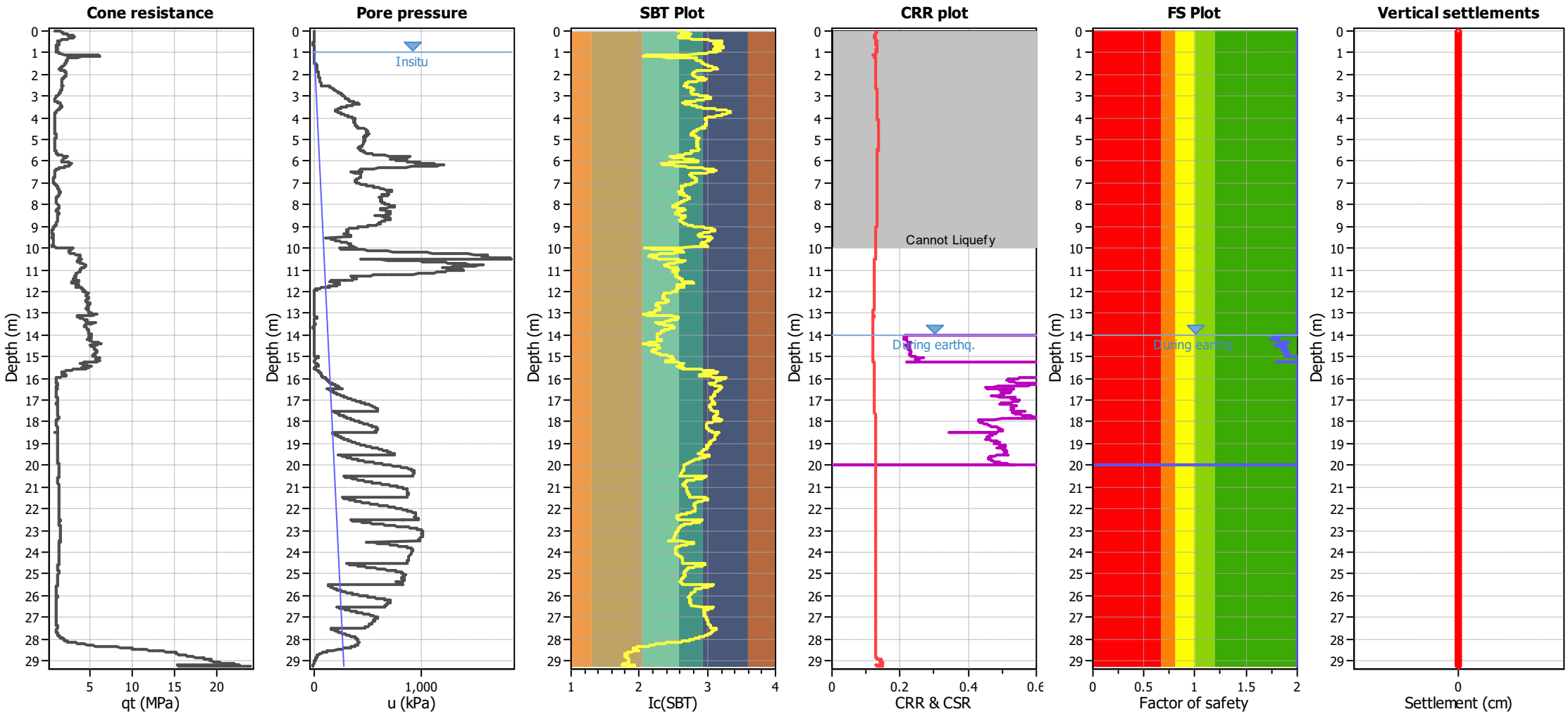
CPT: CPT08
Total depth: 26.56 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	14.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.85	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

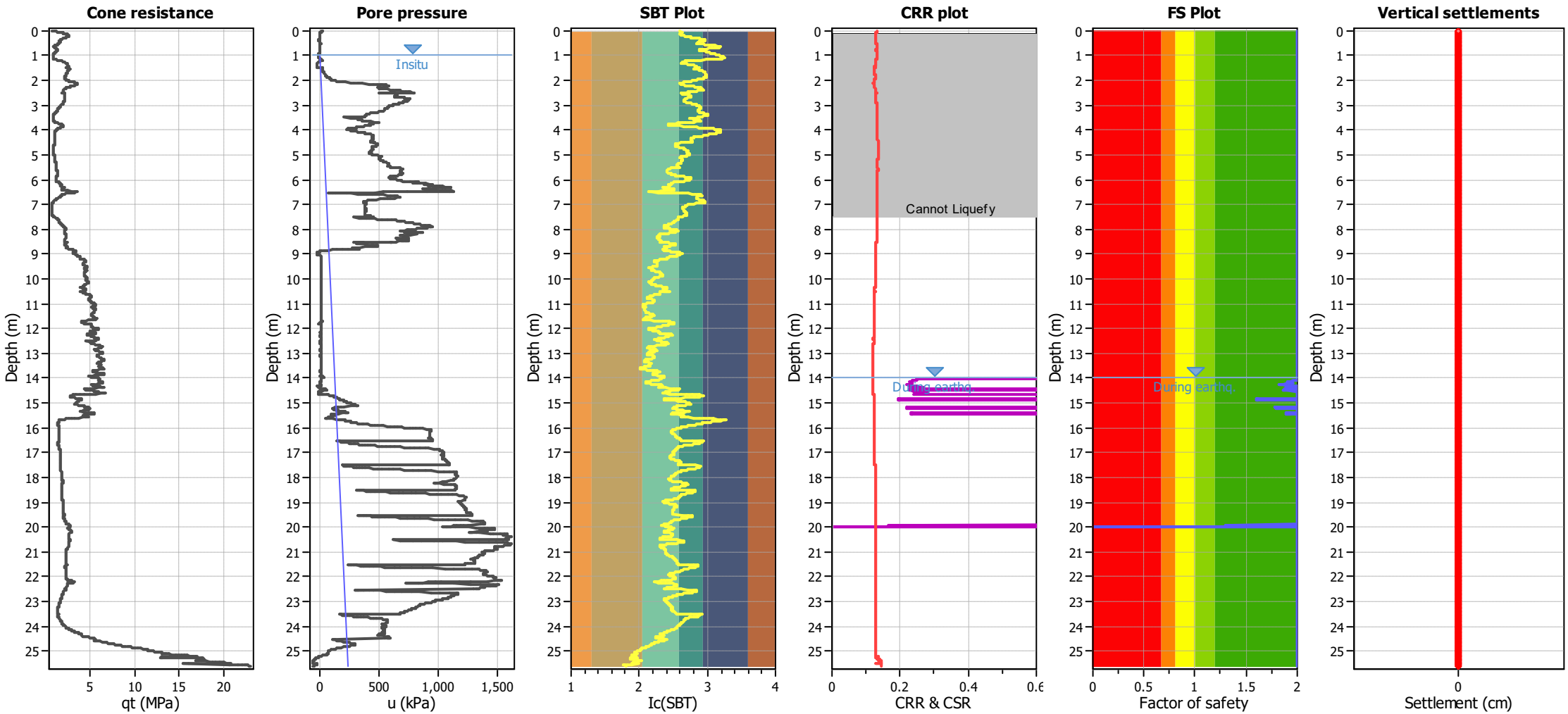
CPT: sCPT05
Total depth: 29.25 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	14.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.85	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

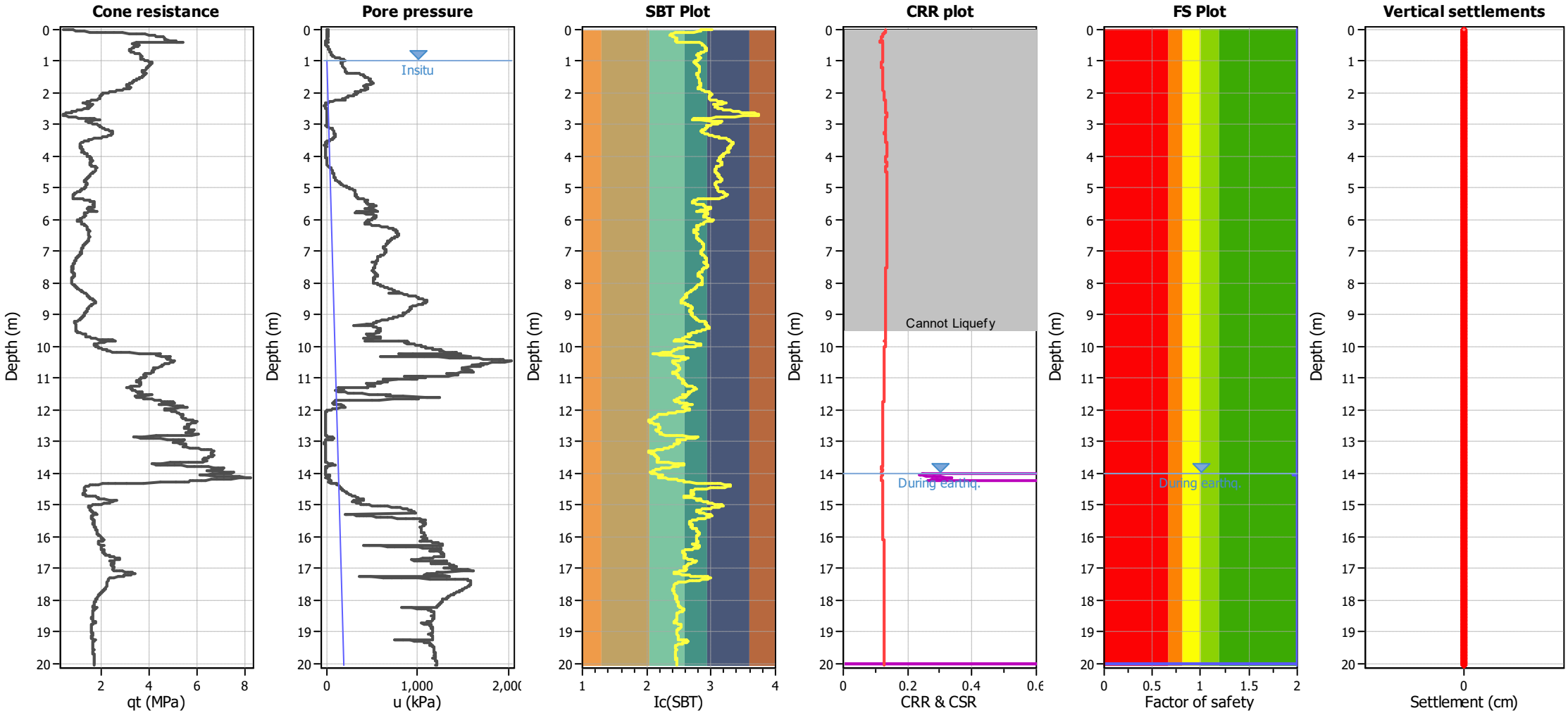
CPT: sCPT06
Total depth: 25.61 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	14.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.85	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: CPT05
Total depth: 20.05 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	14.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	20.00 m
Earthquake magnitude M_w:	6.85	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

APPENDIX H

Stability Analysis Output

SLOPE STABILITY

Design Criteria

The stability of slopes under a range of design conditions is expressed in terms of a factor of safety, which is defined as the ratio of forces resisting failure to the forces causing failure. The following performance standards are recommended for slope stability assessment:

Table 11: Slope Stability Factor of Safety Criteria

Condition	Required Factor of Safety
Static long-term conditions (drained soil conditions, normal groundwater)	1.5
Transient short-term conditions (elevated porewater pressures)	1.2
Ultimate Limit State (ULS) seismic condition	1.0*
Note: *Factor of safety < 1.0 acceptable where displacement-based approach is adopted.	

Slope Stability Analyses

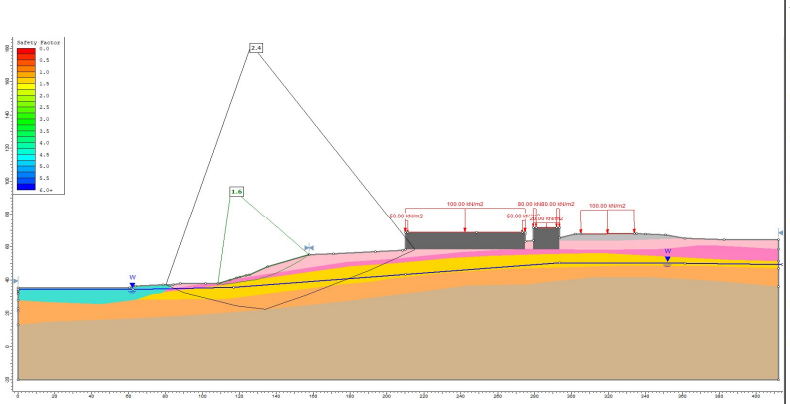
Slope stability analyses were undertaken using the Morgenstern-Price method of slices under both circular and translational failure mechanisms using the software package SLIDE2 Version 6. Seismic displacements were estimated based on a Newmark Sliding Block approach using 50th percentile correlations published in Jibson (2007) and Ambraseys (1995) for non-liquefied soil conditions. Factors of safety for the slope stability analyses and displacements estimated using a Newmark Sliding Block approach are summarised in the table below. Results are presented in ***Appendix G***.

Table 12: Slope Stability Analyses Results

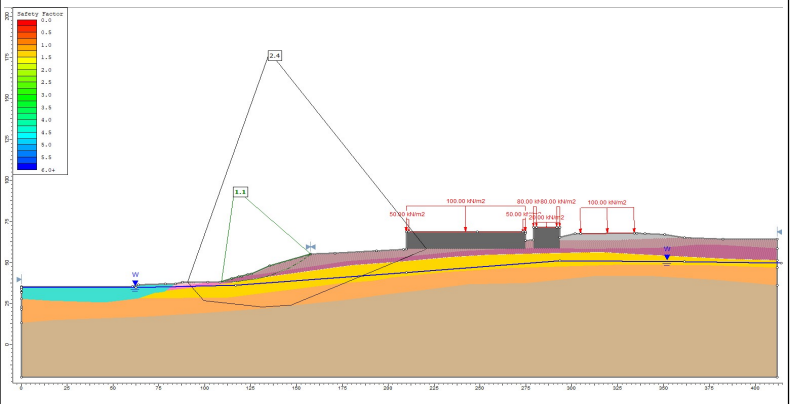
Condition	Factor of Safety	
	Cross-Section N-S	Cross-Section E-W
Static long-term conditions (drained soil conditions, normal groundwater)	2.4 (1)	2.1
Transient short-term conditions (elevated porewater pressures)	2.4 (1)	2.1
Serviceability Limit State 1 (SLS1) seismic condition	1.9	2.1
Serviceability Limit State 2 (SLS2) seismic condition	1.0	1.0
Ultimate Limit State (ULS) PGA seismic condition	0.8 (1)	0.7
Flow Failure	2.1	2.4
Critical Acceleration (peak strength)	0.241g	0.222g
Critical Acceleration (liquefied strength)	0.214g	0.204g
ULS Displacements	<70mm	<80mm
ULS Lateral Stretch	<50mm	<50mm
Note: (1) FoS for slip failures affecting the proposed reservoir.		

Results show that the slope stability factor of safety criteria are achieved for static conditions but are not achieved for the seismic conditions, however, lateral stretch for ULS seismic loads are anticipated to be less than 50mm.

With Valve Chamber - Normal Groundwater Conditions. Failures Filtered to FoS≤1.5



With Valve Chamber - Worst Case Groundwater Conditions. Failures Filtered to FoS≤1.0



Parameters (prevailing scenario)

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Ru Value
Concrete (Water reservoir)		0.01	No Strength			None		0
Stiff clay with sandy bands (Hamilton Ashes)		16	Mohr-Coulomb	3	28	Water Table	Automatically Calculated	
Stiff silty clay with sandy bands (Hamilton Ashes)		16	Mohr-Coulomb	2	26	Water Table	Automatically Calculated	
Medium dense silty sand/sandy silts with very stiff clay bands (Karapiro Formation)		16	Mohr-Coulomb	10	30	Water Table	Automatically Calculated	
Stiff weathered non-welded ignimbrite (Walton Sub group)		17	Mohr-Coulomb	3	28	Water Table	Automatically Calculated	
Very dense non-welded ignimbrite (Walton Subgroup)		17	Mohr-Coulomb	10	32	Water Table	Automatically Calculated	
Loose silts, sands and soft clays (Swamp deposits - Hinuera Formation)		16	Mohr-Coulomb	4	20	Water Table	Automatically Calculated	
Fill		16	Mohr-Coulomb	3	28	Water Table	Automatically Calculated	

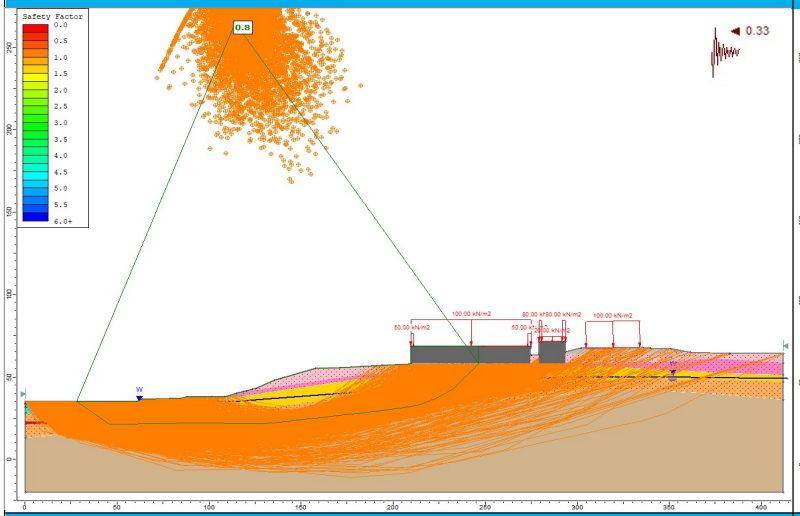
Parameters (worst groundwater scenario)

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Ru Value
Concrete (Water reservoir)		0.01	No Strength			None		0
Stiff clay with sandy bands (Hamilton Ashes)		16	Mohr-Coulomb	3	28	Water Table	Automatically Calculated	
Stiff silty clay with sandy bands (Hamilton Ashes)		16	Mohr-Coulomb	2	26	Water Table	Automatically Calculated	
Medium dense silty sand/sandy silts with very stiff clay bands (Karapiro Formation)		16	Mohr-Coulomb	10	30	Water Table	Automatically Calculated	
Stiff weathered non-welded ignimbrite (Walton Sub group)		17	Mohr-Coulomb	3	28	Water Table	Automatically Calculated	
Very dense non-welded ignimbrite (Walton Subgroup)		17	Mohr-Coulomb	10	32	Water Table	Automatically Calculated	
Loose silts, sands and soft clays (Swamp deposits - Hinuera Formation)		16	Mohr-Coulomb	4	20	Water Table	Automatically Calculated	
Fill		16	Mohr-Coulomb	3	28	Water Table	Automatically Calculated	
Stiff clay with sandy bands (Hamilton Ashes) - Ru 0.3		16	Mohr-Coulomb	3	28	None		0.3
Stiff silty clay with sandy bands (Hamilton Ashes) - Ru 0.3		16	Mohr-Coulomb	2	26	None		0.3

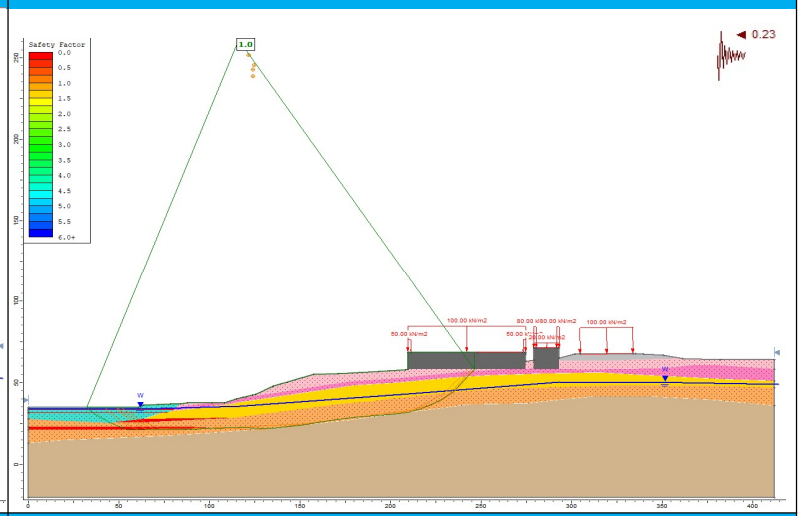
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Project	Reservoir Site Options	*Analysis*	Cuckoo	*Project No.*	HAM2023-0099
Title	N-S Reservoir Cross Section	*Date*	12/06/2025	*Drawing*	STAB 01

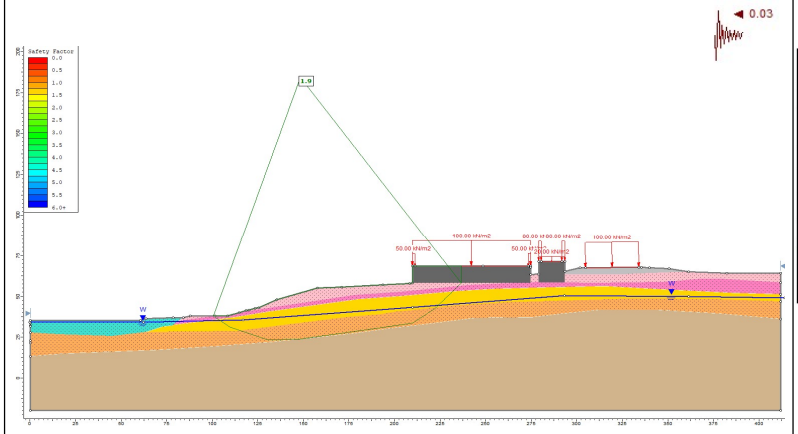
With Valve Chamber - ULS Seismic Event (ag=0.33g) Failures Filtered to FoS≤1.0



With Valve Structure - SLS2 Siesmic Event (ag=0.23g). Failures Filtered to FoS≤1



With Valve Structure - SLS1 Siesmic Event. Failures Filtered to FoS≤1



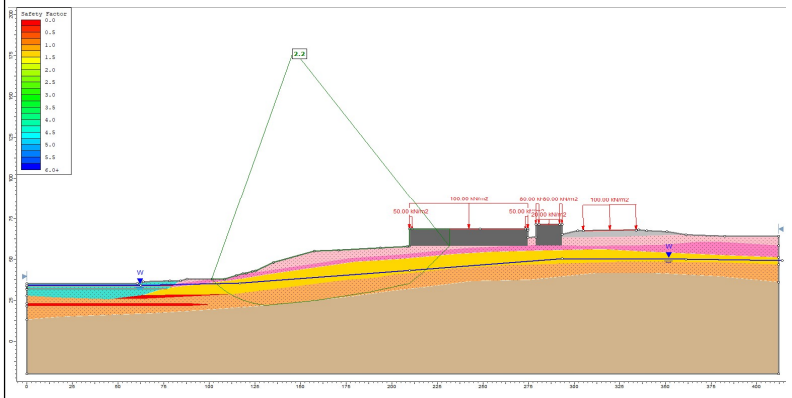
Parameters

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (kPa)	Water Surface	Hu Type	Ru Value
Concrete (Water reservoir)		20	No Strength						None		0
Medium dense silty sand/sandy silts with very stiff clay bands (Karapiro Formation)		16	Mohr-Coulomb	1	30				Water Table	Automatically Calculated	
Very dense non-welded ignimbrite (Walton Subgroup)		17	Mohr-Coulomb	3	32				Water Table	Automatically Calculated	
Fill		16	Mohr-Coulomb	3	28				Water Table	Automatically Calculated	
Stiff clay with sandy bands (Hamilton Ashes) - undrained		16	Undrained	110		Constant			Water Table	Automatically Calculated	
Stiff silty clay with sandy bands (Hamilton Ashes) - undrained		16	Undrained	75		Constant			Water Table	Automatically Calculated	
Stiff weathered non-welded ignimbrite (Walton Sub group) - undrained		17	Undrained	65		Constant			Water Table	Automatically Calculated	
Loose silts, sands and soft clays (Swamp deposits - Hinuera Formation) - liquefied		16	Vertical Stress Ratio				0.08	5	Water Table	Automatically Calculated	

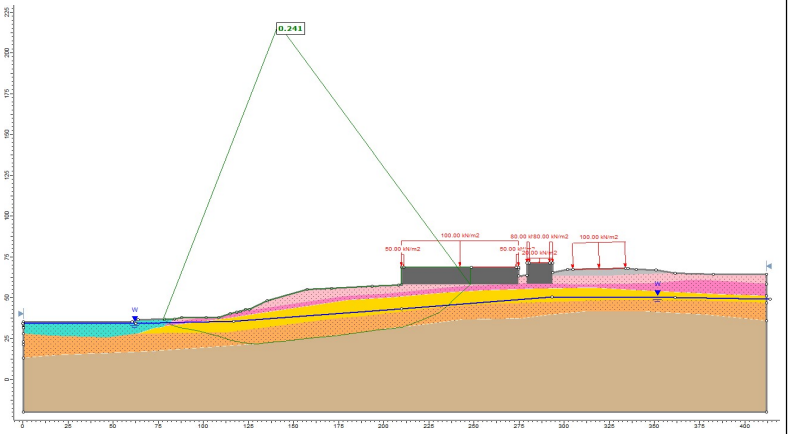
CMW Geosciences
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Project Reservoir Site Options	*Analysis* Cuckoo	*Project No.* HAM2023-0099
Title N-S Reservoir Cross Section	*Date* 12/06/2025	*Drawing* STAB 02

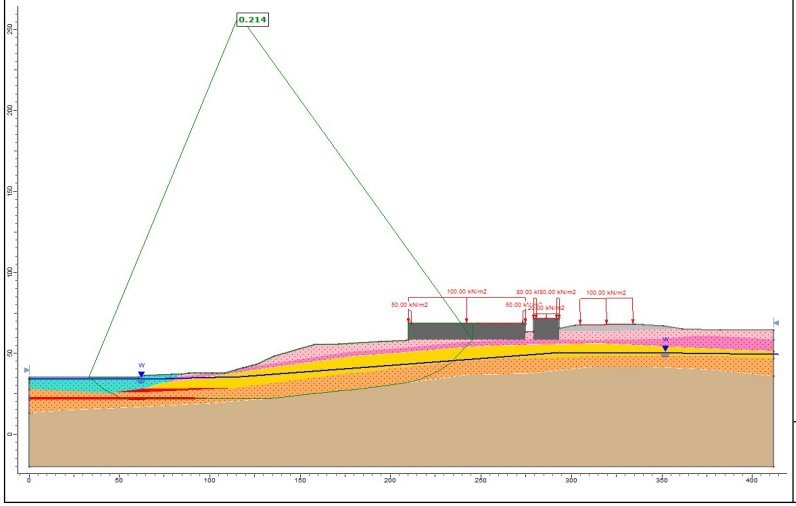
With Valve Chamber - Flow Failure. Failures Filtered to FoS≤1.0



With Valve Chamber -Yield strength - Peak Strength



With Valve Chamber -Peak strength - Liquefied Strength



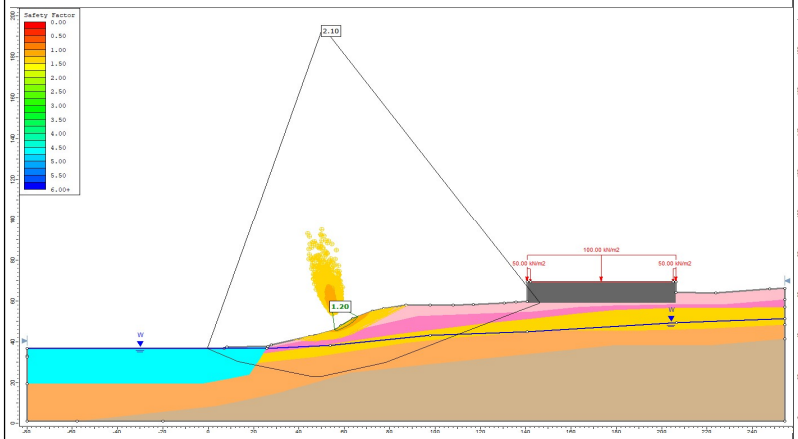
Parameters

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (kPa)	Water Surface	Hu Type	Ru Value
Concrete (Water reservoir)		0.01	No Strength						None		0
Medium dense silty sand/sandy silts with very stiff clay bands (Karapiro Formation)		16	Mohr-Coulomb	10	30				Water Table	Automatically Calculated	
Very dense non-welded ignimbrite (Walton Subgroup)		17	Mohr-Coulomb	10	32				Water Table	Automatically Calculated	
Fill		16	Mohr-Coulomb	3	28				Water Table	Automatically Calculated	
Stiff clay with sandy bands (Hamilton Ashes) - undrained		16	Undrained	110	0	Constant			Water Table	Automatically Calculated	
Stiff silty clay with sandy bands (Hamilton Ashes) - undrained		16	Undrained	75	0	Constant			Water Table	Automatically Calculated	
Stiff weathered non-welded ignimbrite (Walton Sub group) - undrained		17	Undrained	130	0	Constant			Water Table	Automatically Calculated	
Loose silts, sands and soft clays (Swamp deposits - Hinuera Formation)-undrained		16	Undrained	50	0	Constant			Water Table	Automatically Calculated	
Loose silts, sands and soft clays (Swamp deposits - Hinuera Formation) - liquefied		16	Vertical Stress Ratio				0.08	5	Water Table	Automatically Calculated	
Stiff weathered non-welded ignimbrite (Walton Sub group)-cyclic soft		17	Undrained	55	0	Constant			Water Table	Automatically Calculated	

