

Campana Road, Wiri

Geotechnical Appraisal Report

for: Campana Landowners Consortium c/ Capstone Projects Limited



Job No: 66948#GE

Version: Rev 0

eTrack No: 200047532

Date of Issue: 13/03/2024

ACKNOWLEDGEMENT OF SUBMISSION

This report was prepared by Adam Nguyen and reviewed by Jordan Moll

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13/3/2024	Rev 0	200047532	Adam Nguyen	Jordan Moll
19/12/2023	Draft	200047117	Adam Nguyen	Jordan Moll
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1 INTRODUCTION

Campana Landowners Consortium c/ Capstone Projects Limited has engaged Babbage Consultants Limited (Babbage) to provide a geotechnical appraisal in support of a Private Plan Change (PPC) Request to rezone land which forms Allot 190 PSH FO Manurewa, Lot 2 DP 402013, Lot 1 DP 402013, Lot 2 DP 71211 and Lot 3 DP 71211 (the site) to Light Industrial zoning.

This geotechnical appraisal is limited in scope to the area identified on the Site Plan attached in Appendix A. It is based on desk study and a site walkover only and should be read in conjunction with the Applicability and Limitations as attached.

2 DESK STUDY

2.1 Site Description

The site is located in Papatoetoe and is bound by Puhinui Road to south, Campana road to the south-east and by Waokauri Creek or associated tributaries on all other sides as shown in the site plan attached in Appendix A.

The site and surroundings are described as follows:

- The site is currently used for agricultural and commercial purposes and is within the Papatoetoe Future Urban zone. Auckland Airport is located ~2km to the west.
- The majority of the site is relatively flat at around 10m RL, grading gently down to the western, northern and eastern slope crests which are typically at ~5m RL. The slopes are typically 5m high and grade down to sea level at approximately 33 degrees (1V:1.5H). The slopes are heavily vegetated and well protected at the toe by mature mangroves.
- A gully is present within the southeastern extent of the site with an invert level of ~2-3m RL which outlets into the Waokauri Creek. The gully has been partially filled towards its western extents to provide a vehicle crossing, with a culvert in place to convey the overland flow.
- Various low set farm buildings, greenhouses and associated hardscapes and farm tracks are present on the site.
- There are no public stormwater or wastewater services currently present on site according to the Auckland Council GeoMaps website, however the Refining NZ Liquid Fuels Pipeline Marsden to Wiri runs centrally (north-south) through the site as shown on the site plan in Appendix A.

2.2 Historic Aerial Photography

Historic aerial photography from AC Geomaps and Retrolens¹ was reviewed as part of this assessment.

Key changes to land use since 1939 include:

- 1939 - 1965: Most of site is vacant. Some farmhouses in the southern part of the site. After 1965, the site was used as agricultural land.
- 1975 - 1980: Campana Road was under construction.
- 1980 - 1983: Two farm buildings were constructed to the northern end of the Campana Road at 11 Campana Road, LOT 2 DP 71211
- 2006 - 2008: Construction of a farm building at 5 Campana Road, LOT 1 DP 402013.

2.3 Published Geology

The geological map² (see Figure 1) indicates the most parts of the site are underlain by pumiceous deposits of the Puketoka Formation (tp), described as light-grey to orange-brown, pumiceous mud, sand and gravel, with muddy peat and lignite.

The north-eastern extent of the site is indicated to be overlain by lithic tuff of the Auckland Volcanic Field (avt), being thin graded beds of grey, mud- to sand-sized fragments of comminuted, country rock (mainly sandstone, mudstone, alluvium, micaceous sand) together with basalt and basanite fragments.

¹ Retrolens Aerial Photography, sourced from <http://retrolens.nz> and licensed by LINZ CC-BY 3.0.

² Kermode, L.O. (1992): "Geology of the Auckland urban area". Scale 1:50,000. Institute of Geological & Nuclear Sciences geological map 2. 1 sheet + 63 p. IGNS Ltd: Lower Hutt.

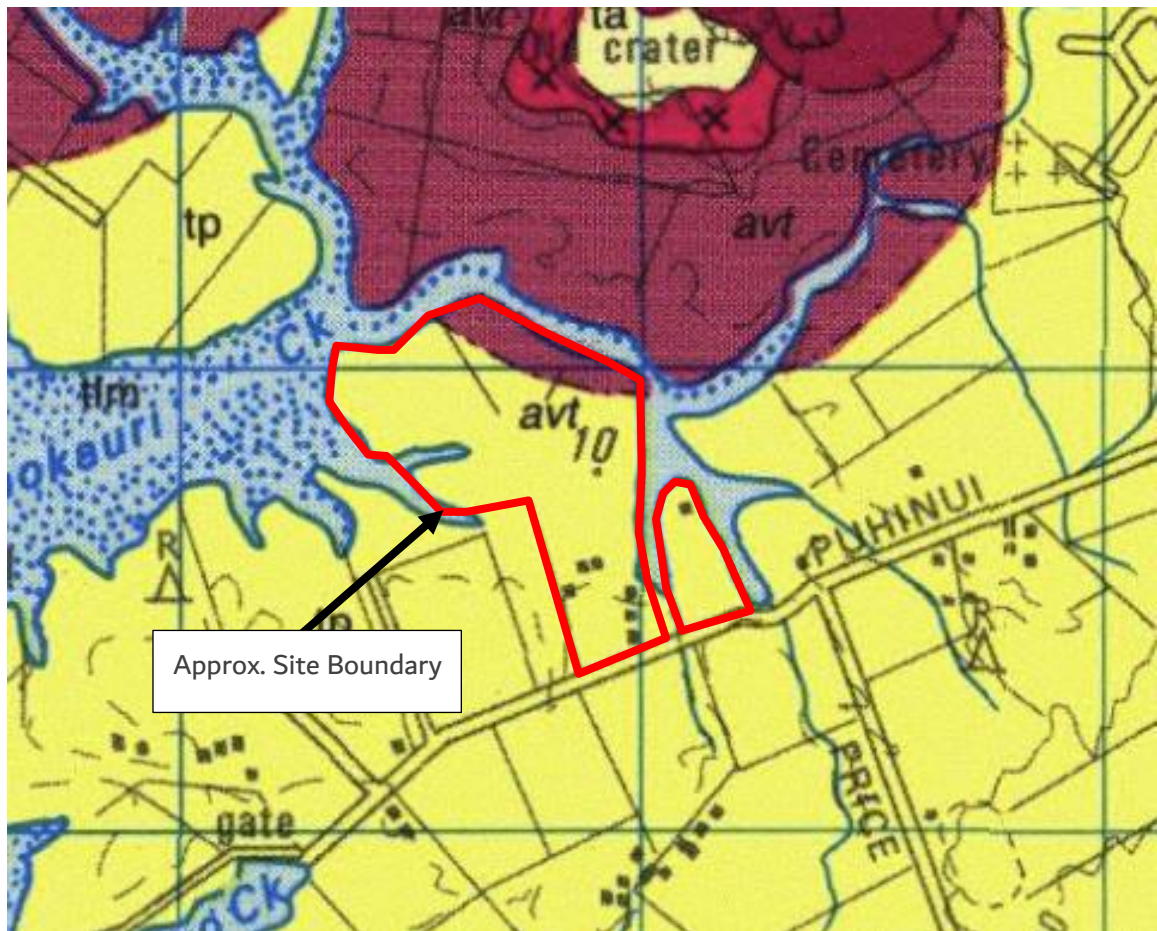


Figure 1: Excerpt of the Auckland Urban Area Geology Map (1:50,000)

2.4 New Zealand Geotechnical Database

The NZ Geotechnical Database³ contains several historic investigations carried out close to the site. These included machine-drilled boreholes and Cone Penetrometer Tests (CPTs) (refer NZGD site plan below in Figure 2). The borehole logs considered in this assessment are attached in Appendix B.

³ NZ Geotechnical Database: <https://www.nzgd.org.nz/>



Figure 2: Available data on the NZGD (accessed 8 November 2023)

2.5 Available Geotechnical Reports

Soil & Rock Consultants prepared a geotechnical report⁴ for a proposed development at 485 Puhinui Road (Lot 2 and 3, DP 402013) in March 2022. The report documents the following scope of geotechnical investigations:

- 16no hand augered boreholes to variable depths, ranging between 1.0m and 5.0m below ground level (bgl);
- Four cone penetrometer tests (CPTs) to depths ranging between 16.8m and 17.3m bgl; and
- Three shrink-swell laboratory tests undertaken to assess soil expansivity.

⁴ Soil & Rock, 2022. Geotechnical Investigation for Proposed RSPCA Development at 485 Puhinui Road, Papatoetoe. Referenced Job Number 211197 and dated 16 March 2022.

Key findings and recommendations within the report are as follows:

- Ground conditions comprised very stiff to hard soils of the Auckland Volcanic Field and Puketoka Formation. Bedrock is inferred to be present at depths ranging from 16.8m to 17.3m bgl (i.e. the termination depth of the CPTs).
- Groundwater level ranged between 1.8m and 3.0m bgl.
- Soils were classified as Moderately Expansive in accordance with B1/AS1, and Seismic Subsoil Class C in accordance with NZS1170.5.
- Some soil layers below 3.0m depth are susceptible to liquefaction and lateral spreading during a Ultimate Limit State (ULS) seismic event, however the thick raft of stiff to hard soils present across the site is expected to reduce the effect of liquefaction at the surface. Vertical liquefaction induced settlement under the ULS (1-500 year APE) design earthquake event were calculated to range between 10mm and 40mm and expected to occur at depths of 3.5m bgl or greater. Lateral spreading was estimated to range between 5mm and 150mm, however the report notes that the assessment methodology tends to over-estimate lateral spreading risk.
- Liquefaction effects are not expected to cause damage that would exceed building performance requirements under ULS conditions. However, the report notes that this assumes lightweight timber framed buildings are adopted.
- Shallow foundations with an inferred 300 kPa geotechnical ultimate bearing capacity were recommended, where supported by stiff natural ground or engineered fill.

3 ANTICIPATED GROUND CONDITIONS

Based on the findings from the desk study, ground conditions are anticipated to comprise a surficial layer of AVF tuff deposits, typically consisting of 1-3m of stiff to hard silt and clay mixtures and medium dense gravelly sand (scoria), underlain by Pleistocene aged alluvial deposits of the Tauranga Group. The alluvium is anticipated to consist of stiff to hard silt and clay mixtures, with interbedded layers of loose and medium dense sand and silty sand and occasional thin peat bands within the upper ~15-20m. The Tauranga Group alluvium is underlain by 40m+ Kaawa Formation sandstone, typically recovered as a dense shelly sand with slight cementation. Localised deposits of fill material are also likely to be present across the site.

Groundwater levels are typically anticipated to be present within 1.5-3m of ground surface centrally within the site, decreasing to close to sea level with increasing proximity to the slope crests.

4 GEOTECHNICAL CONSIDERATIONS

4.1 Seismic Hazard

4.1.1 Seismic Subsoil Class

Based on the information available, the local geology, and our knowledge of the area, we consider that the site can be categorised as a 'shallow soil site' (Subsoil Class C) in accordance with NZS1170.5:2004.

4.1.2 Liquefaction and Lateral Spreading Susceptibility

With respect to the liquefaction potential of the site, the anticipated ground conditions comprise predominantly stiff to hard cohesive material within the upper profile, which are typically not susceptible to liquefaction. Lenses of loose silty sand and sandy may be present which are more susceptible to liquefaction, however considering the relatively low peak ground accelerations associated with the design earthquake events, surface manifestation of liquefaction if considered negligible for SLS and intermediate seismic cases.

Based on the findings from this desk study, the liquefaction analyses documented within the 2022 Soil & Rock report is likely to be reasonably representative for the overall site. The analyses indicates negligible liquefaction is anticipated during 1-25 year Serviceability Limit State (SLS) and 1-100 year intermediate events, and only modest liquefaction is expected during a ULS event (<50mm at depths >3.5m bgl).

Lateral spreading is also possible during a ULS event, however as it is understood there is to be an Open Space zone designated as extending a minimum of 20m back from the coastal slopes (i.e. free faces), and the liquefiable layers present are likely to be discontinuous and lenticular, the risk is expected to be able to be mitigated using widely accepted design and construction methodologies.

Based on the desk study undertaken, liquefaction-induced ground damage during a ULS event is assessed to be in the Minor to Moderate category as defined by the Planning and Engineering Guidance for Potentially Liquefaction Prone Land (MBIE, 2017) document, and the site designated to have a Medium Liquefaction Vulnerability.

Additional site specific geotechnical investigations and laboratory testing will be requiring during subsequent design stages to quantify the liquefaction and lateral spreading risk more accurately and support detailed design.

4.2 Slope Stability and Coastal Hazard

The majority of the site is bordered by ~5m high slopes that grade down to sea level at approximately 33 degrees (1V:1.5H). The majority of the slopes are heavily vegetated and well protected at the toe by mature mangroves. However, a ~50m long section along the northern site boundary shows signs of instability and coastal erosion (refer Figures 3 and 4).



Figure 3: Location of bank erosion section



Figure 4: Slope instability due to bank erosion

Based on observations during the site walkover, the mangroves are less dense in this area and the course of the tributary leading to the Waokauri Creek is such that erosion resulting in undercutting of

the slopes here is more prevalent. The remainder of the slopes appeared reasonably stable, with no obvious signs of movement or instability despite the adverse weather events in early 2023.

Nevertheless, a Building Restriction Line (BRL) set 20m back from the slope crests is recommended, which will align with the proposed 20m wide Open Space zone and also provide mitigation against risk posed by coastal instability or erosion (refer Section 4.3).

4.3 Coastal Hazard

The site is mapped as being within an Area Susceptible to Coastal Instability and/or Erosion (ASCIE) on the Auckland Council GeoMaps website. Future erosion predictions for the 2130 RCP8.5 scenario suggests ~20m of land loss (approximately measured back from current slope crests) is possible (Figure 5).

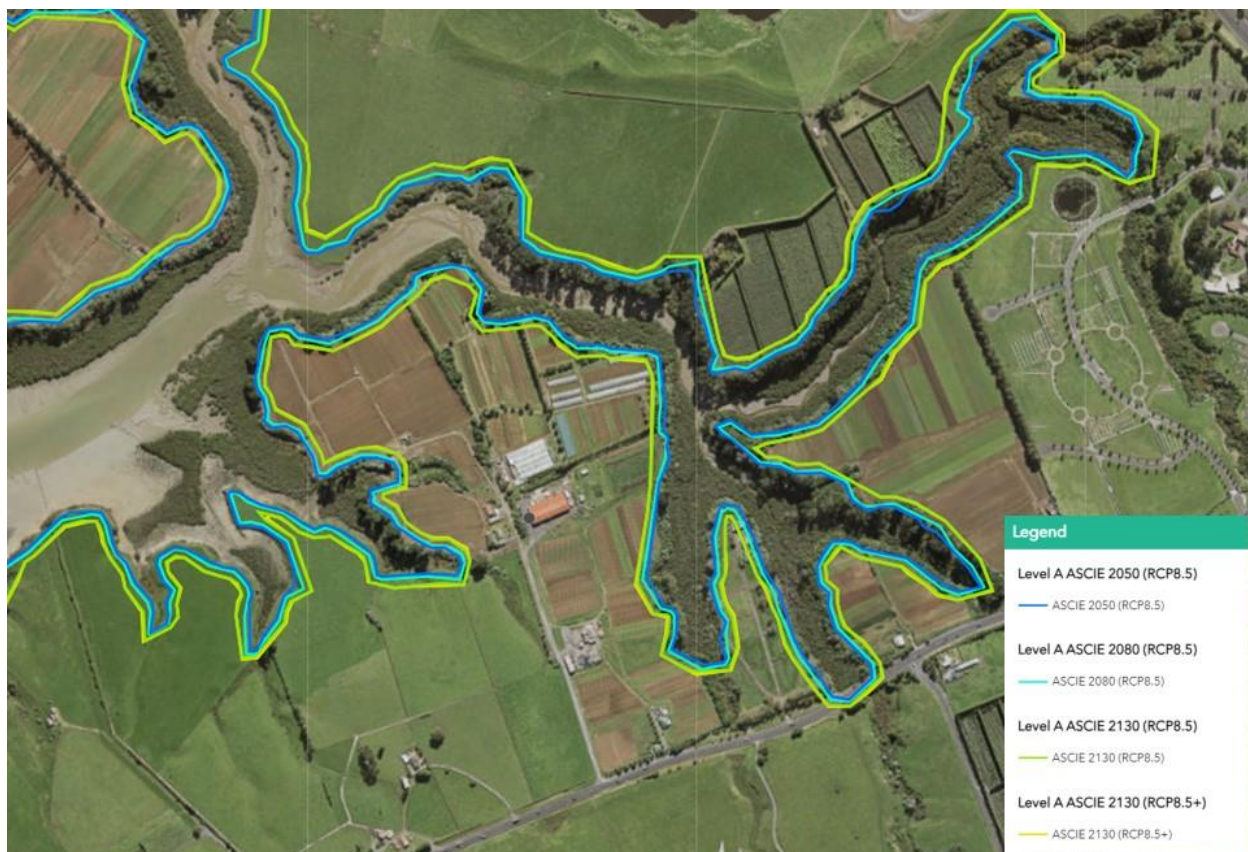


Figure 5: Excerpt of the Auckland Coastal Instability and Erosion Map

It is noted that this assessment is based on a region wide study, and do not consider factors such as slope vegetation, mangrove protection, or coastal setting. Considering the benign (low energy) environment, the mangrove vegetation, and the fact the slopes are fronted by an infilling estuary, these projections are considered highly conservative.

Nevertheless, as the 20m Open Space zone will preclude development within the ASCIE mapped over the next 100 year planning horizon, a site specific Coastal Hazard Assessment is not considered to be required to support this PPC application. Provided that set-back is maintained, the Policies as set out in E36 (Natural Hazards and Flooding), E38 (subdivision-urban), and 106 of the RMA (1991) (Subdivision Consents) are considered to be satisfied, and that the coastal inundation and erosion hazards will likely have little impact to future buildings over a planning horizon to the year 2130 (as per MfE, 2022 ⁵).

4.4 Building Foundations

Foundation selection will largely depend on structural loads, however for typical light industrial structures, shallow foundations are anticipated to be suitable. Piled foundations may be adopted by the designers to mitigate specific design risks such as settlement, significant uplift loads, or to support particularly heavy plant or equipment.

4.5 Earthworks

Ground conditions are expected to be suitable for cut material to be re-used as engineered fill. Further investigation and testing should be undertaken during design development to confirm material types, conditioning requirements (if any) and compaction criteria.

4.6 Stormwater Controls

On site soakage is unlikely to be viable considering subsurface conditions above the water table are anticipated to be compromised predominantly of low permeability silts and clays.

Careful consideration must be made with respect to the design and construction of appropriate stormwater disposal systems in order to ensure that they comply with the relevant AS/NZS standards. These systems should serve to collect all storm water runoff from roofs, decks, driveways and paved areas.

Positive surface gradients should be provided adjacent to the proposed building to direct surface water away from foundations and slabs toward suitable discharge facilities. Ponding of surface water should not be allowed adjacent to the building or on pavements. Under no circumstances should any concentrated stormwater runoff be allowed to discharge directly onto the ground or adjacent structures.

⁵ Ministry for the Environment (MfE). (2022). Interim guidance on the use of new sea-level rise projections. Compiled by R.G. Bell with input and reviews by J. Lawrence, T. Naish, R. Levy and, S. Allan and reviewed by the Ministry for the Environment and a few local government practitioners.

5 SUMMARY AND CONCLUSION

Based on the assessment undertaken, we consider the risk to the site posed by natural hazards such as liquefaction, land instability, subsidence, coastal hazards or flood risk to be low (provided adequate setbacks from the coastal slopes bounding the site are maintained), and accordingly, there are no significant geotechnical issues associated with the site which would preclude its use for Light Industrial zoning.

APPLICABILITY AND LIMITATIONS

This report has been prepared solely for the benefit of Campana Landowners Consortium c/- Capstone Projects Limited as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such party's sole risk.

Opinions and judgements expressed herein are based on our understanding and interpretation of current regulatory standards and should not be construed as legal opinions. Where opinions or judgements are to be relied on they should be independently verified with appropriate legal advice.

All maps, plans, and figures included in this report are indicative only and are not to be used or interpreted as engineering drafts. Do not scale any of the maps, plans or figures in this report. Any information shown here on maps, plans and figures should be independently verified on site before taking any action. Sources for map and plan compositions include LINZ Data and Map Services and local council GIS services. For further details regarding any maps, plans or figures in this report, please contact Babbage Consultants Limited.

Recommendations and opinions in this report are based on data from previous investigations undertaken by others as discussed within this report. The nature and continuity of subsoil conditions away from the boreholes are inferred; actual conditions may vary considerably from the assumed model.

Appendix A

Site Plan





Legend

Services

RNZ Liquid Fuels Pipeline Marsden to Wiri

Soil & Rock Consultants CPT

Bank erosion / Slope instability

Hydrology

Overland Flow Paths - 100ha and above
(25,000)

Overland Flow Paths - 3ha to 100ha
(25,000)

Overland Flow Paths - 1ha to 3ha (15,000)

Overland Flow Paths - 4000m2 to 1ha
(8,000)

Overland Flow Paths - 2000m2 to 4000m2
(5,000)

NZGD - NewZealand Geotechnical Database

InvestigationLog

Borehole

CPT

TestPit

Contours

Contours 0.25m

Site Boundary

0 50 m 100 m
LINZ CC BY 4.0 © Imagery Basemap contributors, , public



Produced by **Datanest.earth**

Title: Site Plan		
Client: Campana Landowners Consortium c/ Capstone Projects Limited		Figure No.: 1 Size: A3
Project: Campana Road Plan Change	Drawn: A.N	
Date: 15-11-2023	Checked: J.M	
Proj No.: 66948#GE	Scale: 1:5000	Version: A

Appendix B

Available Geotechnical Data



BOREHOLE LOG

 PO Box 76477
 Manukau City 2241
Site Identification: **S52**

Sheet 1 of 2

Project: Hunua 4	Coordinates: E 405948.81, N 786916.21	Datum: MtEden2000
Client: WaterCare	Surface RL (m): +8.3m	Total Depth: 20.0m
Site: 437 Puhinui Road	Commenced: 11-Sep-09	Contractor: DCN Drilling Ltd
Job No.: 51-27301-24-00	Completed: 11-Sep-09	Driller: Antoni Temperly

Equipment: Tractor	Inclination: -90	Logged: LW
Shear Vane: Geo 946	Comments: Estimated Coordinates only, Location not surveyed	Processed: AS
Bore Diameter (mm): 96		Checked: MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES
	Vacuum	0						Vacuum extraction							
1.5															
1.5		100				SC		Clayey fine SAND; brown/orange.	M	'L'					SPT S52.01 1.2, 2.1, 0.1, [N=4]
2.5						SP		SAND (medium); brown/yellow speckled black and brown. DILATANT.	M-W	'L'					
2.5		100				SP		SAND (medium); brown/orange mottled brown.	M	'L'					
2.5						SC		Silty clayey fine SAND; brown/orange.	M	L					
2.5						SP		SAND (medium), with minor silt; grey. Poorly graded.	M	'L'					SV SPT S52.02 1.0, 0.1, 0.2, [N=3]
2.5		57				SP		SAND (medium); brown/orange. Poorly graded.	M	'L'					
2.5						SP		SAND (medium); light brown/grey. Interbedded with silty CLAY; orange. Soft, moist, highly plastic.	M	'L'					SPT S52.03 1.0, 1.1, 2.1, [N=5]
2.5		100				SM		Fine sandy SILT; pale grey. Non-plastic.	M	St					
2.5								Coreloss							
2.5		0													
2.5															
2.5		100				CL		Clayey SILT; dark grey. Below 6.3 m becomes stiff.	W	S					SPT S52.04 1.5, 6.4, 4.3, [N=17]
2.5						ML		SILT; light white grey. Non-plastic.	M	VSt					
2.5						SM		Silty SAND (medium); brown/grey.	M	'L'					
2.5		100				SW		SAND (fine to medium) with minor silt; brown/grey.	M	'L'					
2.5						CL		Silty CLAY, with minor fine sand; blue/grey. Moderately plastic.	M	VSt					SPT S52.05 2.3, 3.4, 5.5, [N=17]
2.5		100				CH		Silty CLAY; green/grey. Moderately-highly plastic.	M	VSt					
2.5															
2.5		100				ML		Clayey SILT with minor fine sand. Slightly plastic.	M	VSt					SV 56/8 SPT S52.06 1.0, 2.0, 1.1, [N=4]
2.5															
2.5		100													

BOREHOLE LOG NZ ALT 51-28033-HUNUA 4.GPJ NZ GINT DATA TEMPLATE VER 1.3.GDT 5/2/10



BOREHOLE LOG

PO Box 76477
Manukau City 2241

Site Identification: **S52**

Sheet 2 of 2

Project: Hunua 4 **Coordinates:** E 405948.81, N 786916.21 **Datum:** MtEden2000
Client: WaterCare **Surface RL (m):** +8.3m **Total Depth:** 20.0m
Site: 437 Puhinui Road **Commenced:** 11-Sep-09 **Contractor:** DCN Drilling Ltd
Job No.: 51-27301-24-00 **Completed:** 11-Sep-09 **Driller:** Antoni Temperly

Equipment: Tractor **Inclination:** -90 **Logged:** LW
Shear Vane: Geo 946 **Comments:** Estimated Coordinates only, Location **Processed:** AS
Bore Diameter (mm): 96 not surveyed **Checked:** MB

Depth (m) [Elev.]	Drilling Method	Cone Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES
10.4 (12.1)		100					ML x x x	Clayey SILT with minor fine sand. Slightly plastic.	M	VSt					
11.1		0					SP	Alternating bands of medium SAND; grey, with clayey SILT; grey/brown. Stiff, moist, slightly plastic. Between 11.3 - 11.6 m becomes wet.	M	'L'					SPT S52.07 1.1, 1.2, 3.3, [N=9] 11
12.0 (13.7)		100					ML x x x	Clayey SILT; brown/grey. Slightly plastic.	M	St					
12.5 (14.2)		100					SP	SAND (medium); brown/grey. Poorly graded. Interbanded with clayey SILT; grey/brown. Stiff, moist, slightly plastic.	M	'L'					SPT S52.08 1.1, 1.2, 1.2, [N=6] 12
13.2 (14.9)		100					ML x x x	SILT with minor clay; green/grey. Non-plastic, slightly plastic.	M	VSt					
13.5 (15.2)		100					SM x x x	Silty SAND (medium); green/grey.	M	MD					
14.0 (15.7)		100					SM x x x	SAND (fine to medium); green/grey.	M	VSt					
14.5 (16.2)		100					SP	SAND (fine to medium); green grey. Poorly graded. Below 14.8 m becomes brown/grey.	M	'MD'					
15.0 (16.7)		100					SP	SAND (medium to coarse); grey. Poorly graded. Below 16.0 m drilling disturbed and becomes banded grey with dark green grey.	M	D					SPT S52.10 3.4, 9.11, 13.13, [N=46] 15
16.0 (17.7)		100					SP	Coarse SAND; dark grey. Poorly graded.	M	D					
17.0		100													SPT S52.11 3 for 5mm 8.17, 18.17, 3.3, [N=50+] 17
18.0		100													SPT S52.12 9 for 25mm (SOLID) 6.7, 8.13, 20.9, [N=50] 18
19.0		100													
20.0		100						Between 19.4-19.4 m contains some clay.							SPT S52.13 20 for 30mm SOLID 20.3, 20.3, 20.3, [N=50+] 20
Termination Depth = 20m, Target Depth															

6515339/206

Hunua No. 4 Pipeline Project



Box 1

0.00 to 4.50 m



Box 2

4.50 to 8.00 m

6515339/206

Hunua No. 4 Pipeline Project



Box 3

8.00 to 10.50 m



Box 4

10.50 to 13.50 m

6515339/206

Hunua No. 4 Pipeline Project



Box 5

13.50 to 15.70 m



Box 6

15.70 to 19.10 m

6515339/206

Hunua No. 4 Pipeline Project



Box 7

19.10 to 20.0 m



BOREHOLE LOG

PO Box 76477
Manukau City 2241

Site Identification: **S53**

Sheet 1 of 2

Project: Hunua 4	Coordinates: E 405863.57, N 786878.46	Datum: MtEden2000
Client: WaterCare	Surface RL (m): +5.7m	Total Depth: 20.0m
Site: SE corner 457 Puhinui Road.	Commenced: 11-Sep-09	Contractor: DCN Drilling Ltd
Job No.: 51-27301-24-00	Completed: 11-Sep-09	Driller: Antoni Temperly

Equipment: Tractor	Inclination: 90	Logged: AS
Shear Vane: Geo 902	Comments: Estimated Coordinates only, Location not surveyed	Processed: AS
Bore Diameter (mm): 96		Checked: MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name (minor MAJOR), colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES
0	Hand	0			AVF			HAND EXCAVATED.							
1.15 1.35		100				MH	x x x x	Clayey SILT; orange/brown. Moderately plastic. (Ash)	M	St					SPT S54.01 1.1, 1.1, 1.3, [N=6]
1.22 1.39		100				ML	x x x x	Clayey SILT; orange/yellow. Slightly plastic. (Ash)	M	St					
1.27 1.34		100				CL	x x x x	Silty CLAY; pale brown layered red/black/grey. Moderately plastic.	M	St					
1.30 1.37		100				ML	x x x x	Clayey SILT; pale grey mottled orange/blue. Slightly plastic.	M	St					SV 99/29 SPT S54.02 1.1, 1.1, 1.2, [N=5]
1.35 1.42		80				SC	x x x x	Clayey SAND (fine); pale grey mottled orange/brown. Poorly graded, uncemented.	M	'L'					
1.47 1.54		100				SP	x x x x	SAND (fine to medium); orange/brown/pale grey. Poorly graded, uncemented.	M	L					SV 117/15 SPT S54.03 0.1, 0.1, 2.2, [N=5]
1.49 1.56		100				SP	x x x x	Intermixed SAND (medium to coarse); blue/grey, poorly graded, uncemented AND clayey SAND (fine to medium). At 5.5 m contains some fibrous organic inclusions. Below 5.8 m becomes very loose, wet and DILATANT.	M	L					
1.53 1.60		100				ML	x x x x	Clayey SILT with minor fine sand; brown/grey. Slightly plastic.	M	St					SPT S54.04 0.0, 1.0, 1.0, [N=2]
1.59 1.66		100				SP	x x x x	SAND (fine to medium) with minor clay; grey. Poorly graded, uncemented.	M	VL					
1.71 1.78		100				ML	x x x x	Fine sandy, clayey SILT; grey/brown. Slightly plastic.	M	St					SPT S54.05 0.0, 0.4, 2.2, [N=8]
1.79 1.86		100				ML	x x x x	Fine sandy SILT; white. Non plastic. DILATANT.	M	H					
1.82 1.89		100				SP	x x x x	SAND (fine to medium); brown/black. Poorly graded, uncemented. Contains some fibrous and amorphous organic inclusions. DILATANT.	M	'VL'					
1.84 1.91		100				SP	x x x x	Interbedded SAND (fine to medium); blue/green, poorly graded, uncemented AND clayey SILT; blue/green, very stiff, moist, slightly plastic.	M	L					SPT S54.06 1.1, 2.2, 3.2, [N=9]
1.94 2.01		100													