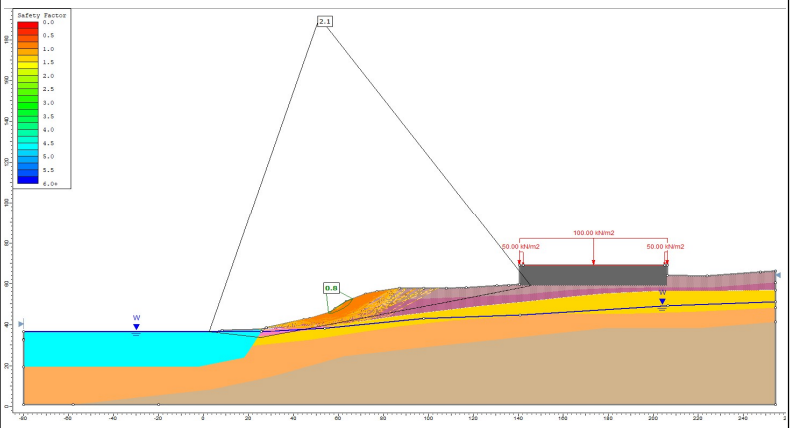
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Project Reservoir Site Options	**Analysis** Cuckoo	**Project No.** HAM2023-0099
Title N-S Reservoir Cross Section	**Date** 12/06/2025	**Drawing** STAB 03

With Valve Chamber - Normal Groundwater Conditions. Failures Filtered to FoS≤1.5



With Valve Chamber - Worst Case Groundwater Conditions. Failures Filtered to FoS≤1.0



Parameters (prevailing scenario)

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Ru Value
Concrete (Water reservoir)		0.01	No Strength			None		0
Stiff clay with sandy bands (Hamilton Ashes)		16	Mohr-Coulomb	3	28	Water Table	Automatically Calculated	
Stiff silty clay with sandy bands (Hamilton Ashes)		16	Mohr-Coulomb	2	26	Water Table	Automatically Calculated	
Medium dense silty sand/sandy silts with very stiff clay bands (Karapiro Formation)		16	Mohr-Coulomb	10	30	Water Table	Automatically Calculated	
Stiff weathered non-welded ignimbrite (Walton Sub group)		17	Mohr-Coulomb	3	28	Water Table	Automatically Calculated	
Very dense non-welded ignimbrite (Walton Subgroup)		17	Mohr-Coulomb	10	32	Water Table	Automatically Calculated	
Loose silts, sands and soft clays (Swamp deposits - Hinuera Formation)		16	Mohr-Coulomb	4	20	Water Table	Automatically Calculated	
Fill		16	Mohr-Coulomb	3	28	Water Table	Automatically Calculated	

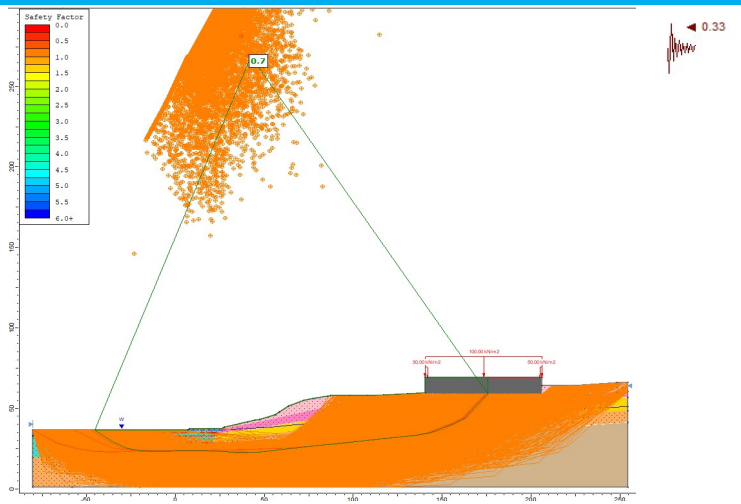
Parameters (worst groundwater scenario)

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Ru Value
Concrete (Water reservoir)		0.01	No Strength			None		0
Stiff clay with sandy bands (Hamilton Ashes)		16	Mohr-Coulomb	3	28	Water Table	Automatically Calculated	
Stiff silty clay with sandy bands (Hamilton Ashes)		16	Mohr-Coulomb	2	26	Water Table	Automatically Calculated	
Medium dense silty sand/sandy silts with very stiff clay bands (Karapiro Formation)		16	Mohr-Coulomb	10	30	Water Table	Automatically Calculated	
Stiff weathered non-welded ignimbrite (Walton Sub group)		17	Mohr-Coulomb	3	28	Water Table	Automatically Calculated	
Very dense non-welded ignimbrite (Walton Subgroup)		17	Mohr-Coulomb	10	32	Water Table	Automatically Calculated	
Loose silts, sands and soft clays (Swamp deposits - Hinuera Formation)		16	Mohr-Coulomb	4	20	Water Table	Automatically Calculated	
Fill		16	Mohr-Coulomb	3	28	Water Table	Automatically Calculated	
Stiff clay with sandy bands (Hamilton Ashes) - Ru 0.3		16	Mohr-Coulomb	3	28	None		0.3
Stiff silty clay with sandy bands (Hamilton Ashes) - Ru 0.3		16	Mohr-Coulomb	2	26	None		0.3

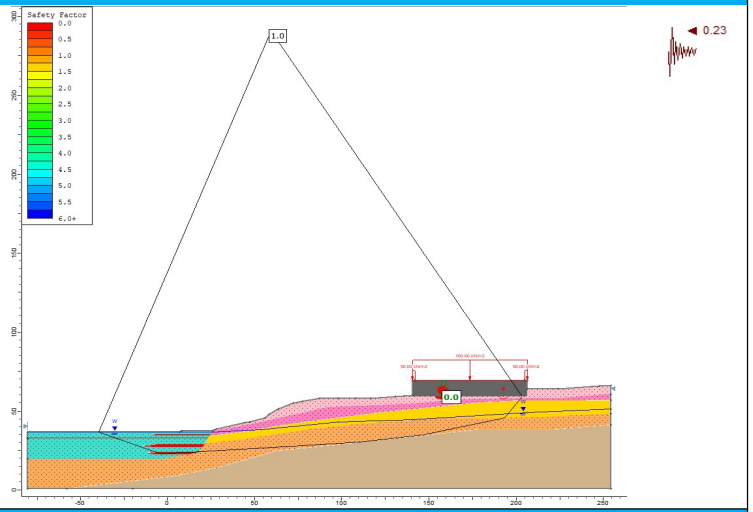
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Project Reservoir Site Options	*Analysis* Cuckoo	*Project No.* HAM2023-0099
Title E-W Reservoir Cross Section	*Date* 12/06/2025	*Drawing* STAB 04

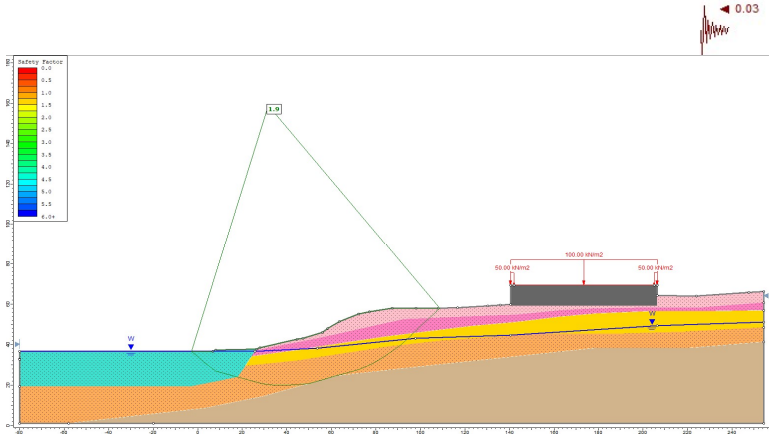
With Valve Chamber - ULS Seismic Event (ag=0.33g) Failures Filtered to FoS≤1.0



With Valve Structure - SLS2 Siesmic Event (ag=0.23g). Failures Filtered to FoS≤1



With Valve Structure - SLS1 Siesmic Event. Failures Filtered to FoS≤1



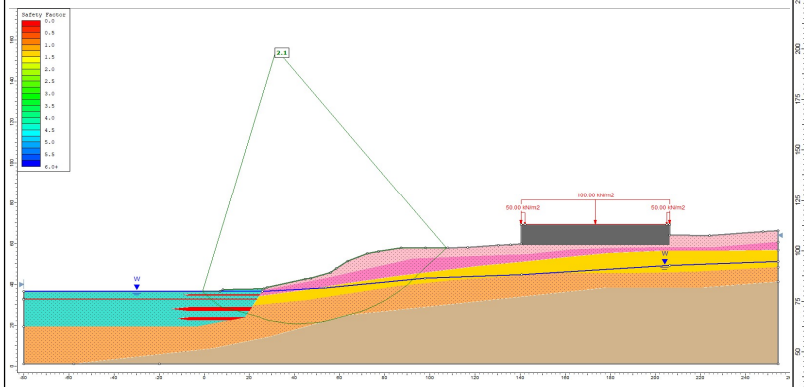
Parameters

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (kPa)	Water Surface	Hu Type	Ru Value
Concrete (Water reservoir)		20	No Strength						None		0
Medium dense silty sand/sandy silts with very stiff clay bands (Karapiro Formation)		16	Mohr-Coulomb	1	30				Water Table	Automatically Calculated	
Very dense non-welded ignimbrite (Walton Subgroup)		17	Mohr-Coulomb	3	32				Water Table	Automatically Calculated	
Fill		16	Mohr-Coulomb	3	28				Water Table	Automatically Calculated	
Stiff clay with sandy bands (Hamilton Ashes) - undrained		16	Undrained	110		Constant			Water Table	Automatically Calculated	
Stiff silty clay with sandy bands (Hamilton Ashes) - undrained		16	Undrained	75		Constant			Water Table	Automatically Calculated	
Stiff weathered non-welded ignimbrite (Walton Sub group) - undrained		17	Undrained	65		Constant			Water Table	Automatically Calculated	
Loose silts, sands and soft clays (Swamp deposits - Hinuera Formation) - liquefied		16	Vertical Stress Ratio				0.08	5	Water Table	Automatically Calculated	

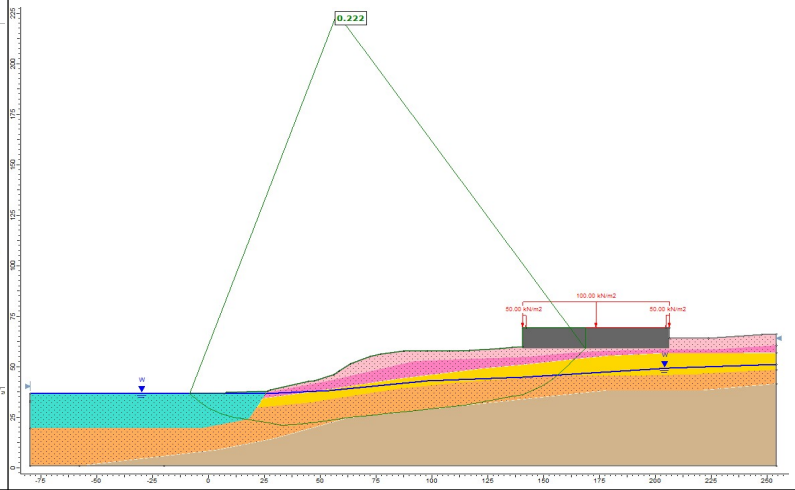
CMW Geosciences
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Project Reservoir Site Options	**Analysis** Cuckoo	**Project No.** HAM2023-0099
Title E-W Reservoir Cross Section	**Date** 12/06/2025	**Drawing** STAB 05

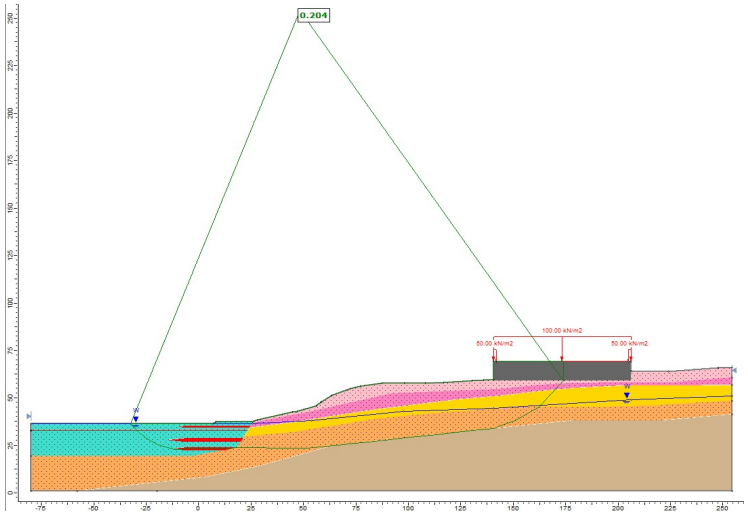
With Valve Chamber - Flow Failure. Failures Filtered to FoS≤1.0



With Valve Chamber -Yield strength - Peak Strength



With Valve Chamber -Peak strength - Liquefied Strength



Parameters

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (kPa)	Water Surface	Hu Type	Ru Value
Concrete (Water reservoir)		0.01	No Strength						None		0
Medium dense silty sand/sandy silts with very stiff clay bands (Karapiro Formation)		16	Mohr-Coulomb	10	30				Water Table	Automatically Calculated	
Very dense non-welded ignimbrite (Walton Subgroup)		17	Mohr-Coulomb	10	32				Water Table	Automatically Calculated	
Fill		16	Mohr-Coulomb	3	28				Water Table	Automatically Calculated	
Stiff clay with sandy bands (Hamilton Ashes) - undrained		16	Undrained	110	0	Constant			Water Table	Automatically Calculated	
Stiff silty clay with sandy bands (Hamilton Ashes) - undrained		16	Undrained	75	0	Constant			Water Table	Automatically Calculated	
Stiff weathered non-welded ignimbrite (Walton Sub group) - undrained		17	Undrained	130	0	Constant			Water Table	Automatically Calculated	
Loose silts, sands and soft clays (Swamp deposits - Hinuera Formation)-undrained		16	Undrained	50	0	Constant			Water Table	Automatically Calculated	
Loose silts, sands and soft clays (Swamp deposits - Hinuera Formation) - liquefied		16	Vertical Stress Ratio				0.08	5	Water Table	Automatically Calculated	
Stiff weathered non-welded ignimbrite (Walton Sub group)-cyclic soft		17	Undrained	55	0	Constant			Water Table	Automatically Calculated	

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Project Reservoir Site Options	**Analysis** Cuckoo	**Project No.** HAM2023-0099
Title E-W Reservoir Cross Section	**Date** 12/06/2025	**Drawing** STAB 06

CMW Geosciences Great People | Practical Solutions	CLIENT: **Hamilton City Council**	DESIGN	HNB
	PROJECT: **IAF Reservoir - Cross section E/W**	CHECKED:	
		REVISION:	6
	TITLE: **COSEISMIC DISPLACEMENTS (PEAK STRENGTH)**	DATE:	17/03/2025
		PROJEC	2023-0099AI

WHEN TO USE THIS SHEET:

Use this sheet when calculating the coseismic displacements of a slip using peak strength parameters.

1. INPUT PARAMETERS

a_c	0.222	g	*Yeild Acceleration (Factor of Safety = 1 with non-liquefied soil strengths)*
PGA	0.33	g	*Design Peak Ground Acceleration*
M	6.91		*Earthquake Magnitude*
h	0	km	*Focal Depth*
d	0	km	*Source Distance*

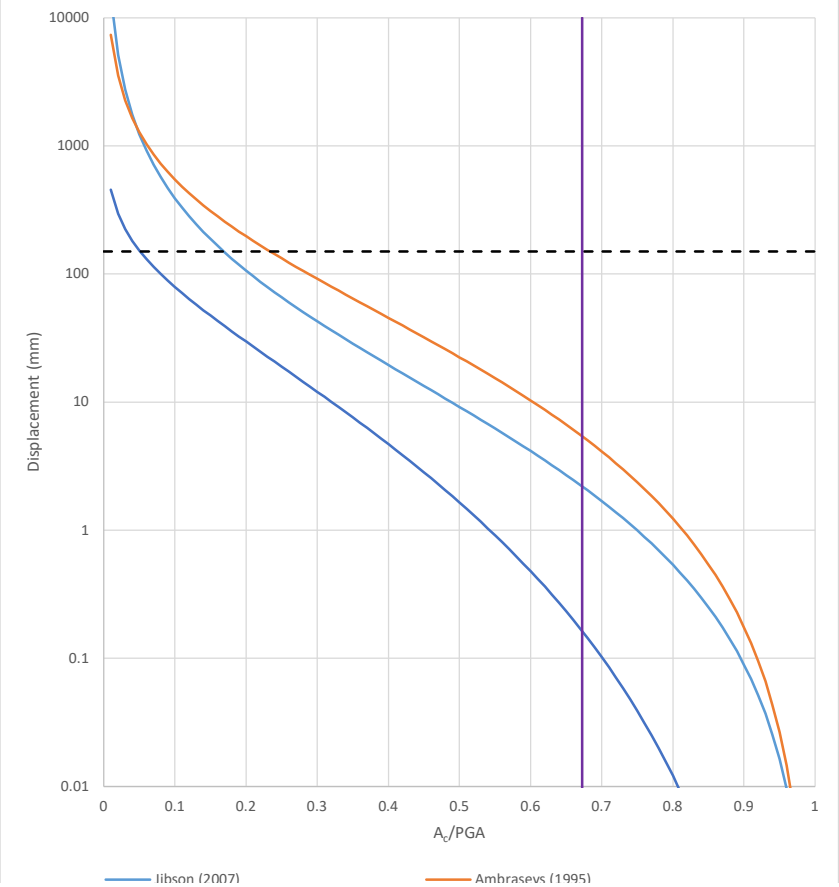
ac/PGA	0.67273
r	0
PGV/PGA Factor	60

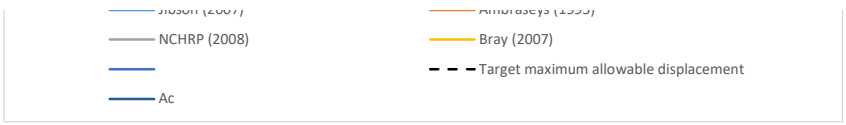
2. RESULTS

	Peak Strengths	
Probability of Exceedence:	**Jibson (2007)**	**Ambraseys (1995)**
50%	2 mm	5 mm
16%	6 mm	21 mm
5%	12 mm	49 mm
2.5%	17 mm	74 mm
0.5%	32 mm	169 mm

3. CHART OPTIONS

Displacements Limit 150 mm




NCHRP (2008)
Bray (2007)
Target maximum allowable displacement
Ac

CMW Geosciences Great People | Practical Solutions	CLIENT: **Hamilton City Council**	DESIG	HNB
	PROJECT: **IAF Reservoir - Cross section N/S**	CHECKED:	
		REVISION:	6
	TITLE: **COSEISMIC DISPLACEMENTS (PEAK STRENGTH)**	DATE:	13/03/2025
		PROJEC	2023-0099AI

WHEN TO USE THIS SHEET:

Use this sheet when calculating the coseismic displacements of a slip using peak strength parameters.

1. INPUT PARAMETERS

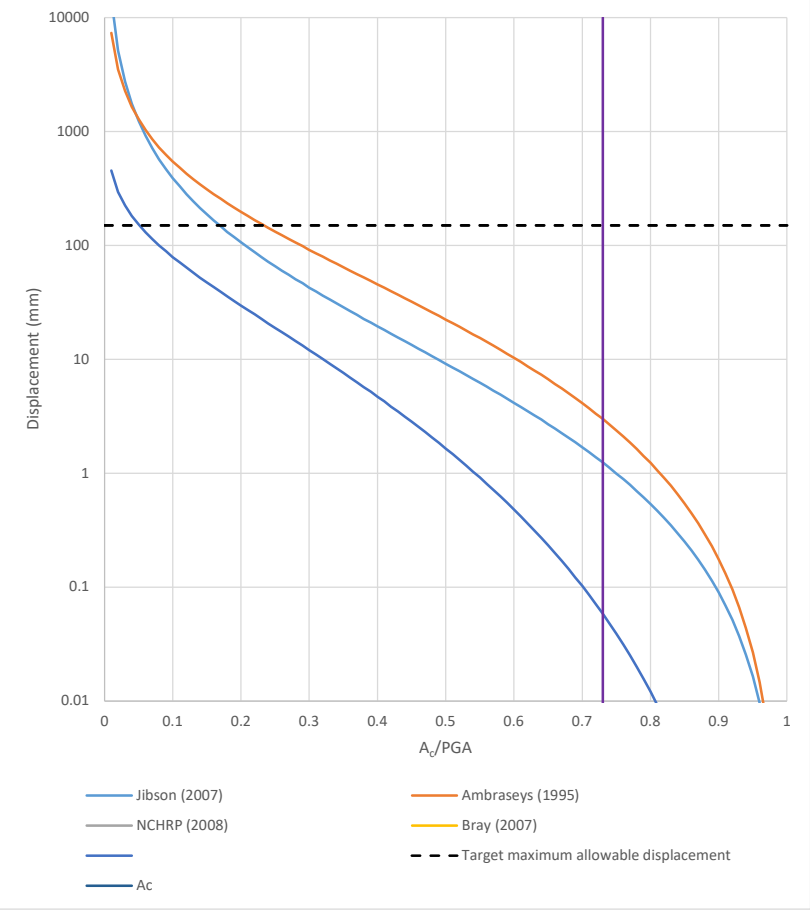
a_c	0.241	g	*Yeild Acceleration (Factor of Safety = 1 with non-liquefied soil strengths)*
PGA	0.33	g	*Design Peak Ground Acceleration*
M	6.91		*Earthquake Magnitude*
h	0	km	*Focal Depth*
d	0	km	*Source Distance*
ac/PGA	0.7303		
r	0		
PGV/PGA Factor	60		

2. RESULTS

	Peak Strengths	
Probability of Exceedence:	**Jibson (2007)**	**Ambraseys (1995)**
50%	1 mm	3 mm
16%	4 mm	11 mm
5%	7 mm	27 mm
2.5%	10 mm	41 mm
0.5%	18 mm	93 mm

3. CHART OPTIONS

Displacements Limit 150 mm



CMW Geosciences Great People | Practical Solutions	CLIENT: **Hamilton City Council**	DESIGNER:	HNB
	PROJECT: **IAF Reservoir - Cross section N/S**	CHECKED:	XXX
		REVISION:	6
	TITLE: **COSEISMIC DISPLACEMENTS (LIQUEFIED STRENGTH)**	DATE:	14/03/2025
		PROJECT:	2023-0099AI

WHEN TO USE THIS SHEET:

Use this sheet when calculating the coseismic displacements of a block using liquefied strengths

1. CALCULATE THE PERIOD OF THE SLIDING MASS (T_s)

1D or 2D?	1D		*Generally 1D, but see guidance tab for details*
H	32	m	*Maximum height of the sliding mass, measured from within the sliding mass*
Vs	266	m/s	*Average shear wave velocity of the sliding mass*
T_s	0.4812	s	

2. SEISMIC PARAMETERS

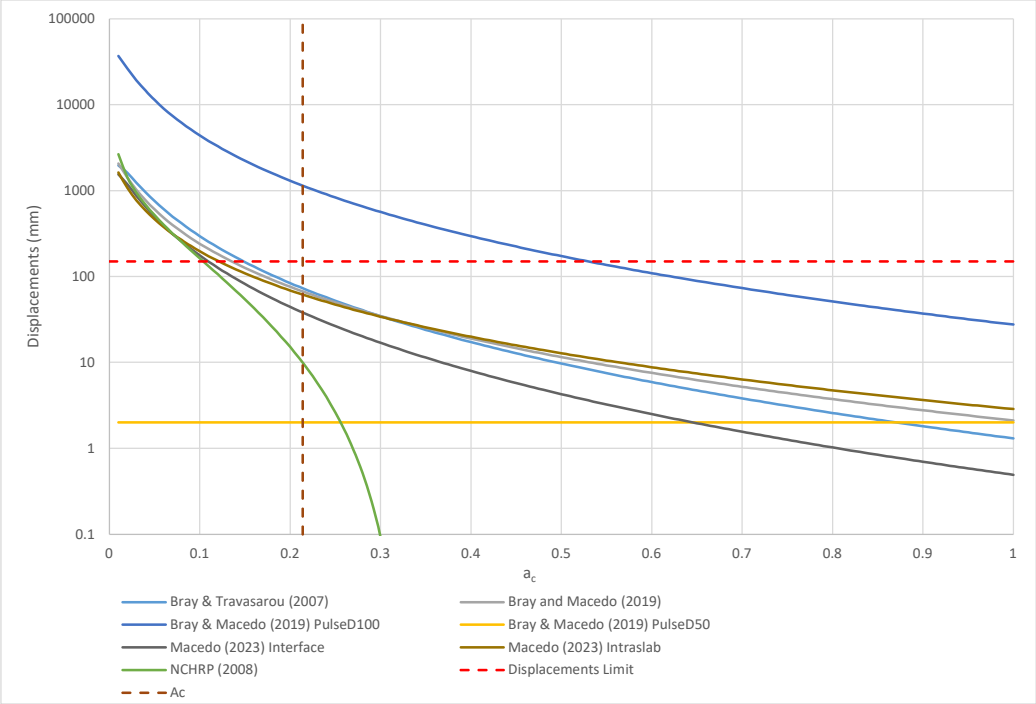
Case	Ordinary Ground Motions		*Only applicable to Bray and Macedo (2019). Almost always ordinary ground motions, see guidance tab re pulses*
Yeild Coefficient (a_c)	0.214	g	
Magnitude (M_w)	6.91		
PGA	0.33	g	
$S_a(1.3T_s)$	0.67	g	*Required for Bray (2019) and Macedo (2023)*
$S_a(1.5T_s)$	0.60	g	*Required for Bray (2007)*
PGV	56.1	cm/s	*Only required For Bray (2019) pulses*
Source Distance, d	0	km	*Only required for NCHRP (2008)*

3. RESULTS

Probability of Exceedence:	**Bray & Travasarou (2007)**	**Bray and Macedo (2019)**	**NCHRP (2008)**
Probability of Negligible Displacement	4%	2%	
50%	70 mm	66 mm	10 mm
16%	138 mm	136 mm	17 mm
5%	213 mm	218 mm	24 mm
2.5%	263 mm	273 mm	28 mm
0.5%	395 mm	426 mm	39 mm
Applicable Seismic Source	***Shallow Crustal***	***Shallow Crustal***	***Shallow Crustal***

4. CHART OPTIONS

Displacements Limit	150



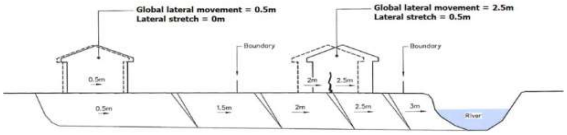
CMW Geosciences Great People | Practical Solutions	CLIENT: **Hamilton City Council**	DESIGNER:	HNB
	PROJECT: **IAF Reservoir - Cross section N/S**	CHECKED:	XXX
		REVISION:	6
	TITLE: **COSEISMIC LATERAL STRETCH (NORTH-SOUTH CROSS SECTION)**	DATE:	14/03/2025
		PROJECT:	2023-0099AI

WHEN TO USE THIS SHEET:
Use this sheet when calculating the coseismic stretch across a block using liquefied strengths

1. CALCULATE THE PERIOD OF THE SLIDING MASS (T_s)

1D or 2D?	1D		*Generally 1D, but see guidance tab for details*
H	30	m	*Maximum height of the sliding mass, measured from within the sliding mass*
Vs	266	m/s	*Average shear wave velocity of the sliding mass*
T_s	0.4511	s	

Figure 12.1: Simplified cross-section showing components of lateral ground movement (values illustrative only)



2. SEISMIC PARAMETERS

Magnitude (M_w)	6.91		
PGA	0.33	g	
$S_a(1.3T_s)$	0.67	g	*Required for Bray (2019)*
$S_a(1.5T_s)$	0.60	g	*Required for Bray (2007) and Bray (2018)*
Source Distance, d	3	km	*Only required for NCHRP (2008)*

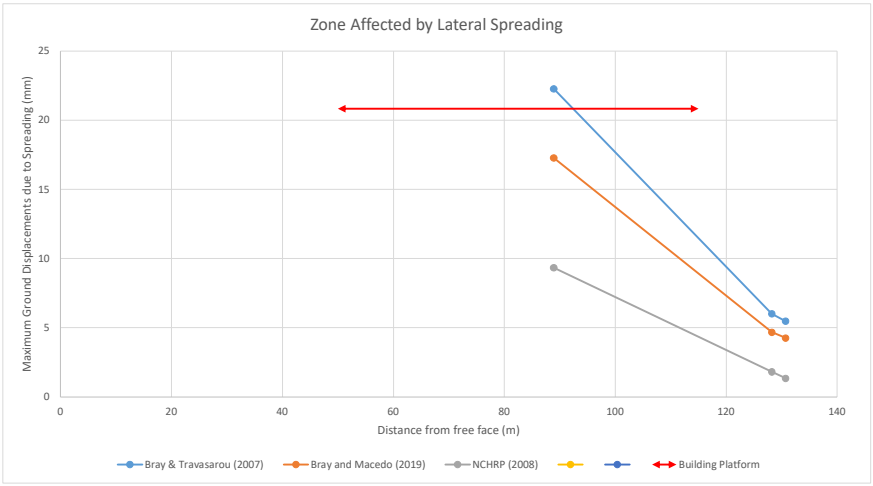
.

3. RESULTS

Distance from Crest of Slope (m):	a_c (liq)	Bray & Travasarou (2007)		Bray and Macedo (2019)		NCHRP (2008)	
		Displacement (mm)	Stretch (mm)	Displacement (mm)	Stretch (mm)	Displacement (mm)	Stretch (mm)
86	0.20	78		70		15	
89	0.23	56	22	53	17	6	9
128	0.24	50	6	48	5	4	2
131	0.25	45	5	44	4	3	1
Seismic Source		***Shallow Crustal***		***Shallow Crustal***		***Shallow Crustal***	

4. CHART OPTIONS

Building platform edge (closest to slope crest)	50
Building platform edge (furthest from slope crest)	115



CMW Geosciences Great People | Practical Solutions	CLIENT: **Hamilton City Council**	DESIGNER:	HNB
	PROJECT: **IAF Reservoir - Cross section N/S**	CHECKED:	XXX
		REVISION:	6
	TITLE: **Pseudo-Spectral Acceleration Calculation using NZS1170.5 (2004)**	DATE:	12/03/2025
		PROJECT:	2023-0099

1. Input Parameters

Location	Hamilton	
Site Class	Class D	*Per Clause 3.1.3*
Return Period	1/2500	*Per AS/NZS1170.0 Table 3.3*
T_s	0.48	*Sliding mass period per Displacement Sheet*
N(T,D)	1	*Near fault factor per Clause 3.1.6*
Z-Value	0.16	*Per Table 3.3*
R_u	1.8	*Per Table 3.5*
$1.3T_s$	0.63	*Degraded sliding mass period (Bray (2019) and Macedo (2023))*
$1.5T_s$	0.72	*Degraded sliding mass period (Bray (2007))*
$1.3T_s$ $C_h(T)$	2.84	*Spectral shape factor for 1.3T_s per Table 3.1*
$1.5T_s$ $C_h(T)$	2.53	*Spectral shape factor for 1.5T_s per Table 3.1*

2. Results

Sa($1.3T_s$)	0.67	*Geometric mean spectral acceleration at 1.3T_s*
Sa($1.5T_s$)	0.60	*Geometric mean spectral acceleration at 1.5T_s*

Notes:

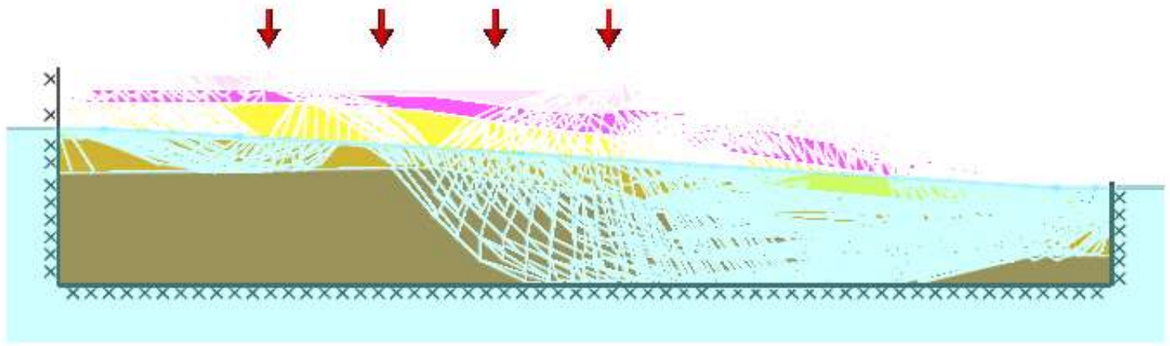
1. This spreadsheet returns the geometric mean component which is required in the Bray (2007), Bray (2019) and Macedo (2023) methods using the Bradley and Baker (2015) correlation. It will not directly match the larger horizontal component typically calculated using NZS1170.5 (2004).
2. This sheet assumes that any near fault factor is 1 (applicable for site not near a fault or site with T_s <1.5). If the site is within 20km of a fault listed in NZS1170.5 (2004) Table 3.6, calculate manually.

APPENDIX I

Bearing Capacity Output

Ruakiwi Road

Hamilton Lake

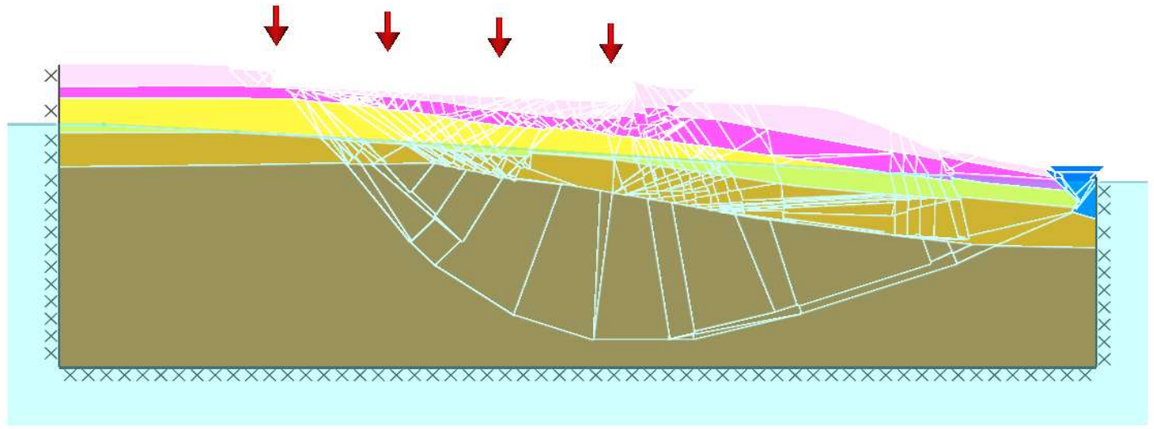


Adequacy Factor
5901

Static

Ruakiwi Road

Waikato River



Adequacy Factor
652.7

ULS Seismic

Key	Name	Unit Weight (Saturated Unit Weight)	Drainage Behaviour	c' (ϕ')	c_u (datum) (gradient) (grid)
	Very Dense Non-Welded Ignimbrite (Walton Subgroup)	17 (17)	Always drained	3* (32*)	0 (0) (0) (-)
	Stiff Clay with Sandy Bands (Hamilton Ashes)	16 (16)	Always drained	3* (28*)	0 (0) (0) (-)
	Stiff Weathered Non-Welded Ignimbrite (Walton Subgroup)	17 (17)	Always drained	3* (28*)	0 (0) (0) (-)
	Medium Dense Silty Sand/ Sandy Silts (Karapiro Formation)	16 (16)	Always drained	1* (30*)	0 (0) (0) (-)
	Stiff Silty Clay with Sandy Bands (Hamilton Ashes)	16 (16)	Always drained	2* (26*)	0 (0) (0) (-)
	Recent Alluvium	16 (16)	Always drained	4* (20*)	0 (0) (0) (-)

Parameters - Static Conditions

Key	Name	Unit Weight (Saturated Unit Weight)	Drainage Behaviour	c' (ϕ')	c_u (datum) (gradient) (grid)
	Unweathered Ignimbrite (Walton Subgroup)	17 (17)	Always undrained	0 (0)	200* (0*) (0*) (-)
	Stiff Clay (Hamilton Ashes)	16 (16)	Always undrained	0 (0)	110* (0*) (0*) (-)
	Weathered Ignimbrite (Walton Subgroup)	17 (17)	Always undrained	0 (0)	110* (0*) (0*) (-)
	(Karapiro Formation)	16 (16)	Always undrained	0 (0)	200* (0*) (0*) (-)
	Stiff Silty Clay (Hamilton Ashes)	16 (16)	Always undrained	0 (0)	75* (0*) (0*) (-)
	Recent Alluvium	16 (16)	Always undrained	0 (0)	50* (0*) (0*) (-)

Parameters - ULS Seismic Conditions

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Project Hamilton City Council - IAF Reservoir	*Analysis* Ultimate Unfactored Bearing Capacity	*Project No.* HAM2023-0099
Location: Ruakiwi Road, Hamilton Lake Site	*Date* 28/05/2025	*Drawing* GUBC 01

APPENDIX J

Static Settlements Output

METHODOLOGY

Fill embankments and future building loads will induce static settlements within the Hamilton Ashes and weathered ignimbrite of the Walton subgroup. Analyses were carried out based on CPT data and oedometer testing to assess soil modulus and consolidation parameters for static settlement analyses.

CPT-based Settlement Predictions

A CPT based assessment was performed for preliminary screening purposes.

Primary and secondary consolidation settlements were assessed using software package CPeT-IT using the following equation:

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

Where S = settlement, Δz = thickness of fine-grained soil layer, $\Delta \sigma_v$ = change in vertical stress or load applied and M_{CPT}=: CPT derived modulus.

In construction practice, 90% of the consolidation settlement (t_{90}) is often targeted during the construction phase. On the basis that t_{90} settlements are achieved during earthworks construction, subsequent post construction settlements were also estimated, which are made up of the remaining 10% consolidation settlement, and secondary creep settlements.

Creep settlements (S_{creep}) were estimated in accordance with the following relationship:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

Where Cα is the compression ratio, t = design life (100 years), t_P = time for primary consolidation.

$C\alpha / C_C = 0.04$, $t_P = 1$ year were used for calculation creep settlements.

Results Summary

Results are summarised below and provided in the following CPeT-IT analyses outputs.

Table 13: Static settlements (estimates based on CPeIT analysis)

CPT No. (*)	Cut/fill (-/+)	Fine-Grained Soils Thickness (m)	Consolidation Settlement (t_{90}) mm)	Long term creep settlement (mm) (**)
CPT01	0	17.5	150	30
CPT02	-1.2	20.0	160	50
sCPT02	0	12.5	80	10
sCPT03	0	20.5	320	50
sCPT04	-1.3	26.5	200	60
CPT05	2.1	20.0	260	90
CPT06	0	20.0	230	90
CPT07	0.3	25.5	270	100
CPT08	0.1	26.0	270	150
CPT No. (*)	Cut/fill (-/+)	Fine-Grained Soils Thickness (m)	Consolidation Settlement (t_{90}) mm)	Long term creep settlement (mm) (**)
sCPT24-06	0	24.0	220	80

Note: (*) CPT03, CPT04, sCPT01 and sCPT05 are located outside of the reservoir and valve chamber project footprint and shall not be considered in terms of static settlement.

(**) Estimated creep settlement over 100-year design life, assuming t_p=6 months.

Silty sands, sandy silts and clays of the Karapiro Formation present settlements estimated to 10% or less of the total settlement for all CPT's. Based on our experience this estimate based on CPT analysis is conservative for this type of material containing an important fraction of coarse and granular material.

Laboratory-based Settlement Predictions

Design Parameters

Results of the laboratory oedometer testing show that the Hamilton Ashes and Walton Subgroup soils are near-normally consolidated meaning that for the proposed fill embankment and foundation pressures, these soils will experience consolidation settlement following the virgin compression (C_c) line.

A summary of the parameters adopted for preliminary design, based on on-site laboratory test data, is summarised as follows:

Table 14: Summary of Consolidation Design Parameters (loading range 100 to 200 kPa)

Parameters	Stiff Clay with sandy layers (Hamilton Ashes)	Stiff silty Clay with sandy layers (Hamilton Ashes)	Weathered non-welded ignimbrite (Walton subgroup)
Compression Index (C_c)	0.233	0.120	0.249
Coefficient of secondary consolidation (C_s)	0.019	0.013	0.020
Initial void ratio (e_0)	2.03	1.67	2.03
Secondary / Primary Compression Index ratio (C_α/ C_c)*	0.05		
Coefficient of vertical consolidation (C_v – m^2/year)	25	25	25
OCR**	3.3	3.3	2.7

Note: Considering the settlement estimates for the Karapiro formation with the CPT approach, the contribution of silty sands, sandy silts and clays of the Karapiro Formation to total settlements has been assessed to be less than 10%. This layer has not been included in the consolidation model under Settle3.

* Value based on experience with similar soils in identical geological layers

** Value based on CPeT-IT estimates and correlation

Methodology

An assessment of static settlements was completed based on elastic theory using the proprietary software Settle3 for the differential embankment height defined in the input documents and an assumed permanent load of 110kPa.

Primary settlement has been calculated based on a non-linear material behaviour:

$$\Delta\varepsilon = \frac{C_r}{1+e_0}\log\left(\frac{P_c}{\sigma_i'}\right) + \frac{C_c}{1+e_0}\log\left(\frac{\sigma_f'}{P_c}\right)$$

Where: Δε = secondary strain at time t, C_r = recompression index, e_0 = initial void ratio, *Pc* = preconsolidation stress, C_c = compression index, σ_i'= initial effective stress, C_c = compression index, σ_f'= final effective stress.

Secondary settlement has been calculated based on Mesri's method:

$$\Delta\varepsilon_s = \frac{C_c}{1+e_p}\frac{C_\alpha}{C_c}\frac{C_\alpha''}{C_\alpha} log\,\frac{t}{t_l}$$

Where: Δε = secondary strain at time t, C_c = compression index, e_p = void ratio at the end of primary consolidation, C_α=secondary compression index, C_α''= postsurcharge secondary compression secant index, t_l = time of load removal.

Results Summary

The results are summarised in the table below and graphical output from the software is presented in Appendix J.

Table 15: Estimated Postconstruction Settlements

Stage	Staging Description	Lower Bound for Static Settlement at the Reservoir for this Stage (mm)	Upper Bound for Static Settlement at the Reservoir for this Stage (mm)	Maximum Differential Static Settlement for this Stage (mm)
1	Fill embankment (construction of the building platform to RL 60.5m)	10	10 to 80	70
2	Construction of the IAF and valve chamber slab and walls	<10	<10	<10
3	Commissioning of the IAF Reservoir	<10 to 65	30 to 165	155
4	Post construction (creep) settlement*	<10	15 to 100	100

Note: * Estimated creep settlement over 100-year design life, assuming t_p=6 months, from Settle3.

Discussion

Predicted laboratory-based primary settlements range from 10 mm to 255 mm and post-construction settlements of 10mm to 100mm are predicted varying laterally with geology (thickness and depth of compressible layers) and proposed fill height. Predicted post-construction differential settlements are expected to be comprised between 10 and 255mm.

These settlements are considered excessive for the proposed development for which a maximum threshold of 100mm differential settlement has been defined by the structural engineering team. Primary settlements are estimated to take approximately 2 to 3 months based on the lab testing data. However, required surcharge periods have ranged from 4 months to 8 months in similar soils in and around Hamilton.

Specific ground improvement measures will be required, as discussed below.

[9] Mesri, G., Lo, D. O. K. and Feng, T. W. 1994. Settlement of embankments on soft clays. Keynote Lecture, Settlement '94, Texas A&M University, College Station, Texas, Geotechnical Special Publication 40, v. 1, 8-56.

Ground Improvement

To minimise post construction static settlements, the following two options may be considered:

- Construction of a temporary surcharge or pre-load fill embankment above design finished ground level, to over-consolidate the compressible soils,
- Construction of rigid inclusion ground improvement as an alternate solution.

Surcharge Design

It is expected that surcharging, without cutting surficial compressible soils, is likely to be the preferred ground improvement technique for this project to reduce post-construction static settlements to acceptable magnitudes.

Surcharge embankment heights were estimated using the method described in Mesri et al (1994)[9] based on achieving 90% primary consolidation (t_{90}) during surcharge with post-construction settlements being limited to 100mm as defined by the Structural Engineer. The surcharge material density is assumed to be 16 kN/m³.

Resulting surcharge embankment heights range up to 6.5m above existing ground levels as shown on ***Appendix J***, depending on soft soil thickness and proposed fill depths. Settlement estimates and surcharge heights are based on a limited amount of laboratory test data and preload heights and duration are ubject to change based on results of settlement monitoring.. As there will inevitably be some variation in soil composition and resulting settlement profiles from one location to the next, it is imperative that regular settlement monitoring is undertaken during construction to back analyse consolidation settlement parameters and progressively refine the surcharge design. All plates must be installed on natural ground to capture the full magnitude of settlements.

It is recommended that fill embankments are temporarily terminated at least 5m from existing infrastructure. Surface settlement monitoring points should be established prior to filling at the temporary embankment crest, toe, 2m from the toe and 5m from the toe to determine edge effects. This will provide confidence to place the remaining fill without impacting adjacent infrastructures.

CFA (Continuous Flight Auger) Rigid Inclusion Ground Improvement Design

An alternative solution is the installation of CFA (Continuous Flight Auger) Rigid Inclusions to support the proposed reservoir tank and reduce the static settlements (Domain 2 according to ASIRI[10]). The rigid inclusion ground improvement system will have to be designed to comply with the following standards where applicable:

- NZ Building Code, clause B1
- AS2159: 2009, Piling – Design and Installation
- Tomlinson, 4th edition, Piling Design and Construction Practices, 1994
- Collin, Han & Huang, Geosynthetic-Reinforced Column-Support Embankment Guidelines, 2005
- NZGS/SESOC Construction Specification: Bored and Driven Piles: June 2022
- Projet national ASIRI: Recommendations for the Design, Construction and Control of Rigid Inclusion Ground Improvements (2013)
- NF P94-262:2012-07-01: Justification of geotechnical work - National application standards for the implementation of Eurocode 7 - Deep foundations

A geotechnical strength reduction factor of 1.0 has been selected based on settlement control design philosophy. The structural design of the rigid inclusions shall be undertaken in accordance with AS2159:2009 for unreinforced concrete elements and AS3600 where ULS pile stress (load / shaft x-section area) < 29% pile Unconfined Compressive Strength (UCS).

A GAP65 gravel raft will be required as a Load Transfer Platform beneath the concrete raft foundation to facilitate load transfer to the rigid inclusions and to provide isolation between the structural foundation elements and ground

[10] Projet national ASIRI (2013). *Recommendations for the Design, Construction and Control of Rigid Inclusion Ground Improvements*

improvement rigid inclusions. The LTP is designed in accordance with ASIRI[9] and considers a bearing capacity punching failure mechanism from the 300mm diameter CFA rigid inclusion based on Prandtl failure diagram and shear cone failure.

The CFA design loads have been assessed based on the pressures presented below.

Table 16: CFA RI Design Loads Rigid Inclusion Design

SLS Compression (kPa)	Tributary Area (m^2)	RI Grid (m)	SLS Design Load (kN) / RI
110	1.44	1.2x1.2	175
Notes: Maximum load of 110 kPa of tank loading is considered for settlement calculation.			

The results of the preliminary CFA ground improvement design are summarised below**.** Design calculations are presented in Appendix J.

Table 17 Preliminary Rigid Inclusions Details

Design Load (SLS) (kN/RI)	Negative Friction (kN)[1]	RI Length (m)	Shaft Dia. (m)	Concrete UCS (MPa)	Geotechnical Ultimate Capacity (kN)	Settlement - SLS Design Load (mm)	Spring Stiffness (kPa/m)[2]
175	225	11	0.35	30	490	85	49,120
Notes: [1] Negative friction has been assessed based on Eurocode 7-NF P94-262:2012-07-01							

A permanent load transfer platform (LTP) will be placed between the top of the CFA rigid inclusion ground improvements and underside of the concrete base slab. Load Transfer Platform details are presented below:

Table 18: Load Transfer Platform Details

Maximum Load (ULS) (kPa)	LTP Material (m)	LTP Material Young Modulus (MPa)	LTP Thickness (m)	Friction Angle for LTP Material (deg)	Geogrid	Limit Stress at Inclusion Head qp+ (kPa)
225	GAP 65	35	0.6	35	Duragid 40/40	1,026
Note: [1] Limit stress at inclusion head shall be taken into account into the structural design of the slabRigid inclusions are designed to reduce settlement (Domain 2), bearing capacity (Domain 1) assessment is not required as per ASIRI (2013)						

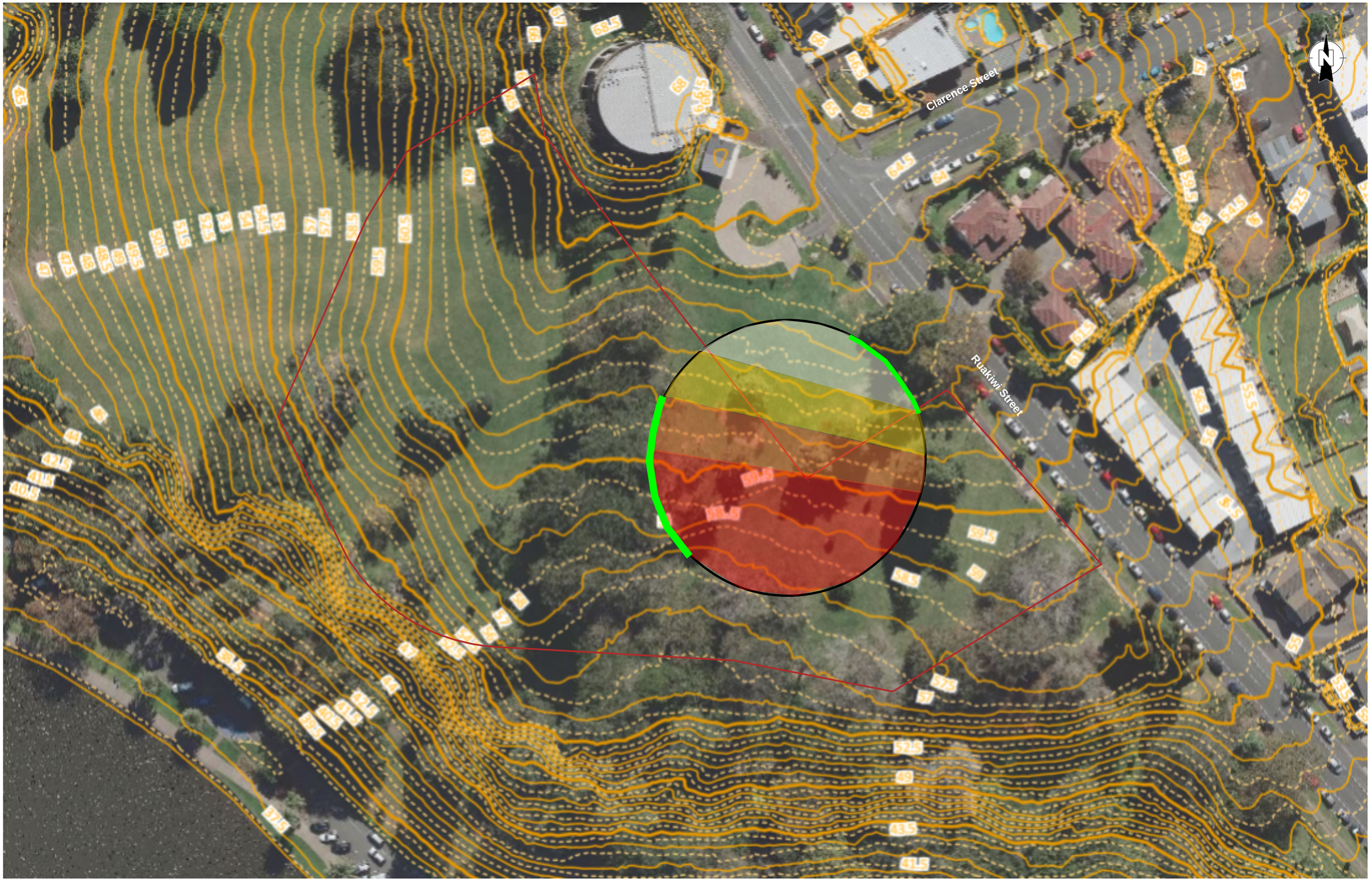
A geocloth will be required at the base of the LTP platform to prevent fines migration. CFA rigid inclusion set out relative to foundations to be completed by a qualified surveyor to verify position prior to construction.

Excavations must be subject to inspection by CMW engineering geologist / geotechnical engineer to verify the strength of the subgrade layer. CMW to verify RI diameter, depth, spacing, embedment and material and concrete strength.

All GAP65 fill for the load transfer platform must be compacted to achieve a minimum of 95% Maximum Dry Density (MDD). Nuclear Densometer testing (NDM) of the GAP65 load transfer platform to verify compacted density requirements. Lab test certificates to establish MDD should be less than six months old.

Contractor will maintain rigid inclusion installation records as per NZGS piling guidelines confirming minimum target depths or criteria achieved.

If this CFA ground improvement solution is preferred, LTP thickness, material and construction specifications could be refined.



Legend

Reservoir footprint

Proposed new designation

Proposed preloads above existing ground level with in-situ soils (density 16kN/m3) and no undercuts

+ 6.50 m

+ 5.50 m

+ 4.50 m

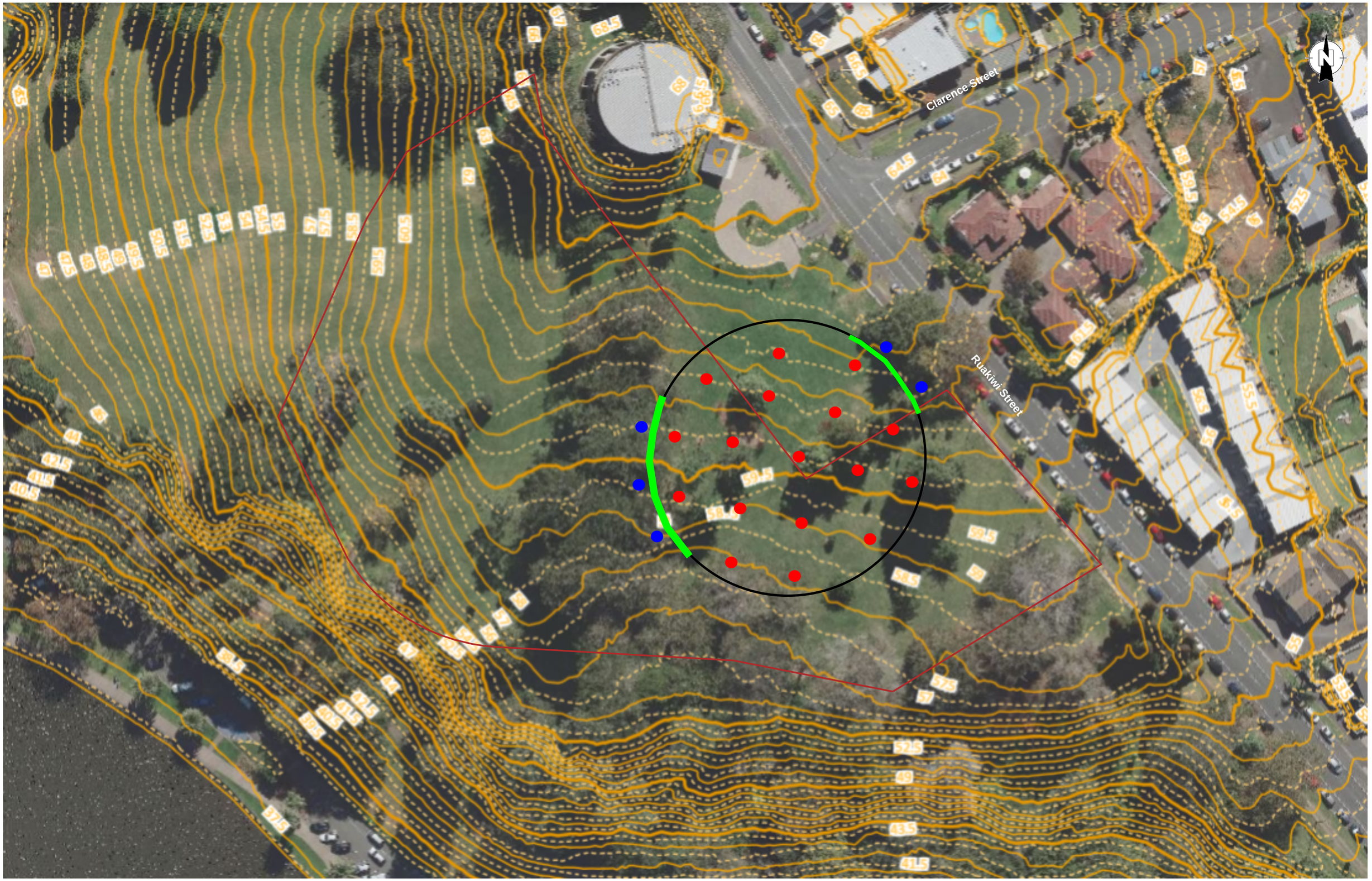
+ 3.50 m

Retaining blocks to limit preload batter on the root protection zone

0 50m

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CLIENT: HAMILTON CITY COUNCIL	DRAWN: HNB	HAM2023-0099
PROJECT: IAF RESERVOIR	CHECKED: HP	DRAWING: 02
	REVISION: 01	SCALE: NA
TITLE: PRELOAD EMBANKMENTS	DATE: 27/06/2025	SHEET: A3 L



Legend

- Reservoir footprint
- Proposed new designation
- Proposed settlement monitoring plates
- Proposed settlement monitoring plates within the root protection zone
- Settlement plates to be installed 4 weeks prior to preload and monitored every 2 weeks
- Retaining blocks to limit preload batter on the root protection zone