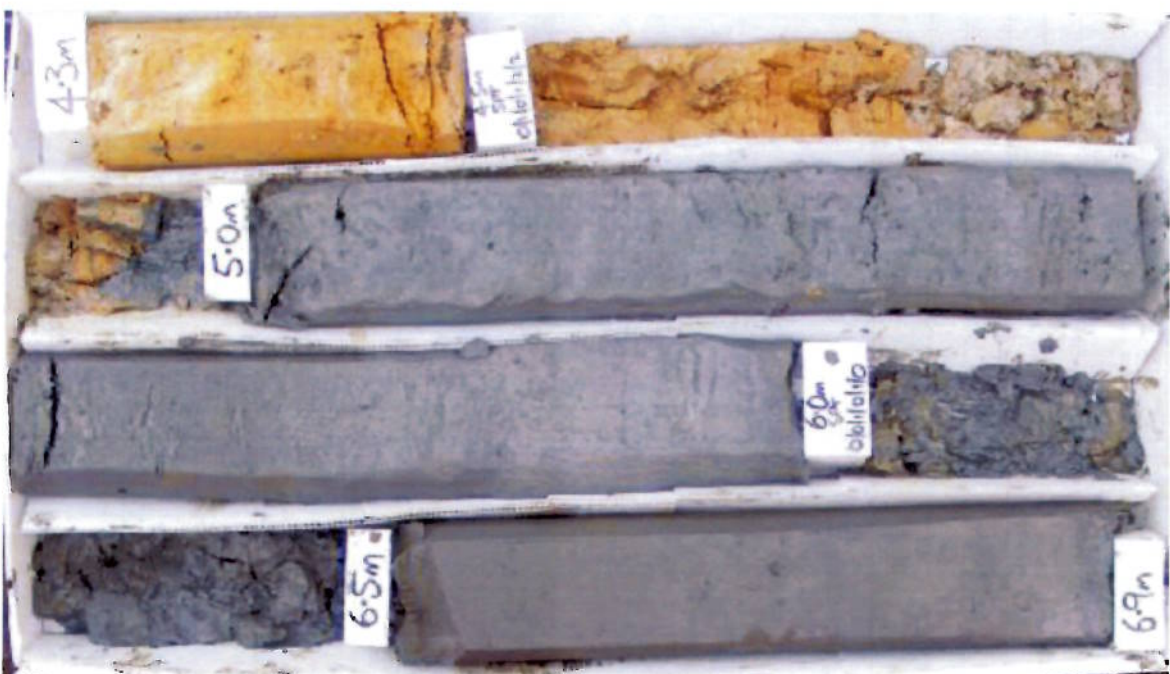
6515339/206

Hunua No. 4 Pipeline Project



Box 1

0.00 to 4.30 m

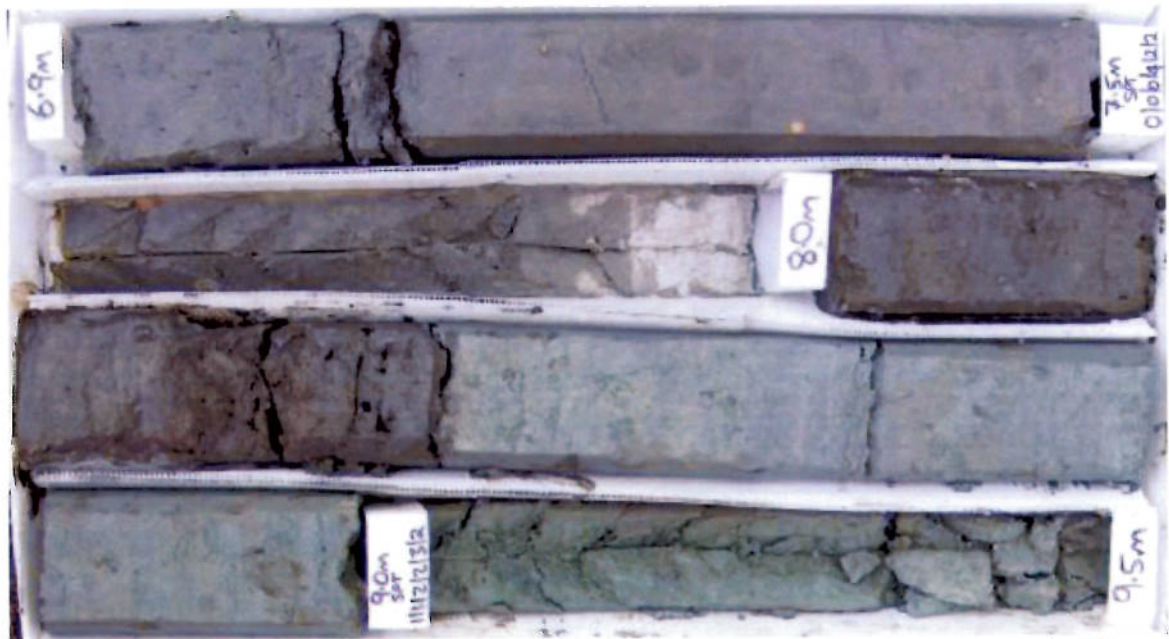


Box 2

4.30 to 6.90 m

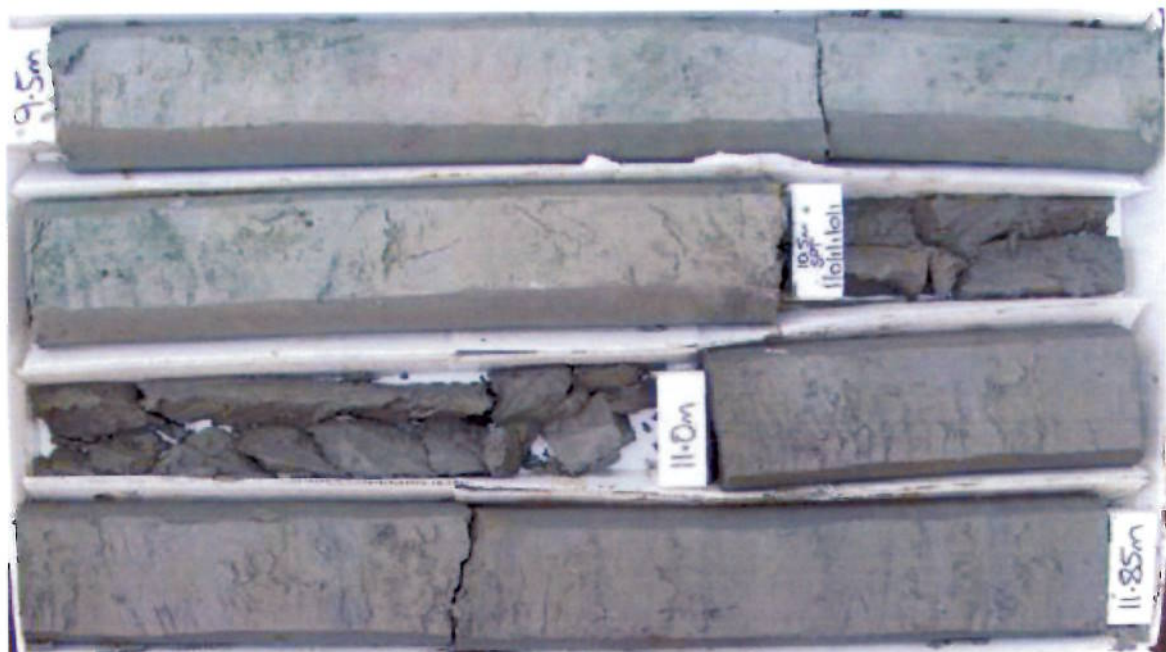
6515339/206

Hunua No. 4 Pipeline Project



Box 3

6.90 to 9.50 m

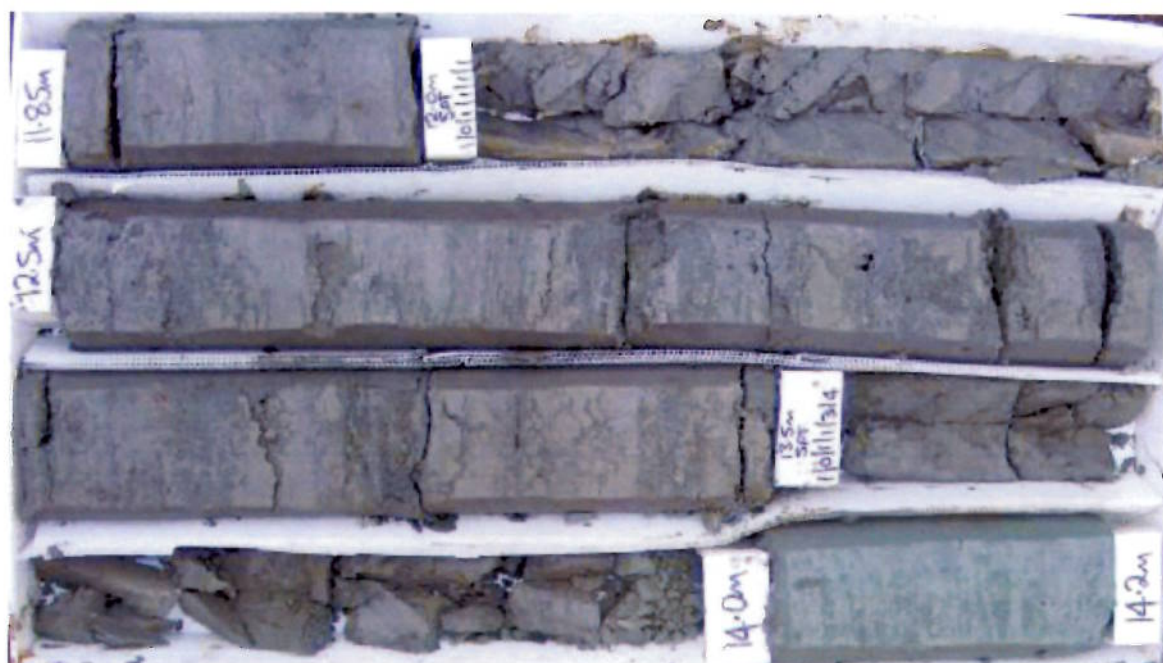


Box 4

9.5 to 11.85 m

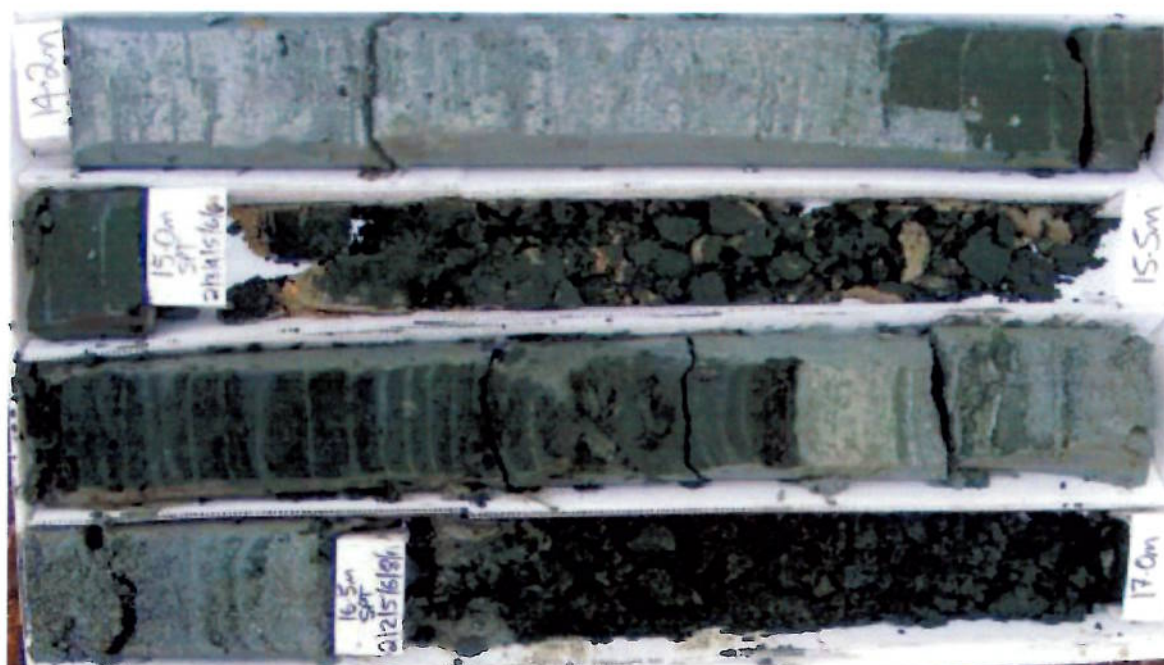
6515339/206

Hunua No. 4 Pipeline Project



Box 5

11.85 to 14.20 m

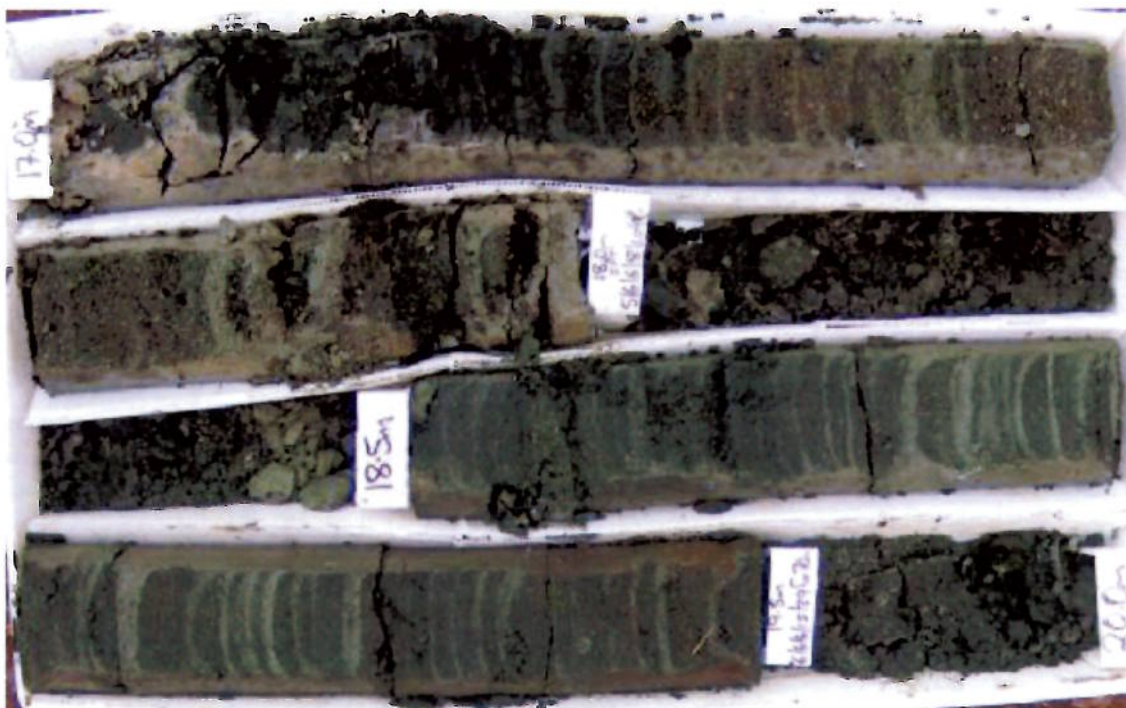


Box 6

14.20 to 17.00 m

6515339/206

Hunua No. 4 Pipeline Project



Box 7

17.00 to 20.00 m



BOREHOLE LOG

PO Box 76477
Manukau City 2241

Site Identification: **S54**

Sheet 3 of 3

Project: Hunua 4

Client: WaterCare

Site: SW corner 457 Puhinui Road.

Job No.: 51-27301-24-00

Coordinates: E 405735.69, N 786822.83

Surface RL (m): +9.0m

Commenced: 14-Sep-09

Completed: 14-Sep-09

Datum: MtEden2000

Total Depth: 20.2m

Contractor: DCN Drilling Ltd

Driller: Antoni Temperly

Equipment: Tractor

Inclination: 90

Logged: AS

Shear Vane: Geo 902

Comments: Estimated Coordinates only, Location not surveyed

Processed: AS

Bore Diameter (mm): 96

Checked: MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating	
20.2 [+9.0]		100				SP		Termination Depth = 20.2m, Target Depth	M	VD						5.5, 10.11, 13.15, [N=49]
21																
22																
23																
24																
25																
26																
27																
28																
29																
30																

6515339/206

Hunua No. 4 Pipeline Project



Box 1

0.00 to 3.85m

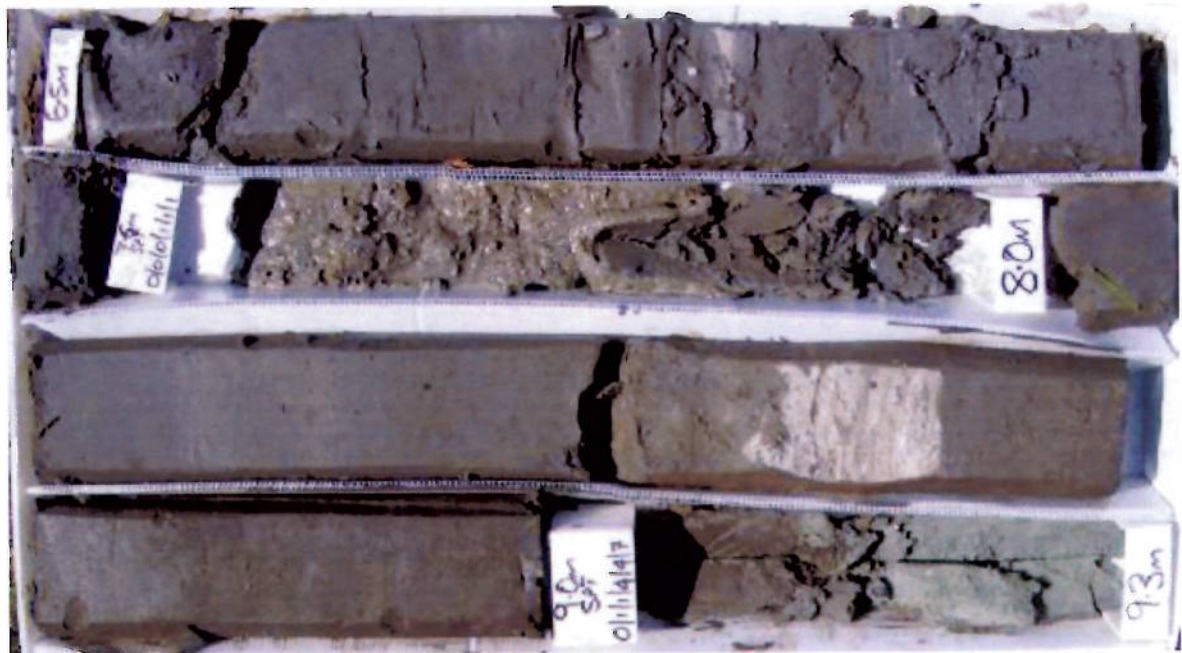


Box 2

3.85 to 6.50 m

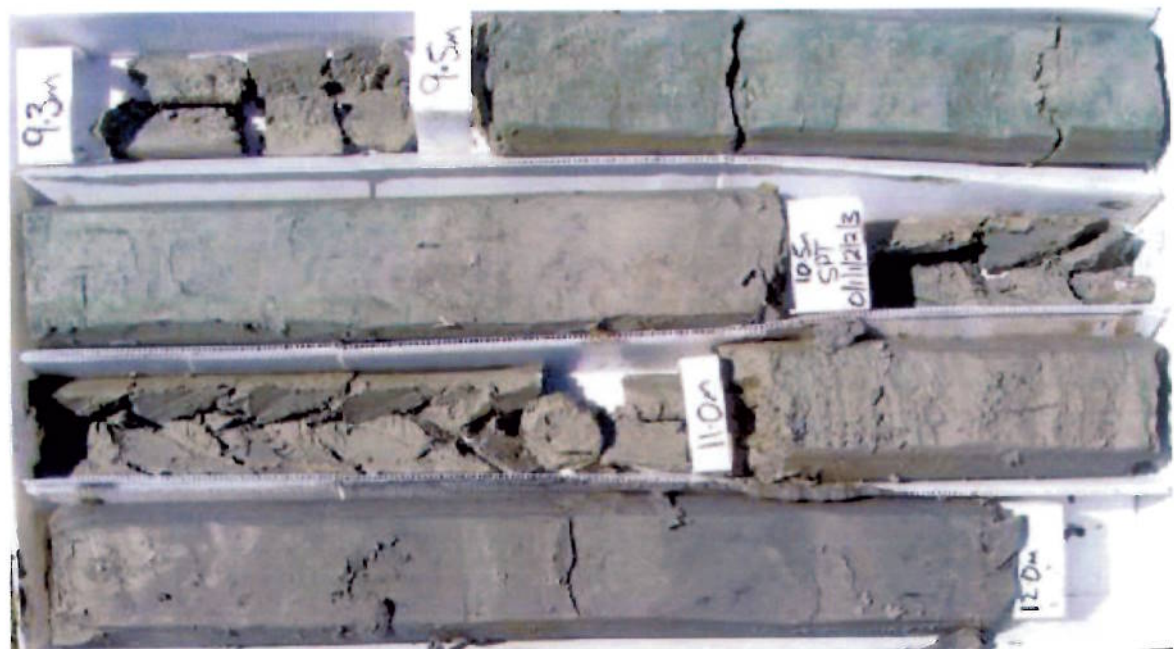
6515339/206

Hunua No. 4 Pipeline Project



Box 3

6.50 to 9.30 m



Box 4

9.30 to 12.00 m

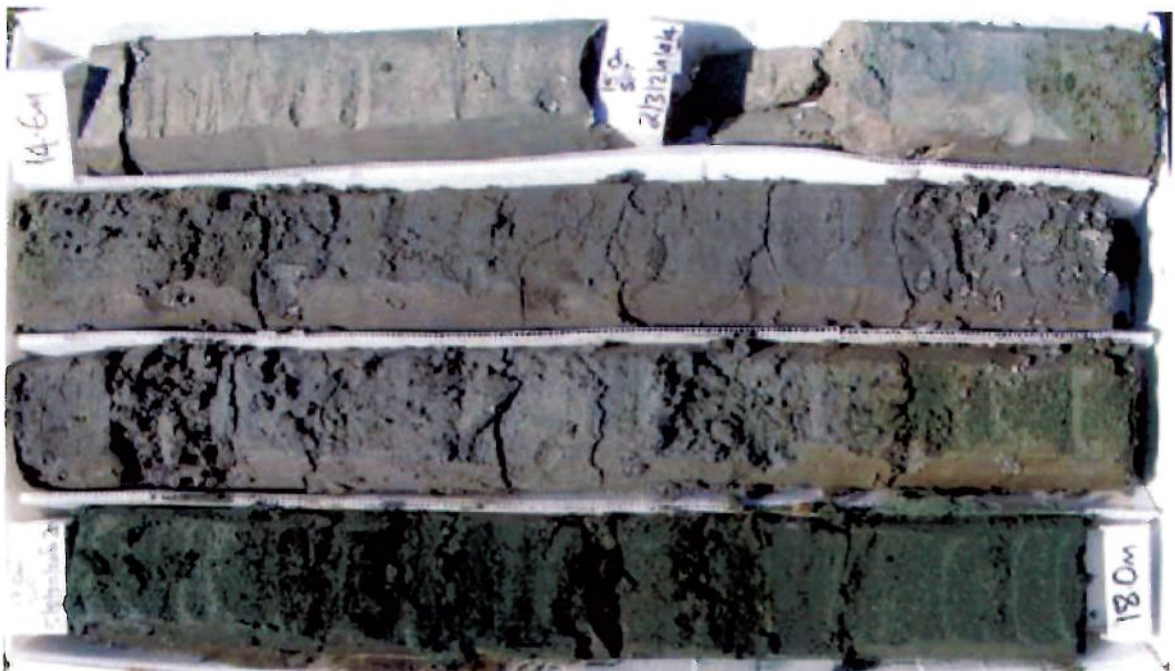
6515339/206

Hunua No. 4 Pipeline Project



Box 5

12.00 to 14.60 m

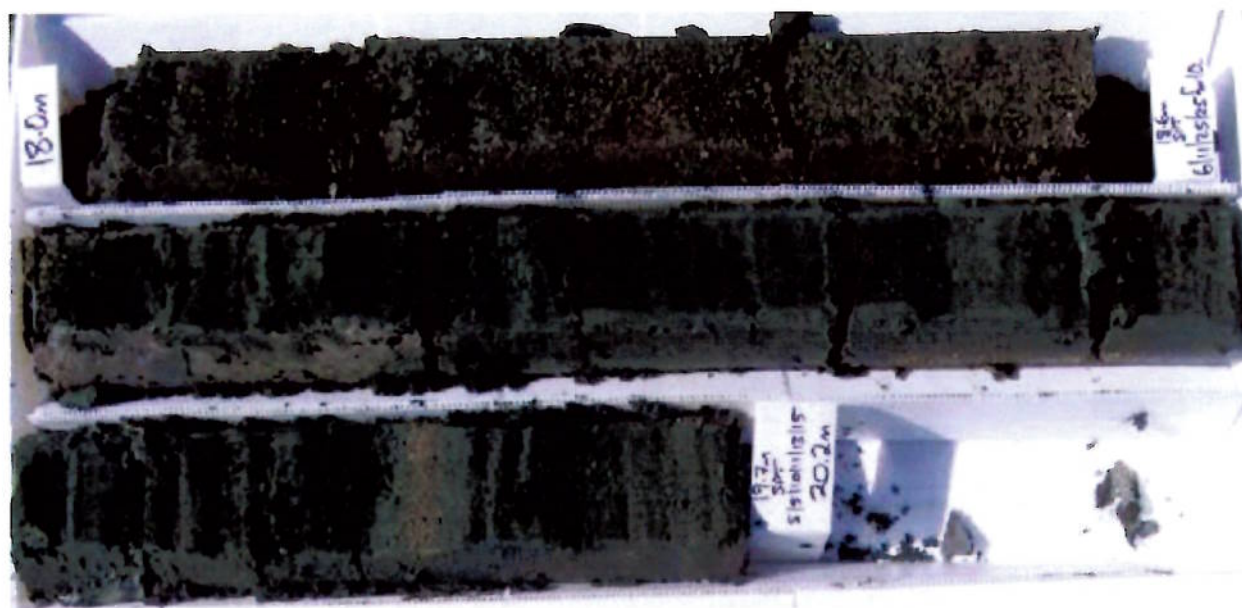


Box 6

14.60 to 18.00 m

6515339/206

Hunua No. 4 Pipeline Project



Box 7

18.00 to 20.20 m



BOREHOLE LOG

 PO Box 76477
 Manukau City 2241
Site Identification: **S55**

Sheet 2 of 2

Project: Hunua 4 **Coordinates:** E 405673.14, N 786800.55 **Datum:** MtEden2000
Client: WaterCare **Surface RL (m):** +11.5m **Total Depth:** 20.0m
Site: Corner Crawford Ave and Miro St **Commenced:** 15-Sep-09 **Contractor:** DCN Drilling Ltd
Job No.: 51-27301-24-00 **Completed:** 15-Sep-09 **Driller:** Antoni Temperly

Equipment: Tractor **Inclination:** 90 **Logged:** AS
Shear Vane: Geo 902 **Comments:** Estimated Coordinates only, Location **Processed:** MB
Bore Diameter (mm): 96 not surveyed **Checked:** MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	EW VW WS ES VS ES	Estimated Rock Strength	RQD (%)	Defect Spacing (mm) 20 60 200 600 2000	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating				
10.9 [+11.5]	Open Barrel	100	None		Puketoka Fm	SC		Clayey SAND; brown/grey. Uncemented, poorly graded, contains some fibrous organic inclusions.	M	VL						SPT S55.06 1.0, 0.1, 1.1, [N=3]				
11.1 [+11.3]		ML					SILT: white. Non-plastic, DILATANT.	W	H											
11.2 [+11.2]		SC					Clayey SAND; brown/grey. Uncemented, poorly graded, contains some fibrous organic inclusions.	M	VL											
12.0 [+10.4]		ML					Interbedded fine sandy SILT, blue green, slightly plastic and silty SAND, blue green, 'loose', moist, uncemented, poorly graded	M	VSt											
12.4 [+10.0]		CL					Interbedded silty CLAY, brown, moderately plastic and silty SAND (fine), green blue, 'loose', moist, uncemented, poorly graded.	M	VSt											
13.2 [+9.2]		CL					Silty CLAY; brown mottled green. Slightly to moderately plastic.	M	VSt											
13.3 [+9.1]		ML					Clayey SILT; brown/green. Slightly plastic, contains some fibrous organic inclusions.	M	VSt											
14.3 [+8.1]						100						At 14.3 m fibrous organic horizon. Below 14.4 m becomes green brown.								SV 117/17 SPT S55.08 1.0, 1.1, 1.2, [N=5]
15.0 [+7.4]						100														SV 124/26
16.1 [+6.3]						100				ML		Clayey fine sandy SILT; blue/green. Non-plastic.	M	VSt						SV 124/22 SPT S55.09 0.2, 2.2, 4.4, [N=12]
17.0 [+5.4]						100				SM		Silty SAND (fine); green. Uncemented, poorly graded.	M	'MD'						
17.8 [+5.0]						100				SP		SAND (fine); green. Uncemented, poorly graded.	M	MD						SPT S55.10 3.3, 5.4, 7.8, [N=24]
18.8 [+3.6]						100														SPT S55.11 3.4, 6.6, 8.8, [N=28]
19.8 [+2.6]						100														SPT S55.12 for 5 mm 6.13, 16.25, 9.1, [N=50+]
20.0 [+2.4]						0						Termination Depth = 20m. Target Depth		VD						

BOREHOLE LOG NZ ALT 51-28033-HUNUA 4.GPJ NZ GINT DATA TEMPLATE VER 1.3.GDT 5/2/10

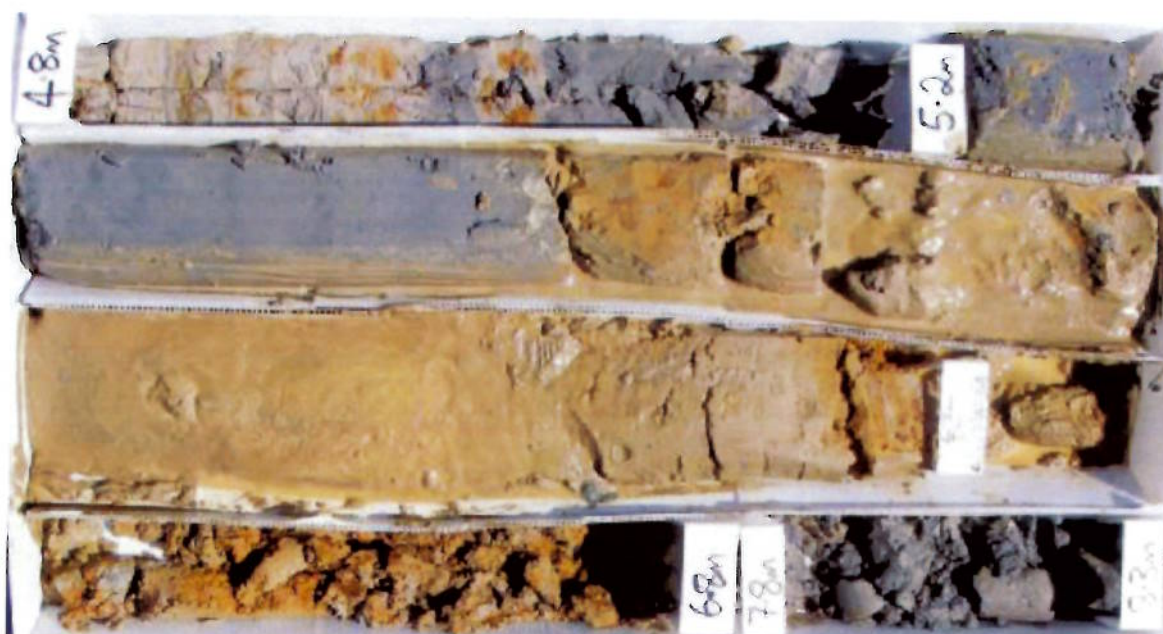
6515339/206

Hunua No. 4 Pipeline Project



Box 1

0.00 to 4.80 m

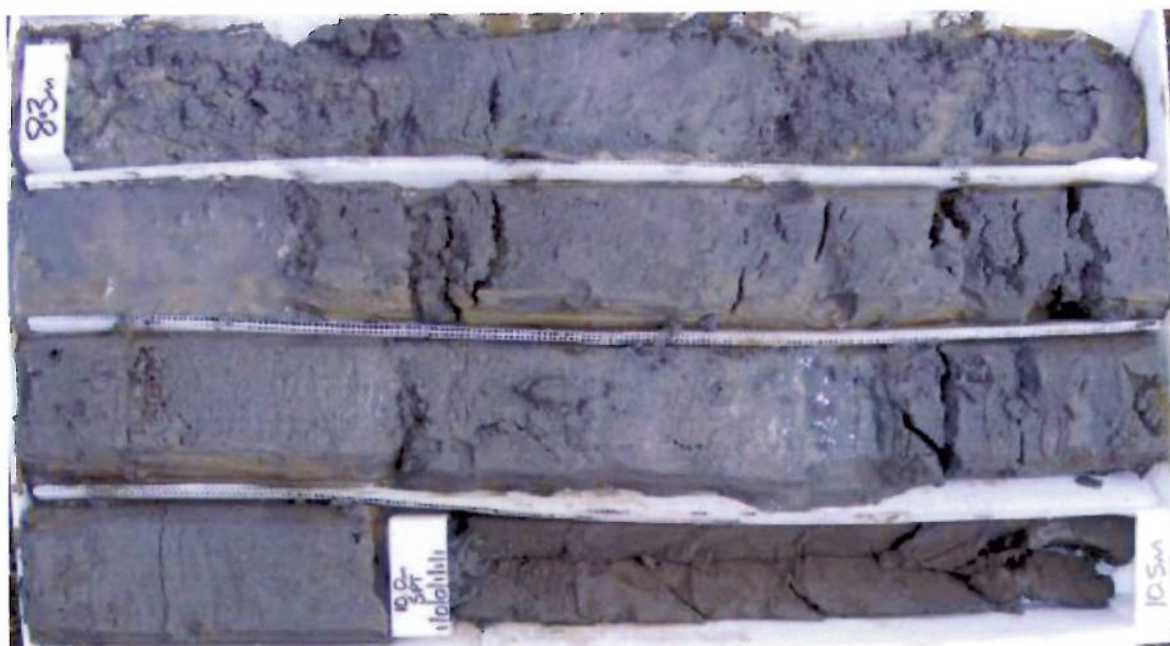


Box 2

4.80 to 8.30 m

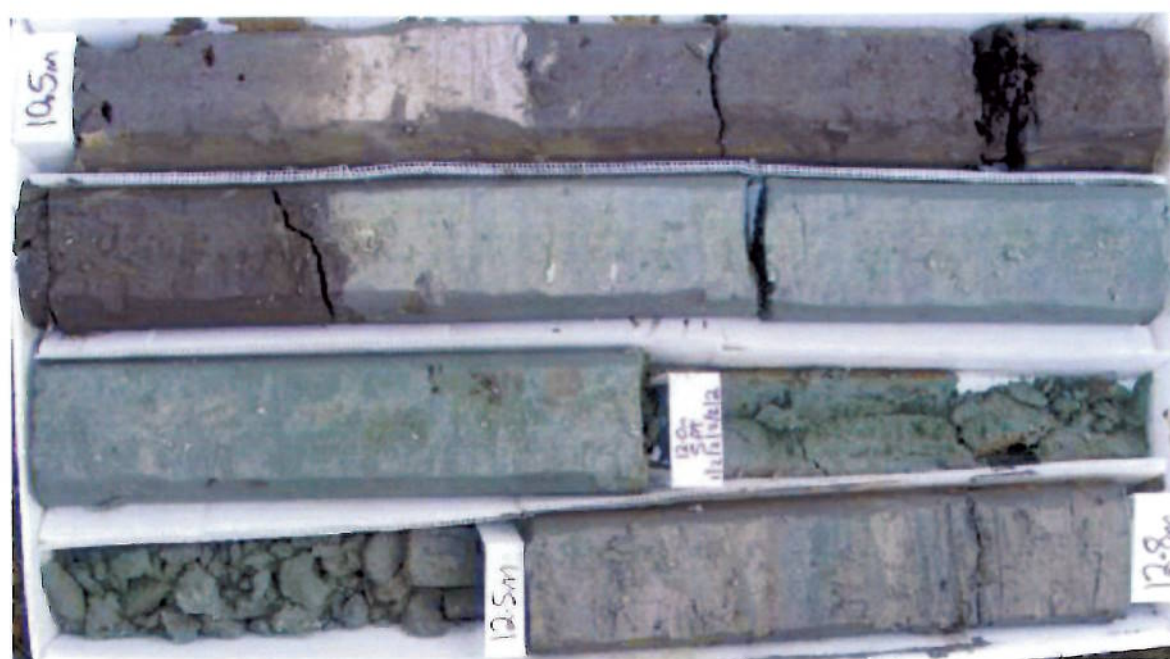
6515339/206

Hunua No. 4 Pipeline Project



Box 3

8.30 to 10.50 m

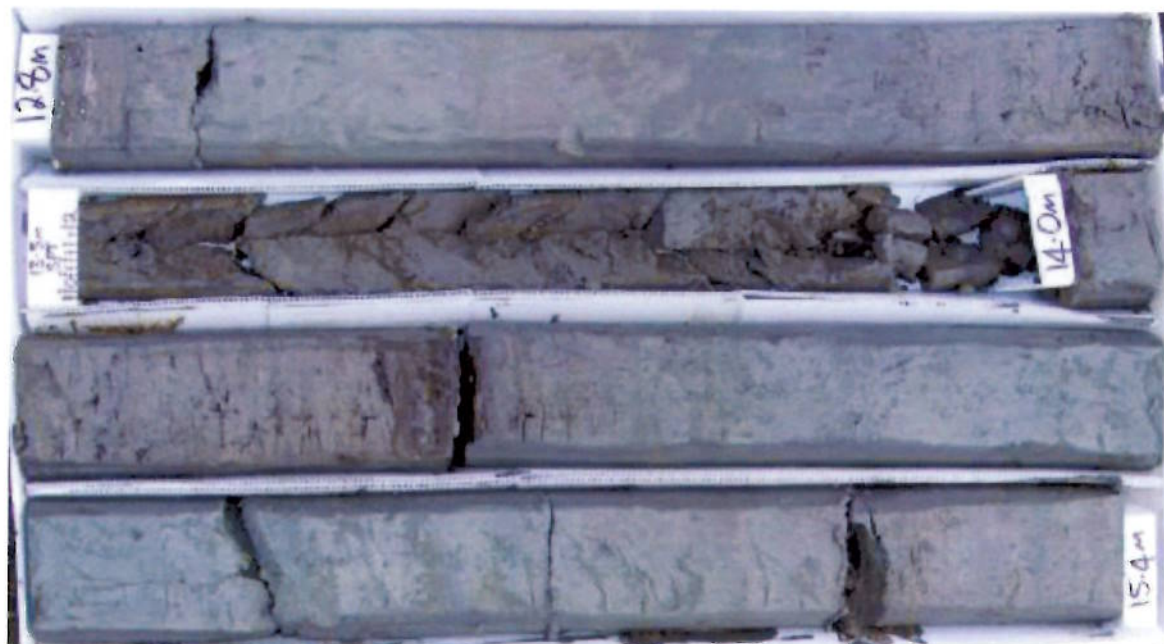


Box 4

10.50 to 12.80 m

6515339/206

Hunua No. 4 Pipeline Project



Box 5

12.80 to 15.40 m

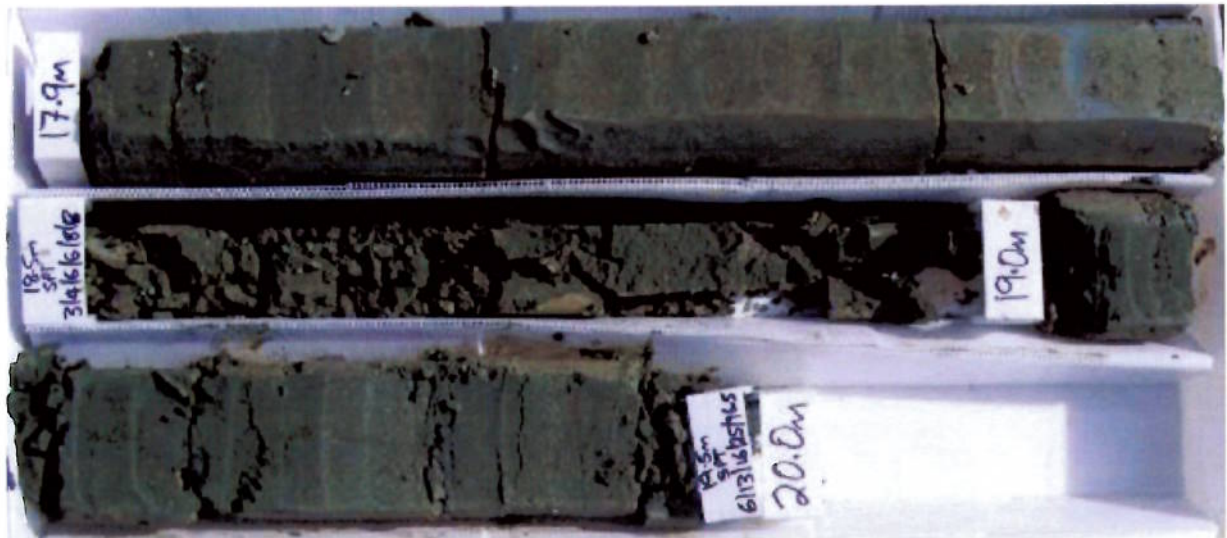


Box 6

15.40 to 17.90 m

6515339/206

Hunua No. 4 Pipeline Project



Box 7

17.90 to 20.00 m



GHD Limited

BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S132P**

Sheet 1 of 1

Project:	Hunua 4	Coordinates: E 405492.6, N 786776.85	Datum: MtEden2000
Client:	WaterCare	Surface RL (m): +14.0m	Total Depth: 8.0m
Site:	SH20 and Campana	Commenced: 13-Nov-09	Contractor: DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed: 13-Nov-09	Driller: Lance Vuglar

Equipment: Tractor	Inclination: 90	Logged: LW
Shear Vane: Geo 902	Comments: Estimated Coordinates only, Location not surveyed	Processed: LW
Bore Diameter (mm): 96		Checked: MB