0 50m

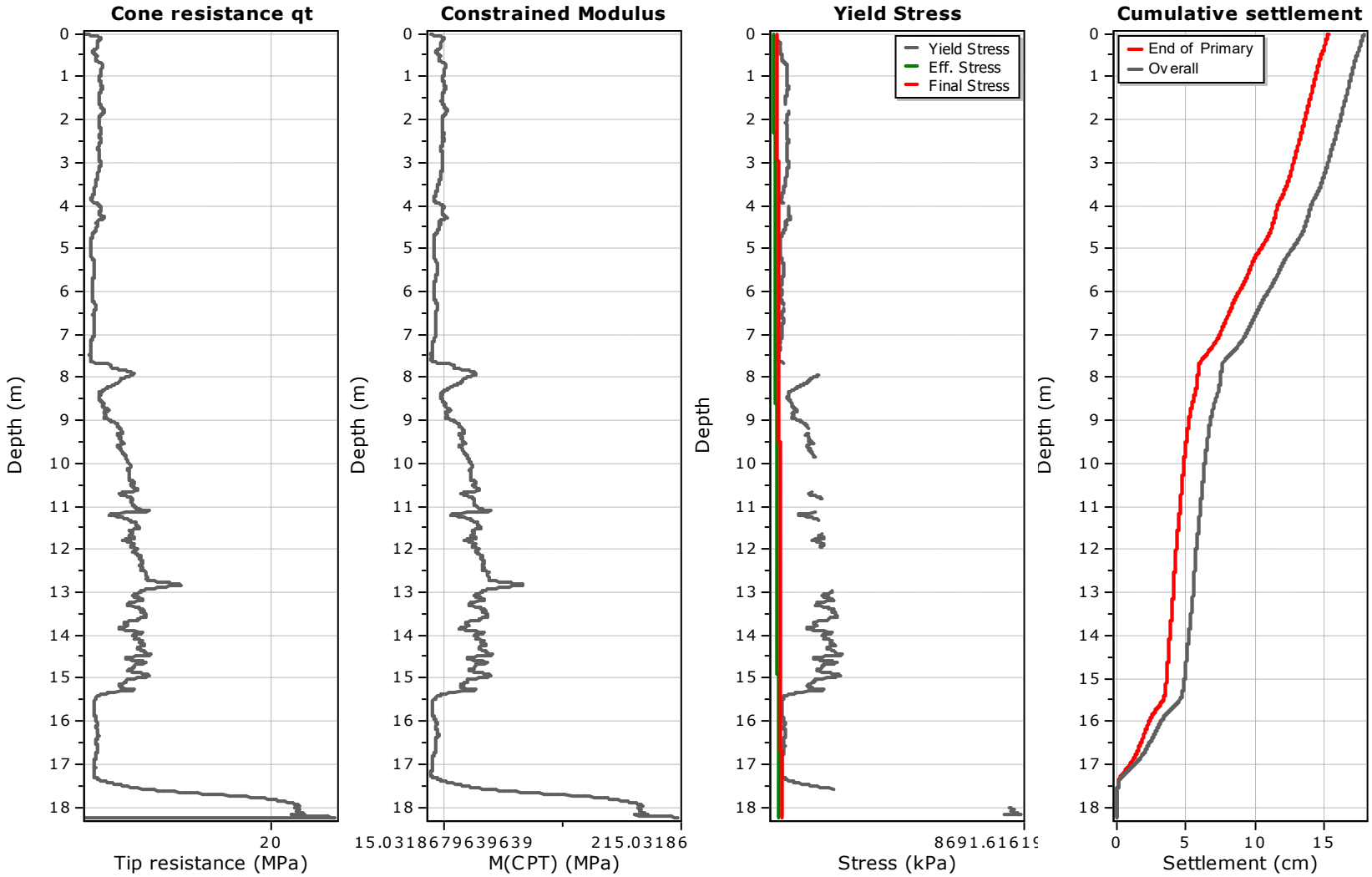
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CLIENT: HAMILTON CITY COUNCIL		DRAWN: HNB	HAM2023-0099
PROJECT: IAF RESERVOIR		CHECKED: HP	DRAWING: 02
		REVISION: 01	SCALE: NA
TITLE: SETTLEMENT MONITORING PLATES		DATE: 27/06/2025	SHEET: A3 L

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: CPT01
Total depth: 18.25 m, Date: 26/10/2023
Surface Elevation: 63.00 m, Est. GWL: 0.80 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Circular
Footing diameter: 65.00 (m)
L/B: 1.0
Footing pressure: 110.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 1200 months

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

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

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

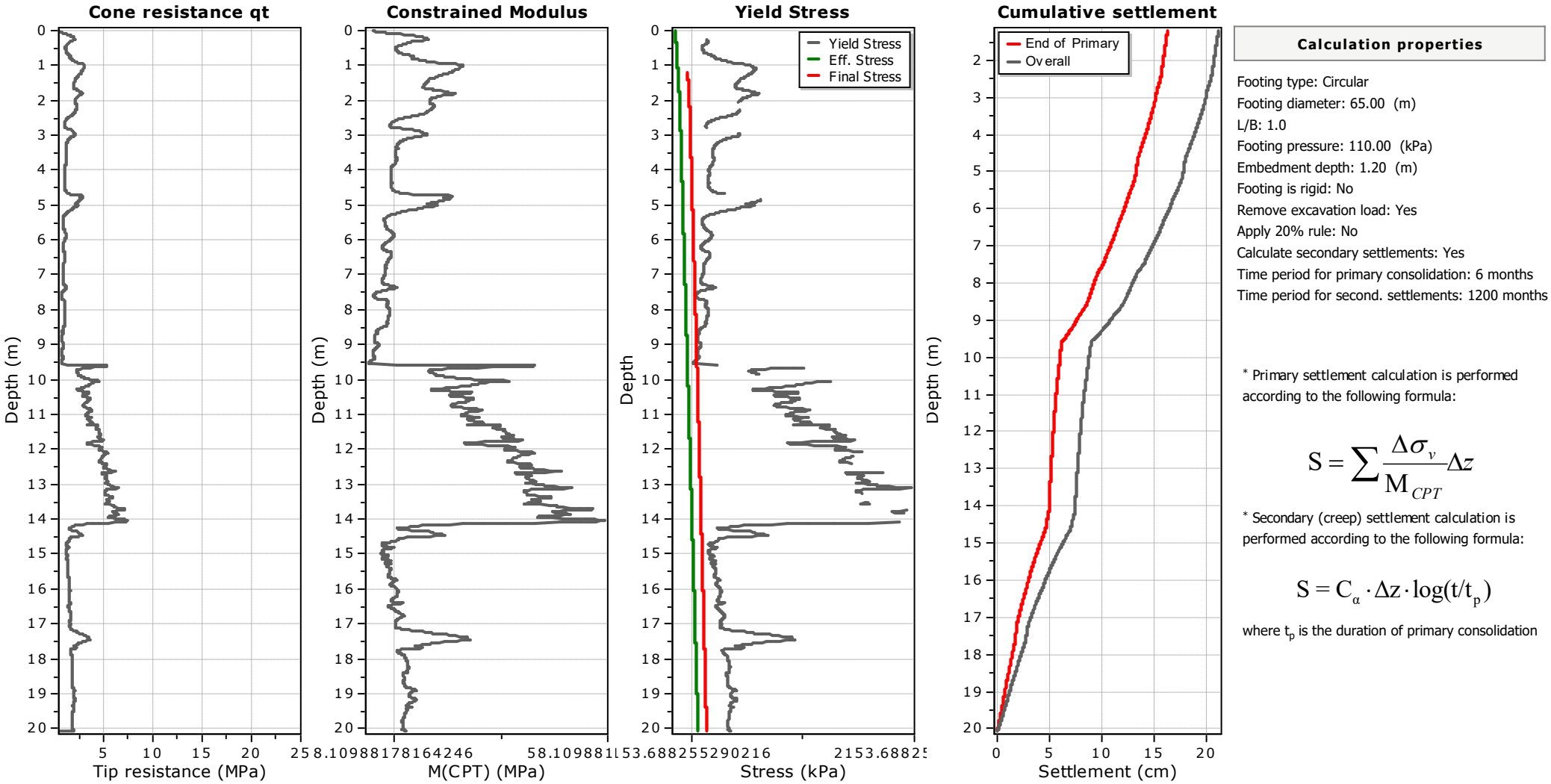
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: CPT02
Total depth: 20.07 m, Date: 26/10/2023
Surface Elevation: 61.70 m, Est. GWL: 2.10 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Circular
Footing diameter: 65.00 (m)
L/B: 1.0
Footing pressure: 110.00 (kPa)
Embedment depth: 1.20 (m)
Footing is rigid: No
Remove excavation load: Yes
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 1200 months

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

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

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

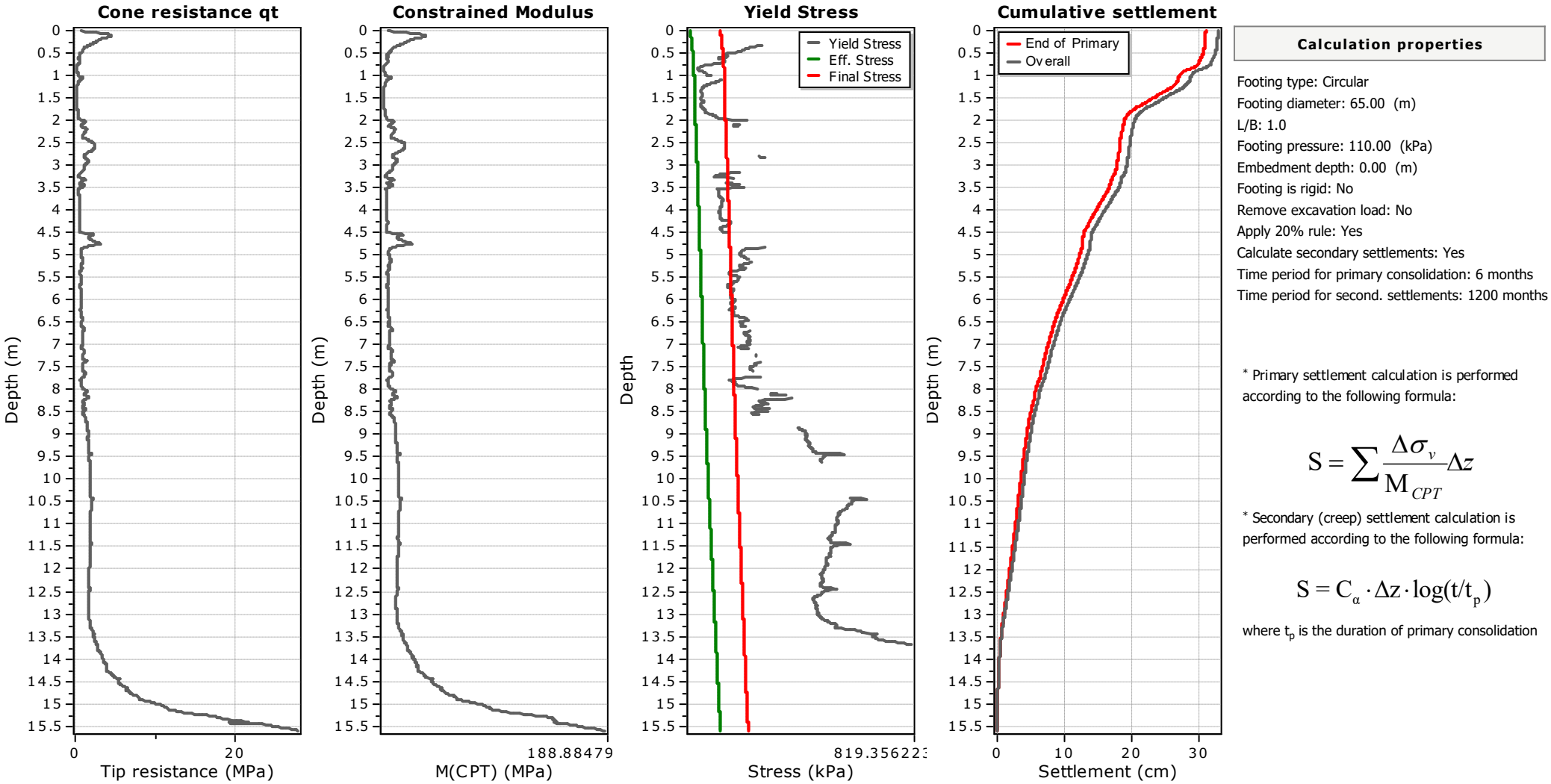
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: CPT04
Total depth: 15.61 m, Date: 11/03/2025
Surface Elevation: 0.00 m, Est. GWL: 0.70 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Circular
Footing diameter: 65.00 (m)
L/B: 1.0
Footing pressure: 110.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 1200 months

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

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

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

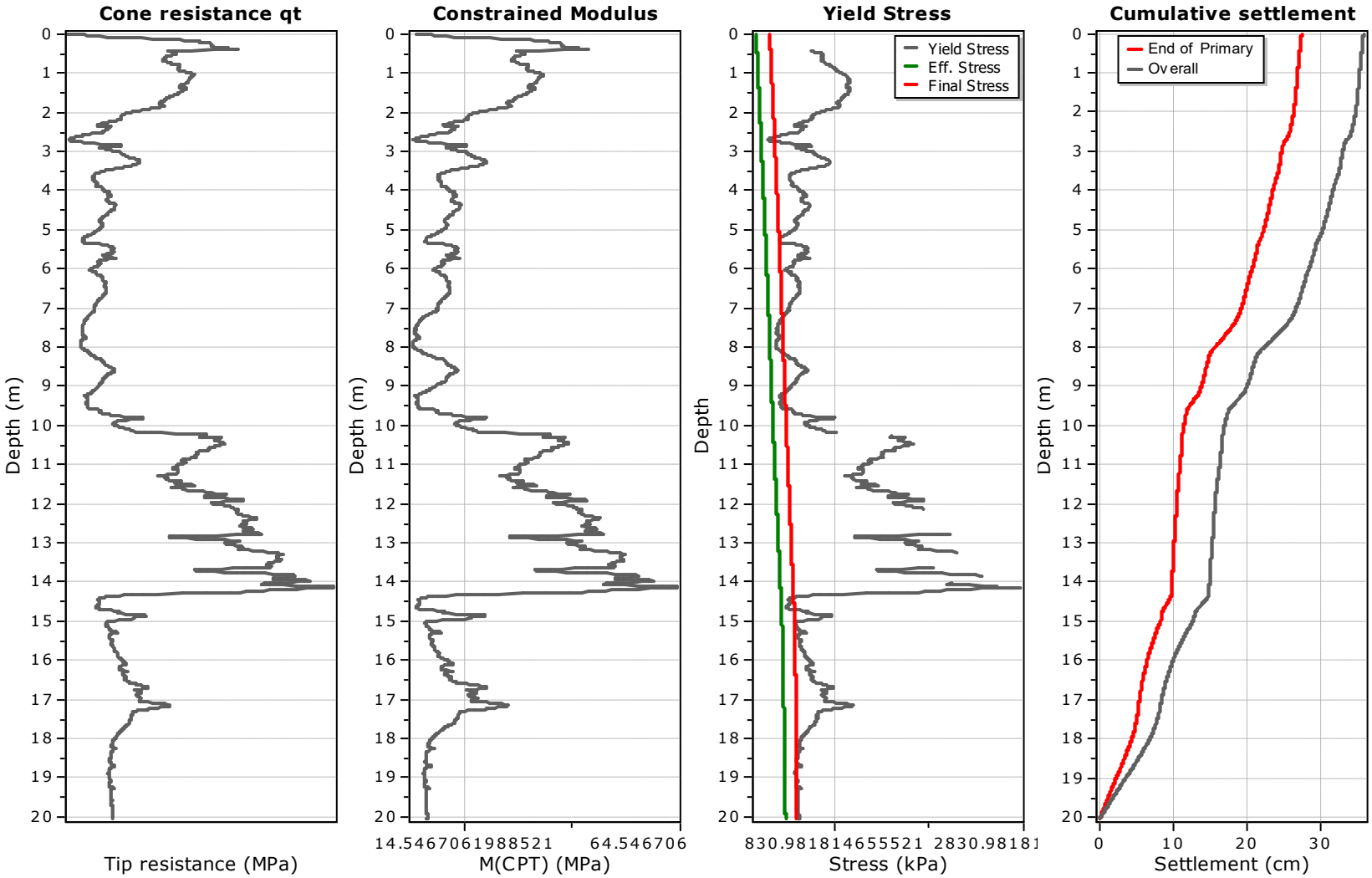
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: CPT05
Total depth: 20.05 m, Date: 11/03/2025
Surface Elevation: 0.00 m, Est. GWL: 15.20 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Circular
Footing diameter: 65.00 (m)
L/B: 1.0
Footing pressure: 143.60 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 1200 months

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

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

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

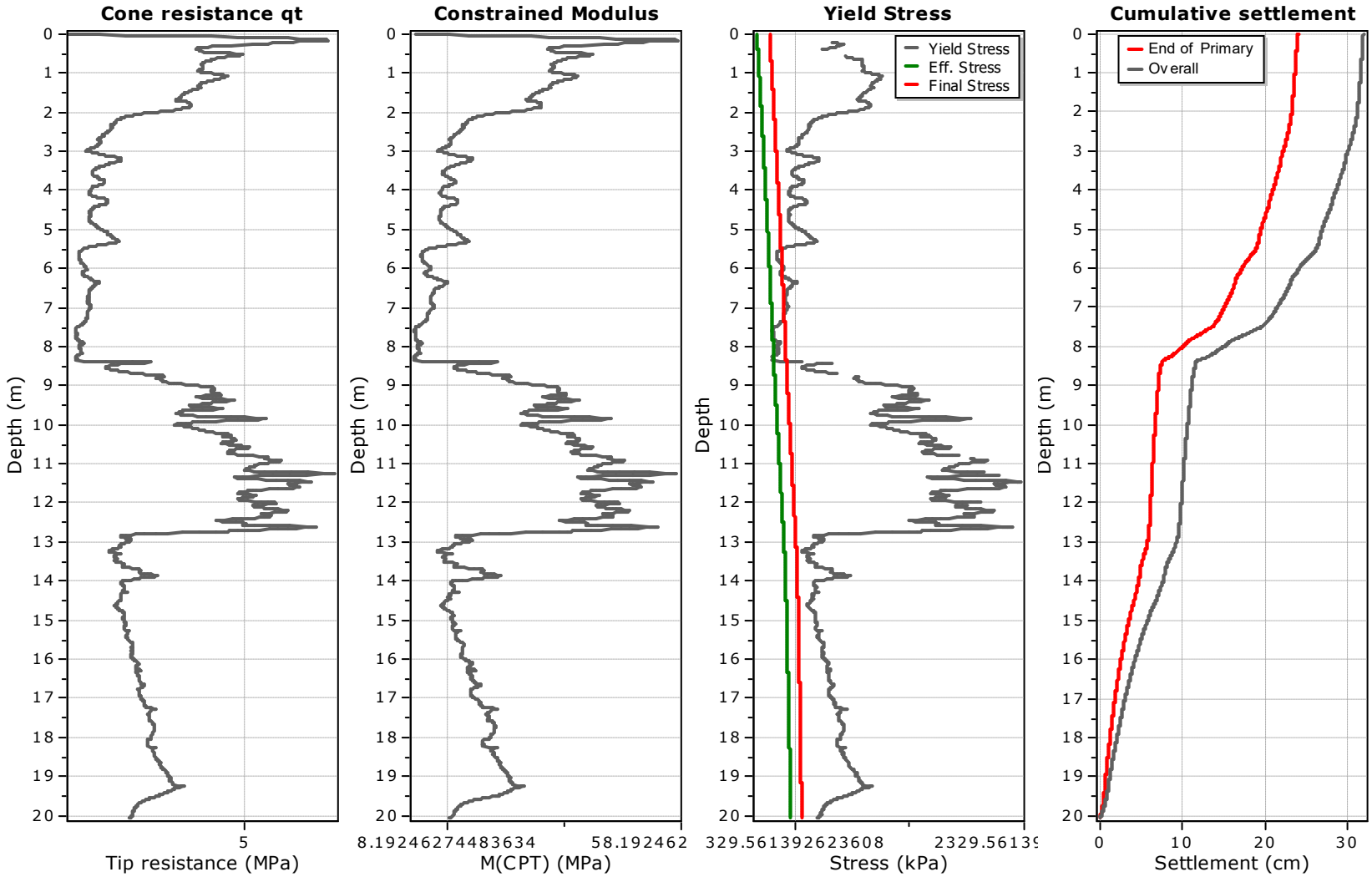
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: CPT06
Total depth: 20.06 m, Date: 11/03/2025
Surface Elevation: 0.00 m, Est. GWL: 13.70 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Circular
Footing diameter: 65.00 (m)
L/B: 1.0
Footing pressure: 110.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 1200 months

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

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

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

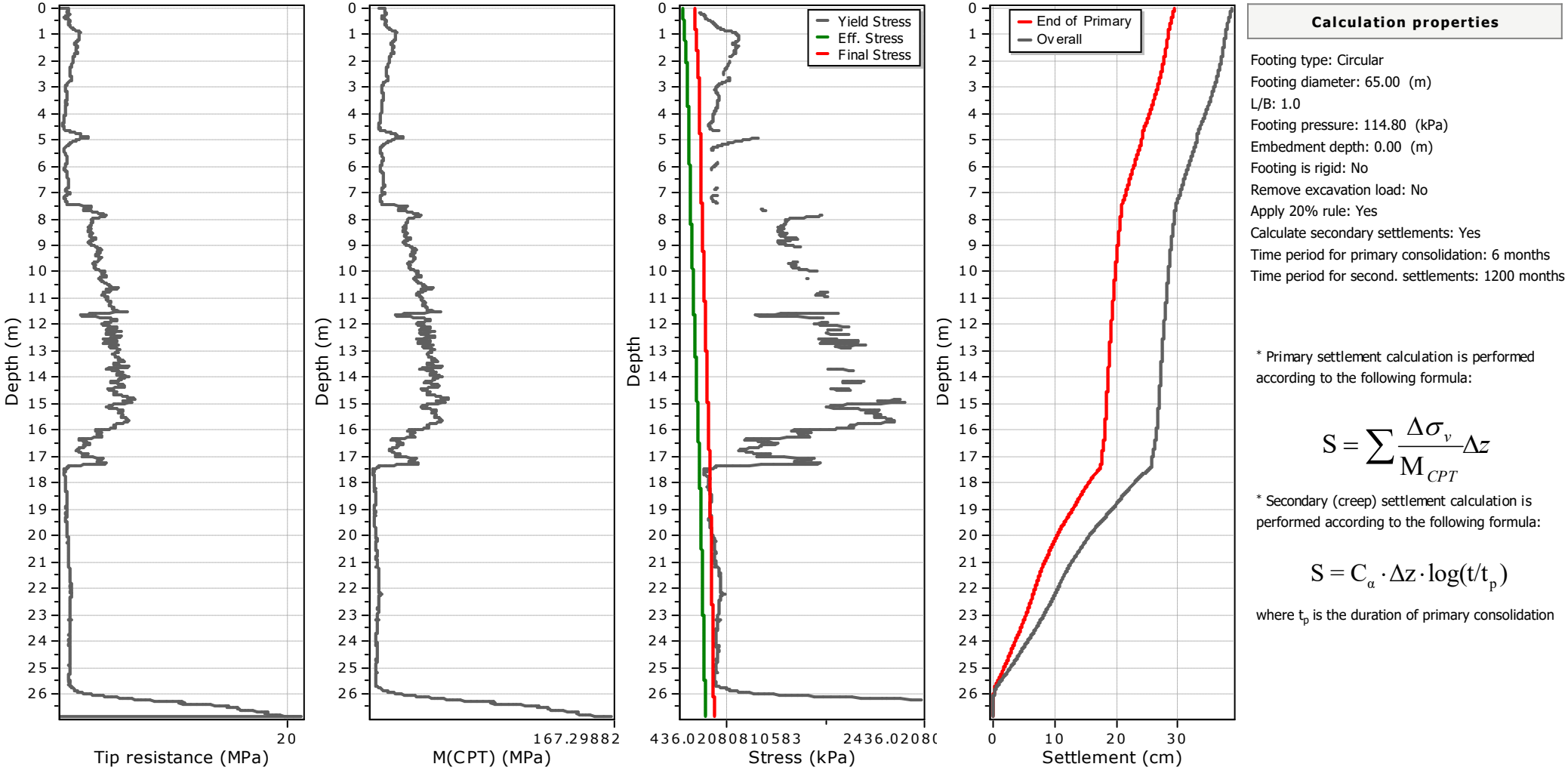
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: CPT07
Total depth: 26.86 m, Date: 11/03/2025
Surface Elevation: 0.00 m, Est. GWL: 2.40 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Circular
Footing diameter: 65.00 (m)
L/B: 1.0
Footing pressure: 114.80 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 1200 months

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

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

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

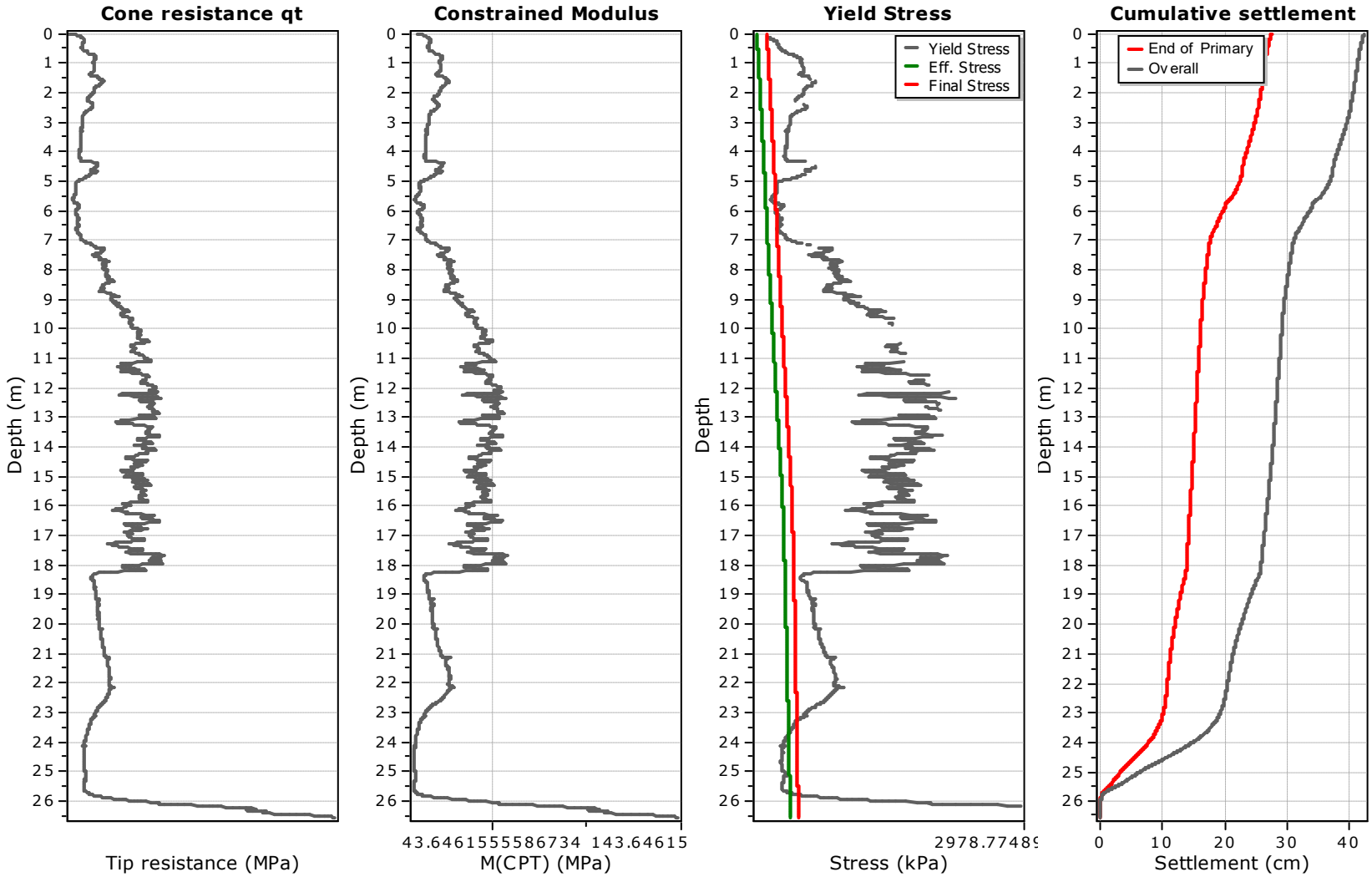
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: CPT08
Total depth: 26.56 m, Date: 11/03/2025
Surface Elevation: 0.00 m, Est. GWL: 15.80 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 65.00 (m)
L/B: 1.0
Footing pressure: 111.60 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 1200 months

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

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

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

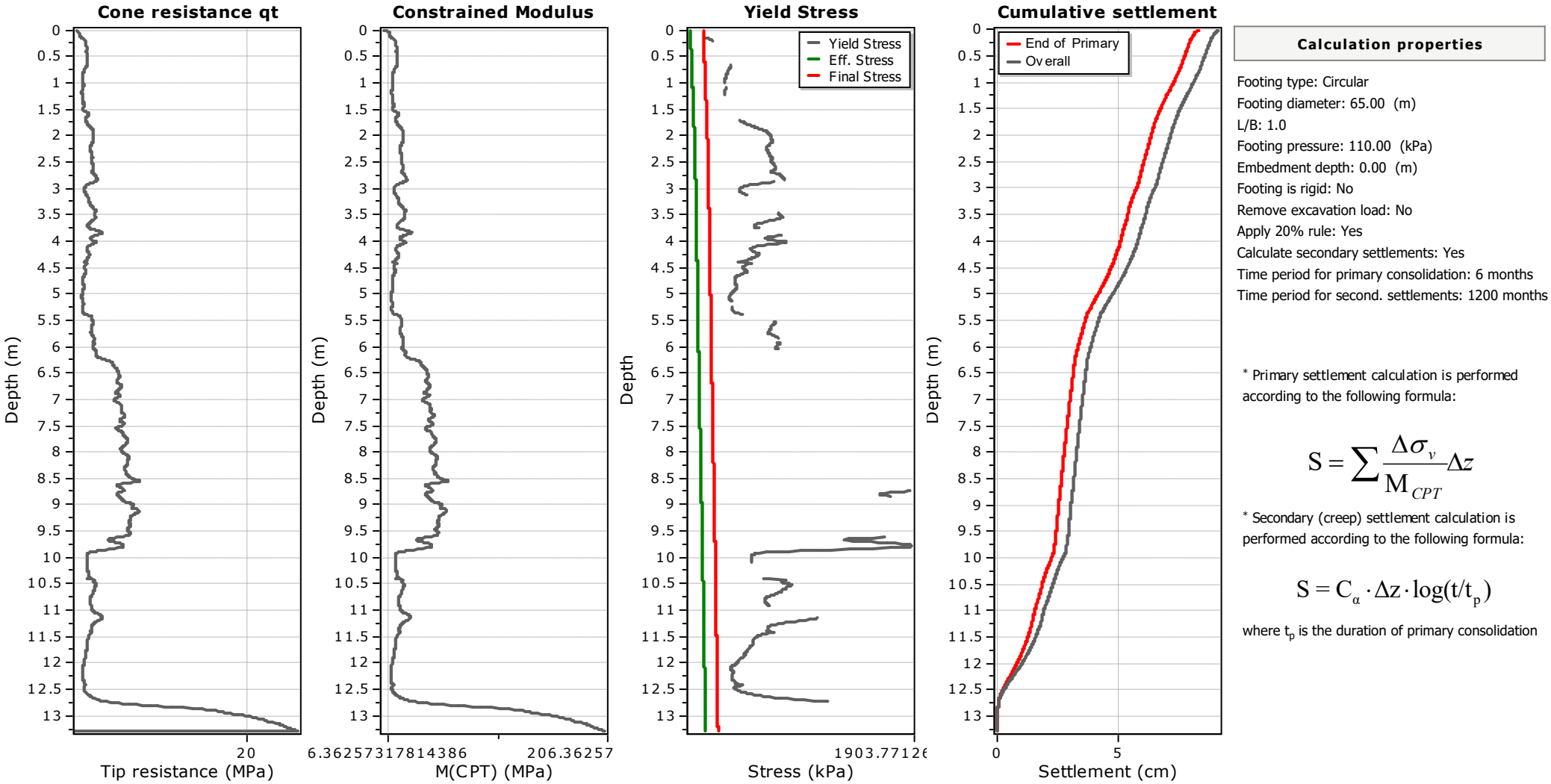
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: sCPT02
Total depth: 13.29 m, Date: 11/03/2025
Surface Elevation: 0.00 m, Est. GWL: 2.20 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Circular
Footing diameter: 65.00 (m)
L/B: 1.0
Footing pressure: 110.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 1200 months

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

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

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

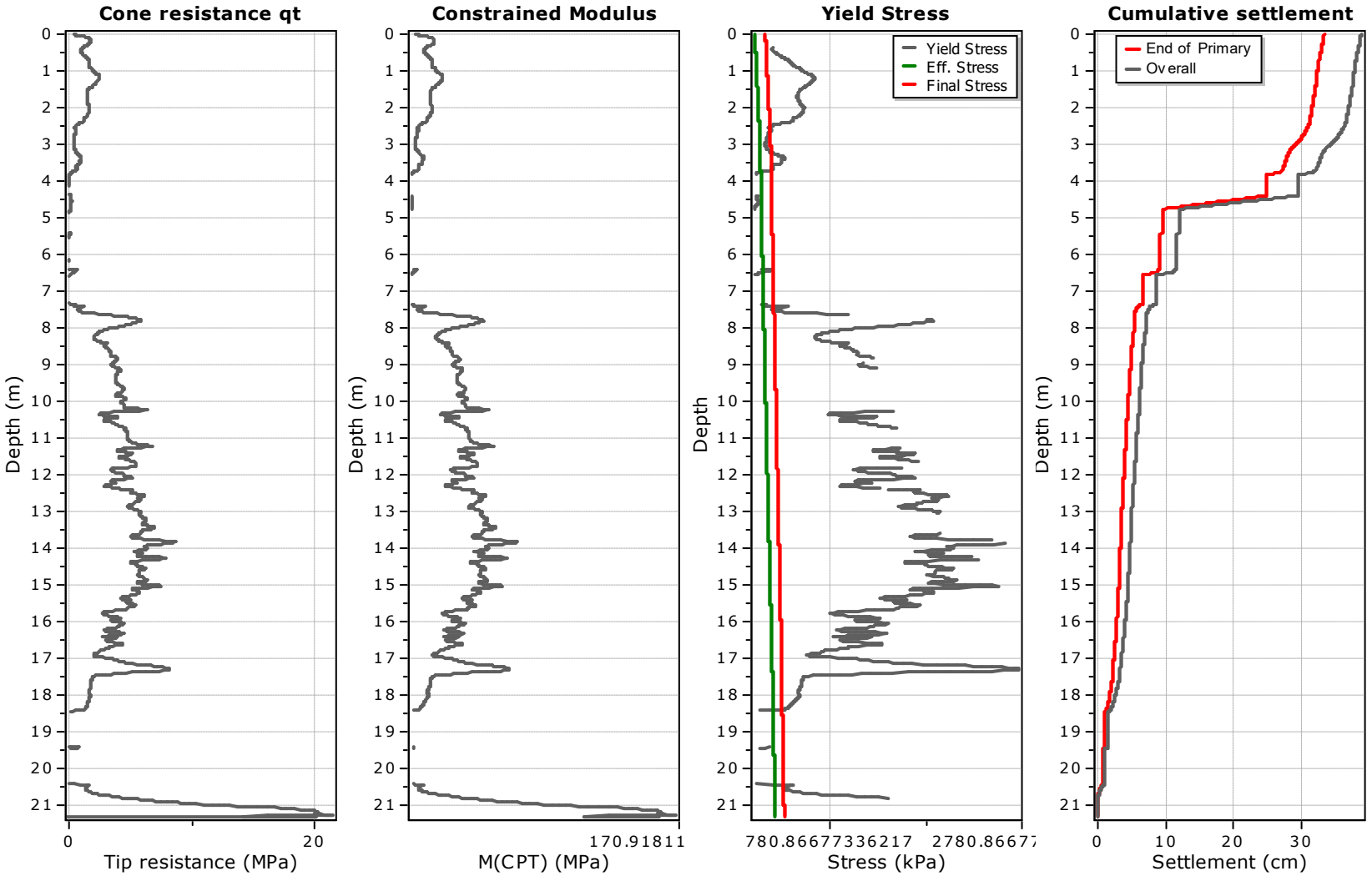
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: sCPT03
Total depth: 21.30 m, Date: 11/03/2025
Surface Elevation: 0.00 m, Est. GWL: 3.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Circular
Footing diameter: 65.00 (m)
L/B: 1.0
Footing pressure: 110.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 1200 months

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

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

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

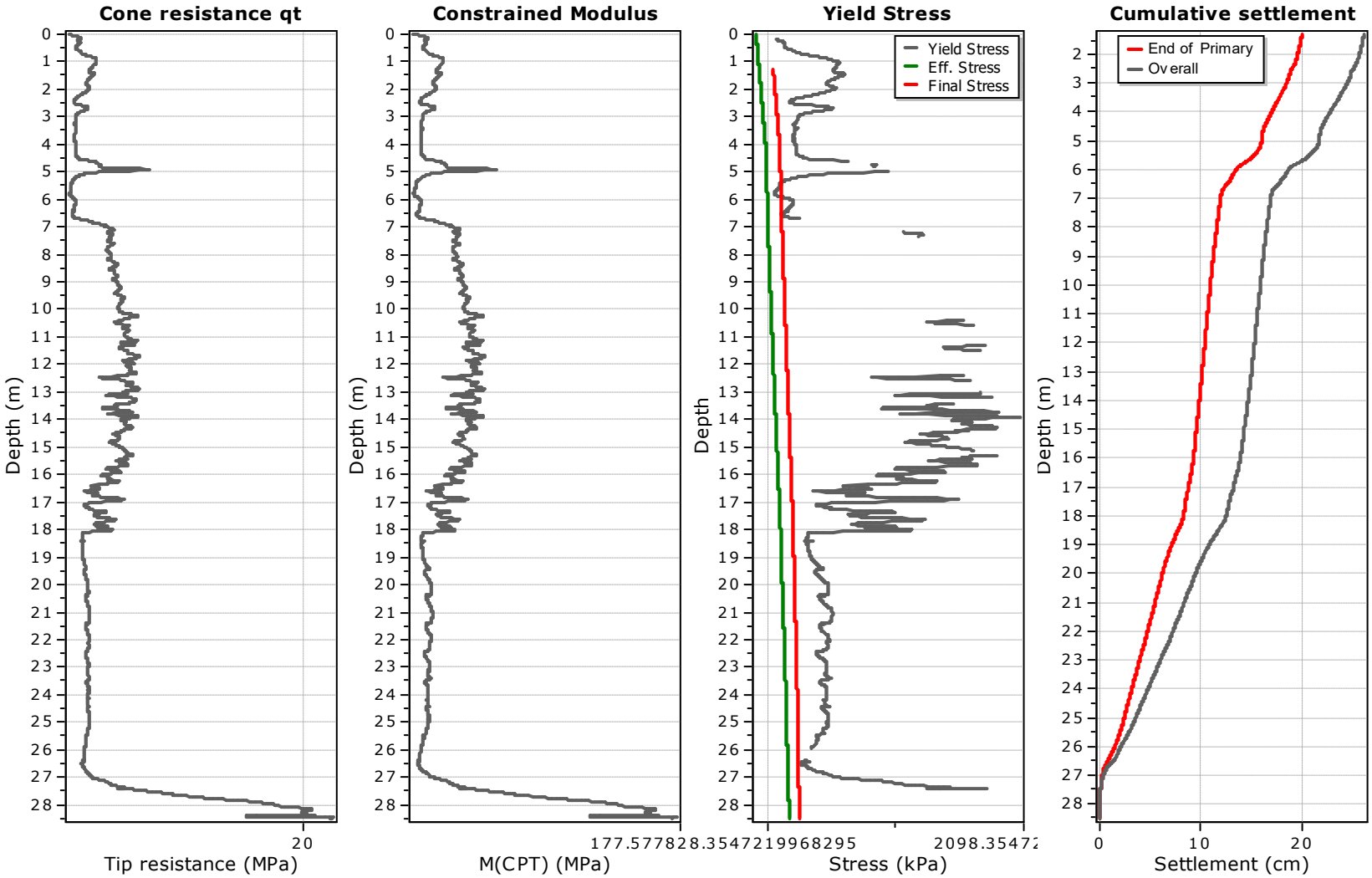
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: sCPT04
Total depth: 28.50 m, Date: 11/03/2025
Surface Elevation: 0.00 m, Est. GWL: 4.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Circular
Footing diameter: 65.00 (m)
L/B: 1.0
Footing pressure: 110.00 (kPa)
Embedment depth: 1.30 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 1200 months

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

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

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

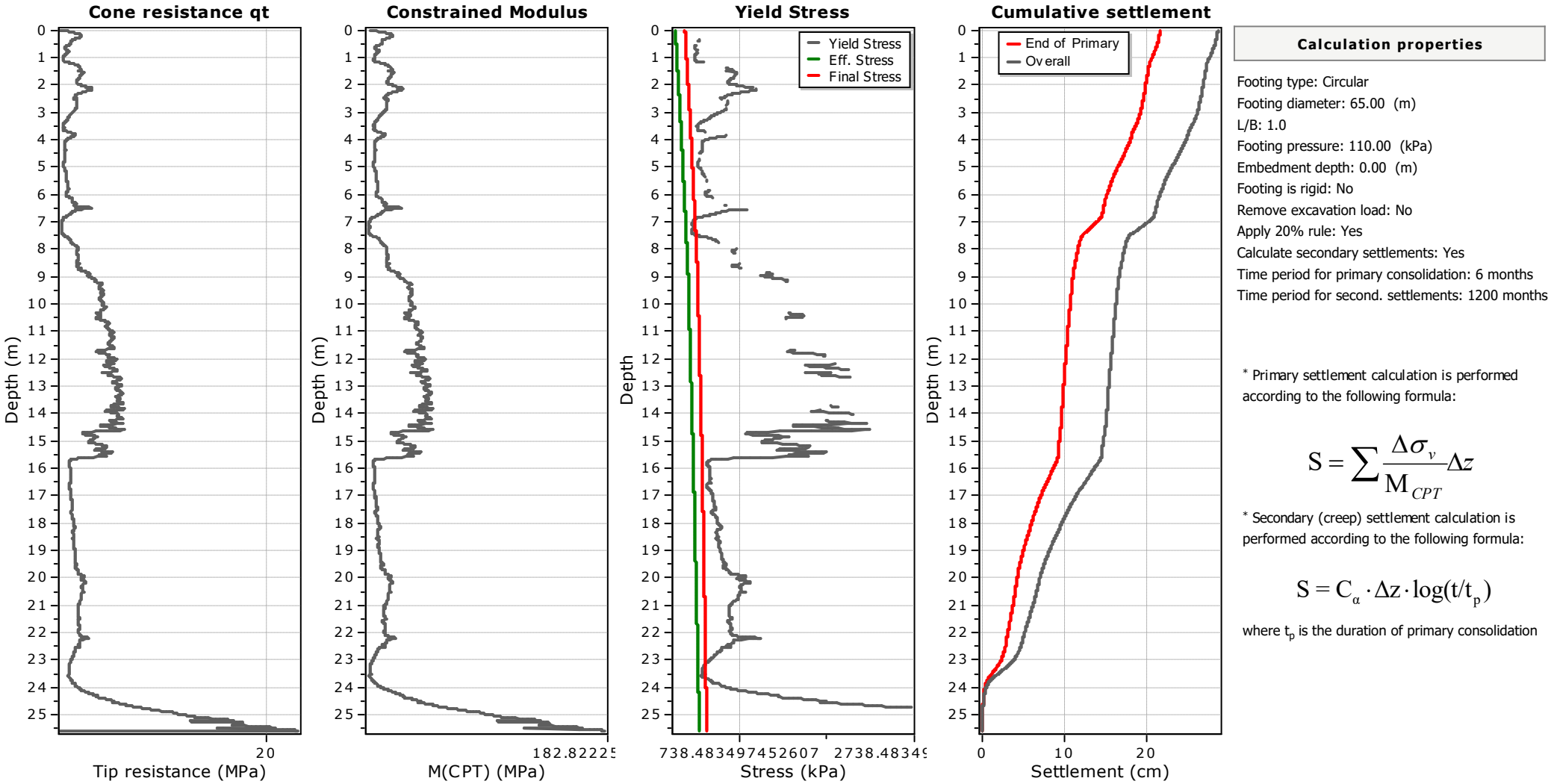
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Project: HCC IAF Reservoir Optioneering
Location: Ruakiwi Rd, Hamilton Lake

CPT: sCPT06
Total depth: 25.61 m, Date: 11/03/2025
Surface Elevation: 0.00 m, Est. GWL: 8.70 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Circular
Footing diameter: 65.00 (m)
L/B: 1.0
Footing pressure: 110.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 1200 months

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

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

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

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

rocscience



IAF Reservoir

CMW

Report Creation Date: 2025/06/12, 22:10:09

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Settle3 Analysis Information

IAF Reservoir

Project Settings

Document Name	Reservoir-section view-OCR3
Project Title	IAF Reservoir
Analysis	Staged construction / settlement calculations
Author	HNB
Company	CMW
Date Created	21/03/2025, 10:52:38 am
Last saved with Settle3 version	5.024
Stress Computation Method	Boussinesq
Stress Units	Metric, stress as kPa
Settlement Units	millimeters
Time-dependent Consolidation Analysis	
Time Units	months
Permeability Units	meters/year

Advanced Settings

Start of secondary consolidation (% of primary)	1
Min. stress for secondary consolidation (% of initial)	1
Reset time when load changes for secondary consolidation	Yes
Minimum settlement ratio for subgrade modulus	0.9
Use average poisson's ratio to calculate layered stresses	
Update Cv in each time step (improves consolidation accuracy)	
Ignore negative effective stresses in settlement calculations	
Add field points to load edges	

Soil Profile

Layer Option	Extruded Section Layers

Stage Settings

Stage #	Name	Time [months]
1	Fill1	0
2	Fill2	0.2
3	Fill3	0.4
4	Reservoir + valve base construction	1
5	Reservoir + valve walls	2
6	In service	3
7	100 years	1200

Results

Time taken to compute: 5.7852 seconds

Stage: Fill1 = 0 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	-4.80214	70.776
Total Consolidation Settlement [mm]	-4.80214	70.776
Virgin Consolidation Settlement [mm]	0	59.6592
Recompression Consolidation Settlement [mm]	-4.80214	12.5098
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	0
Loading Stress ZZ [kPa]	-45.6558	152.369
Loading Stress XX [kPa]	-26.14	136.595
Loading Stress YY [kPa]	-42.4584	127.389
Effective Stress ZZ [kPa]	-0.68448	400.529
Effective Stress XX [kPa]	-3.9389	402.055
Effective Stress YY [kPa]	-1.56563	402.327
Total Stress ZZ [kPa]	-0.68448	561.623
Total Stress XX [kPa]	-3.9389	562.291
Total Stress YY [kPa]	-1.56563	564.812
Modulus of Subgrade Reaction (Total) [kPa/m]	-16801.4	680837
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	-16801.4	680837
Total Strain	-0.00587571	0.232085
Pore Water Pressure [kPa]	0	175.924
Excess Pore Water Pressure [kPa]	0	33.6556
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	29.8721
Void Ratio	0	2.04469
Permeability [m/y]	0	1147.63
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	-0.0107171	6.39494

Stage: Fill2 = 0.2 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	-4.69611	82.2355
Total Consolidation Settlement [mm]	-4.69611	82.2355
Virgin Consolidation Settlement [mm]	0	69.5509
Recompression Consolidation Settlement [mm]	-4.69611	14.1929
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	0
Loading Stress ZZ [kPa]	-45.6558	167.663
Loading Stress XX [kPa]	-26.14	135.103
Loading Stress YY [kPa]	-42.4584	139.014
Effective Stress ZZ [kPa]	0	400.523
Effective Stress XX [kPa]	-5.50362	402.698
Effective Stress YY [kPa]	-2.44408	403.117
Total Stress ZZ [kPa]	0	564.89
Total Stress XX [kPa]	-5.50362	567.598
Total Stress YY [kPa]	-2.44408	569.844
Modulus of Subgrade Reaction (Total) [kPa/m]	-2652.29	3.785e+06
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	-2652.29	3.785e+06
Total Strain	-0.00587571	0.251617
Pore Water Pressure [kPa]	0	188.9
Excess Pore Water Pressure [kPa]	0	41.3655
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	29.8721
Void Ratio	0	2.04469
Permeability [m/y]	0	1147.63
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	-0.00664434	6.67216

Stage: Fill3 = 0.4 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	-0.543676	86.2727
Total Consolidation Settlement [mm]	-4.64325	86.2727
Virgin Consolidation Settlement [mm]	0	72.8567
Recompression Consolidation Settlement [mm]	-4.64325	14.8986
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	44.7978
Loading Stress ZZ [kPa]	-45.6558	176.654
Loading Stress XX [kPa]	-26.14	134.27
Loading Stress YY [kPa]	-42.4584	144.439
Effective Stress ZZ [kPa]	0	400.547
Effective Stress XX [kPa]	-6.04359	402.892
Effective Stress YY [kPa]	-2.71263	403.466
Total Stress ZZ [kPa]	0	565.603
Total Stress XX [kPa]	-6.04359	568.878
Total Stress YY [kPa]	-2.71263	571.086
Modulus of Subgrade Reaction (Total) [kPa/m]	0	196575
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	-2681.74	487681
Total Strain	-0.00587571	0.258293
Pore Water Pressure [kPa]	0	194.111
Excess Pore Water Pressure [kPa]	0	46.5233
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	29.8721
Void Ratio	0	2.04469
Permeability [m/y]	0	1147.63
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	-0.0113817	6.88199

Stage: Reservoir + valve base construction = 1 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	-0.0153358	147.001
Total Consolidation Settlement [mm]	-4.55563	86.5641
Virgin Consolidation Settlement [mm]	0	72.8567
Recompression Consolidation Settlement [mm]	-4.55563	15.2229
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	101.939
Loading Stress ZZ [kPa]	-45.6558	176.654
Loading Stress XX [kPa]	-26.14	134.27
Loading Stress YY [kPa]	-42.4584	144.439
Effective Stress ZZ [kPa]	0	400.629
Effective Stress XX [kPa]	-6.04359	402.956
Effective Stress YY [kPa]	-2.71263	403.615
Total Stress ZZ [kPa]	0	565.603
Total Stress XX [kPa]	-6.04359	568.878
Total Stress YY [kPa]	-2.71263	571.086
Modulus of Subgrade Reaction (Total) [kPa/m]	0	92611
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	-2735.49	218650
Total Strain	-0.00587571	0.258293
Pore Water Pressure [kPa]	0	194.861
Excess Pore Water Pressure [kPa]	0	44.6361
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	29.8721
Void Ratio	0	2.04469
Permeability [m/y]	0	1147.63
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	-0.0113817	6.88199

Stage: Reservoir + valve walls = 2 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	-0.0237724	169.228
Total Consolidation Settlement [mm]	-4.46136	86.8391
Virgin Consolidation Settlement [mm]	0	72.8567
Recompression Consolidation Settlement [mm]	-4.46136	15.5336
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	127.032
Loading Stress ZZ [kPa]	-45.6558	176.654
Loading Stress XX [kPa]	-26.14	134.27
Loading Stress YY [kPa]	-42.4584	144.439
Effective Stress ZZ [kPa]	0	400.716
Effective Stress XX [kPa]	-6.04359	403.024
Effective Stress YY [kPa]	-2.71263	403.779
Total Stress ZZ [kPa]	0	565.603
Total Stress XX [kPa]	-6.04359	568.878
Total Stress YY [kPa]	-2.71263	571.086
Modulus of Subgrade Reaction (Total) [kPa/m]	0	62072.2
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	-2798.94	199572
Total Strain	-0.00587571	0.258293
Pore Water Pressure [kPa]	0	195.321
Excess Pore Water Pressure [kPa]	0	43.2682
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	29.8721
Void Ratio	0	2.04469
Permeability [m/y]	0	1147.63
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	-0.0113817	6.88199

Stage: In service = 3 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	-0.0248687	221.807
Total Consolidation Settlement [mm]	-0.0248687	120.873
Virgin Consolidation Settlement [mm]	0	101.566
Recompression Consolidation Settlement [mm]	-0.0248687	19.4729
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	142.103
Loading Stress ZZ [kPa]	-45.6558	204.692
Loading Stress XX [kPa]	-54.5719	151.213
Loading Stress YY [kPa]	-73.6717	161.951
Effective Stress ZZ [kPa]	0	400.788
Effective Stress XX [kPa]	-28.2611	408.754
Effective Stress YY [kPa]	-26.9522	409.799
Total Stress ZZ [kPa]	0	613.783
Total Stress XX [kPa]	-28.2611	622.335
Total Stress YY [kPa]	-26.9522	627.587
Modulus of Subgrade Reaction (Total) [kPa/m]	0	18985.2
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	0	36297.4
Total Strain	-0.00224069	0.280332
Pore Water Pressure [kPa]	0	257.454
Excess Pore Water Pressure [kPa]	0	111.867
Degree of Consolidation [%]	0	96.8731
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	7.82978
Void Ratio	0	2.03595
Permeability [m/y]	0	1147.63
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	-8.88178e-16	9.48546

Stage: 100 years = 1200 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	0	433.771
Total Consolidation Settlement [mm]	0	127.833
Virgin Consolidation Settlement [mm]	0	101.566
Recompression Consolidation Settlement [mm]	0	27.5835
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	433.295
Loading Stress ZZ [kPa]	-45.6558	204.692
Loading Stress XX [kPa]	-54.5719	151.213
Loading Stress YY [kPa]	-73.6717	161.951
Effective Stress ZZ [kPa]	0	461.728
Effective Stress XX [kPa]	-28.2611	470.28
Effective Stress YY [kPa]	-26.9522	475.532
Total Stress ZZ [kPa]	0	613.783
Total Stress XX [kPa]	-28.2611	622.335
Total Stress YY [kPa]	-26.9522	627.587
Modulus of Subgrade Reaction (Total) [kPa/m]	0	10737.4
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	0	19215.4
Total Strain	-0.00224069	0.280332
Pore Water Pressure [kPa]	0	152.055
Excess Pore Water Pressure [kPa]	-1.82604e-13	3.09269e-12
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	7.82978
Void Ratio	0	2.03595
Permeability [m/y]	0	1147.63
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	-8.88178e-16	9.48546

Loads

1. Circular Load: "Circular Load 3"

Radius	29.5 m
Center	(-4.25751e-14, -1.2845e-14)
Load Type	Flexible
Area of Load	2720.11 m2
Load	10 kPa

Advanced Staging

Stage	Load Factor	Bottom Elevation [m]
Fill1 = 0 mon	1	60.5
Fill2 = 0.2 mon	1	60.5
Fill3 = 0.4 mon	1	60.5
Reservoir + valve base construction = 1 mon	1	60.5
Reservoir + valve walls = 2 mon	1	60.5
In service = 3 mon	11	60.5
100 years = 1200 mon	11	60.5

2. Polygonal Load: "Polygonal Load 5"

Label	Polygonal Load 5
Load Type	Flexible
Area of Load	283.355 m2
Load	130 kPa

Advanced Staging

Stage	Load Factor	Bottom Elevation [m]
Fill1 = 0 mon	1	58.4
Fill2 = 0.2 mon	1	58.4
Fill3 = 0.4 mon	1	58.4
Reservoir + valve base construction = 1 mon	1	58.4
Reservoir + valve walls = 2 mon	1	58.4
In service = 3 mon	1	58.4
100 years = 1200 mon	1	58.4

Coordinates

X [m]	Y [m]
-29.5	3.39728e-14
-29.0518	5.12262
-27.7209	10.0896
-25.5477	14.75
-22.5983	18.9622
-18.9622	22.5983
-14.75	25.5477
-10.0896	27.7209
-5.12262	29.0518

-1.42109e-14	29.5
5.12262	29.0518
10.0896	27.7209
14.75	25.5477
18.9622	22.5983
22.5983	18.9622
25.5477	14.75
27.7209	10.0896
29.0518	5.12262
29.5	2.32037e-14
29.0518	-5.12262
27.7209	-10.0896
25.5477	-14.75
22.5983	-18.9622
18.9622	-22.5983
14.75	-25.5477
10.0896	-27.7209
5.12262	-29.0518
-2.13163e-14	-29.5
-5.12262	-29.0518
-10.0896	-27.7209
-14.75	-25.5477
-18.9622	-22.5983
-22.5983	-18.9622
-25.5477	-14.75
-27.7209	-10.0896
-29.0413	-5.16185
-30.529	-5.38309
-29.1305	-10.6026
-26.8468	-15.5
-23.7474	-19.9264
-19.9264	-23.7474
-15.5	-26.8468
-10.6026	-29.1305
-5.38309	-30.529
-1.6791	-30.8531
1.6791	-30.8531
5.38309	-30.529
10.6026	-29.1305
15.5	-26.8468
19.9264	-23.7474
23.7474	-19.9264
26.8468	-15.5
29.1305	-10.6026
30.529	-5.38309
31	2.28012e-14
30.529	5.38309
29.1305	10.6026
26.8468	15.5
23.7474	19.9264
19.9264	23.7474
15.5	26.8468
10.6026	29.1305

5.38309	30.529
-1.55431e-14	31
-5.38309	30.529
-10.6026	29.1305
-15.5	26.8468
-19.9264	23.7474
-23.7474	19.9264
-26.8468	15.5
-29.1305	10.6026
-30.529	5.38309
-31	3.41949e-14
-30.5316	-5.35369
-29.0518	-5.12262

3. Rectangular Load: "Rectangular Load 7"

Length	25 m
Width	13.5 m
Rotation angle	25 degrees
Load Type	Flexible
Area of Load	337.5 m2
Load	20 kPa
Elevation	58.35 m
Installation Stage	Fill1 = 0 mon

Coordinates

X [m]	Y [m]
-20.0817	30.5042
2.57602	41.0697
-3.12933	53.3048
-25.787	42.7393

4. Polygonal Load: "Polygonal Load 8"

Label	Polygonal Load 8
Load Type	Flexible
Area of Load	72.8409 m2
Load	10 kPa

Advanced Staging

Stage	Load Factor	Bottom Elevation [m]
Fill1 = 0 mon	1	58.35
Fill2 = 0.2 mon	1	58.35
Fill3 = 0.4 mon	1	58.35
Reservoir + valve base construction = 1 mon	1	58.35
Reservoir + valve walls = 2 mon	1	58.35
In service = 3 mon	8	58.35
100 years = 1200 mon	8	58.35

Coordinates

X [m]	Y [m]
-14.5061	47.9997
-14.0286	47.119
-3.61302	51.9759
1.24709	41.5533
-19.598	31.8331
-24.4581	42.2557
-14.1734	47.0515
-14.6497	47.9328
-25.787	42.7393
-20.0817	30.5042
2.57602	41.0697
-3.12933	53.3048
-14.6497	47.9328

5. Fill Load: "Fill Load 6"

Label	Fill Load 6
Load Type	Flexible
Area of Load	4392.93 m2
Load	18 kPa
Elevation	59.4847 m
Installation Stage	Fill1 = 0 mon

Coordinates

X [m]	Y [m]
-40.2385	-2.17424
-41.9303	-8.48819
-42.5	-15
-41.9303	-21.5118
-40.2385	-27.8258
-37.476	-33.75
-33.7267	-39.1045
-29.1045	-43.7267
-23.75	-47.476
-17.8258	-50.2385
-11.5118	-51.9303
-5	-52.5
1.51181	-51.9303
10	-50
15.3997	-46.3208
21.2528	-41.5784
26.4419	-35.2268
30.2385	-27.8258
31.9303	-21.5118
32.5	-15
31.9303	-8.48819
30.2385	-2.17424
27.476	3.75
23.7267	9.10454
19.1045	13.7267
13.75	17.476
7.82576	20.2385
1.51181	21.9303
-5	22.5
-11.5118	21.9303
-17.8258	20.2385
-26.8468	15.5
-33.7267	9.10454
-37.476	3.75