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES	Piezometer	
	Vacuum	0			Fill			VACUUM EXTRACTION									
13 [+12.5]		60				CH		Silty CLAY; trace gravel; grey blotched orange. Moderately plastic	M	VSt						SPT S132.01 1,1, 2,1, 2,3, [N=8]	
19 [+12.1]						ML		Clayey SILT; light grey mottled orange. Slightly plastic, contains trace organics (rootlets).	M	VSt							
21 [+11.6]		100				CH		Silty CLAY, trace sand (fine); grey layered brown and red. Highly plastic. Below 2.6 m becomes light grey layered dark brown	M	VSt						SV 177/44	
30 [+11.0]		100			Alluvium	CL		Sandy CLAY; light grey/white. Slightly plastic.	M	VSt						SV 159/44 2,2, 2,3, SPT S132.02 3,4, [N=12]	
34 [+10.6]		70				SP		SAND (fine), minor silt and clay; light grey. Poorly graded. Below 4.0 m becomes interbedded with silty CLAY, light white/brown, stiff, moist, highly plastic.	M	'L'						SV 76/7	
45 [+9.5]	Open Barrel	100	None	Standing water on drilling completion 4.5 m	Auckland Volcanic Field	SM		Silty SAND, some clay; orange mottled light grey and red. Poorly graded.	M	L						SV 66/15 1,1, 0,1, SPT S132.03 1,1, [N=3]	
47 [+9.3]		SP					SAND (fine), minor silt; red blotched light grey. Poorly graded. Below 5.1 m becomes orange.	M	L						SV 62/3		
55 [+7.9]		SP					SAND (fine to medium); brown mottled grey, speckled black. Poorly graded, contains minor organic speckles. Below 5.5 m becomes orange blotched grey, contains minor clay. Below 6.0 m becomes orange/brown mottled dark brown.	M	L						SPT S132.04 1,0, 1,1, 1,2, [N=5]		
68 [+7.2]		SP					SAND (fine), minor silt; orange/brown. Poorly graded. Below 7.4 m contains organic clasts Below 7.75 m becomes fine to medium gravel.	M	L						SPT S132.05 1,1, 1,2, 3,3, [N=9]		
80 [+6.0]								Termination Depth = 8m, Target Depth									
			</														

6515339/206

Hunua No. 4 Pipeline Project



Box 1

0.00 to 3.50 m



Box 2

3.50 to 6.00 m

6515339/206

Hunua No. 4 Pipeline Project



Box 3

6.0 to 8.0 m



GHD Limited

BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S133P**

Sheet 1 of 1

Project: Hunua 4	Coordinates: E 405387.22, N 787038.73	Datum: MtEden2000
Client: WaterCare	Surface RL (m): +8.4m	Total Depth: 9.0m
Site: Camparna Road	Commenced: 02-Nov-09	Contractor: DCN Drilling Ltd
Job No.: 51-27301-24-00	Completed: 02-Nov-09	Driller: Lance Vuglar

Equipment: Marooka	Inclination: 90	Logged: JA
Shear Vane: Geo 902	Comments: Estimated Coordinates only, Location not surveyed	Processed: LW
Bore Diameter (mm): 96		Checked: MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES	Piezometer
	Vacuum	0			Inferred Fill			VACUUM EXTRACTION							Con S133E.01	
1.5 [+6.9]																
1.6 [+6.8]																
2.0 [+6.4]		100				ML	x x x x	SILT, some sand, minor gravel (fine to medium); dark brown. Non plastic.	M	St					SPT S133E.02	1,1, 1,1, 2,2, [N=6]
2.4 [+6.0]						ML	x x x x	Clayey SILT, trace sand (fine); light brown. Highly plastic?	M	S						
2.6 [+5.8]		100				CH	x x x x	SILT, some fine sand, trace clay; light brown mottled dark brown. Low plasticity.	M	St					SV 95/66	
3.4 [+5.0]						MH	x x x x	Silty CLAY, trace sand (fine); light brown mottled orange. Highly plastic.	M	St						
3.6 [+4.8]		100				Pt	x x x x	Clayey SILT, trace sand (fine); light brown mottled red/blue speckled black. Highly plastic.	M	St					SPT S133E.03	1,1, 2,2, 2,2, [N=8]
4.2 [+4.2]						MH	x x x x	PEAT, some sand (fine to medium), trace clay; dark brown. Low plasticity.	M	F						
5.3 [+3.1]		100				SP	x x x x	SILT, minor sand and clay; light grey mottled grey and red/blue, speckled black. Highly plastic.	M	S						
6.7 [+1.7]						SP	x x x x	Below 4.1 m contains some sand. SAND, some silt, trace clay; light grey mottled orange.	Sat	'MD'						
7.3 [+1.1]		100				SP	x x x x	Below 4.6 m contains trace amorphous organics, mottled black.								
8.4 [+0.0]						SP	x x x x	SAND (fine to medium), minor silt; light grey speckled black. DILATANT, contains mica.	Sat	L					SPT S133.04	1,1, 1,1, 3,3, [N=8]
9.0 [+0.6]		100				ML	x x x x	Below 6.0 m contains some silt.								
						ML	x x x x	SILT, minor sand (fine) and clay; green/grey. Low plasticity.	M	F						
		100				SM	x x x x	Below 7.15 m contains some fine sand. Silty SAND; green/grey speckled black.	M	'MD'					SPT S133.05	1,1, 1,1, 2,2, [N=6]
						SM	x x x x	At 7.5 m moderately thin bed (80 mm) of firm sandy SILT; light grey speckled black (pumacious).								
		100				SP	x x x x	At 8.0 m moderately thin bed of silt, trace clay; green/grey. Low plasticity.								
						SP	x x x x	SAND, some silt; light grey, speckled black.	W	D					SPT S133.06	2,6, 6,6, 12,17, [N=41]
								Termination Depth = 9m, Target Depth								

BOREHOLE LOG NZ ALT 51-28033-HUNUA 4 GPJ NZ GINT DATA TEMPLATE VER 1.3 GDT 5/2/10

6515339/206

Hunua No. 4 Pipeline Project



Box 1

0.0 to 5.45 m



Box 2

5.5 to 9.0 m



BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S134P**

Sheet 1 of 2

Project:	Hunua 4	Coordinates:	E 405284.37, N 787274.65	Datum:	MtEden2000
Client:	WaterCare	Surface RL (m):	+10.0m	Total Depth:	20.0m
Site:	Camparna Road	Commenced:	02-Nov-09	Contractor:	DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed:	06-Nov-09	Driller:	Lance Vuglar

Equipment:	Marooka	Inclination:	90	Logged:	JA
Shear Vane:	Geo 902	Comments:	Estimated Coordinates only, Location not surveyed	Processed:	LW
Bore Diameter (mm):	96			Checked:	MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES	Piezometer
	Vacuum	0		Nov 09 water level	Inferred Fill			VACUUM EXTRACTION							Con S134E.01	
100					AVF	ML	x x x	SILT, some sand, minor gravel (fine to medium); light brown to dark brown. Interbedded with thin lenses of gravel (fine to medium). Below 1.4 m becomes Firm.	M	S					SPT S134E.02 4.7, 8.9, 4.5, [N=26]	
60						ML	x x x	Sandy SILT, trace gravel (fine); brown mottled light brown. Non plastic. Below 1.8 m becomes dark brown, some organic SILT.	M	St						
100						ML	x x x	Sandy SILT, dark blue/grey. Non plastic.	M	S						
100						ML	x x x	SILT, minor sand, trace clay; brown speckled black. Low plasticity, SENSITIVE.	M	F					SPT S134E.03 0.1, 0.1, 1.1, [N=3]	
100						ML	x x x	Clayey SILT; light brown speckled black. Low plasticity, SENSITIVE Below 3.6 m becomes light blue mottled light brown.	M	St					SV 89/29	
100						SM	x x x	Below 5.2 becomes light brown mottled light blue/grey Silty SAND, light blue mottled brown. At 5.65 m thin bed of SILT; light brown.	M	L					SV 88/26 1.2, 2.3, 2.3, [N=10]	
100						SP	x x x	SAND, some silt; light blue. DILATANT. At 6.1 m thin bed of SILT, light brown, very stiff, moist, non plastic.	Sat	L					SV 146/35 1.0, 1.1, 2.2, [N=6]	
100						ML	x x x	At 7.3 m very thin bed of SILT; light brown, very stiff, moist, non plastic. Below 7.5 m becomes light blue/grey.	M	St					SPT S134E.06 1.1, 2.4, 4.6, [N=16]	
100						SM	x x x	Silty SAND; blue/grey. Contains mica.	Sat	'MD'						
100						ML	x x x	SILT, trace sand (fine) and clay; brown/grey. Low plasticity.	M	St					SPT S134E.07 3.3, 4.3, 5.5, [N=17]	

BOREHOLE LOG NZ ALT 51-28033-HUNUA 4 GPJ NZ GINT DATA TEMPLATE VER 1.3 GDT 5/2/10



BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S134P**

Sheet 2 of 2

Project:	Hunua 4	Coordinates:	E 405284.37, N 787274.65	Datum:	MtEden2000
Client:	WaterCare	Surface RL (m):	+10.0m	Total Depth:	20.0m
Site:	Camparna Road	Commenced:	02-Nov-09	Contractor:	DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed:	06-Nov-09	Driller:	Lance Vuglar

Equipment:	Marooka	Inclination:	90	Logged:	JA
Shear Vane:	Geo 902	Comments:	Estimated Coordinates only, Location not surveyed	Processed:	LW
Bore Diameter (mm):	96			Checked:	MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating	Piezometer
10.3 (0.3)		100					ML	SILT, trace sand (fine) and clay; brown/grey. Low plasticity.	M	St						
10.5 (0.5)							SM	Silty SAND; green/grey.	M	'L'						
11		0					ML	Sandy SILT; grey mottled dark brown. Low plasticity. Below 10.9 m becomes dark brown.	M	VSt					SPT S134E.08 0.1, 0.1, 1.1, [N=3]	11
11.5 (1.5)							OL	Organic SILT, trace clay; very dark brown. Low plasticity.	M	VSt					SV 164/29	
11.9 (1.9)							MH	Below 11.8 m contains sand (fine) laminations, light brown/grey, moist. Clayey SILT; grey mottled light grey. Highly plastic. Below 12.3 m contains minor sand. Below 12.5 m contains trace fibrous organics. Below 12.7 m contains trace sand.	M	St					SPT S134E.09 1.2, 3.3, 4.5, [N=15]	12
12.3 (2.3)							ML	Clayey SILT, green/grey. Low plasticity, SENSITIVE	M	VSt					SV 189/35	13
14.0 (4.0)		0					ML	SILT; red/brown. Non plastic.	M	F					SV 163/28 1.1, 2.2, [N=8]	14
14.3 (4.3)							ML	Clayey SILT; blue/grey mottled light brown. Low plasticity	M	H					SV 205+	
15								Below 14.9 m contains trace sand Below 15.3 m minor fine sand. Below 15.6 m contains some sand.							SV 205+ 3.4, 5.4, 5.7, [N=21]	15
16		100														16
16.3 (6.3)							ML	SILT, minor sand; blue/grey. Non plastic.	M	VSt					SPT S134E.12 6.7, 7.8, 10.12, [N=37]	17
17								Below 17.1 m contains some sand. Below 17.5 m contains trace amorphous organics.								17
17.9 (7.9)		100					SM	Silty SAND, blue/grey. Contains trace organics.	M	VD					SPT S134E.13 for 25 mm 4.7, 10.16, 18.10, [N=50+]	18
19		0														19
19.6 (9.6)		100					SP	SAND, trace silt and coarse gravel; blue/grey.	M	VD					SPT S134E.14 for 60 mm 21.14, 24.62, *+, [N=50+]	20
20								Termination Depth = 19.95m, Target Depth								20

BOREHOLE LOG NZ ALT 51-28033-HUNUA 4 GPJ NZ GINT DATA TEMPLATE VER 1.3 GDT 5/2/10

6515339/206

Hunua No. 4 Pipeline Project



Box 1

0.0 to 3.7 m



Box 2

3.7 to 7.0 m

6515339/206

Hunua No. 4 Pipeline Project



Box 3

7.0 to 10.0 m



Box 4

10.0 to 12.70m

6515339/206

Hunua No. 4 Pipeline Project



Box 5

12.7 to 15.9 m



Box 6

15.9 to 19.95 m



BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S135P**

Sheet 1 of 4

Project:	Hunua 4	Coordinates:	E 405159.33, N 787471.12	Datum:	MtEden2000
Client:	WaterCare	Surface RL (m):	+5.7m	Total Depth:	35.0m
Site:	Pukaki Creek South	Commenced:	06-Nov-09	Contractor:	DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed:	06-Nov-09	Driller:	Lance Vuglar

Equipment:	Marooka	Inclination:	90	Logged:	JL
Shear Vane:	Geo 902	Comments:	Estimated Coordinates only, Location not surveyed	Processed:	LW
Bore Diameter (mm):	96			Checked:	MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES	Piezometer
95								Clayey SILT, trace sand (fine); dark brown. Highly plastic, contains trace organics (rootlets).	M	H					Con 135E.01	
								Clayey fine sandy SILT, trace fine gravel; brown speckled dark grey/red/brown. Highly plastic. Gravel; sandstone fragments (breaks under finger pressure). Silty SAND (fine), some clay; brown.	M	St					SV 205+	
								At 1.15 m and 1.3 m, thin (50 mm) bed of fine to medium gravelly SAND (fine to medium); red/brown speckled black, moist.							SV 98/15	
100								Fine to medium gravelly SAND (fine to medium); red/brown speckled black. Non plastic. Gravel; angular to subangular dark grey sandstone.	M	MD					SV 56/13 SPT 135E.02 1.1, 3.4, [N=9]	
58								Below 2.7 m contains some clay. At 2.85 m thin (60 mm) bed of hard SILT (dark green).							SV 89/18	
100															SV 79/19 SPT 135E.03 2.2, 3.3, 5.5, [N=16]	
100								Silty CLAY; dark grey. Highly plastic.	W	F					SV 41/10 U(50) S135.04	
100								Clayey SILT, trace sand (fine); light grey/blue. Highly plastic.	W	St?					SPT S135.05 0.0, 1.1, 1.2, [N=5]	
100								Silty SAND (fine), some clay; light blue. Highly plastic. Below 5.4 m becomes stained yellow/grey. Below 5.6 m contains trace clay. Becomes non plastic.	W	MD					SV 175/34 SPT 135.06 1.0, 1.3, 3.4, [N=11]	
100															SPT 135.07 1.1, 2.3, 5.7, [N=17]	
78								Below 9.0 m becomes dense	D						SPT 135.08 3.6, 7.8, 10.10, [N=35]	
100								At 9.5 m thin (50 mm) bed of cemented sand.								
77								Clayey SILT, trace fine sand; grey/brown. Highly plastic. Micaceous.	W							

BOREHOLE LOG NZ ALT 51-28033-HUNUA 4 GPJ NZ GINT DATA TEMPLATE VER 1.3 GDT 5/2/10



BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S135P**

Sheet 2 of 4

Project:	Hunua 4	Coordinates:	E 405159.33, N 787471.12	Datum:	MtEden2000
Client:	WaterCare	Surface RL (m):	+5.7m	Total Depth:	35.0m
Site:	Pukaki Creek South	Commenced:	06-Nov-09	Contractor:	DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed:	06-Nov-09	Driller:	Lance Vuglar

Equipment:	Marooka	Inclination:	90	Logged:	JL
Shear Vane:	Geo 902	Comments:	Estimated Coordinates only, Location not surveyed	Processed:	LW
Bore Diameter (mm):	96			Checked:	MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating	Piezometer
77						MH			W							
100						SM		Silty SAND (fine), trace clay; grey/brown. Below 10.4 m becomes stripped light grey.	W	'MD'					SPT 135.09 2.2, 3.2, 2.3, [N=10]	
62						MH		Clayey SILT, trace to minor sand (fine); brown. Highly plastic. At 11.6 m thin (60 mm) bed of silty SAND (fine), trace to minor clay, moist.	M	VSt						
100						MH		Clayey SILT, trace fine sand; dark green. Highly plastic, micaceous.	M	VSt					SV 154/19 1.2, 3.3, 4.5, [N=15] SPT 135.10	
88															SV 175/57	
100						SM		Clayey silty SAND (fine); green. Micaceous	M	L					SV 135/51 1.1, 1.1, 1.2, [N=5] SPT 135.11	
100								Below 15.0 m becomes medium dense.		MD					SV 205+	
80						SM		Silty SAND (fine to medium), trace clay; brown/grey.	M	'MD'					SV 178/68 1.2, 2.2, 3.5, [N=12] SPT 135.12	
100						SP		SAND (fine to medium), some silt; brown/grey.	M	MD					SPT 135.13 2.3, 4.4, 8.8, [N=24]	
82								Below 17.4 m contains trace gravel (fine to medium); with dark green speckled sand. Gravel: breakable siltstone/sandstone.								
100						SP		SAND (fine to medium), trace silt; green.	W	D					SPT 135.14 3.5, 6.8, 10.12, [N=36]	
100								Below 19.5 m sand becomes fine to medium.							SPT 135.15 4.5, 7.8, 9.13, [N=37]	

BOREHOLE LOG NZ ALT 51-28033-HUNUA 4 GP1 NZ GINT DATA TEMPLATE VER 1.3 GDT 5/2/10



GHD Limited

BOREHOLE with Piezo LOG

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Manukau City 2241

Site Identification: **S135P**

Sheet 3 of 4

Project:	Hunua 4	Coordinates:	E 405159.33, N 787471.12	Datum:	MtEden2000
Client:	WaterCare	Surface RL (m):	+5.7m	Total Depth:	35.0m
Site:	Pukaki Creek South	Commenced:	06-Nov-09	Contractor:	DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed:	06-Nov-09	Driller:	Lance Vuglar

Equipment:	Marooka	Inclination:	90	Logged:	JL
Shear Vane:	Geo 902	Comments:	Estimated Coordinates only, Location not surveyed	Processed:	LW
Bore Diameter (mm):	96			Checked:	MB

BOREHOLE LOG NZ ALT - 51-28033-HUNUA 4.GPJ NZ GINT DATA TEMPLATE VER 1.3 GDT - 5/2/10																						
Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength			RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating	Piezometer				
21	HQ Coring	90	None		Puketoka Fm	SP		SAND (fine to medium), trace silt; green.	W	D												
22		70																				
23		80																				
24		60																				
25		95							SM		At 24 m thin (70 mm) bed of silty SAND (fine); green, moist. Contains trace mica.											
26																						
27		67											Silty SAND (fine); green.	M	D							
28													Below 25.5 m contains trace clay.									
29		13																				
30																						
31						SP		SAND (medium to coarse), trace clay and silt; dark green. Contains trace mica.	M	'VD'												
32						SP		SAND (fine to medium), trace silt; dark green. Contain trace mica.	M	'VD'												
33		51																				
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35		4																				
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BOREHOLE LOG NZ ALT 51-28033-HUNUA 4 GPJ NZ GINT DATA TEMPLATE VER 1.3 GDT 5/2/10



GHD Limited

BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S135P**

Sheet 4 of 4

Project:	Hunua 4	Coordinates:	E 405159.33, N 787471.12	Datum:	MtEden2000
Client:	WaterCare	Surface RL (m):	+5.7m	Total Depth:	35.0m
Site:	Pukaki Creek South	Commenced:	06-Nov-09	Contractor:	DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed:	06-Nov-09	Driller:	Lance Vuglar

Equipment:	Marooka	Inclination:	90	Logged:	JL
Shear Vane:	Geo 902	Comments:	Estimated Coordinates only, Location not surveyed	Processed:	LW
Bore Diameter (mm):	96			Checked:	MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating	Piezometer
31	HQ Coring	4	None		Puketoka Fm	SP		SAND (fine to medium), trace silt; dark green. Contain trace mica.	M	'VD'					SPT 135.22 for 55 mm (Solid) 13,29, 16,16, 18,* [N=50+]	31
32		7														
33		31						SAND (fine to coarse); green.	M	D					SPT 135.23 6,9, 10,11, 12,13, [N=46]	32
34		37													SPT 135.24 2,7, 8,10, 13,18, [N=49]	34
35								Below 34.9 m becomes dark green. Termination Depth = 35m, Target Depth							SPT 135.25 6,13, 13,17, 21,* [N=50+]	35
36																
37																
38																
39																
40																

BOREHOLE LOG NZ ALT 51-28033-HUNUA 4.GPJ NZ GINT DATA TEMPLATE VER 1.3.GDT 5/2/10

6515339/206

Hunua No. 4 Pipeline Project



Box 1

0.0 to 3.0m



Box 2

3.0 to 7.0m

6515339/206

Hunua No. 4 Pipeline Project



Box 3

7.0 to 9.8m

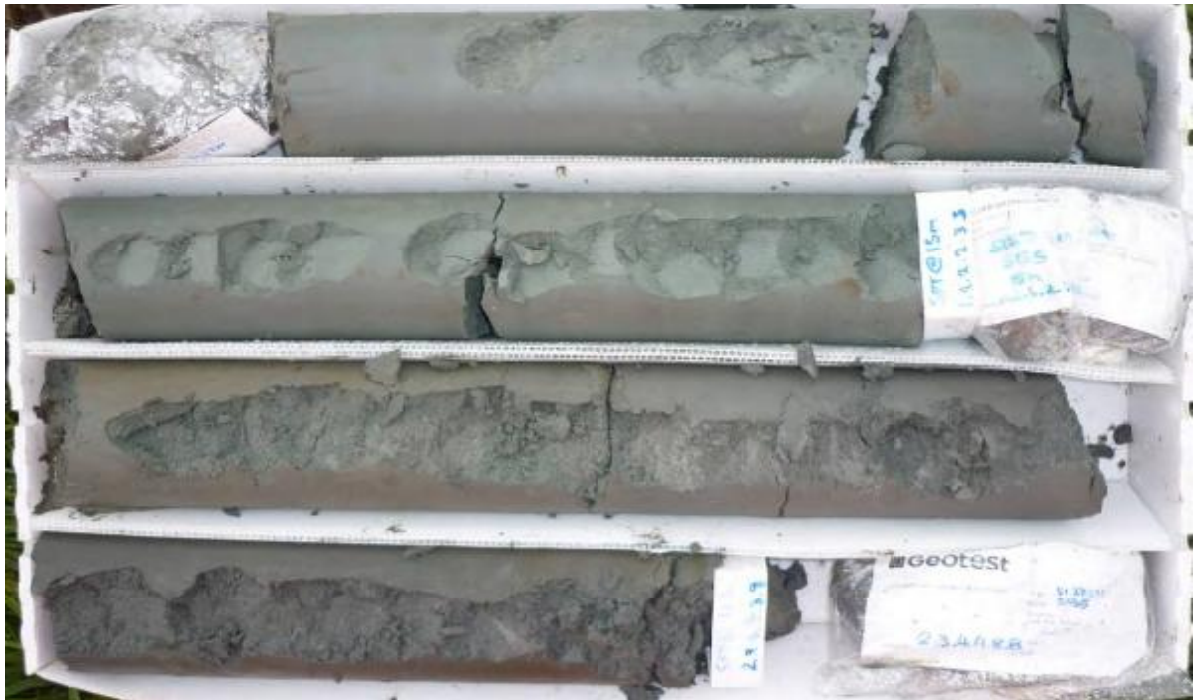


Box 4

9.8 to 13.5m

6515339/206

Hunua No. 4 Pipeline Project



Box 5

13.5 to 17.0m



Box 6

17.0 to 19.5m

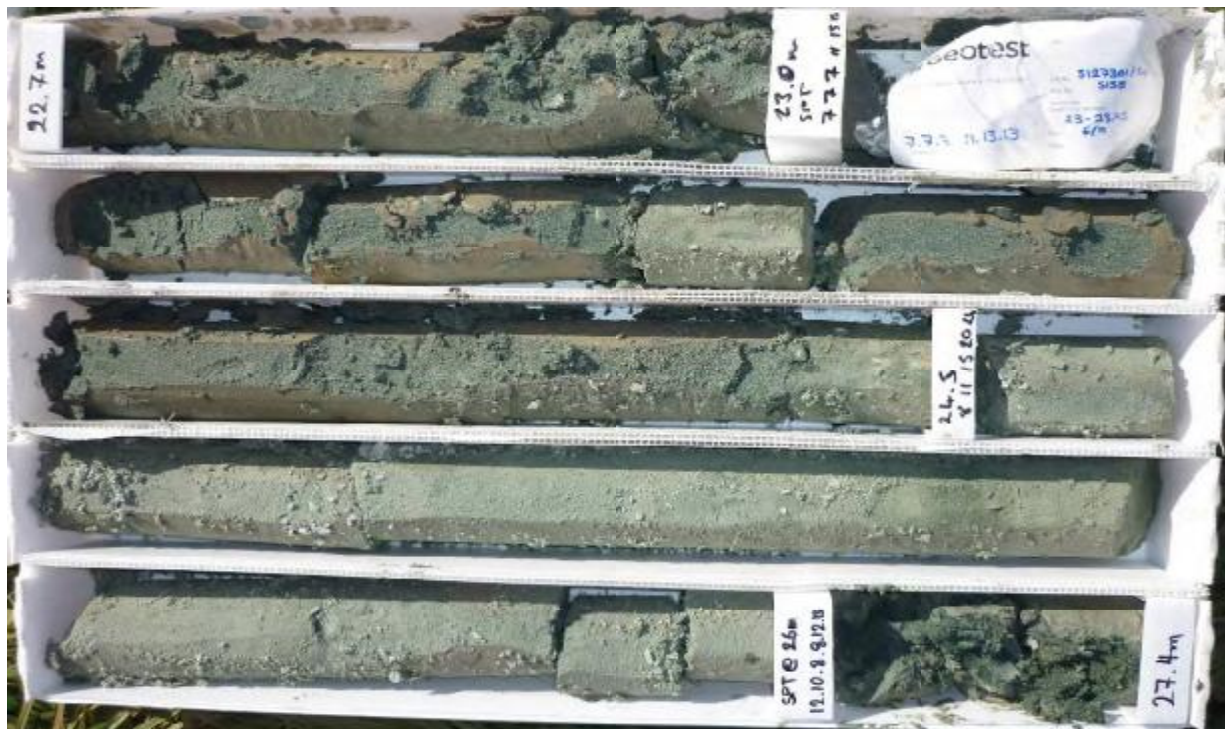
6515339/206

Hunua No. 4 Pipeline Project



Box 7

19.5 to 22.7m



Box 8

22.7 to 27.4m

6515339/206

Hunua No. 4 Pipeline Project



Box 9

27.4 to 35m



BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S136P**

Sheet 1 of 4

Project:	Hunua 4	Coordinates: E 404753.6, N 787503.81	Datum: MtEden2000
Client:	WaterCare	Surface RL (m): +10.6m	Total Depth: 35.0m
Site:	Pukaki Creek North	Commenced: 09-Nov-09	Contractor: DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed: 10-Nov-09	Driller: Antoni Temperly

Equipment: Marooka	Inclination: 90	Logged: JL
Shear Vane: Geo 902	Comments: Estimated Coordinates only, Location	Processed: LW
Bore Diameter (mm): 96	not surveyed	Checked: MB

[illegible]



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BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S136P**

Sheet 2 of 4

Project: Hunua 4						Coordinates: E 404753.6, N 787503.81							Datum: MtEden2000							
Client: WaterCare						Surface RL (m): +10.6m							Total Depth: 35.0m							
Site: Pukaki Creek North						Commenced: 09-Nov-09							Contractor: DCN Drilling Ltd							
Job No.: 51-27301-24-00						Completed: 10-Nov-09							Driller: Antoni Temperly							
Equipment: Marooka						Inclination: 90										Logged: JL				
Shear Vane: Geo 902						Comments: Estimated Coordinates only, Location										Processed: LW				
Bore Diameter (mm): 96						not surveyed										Checked: MB				
Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating	Piezometer				
11.1 [11.4 (-0.8)]	Open Barrel	100			Auckland Volcanic Field	SP	[Pattern]	SAND (fine to medium), trace silt; brown speckled dark brown. Micaceous, contains trace organics.	MW	L										
0																				
72		SP				[Pattern]	SAND (fine), some silt, trace clay; orange/brown speckled black/brown/grey. Contains trace organics.	M	'MD'											
12.2 [12.4]																				
13.3		0			Puketoka Fm	SM	[Pattern]	Silty SAND (fine to medium); dark grey speckled dark brown. Micaceous, contains trace decomposed wood fragments.	W	L										
85																				
20																				
85																				
15.1 [14.9]		100				CH	[Pattern]	Silty CLAY; dark brown. Highly plastic.	M	VSt										
16.9 [16.3]		100				MH	[Pattern]	Below 15.8 m becomes silty SAND, brown. Micaceous. Clayey SILT, trace fine sand; grey/green. Highly plastic. Micaceous. Below 16.3 m contains some sand.	M	H										
17.0 [16.4]		100				CH	[Pattern]	Silty CLAY; dark brown. Highly plastic. Below 17.1 m colour grades to brown. Below 17.3 m colour grades to brown/green.	M	VSt										
17.9 [16.9]		95				MH	[Pattern]	Clayey SILT, trace fine sand; grey/green. Highly plastic, micaceous.	M	VSt										
17.9 [17.3]	HQ Coring	100				SM	[Pattern]	Silty SAND (fine to medium), trace clay; green.	M	MD										
19																				
20		17					[Pattern]	Below 19.5 m contains minor highly plastic clay.												



BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S136P**

Sheet 3 of 4

Project:	Hunua 4	Coordinates: E 404753.6, N 787503.81	Datum: MtEden2000
Client:	WaterCare	Surface RL (m): +10.6m	Total Depth: 35.0m
Site:	Pukaki Creek North	Commenced: 09-Nov-09	Contractor: DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed: 10-Nov-09	Driller: Antoni Temperly

Equipment: Marooka	Inclination: 90	Logged:	JL
Shear Vane: Geo 902	Comments: Estimated Coordinates only, Location	Processed:	LW
Bore Diameter (mm): 96	not surveyed	Checked:	MB

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength FW LW WW W MS S VS ES	RQD (%)	Defect Spacing (mm) 20 80 200 600 2000	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating	Piezometer		
0	HQ Coring	0	None		Puketoka Fm	SM		Silty SAND (fine to medium), trace clay; green. Below 20.0 m becomes loose.	M	MD						SPT S136.15 1,1, 1,2, 2,3, [N=8]	21	
55		0								L								22
0		0								MD								23
0		0								SPT S136.16 0,0, 1,1, 1,1, [N=4]	22							
20		0										23						
24		20										24						
25		13				0				SPT S136.17 2,2, 2,4, 3,6, [N=15]	23							
26		13										24						
27		0										25						
28		13								SPT S136.18 5,10, for 30 mm (solid) 12,15, 16,10, [N=50+]	25							
29	27	26																
30	27	27																
31						SP		SAND (fine to medium); dark green/grey.	M	VD					SPT S136.19 23,30, ***, [N=50+] (solid)	26		
32										28							27	
33										29							28	
34						SP		SAND (fine to medium); dark green/grey.	M	VD					SPT S136.20 20,30, ***, [N=50+] (solid)	28		
35										30							29	
36										31							30	
37						SP		SAND (fine to medium); dark green/grey.	M	VD					SPT S136.21 10,14, 20,20, ***, [N=50+] (solid)	29		
38										32							30	
39										33							31	
40						SP		SAND (fine to medium); dark green/grey.	M	VD					SPT S136.22 10,14, 20,20, ***, [N=50+] (solid)	30		
41										34							31	
42										35							32	



GHD Limited

BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S136P**

Sheet 4 of 4

Project:	Hunua 4	Coordinates:	E 404753.6, N 787503.81	Datum:	MtEden2000
Client:	WaterCare	Surface RL (m):	+10.6m	Total Depth:	35.0m
Site:	Pukaki Creek North	Commenced:	09-Nov-09	Contractor:	DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed:	10-Nov-09	Driller:	Antoni Temperly

Equipment:	Marooka	Inclination:	90	Logged:	JL
Shear Vane:	Geo 902	Comments:	Estimated Coordinates only, Location not surveyed	Processed:	LW
Bore Diameter (mm):	96			Checked:	MB

Depth (m) / [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength					RQD (%)	Defect Spacing (mm)				TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating	Piezometer
31	HQ Coring	27	None		Puketoka Fm	SP		SAND (fine to medium); dark green/grey. Below 30.3 m becomes dark green and wet.	M	VD										SPT S136.22 9,12, 12,15, 25,* [N=50+]	31		
32		19				SP		SAND (fine to medium), trace fine gravel; grey. Gravel: sub rounded sandstone. Below 31.8 m colour grades to light brown/green.	W	D									SPT S136.23 (solid) 10,9, 4,13, 13,13, [N=50+]	32			
33		40				GP		Fine gravelly SAND (fine to coarse); grey. Below 33.4 m colour grades to brown. Contains trace decomposed organic fragments. Below 35.5 m color grades into dark green.	W	VD									SPT S136.24 (solid) 7,7, 7,40, 11,9, [N=50+]	33			
34																							34
35								Termination Depth = 35m, Target Depth											SPT S136.25 7,8, (solid) 8,11, 14,11, [N=44]	35			
36																				36			
37																				37			
38																				38			
39																				39			
40																				40			

BOREHOLE LOG NZ ALT 51-28033-HUNUA 4 GPJ NZ GINT DATA TEMPLATE VER 1.3 GDT 5/2/10

6515339/206

Hunua No. 4 Pipeline Project



Box 1

0 to 3.45m



Box 2

3.45 to 7.0m

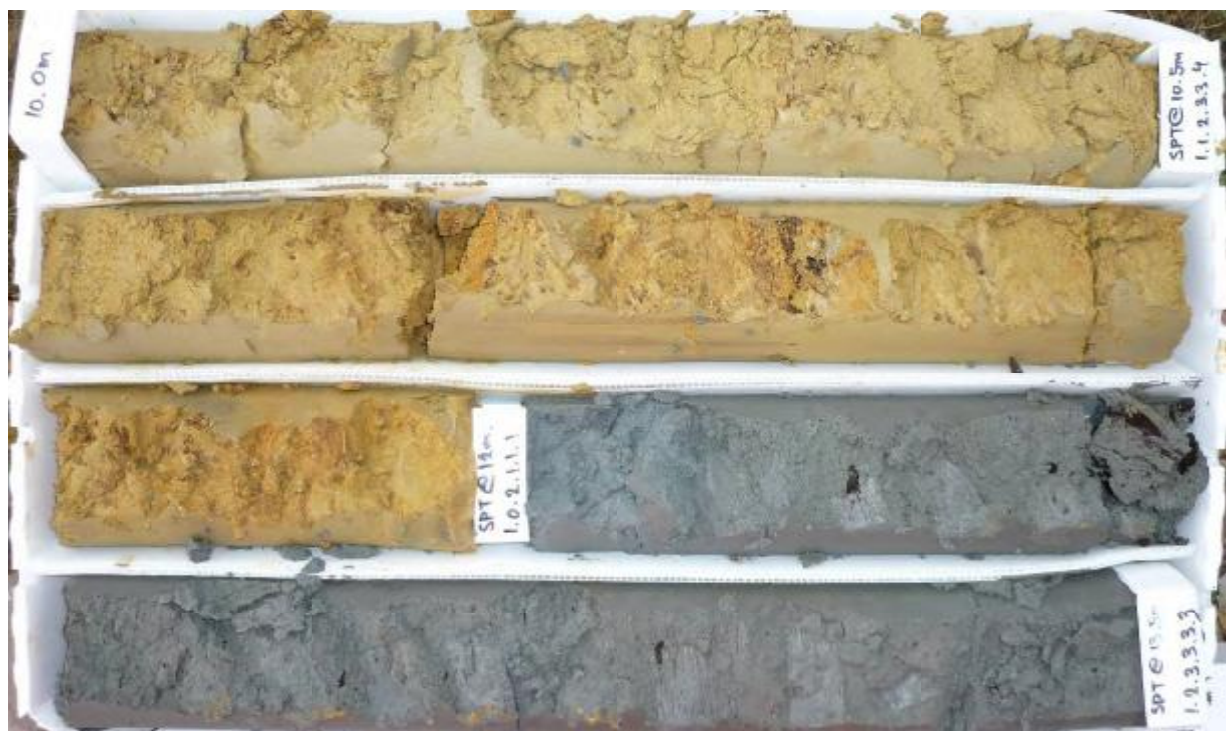
6515339/206

Hunua No. 4 Pipeline Project



Box 3

7.0 to 10.0m



Box 4

10.0 to 13.5m

6515339/206

Hunua No. 4 Pipeline Project



Box 5

13.5 to 16.5m



Box 6

16.5 to 24.3m



GHD Limited

BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S138P**

Sheet 1 of 4

Project:	Hunua 4	Coordinates:	E 404973.2, N 787427.3	Datum:	MtEden2000
Client:	WaterCare	Surface RL (m):	+3.9m	Total Depth:	35.0m
Site:	Pukaki Creek South	Commenced:	03-Nov-09	Contractor:	DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed:	05-Nov-09	Driller:	Lance Vuglar

Equipment:	Marooka	Inclination:	90	Logged:	JL
Shear Vane:	Geo 902	Comments:	Estimated Coordinates only, Location not surveyed	Processed:	LW
Bore Diameter (mm):	96			Checked:	MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES /	Piezometer
0.4 [+3.9]																
0.6 [+3.3]		80						Fine sandy SILT, some clay; dark brown. Highly plastic, micaceous, contains some organics (rootlets).	M	H					Con S138E.01	
0.8 [+3.1]								Silty SAND (fine), minor gravel (fine); dark brown.	M	'L'					SV UTP	
1.5 [+2.4]								SAND (fine), trace silt, trace gravel (fine); dark brown speckled black. Contain trace organics.	M	'L'					SV UTP	
2.3 [+1.6]								Fine sandy SILT, minor clay; brown. Moderately to highly plastic.	M	H					SV UTP	
3.4 [+0.5]		64			AVF	SM		At 1.4 m 20 mm thick decomposed wood fragment.	W	L					SV 79/6 SPT S138E.02	1.0, 1.2, 2.2, [N=7]
4.2 [+0.3]								Silty SAND (fine to medium), trace gravel (fine); brown.								
5.7 [+1.8]		100				SP		Fine to medium gravelly SAND (fine to medium); brown speckled dark grey/orange. Gravel: sub-angular, dark grey sandstone. Below 2.5 m contains trace to minor clay.	M	MD					SV UTP	
6.2 [+2.3]																
7.5 [+1.0]		100														
8.1 [+0.4]																
9.2 [+0.3]		95				MH		Clayey SILT, trace fine sand; black. Highly plastic.	W	St					SV 99/12	
10.1 [+0.4]								Below 4.0 m colour grades into brown/grey.								
11.6 [+0.9]						MH		Clayey SILT, some sand (fine); green/brown speckled black. Highly plastic, micaceous.	M	St					SV 98/20 SPT S138.04	0.1, 1.2, 2.2, [N=7]
12.3 [+0.2]		0				MH		Clayey SILT, minor sand (fine); dark brown. Highly plastic, micaceous.	M	St						
13.6 [+0.9]																
14.2 [+0.3]		80				MH		Clayey SILT, some sand (fine); grey/brown speckled black. Highly plastic.	M	St						
15.3 [+0.2]						SP		SAND (fine to medium); grey. Non plastic.	M	'VL'					SPT S138.05	0.0, 0.0, 1.1, [N=2]
16.1 [+0.4]		100			Puketoka Fm	SM		Silty SAND (fine), some clay; dark green/brown. Micaceous	M	L						
17.5 [+0.9]																
18.1 [+0.3]		100				MH		Clayey SILT, some sand (fine); dark grey/brown. Micaceous.	M	VSt					SV 190/37 SPT S138.06	1.0, 2.1, 1.0, [N=4]
19.2 [+0.2]						SM		Clayey silty SAND (fine); brown. Highly plastic, micaceous.	M	'L'					SV 161/41	
20.1 [+0.3]		100						Below 8.7 m contains trace fine sand								
21.6 [+0.8]						CH		Silty CLAY, trace fine sand; green. Highly plastic, micaceous. Contains trace decomposed organic fragments.	M	H					SV 205/68 SPT S138.07	1.2, 3.3, 5.5, [N=16]
22.3 [+0.1]		100														

BOREHOLE LOG NZ ALT 51-28033-HUNUA 4 GPJ NZ GINT DATA TEMPLATE VER 1.3 GDT 5/2/10



BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S138P**

Sheet 2 of 4

Project:	Hunua 4	Coordinates:	E 404973.2, N 787427.3	Datum:	MtEden2000
Client:	WaterCare	Surface RL (m):	+3.9m	Total Depth:	35.0m
Site:	Pukaki Creek South	Commenced:	03-Nov-09	Contractor:	DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed:	05-Nov-09	Driller:	Lance Vuglar

Equipment:	Marooka	Inclination:	90	Logged:	JL
Shear Vane:	Geo 902	Comments:	Estimated Coordinates only, Location not surveyed	Processed:	LW
Bore Diameter (mm):	96			Checked:	MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES	Piezometer
10.8 [7.9]		100				CH		At 9.9 m thin (100 mm) bed of silty SAND (fine), trace clay; green, moist, low plasticity. Silty CLAY, trace fine sand; green. Highly plastic, micaceous. Contains trace decomposed organic fragments. Between 10.4 to 10.5 m becomes dark brown.	M	H					SV 205+	
11.5 [7.6]		100				MH		Clayey SILT, trace sand (fine); dark brown speckled black. Highly plastic, micaceous. Contains trace decomposed organics. Below 11.3 m colour becomes green.	M	H					SV 205+ 1.2, 3.3, SPT S138.08 4.4, [N=14]	
12.5 [8.6]		100				SM		Clayey silty SAND (fine); green. Highly plastic, micaceous.	M	MD					SV UTP	
13.0 [8.1]		0				SP		SAND (fine to medium), trace silt; green/brown. Micaceous.	M	'MD'					SV UTP 1.2, 2.3, SPT S138.09 5.5, [N=15]	
14.1 [7.2]		100				SM		Silty SAND (fine), some clay; green/brown. Micaceous	M	L					SV 146/36	
14.8 [7.5]		100				SM		Clayey silty SAND (fine), trace gravels (fine); green/brown speckled dark green. Gravel: sub-rounded, dark green siltstone/sandstone.		'L'					SV UTP 1.1, 2.2, SPT S138.10 2.3, [N=9]	
15.0 [7.3]		0				SP		At 14.7 m 100 mm bed of clayey SILT; green/brown. Moist, non plastic. SAND (fine), trace silt and clay; dark green. LOW DILATANCY.	W	D					SPT S138.11 1.2, 4.6, 8.8, [N=26]	
17.5 [5.8]		100													SPT S138.12 3.8, 10.10, 12.14, [N=46]	
18.3 [5.1]		33				SP		SAND (fine to coarse), trace gravels (fine); dark green. Gravel/sand: Silica.	W	VD					SPT S138.13 for 50 mm 10.14, 20.30, [N=50+]	
		100						Below 18.3 m contains minor clay.								
		0														

BOREHOLE LOG NZ ALT 51-28033-HUNUA 4 GPJ NZ GINT DATA TEMPLATE VER 1.3 GDT 5/2/10



GHD Limited

BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S138P**

Sheet 3 of 4

Project:	Hunua 4	Coordinates:	E 404973.2, N 787427.3	Datum:	MtEden2000
Client:	WaterCare	Surface RL (m):	+3.9m	Total Depth:	35.0m
Site:	Pukaki Creek South	Commenced:	03-Nov-09	Contractor:	DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed:	05-Nov-09	Driller:	Lance Vuglar

Equipment:	Marooka	Inclination:	90	Logged:	JL
Shear Vane:	Geo 902	Comments:	Estimated Coordinates only, Location not surveyed	Processed:	LW
Bore Diameter (mm):	96			Checked:	MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating	Piezometer
20.5 [+8.6]		0					SP	SAND (fine to coarse), trace gravels (fine); dark green. Gravel/sand: Silica.	W	VD					SPT S138.14 8,1, 8,12, 13,14, [N=47]	
21 [+7.1]		80					SM	Silty SAND (fine to medium), trace minor clay; dark green.	W	'VD'						
22		43					SP	At 21.02 m thin (20 mm) layer of SILT SAND (fine to coarse); brown/green. Slightly cemented.	W	VD					SPT S138.15 30,25, 25,*, [N=50+]	
23		15						Below 23.1 m becomes stripped dark brown (5 mm thick)							SPT S138.16 16,15, 19,23, 8,*, [N=50+]	
24																
25		0			Puketoka Fm										SPT S138.17 7,11, 16,19, 15,*, [N=50+]	
26		67													SPT S138.18 9,9, 8,9, 8,11, [N=36]	
27							SP	SAND (medium to coarse); brown/green	W	VD					SPT S138.19 12,18, 27,27, *,*, [N=50+]	
28		60														
29		61													SPT S138.20 10,15, 19,19, 21,*, [N=50+]	
30																

BOREHOLE LOG NZ ALT 51-28033-HUNUA 4 GPJ NZ GINT DATA TEMPLATE VER 1.3 GDT 5/2/10



GHD Limited

BOREHOLE with Piezo LOG

PO Box 76477
Manukau City 2241

Site Identification: **S138P**

Sheet 4 of 4

Project:	Hunua 4	Coordinates:	E 404973.2, N 787427.3	Datum:	MtEden2000
Client:	WaterCare	Surface RL (m):	+3.9m	Total Depth:	35.0m
Site:	Pukaki Creek South	Commenced:	03-Nov-09	Contractor:	DCN Drilling Ltd
Job No.:	51-27301-24-00	Completed:	05-Nov-09	Driller:	Lance Vuglar

Equipment:	Marooka	Inclination:	90	Logged:	JL
Shear Vane:	Geo 902	Comments:	Estimated Coordinates only, Location not surveyed	Processed:	LW
Bore Diameter (mm):	96			Checked:	MB

Depth (m) [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/Relative Density	Weathering	Estimated Rock Strength	RQD (%)	Defect Spacing (mm)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating	Piezometer
31	HQ Coring	61	None		Puketoka Fm	SP		SAND (medium to coarse); brown/green	W	VD					SPT S138.21 for 50 mm (solid) 7,8, 9,12, 40,* [N=50+]	
32		53													SPT S138.22 (solid) 13,17, 27,23, ** [N=50+]	
33		20														
34		57				SP		SAND (medium to coarse); green. Slightly cemented.	W	VD					SPT S138.23 (solid) 9,11, 13,17, 20,* [N=50+]	
35								Termination Depth = 35m, Target Depth							SPT S138.24 for 45 mm (solid) 17,22, 24,26, ** [N=50+]	
36																
37																
38																
39																
40																

BOREHOLE LOG NZ ALT 51-28033-HUNUA 4.GPJ NZ GINT DATA TEMPLATE VER 1.3.GDT 5/2/10

6515339/206

Hunua No. 4 Pipeline Project



Box 1

0.0 to 2.8m



Box 2

2.8 to 6.0m

6515339/206

Hunua No. 4 Pipeline Project



Box 3

6.0 to 8.6m



Box 4

8.6 to 11.0m

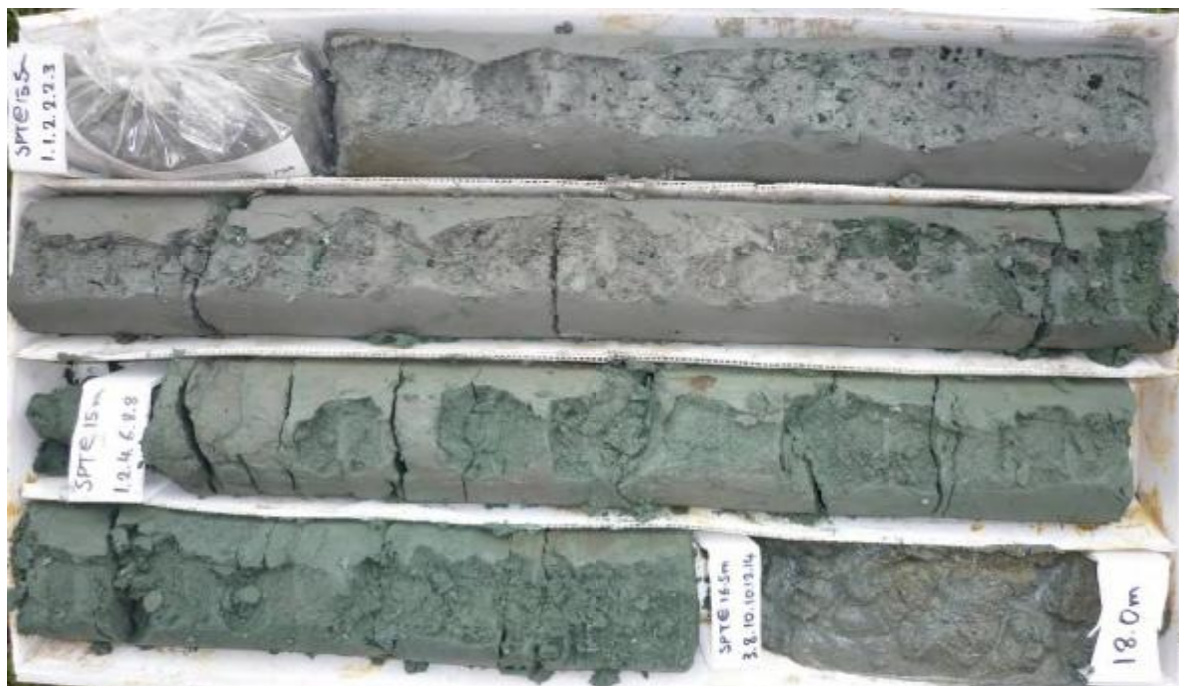
6515339/206

Hunua No. 4 Pipeline Project



Box 5

11.0 to 13.5m

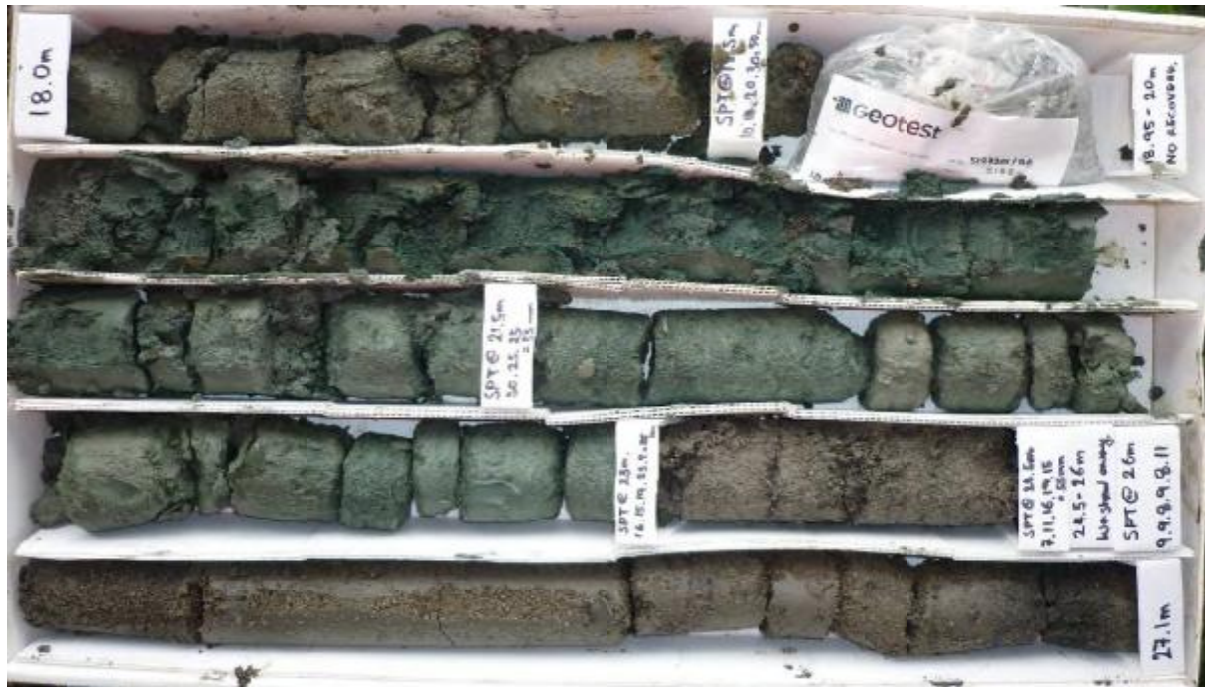


Box 6

13.5 to 18.0m

6515339/206

Hunua No. 4 Pipeline Project



Box 7

18.0 to 27.1m



Box 8

27.1 to 31.7m

6515339/206

Hunua No. 4 Pipeline Project



Box 9

31.7 to 35m

BOREHOLE LOG

SHEET 1 OF 1

BOREHOLE LOG

JOB NO: 8886

DRILLED BY: Brown Bros.
LOGGED BY LPA CHECKED BY: JCC

NZGD ID: BH 70110



TONKIN & TAYLOR LTD.

ENGINEERING LOG TERMINOLOGY

DRILLING OR EXCAVATION

FLUID LOSS	WATER	CORE RECOVERY	METHOD/CASING	PENETRATION
		Core recovered expressed as percentage of the length of the core run.	Shows drilling method and depth of casing.	

SAMPLES AND TESTS

SAMPLE TYPE	TESTS	GRAPHIC LOG	TYPICAL SYMBOLS
☐ OPEN BARREL ☐ DOUBLE OR TRIPLE TUBE ☐ STANDARD PENETRATION TEST ☐ LARGE DIAMETER THIN WALLED TUBE ☐ SMALL DIAMETER THIN WALLED TUBE ☐ BULK SAMPLE	N = 22 SPT. UNCORRECTED BLOW COUNT FOR 300MM ● 75kPa UNDRAINED SHEAR STRENGTH AS MEASURED BY FIELD VANE ☒ PRESSUREMETER TEST * LABORATORY TEST(S) CARRIED OUT — UNSPECIFIED OR SPECIFIED AS BELOW LV - LABORATORY VANE AL - ATTERBERG LIMITS UU - UNDRAINED TRIAXIAL PSD - PARTICLE SIZE C ϕ - EFFECTIVE STRESS CONS - CONSOLIDATION DS - DIRECT SHEAR COMP - COMPACTION UC - UNCONFINED COMPRESSION IS - POINT LOAD	The Graphic Log shows soil and rock substances, significant defects, and core loss. Soil and rock substances represented by clear contrasting symbols consistent for each project.	

Length of sample indicated by length of symbol.

SOIL DESCRIPTION

CLASSIFICATION SYMBOL	MOISTURE CONTENT	UNDRAINED SHEAR STRENGTH	RELATIVE DENSITY
Based on USBR Unified Soil Classification System Visual Method for field identification. Classification symbols based on Laboratory Method may differ.	D - DRY, LOOKS AND FEEL DRY M - MOIST, NO FREE WATER ON HAND WHEN REMOULding W - WET, FREE WATER ON HAND WHEN REMOULding Moisture content may be compared to the plastic limit (PL) eg M > PL = moist, moisture content greater than the plastic limit	Cu (kPa) VS - VERY SOFT < 10 S - SOFT 10 to 25 F - FIRM 25 to 50 St - STIFF 50 to 100 VSt - VERY STIFF 100 to 200 H - HARD > 200 Fb - FRIABLE	SPT-UNCORRECTED N VALUE VL - VERY LOOSE 0 to 4 L - LOOSE 4 to 10 MD - MEDIUM DENSE 10 to 30 D - DENSE 30 to 50 VD - VERY DENSE > 50

ROCK DESCRIPTION

WEATHERING	ROCK STRENGTH	SIGNIFICANT DEFECTS
Fr - FRESH	UCS (MPa)	SIGNIFICANT DEFECTS SHOWN GRAPHICALLY
SW - SLIGHTLY WEATHERED	EXTREMELY LOW < 2	
HW - HIGHLY WEATHERED	VERY LOW 2 to 6	
EW - EXTREMELY WEATHERED	LOW 6 to 20	
	MODERATE 20 to 60	
	HIGH 60 to 200	
	VERY HIGH > 200	

NOTES

A	Geological Model review, TBT boreholes included	1/12	14/12/88
O	First Issue		
REVISION			
Drawing Checked			
APPROVED			
The drawing is to be used for construction purposes unless signed as approved			
REFERENCE			



TONKIN & TAYLOR
CONSULTING ENGINEERS, SURVEYORS, PLANNERS
8 BALFOUR STREET, AUCKLAND
DUNEDIN, CHRISTCHURCH, WELLINGTON, HAMILTON, TAIHARU, TIMARU

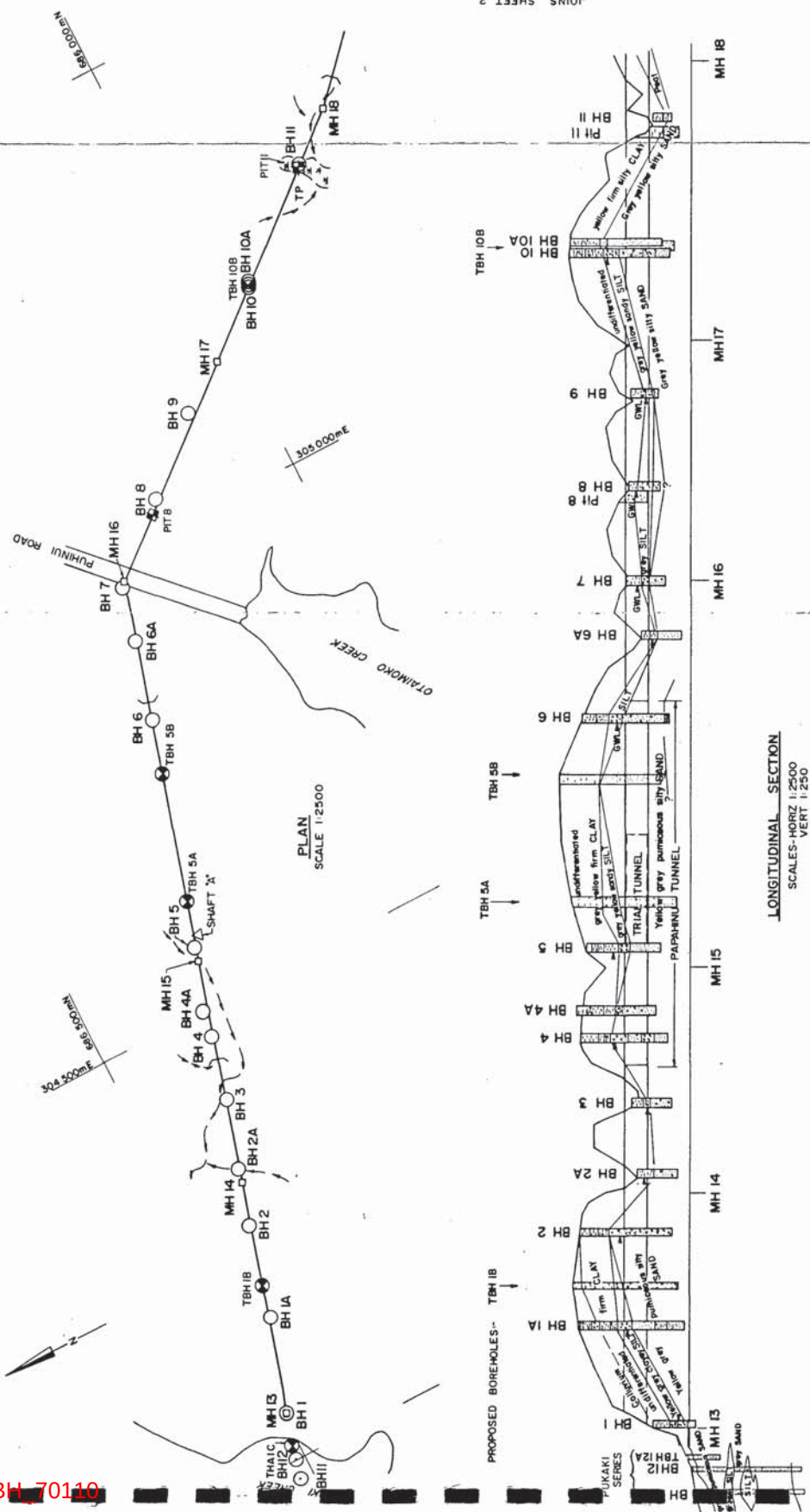
TITLE
AUCKLAND REGIONAL AUTHORITY

SOUTH WEST INTERCEPTOR

Borehole Location Plan and Longitudinal Section (inferred)

Sheet 1 of 4 Sheets
ORIGINAL SCALES
As Shown

DRAWING NO.	8886 - 2
DATE	FEB 1989
Revision	0A



- Legend**
- BH ARA Boreholes 1972 - 1976
 - TBH Tonkin & Taylor Boreholes 1989
 - PIT Tonkin & Taylor Investigation Pits
- Reference**
- ARA Drawing 140013 Sheet 4
 - "South Western Interceptor - Part 3, Plan and Longitudinal Section 5601 - 7139m"

Graphic Scale

PROJECT: S.W. INTERCEPTOR

LOCATION: S. AUCKLAND

BOREHOLE No: 5A

CLIENT: A.R.A DRAINAGE

JOB No: 8886

SHEET: 1 OF: 1

LOG TYPES: NATURAL GAMMA CALIPER DENSITY

CO-ORDINATES:

DRILL TYPE: FAIRING 500

CASING DEPTH/TYPE:

RL:

DRILL METHOD: ROTARY

LOGGED BY: LPA

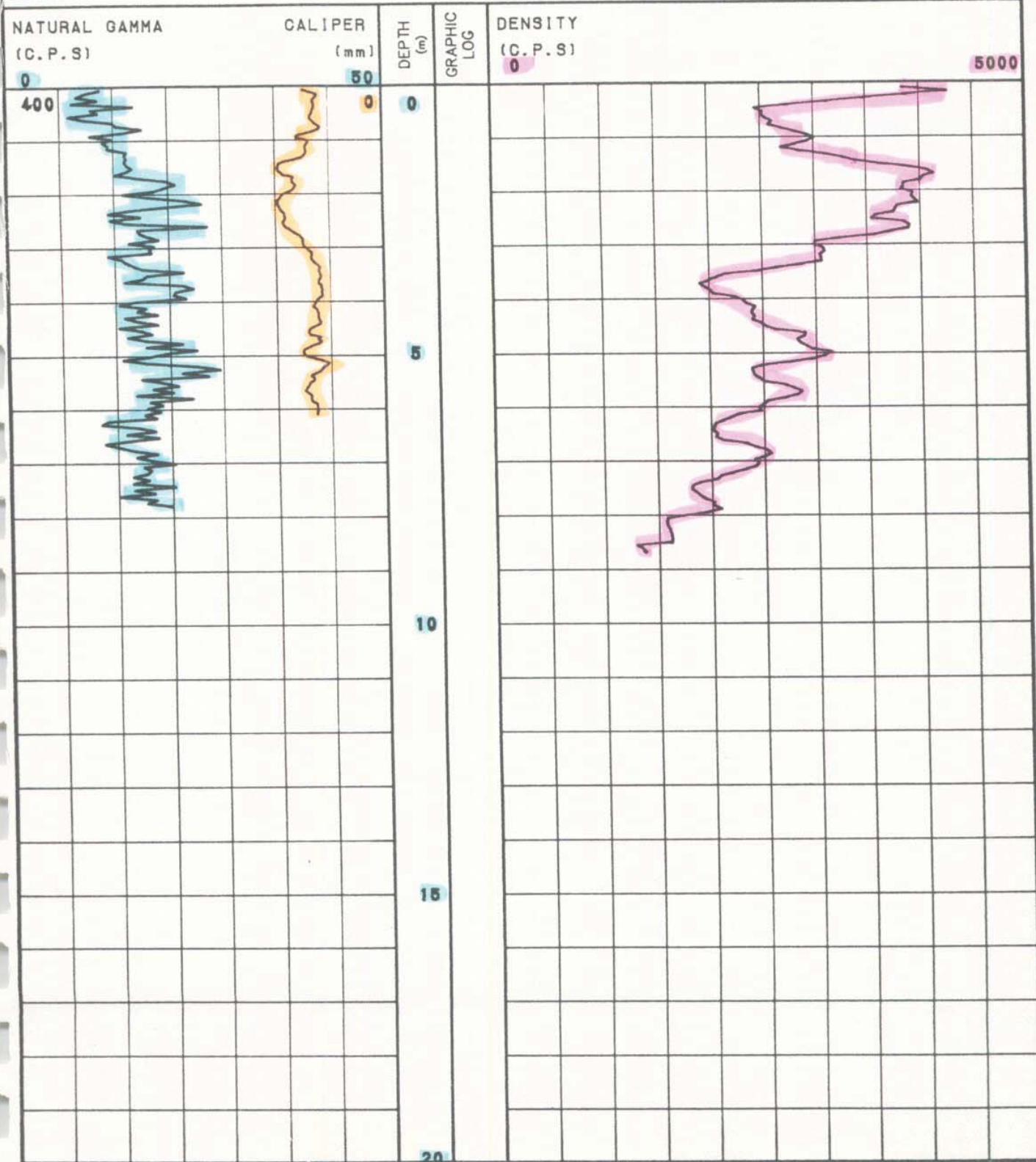
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BOREHOLE FLUID:

DATE: 29-05-88

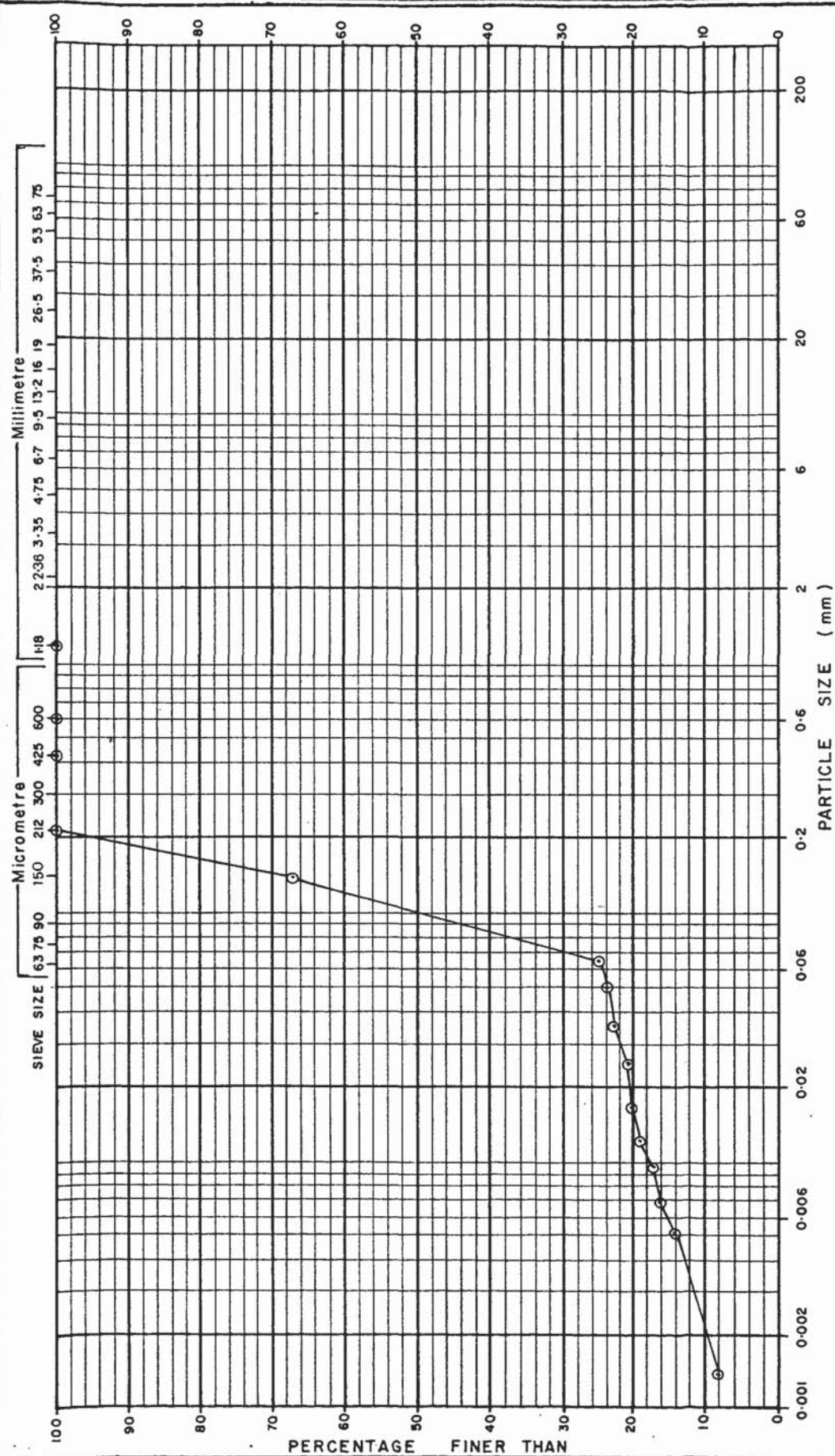
COMMENTS:

DENSITY-SOURCE & SPACINGS: 200mm 5 m/Cu





GEOTECHNICS LTD. MATERIALS TESTING & INSTRUMENTATION SPECIALISTS
PO BOX 5271 AUCKLAND NEW ZEALAND
19 MORGAN STREET NEWMARKET AUL 1
TELEPHONE (09) 793 067 TELEX NZ 21594 FAX (09) 370 265



CLAY	SILT			SAND			GRAVEL			TESTED BY: SA
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	
JOB No: 8886	NATURAL / AIR DRIED / OVEN DRIED / UNKNOWN									DATE: 13/7/89
SITE: SWINTER	WET SIEVED / DRY SIEVED / PIPELINE / HYDROMETER									CHECKED BY: VOC
	TEST METHOD USED: NZS 4402:1986 TEST-284/282/28.4									DATE: 13/7/89
	PLOTING SYMBOL: ○									
	SOLID DENSITY (t/m ³) Assumed / measured 2.65									
REMARKS										



TOMKIN & TAYLOR LTD.

BOREHOLE LOG

BOREHOLE NO: 58
SHEET 1 OF 2

PROJECT: PIPELINE INVESTIGATION LOCATION: PUHINUI ROAD, WIRI JOB NO: 8886
CO-ORDINATES: refer Dwg 8886 DRILL TYPE: Rotary machine rig HOLE STARTED: 25/5/89
DRILL METHOD: Open barrel, SPT, HOLE FINISHED: 25/5/89
RL: Brass tube DRILLED BY: Brown Bros.
DATUM: DRILL FLUID: Water LOGGED BY LPA CHECKED BY: JCC

DRILLING AND TESTS										ENGINEERING DESCRIPTION				GEOLOGICAL	
FLUID LOSS	WATER	CORE RECOVERY	METHOD/CASING	SAMPLES, TESTS	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SHEAR STRENGTH OR RELATIVE DENSITY	ESTIMATED SHEAR STRENGTH, kPa	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT	
									TOPSOIL						
				• Cu=138kPa					SILT, clayey, sl.organic, light brown with dark brown staining-						
				• Cu=173kPa		1			SILT, sl.clayey, orange/brown						
				• Cu=130kPa					- becomes more clayey		Vst				
				• Cu=91kPa		2			CLAY, sl.silty, yellow with light grey staining						
				• Cu=133kPa					- becomes light grey with white pumiceous grains and red staining						
						3			- becomes sl.sandy						
				• Cu=123kPa		4			SAND, fine, light grey						
				N=12 (4/5/7)		5			- becomes light brown with black oxide staining		MD				
						6			- pumiceous						
						7									
						8			- some yellow bands with light grey CLAY layers						
				N=16 (6/8/8)		9					MD				
						10									



TOMKIN & TAYLOR LTD.