6. Fill Load: "Fill Load 2"

Label	Fill Load 2
Load Type	Flexible
Area of Load	2902.61 m2
Load	18 kPa
Elevation	59.489 m
Installation Stage	Fill2 = 0.2 mon

Coordinates

X [m]	Y [m]
-31.4138	0.25
-33.6606	-4.56839
-35.0366	-9.70373
-35.5	-15
-35	-20
-33.6606	-25.4316
-31.4138	-30.25
-28.3644	-34.605
-24.605	-38.3644
-20.25	-41.4138
-15.4316	-43.6606
-10	-45
0	-45
5.43161	-43.6606
10.25	-41.4138
14.95	-38.0194
18.3644	-34.605
21.4138	-30.25
23.6606	-25.4316
25	-20
25.5	-15
25.0366	-9.70373
23.6606	-4.56839
21.4138	0.25
18.3644	4.60502
14.605	8.36436
10.25	11.4138
5.43161	13.6606
0.296269	15.0366
-5	15.5
-10	15
-15.4316	13.6606
-20.25	11.4138
-24.605	8.36436
-28.3644	4.60502

7. Fill Load: "Fill Load 3"

Label	Fill Load 3
Load Type	Flexible
Area of Load	1578.96 m2
Load	9 kPa
Elevation	59.4836 m
Installation Stage	Fill3 = 0.4 mon

Coordinates

X [m]	Y [m]
-24.4856	-3.75
-26.1431	-7.30455
-27.1582	-11.0929
-27.5	-15
-27.5	-19.663
-26.1431	-22.6955
-23.1529	-28.1533
-19.4627	-32.236
-16.25	-34.4856
-12.6955	-36.1431
-8.90708	-37.1582
-5	-37.5
-1.09292	-37.1582
2.69545	-36.1431
6.882	-34.577
9.46272	-32.236
12.236	-29.4627
15	-25
16.5814	-21.0597
17.5	-15
17.1582	-11.0929
16.1431	-7.30455
15	-5
14.4856	-3.75
12.236	-0.537279
7.94795	3.29665
5	5
1.40509	6.48884
-1.09292	7.15817
-5	7.5
-8.90708	7.15817
-12.6955	6.14308
-15	5
-19.4627	2.236

Excavations

1. Excavation: "Excavation 1"

Elevation	60.5 m
Installation Stage	Fill1 = 0 mon

Coordinates

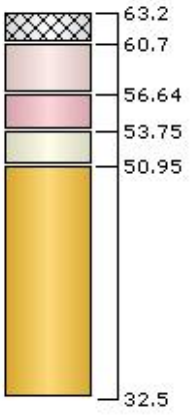
X [m]	Y [m]
-26.8468	15.5
-23.75	17.476
-17.8258	20.2385
-11.5118	21.9303
-5	22.5
1.51181	21.9303
7.82576	20.2385
13.75	17.476
19.1045	13.7267
23.7267	9.10454
27.476	3.75
30.2385	-2.17424
30.6573	-3.91655
31	2.28012e-14
30.529	5.38309
29.1305	10.6026
26.8468	15.5
23.7474	19.9264
19.9264	23.7474
15.5	26.8468
10.6026	29.1305
5.38309	30.529
-1.55431e-14	31
-5.38309	30.529
-10.6026	29.1305
-15.5	26.8468
-19.9264	23.7474
-23.7474	19.9264

Soil Layers

Ground Surface Drained: Yes

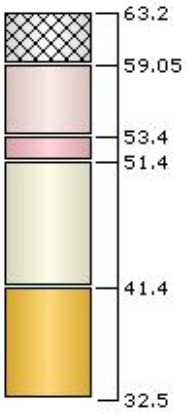
XY Location: : (-32.2919, 85.047)

Layer #	Type	Thickness [m]	Elevation [m]	Drained at Bottom
1	Stiff CLAY with sand (Hamilton ashes)	3.78026	60.699	No
2	Stiff silty CLAY with sand (Hamilton ashes)	2.94658	56.9187	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Watonsbgroup)	2.89663	53.9722	Yes
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	18.626	51.0755	No



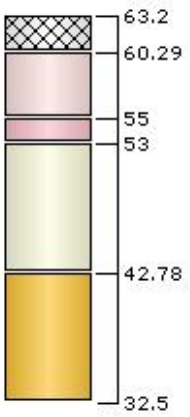
BH24-04

XY Location:		BH24-04: (-1, -19)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	5	58.4	No
2	Stiff silty CLAY with sand (Hamilton ashes)	2	53.4	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	10	51.4	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	2.8	41.4	No



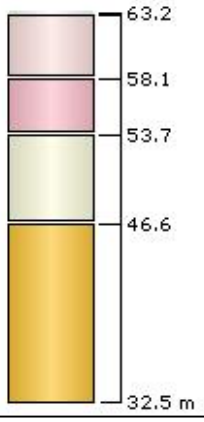
BH24-06

XY Location:		BH24-06: (-5, -4.5)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	5	60	No
2	Stiff silty CLAY with sand (Hamilton ashes)	2	55	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	10	53	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	2.8	43	No



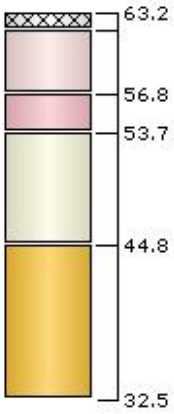
BH24-05

XY Location:		BH24-05: (-6, 31)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	5	63.1	No
2	Stiff silty CLAY with sand (Hamilton ashes)	4.4	58.1	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	7.1	53.7	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	0	46.6	No



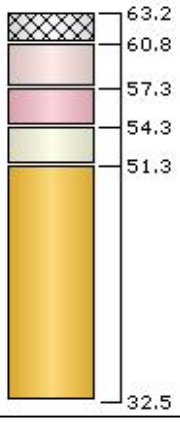
BH24-03

XY Location:		BH24-03: (16, 22)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	5	61.8	No
2	Stiff silty CLAY with sand (Hamilton ashes)	3.1	56.8	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	8.9	53.7	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	3.5	44.8	No



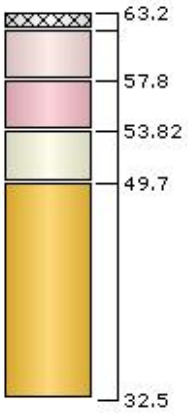
BH24-02

XY Location:		BH24-02: (-74, 53)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	3.5	60.8	No
2	Stiff silty CLAY with sand (Hamilton ashes)	3	57.3	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	3	54.3	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	3	51.3	No



BH24-01

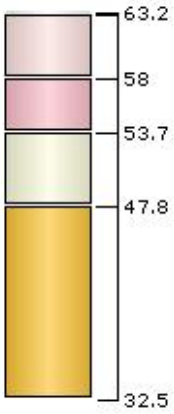
XY Location:		BH24-01: (-12, 58)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	4	61.8	No
2	Stiff silty CLAY with sand (Hamilton ashes)	1	57.8	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	7.1	56.8	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	2.5	49.7	No



CPT01

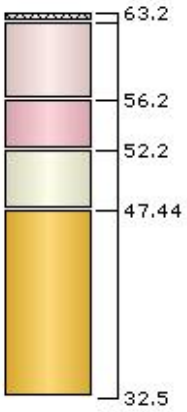
XY Location: CPT01: (9, 33)

Layer #	Type	Thickness [m]	Elevation [m]	Drained at Bottom
1	Stiff CLAY with sand (Hamilton ashes)	5	63	No
2	Stiff silty CLAY with sand (Hamilton ashes)	2.5	58	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	7.7	55.5	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	2.3	47.8	No



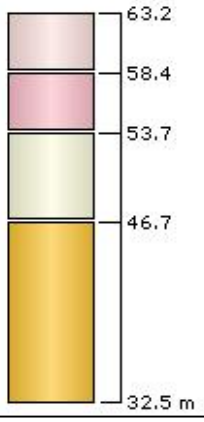
CPT02

XY Location:		CPT02: (-8, 19)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	5.5	61.7	No
2	Stiff silty CLAY with sand (Hamilton ashes)	4	56.2	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	4.5	52.2	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	6	47.7	No



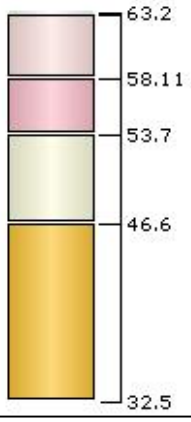
CPT03

XY Location:		CPT03: (-63, 29)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	4.8	63.2	No
2	Stiff silty CLAY with sand (Hamilton ashes)	4.7	58.4	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	7	53.7	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	5.5	46.7	No



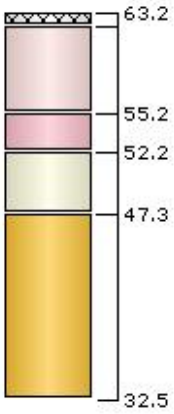
CPT05

XY Location:		CPT05: (-24, 24)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	4.5	61.3	No
2	Stiff silty CLAY with sand (Hamilton ashes)	5	56.8	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	5	51.8	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	5.6	46.8	No



CPT06

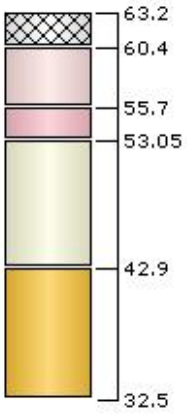
XY Location:		CPT06: (-26, 9)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	5	60.2	No
2	Stiff silty CLAY with sand (Hamilton ashes)	3	55.2	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	4.9	52.2	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	7.2	47.3	No



CPT07

XY Location: CPT07: (10, 3)

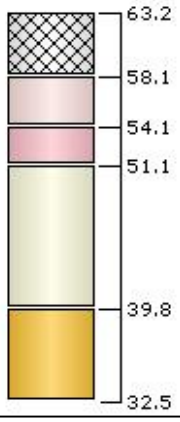
Layer #	Type	Thickness [m]	Elevation [m]	Drained at Bottom
1	Stiff CLAY with sand (Hamilton ashes)	4.7	60.4	No
2	Stiff silty CLAY with sand (Hamilton ashes)	2.6	55.7	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	10.2	53.1	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	8.5	42.9	No



CPT08

XY Location: CPT08: (17, -24)

Layer #	Type	Thickness [m]	Elevation [m]	Drained at Bottom
1	Stiff CLAY with sand (Hamilton ashes)	4	58.1	No
2	Stiff silty CLAY with sand (Hamilton ashes)	3	54.1	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	11.3	51.1	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	7.3	39.8	No



Section Definition

Section Line Plan View Coordinates

X [m]	Y [m]
-20	55
25	-55

Soil Properties

Property	Stiff CLAY with sand (Hamilton ashes)	Stiff silty CLAY with sand (Hamilton ashes)	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)
Color				
Unit Weight [kN/m3]	18	18	18	18
Saturated Unit Weight [kN/m3]	18	18	18	18
K0	1	1	1	1
Primary Consolidation	Enabled	Enabled	Disabled	Enabled
Material Type	Non-Linear	Non-Linear		Non-Linear
Cc	0.233	0.12	-	0.249
Cr	0.016	0.013	-	0.02
e0	2.03	1.67	-	2.03
OCR	3.3	3.3	-	2.7
Cv [m2/y]	25	25	-	25
Cvr [m2/y]	25	25	-	25
B-bar	1	1	-	1
Secondary Consolidation	Standard	Standard	Disabled	Standard
Ca	0.03	0.03	-	0.03
Car	0.03	0.03	-	0.03
Undrained Su A [kN/m2]	0	0	0	0
Undrained Su S	0.2	0.2	0.2	0.2
Undrained Su m	0.8	0.8	0.8	0.8
Piezo Line ID	1	1	1	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	9.81 kN/m3

Piezometric Line Entities

ID	Elevation (m)
1	48 m

Query

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
2	Query Point 2	3.006, 23.925	Auto: 61

Field Point Grid

Number of points	662
Expansion Factor	1

Grid Coordinates

X [m]	Y [m]
102.523	155.07
102.523	-125.023
-144.023	-125.023
-144.023	155.07

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IAF Reservoir

CMW

Report Creation Date: 2025/06/12, 22:12:15

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Settle3 Analysis Information

IAF Reservoir

Project Settings

Document Name	Reservoir-section view-preload-OCR3.3+mesri0
Project Title	IAF Reservoir
Analysis	Staged construction / settlement calculations
Author	HNB
Company	CMW
Date Created	21/03/2025, 10:52:38 am
Last saved with Settle3 version	5.024
Stress Computation Method	Multiple Soil Layers
Stress Units	Metric, stress as kPa
Settlement Units	millimeters
Time-dependent Consolidation Analysis	
Time Units	months
Permeability Units	meters/year

Advanced Settings

Start of secondary consolidation (% of primary)	1
Min. stress for secondary consolidation (% of initial)	1
Reset time when load changes for secondary consolidation	Yes
Minimum settlement ratio for subgrade modulus	0.9
Use average poisson's ratio to calculate layered stresses	
Update Cv in each time step (improves consolidation accuracy)	
Ignore negative effective stresses in settlement calculations	
Add field points to load edges	

Soil Profile

Layer Option	Extruded Section Layers

Stage Settings

Stage #	Name	Time [months]
1	Inital stage	0
2	preload	0.1
3	settlement monitoring	4.5
4	remove preload	5
5	Fill1	5.2
6	Fill2	5.4
7	Fill3	5.6
8	Reservoir + valve base construction	6.2
9	Reservoir + valve walls	7.2
10	In service	8.2
11	100 years	1200

Results

Time taken to compute: 0.977519 seconds

Stage: Inital stage = 0 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	0	0
Total Consolidation Settlement [mm]	0	0
Virgin Consolidation Settlement [mm]	0	0
Recompression Consolidation Settlement [mm]	0	0
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	0
Loading Stress ZZ [kPa]	0	0
Effective Stress ZZ [kPa]	0	400.529
Total Stress ZZ [kPa]	0	552.584
Modulus of Subgrade Reaction (Total) [kPa/m]	0	0
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	0	0
Total Strain	0	0
Pore Water Pressure [kPa]	0	152.055
Excess Pore Water Pressure [kPa]	0	0
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [kPa]	0.0235779	1081.11
Over-consolidation Ratio	1	3.3
Void Ratio	0	2.03
Permeability [m/y]	0	78.8073
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	100
Undrained Shear Strength	0	0

Stage: preload = 0.1 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	0	0
Total Consolidation Settlement [mm]	0	0
Virgin Consolidation Settlement [mm]	0	0
Recompression Consolidation Settlement [mm]	0	0
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	0
Loading Stress ZZ [kPa]	0	0
Effective Stress ZZ [kPa]	0	400.529
Total Stress ZZ [kPa]	0	552.584
Modulus of Subgrade Reaction (Total) [kPa/m]	0	0
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	0	0
Total Strain	0	0
Pore Water Pressure [kPa]	0	152.055
Excess Pore Water Pressure [kPa]	0	0
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [kPa]	0.0235779	1081.11
Over-consolidation Ratio	1	3.3
Void Ratio	0	2.03
Permeability [m/y]	0	78.8073
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	100
Undrained Shear Strength	0	0

Stage: settlement monitoring = 4.5 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	0	0
Total Consolidation Settlement [mm]	0	0
Virgin Consolidation Settlement [mm]	0	0
Recompression Consolidation Settlement [mm]	0	0
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	0
Loading Stress ZZ [kPa]	0	0
Effective Stress ZZ [kPa]	0	400.529
Total Stress ZZ [kPa]	0	552.584
Modulus of Subgrade Reaction (Total) [kPa/m]	0	0
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	0	0
Total Strain	0	0
Pore Water Pressure [kPa]	0	152.055
Excess Pore Water Pressure [kPa]	0	0
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [kPa]	0.0235779	1081.11
Over-consolidation Ratio	1	3.3
Void Ratio	0	2.03
Permeability [m/y]	0	78.8073
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	100
Undrained Shear Strength	0	0

Stage: remove preload = 5 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	0	0
Total Consolidation Settlement [mm]	0	0
Virgin Consolidation Settlement [mm]	0	0
Recompression Consolidation Settlement [mm]	0	0
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	0
Loading Stress ZZ [kPa]	0	0
Effective Stress ZZ [kPa]	0	400.529
Total Stress ZZ [kPa]	0	552.584
Modulus of Subgrade Reaction (Total) [kPa/m]	0	0
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	0	0
Total Strain	0	0
Pore Water Pressure [kPa]	0	152.055
Excess Pore Water Pressure [kPa]	0	0
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [kPa]	0.0235779	1081.11
Over-consolidation Ratio	1	3.3
Void Ratio	0	2.03
Permeability [m/y]	0	78.8073
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	100
Undrained Shear Strength	0	0

Stage: Fill1 = 5.2 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	-5.05226	15.6491
Total Consolidation Settlement [mm]	-5.05226	15.6491
Virgin Consolidation Settlement [mm]	0	4.09677
Recompression Consolidation Settlement [mm]	-5.05226	12.5098
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	0
Loading Stress ZZ [kPa]	-46.0988	152.369
Effective Stress ZZ [kPa]	-0.467268	400.529
Total Stress ZZ [kPa]	-0.467268	560.316
Modulus of Subgrade Reaction (Total) [kPa/m]	-167673	3.55501e+06
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	-167673	3.55501e+06
Total Strain	-0.0061141	0.0184872
Pore Water Pressure [kPa]	0	175.874
Excess Pore Water Pressure [kPa]	0	33.6532
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	33.0673
Void Ratio	0	2.04528
Permeability [m/y]	0	78.8073
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	-0.00496558	6.39509

Stage: Fill2 = 5.4 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	-4.95872	17.8682
Total Consolidation Settlement [mm]	-4.95872	17.8682
Virgin Consolidation Settlement [mm]	0	4.77603
Recompression Consolidation Settlement [mm]	-4.95872	14.1928
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	0
Loading Stress ZZ [kPa]	-46.0988	167.663
Effective Stress ZZ [kPa]	0	400.588
Total Stress ZZ [kPa]	0	563.714
Modulus of Subgrade Reaction (Total) [kPa/m]	-2650.28	2.07386e+07
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	-2650.28	2.07386e+07
Total Strain	-0.0061141	0.0198284
Pore Water Pressure [kPa]	0	188.853
Excess Pore Water Pressure [kPa]	0	41.3398
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	33.0673
Void Ratio	0	2.04528
Permeability [m/y]	0	78.8073
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	6.04354
Undrained Shear Strength	-0.00762868	6.67216

Stage: Fill3 = 5.6 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	-4.72209	19.1129
Total Consolidation Settlement [mm]	-4.91106	19.1129
Virgin Consolidation Settlement [mm]	0	5.00304
Recompression Consolidation Settlement [mm]	-4.91106	14.8984
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	1.49326
Loading Stress ZZ [kPa]	-46.0988	176.654
Effective Stress ZZ [kPa]	0	400.632
Total Stress ZZ [kPa]	0	564.454
Modulus of Subgrade Reaction (Total) [kPa/m]	-2818.81	927936
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	-2679.09	8.12669e+06
Total Strain	-0.0061141	0.0202869
Pore Water Pressure [kPa]	0	194.065
Excess Pore Water Pressure [kPa]	0	46.5893
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	33.0673
Void Ratio	0	2.04528
Permeability [m/y]	0	78.8073
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	11.5717
Undrained Shear Strength	-0.00419301	6.88199

Stage: Reservoir + valve base construction = 6.2 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	-4.22276	19.771
Total Consolidation Settlement [mm]	-4.82468	19.4438
Virgin Consolidation Settlement [mm]	0	5.00304
Recompression Consolidation Settlement [mm]	-4.82468	15.2227
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	3.39797
Loading Stress ZZ [kPa]	-46.0988	176.654
Effective Stress ZZ [kPa]	0	400.709
Total Stress ZZ [kPa]	0	565.601
Modulus of Subgrade Reaction (Total) [kPa/m]	-3270.98	235192
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	-2731.76	2.56657e+06
Total Strain	-0.0061141	0.0202869
Pore Water Pressure [kPa]	0	194.864
Excess Pore Water Pressure [kPa]	0	44.7492
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	33.0673
Void Ratio	0	2.04528
Permeability [m/y]	0	78.8073
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	27.5992
Undrained Shear Strength	-0.00536467	6.88199

Stage: Reservoir + valve walls = 7.2 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	-3.64073	20.744
Total Consolidation Settlement [mm]	-4.70654	19.7511
Virgin Consolidation Settlement [mm]	0	5.00304
Recompression Consolidation Settlement [mm]	-4.70654	15.5334
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	4.4131
Loading Stress ZZ [kPa]	-46.0988	176.654
Effective Stress ZZ [kPa]	0	400.742
Total Stress ZZ [kPa]	0	565.601
Modulus of Subgrade Reaction (Total) [kPa/m]	-4020.23	71770.6
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	-2796.29	592224
Total Strain	-0.0061141	0.0202869
Pore Water Pressure [kPa]	0	195.321
Excess Pore Water Pressure [kPa]	0	43.2675
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	33.0673
Void Ratio	0	2.04528
Permeability [m/y]	0	78.8073
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	44.3694
Undrained Shear Strength	-0.00536467	6.88199

Stage: In service = 8.2 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	-0.025167	28.7755
Total Consolidation Settlement [mm]	-0.025167	26.4221
Virgin Consolidation Settlement [mm]	0	6.97451
Recompression Consolidation Settlement [mm]	-0.025167	19.4727
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	5.04478
Loading Stress ZZ [kPa]	-46.0988	204.692
Effective Stress ZZ [kPa]	0	400.807
Total Stress ZZ [kPa]	0	613.47
Modulus of Subgrade Reaction (Total) [kPa/m]	0	24832.9
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	0	36981.4
Total Strain	-0.0022976	0.0218003
Pore Water Pressure [kPa]	0	257.321
Excess Pore Water Pressure [kPa]	0	111.777
Degree of Consolidation [%]	0	87.4408
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	7.97671
Void Ratio	0	2.03608
Permeability [m/y]	0	78.8073
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	11.4235
Undrained Shear Strength	-8.88178e-16	9.48545

Stage: 100 years = 1200 mon

Data Type	Minimum	Maximum
Total Settlement [mm]	0	35.0565
Total Consolidation Settlement [mm]	0	33.852
Virgin Consolidation Settlement [mm]	0	6.97451
Recompression Consolidation Settlement [mm]	0	27.5767
Immediate Settlement [mm]	0	0
Secondary Settlement [mm]	0	17.0506
Loading Stress ZZ [kPa]	-46.0988	204.692
Effective Stress ZZ [kPa]	0	461.415
Total Stress ZZ [kPa]	0	613.47
Modulus of Subgrade Reaction (Total) [kPa/m]	0	12071.8
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	0	13477.8
Total Strain	-0.0022976	0.0218003
Pore Water Pressure [kPa]	0	152.055
Excess Pore Water Pressure [kPa]	-1.62679e-13	3.47532e-12
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	0.0237098	1081.11
Over-consolidation Ratio	1	7.97671
Void Ratio	0	2.03608
Permeability [m/y]	0	78.8073
Coefficient of Consolidation [m^2/y]	0	25
Hydroconsolidation Settlement [mm]	0	0
Average Degree of Consolidation [%]	0	100
Undrained Shear Strength	-8.88178e-16	9.48545

Loads

1. Circular Load: "Circular Load 3"

Radius	29.5 m
Center	(-4.25751e-14, -1.2845e-14)
Load Type	Flexible
Area of Load	2720.11 m2
Load	10 kPa

Advanced Staging

Stage	Load Factor	Bottom Elevation [m]
Inital stage = 0 mon	0	0
preload = 0.1 mon	0	0
settlement monitoring = 4.5 mon	0	0
remove preload = 5 mon	0	0
Fill1 = 5.2 mon	1	60.5
Fill2 = 5.4 mon	1	60.5
Fill3 = 5.6 mon	1	60.5
Reservoir + valve base construction = 6.2 mon	1	60.5
Reservoir + valve walls = 7.2 mon	1	60.5
In service = 8.2 mon	11	60.5
100 years = 1200 mon	11	60.5

2. Polygonal Load: "Polygonal Load 5"

Label	Polygonal Load 5
Load Type	Flexible
Area of Load	283.355 m2
Load	130 kPa

Advanced Staging

Stage	Load Factor	Bottom Elevation [m]
Inital stage = 0 mon	0	0
preload = 0.1 mon	0	0
settlement monitoring = 4.5 mon	0	0
remove preload = 5 mon	0	0
Fill1 = 5.2 mon	1	58.4
Fill2 = 5.4 mon	1	58.4
Fill3 = 5.6 mon	1	58.4
Reservoir + valve base construction = 6.2 mon	1	58.4
Reservoir + valve walls = 7.2 mon	1	58.4
In service = 8.2 mon	1	58.4
100 years = 1200 mon	1	58.4

Coordinates

X [m]	Y [m]
-29.5	3.39728e-14

-29.0518	5.12262
-27.7209	10.0896
-25.5477	14.75
-22.5983	18.9622
-18.9622	22.5983
-14.75	25.5477
-10.0896	27.7209
-5.12262	29.0518
-1.42109e-14	29.5
5.12262	29.0518
10.0896	27.7209
14.75	25.5477
18.9622	22.5983
22.5983	18.9622
25.5477	14.75
27.7209	10.0896
29.0518	5.12262
29.5	2.32037e-14
29.0518	-5.12262
27.7209	-10.0896
25.5477	-14.75
22.5983	-18.9622
18.9622	-22.5983
14.75	-25.5477
10.0896	-27.7209
5.12262	-29.0518
-2.13163e-14	-29.5
-5.12262	-29.0518
-10.0896	-27.7209
-14.75	-25.5477
-18.9622	-22.5983
-22.5983	-18.9622
-25.5477	-14.75
-27.7209	-10.0896
-29.0413	-5.16185
-30.529	-5.38309
-29.1305	-10.6026
-26.8468	-15.5
-23.7474	-19.9264
-19.9264	-23.7474
-15.5	-26.8468
-10.6026	-29.1305
-5.38309	-30.529
-1.6791	-30.8531
1.6791	-30.8531
5.38309	-30.529
10.6026	-29.1305
15.5	-26.8468
19.9264	-23.7474
23.7474	-19.9264
26.8468	-15.5
29.1305	-10.6026
30.529	-5.38309

31	2.28012e-14
30.529	5.38309
29.1305	10.6026
26.8468	15.5
23.7474	19.9264
19.9264	23.7474
15.5	26.8468
10.6026	29.1305
5.38309	30.529
-1.55431e-14	31
-5.38309	30.529
-10.6026	29.1305
-15.5	26.8468
-19.9264	23.7474
-23.7474	19.9264
-26.8468	15.5
-29.1305	10.6026
-30.529	5.38309
-31	3.41949e-14
-30.5316	-5.35369
-29.0518	-5.12262

3. Rectangular Load: "Rectangular Load 7"

Length	25 m
Width	13.5 m
Rotation angle	25 degrees
Load Type	Flexible
Area of Load	337.5 m2
Load	20 kPa
Elevation	57.6 m
Installation Stage	Reservoir + valve base construction = 6.2 mon

Coordinates

X [m]	Y [m]
-20.0817	30.5042
2.57602	41.0697
-3.12933	53.3048
-25.787	42.7393

4. Polygonal Load: "Polygonal Load 8"

Label	Polygonal Load 8
Load Type	Flexible
Area of Load	72.8409 m2
Load	10 kPa
Elevation	57.6 m
Installation Stage	Reservoir + valve base construction = 6.2 mon

Coordinates

X [m]	Y [m]
-14.5061	47.9997
-14.0286	47.119
-3.61302	51.9759
1.24709	41.5533
-19.598	31.8331
-24.4581	42.2557
-14.1734	47.0515
-14.6497	47.9328
-25.787	42.7393
-20.0817	30.5042
2.57602	41.0697
-3.12933	53.3048
-14.6497	47.9328

5. Fill Load: "Fill Load 6"

Label	Fill Load 6
Load Type	Flexible
Area of Load	4392.93 m2
Load	18 kPa
Elevation	59.4847 m
Installation Stage	Fill1 = 5.2 mon

Coordinates

X [m]	Y [m]
-40.2385	-2.17424
-41.9303	-8.48819
-42.5	-15
-41.9303	-21.5118
-40.2385	-27.8258
-37.476	-33.75
-33.7267	-39.1045
-29.1045	-43.7267
-23.75	-47.476
-17.8258	-50.2385
-11.5118	-51.9303
-5	-52.5
1.51181	-51.9303
10	-50
15.3997	-46.3208
21.2528	-41.5784
26.4419	-35.2268
30.2385	-27.8258
31.9303	-21.5118
32.5	-15
31.9303	-8.48819
30.2385	-2.17424
27.476	3.75
23.7267	9.10454
19.1045	13.7267
13.75	17.476
7.82576	20.2385
1.51181	21.9303
-5	22.5
-11.5118	21.9303
-17.8258	20.2385
-26.8468	15.5
-33.7267	9.10454
-37.476	3.75

6. Fill Load: "Fill Load 2"

Label	Fill Load 2
Load Type	Flexible
Area of Load	2902.61 m2
Load	18 kPa
Elevation	59.489 m
Installation Stage	Fill2 = 5.4 mon