BOREHOLE LOG

BOREHOLE NO: 5B
SHEET 2 OF 2

PROJECT: PIPELINE INVESTIGATION		LOCATION: PUHINUI ROAD, WIRI		JOB NO: 8886									
CO-ORDINATES: refer Dwg 8886		DRILL TYPE Rotary machine rig		HOLE STARTED: 25/5/89									
RL:		DRILL METHOD: Open barrel, SPT, Brass tube		HOLE FINISHED: 25/5/89									
DATUM:		DRILL FLUID: Water		DRILLED BY: Brown Bros.									
				LOGGED BY LPA CHECKED BY: JCC									
DRILLING AND TESTS			ENGINEERING DESCRIPTION			GEOLOGICAL							
FLUID LOSS	WATER	CORE RECOVERY	METHOD/CASING	SAMPLES, TESTS	RL (m) DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SHEAR STRENGTH OR RELATIVE DENSITY	ESTIMATED SHEAR STRENGTH, kPa	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	PUMICEOUS SILTS & SANDS
Piezometer Tip at 11.9m					10			- becomes silty, sl. clayey dark yellow					
					11			SILT, sl. sandy, sl. clayey		St			
				• Cu=77kPa				SAND, fine, dk. yellow					
					12			End of Borehole @ 12.0m					
					13								

NOTES

A	Geological Model review, TBT boreholes included	1/12	24/288
O	First Issue		
REVISION			
Drawing Checked			
Approved			
The drawing is to be used for construction purposes unless signed as approved			
REFERENCE			



TOKIN & TAYLOR
CONSULTING ENGINEERS, SURVEYORS, PLANNERS
8 BALFOUR STREET, AUCKLAND
DUNEDIN, CHRISTCHURCH
DUNINGAN, TAIPEI

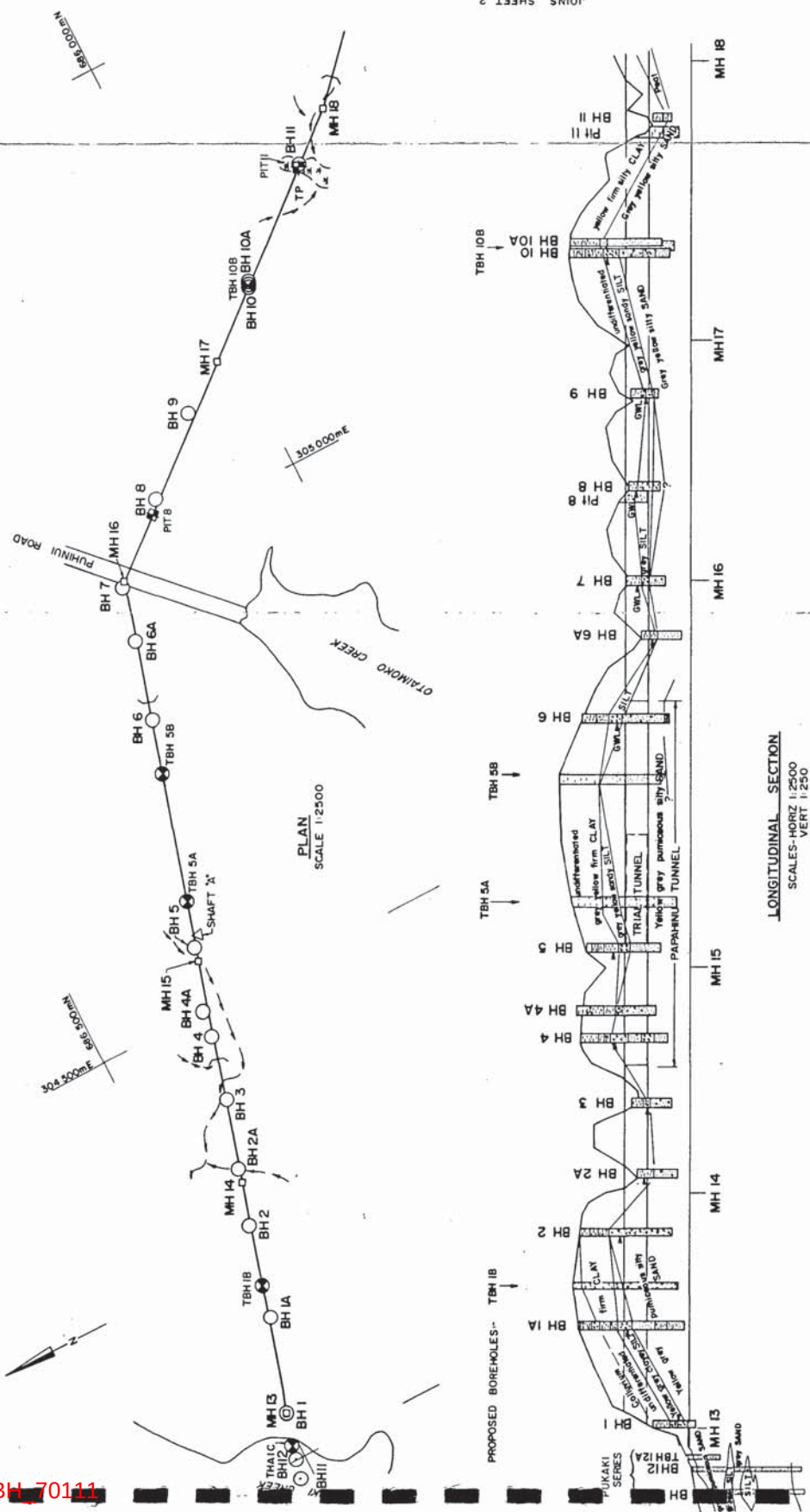
TITLE
AUCKLAND REGIONAL AUTHORITY

SOUTH WEST INTERCEPTOR

Borehole Location Plan and Longitudinal Section (inferred)

Sheet 1 of 4 Sheets
ORIGINAL SCALES
As Shown

DRAWING NO. 8886-2
DATE FEB 1989
Revision 0A



- Legend**
- BH ARA Boreholes 1972 - 1976
 - TBH Tonkin & Taylor Boreholes 1989
 - PIT Tonkin & Taylor Investigation Pits
- Reference**
- ARA Drawing 140013 Sheet 4
 - "South Western Interceptor - Part 3, Plan and Longitudinal Section 5601 - 7139m"

Graphic Scale



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Client: **AIAL & NZTA**
Project: **SH20B - Accelerated Design Variation**
Location: **Campana Road**
Project Reference: **504330**

AU20-BH01

Sheet 1 of 6

BOREHOLE INFORMATION Method: Rotary Core Conventional Equipment: Drill rig Contractor: Drillforce	CO-ORDINATES: Mt Eden Circuit 2000 Easting: 405430.16m Northing: 786657.24m Reduced level: 11.12m (Auckland MSL 1946 Datum)	Date started: 12/02/2020 Date completed: 13/02/2020 Inclination: -90° Azimuth: N/A	Logged by: MB Input by: MB Checked by: KM Verified by: BOL
---	--	---	---

Method	R.L. (m)	Length (m)	Graphic Log	Layer Code	Material Description	Weathering/USC	Testing	TCR (%)	SCR (%)	RQD (%)	Fracture Log	Stratigraphy Defect Description Additional Notes	Installation
HA	11			Fc	0m: Silty CLAY with trace sand and organics; brownish red mottled grey and orange. "Hard", dry, Intermediate to low plasticity. [FILL]	CL-ML		100				0m: FILL	
HQ3	10			TAo	0.9m: Organic SILT with some sand; brownish black. "Stiff", dry, intermediate plasticity. Organics are amorphous, consolidated. [RECENT ALLUVIUM/TOPSOIL]	OL		100				0.9m: TAURANGA GROUP	
SPT					1.5m: SILT with some sand; light grey mottled orange. "Stiff", dry, low plasticity. Sand is fine to medium grained, rounded. Composition of sand is mostly quartz and pumice. [PUKETOKA FORMATION]		1.5m: SPT 0 for 0mm/ 0,0,0,0 N = 0	89					
HQ3	9			TPz	2.05m:...changes to "firm"	ML		100					
					2.55m:...changes to "soft"								
					2.9m:...changes to "stiff"								
SPT	8			NC	3m: CORE LOSS		3m: SPT 3 for 3mm/ 0,0,0,0 N = 0	0				3m: Core loss	
HQ3				TPz	3.45m: SILT with some sand and trace organics; dark greyish black. "Soft", moist, low plasticity, dilatent. Sand is fine to medium grained, rounded. Composition of sand is mostly quartz and pumice. 3.55m:...changes to "firm" 3.6m:...trace organics consist of tree roots. Sand is lensoidal. 3.65m:...changes to reddish brown. Interbedded with light brownish red SAND. Sand is fine to medium grained, rounded to subrounded.	ML		57				3.65m: reddish brown is likely due to iron staining from sands	
SPT				TPs	4.5m: Silty SAND; light brown interbedded grey. Medium dense, moist. Sand is fine grained, rounded to subrounded, dilatent.	SW-SM	4.5m: SPT 7 for 7mm/ 3,4,3,5 N = 15	50					
	5							0					

REMARKS:
1.) Inferred soil strengths are indicated by the use of "quotation marks".

Water Level Readings:
Date Time | Hole Depth | Water Level
(1) 13/02/20 10:00 | m | 2.37 m bgl
(2) 14/02/20 07:00 | m | 7.5 m bgl

Water Level Readings:			
Date	Time	Hole Depth	Water Level
(1)	13/02/20 10:00	m	2.37 m bgl
(2)	14/02/20 07:00	m	7.5 m bgl

BOREHOLE INFORMATION	CO-ORDINATES: Mt Eden Circuit 2000	Date started: 12/02/2020	Logged by: MB
Method: Rotary Core Conventional	Easting: 405430.16m	Date completed: 13/02/2020	Input by: MB
Equipment: Drill rig	Northing: 786657.24m	Inclination: -90°	Checked by: KM
Contractor: Drillforce	Reduced level: 11.12m	Azimuth: N/A	Verified by: BOL
	(Auckland MSL 1946 Datum)		

[illegible]

REMARKS:
1.) Inferred soil strengths are indicated by the use of "quotation marks".

Water Level Readings:		
Date	Time	Water Level
(1) 13/02/20	10:00	2.37 m bgl
(2) 14/02/20	07:00	7.5 m bgl

Client: **AIAL & NZTA**
Project: **SH20B - Accelerated Design Variation**
Location: **Campana Road**
Project Reference: **504330**

AU20-BH01

Sheet 4 of 6

BOREHOLE INFORMATION

Method: Rotary Core Conventional
Equipment: Drill rig
Contractor: Drillforce

CO-ORDINATES: Mt Eden Circuit 2000

CO-ORDINATES: Mt Eden Circuit 2000
Easting: 405430.16m
Northing: 786657.24m
Reduced level: 11.12m
(Auckland MSL 1946 Datum)

Date started: 12/02/2020
Date completed: 13/02/2020
Inclination: -90°
Azimuth: N/A

Logged by: MB
 Input by: MB
 Checked by: KM
 Verified by: BOL

(Auckland MSL 1946 Datum)															
Method	R.L. (m)	Length (m)	Graphic Log	Layer Code	Material Description	Weathering/USC	Testing	TCR (%)	SCR (%)	RQD (%)	Fracture Log	Stratigraphy Defect Description Additional Notes	Installation		
SPT	-4			TPs	15m: Silty SAND; bluish greenish grey. "Medium dense", moist to dry. Sand is fine to medium grained, rounded to subrounded, quartz.	SW-SM	15m: SPT 11 for 11mm/ 5,6,8,9 N = 28	100			VWS WS MWS CS EGS	15m: KAAWA FORMATION			
HQ3	-5	16							57						
SPT	-17								100						
HQ3	-6								90						
SPT	-7								100						
HQ3	-8				17m: SAND; bluish greenish grey. "Medium dense", moist to dry. Sand is fine grained with trace medium grains. All subrounded to subangular, well graded.	SW	18m: SPT 19 for 19mm/ 12,12,20,6 for 20mm N = 50+	100							
HQ3	-19						100								
SPT	-20						22								
							100								
					18.75m: ...Gravel is poorly cemented sand.										
					19.5m: ...changes to medium dense		19.5m: SPT 4 for 4mm/ 2,4,4,6 N = 16								

REMARKS:

1.) Inferred soil strengths are indicated by the use of "quotation marks".

Water Level Readings:

Water Level Readings:		
Date	Time	Water Level
(1)	13/02/20 10:00	2.37 m bgl
(2)	14/02/20 07:00	7.5 m bgl

Water Level Readings:		
Date	Time	Water Level
(1) 13/02/20	10:00	2.37 m bgl
(2) 14/02/20	07:00	7.5 m bgl

BOREHOLE INFORMATION					CO-ORDINATES: Mt Eden Circuit 2000		Date started: 12/02/2020 Date completed: 13/02/2020		Logged by: MB Input by: MB Checked by: KM Verified by: BOL				
Method: Rotary Core Conventional Equipment: Drill rig Contractor: Drillforce					Easting: 405430.16m Northing: 786657.24m Reduced level: 11.12m (Auckland MSL 1946 Datum)		Inclination: -90° Azimuth: N/A						
Method	R.L. (m)	Length (m)	Graphic Log	Layer Code	Material Description	Weathering/USC	Testing	TCR (%)	SCR (%)	RQD (%)	Fracture Log	Stratigraphy Defect Description Additional Notes	Installation
HQ3	-14			KAs	24.45m: Silty SAND with trace gravel; bluish greenish grey. "Medium dense", wet to moist. Sand is fine to medium grained rounded to sub rounded, interbedded dark grey.	SW-SM		57			VMS WS MWS S US VCS EGS		

End of borehole at 25.5m (Target Depth Reached)

REMARKS:
1.) Inferred soil strengths are indicated by the use of "quotation marks".

Water Level Readings:			
Date	Time	Hole Depth	Water Level
(1)	13/02/20 10:00	m	2.37 m bgl
(2)	14/02/20 07:00	m	7.5 m bgl

SH20b Accelerated Design – Campana Rd.

aurecon

Borehole Reference: AU20-BH01

Date Drilled: 12/02/2020

Photographed By: Miles Buob

Date Photographed: 12/02/2020



Box 1 0 to 2.4 metres below ground level (bgl)



Box 2 2.4 to 6.9 metres bgl

SH20b Accelerated Design – Campana Rd.

aurecon

Borehole Reference: AU20-BH01

Date Drilled: 12/02/2020

Photographed By: Miles Buob

Date Photographed: 12/02/2020



Box 3 6.9 to 10.2 metres bgl



Box 4 10.2 to 13.95 metres bgl

SH20b Accelerated Design – Campana Rd.

aurecon

Borehole Reference: AU20-BH01

Date Drilled: 12/02/2020

Photographed By: Miles Buob

Date Photographed: 12/02/2020



Box 5 13.95 to 17.75 metres bgl



Box 6 17.75 to 20.4 metres bgl

SH20b Accelerated Design – Campana Rd.

aurecon

Borehole Reference: AU20-BH01

Date Drilled: 12/02/2020

Photographed By: Miles Buob

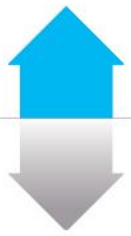
Date Photographed: 12/02/2020



Box 7 20.4 to 17.75 metres bgl



Box 8 24.0 to 25.5 metres bgl



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Geotechnical Investigation for Proposed RSPCA Development at 485 Puhinui Road, Papatoetoe

Rev A

16 March 2022

Job No. 211197



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**GEOTECHNICAL INVESTIGATION
FOR PROPOSED RSPCA DEVELOPMENT AT
485 PUHINUI ROAD, PAPATOETOE**

Job Number:	211197
Name of Project:	485 Puhinui Road, Papatoetoe
Client:	The Royal New Zealand SPCA
Author:	Ben Young, Senior Engineering Geologist, MEngNZ
Reviewer: / Authoriser	Bruce Green, Senior Geotechnical Engineer, CMEngNZ, CPEng
Document Version:	A
Printed:	16 March 2022
Author Signature:	
Reviewer / Authoriser Signature:	

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Appendices:

Appendix A: Drawings

Appendix B: Investigation Logs (Augerholes and Piezometers)

Appendix C: Laboratory Test Results

Appendix D: Cone Penetration Testing (CPT) Results

Appendix E: Liquefaction Analysis Results

Report Summary

The following summarises the findings of this report however is not to be taken in isolation. It is a requirement that any user of this report review the document in its entirety, including all appendices.

Feature	Commentary
RMA: Section106	No <i>geotechnical</i> natural hazards were identified (as listed in these Act) that are considered an undue impediment to construction or that cannot be reasonably addressed by typical engineering design and construction
Fill	Non-engineered fill was found at the site. The fill thickness was proven to be up to 1.2 m but could be thicker. The fill is not suitable for support of structures.
Natural Soils	Very stiff to hard soils of the Auckland Volcanic Field and Puketoka Formation underlie the site.
Unduly Weak, Sensitive, or Compressible Soils	Not Encountered
Groundwater	Groundwater levels ranged between 1.8 m and 3.0 m. A design groundwater level of 2.0 m was adopted for our liquefaction assessment.
Seismic Site Class	Site Class C
Expansive Soils	Classified as Moderately Expansive in accordance with B1/AS1
Slope Stability	The proposed building platforms are near level or gently sloping (less than 5°). Slope stability is not a risk to the development.
Liquefaction	Some soil layers below 3.0 m depth are susceptible to liquefaction. There is a risk of liquefaction induced settlement and lateral spreading at the site under the ULS seismic event. A thick raft of stiff to hard soils is present that will reduce the effect of liquefaction at the surface. We do not expect liquefaction effects to cause any damage to the proposed buildings that would exceed the buildings performance requirements under ULS conditions. This assumes lightweight timber framed buildings are used at the site.
Foundations	Shallow foundations are suitable where supported by stiff natural ground or engineered fill.
Drawing Review prior to Consent Application	Required
Construction Observation	Recommended

1.0 Introduction

Soil & Rock Consultants (S&RC) were engaged by The Royal New Zealand SPCA ('SPCA') to carry out a geotechnical investigation at 485 Puhinui Road, Papatoetoe. The SPCA plan to develop the site into a new animal care and rehoming centre. Our proposal has been scoped to support a Resource Consent application and inform structural design with respect to the building foundations.

Our investigation has been informed by Section 106 of the Resource Management Act which lists 'Natural Hazards' that must be considered by Council when assessing a Resource Consent application. Our assessment has also extended to consideration of the following points.

- Identification of geotechnical constraints to the proposed development and provision of recommendations to mitigate those constraints.
- Provision of a seismic site class in accordance with NZS1170.5:2004.
- Determination of the Expansive Soil Class in accordance with B1/AS1.
- An assessment of the risk of natural hazards affecting the site in accordance with Section 106 of the Resource Management Act.
- Assessment of the risk of liquefaction.
- Provision of geotechnical recommendations to support foundation design

The primary purpose of this reporting is to identify the issues discussed above and provide associated remedial, mitigating, and design recommendations in order that Resource Consent can be granted. Information and advice related to good construction practise are also provided.

1.1 Limitations

This report has been prepared by Soil & Rock Consultants for the sole benefit of The Royal New Zealand SPCA (the client) and their appointed sub-consultants with respect to the development proposed 485 Puhinui Road, Papatoetoe and the brief given to us.

This report can also be used by Auckland Council as part of Resource Consent processing.

The data and/or opinions contained in this report may not be used in other contexts, for any other purpose or by any other party without our prior review and agreement. This report may only be read or transmitted in its entirety, including the appendices.

The recommendations given in this report are based on data obtained from discrete locations and soil conditions between locations are inferred only. Our geotechnical models are based on those actual and inferred conditions. Variations between test locations may occur and Soil & Rock Consultants should be contacted in this event.

Soil & Rock Consultants should also be contacted should the scope or scale of the development proposal vary from that currently indicated.

2.0 Site Description

485 Puhinui Road is located on the northern side of Puhinui Road and is bound by Campana Road to its west and a tributary stream of the Waokauri Creek to the east. Auckland International Airport is located less than 2km to the west.

The property is legally described as Lot 2 and DP No 402013, is roughly rectangular in shape and covers an area of 7.1636 HA.

The proposed area of development ('the site') comprises roughly the centre third of the property. The wider site area is current utilised for market gardening. Numerous farm buildings are located near the western half of the centre of the site, which is of near-level topography. Some concrete hardstand areas are associated with the buildings. The eastern half of the site is gently sloping (less than 5°) down to the east towards the stream. Beyond the eastern property boundary the stream bank is steep (locally up to 30°) and is well vegetated with thick bush. The area of the proposed development is situated well away from any steeper slopes.

While the Auckland Council GIS website indicates that no underground public services currently traverse the site, it does show both the RNZ liquid fuels Marsden to Wiri pipeline and Vector overhead power lines run through the adjacent Campana Rd corridor. Based on discussions with the current land occupier underground water lines used to irrigate crops may be present across the site.

A schematic site plan is included as Figure 1 below.

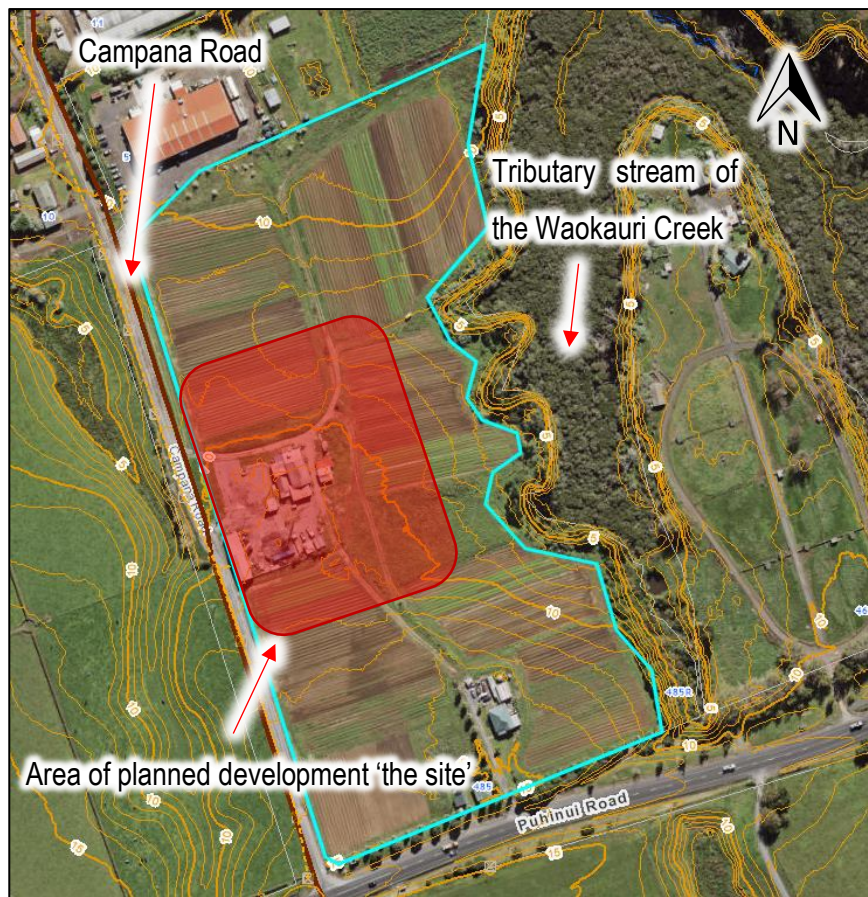


Figure 1: Aerial Image (Source: Auckland Council GeoMaps Website). Area of planned development indicative only and derived from preliminary architectural plans prepared by Chow Hill dated October 2021.

2.1 Proposed Development

Drawings prepared by Chow Hill Architects show the proposed development will include construction of numerous buildings across the site. All existing structures and hardstand areas will be removed as part of the development.

The buildings will be laid out in 12 wings across the western part of the centre of the site. Our understanding¹ is that the buildings will be single story structures that will meet the requirements for 'lightweight timber framed

¹ Based on discussions with Carnoustie Management Ltd, project managers for the development.

buildings' as outlined by NZS3604. Site access and paved parking areas will be built to the north and south of the building. An indicative site plan is included as Figure 2.

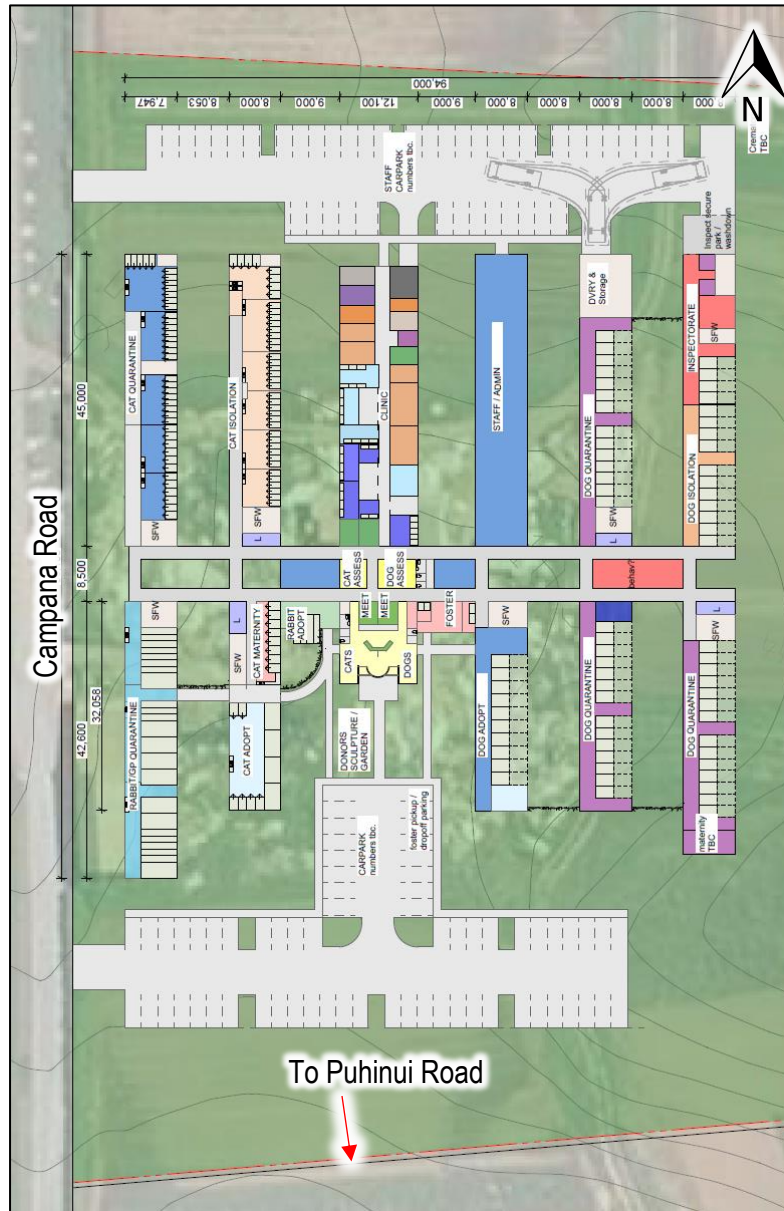


Figure 2: Proposed Development (Source: Site Plan by Chow Hill Architects)

No earthworks plans are currently available. Given the existing site contours if earthworks are needed, we expect they would be very limited in depth/thickness.

3.0 Geology

Reference to the GNS New Zealand Geological Web Map 1:250,000 Geology map, indicates the site is underlain by recent alluvial soils of the Puketoka Formation. Auckland Basalts Tuff is mapped at the northern end of Campana Road (refer Figure 3).

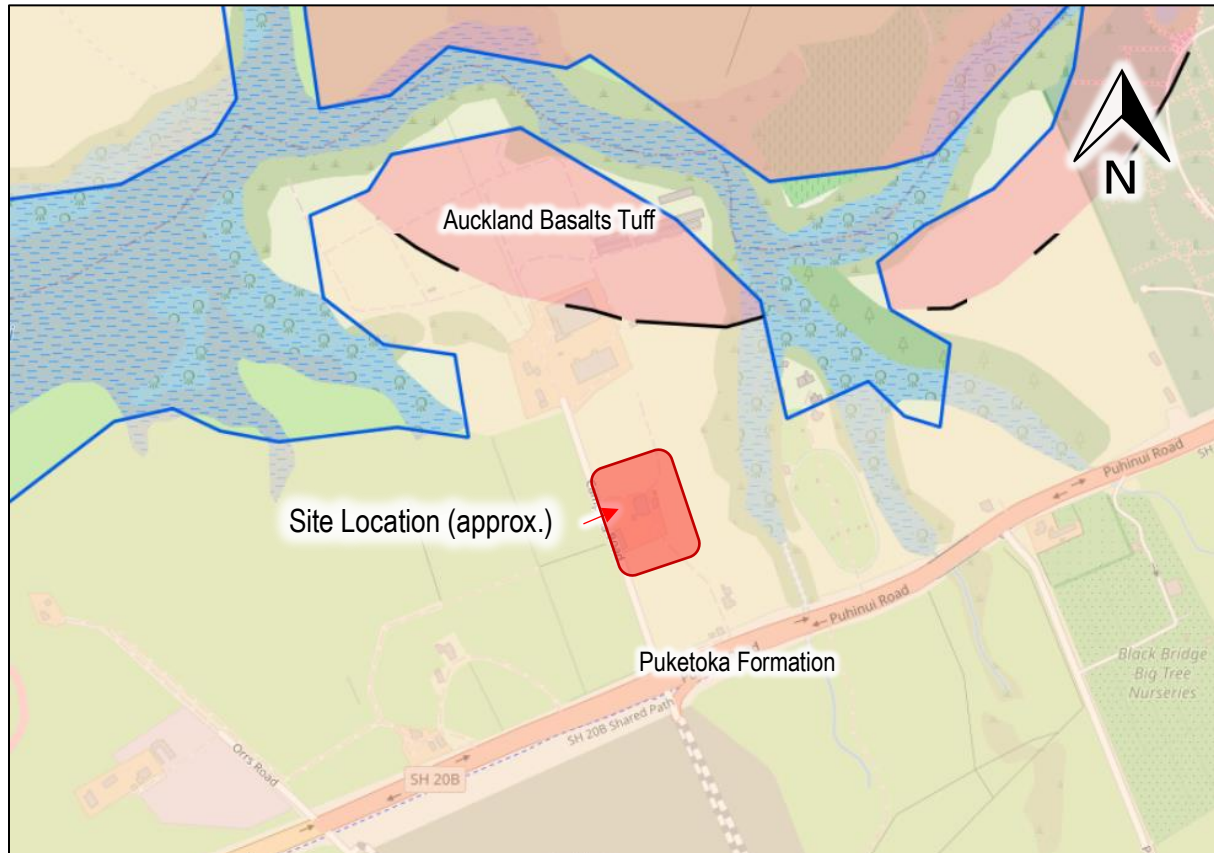


Figure 3: Geological Map (Source: GNS WebMaps Website)

Puketoka Formation alluvial deposits are described as “*Pumiceous mud, sand and gravel with muddy peat and lignite: rhyolite pumice, including non-welded ignimbrite, tephra and alluvia*”. These soils can vary in their strength and nature over short vertical and lateral distances. These soils can vary in thickness and are typically underlain by soils and rock of the East Coast Bays Formation.

While not shown on the geological map thin layers of volcanic airfall deposits (ash) or fill may also be present at the site. These units are not typically shown on geological maps.

4.0 Field Investigation

The field investigation was carried out on 18 January 2022 (hand augers) and 25 January (CPT) and included the following components:

- Site walkover by a senior Engineering Geologist from S&RC.
- Drilling of 10 hand augerholes with a target depth of 3.0 m (AH01 to AH12 excluding AH04 and AH09). The purpose of these augerholes was to confirm the nature of the near surface soils and support foundation design recommendations.
- Drilling of 4 hand augerholes with a target depth of 1.0 m (AH13 to AH16 inclusive). Scala penetrometer testing was completed next to these augerholes to a depth of 1.0 m. The purpose of these augerholes and penetrometer testing was to inform pavement design requirements for the carpark areas.
- Drilling of 2 hand augerholes with a target depth of 5.0 m (AH04 and AH09). Standpipe piezometers were installed in these augerholes. The purpose of these augerholes was to inform our geotechnical ground model for the site as well as establishing groundwater levels.
- Two (2) subsequent site visits (at approximately 1-week intervals) to measure the groundwater levels in the piezometers.
- Carry out four (4) Cone Penetration Tests (CPTs) to obtain a detailed strength profile of the site soils at depth, provide data for analysis of potential settlement and liquefaction, and help determine the seismic site class.
- Retrieval and laboratory testing of four (4) soil sample for the purposes of providing a soil expansivity classification in accordance with B1/AS1.

The test locations are shown on the Site Plan, Drawing No 211197/1 (Appendix A). The locations are approximate only.

Appendix B includes:

- engineering logs of the soils recovered in the hand augers
 - penetrometer test results
 - piezometer layout and specification.
-

Our laboratory test results are included in Appendix C and summary plots from the CPT are included in Appendix D.

4.1 Quality Assurance

Measurements of undrained shear strength were undertaken within in the augerholes using a handheld shear vane in accordance with the New Zealand Geotechnical Society Guidelines for Handheld Shear Vane Tests, dated August 2001. Peak and remoulded vane shear strengths shown on the attached augerhole logs represent dial readings adjusted using the BS 1377 calibration factor given on the log.

A visual-tactile field classification of the soils encountered during drilling was carried out in accordance with “Guidelines for the Field Classification and Description of Soil and Rock for Engineering Purposes”, issued by the New Zealand Geotechnical Society Inc. (2005).

CPTs were carried out on 25 January 2022 by ProDrill in accordance with NZS 4402.6.5.3:1988 and also in general accordance with ASTM D5778-07, DIN 4094-1 and ISSMFE Appendix A TC16. During each test, the CPT probe was pushed into the ground at a constant rate of 20mm/s $\pm$ 5mm/s. Sensors in the cone produced continuous analogue data of cone resistance (q_c), sleeve friction (f_s) and pore water pressure (u_2) that was converted to digital form at intervals of depth.

The nature of CPT means that some parameters are accurately measured (e.g. cone resistance, skin friction) and others are inferred or calculated (moduli, soil type etc.). No soil sample is retrieved for visual, tactile or laboratory assessment using this test method.

Dynamic Cone (Scala) Penetrometer testing was carried out in-lieu of shear vane testing where soils became sand-dominated. Testing was carried out in general accordance with NZS 4402 Test 6.5.2: 1988.

4.2 Subsurface Conditions

Subsurface conditions have been interpolated between the test locations and localised variations will exist between and away from the test locations.

In general, the soils encountered comprised localised layers of topsoil or fill underlain by soils of either the Auckland Volcanic Field or alluvial soils of the Puketoka Formation. An outline of the soil conditions and

investigation results is given below and summarised in Table 1. Detailed descriptions of the soils are given on the attached logs (Appendix B).

- **Topsoil.** Where topsoil was encountered its thickness ranged between 0.1 m and 0.4 m below present ground level (bpgl). These materials are unsuitable for the support of permanent structures (i.e. building foundations, floor slabs, pavements etc.).

The depth, lateral extent, and composition of the topsoil will vary across the site. In addition, Soil & Rock Consultants have been involved with former horticultural sites where considerable quantities of buried plastic planter bags and similar have been encountered during site clearance. Project budgeting should allow for this type of occurrence.

- **Fill.** Fill was encountered in some augerholes - mostly on the southern area of the proposed development. The fill thickness varied. Where its base was found the fill was between 0.1 m and 1.2 m thick. The base of the fill was not found in two augerholes (AH02 and AH03) where drilling was terminated at shallow depths (0.25 m and 0.3 m respectively) on obstacles within the fill that could not be penetrated.

The fill has been placed without engineering supervision and should not be relied on for support of permanent structures.

The depth, lateral extent, and composition of the fill will vary across the site.

- **Auckland Volcanic Field.** Residual soils of the Auckland Volcanic Field (AVF) were encountered in most augerholes. Where AVF soil was present the depth to its base ranged between 0.7 m to greater than 3.0 m. The AVF soils comprised stiff to hard silt with lesser fine sand and clay.
- **Tauranga Group.** Puketoka Formation alluvial deposits were encountered at each test location where the base of the fill or AVF soils was found. The base of the Puketoka Formation was not found in any augerholes.

The alluvial soils comprised stiff to hard silts with lesser amounts of clay and fine sand with occasional clay dominant zones. Vane shear strengths recorded within the alluvial material were all greater than 64 kPa and were typically greater than 100 kPa.

Waitemata Group soils and rock are expected to underly the Puketoka Formation at depth.

- **Scala Penetrometer Testing.** Scala Penetrometer testing was carried out from the base of augerholes that encountered obstacles that couldn't be penetrated (AH02), in horizons that were granular in nature (fill in AH06) and in the four augerholes intended to support pavement design (AH13 to AH16).

Refusal was not encountered in any of the natural soils at the site.

Test results in the granular fill horizon in AH06 indicated densities reducing from dense at the surface to loose at 0.9 m depth.

Test results in the augerholes intended to support pavement design were variable, decreasing from the ground surface, and generally indicating medium-dense soils.

- **Cone Penetrometer Testing.** Cone Penetrometer Tests (CPT) were carried out at four locations. Refusal, inferred to be contact with hard, less weathered rock of the Waitemata Group, was encountered at depths ranging between 16.8m and 17.3m bpgl. Termination depths are summarised in Table 2.

Tip pressures in the CPT were generally higher below 15.0 m in comparison to the tip pressures above. This depth is likely to be the upper surface of the Waitemata Group soils or highly weathered rock.

- **Groundwater.** Groundwater measurements were carried out within the hand augerholes on the day of drilling (18 January 2022) and are summarised in Table 1. The results of groundwater monitoring completed within the piezometers is discussed in Section 4.3 below. Where groundwater was found its depth ranged between 1.8 m and 3.0 m bpgl. Where groundwater was not encountered the augerholes were terminated at depths of 3.0 m or less.

Groundwater measurements taken during drilling are not always an accurate portrayal of the actual long-term groundwater table. Groundwater levels can take time to stabilise within the augerhole following drilling.

Table 1 – Summary of Subsurface Conditions

Test ID	Termination		Depth (m) to the base of:		Vane Shear Strength Range (kPa)	Scala Penetrometer Termination (m)	Groundwater Depth (m)
	Depth (m)	Reason	Topsoil/Fill	AVF			
All depths measured in (m) below present ground level. (Rounded to 1 DP)							
AH01	3.0	Target depth	0.1 (TS)	0.8	96 - > 200		NE
AH02	0.25	Obstacle	>0.25 (FILL)	NE		0.25	NE
AH03	0.3	Obstacle	>0.3 (FILL)	NE	NT	NT	NE
AH04	4.3	Collapse	1.0 (FILL)	NE	103- > 200		3.0
AH05	3.0	Target depth	0.2 (TS)	NE	143 - > 200		NE
AH06	3.0		1.2 (FILL)	>3.0	90 - > 200		3.0
AH07	3.0		0.4(TS)	NE	77 - 180		2.6
AH08	3.0		0.1 (TS)	0.8	124 - 200		2.7
AH09	5.0		0.1 (FILL)	1.7	64 - > 200		2.7
AH10	3.0		0.2 (TS)	2.0	122 - > 200		NE
AH11	3.0		0.2 (TS)	1.8	163 - > 200		NE
AH12	3.0		0.1 (TS)	0.7	112 - > 200		NE
AH13	1.0		NE	>1.0	150 - > 200		NE
AH14	1.0		0.1 (TS)	0.9	114 - > 200		NE
AH15	1.0		NE	>1.0	182 - > 200		NE
AH16	1.0			NE	>1.0	>200	

NE = Not Encountered

NT = Not Tested

TS = Topsoil

Table 2 –CPT Summary

Test ID	Termination Depth (m) bpgl
CPT01	16.8
CPT02	16.8
CPT03	17.3
CPT04	17.0

4.3 Groundwater Monitoring

Two piezometers were installed at the site on 18 January 2022. Construction and lithology logs are included in Appendix B. Water levels within the piezometers were measured on 27 January and 1 February 2022. The groundwater monitoring results are shown in Table 3 below.

Table 3 – Results of Groundwater Monitoring

Location	Piezometer Reading Range	Monitored Lithology	Groundwater Levels (bpgl – 1 dp)		
	m bpgl		18/01/22 (On installation)	27/01/22 (+9 days)	01/02/22 (+14 days)
AH04 / PZ01	2.7 – 3.0	Tauranga Group	3.0 m	2.7 m	2.9 m
AH09 / PZ02	1.8 – 2.7		2.7 m	2.0 m	1.8 m

Water levels may be higher especially after periods of prolonged wet weather or during winter months.

5.0 Expansive Soils

Four soil samples were retrieved from near-surface strata. Three of the retrieved samples (SS01 to SS03) were tested in our laboratory to determine soil expansivity characteristics in accordance with AS 1289.7.1.1. One sample was unable to be tested due to damage on extrusion.

The laboratory test results indicate the soils lie in 'Expansive Soil Class M – Moderately Expansive' as given in B1/AS1. B1/AS1 states that Class M soils experience surface movements of up to 550 mm. Foundation design should take account of this classification. Laboratory test results are presented in Appendix C.

6.0 Sensitive Soils

The ratio of peak to remoulded vane shear strength values recorded during our investigation ranges approximately between 2 and 4, indicative of a 'moderately sensitive' subgrade. These soils are potentially susceptible to mechanical disturbance and/or exposure to the elements and soils that test well in-situ can perform poorly when construction is underway. Care is therefore required during construction to ensure the soils are protected to ensure favourable short and long-term subgrade and foundation performance.

Practical means of protecting the soils include avoidance of vibration-based compaction equipment, protecting the subgrade following initial site clearance, minimising the passage of heavy or vibrating construction plant, and extra care during foundation excavations, particularly any pile excavations.

7.0 Seismic Design Parameters

The site is considered a Class C – ‘Shallow Soil Site’ as defined by NZS 1170.5:2004.

We have calculated the Peak Ground Acceleration (PGA) in accordance with section 6.2 of the Bridge Manual² based on the following assumptions:

- Class C soils
- A design life of 50 years
- An ARI of 1/500 (Table 3.3 of 1170.0: 2002)
- R_u of 1 (Table 3.5 of 1170.5: 2004)
- $F = 1.33$ (Section 6.2 of the Bridge Manual)
- $C_0, 1000 = 0.15$ (Figure 6.1(a) of the Bridge Manual)

A PGA value of 0.15g (ULS) with an effective earthquake magnitude of 5.75 (from Figure 6.2(d) of the Bridge Manual) should be adopted for design purposes for structures with a 50-year design life.

Note that design for retaining walls and slopes should use a 100-year design life and a larger design PGA would apply.

8.0 Slope Stability

The proposed development is shown to take place over gently-sloping to near-level ground (less than 5°) and is underlain by very stiff to hard soils. Ground slopes are expected to be further reduced during development of the site. Slope instability is not a risk for the proposed development.

² ‘The Bridge Manual’ Prepared by NZTA, ref: SP/M/022, edition 3, amendment 3, effective October 2018

Sideslopes of the Waokauri Creek are located approximately 50 m to the east. Any development within 12 m of the crest of the creek sideslopes will require specific geotechnical assessment.

9.0 Liquefaction Induced Settlement and Lateral Spreading

We have carried out a screening assessment to assess the risk of liquefaction induced ground settlement and lateral spreading affecting the site. This assessment meets the requirements for a Level D – site specific assessment in accordance with relevant MBIE guidelines.

Assessments of liquefaction potential were carried out based on the method of Boulanger & Idriss (2014) following the Zhang et. al. (2002) procedure to determine possible ground subsidence across the site during design seismic events. Liquefaction analyses have been carried out for Ultimate Limit State (ULS – 1:500 year return period) and Serviceability Limit State (SLS – 1:50 year return period) design seismic events using design peak ground accelerations and earthquake magnitudes outlined above. The CPT liquefaction assessment as calculated by CLiq software (version 2.1.6.11) is included in Appendix E.

No liquefaction-related laboratory testing was completed during preparation of this report. The liquefaction potential has been assessed using CPT data only. A water level of 2.0 m was used as the design groundwater levels in the liquefaction assessment. The ‘actual’ groundwater depth will vary seasonally.

The analyses indicate no liquefaction is expected under the SLS seismic event.

Liquefaction induced settlement and lateral spread is predicted by our model under the ULS seismic event. The amount of settlement and spread and the depth ranges where this is modelled to occur are summarised in Table 4.

Table 4 - Summary of predicted effects under the ULS design event

CPT ID	Liquefaction Induced Settlement		Lateral Spread	
	Amount	Depth Range (m)	Amount	Depth Range (m)
CPT - 01	40 mm	5.5 – 7.5	150 mm	5.5 – 6.0
CPT - 02	10 mm	3.5 – 7.0 9.5 – 10.0	5 mm	4.5 – 6.0
CPT - 03	30 mm	3.0 – 5.5 7.5 – 10	60 mm	3.7 – 5.7
CPT - 04	15 mm	4.0 – 7.0 9.5 – 10	40 mm	5.0 – 6.0

Note: Depth ranges are approximate only.

The analyses indicate vertical liquefaction-induced settlement under the ULS design seismic event is calculated to be in the order of 10 mm to 40 mm. All liquefaction is expected to occur at depths of 3.5 m or greater.

The risk of lateral spread has been assessed assuming a 3.0 m high free face located 50 m from the CPT. This represents the sideslopes of the Waokauri Creek to the east of the site. This site geometry is based on contours available from Auckland Councils GeoMaps website which are derived from LIDAR measurements. The results of our lateral spreading risk assessment indicate that the ground surface at the CPT locations could move towards the Waokauri Creek between 5 mm and 150 mm.

Given:

- stiff to hard soils underly the site
- a 'raft' of non-liquefiable soils 3 m to 5.5 m approximate thickness is expected below the site
- this assessment methodology tends to over report lateral spread risks
- timber frame structures are proposed at the site. This type of structure generally tolerates movement well

We consider the expected lateral stretch³ that buildings at the site would experience would be within the performance limits expected for the structures in a ULS event.

Liquefaction Conclusions

Whilst liquefaction-induced settlement and lateral spread are predicted at the site under the ULS design seismic event we do not expect liquefaction effects to cause any damage to the proposed buildings that would exceed building performance requirements under ULS conditions. This inference assumes lightweight timber framed construction.

Pile design (if piles are required) must consider the depths at which liquefaction-induced settlement is expected. If piles are required, specific assessment is required to support detailed design to confirm suitable embedment depths.

Piles should not be embedded less than 6 times the pile diameter (or 2.0m, whichever is the greater) above liquifiable soils. Skin friction should not be used in the liquefiable zone.

10.0 Foundation Design Recommendations

10.1 General

S&RC should inspect all foundation excavations to determine whether the exposed soil and foundation conditions are consistent with those described in this report.

Groundwater should be kept clear of foundation excavations to avoid softening of soils.

10.2 Shallow Foundations

The natural site soils below any existing fill are considered suitable for the use of shallow foundations which may comprise a 'waffle' or 'rib-raft' slab (surface-supported, no embedment) or traditional strip/pad/Senton footings. Traditional strip/pad/Senton piles should be embedded a minimum of 600 mm into stiff natural

³ The stretching across a building that occurs due to lateral spreading of the supporting ground.

ground or engineered fill and designed to accommodate the expansivity characteristics of the soils, classified as Expansive Soil Class M as per Section 5.0 of this report.

A Design (Dependable) Bearing Capacity of 150 kPa is available for Ultimate Limit State Design of shallow foundations carried out in accordance with B1/AS1, B1/VM4 and AS/NZS 1170:2002. A Strength Reduction Factor (ϕ_{bc}) of 0.5 has been applied to the Geotechnical Ultimate Bearing Capacity value to determine the Design Bearing Capacity.

The fill present across much of the site cannot be relied on for the support of structures. Either foundations will need to be deepened to penetrate the fill or otherwise the fill can be removed and the ground surface built up to design levels using engineered fill.

10.3 Pile Foundations

Pile foundations may be needed where:

- non-engineered fill or other unsuitable material remains in-situ
- bearing capacity requirements are greater than those given for shallow foundations

If piles are needed then a detailed liquefaction assessment will be needed at the detailed design stage to confirm suitable embedment depths. The purpose of that assessment would be to ensure piles are not embedded in, or influenced by, loss of support from liquefiable layers.

We recommend any proposed pile foundations take the form of bored, concrete-encased timber, or steel-reinforced concrete piles embedded into stiff natural ground. Pile excavations that penetrate groundwater, expected from approximately 2.0 m depth bpgl, will be susceptible to collapse and casing may be required. Pumps capable of handling slurry-rich material will also be required during construction.

Soil strength parameters applicable to Ultimate Limit State Design in accordance with AS/NZS 1170:2002 are given in Table 5. These parameters may only be adopted for piles with a length-to-diameter ratio greater than five ($L/D > 5$), and that are embedded into stiff natural ground.

Table 5 – Ultimate Limit State Pile Design Parameters

Material	Ultimate End Bearing Capacity	Ultimate Skin Friction
Non-Engineered Fill	Not applicable	Nil
Alluvial Deposits or AVF Soils	450kPa	20kPa

A Strength Reduction Factor not greater than $\phi_{pc} = 0.5$ should be applied to the Geotechnical Ultimate Capacity values to determine the Design (Dependable) Capacity values.

Skin friction should be ignored within non-engineered fill and/or the upper 0.6 m of pile length (whichever is the deeper) to take soil expansivity movements into account and also within the liquefiable zone. Skin friction should also be ignored if the pile holes are permanently cased.

Negative skin friction should be assessed for any part of a pile situated above liquefiable zones. This is to account for drawdown forces on the pile that could occur as a result of liquefaction-induced settlement.

Driven piles are technically feasible but are likely to encounter issues with strength reduction soils during driving due to the creation of excess pore water pressures in dilatant soils. We can provide specific recommendations if driven piles are considered.

11.0 Floor Slabs and Pavements

All topsoil, non-engineered fill, vegetation, organic or otherwise unsuitable material should be removed from under floor slab and pavement areas prior to construction.

Given the land use for the property is currently market gardening it is reasonable to expect the upper surface has been disturbed and reworked during planting and harvesting processes. Contingency should be allowed for in project costing to remove near-surface soils or rework them to a suitable standard. Disturbed ground and possibly additional filling should also be expected in areas where existing structures are to be removed.

For preliminary design a CBR value of 3% or a modulus of subgrade reaction of 20 kPa/mm are considered appropriate for flexible and rigid pavements respectively. These values should be confirmed by specific testing by S&RC following preparation of the subgrade.

Maintaining the natural moisture content of a subgrade prior to construction is important. The subgrade should be protected from desiccation, rain damage, and plant-trafficking by placing a protective layer of granular fill immediately upon excavating or filling to grade following inspection by the Geotechnical Engineer. The granular fill can later be left in-situ as a construction sub-base or basecourse if managed well and protected from damage. We recommend watering the subgrade approximately 48 hours prior to concrete placement to return the subgrade to its inferred pre-excavation moisture content.

Any concrete floor-slab or pavement should be underlain by a basecourse of clean, free-draining granular fill as specified by the designer and should be subjected to compaction by a device of appropriate weight and energy. Silty or sandy subgrades are generally sensitive to disturbance and 'static' rolling only (no vibration) is recommended.

12.0 Cuts and Fills

All fills, regardless of depth, must be placed in accordance with NZS 4431:1989 with respect to subgrade preparation and standard of compaction.

Any proposal to create cuts or fills greater than 600 mm in height should be the subject of specific design advice.

13.0 Soil Contamination

The site has been used for market gardening. Soils may have been contaminated from spraying products such as pesticides and herbicides. If contaminated soils are present then there may be special requirements on their handling and disposal.

We understand that a contamination assessment is being completed by others. The contamination assessment report should be referred to for specialist advice on managing risks associated with soil contamination.

14.0 Retaining Structures

Any retaining over 600 mm retained height or supporting a surcharge should be the subject of engineering design. We can provide design recommendations if requested.

15.0 Stormwater

Concentrated stormwater flows must not be allowed to run onto or over slopes or saturate the ground as this could adversely affect slope stability or foundation conditions. Flows from all impermeable areas must be collected and carried in sealed pipes to a disposal point approved by Council. Disposal to ground may only be carried out subject to consultation with S&RC.

16.0 Underground Services

While not anticipated, public or private underground services, either mapped or unmapped, of any type (gas, pipelines, fibre, electricity etc) could be present. A thorough service-search should be carried out prior to commencement of excavations.

17.0 Drawing Review

No detailed drawings of the proposed development were provided at the time of preparation of this report. Once plans are available they should be submitted to S&RC so that the applicability and implementation of the recommendations made in this report can be confirmed prior to application for Building Consent.

18.0 Observation of Construction

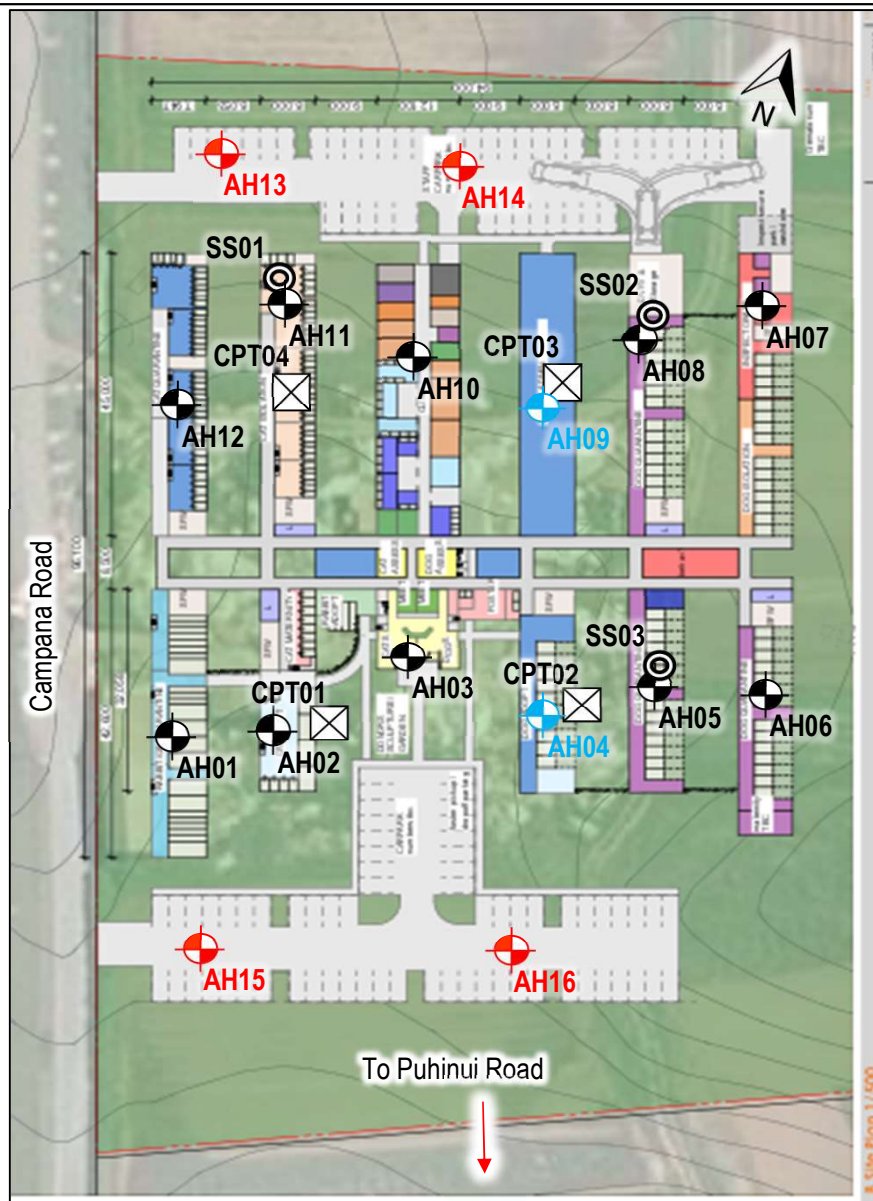
The recommendations given in this report are based on limited site data from discrete locations. It is in the nature of geotechnical engineering that variations in ground conditions will exist across a site. S&RC should be engaged to inspect excavations and foundation conditions exposed during construction so that 'actual' ground conditions can be compared with those assumed in formulating this report.

The aspects of the development that require geotechnical observation, testing, and final certification will be determined by Council and given in the Special Conditions of the Consent. The Contractor should make themselves familiar with those conditions and ensure adequate observations are carried out. In any case, the contractor should notify S&RC should ground conditions encountered during construction vary from those described in this report. Any ground covered by fill or concrete prior to geotechnical inspection will be specifically excluded from completion certification (PS4).

End of Report Text – Appendices Follow

Appendix A

Drawings



Key

-  **AHXX** Shallow 1.0 m HA to investigate design requirements for pavements
-  **AHXX** HA with target depth of 3.0 m to investigate ground conditions in building location
-  **AHXX** HA with target depth of 5.0 m and a piezometer installed.
-  **CPTXX** CPT to target depth of 20m to investigate deeper ground conditions.
-  **SS02** Shrink swell sample locations

background image sourced from Chow Hill Architects.
Site layout schematic only.



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DRAWING NO: **211197/1**
DATE: March 2022
DRAWN: BY
SCALE: NTS

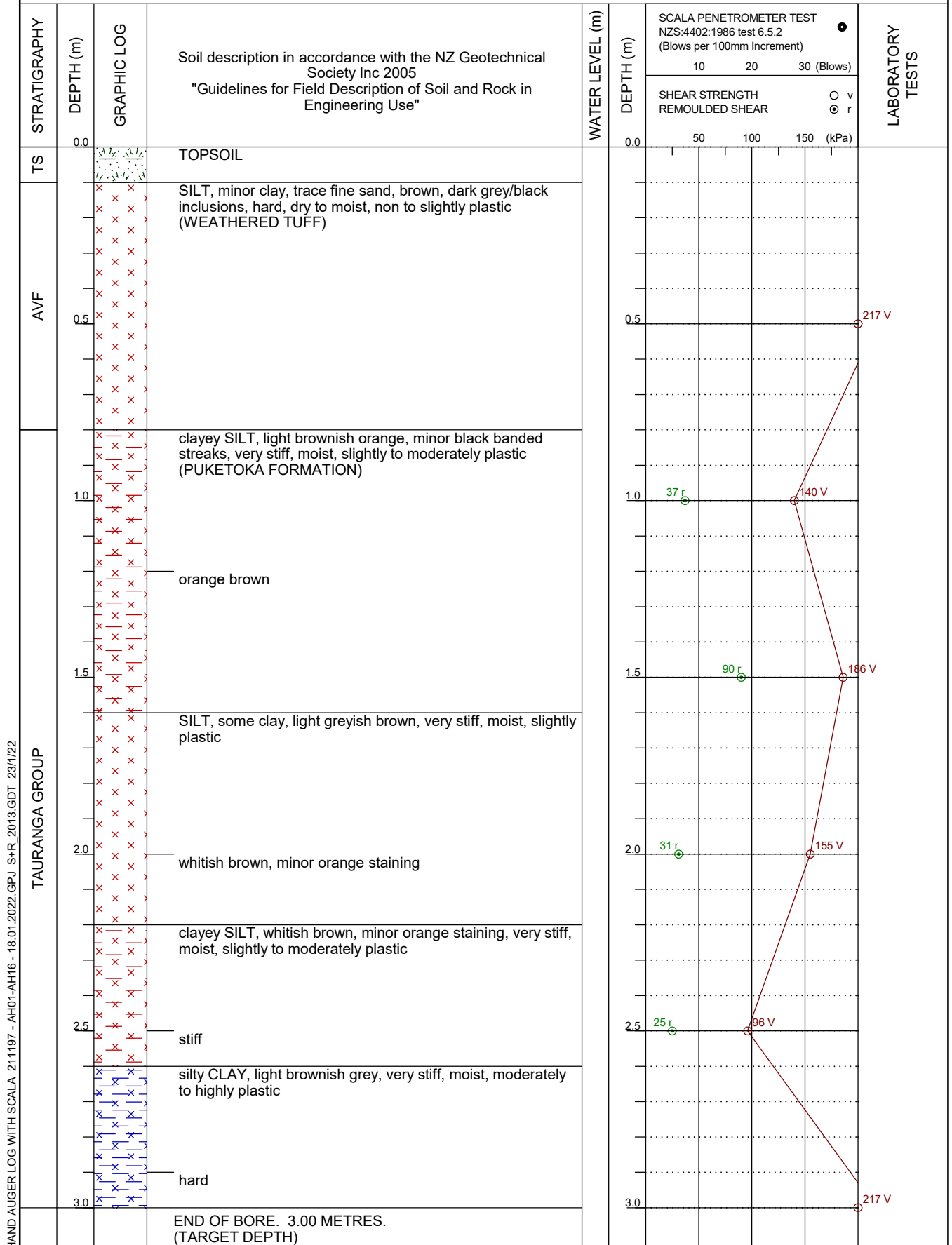
INVESTIGATION PLAN 485 PUHINUI ROAD, PAPATOETOE

Appendix B

Investigation Logs (Augerholes and Piezometer)

Drill Type: 50mmØ Hand Auger
Drilled By: HH
Date Started: 18/1/22
Date Finished: 18/1/22

Project No: 211197
Coordinates:
Ground Elevation:
Water Level: Groundwater Not Encountered

Logged By: HH
Shear Vane No - Calibration Date: GEO1591 - 5/03/2021
Surface Conditions: Near Level, Grass


HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R_2013.GDT 23/1/22



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CLIENT: SPCA New Lynn - Carnoustie Management

PROJECT: Geotechnical Investigation, 485 Puhinui Road,
Papatoetoe

Auger Hole No: AH02

Sheet 1 of 1

Drill Type: 50mmØ Hand Auger

Drilled By: RH

Date Started: 18/1/22

Date Finished: 18/1/22

Project No: 211197

Coordinates:

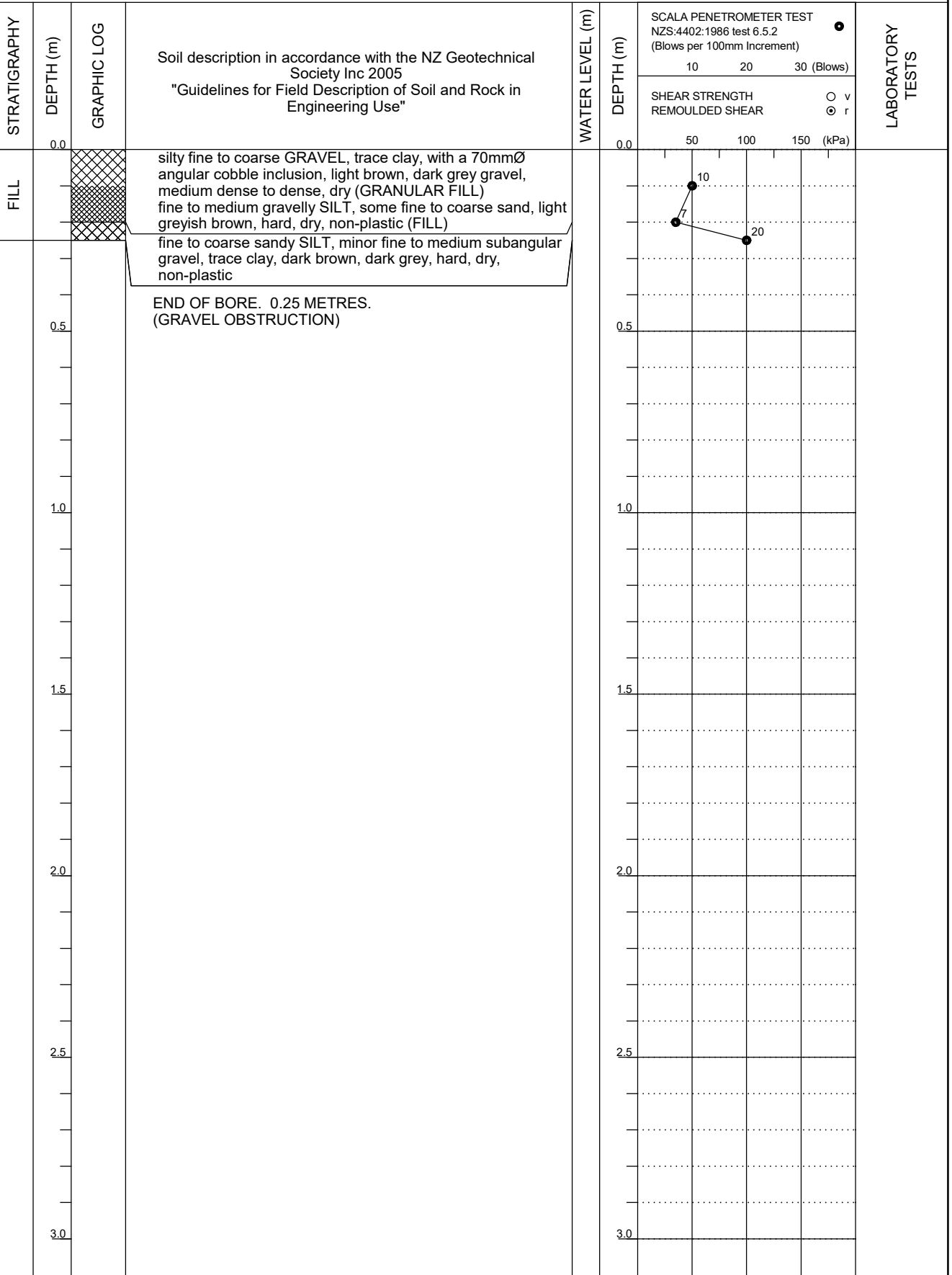
Ground Elevation:

Water Level: Groundwater Not Encountered

Logged By: RH

Shear Vane No - Calibration Date: GEO765 - 10/03/2021

Surface Conditions: Slightly Sloping, Soil



HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R_2013.GDT 23/1/22



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CLIENT: SPCA New Lynn - Carnoustie Management

PROJECT: Geotechnical Investigation, 485 Puhinui Road, Papatoetoe

Auger Hole No: AH04/PZ01

Sheet 1 of 1

Drill Type: 75mmØ Hand Auger

Drilled By: JT

Date Started: 18/1/22

Date Finished: 18/1/22

Project No: 211197

Coordinates:

Ground Elevation:

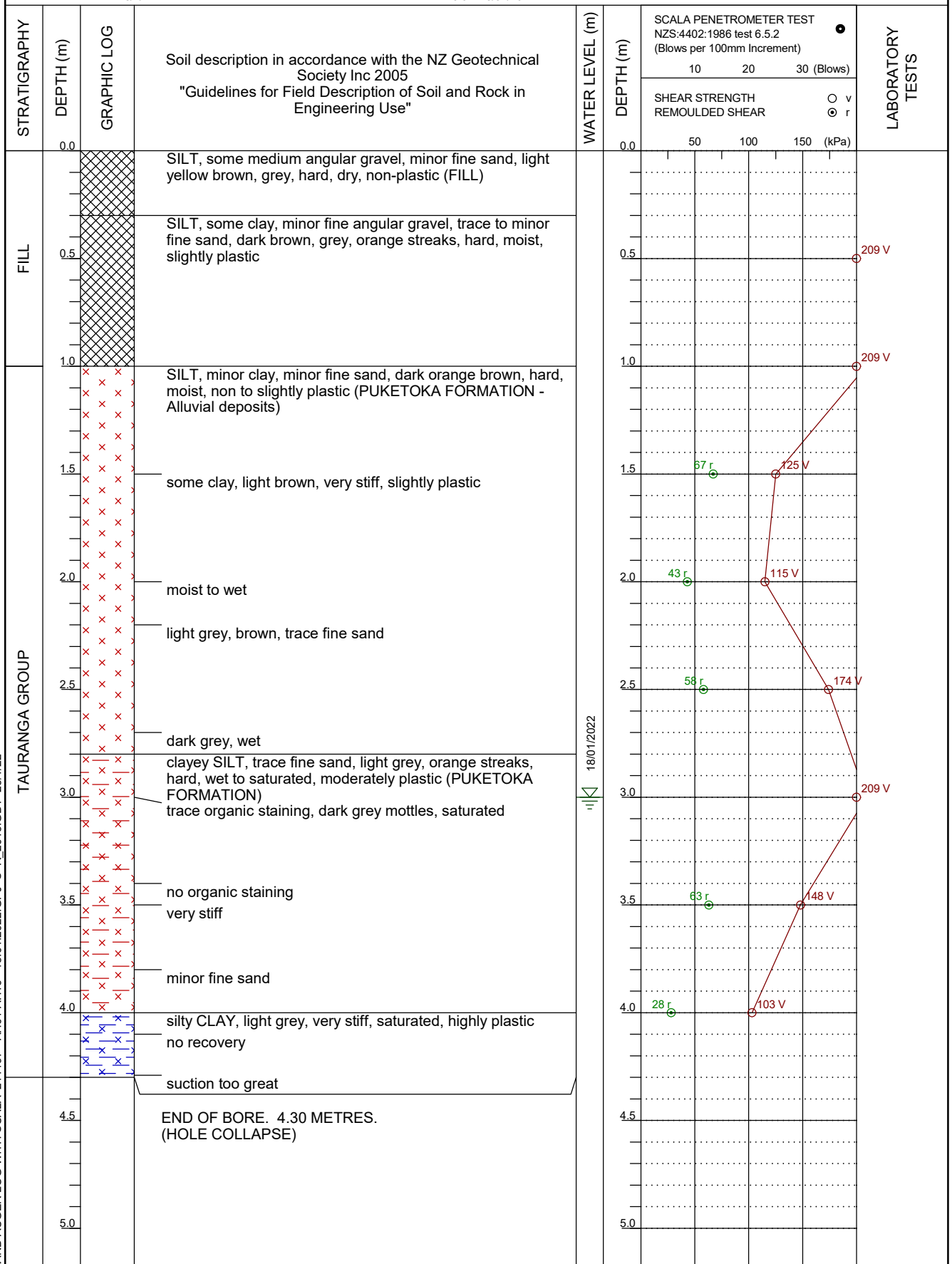
Water Level: 3.0m 18/01/2022

Logged By: JT

Shear Vane No - Calibration Date: GEO403 - 24/02/2021

Surface Conditions: Slightly Sloping, Soil

HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R_2013.GDT 23/1/22



Drill Type: 50mmØ Hand Auger

Project No: 211197

Logged By: KM

Drilled By: KM

Coordinates:
Shear Vane No - Calibration Date: DR3127 - 28/09/2021

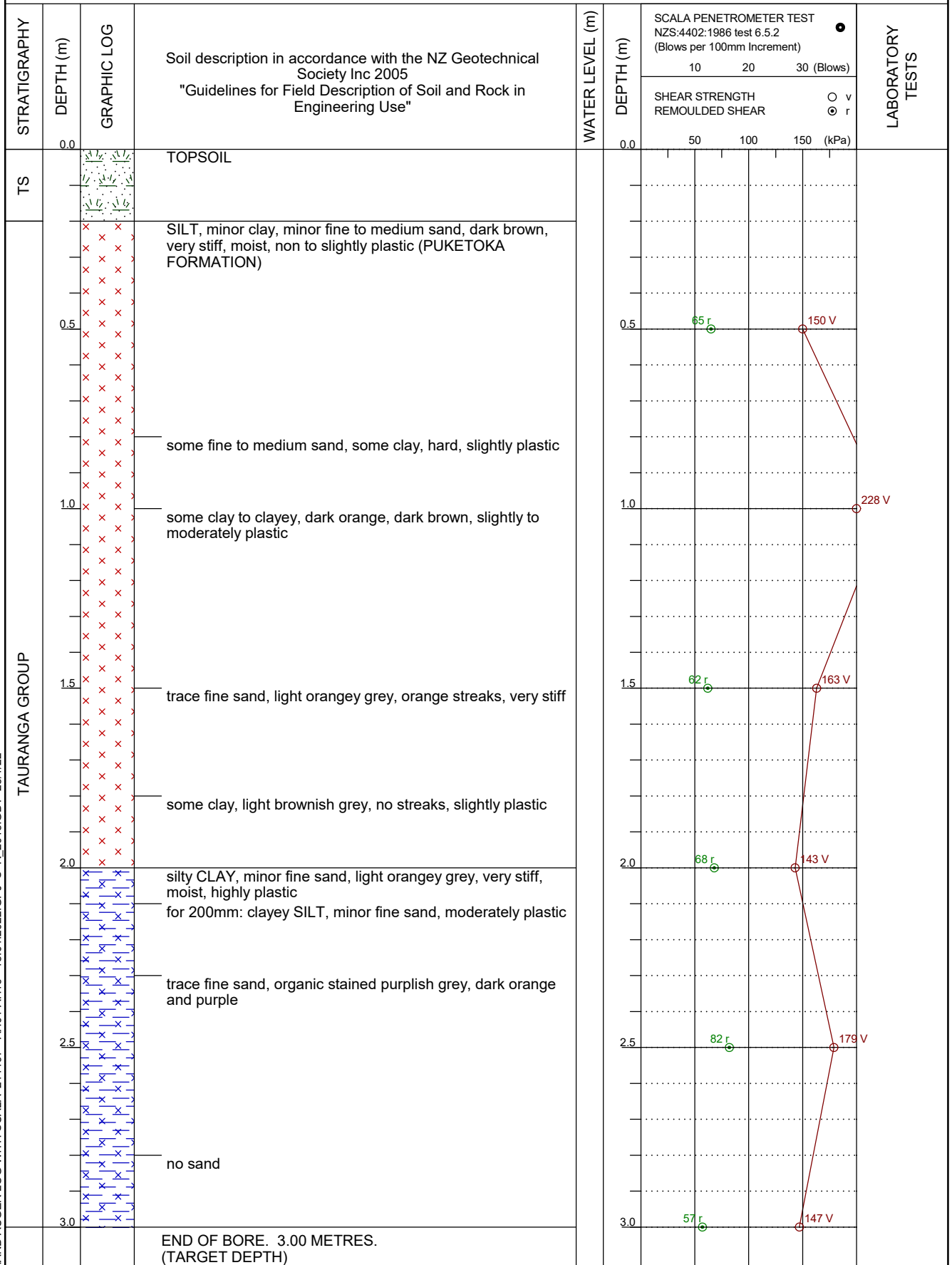
Date Started: 18/1/22

Ground Elevation:
Surface Conditions: Near Level, Grass

Date Finished: 18/1/22

Water Level: Groundwater Not Encountered

HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R_2013.GDT 23/1/22





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PROJECT: Geotechnical Investigation, 485 Puhinui Road, Papatoetoe

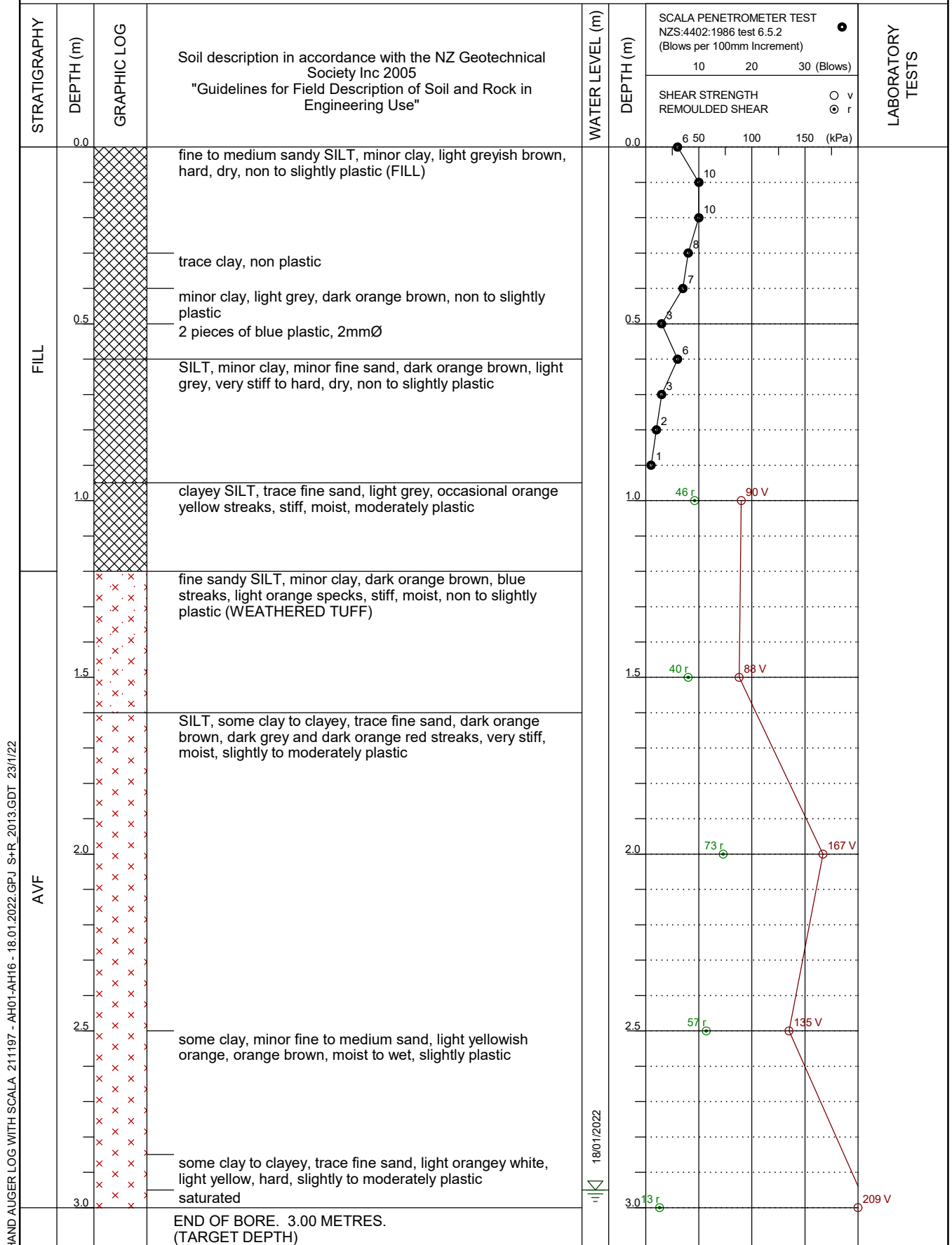
Auger Hole No: AH06

Sheet 1 of 1

Drill Type: 50mmØ Hand Auger
Drilled By: RH
Date Started: 18/1/22
Date Finished: 18/1/22