Coordinates

X [m]	Y [m]
-31.4138	0.25
-33.6606	-4.56839
-35.0366	-9.70373
-35.5	-15
-35	-20
-33.6606	-25.4316
-31.4138	-30.25
-28.3644	-34.605
-24.605	-38.3644
-20.25	-41.4138
-15.4316	-43.6606
-10	-45
0	-45
5.43161	-43.6606
10.25	-41.4138
14.95	-38.0194
18.3644	-34.605
21.4138	-30.25
23.6606	-25.4316
25	-20
25.5	-15
25.0366	-9.70373
23.6606	-4.56839
21.4138	0.25
18.3644	4.60502
14.605	8.36436
10.25	11.4138
5.43161	13.6606
0.296269	15.0366
-5	15.5
-10	15
-15.4316	13.6606
-20.25	11.4138
-24.605	8.36436
-28.3644	4.60502

7. Fill Load: "Fill Load 3"

Label	Fill Load 3
Load Type	Flexible
Area of Load	1578.96 m2
Load	9 kPa
Elevation	59.4836 m
Installation Stage	Fill3 = 5.6 mon

Coordinates

X [m]	Y [m]
-24.4856	-3.75
-26.1431	-7.30455
-27.1582	-11.0929
-27.5	-15
-27.5	-19.663
-26.1431	-22.6955
-23.1529	-28.1533
-19.4627	-32.236
-16.25	-34.4856
-12.6955	-36.1431
-8.90708	-37.1582
-5	-37.5
-1.09292	-37.1582
2.69545	-36.1431
6.882	-34.577
9.46272	-32.236
12.236	-29.4627
15	-25
16.5814	-21.0597
17.5	-15
17.1582	-11.0929
16.1431	-7.30455
15	-5
14.4856	-3.75
12.236	-0.537279
7.94795	3.29665
5	5
1.40509	6.48884
-1.09292	7.15817
-5	7.5
-8.90708	7.15817
-12.6955	6.14308
-15	5
-19.4627	2.236

8. Pre-Load: "Pre-Load"

Fill Unit Weight	18 kN/m3
Fill Height	6.5 m
Load Type	Flexible
Area of Load	6596.33 m2
Load	117 kPa

Advanced Staging

Stage	Load Factor	Bottom Elevation [m]
Inital stage = 0 mon	0	6.98529e-315
preload = 0.1 mon	1	6.98529e-315
settlement monitoring = 4.5 mon	1	6.98529e-315
remove preload = 5 mon	0	6.98529e-315
Fill1 = 5.2 mon	0	6.98529e-315
Fill2 = 5.4 mon	0	6.98529e-315
Fill3 = 5.6 mon	0	6.98529e-315
Reservoir + valve base construction = 6.2 mon	0	6.98529e-315
Reservoir + valve walls = 7.2 mon	0	6.98529e-315
In service = 8.2 mon	0	6.98529e-315
100 years = 1200 mon	0	6.98529e-315

Coordinates

X [m]	Y [m]
5	-65
56.101	2.155
-5	45
-60	-20
-50	-30

Excavations

1. Excavation: "Excavation 1"

Elevation	60.5 m
Installation Stage	Fill1 = 5.2 mon

Coordinates

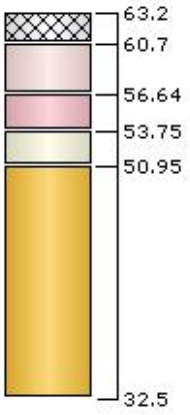
X [m]	Y [m]
-26.8468	15.5
-23.75	17.476
-17.8258	20.2385
-11.5118	21.9303
-5	22.5
1.51181	21.9303
7.82576	20.2385
13.75	17.476
19.1045	13.7267
23.7267	9.10454
27.476	3.75
30.2385	-2.17424
30.6573	-3.91655
31	2.28012e-14
30.529	5.38309
29.1305	10.6026
26.8468	15.5
23.7474	19.9264
19.9264	23.7474
15.5	26.8468
10.6026	29.1305
5.38309	30.529
-1.55431e-14	31
-5.38309	30.529
-10.6026	29.1305
-15.5	26.8468
-19.9264	23.7474
-23.7474	19.9264

Soil Layers

Ground Surface Drained: Yes

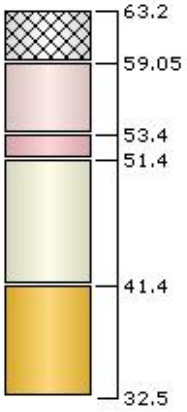
XY Location: : (-32.2919, 85.047)

Layer #	Type	Thickness [m]	Elevation [m]	Drained at Bottom
1	Stiff CLAY with sand (Hamilton ashes)	3.78026	60.699	No
2	Stiff silty CLAY with sand (Hamilton ashes)	2.94658	56.9187	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Watonsbgroup)	2.89663	53.9722	Yes
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	18.626	51.0755	No



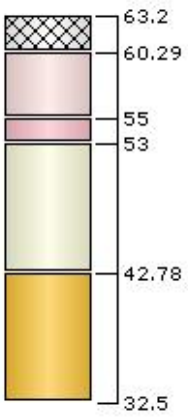
BH24-04

XY Location:		BH24-04: (-1, -19)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	5	58.4	No
2	Stiff silty CLAY with sand (Hamilton ashes)	2	53.4	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	10	51.4	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	2.8	41.4	No



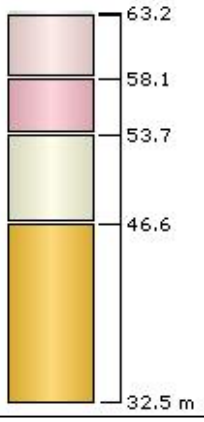
BH24-06

XY Location:		BH24-06: (-5, -4.5)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	5	60	No
2	Stiff silty CLAY with sand (Hamilton ashes)	2	55	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	10	53	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	2.8	43	No



BH24-05

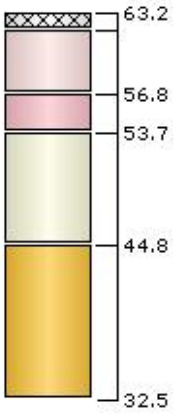
XY Location:		BH24-05: (-6, 31)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	5	63.1	No
2	Stiff silty CLAY with sand (Hamilton ashes)	4.4	58.1	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	7.1	53.7	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	0	46.6	No



BH24-03

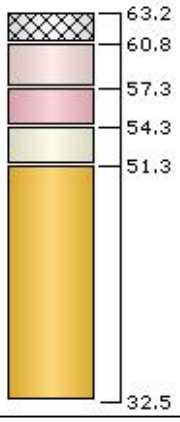
XY Location: BH24-03: (16, 22)

Layer #	Type	Thickness [m]	Elevation [m]	Drained at Bottom
1	Stiff CLAY with sand (Hamilton ashes)	5	61.8	No
2	Stiff silty CLAY with sand (Hamilton ashes)	3.1	56.8	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	8.9	53.7	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	3.5	44.8	No



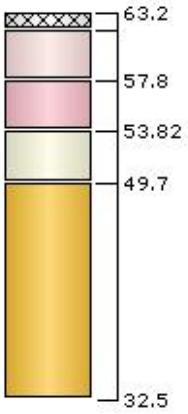
BH24-02

XY Location:		BH24-02: (-74, 53)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	3.5	60.8	No
2	Stiff silty CLAY with sand (Hamilton ashes)	3	57.3	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	3	54.3	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	3	51.3	No



BH24-01

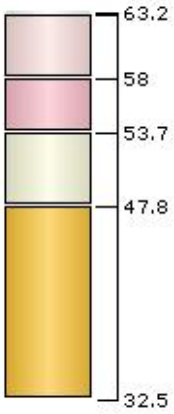
XY Location:		BH24-01: (-12, 58)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	4	61.8	No
2	Stiff silty CLAY with sand (Hamilton ashes)	1	57.8	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	7.1	56.8	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	2.5	49.7	No



CPT01

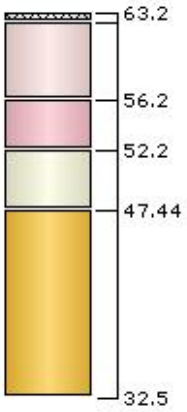
XY Location: CPT01: (9, 33)

Layer #	Type	Thickness [m]	Elevation [m]	Drained at Bottom
1	Stiff CLAY with sand (Hamilton ashes)	5	63	No
2	Stiff silty CLAY with sand (Hamilton ashes)	2.5	58	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	7.7	55.5	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	2.3	47.8	No



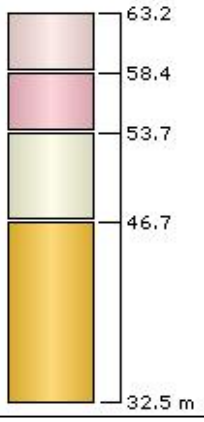
CPT02

XY Location:		CPT02: (-8, 19)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	5.5	61.7	No
2	Stiff silty CLAY with sand (Hamilton ashes)	4	56.2	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	4.5	52.2	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	6	47.7	No



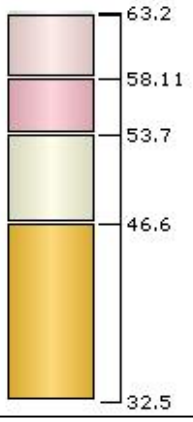
CPT03

XY Location:		CPT03: (-63, 29)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	4.8	63.2	No
2	Stiff silty CLAY with sand (Hamilton ashes)	4.7	58.4	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	7	53.7	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	5.5	46.7	No



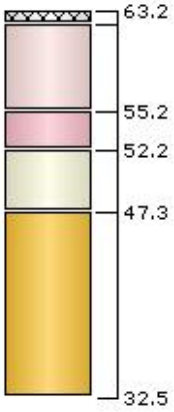
CPT05

XY Location:		CPT05: (-24, 24)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	4.5	61.3	No
2	Stiff silty CLAY with sand (Hamilton ashes)	5	56.8	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	5	51.8	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	5.6	46.8	No



CPT06

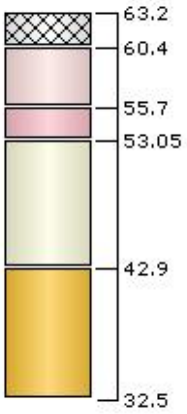
XY Location:		CPT06: (-26, 9)		
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**	**Drained at Bottom**
1	Stiff CLAY with sand (Hamilton ashes)	5	60.2	No
2	Stiff silty CLAY with sand (Hamilton ashes)	3	55.2	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	4.9	52.2	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	7.2	47.3	No



CPT07

XY Location: CPT07: (10, 3)

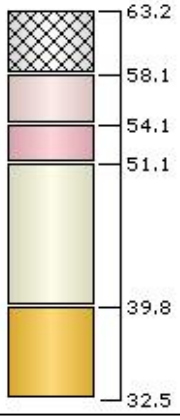
Layer #	Type	Thickness [m]	Elevation [m]	Drained at Bottom
1	Stiff CLAY with sand (Hamilton ashes)	4.7	60.4	No
2	Stiff silty CLAY with sand (Hamilton ashes)	2.6	55.7	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	10.2	53.1	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	8.5	42.9	No



CPT08

XY Location: CPT08: (17, -24)

Layer #	Type	Thickness [m]	Elevation [m]	Drained at Bottom
1	Stiff CLAY with sand (Hamilton ashes)	4	58.1	No
2	Stiff silty CLAY with sand (Hamilton ashes)	3	54.1	No
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	11.3	51.1	No
4	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)	7.3	39.8	No



Section Definition

Section Line Plan View Coordinates

X [m]	Y [m]
-20	55
25	-55

Soil Properties

Property	Stiff CLAY with sand (Hamilton ashes)	Stiff silty CLAY with sand (Hamilton ashes)	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	Stiff to VSt Weathered non welded ignimbrite (Walton Subgroup)
Color				
Unit Weight [kN/m3]	18	18	18	18
Saturated Unit Weight [kN/m3]	18	18	18	18
K0	1	1	1	1
Primary Consolidation	Enabled	Enabled	Disabled	Enabled
Material Type	Non-Linear	Non-Linear		Non-Linear
Cc	0.016	0.013	-	0.02
Cr	0.016	0.013	-	0.02
e0	2.03	1.67	-	2.03
OCR	3.3	3.3	-	2.7
Cv [m2/y]	25	25	-	25
Cvr [m2/y]	25	25	-	25
B-bar	1	1	-	1
Secondary Consolidation	Mesri	Mesri	Disabled	Mesri
Ca/Cc	0.05	0.05	-	0.05
Multiple Stress Option	User Defined E = 10000 kPa	User Defined E = 10000 kPa	E from Es = 10000 kPa	User Defined E = 10000 kPa
Undrained Su A [kN/m2]	0	0	0	0
Undrained Su S	0.2	0.2	0.2	0.2
Undrained Su m	0.8	0.8	0.8	0.8
Piezo Line ID	1	1	1	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	9.81 kN/m3

Piezometric Line Entities

ID	Elevation (m)
1	48 m

Query

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
2	Query Point 2	3.006, 23.925	Auto: 61
3	Query Point 3	-10.7798, -13.569	Auto: 75

Field Point Grid

Number of points	721
Expansion Factor	1

Grid Coordinates

X [m]	Y [m]
126.124	155.07
126.124	-135.023
-144.023	-135.023
-144.023	155.07

Time Points

Point #	(X,Y) Location	Elevation	Goal Type	Goal	Time Until Goal
1	10.0896, -27.7209	57 m	Degree of Consolidation	90%	2.26868 mon
2	10.0896, -27.7209	57 m	Degree of Consolidation	90%	3.32109 mon
3	10.0896, -27.7209	57 m	Degree of Consolidation	90%	3.3528 mon
4	10.0896, -27.7209	57 m	Degree of Consolidation	90%	2.75602 mon
5	10.0896, -27.7209	57 m	Degree of Consolidation	90%	4.40538 mon
6	10.0896, -27.7209	57 m	Degree of Consolidation	90%	-1 mon

CMW Geosciences Great People | Practical Solutions	CLIENT:	HCC	DESIGNER: HNB
	PROJECT:	IAF RESERVOIR	CHECKED: HSP
			REVISION: 0
	TITLE:	RIGID INCLUSION DESIGN (SINGLE INCLUSION)	DATE: 23/06/2025
			PROJECT: HAM2023-0099AI

Rigid Inclusion Parameters:

Rigid Inclusion diameter:	0.35	m
Rigid Inclusion length:	11	m
Adopted concrete strength:	30	MPa
Overlying GAP65 thickness:	0.7	m
GAP65 Young's Modulus	35	MPa

Reduction Factors:

Compression:	1.0
Tension:	0.8

Structural Loads:

Type	SLS Working Load (kN)	ULS Load (kN)	Factored Tensile Load (kN)
1	400	450	

Note: SLS working load is based on a uniform load of 120 kPa on the slab and a negative skin friction based on Eurocode7 equal to 225kN per RI

Ground Model Parameters:

Soil Type	Strata	Top of strata (mBGL)	Ultimate shaft friction, fs (kPa)	Ultimate base capacity, fb (kPa)	Young's Modulus, E (MPa)	Poissons Ratio, v
1	Stiff CLAY with sand (Hamilton ashes)	0.0	24	560	25	0.35
2	Stiff silty CLAY with sand (Hamilton ashes)	5.0	18	400	30	0.35
3	Silty SANDS, sandy SILTS and CLAYS (Karapiro fm/Waton sbgroup)	7.0	45	1260	70	0.3
4						
5						

Output Summary

Rigid Inclusion Diameter	0.35	m
Rigid Inclusion Length (m)	11	m
Working Load	400	kN
Ultimate Load	450	kN
Tension Load	0	kN
Compression Capacity	490	kN
Tension Capacity	295	kN
Concrete Strength	30	MPa
Elastic Shortening	1.0	mm
Base Settlement	0.5	mm
GAP65 Settlement	83	mm
Total Settlement	85	mm
Spring Stiffness	49120	kPa/m

CMW Geosciences Great People | Practical Solutions	CLIENT:	HCC	DESIGNER: HNB
	PROJECT:	IAF RESERVOIR	CHECKED: HSP
			REVISION: 0
	TITLE:	RIGID INCLUSION DESIGN (SINGLE INCLUSION)	DATE: 23/06/2025
			PROJECT: HAM2023-0099AI

Rigid Inclusion Details		
Cross Sectional Area	0.096	m^2
Circumference	1.100	m

Segment	Top Depth (m)	Bottom Depth (m)	Soil Type	f'_s	f'_b	Skin Friction [Compression] (kPa)	Skin Friction [Tension] (kPa)	End Bearing [Compression] (kPa)
1	0.00	0.10	1	24.177806	560	2.66	2.13	53.88
2	0.10	0.20	1	24.177806	560	2.66	2.13	53.88
3	0.20	0.30	1	24.177806	560	2.66	2.13	53.88
4	0.30	0.40	1	24.177806	560	2.66	2.13	53.88
5	0.40	0.50	1	24.177806	560	2.66	2.13	53.88
6	0.50	0.60	1	24.177806	560	2.66	2.13	53.88
7	0.60	0.70	1	24.177806	560	2.66	2.13	53.88
8	0.70	0.80	1	24.177806	560	2.66	2.13	53.88
9	0.80	0.90	1	24.177806	560	2.66	2.13	53.88
10	0.90	1.00	1	24.177806	560	2.66	2.13	53.88
11	1.00	1.10	1	24.177806	560	2.66	2.13	53.88
12	1.10	1.20	1	24.177806	560	2.66	2.13	53.88
13	1.20	1.30	1	24.177806	560	2.66	2.13	53.88
14	1.30	1.40	1	24.177806	560	2.66	2.13	53.88
15	1.40	1.50	1	24.177806	560	2.66	2.13	53.88
16	1.50	1.60	1	24.177806	560	2.66	2.13	53.88
17	1.60	1.70	1	24.177806	560	2.66	2.13	53.88
18	1.70	1.80	1	24.177806	560	2.66	2.13	53.88
19	1.80	1.90	1	24.177806	560	2.66	2.13	53.88
20	1.90	2.00	1	24.177806	560	2.66	2.13	53.88
21	2.00	2.10	1	24.177806	560	2.66	2.13	53.88
22	2.10	2.20	1	24.177806	560	2.66	2.13	53.88
23	2.20	2.30	1	24.177806	560	2.66	2.13	53.88
24	2.30	2.40	1	24.177806	560	2.66	2.13	53.88
25	2.40	2.50	1	24.177806	560	2.66	2.13	53.88
26	2.50	2.60	1	24.177806	560	2.66	2.13	53.88
27	2.60	2.70	1	24.177806	560	2.66	2.13	53.88
28	2.70	2.80	1	24.177806	560	2.66	2.13	53.88
29	2.80	2.90	1	24.177806	560	2.66	2.13	53.88
30	2.90	3.00	1	24.177806	560	2.66	2.13	53.88
31	3.00	3.10	1	24.177806	560	2.66	2.13	53.88
32	3.10	3.20	1	24.177806	560	2.66	2.13	53.88
33	3.20	3.30	1	24.177806	560	2.66	2.13	53.88
34	3.30	3.40	1	24.177806	560	2.66	2.13	53.88
35	3.40	3.50	1	24.177806	560	2.66	2.13	53.88
36	3.50	3.60	1	24.177806	560	2.66	2.13	53.88
37	3.60	3.70	1	24.177806	560	2.66	2.13	53.88
38	3.70	3.80	1	24.177806	560	2.66	2.13	53.88
39	3.80	3.90	1	24.177806	560	2.66	2.13	53.88
40	3.90	4.00	1	24.177806	560	2.66	2.13	53.88
41	4.00	4.10	1	24.177806	560	2.66	2.13	53.88
42	4.10	4.20	1	24.177806	560	2.66	2.13	53.88
43	4.20	4.30	1	24.177806	560	2.66	2.13	53.88
44	4.30	4.40	1	24.177806	560	2.66	2.13	53.88
45	4.40	4.50	1	24.177806	560	2.66	2.13	53.88
46	4.50	4.60	1	24.177806	560	2.66	2.13	53.88
47	4.60	4.70	1	24.177806	560	2.66	2.13	53.88
48	4.70	4.80	1	24.177806	560	2.66	2.13	53.88
49	4.80	4.90	1	24.177806	560	2.66	2.13	53.88
50	4.90	5.00	1	24.177806	560	2.66	2.13	53.88
51	5.00	5.10	2	18.458781	400	2.03	1.62	38.48
52	5.10	5.20	2	18.458781	400	2.03	1.62	38.48
53	5.20	5.30	2	18.458781	400	2.03	1.62	38.48
54	5.30	5.40	2	18.458781	400	2.03	1.62	38.48
55	5.40	5.50	2	18.458781	400	2.03	1.62	38.48
56	5.50	5.60	2	18.458781	400	2.03	1.62	38.48
57	5.60	5.70	2	18.458781	400	2.03	1.62	38.48
58	5.70	5.80	2	18.458781	400	2.03	1.62	38.48
59	5.80	5.90	2	18.458781	400	2.03	1.62	38.48
60	5.90	6.00	2	18.458781	400	2.03	1.62	38.48
61	6.00	6.10	2	18.458781	400	2.03	1.62	38.48
62	6.10	6.20	2	18.458781	400	2.03	1.62	38.48
63	6.20	6.30	2	18.458781	400	2.03	1.62	38.48
64	6.30	6.40	2	18.458781	400	2.03	1.62	38.48
65	6.40	6.50	2	18.458781	400	2.03	1.62	38.48
66	6.50	6.60	2	18.458781	400	2.03	1.62	38.48
67	6.60	6.70	2	18.458781	400	2.03	1.62	38.48
68	6.70	6.80	2	18.458781	400	2.03	1.62	38.48
69	6.80	6.90	2	18.458781	400	2.03	1.62	38.48
70	6.90	7.00	2	18.458781	400	2.03	1.62	38.48
71	7.00	7.10	3	44.916051	1260	4.94	3.95	121.23
72	7.10	7.20	3	44.916051	1260	4.94	3.95	121.23
73	7.20	7.30	3	44.916051	1260	4.94	3.95	121.23
74	7.30	7.40	3	44.916051	1260	4.94	3.95	121.23
75	7.40	7.50	3	44.916051	1260	4.94	3.95	121.23
76	7.50	7.60	3	44.916051	1260	4.94	3.95	121.23
77	7.60	7.70	3	44.916051	1260	4.94	3.95	121.23
78	7.70	7.80	3	44.916051	1260	4.94	3.95	121.23
79	7.80	7.90	3	44.916051	1260	4.94	3.95	121.23
80	7.90	8.00	3	44.916051	1260	4.94	3.95	121.23
81	8.00	8.10	3	44.916051	1260	4.94	3.95	121.23
82	8.10	8.20	3	44.916051	1260	4.94	3.95	121.23

CMW Geosciences Great People | Practical Solutions	CLIENT: HCC PROJECT: IAF RESERVOIR TITLE: RIGID INCLUSION DESIGN (SINGLE INCLUSION)	DESIGNER: HNB CHECKED: HSP REVISION: 0 DATE: 23/06/2025 PROJECT: HAM2023-0099AI

83	8.20	8.30	3	44.916051	1260	4.94	3.95	121.23
84	8.30	8.40	3	44.916051	1260	4.94	3.95	121.23
85	8.40	8.50	3	44.916051	1260	4.94	3.95	121.23
86	8.50	8.60	3	44.916051	1260	4.94	3.95	121.23
87	8.60	8.70	3	44.916051	1260	4.94	3.95	121.23
88	8.70	8.80	3	44.916051	1260	4.94	3.95	121.23
89	8.80	8.90	3	44.916051	1260	4.94	3.95	121.23
90	8.90	9.00	3	44.916051	1260	4.94	3.95	121.23
91	9.00	9.10	3	44.916051	1260	4.94	3.95	121.23
92	9.10	9.20	3	44.916051	1260	4.94	3.95	121.23
93	9.20	9.30	3	44.916051	1260	4.94	3.95	121.23
94	9.30	9.40	3	44.916051	1260	4.94	3.95	121.23
95	9.40	9.50	3	44.916051	1260	4.94	3.95	121.23
96	9.50	9.60	3	44.916051	1260	4.94	3.95	121.23
97	9.60	9.70	3	44.916051	1260	4.94	3.95	121.23
98	9.70	9.80	3	44.916051	1260	4.94	3.95	121.23
99	9.80	9.90	3	44.916051	1260	4.94	3.95	121.23
100	9.90	10.00	3	44.916051	1260	4.94	3.95	121.23
101	10.00	10.10	3	44.916051	1260	4.94	3.95	121.23
102	10.10	10.20	3	44.916051	1260	4.94	3.95	121.23
103	10.20	10.30	3	44.916051	1260	4.94	3.95	121.23
104	10.30	10.40	3	44.916051	1260	4.94	3.95	121.23
105	10.40	10.50	3	44.916051	1260	4.94	3.95	121.23
106	10.50	10.60	3	44.916051	1260	4.94	3.95	121.23
107	10.60	10.70	3	44.916051	1260	4.94	3.95	121.23
108	10.70	10.80	3	44.916051	1260	4.94	3.95	121.23
109	10.80	10.90	3	44.916051	1260	4.94	3.95	121.23
110	10.90	11.00	3	44.916051	1260	4.94	3.95	121.23

Compression		
Shaft Capacity	371.07	kN
Base Capacity	121.23	kN
Total Compression Capacity	492.29	kN

Tension		
Shaft Capacity	296.85	kN
Total Tension Capacity	296.85	kN

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Parameter	Value		
ULS Compression Load	450	kN	AS2159:2009 Clause 5.3.5
k	1		AS2159:2009 Table 5.3.2
φ_s	0.65		AS3600:2018 Table 2.2.3
A_g	0.096	m^2	
Minimum Compressive Strength Required ($f_{c\,min}$)	15.99	MPa	
Compressive Strength Adopted (f_c)	30	MPa	ADOPTED CONCRETE STRENGTH IS SUFFICIENT

5.3.5 Unreinforced piles

An unreinforced pile shall be permitted where the design action effect does not exceed $0.45\ kf'_c\phi_s A_g$.

TABLE 5.3.2

ASSESSMENT OF CONCRETE PLACEMENT FACTOR (k)

Pile construction method	Circumstances in which k = 1 is appropriate	Circumstances in which k =0.75 is appropriate
All	Successful use of specified construction methods in similar ground conditions.	No successful use of specified construction methods in similar ground conditions.
	At least 5% of piles are integrity tested over the full length of the shaft by an appropriate means.	No dynamic load-testing or integrity-testing to be performed.
CFA and cast in place displacement piling	Full, real time monitoring of auger extraction rate, concrete/grout pressure, volume, pile depth and drilling parameters to be undertaken.	Piles installed with partial monitoring. (e.g. measurement of concrete/grout pressure and volume only).
Bored piles constructed under drilling fluid	Regular on site testing of drilling fluid, embedment depth of tremie tube to be regularly monitored and recorded during concreting. Hard copies of construction records to be maintained.	No regular testing of drilling fluids or monitoring of tremie and concrete depths during concreting. Hard copies of construction records not to be maintained.
Preformed Driven	Monitoring of driving stresses during pile installation in difficult ground conditions to check that high compression and/or tension stresses will not lead to pile damage.	No monitoring of driving stresses during pile installation in difficult ground conditions.

NOTES:

1 The above table assumes that the method of pile construction adequately addresses the major construction risks on the site. If this is not the case then an alternative method of construction should be adopted

2 CFA piles constructed without either full or partial monitoring are not recommended

3 If shaft integrity testing cannot be carried out over the full length of the pile shaft the designer shall consider using a k factor of less than 1.0. Choice of the k factor shall consider the percentage of piles to be integrity tested, the length of the pile shaft over which the integrity testing can be carried out and the level of load in the pile shaft at the maximum depth of integrity testing.

TABLE 2.2.3

STRESS REDUCTION FACTORS (ϕ_s)

Material	Stress reduction factor (ϕ_s)
Concrete in compression	0.65
Steel in tension	
Class N	0.85
Class L	0.65
Tendons	0.85

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Parameter	Value		
Shaft Working Load (W_s)	371.1	kN	**Tomlinson; 6th Edition, Pile Design and Construction Practice Equation 4.38**
Base Working Load (W_b)	28.9	kN	
Shaft Cross-Sectional Area (A_s)	0.10	m2	
Base Cross-Sectional Area (A_b)	0.10	m2	
Youngs Modulus of End Bearing Soil (E_b)	70.00	MPa	
Rigid Inclusion Length (L)	11.0	m	
Concrete Stiffness (E_p)	25743	MPa	**NZS3101:2006 Clause 5.2.3 (b) - (*Assumed Concrete Density ρ=2300kg/m³*)**
Poissons Ratio of End Bearing Soil (v)	0.30		
Shape Factor (I_p)	0.50		**Tomlinson; 6th Edition, Pile Design and Construction Practice Section 4.6**
Elastic Shortening	1.0	mm	
Base Settlement	0.5	mm	
GAP65 Settlement	83.2	mm	
Total Settlement	84.6	mm	
Spring Stiffness	49120	kPa/m	

$$\rho = \frac{(W_s + 2W_b)L}{2A_sE_p} + \frac{\pi}{4} \cdot \frac{W_b}{A_b} \cdot \frac{B(1-v^2)I_p}{E_b} \qquad (4.38)$$

For a Poisson's ratio of 0 to 0.25 and $L/B > 5$, I_p is taken as 0.5 when the last term approximates to 0.5 $W_b/(BE_b)$. Values of E_b are obtained from plate loading tests at pile base level or from empirical relationships with the results of laboratory or in-situ soil tests given in Sections 5.2 and 5.3. The value of E_b for bored piles in coarse soils should correspond to the loose state unless the original in-situ density can be maintained by drilling under bentonite or restored by base grouting.

5.2.3 ***Modulus of elasticity***

The modulus of elasticity, E_c, for concrete shall be taken from the appropriate value given below:

(a) From a value established by testing of plain concrete in environmental conditions representative of those to which the proposed structure will be exposed;

(b) From the expression

$$\left[4700\sqrt{f_c'}\right]\left(\frac{\rho}{2300}\right)^{1.5} \text{ MPa} \quad \text{.....(Eq 5–1)}$$

(c) In analyses in which strain induced actions are critical, the modulus of elasticity shall be equal to or greater than the value calculated using Equation 5–1 but with a concrete strength of (f_c' + 10) MPa substituted for f_c';

(d) In analyses of members for the serviceability limit state, the modulus of elasticity may be calculated using Equation 5–1 but with a concrete strength of (f_c' + 10) MPa substituted for f_c'.

APPENDIX K

Geotechnical Risk Register

CMW Safety in Design Risk Assessment

HAM2023-0099AE IAF Reservoir - 23/06/2025

Design Element	Hazard	Description	Assessed Risk			Controls Incorporated in Design	Residual Risk		
			Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Earthworks	Falling from height	Injury to construction staff while constructing steep temporary or permanent earthworks cut or fill faces.	4	3	12	Temporary barrier fence or other means to be used to ensure persons cannot access to the edge of steep excavations	4	1	4
	Striking underground services	Injury to construction staff if live services are struck.	4	2	8	All sites cleared for services prior to site investigations and earthworks construction	4	1	4
	Moving Machinery	Injury to construction staff.	4	3	12	Separate moving machinery from light vehicles and person movements with fencing and/or safe distances from exposed construction staff operations.	4	1	4
	Working at edges of excavations	Injury to construction staff.	4	3	12	Install safety barriers, exclusion zones, signage as necessary to warn of hazard.	4	1	4
	Trench excavation collapse	Injury to construction staff or persons due to crushing/impact injury.	4	3	12	Follow Worksafe requirements, trench shields or benching of excavations to be used. No staff to enter the trench without appropriate and approved measures already in place.	4	1	4
	Cut / fill batter collapse	Injury to construction staff during construction.	4	3	12	Safe distances and appropriate temporary slope gradients and heights to be assessed prior to construction and monitored during to confirm as appropriate, safe distances and barrier fencing to be used on site where deemed necessary.	4	1	4
	Excessive noise during construction	Damage to hearing of construction staff or persons adjacent to the site.	3	3	9	Comply with appropriate allowances for noise on site, ear protection to be worn where appropriate, setback distances from adjacent sites or notified working hours to avoid conflict with adjacent property inhabitants.	3	1	3
	Machinery rollover	Machinery trafficability over soft, wet or uneven ground.	4	3	12	Appropriate construction of temporary haul roads, implement drainage and geofabrics, appropriate driver training.	4	1	4
	Contaminated Soils	Airborne or in-ground contaminants affecting construction staff.	2	2	4	Perform an Environmental assessment of the site prior to construction.	2	1	2
Crane Pad / Plant Platform	Moving Machinery	Injury to construction staff.	4	3	12	Separate moving machinery from light vehicles and person movements with fencing and/or safe distances from exposed construction staff operations.	4	1	4
	Plant platform instability	Injury to construction staff or persons due to crushing/impact injury.	4	3	12	Design to incorporate adequate factor of safety, prepare lift management plans to ensure adequate separation between plant and persons.	4	1	4
	Excessive plant settlement	Plant / equipment damage, injury to construction staff or persons due to sudden plant / load movements.	4	3	12	Undertake trial lift with adequate separation of plant and load from persons, monitor settlements during lift.	4	1	4

NOTE: It is the Contractors responsibility to cover construction related risks in a more comprehensive manner (being the competent party in that respect).

Safety in Design Assessment Framework

Risk Matrix		Consequence				
		Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Likelihood	Event Will Occur 5	Medium 5	High 10	High 15	Extreme 20	Extreme 25
	Event Almost Certain to Occur 4	Low 4	Medium 8	High 12	Extreme 16	Extreme 20
	Event May Occur 3	Low 3	Medium 6	High 9	High 12	High 15
	Event Not Likely to Occur 2	Low 2	Low 4	Medium 6	Medium 8	High 10
	Event Rarely Occurs 1	Low 1	Low 2	Low 3	Low 4	Medium 5

APPENDIX L

Earthworks specifications

1.0 INTRODUCTION

This Earthworks specification covers the geotechnical remediation works and associated earthworks outlined in the CMW Geotechnical Design Report (GDR), referenced HAM2023-0099AI Rev0. It provides detail on the required specification for:

- Site clearance and preparation including topsoil stripping and stockpiling;
- Geotechnical stabilisation works such as undercuts;
- Cut to fill earthworks operations;
- Fill materials and testing requirements;
- Earthworks finishing and respread of topsoil; and,
- As-built records.

Unless varied onsite by the Geotechnical Engineer, the following specification requirements must be met for CMW Geosciences (CMW) to provide a Geotechnical Completion Report for the earthworks.

2.0 RELEVANT DOCUMENTS

2.1 Standards, Guidelines and Consents

The works shall comply with the relevant sections of the following standards, guidelines and consents:

1. Health & Safety at Work Act 2015 and Regulations 2016;
2. All Project Resource Consent Conditions and Engineering Works Approvals;
3. The Waikato Local Authority Shared Services - Regional Infrastructure Technical Specifications (RITS);
4. Waikato Regional Council Guidelines – Erosion And Sediment Control For Soil Disturbing Activities;
5. NZS 4402: 1986 Methods of Testing Soils for Civil Engineering Purposes;
6. WorkSafe NZ – Excavation Safety Good Practice Guidelines, July 2016.

2.2 Geotechnical Investigation / Design Report

Details of the geotechnical investigation, soil conditions encountered and the design of the geotechnical remedial works are contained in the CMW report HAM2023-0099AI Rev.0. The contractor should be aware of the contents and recommendations contained in that report.

The works shall comply with the recommendations contained in that report.

2.3 Construction Drawings

- The works shall comply with the consented 'Construction Issue' drawings.

2.4 Conflicting Information

Where there is any conflict or discrepancy in the requirements of this specification and the documents listed above the matter shall be referred to the Geotechnical Engineer (CMW) for clarification.

3.0 GEOTECHNICAL OBSERVATIONS

The following items form hold points in the construction works that require observation, testing and approval by the Geotechnical Engineer (CMW):

Table 3.1: Geotechnical observations requirements

Construction Phase	Requirement
• All stripped / benched areas, undercut areas and other excavations prior to placement of any filling. • Foundations for filling once topsoil and unsuitable materials have been stripped prior to fill placement	• Inspection to verify exposed / benched subsoil conditions and strengths, • Recommend additional works if necessary. • Surveyor to confirm pre-fill ground levels and record all undercut extents and levels prior to backfilling.
• Placement and compaction of fill • Field verification of subgrade strength and field density testing of backfill	• Any imported soil fill materials prior to placement on site, drainage aggregate quality prior to placement, geotextile layers (if needed) once in place and prior to backfilling, • Filling placed at regular intervals to comply with the fill test frequency requirements below • Earthworks compaction control testing to achieve compaction control criteria, • Compaction of backfilling in critical service trenches
Preload and Settlement monitoring	• Installation of settlement monitoring plates or points, • Application of pre-load and approval prior to its removal. • Periodic review of underfill settlement monitoring pins during and following earthfill construction to verify settlement trends.
Any unforeseen ground conditions that may impact on the construction works or future land use	• Contractor shall contact and inform the Geotechnical Engineer as soon as an unforeseen geotechnical situation arises in order to implement specific measures.

It is the contractor's responsibility to ensure that the Geotechnical Engineer is given reasonable notice and opportunity to observe the above works and that the works do not proceed until approval has been gained from the Geotechnical Engineer.

We require a minimum of 48-hours notice for site observations and testing.

4.0 EARTHWORKS SPECIFICATION

4.1 General

All earthwork activities must be carried out in general accordance with the requirements of the Regional Infrastructure Technical Specification under the guidance of a Chartered Professional Geotechnical Engineer.

Those requirements are summarised below.

4.2 Site Preparation

The Contractor shall remove all vegetation from the site of the earthworks except for trees indicated for preservation either by marking on the site or noted on the drawings and clear the remainder of the site.

Clearing shall mean the felling of all trees, except those indicated, removal of all growth other than grass and weeds, extraction of tree stumps, demolition of fences and other minor items remaining in the way of site stripping, and the complete disposal of all items. Stumping shall mean the removal of all roots greater than 25mm in diameter.

Cleared areas shall be stripped to remove all turf and organic topsoil to depths designated by the Engineer ahead of or during the stripping operations. Stripping shall also cover picking up any old topsoil stockpiles and any buried topsoil detected during the course of the works. The depth shall be sufficient to remove all materials considered unsuitable as fill or unsuitable to remain beneath fill but will not necessarily extend to the full limit of organic penetration.

4.3 Topsoil Stripping

Topsoil stripping shall be undertaken across the entire earthwork extents as per the drawings and placed in suitable stockpile locations outside of the immediate work site as determined by the Contractor. Topsoil stripping should be undertaken to a sufficient depth such that all organic material and significant plant roots are removed. It shall also cover picking up any old topsoil stockpiles and any buried topsoil detected during the works. The depth shall be sufficient to remove all materials considered unsuitable as fill or unsuitable to remain beneath fill but will not necessarily extend to the full limit of organic penetration.

Topsoil stockpile surfaces shall be shaped to form a continuous smooth surface.

4.4 Erosion and Sediment Control

The works shall be carried out in accordance with the project Erosion and Sediment Control Management Plan and associated drawings.

The contractor shall ensure good control of surface water runoff at all times by shaping of the surface in cut and fill areas to prevent ponding during rainfall events.

The location of temporary Sediment Retention Ponds (SRP) on sloping ground shall be decided upon with input from the Geotechnical Engineer. Where comment of SRP stability is sought by Council then all fill materials used to form batters, must be placed as engineered fill and tested accordingly unless advised otherwise by the Geotechnical Engineer.

When decommissioning temporary sediment ponds, all water softened material in the bases and sides of the ponds shall be removed and undercut to the satisfaction of the Geotechnical Engineer. Backfilling of temporary ponds shall be to the compaction standard for general filling unless otherwise specified.

4.5 Stockpiles

Topsoil stockpiles can add significant driving force for slope instability when placed at or near the crest of a slope. The location of all temporary stockpiles must be approved by the Geotechnical Engineer prior to placement. Where stockpiles cannot be avoided above sloping ground, they should be placed over a wide area with the height restricted under the direction of the Geotechnical Engineer.

4.6 Fill Foundations and Benching Slopes

The foundation on which filling is to be placed must be observed by the Geotechnical Engineer following clearing and prior to the placement of any filling to confirm the strength of the underlying soils is sufficient.

Where it is found, after clearing and stripping operations as specified, that the foundation on which filling is to be placed is unstable, or in cuttings if it is found after the excavation has been cut down to the levels shown in the drawings that unstable ground is encountered, then the Engineer may direct that the soft, yielding, or unstable materials causing such instability shall be removed to such depth as directed.

Benching of slopes prior to the placement and compaction of filling should be carried out in accordance with the normal requirements of NZS 4431 and related documents as mentioned above, especially on the steeper areas of the site, to ensure that the filling placed is keyed into the underlying natural ground. This would involve the cutting of benches approximately the width of a bulldozer, with a slight reverse gradient back into the slope. The optimum depth of each bench is best confirmed by careful Engineering inspections during construction.

For the proposed project, for fill depths of greater than 1m across the building platform, the existing subgrade shall be prepared by stripping topsoil and placing engineered fill.

For the proposed project, fill depths of less than 1m, the turf and topsoil shall be removed and the subgrade tested to verify that an undrained shear strength (S_u) of at least 60kPa is available to at least 1m below design ground level. Where S_u > 60kPa, fill placement may commence, where Su < 60kPa, the subgrade shall be undercut to 1m below design ground level or where S_u > 60kPa, whichever is encountered first.

4.7 Temporary Batters and Excavation Stability

The temporary stability of the works is the responsibility of the main contractor. All works are to be completed in accordance with the requirements of current safety legislation and WorkSafe NZ.

Slope instability during construction is a significant risk where earthworks may cause changes to slope geometry or groundwater conditions.

The causes of instability during earthworks may include:

- Removal of toe support due to excavation;
- Over-steepening of slope angles in temporary batters;
- Geological defects in the soil mass, particularly where these are exposed in excavation faces;
- Elevated groundwater levels following rainfall, perched groundwater or rapid recharge due to the reduced distance to an impermeable layer due to cut operations; and,
- Additional loading upslope of excavations. i.e. construction equipment or stockpiles.

To help mitigate these risks the contractor should consider:

- Staging excavations which reduce support to slopes or create temporarily over steepened slopes, to ensure large areas are not left unsupported. The allowable length of excavation to have open at any one time will vary and is dependent on a number of factors such as, local ground conditions, groundwater, length of time the excavation will be open, weather, depth of excavation, geological defects present and the earthworks equipment and methodology used;
- Ceasing works in excavations during rainfall and assessing stability of excavations following rainfall events prior to resuming work;
- Benching or battering back of excavation faces;
- Ensuring good control of surface water runoff above excavations and batters;
- Covering steep batters with impermeable covers where they may be left without support for any significant period of time;
- Avoiding loading the crests of slopes and excavations (including loading with working plant);
- Putting in place comprehensive risk identification and management procedures and work methodologies for temporary excavation stability;
- Carrying out regular inspections of the areas upslope of excavations and the excavation slope to look for signs of instability such as ground displacement and the development or propagation of cracks; and,

- Seeking advice from the Geotechnical Engineer where there is doubt as to the stability of a slope or excavation.

4.8 Fill Materials and Conditioning

4.8.1 Material Types

Material Types		
Material Type	**Description**	**Comments**
T	Topsoil	Natural material at surface
F	Fine-grained	Based on more than 35% material passing the 63µm sieve
I	Intermediate-grained	Based on material that has between 15% to 35% passing the 63µm sieve
C	Coarse Grained or aggregate	Based on no more than 15% material passing the 63µm sieve
R	Rock	Material described as rock as per NZGS Field Description of Soil and Rock
M	Manufactured	Any manufactured material created or modified for the purpose of earthworks (such as crushed concrete, recycled asphalt, etc)

The soils at this site are predominantly classified as material type F.

4.8.2 Blending of Unsuitables

The blending of 'unsuitables' into structural fills may be undertaken only at the discretion of the Geotechnical Engineer following a request by the contractor and with sufficient time for appropriate consideration. Approval for any such blending must be sought from and provided by the Geotechnical Engineer in writing prior to the commencement of any blending.

In consideration of any such requests, the Geotechnical Engineer will need to be able to assess, et. al., the composition of the materials requested to be blended, the location on the site for the proposed fills, the fill depths and the elevation of the blended materials within the fills and any environmental constraints.

As a minimum, it is expected that any blended fills will be directed to comply with the following conditions:

- All significant, solid inorganics (such as roots and stumps) to be removed prior to blending; and,
- All inclusions of suitable man-made materials (e.g. concrete) and any excavated rock must comply with the normal compaction requirements specified herein in terms of size and ability for appropriate compaction to be achieved in close vicinity to the inclusions.
- All blended materials must be appropriately mixed/ blended normal fill materials to the specified ratio. Un-mixed interlayering of normal engineered filling with unsuitables will not be accepted.
- As a preliminary indication, it is expected that the ratio of unsuitables to suitable fill will not exceed 1 in 10 by volume.

It is expected that the Geotechnical Engineer will also need to apply limits to the location/ depth of blended fills within any specified fill area.

4.8.3 Hardfill

Hardfill used as structural filling shall be a graded, unweathered, durable, crushed rock product approved by the Geotechnical Engineer, with a grading suitable for compaction.

4.8.4 Material Conditioning

Within the proposed cut areas, the natural subgrade will comprise stiff silt clay/ clay of the Hamilton Ashes unit. We expect that excavation of these materials will be readily achieved with normal earthworks plant, such as scrapers and bulldozers with scoops. Recent project experience suggests these materials should be suitable for re-use as bulk fill and subgrade fill subject to appropriate moisture conditioning. This may be done by harrowing (such as with discs) and air drying when conditions permit or by the addition of hydrated lime.

The addition of lime and/or cement to engineered filling in concentrations greater than 3% requires the approval of the Geotechnical Engineer.

All additives such as lime or cement proposed for use in backfill materials for Reinforced Earth Slopes or other materials in contact with geosynthetics must be approved and monitored by the Geotechnical Engineer.

4.9 Fill Placement, Compaction and Testing Requirements

4.9.1 General

The fill may comprise either granular or cohesive material subject to being free of any organic material and having no particles greater than 150mm diameter.

Most of the proposed cut material, including the natural and existing fill materials should be suitable for reuse as engineered certified fill. Soil textures and moisture contents will however vary widely and careful management, conditioning and compaction control will be required.

All earth fill must be placed to ensure adequate bonding between successive fill lifts by ripping any natural subgrade or fill surfaces that have become dry prior to placing the following fill lift.

Fill surfaces shall be maintained in good state at all times to prevent surface ponding of water and shall be shaped to ensure erosion and sediment controls are met.

4.9.2 Soil Fill

Soil placed in fills shall be conditioned and compacted until the following conditions are satisfied.

It should be noted that the surface of the fill area prior to placement of subsequent fill lifts should be in a state so as not to create a break in the consistency of the fill material between lifts. For example, if surfaces are left to dry out, or rolled to seal them from rainfall infiltration then the surface must be broken up and scarified with rippers or by other means to ensure a good bond between fill lifts.

The maximum lift of filling placed before compaction is dependent on the size and nature of the compaction equipment. Typically, 250mm to 300mm loose depth is considered the maximum for a Cat 815/820 type compactor. In any event the contractor must ensure that the fill is placed and compacted to achieve even and adequate compaction throughout each layer/lift.

The test criteria and frequency are set out below.

Table 4.1: Compaction requirements for General Fill

Material Type	Test and Method	Acceptance Requirement	Minimum Frequency
F (Fine-grained) Cohesive soils (Hamiton Ashes)	Particle size distribution (NZS4407 test 3.8 or NZS4402.2.8.1)	100% passing 19mm sieve and min. 35% passing 0.075mm sieve	1 per source and 1 per change in material
	Dry density / water content relationship (NZS4402.4.1.1, NZS4402.4.1.2)	OMC and MDD determined	
	Water content (NZS4402.2.1)	Between OMC -2% and OMC +4%	
	Solid density (NZS4402.2.7.1 or 2.7.2)	Solid density determined	
	Liquid and plastic limits (NZS4402.2.2, NZS4402.2.3 and NZS4402.2.4)	PI < 25% and LL <50%	1 per source, 1 per change in material and 1 per 4,000m^3
	Field water content and density (NDM) (NZS4402.2.1 and NZS4407 test 4	>90% MDD and minimum <10% air voids over 10 tests. Maximum single value 12%	2 per 1,000m^3 (minimum 2 per lift)
	Shear strength (NZGS guideline for hand held shear vane)	Minimum average 140kPa over 10 tests. Minimum single value 120kPa	
C (Coarse-grained) Granular soils (Imported sand)	Particle size distribution (NZS4407 test 3.8 or NZS4402.2.8.1)	100% passing 75mm sieve and min 15% and max 35% passing 0.075mm sieve	1 per source and 1 per change in material
	Dry density / water content relationship (NZS4402.4.1.1, NZS4402.4.1.2)	OMC and MDD determined	
	Water content (NZS4402.2.1)	Between OMC -2% and OMC +4%	
	Solid density (NZS4402.2.7.1 or 2.7.2)	Solid density determined	
	Field water content and density (NDM) (NZS4402.2.1 AND NZS4407 test 4)	>95% MDD and minimum <15% air voids over 10 tests. Maximum single value 12%	1 per 1,000m^3 (min 2 per lift)
	Dynamic Cone Penetrometer	>5 blows per 100mm	2 per 1,000m^3 (min 2 per lift)
	Impact test – 4.5kg hammer (ASTM D 5874)	CIV > 32	1 per 50m^3 on each compacted layer (min 2 per lift)

The test criteria and/or frequency may be relaxed at the discretion of the Geotechnical Engineer (CMW) for the project or in a discrete fill area subject to the consistency of the results achieved being acceptable over a specified period of time

4.9.3 Hardfill

The test criteria and frequency are set out below for hardfill.

Table 4.2: Compaction requirements for General fill (Imported aggregates)

Material Type	Test and Method	Acceptance Requirement	Min Frequency
GAP65	Particle size distribution (NZS4407 test 3.8 or NZS4402.2.8.1)	Refer GAP65 particle size criteria in NZS4431	1 per source and 1 per change in material
	Dry density / water content relationship (NZS4402.4.1.1, NZS4402.4.1.2)	OMC and MDD determined	
	Solid density (NZS4402.2.7.1 or 2.7.2)	Solid density determined	
	Weathering quality index	AA, AB, AC, BA, BB or CA	
	Field water content and density (NDM) (NZS4402.2.1 AND NZS4407 test 4)	>95% MDD and minimum <15% air voids over 10 tests. Maximum single value 12%	1 per 1,000m^3 (min 2 per lift)
	Dynamic Cone Penetrometer	>5 blows per 100mm	1 per 500m^3 (min 2 per lift)
	Impact test – 4.5kg hammer (ASTM D 5874)	CIV > 32	1 per 50m^3 on each compacted layer (min 2 per lift)
GAP40	Particle size distribution (NZS4407 test 3.8 or NZS4402.2.8.1)	Refer GAP40 particle size criteria in NZS4431	1 per source and 1 per change in material
	Dry density / water content relationship (NZS4402.4.1.1, NZS4402.4.1.2)	OMC and MDD determined	
	Solid density (NZS4402.2.7.1 or 2.7.2)	Solid density determined	
	Weathering quality index	AA, AB, AC, BA, BB or CA	
	Field water content and density (NDM) (NZS4402.2.1 AND NZS4407 test 4)	>95% MDD and minimum <15% air voids over 10 tests. Maximum single value 12%	1 per 1,000m^3 (min 2 per lift)
	Dynamic Cone Penetrometer	>5 blows per 100mm	1 per 500m^3 (min 2 per lift)
	Impact test – 4.5kg hammer (ASTM D 5874)	CIV > 32	1 per 50m^3 on each compacted layer (min 2 per lift)

4.9.4 Compaction Testing Reporting Requirements

- All test location coordinates to be recorded by handheld GPS with reference to the NZTM projection. Test location coordinates, with date and test number reference are to be provided to the Geotechnical Engineer in electronic (excel) format on a weekly basis. Alternatively, the Geotechnical Engineer may approve the use of site plans to mark the location of tests in lieu of GPS location.
- The volume of filling placed for each progress claim month (typically ending 20th of the month) including all filling placed (undercut and cut to fill) to be provided to the Geotechnical Engineer monthly by the contractor or Engineer to the Contract to allow assessment of test frequency adequacy.
- Interim fill test summaries are to be provided to the Geotechnical Engineer for review on a regular basis.

4.10 Subsurface Drainage

4.10.1 General

Drainage for shear keys, fill drainage keys, buttress fills, and counterfort drains shall be constructed in accordance with the design drawings and standard details.

4.10.2 Materials

Pipes

Drainage pipes used in subsoil drainage shall be 160mm diameter highway grade drain coil. Drain coil walls shall be perforated or solid as detailed in the design drawings or directed by the Geotechnical Engineer on site. Drain coils shall not have a geofabric filter sock unless requested by the Geotechnical Engineer on site.

Aggregate

Subsoil drainage will have a 100-year design life and should be essentially maintenance free. This requires a high-quality drainage aggregate with the following properties:

- Self-filters against the soils present on site preventing loss of permeability over time; or, able to be practically wrapped in a suitable geofabric filter.
- High permeability, which translates to a low fines content; and
- Stable and not subject to crushing, weathering, internal erosion or piping, or significant loss of volume (settlement) over time.

Ideally the drainage aggregate should be a well graded self-filtering material such as a clean (free of significant cohesive fines) scoria SAP50 product or Transit F/2 specification filter media.

Alternatively, for shear key drainage, blanket drains, underfill drainage and all applications where full encapsulation with a geofabric filter cloth can be relatively simply and safely achieved, an open graded product, preferably 27/7 Scoria may be used. Care will need to be taken to ensure that the cloth fully encapsulates the aggregate. Observation of the cloth wrap should form an inspection hold point prior to backfilling over the drain. Drain coils in this instance do not require a filter sock.

Light compaction (i.e. tamping with back of excavator bucket) only is to be applied to drainage aggregates.

Filter Cloth

Any filter cloth surround specified on the drawings shall meet the requirements of Transit Specification TNZ/F7, Filtration Class 2 and Strength Class B unless otherwise specified on the drawings.

Trench Backfill in Service Trenches

It is important on all sloping land that service trenches running parallel to contours are avoided where possible as they can permit the ingress of surface water and/or lateral movement of trench sides that could lead to progressive land slippage, help develop tension cracks and possibly lead to slope and building instability.

Backfilling of all trenches should be to the general fill standard above unless specifically varied in writing by the Geotechnical Engineer and where possible the pipe bedding in all trenches on steep ground should contain a 50mm diameter perforated drain coil that is connected into each manhole on the line. This is to help prevent instability arising from the ingress of surface water and/or lateral movement of trench sides that could lead to progressive land slippage and is especially important where the lines are in close proximity to buildings.

4.10.3 Depth and Extent

The location, extent and depth of the drainage shown on the design drawings may be varied on site by the Geotechnical Engineer in response to the ground conditions encountered.

4.10.4 Drainage Outlets and Inspection Points

Outlets for subsurface drainage shall be provided at regular intervals shown on the drawings or as determined on site by the Geotechnical Engineer. Pipe outlets shall be specifically formed structures with adequate protection such as a headwall and/or rock rip rap. The position of all outlets shall be recorded on the asbuilt drawings.

Where possible it is good practice to include additional inspection and/or flushing points in the subsoil drainage system in the event that their performance needs to be confirmed in the future.

In any event, at least one temporary flush point is required for each subsoil drainage system to enable flushing of the system once the earthworks are substantially complete.

The flushing of the subsoil drainage system must be witnessed by the Geotechnical Engineer.

4.11 Finishing Works and Topsoil Spread

4.11.1 Overcut

All areas cut to below finished level should be reinstated with engineered filling to the satisfaction of the Geotechnical Engineer.

4.11.2 Topsoil Depth

Topsoil respread depth should be between 100mm and 300mm, or as directed by the Engineer to the contract. On ground steeper than 1V:3H the surface should be roughened under the supervision of the Geotechnical Engineer prior to topsoil placement.

4.11.3 Unsuitable Materials

At the conclusion of earthworks all surplus unsuitable materials should be removed from site or placed in designated permanent stockpiles. The size and location of such stockpiles must be approved by the Geotechnical Engineer and recorded on the asbuilt drawings.

5.0 MONITORING

5.1 Settlement Monitoring

Settlement monitoring is detailed in ***Appendix J.***

The number and position of monitoring points and the frequency of post construction settlement monitoring is to be confirmed with the Geotechnical Engineer during construction.

Settlement monitoring is to be undertaken by a licenced surveyor and results provided to the Geotechnical Engineer.

It is the contractors' responsibility to ensure the integrity of the monitoring points is maintained during the works.

Client to consider monitoring settlements along the boundaries, particularly for the existing houses along the Western Boundary. If fill embankments are as per Section 6.3 of the CMW settlement memo, settlements at existing houses due to pre-loading at the Bourn Heath site is anticipated to be minimal.

5.2 Settlement Markers

Fabrication, supply, installation and maintaining integrity of settlement monitoring instrumentation shall be the Contractor's responsibility. Where instrumentation becomes inoperative during installation or operation, it shall be replaced immediately and monitoring recommenced, with the subsequent data given to the same reference as the previous data.

Equipment shall consist of 600mm x 600mm base plate (typically 20mm thickness),150mm PVC duct, 32mm diameter threaded bar with couplers for extensions at 1m intervals and waratahs and coloured flagging for protection following installation.

Installation of the settlement markers shall occur at the base of the fill, prior to placement of any fill to capture the full magnitude of settlement. They shall be installed on a 100mm thick sand layer to form an even and smooth foundation which will be levelled using a spirit level. Monitoring shall commence before construction and the data shall be referenced to the baseline data. Partial placement of surcharge and excavation back down to install an instrument is not acceptable. Upon installation, the instrument locations are to be fixed with GPS.

Unless instructed otherwise by the Geotechnical Engineer to avoid bearing capacity failure, it is important that surcharge filling is placed to its design height and full lateral extents in its entirety in a single, rapid operation to allow for measurement of a single settlement curve.

Inner bars will be attached to the plate and must be capable of extensions up through the fill as the height is increased. The extensions shall be coupled to the previous bar using a screw head.

Compaction of the fill surrounding the settlement plate and tubes shall be by hand to prevent damage. Any damage that occurs must be communicated to CMW discuss reinstatement options.

Survey measurements are to be undertaken regularly by the Contractor as specified on the drawings, to within an accuracy of 2mm. Copies of monitoring (in both paper and electronic formats MS Excel or equivalent) must be provided to CMW within 24 hours of each reading. The installation of additional monitoring instrumentation maybe required subject to the results received. It is important that the finished / surcharge surface RL is recorded and reported together with the instrument data.

6.0 ASBUILT INFORMATION REQUIREMENTS

Certain as-built information must be provided to CMW to certify earthworks. It is the contractor's responsibility to ensure that all of the following items are surveyed prior to placing filling. The survey of these items should therefore form a hold point in the construction sequence.

- The location and invert of all sub surface drainage; and,
- The depth of filling placed including all benching, undercuts, shear or fill drainage keys and temporary ponds which have been backfilled.

CMW require the following as-built information to be provided to certify earthworks:

- Cut and fill depth plan (including undercuts and shear keys).
- Final contour plan.
- Drainage locations and inverts (surface and subsurface).
- Drainage outlet locations (surface and subsurface).
- Details of any defined overland flow paths.
- Material data for imported products used such as draincoils, aggregates and geofabrics as well as confirmation that products installed comply with the requirements of the project drawings and this specification; and,
- Any settlement monitoring data.

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