Project No: 211197
Coordinates:
Ground Elevation:
Water Level: 3.0m 18/01/2022

Logged By: RH
Shear Vane No - Calibration Date: GEO765 - 10/03/2021
Surface Conditions: Near Level, Grass



HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R_2013.GDT 23/1/22

18/01/2022



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PROJECT: Geotechnical Investigation, 485 Puhinui Road,
Papatoetoe

Auger Hole No: AH07

Sheet 1 of 1

Drill Type: 50mmØ Hand Auger

Drilled By: JT

Date Started: 18/1/22

Date Finished: 18/1/22

Project No: 211197

Coordinates:

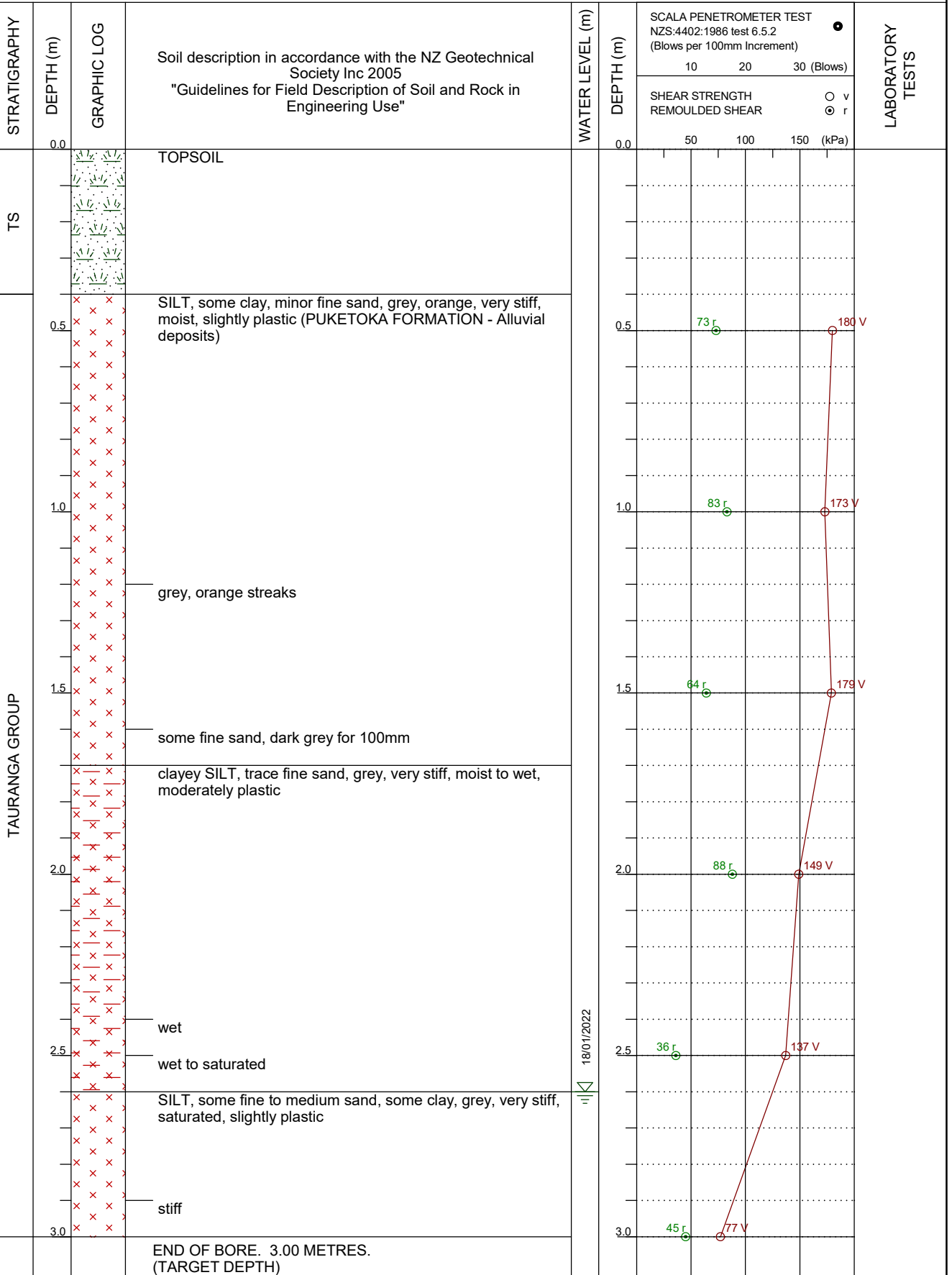
Ground Elevation:

Water Level: 2.6m 18/01/2022

Logged By: JT

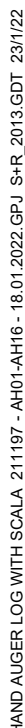
Shear Vane No - Calibration Date: GEO403 - 24/02/2021

Surface Conditions: Near Level, Grass



HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R 2013.GDT 23/1/22

Logged By: HH
Shear Vane No - Calibration Date: GEO1591 - 5/03/2021
Surface Conditions: Slightly Sloping Grass





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PROJECT: Geotechnical Investigation, 485 Puhinui Road, Papatoetoe

Auger Hole No: AH09/PZ02

Sheet 1 of 1

Drill Type: 75mmØ Hand Auger

Drilled By: RH

Date Started: 18/1/22

Date Finished: 18/1/22

Project No: 211197

Coordinates:

Ground Elevation:

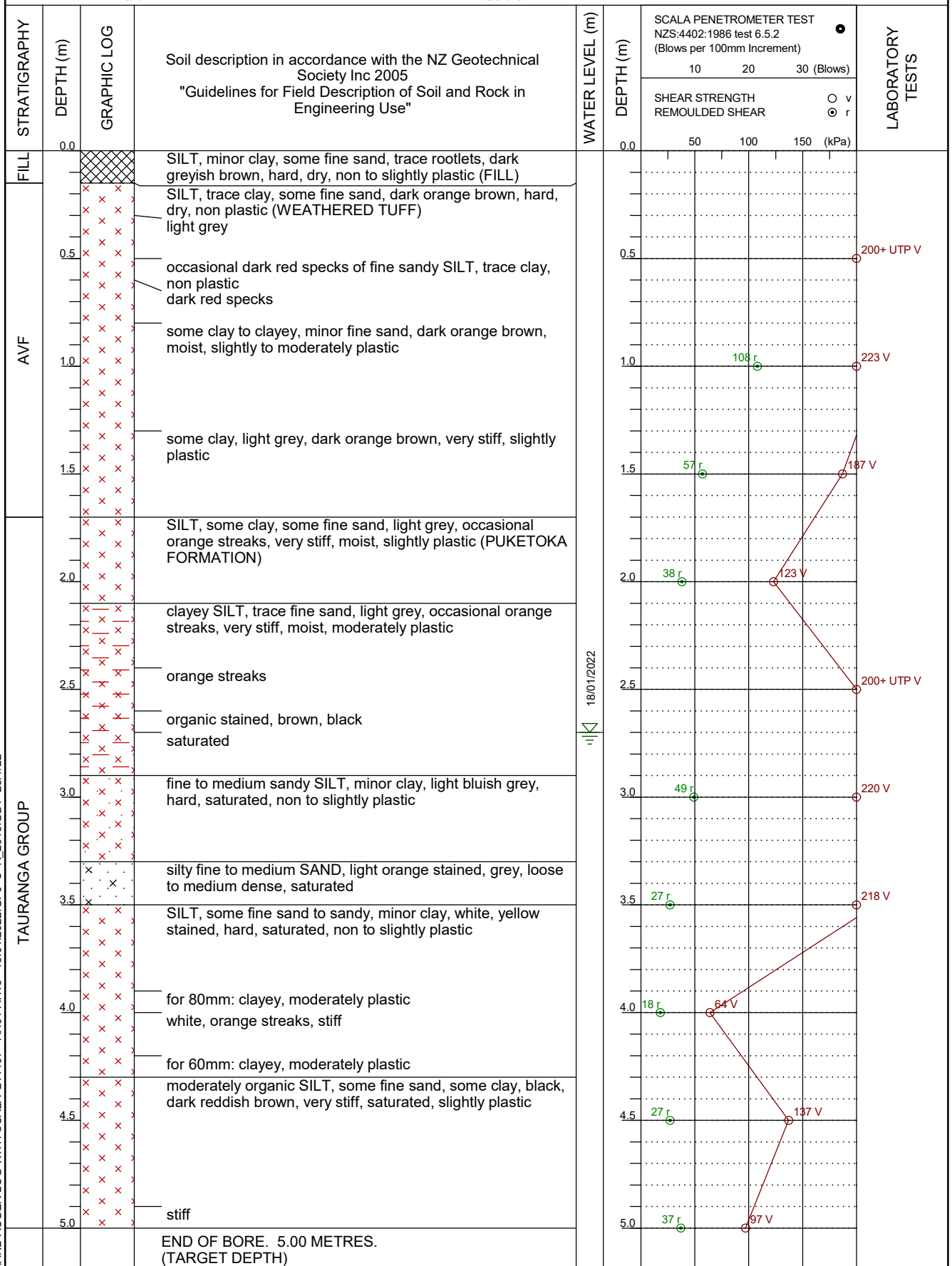
Water Level: 2.7m 18/01/2022

Logged By: RH

Shear Vane No - Calibration Date: GEO765 - 10/03/2021

Surface Conditions: Near Level, Grass

HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R_2013.GDT 23/1/22





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CLIENT: SPCA New Lynn - Carnoustie Management

PROJECT: Geotechnical Investigation, 485 Puhinui Road,
Papatoetoe

Auger Hole No: AH10

Sheet 1 of 1

Drill Type: 50mmØ Hand Auger

Drilled By: KM

Date Started: 18/1/22

Date Finished: 18/1/22

Project No: 211197

Coordinates:

Ground Elevation:

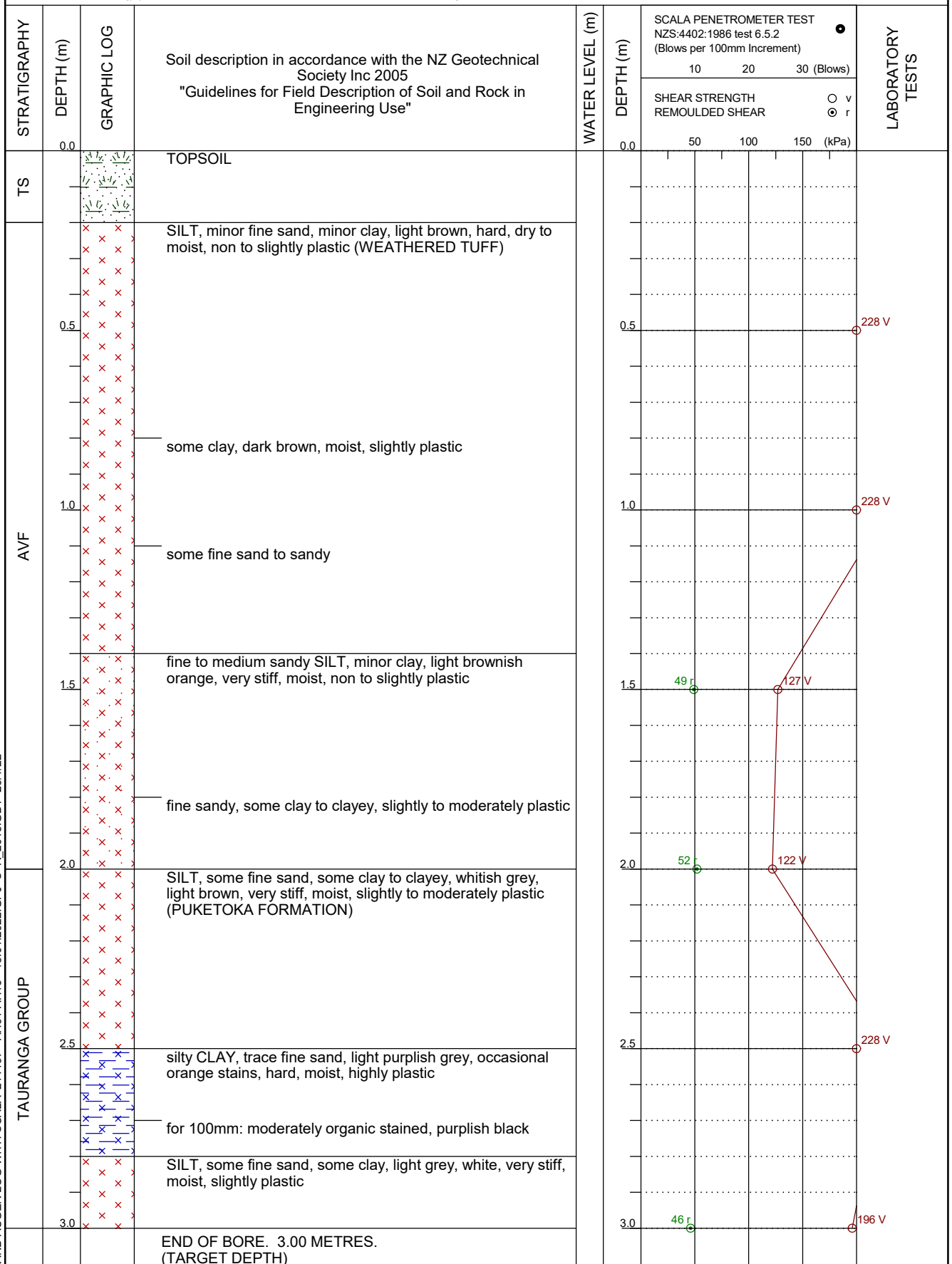
Water Level: Groundwater Not Encountered

Logged By: KM

Shear Vane No - Calibration Date: DR3127 - 28/09/2021

Surface Conditions: Near Level, Grass

HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R_2013.GDT 23/1/22





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CLIENT: SPCA New Lynn - Carnoustie Management

PROJECT: Geotechnical Investigation, 485 Puhinui Road,
Papatoetoe

Auger Hole No: AH11

Sheet 1 of 1

Drill Type: 50mmØ Hand Auger

Drilled By: KM

Date Started: 18/1/22

Date Finished: 18/1/22

Project No: 211197

Coordinates:

Ground Elevation:

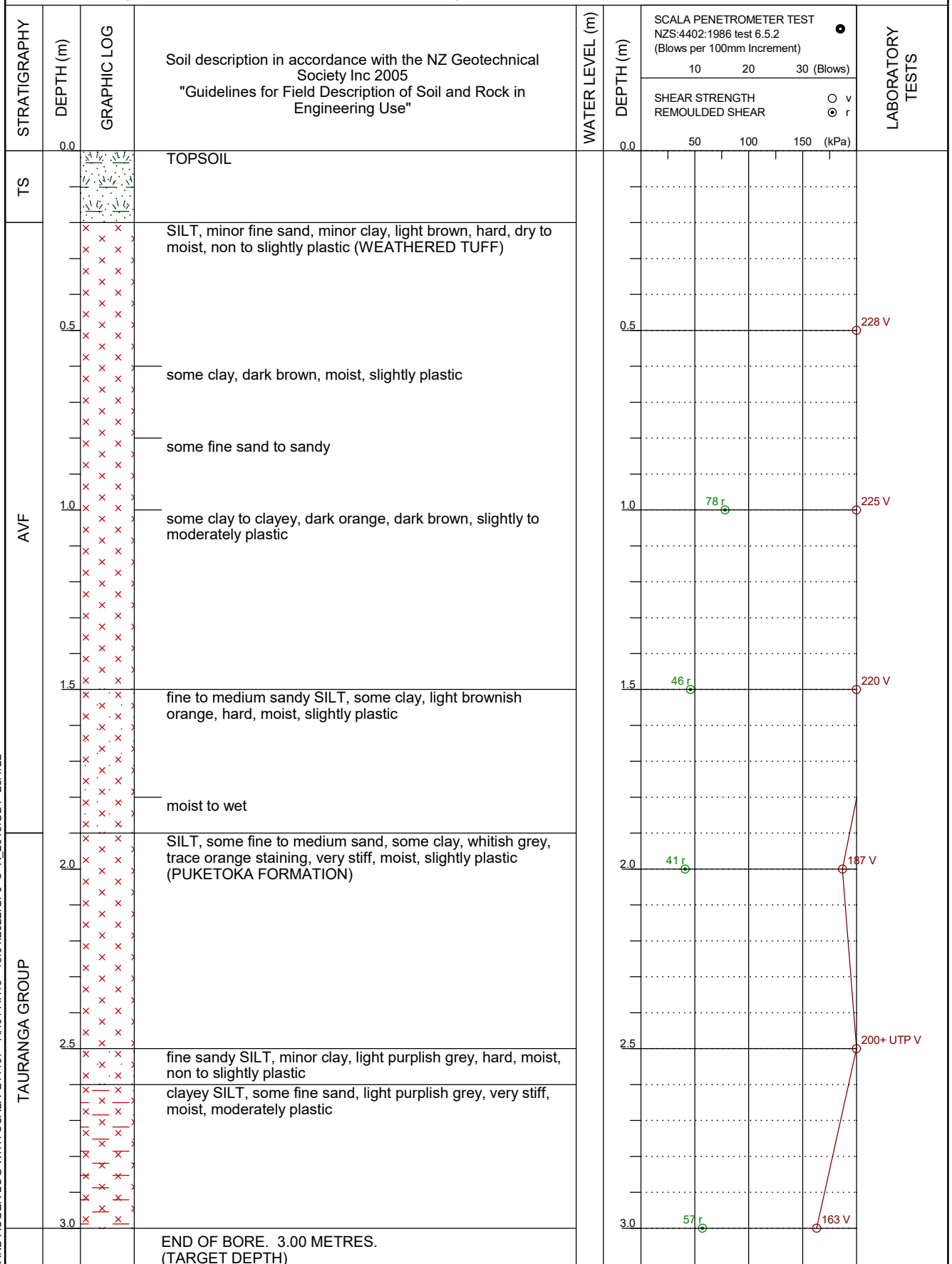
Water Level: Groundwater Not Encountered

Logged By: KM

Shear Vane No - Calibration Date: DR3127 - 28/09/2021

Surface Conditions: Near Level, Grass

HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R_2013.GDT 23/1/22



Drill Type: 50mmØ Hand Auger

Project No: 211197

Logged By: HH

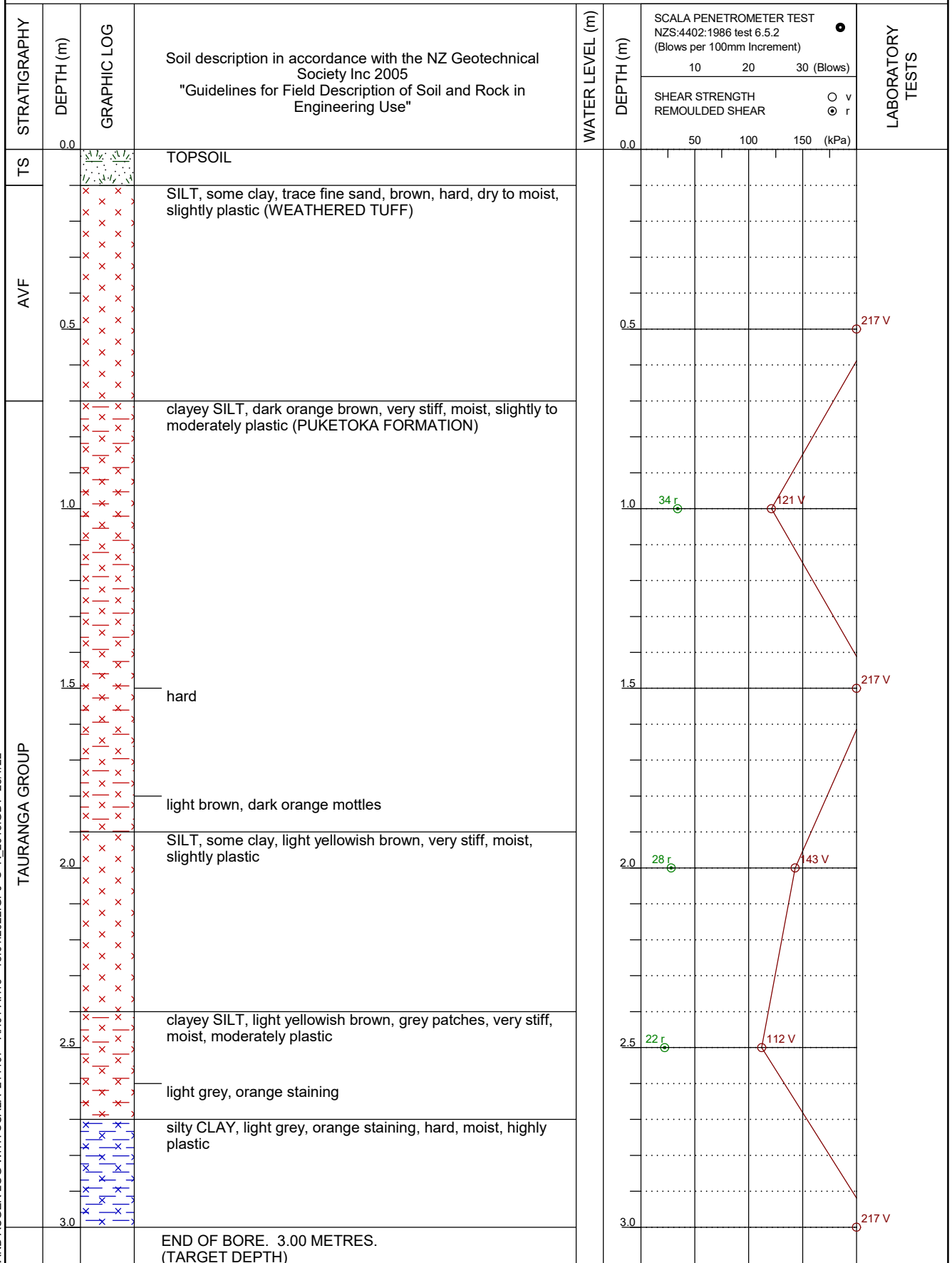
Drilled By: HH

Coordinates:
Shear Vane No - Calibration Date: GEO1591 - 5/03/2021

Date Started: 18/1/22

Ground Elevation:
Surface Conditions: Slightly Sloping, Grass

Date Finished: 18/1/22

Water Level: Groundwater Not Encountered


HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R 2013.GDT 23/1/22

Drill Type: 50mmØ Hand Auger

Project No: 211197

Logged By: KM

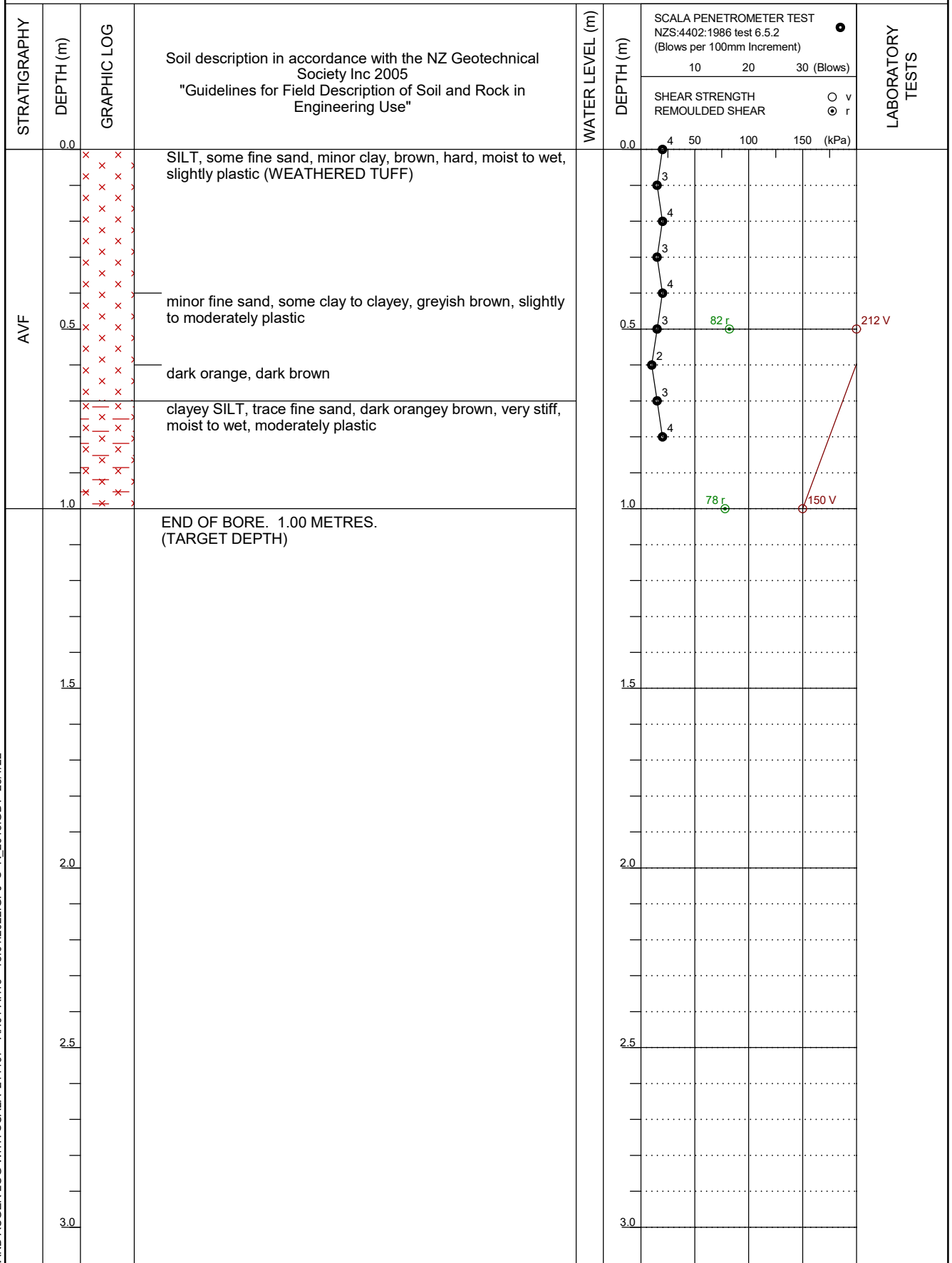
Drilled By: KM

Coordinates:
Shear Vane No - Calibration Date: DR3127 - 28/09/2021

Date Started: 18/1/22

Ground Elevation:
Surface Conditions: Slightly Sloping, Soil

Date Finished: 18/1/22

Water Level: Groundwater Not Encountered


HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R_2013.GDT 23/1/22

Drill Type: 50mmØ Hand Auger

Project No: 211197

Logged By: KM

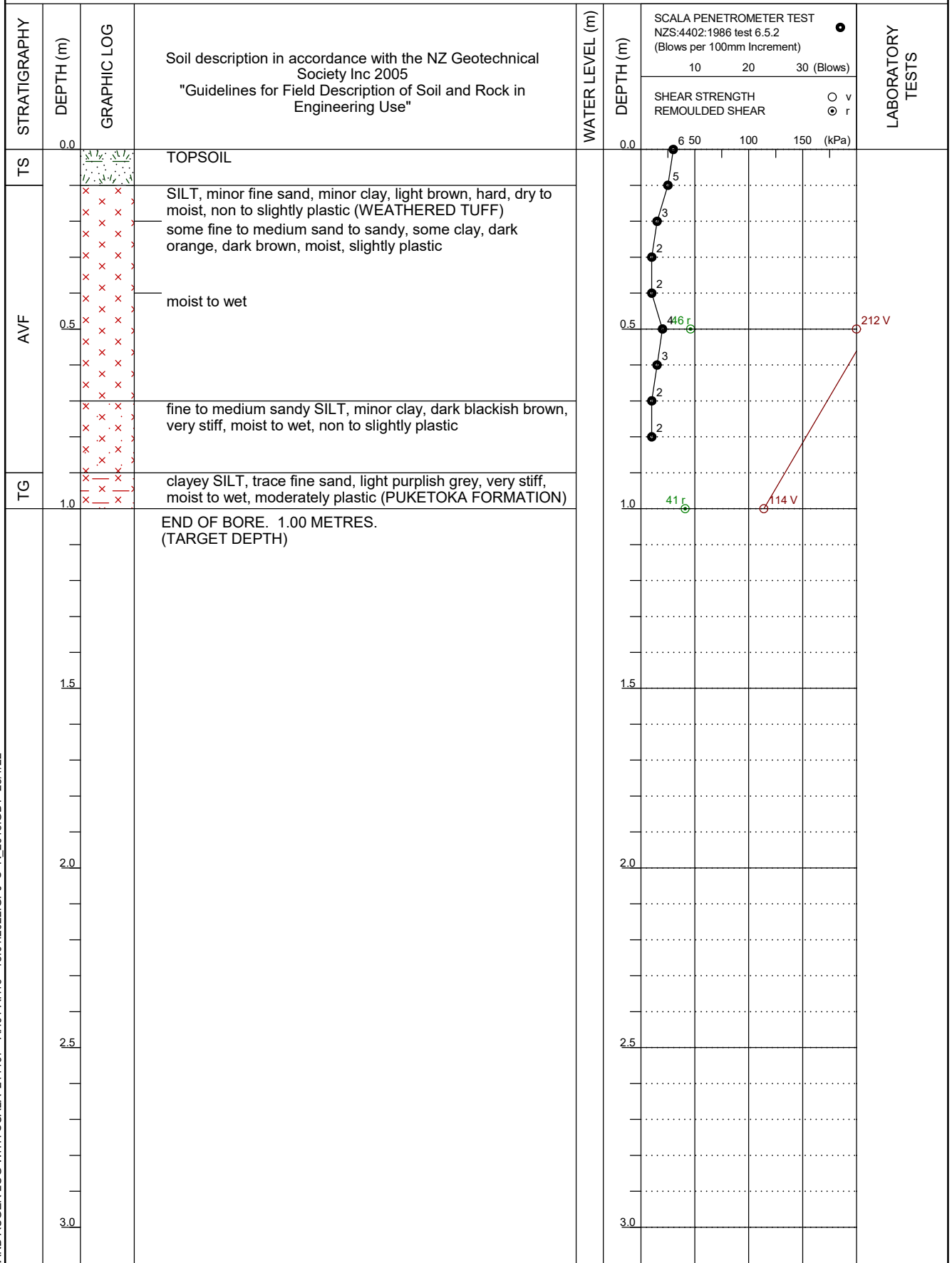
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Coordinates:
Shear Vane No - Calibration Date: DR3127 - 28/09/2021

Date Started: 18/1/22

Ground Elevation:
Surface Conditions: Slightly Sloping, Soil

Date Finished: 18/1/22

Water Level: Groundwater Not Encountered


HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R_2013.GDT 23/1/22

Drill Type: 50mmØ Hand Auger

Project No: 211197

Logged By: JT

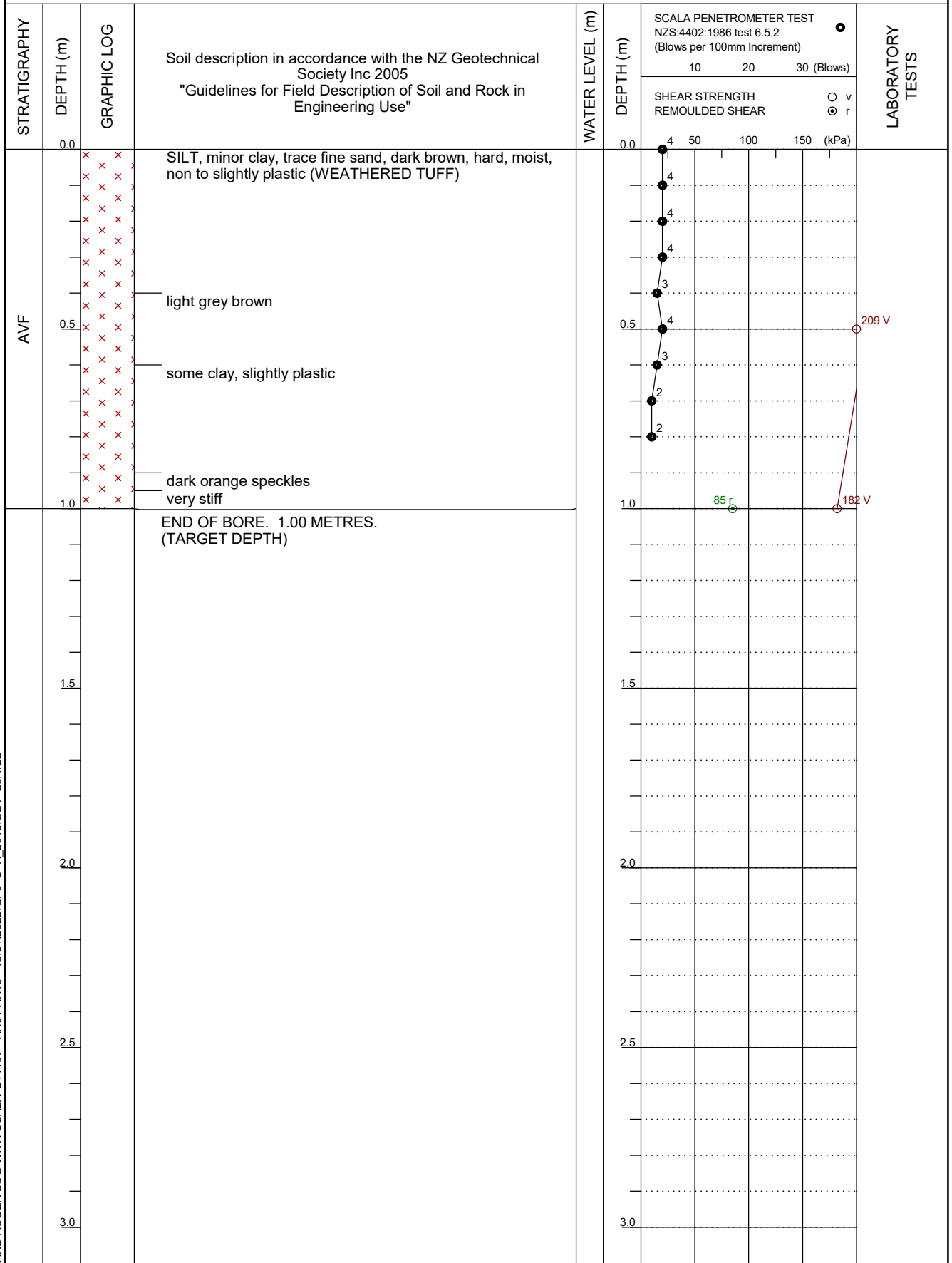
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Coordinates:
Shear Vane No - Calibration Date: GEO403 - 24/02/2021

Date Started: 18/1/22

Ground Elevation:
Surface Conditions: Near Level, Grass

Date Finished: 18/1/22

Water Level: Groundwater Not Encountered


HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R_2013.GDT 23/1/22



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Auger Hole No: AH16

Sheet 1 of 1

Drill Type: 50mmØ Hand Auger

Drilled By: HH

Date Started: 18/1/22

Date Finished: 18/1/22

Project No: 211197

Coordinates:

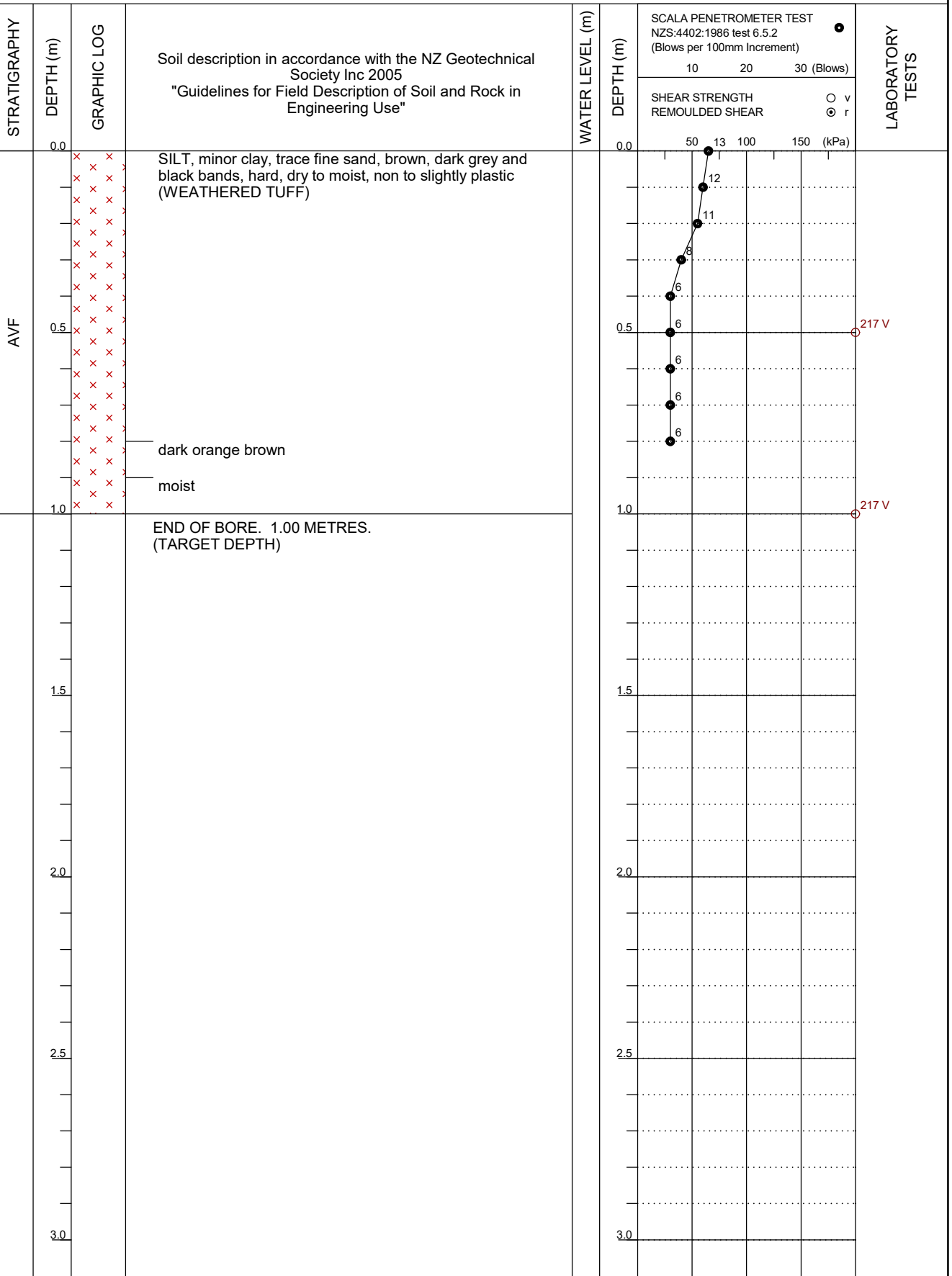
Ground Elevation:

Water Level: Groundwater Not Encountered

Logged By: HH

Shear Vane No - Calibration Date: GEO1591 - 5/03/2021

Surface Conditions: Near Level, Grass



HAND AUGER LOG WITH SCALA 211197 - AH01-AH16 - 18.01.2022.GPJ S+R_2013.GDT 23/1/22



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CLIENT: SPCA New Lynn - Carnoustie Management

PROJECT: Geotechnical Investigation, 485 Puhinui Road, Papatoetoe

Auger Hole No: AH04/PZ01

Sheet 1 of 1

Drill Type: 75mmØ Hand Auger

Drilled By: JT

Date Started: 18/1/22

Date Finished: 18/1/22

Project No: 211197

Coordinates:

Ground Elevation:

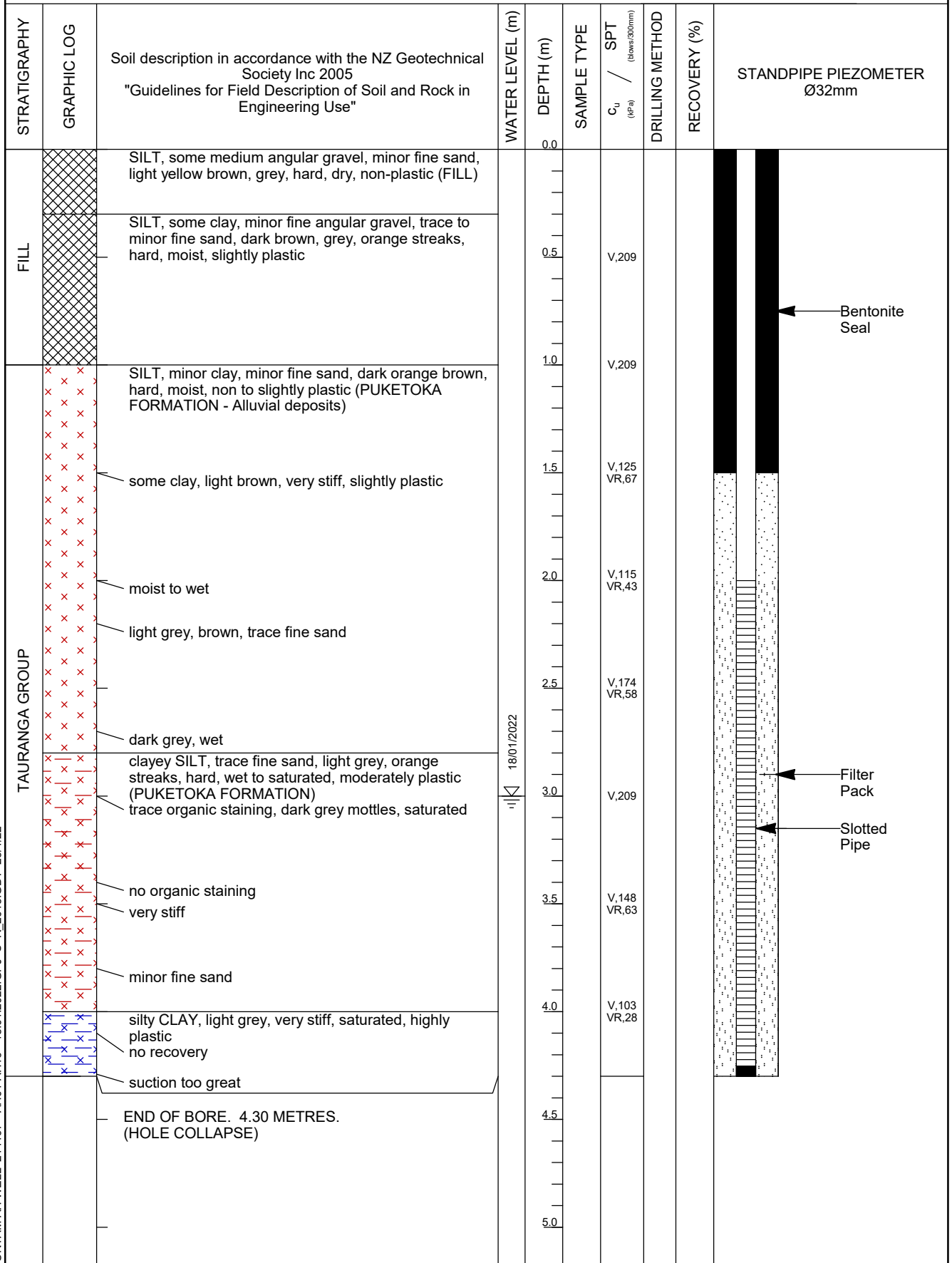
Water Level: 3.0m 18/01/2022

Logged By: JT

Shear Vane No - Calibration Date: GEO403 - 24/02/2021

Surface Conditions: Slightly Sloping, Soil

CONTAM AH WELL 211197 - AH01-AH16 - 18.01.2022.GPJ S+R 2013.GDT 23/1/22



Drill Type: 75mmØ Hand Auger

Project No: 211197

Logged By: RH

Drilled By: RH

Coordinates:
Shear Vane No - Calibration Date: GEO765 - 10/03/2021

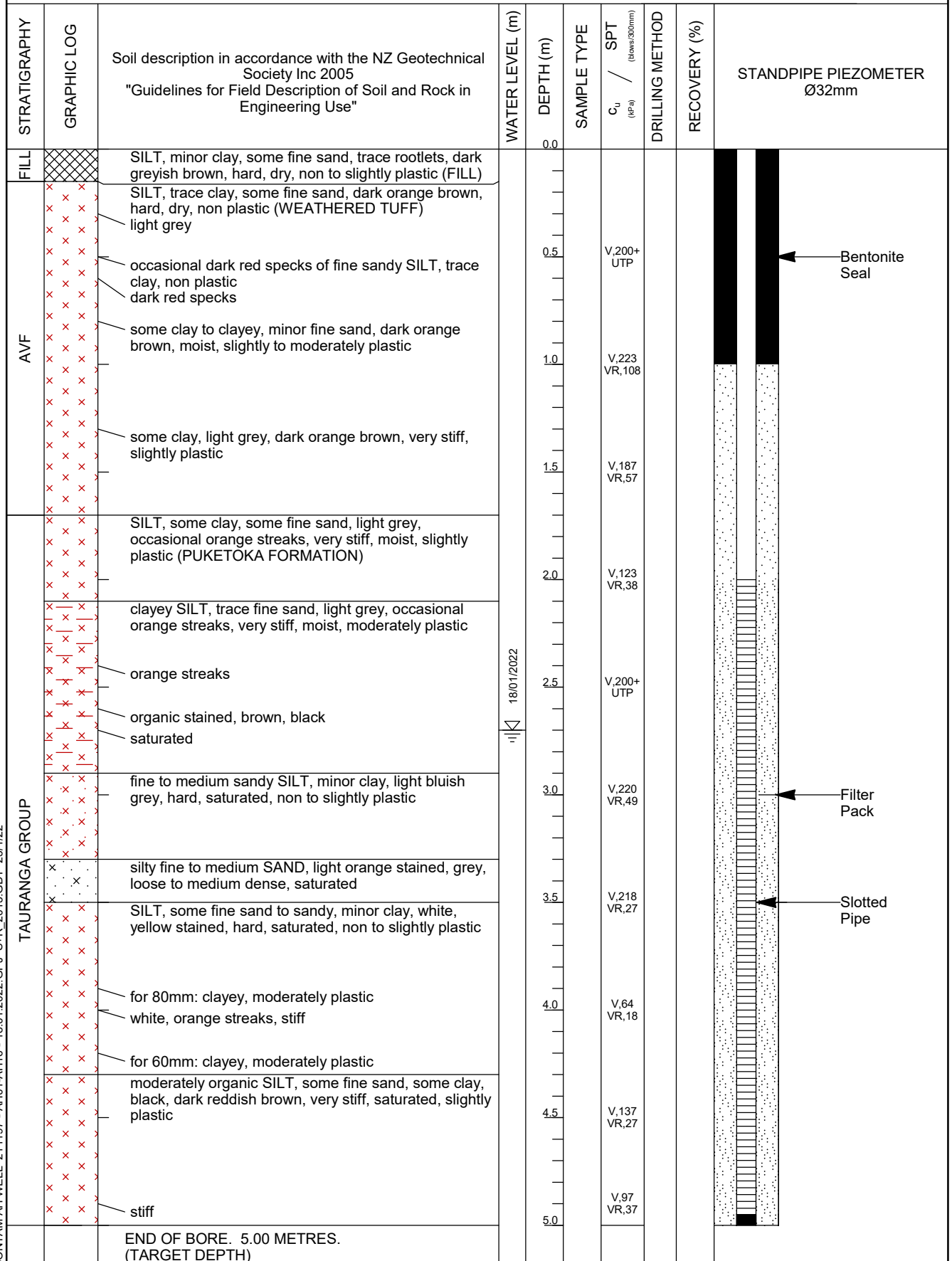
Date Started: 18/1/22

Ground Elevation:
Surface Conditions: Near Level, Grass

Date Finished: 18/1/22

Water Level: 2.7m 18/01/2022

CONTAM AH WELL 211197 - AH01-AH16 - 18.01.2022.GPJ S+R 2013.GDT 23/1/22



Appendix C

Laboratory Test Results

Shrink-Swell Test Results

Job Name:	485A Puhinui Road, Wiri	Job No:	211197
Date:	19-Jan-22	Tested By:	JP
Sample Location:	SS01	Date Sampled:	18-Jan-22
Sampling method:	Push Tube	Sampled By:	JT
Sampling depth (m):	0.7-1	Inert inclusions (%):	0
Sample condition:	Good	Extent of cracking (%):	10
		Extent of crumbling (%):	0

Sample description: SILT, some fine to medium sand, trace clay, trace fine angular gravel, dark brown, dark grey speckles, light brown speckles, hard, dry to moist, non plastic (FILL)

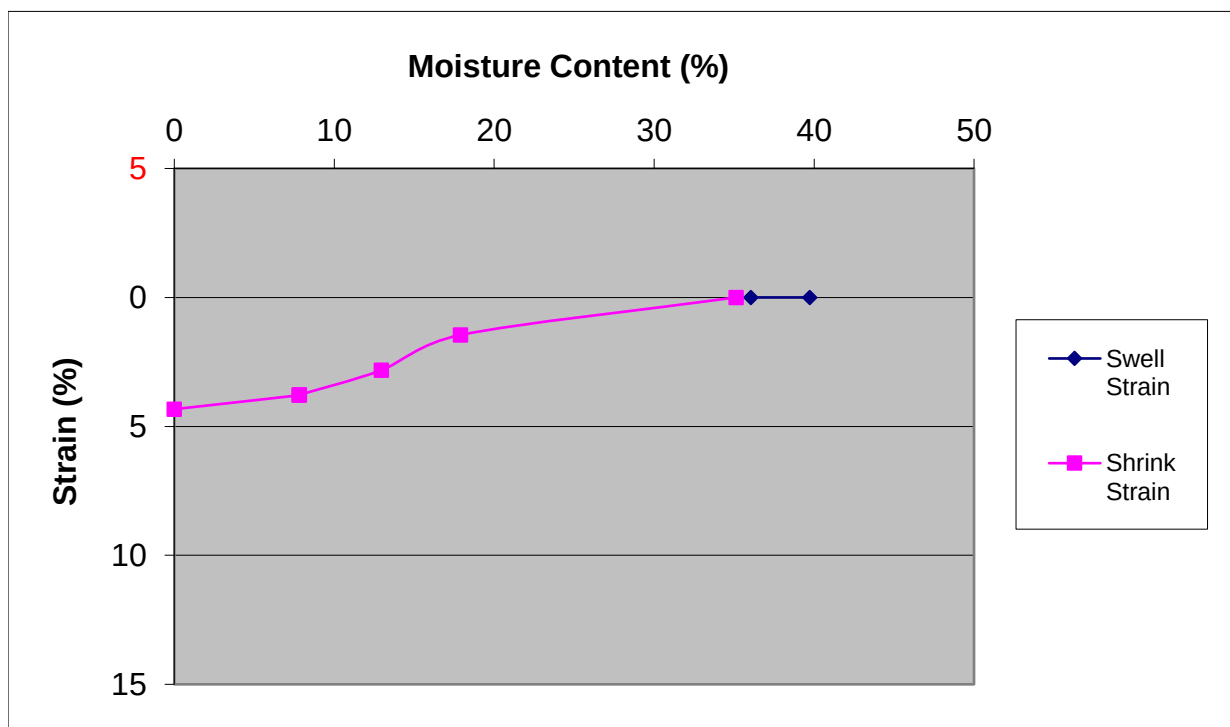
Wet Density	γ (t/m ³) =	1.64
Dry Density	γ_d (t/m ³) =	1.21

Shrinkage Test

Initial moisture content (%) =	35.1
ϵ_{sh} = Magnitude of total shrinkage strain (%) =	4.3

Swell Test

ϵ_{sw} = Magnitude of the swelling strain (%) =	-0.2
(Note: The ϵ_{sw} value is negative if the sample has undergone consolidation)	
Initial moisture content (%) =	39.7
Final moisture content (%) =	36.0



Shrink-Swell index

Iss = **2.4** Strain per ΔpF (%)

Testing Method: AS1289.7.1.1 - 2003 Soil reactivity tests

Shrink-Swell Test Results

Job Name:	485A Puhinui Road, Wiri	Job No:	211197
Date:	19-Jan-22	Tested By:	JP
Sample Location:	SS02	Date Sampled:	18-Jan-22
Sampling method:	Push Tube	Sampled By:	JT
Sampling depth (m):	0.6-0.9	Inert inclusions (%):	0
Sample condition:	Good	Extent of cracking (%):	<5
		Extent of crumbling (%):	0

Sample description: fine sandy SILT, trace clay, trace fine to medium angular gravel, dark brown, hard, dry to moist, non plastic (FILL)

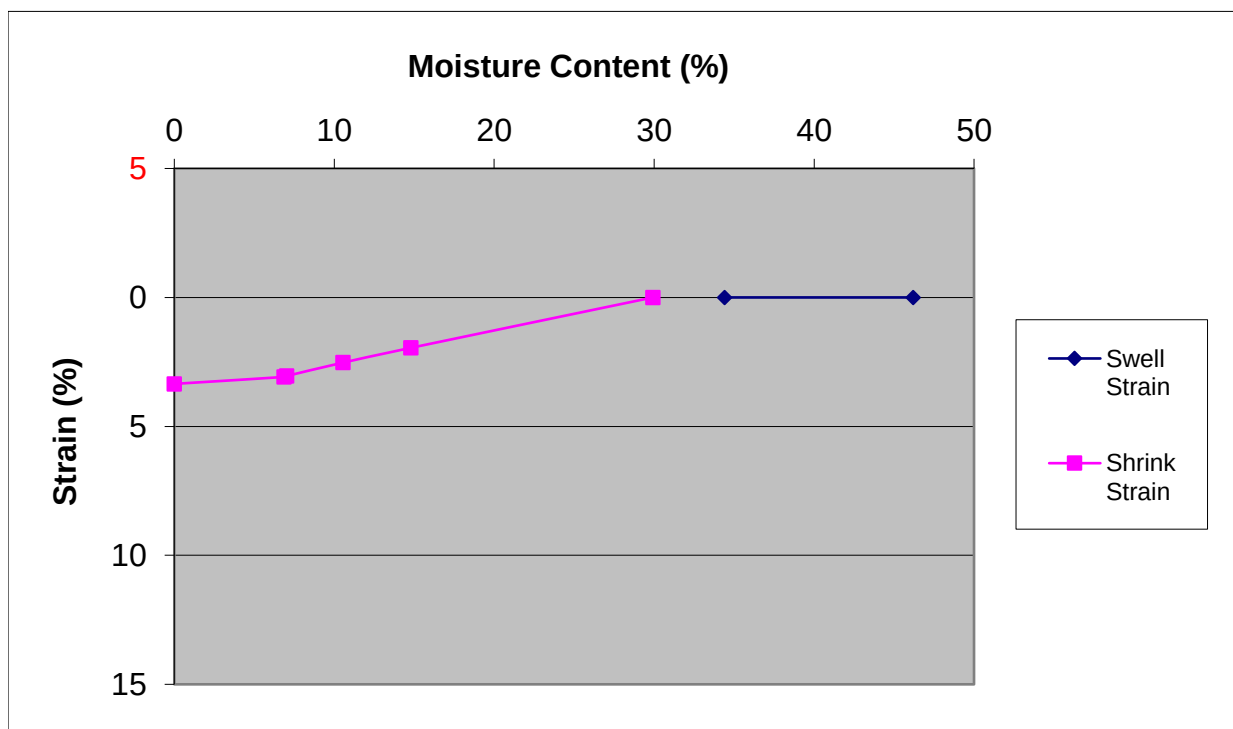
Wet Density	γ (t/m ³) =	1.83
Dry Density	γ_d (t/m ³) =	1.41

Shrinkage Test

Initial moisture content (%) =	29.9
ϵ_{sh} = Magnitude of total shrinkage strain (%) =	3.4

Swell Test

ϵ_{sw} = Magnitude of the swelling strain (%) =	-0.2
(Note: The ϵ_{sw} value is negative if the sample has undergone consolidation)	
Initial moisture content (%) =	34.4
Final moisture content (%) =	46.2



Shrink-Swell index

Iss = **1.9** Strain per ΔpF (%)

Testing Method: AS1289.7.1.1 - 2003 Soil reactivity tests

Shrink-Swell Test Results

Job Name:	485A Puhinui Road, Wiri	Job No:	211197
Date:	19-Jan-22	Tested By:	JP
Sample Location:	SS03	Date Sampled:	18-Jan-22
Sampling method:	Push Tube	Sampled By:	JT
Sampling depth (m):	0.5-0.8	Inert inclusions (%):	<1
Sample condition:	Good	Extent of cracking (%):	5
		Extent of crumbling (%):	1

Sample description: fine sandy SILT, minor medium sand, trace clay, orange brown, hard, dry to moist, non plastic

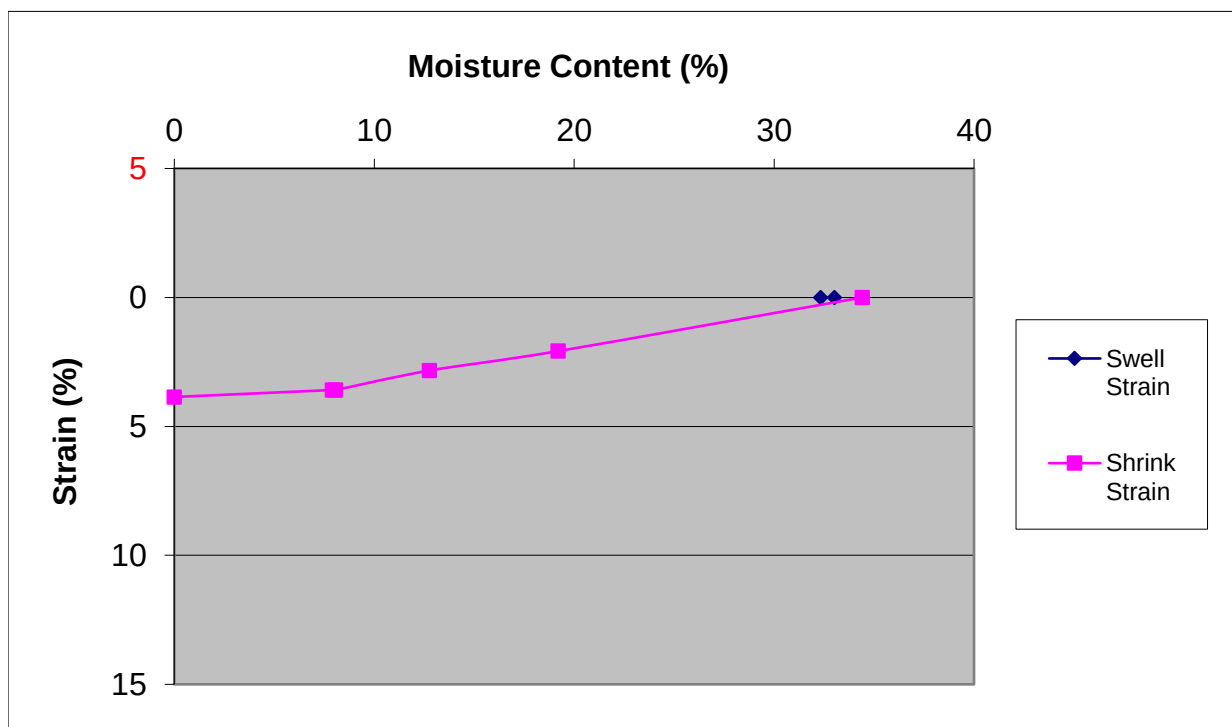
Wet Density	γ (t/m ³) =	1.87
Dry Density	γ_d (t/m ³) =	1.39

Shrinkage Test

Initial moisture content (%) =	34.4
ϵ_{sh} = Magnitude of total shrinkage strain (%) =	3.9

Swell Test

ϵ_{sw} = Magnitude of the swelling strain (%) =	-0.4
(Note: The ϵ_{sw} value is negative if the sample has undergone consolidation)	
Initial moisture content (%) =	33.0
Final moisture content (%) =	32.3



Shrink-Swell index

Iss = **2.1** Strain per ΔpF (%)

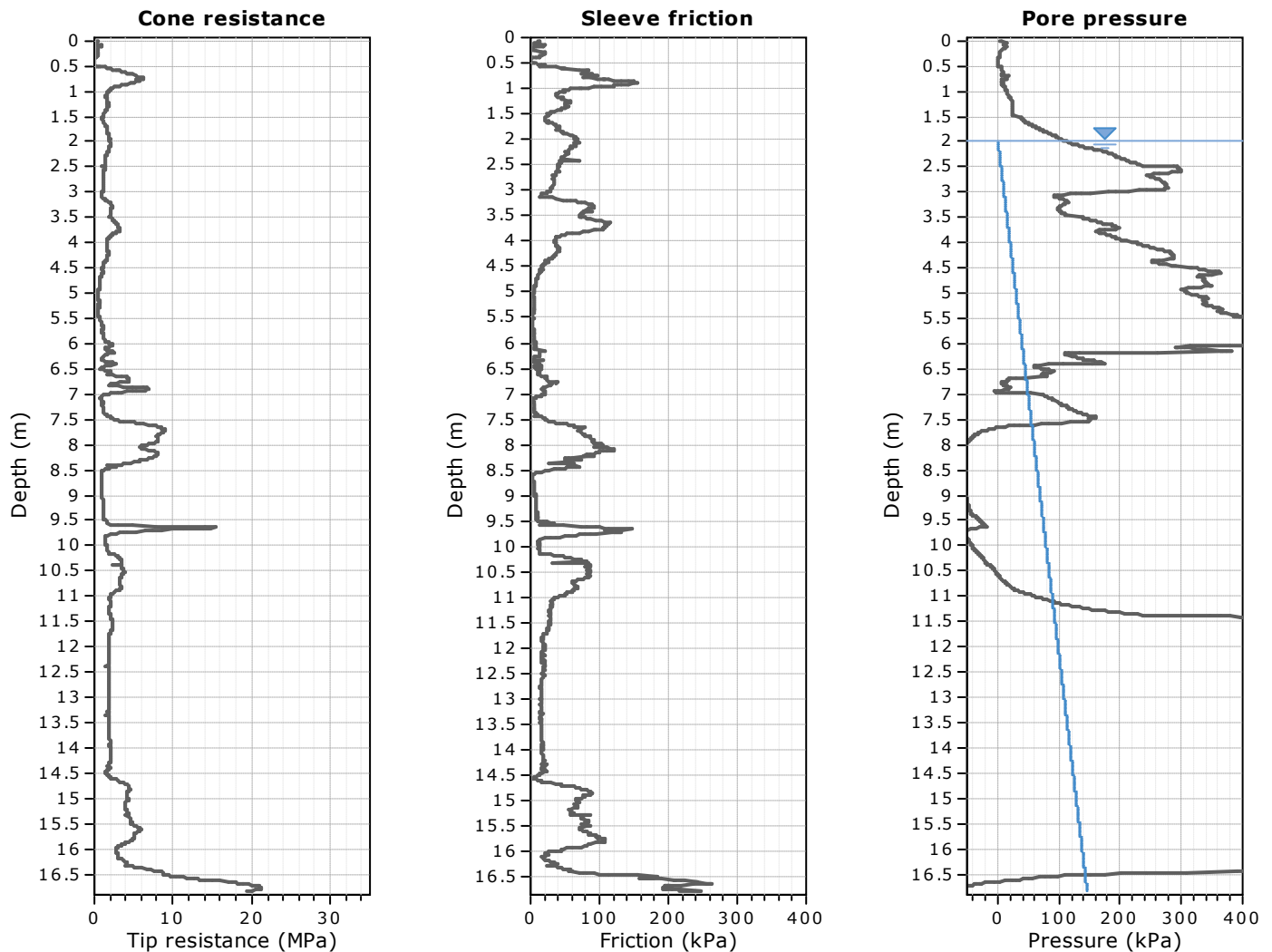
Testing Method: AS1289.7.1.1 - 2003 Soil reactivity tests

Appendix D

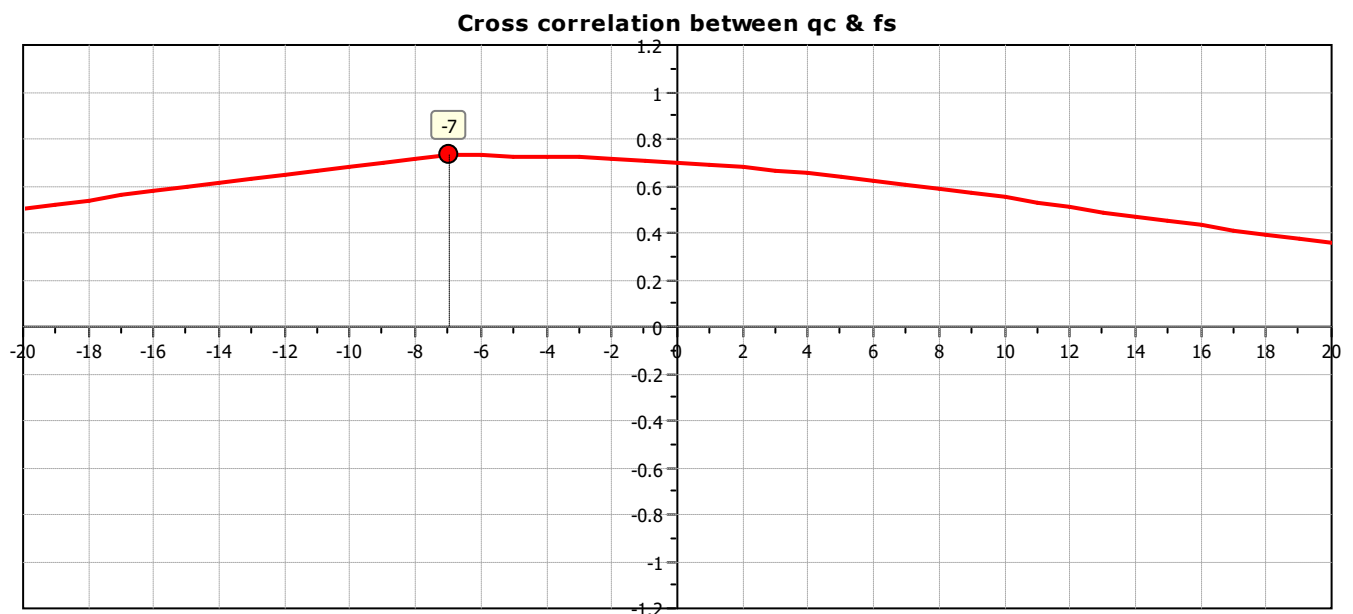
Cone Penetration Testing (CPT) Results

Project: Wiri SPCA

Location: 485 Puihinui Road, Papatoetoe

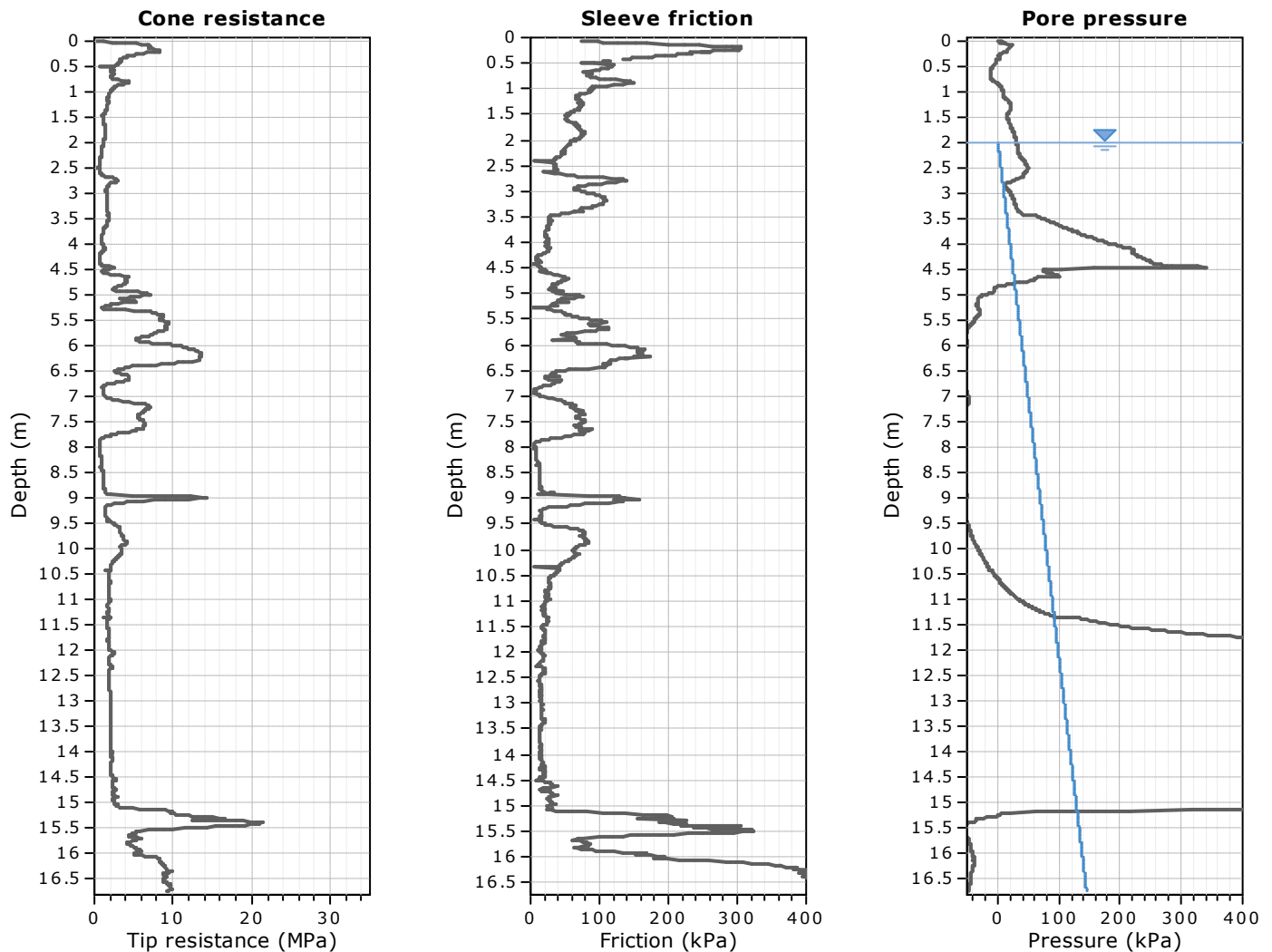


The plot below presents the cross correlation coefficient between the raw q_c and f_s values (as measured on the field). X axes presents the lag distance (one lag is the distance between two successive CPT measurements).

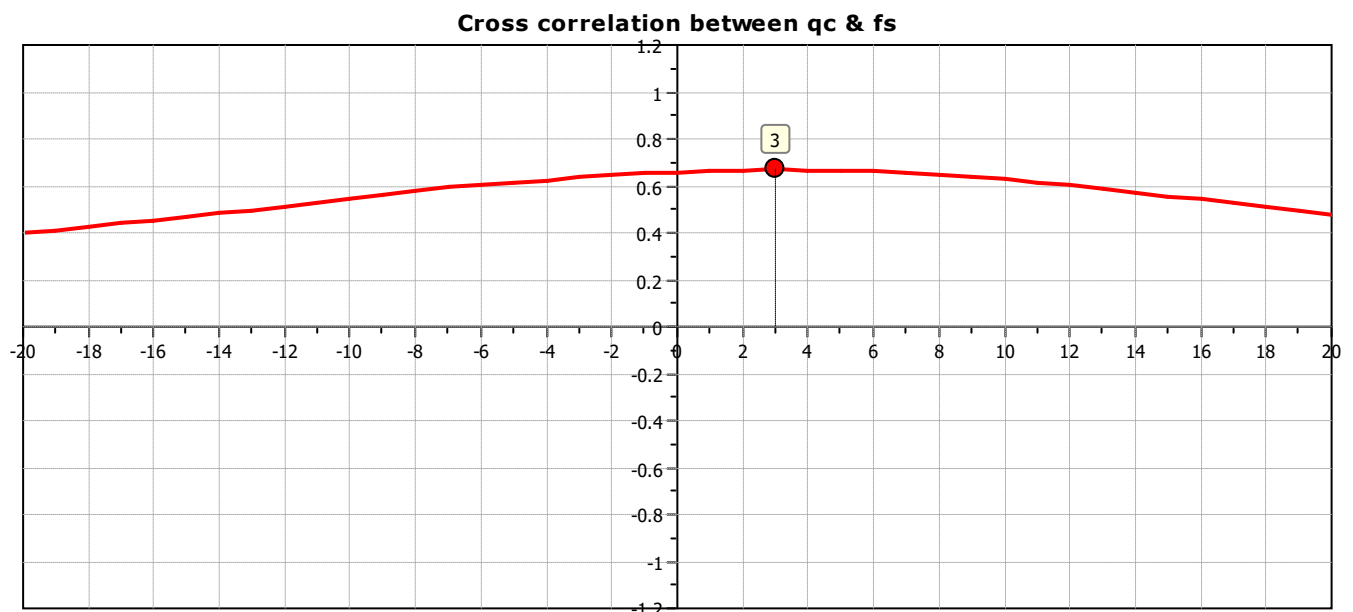


Project: Wiri SPCA

Location: 485 Puihinui Road, Papatoetoe

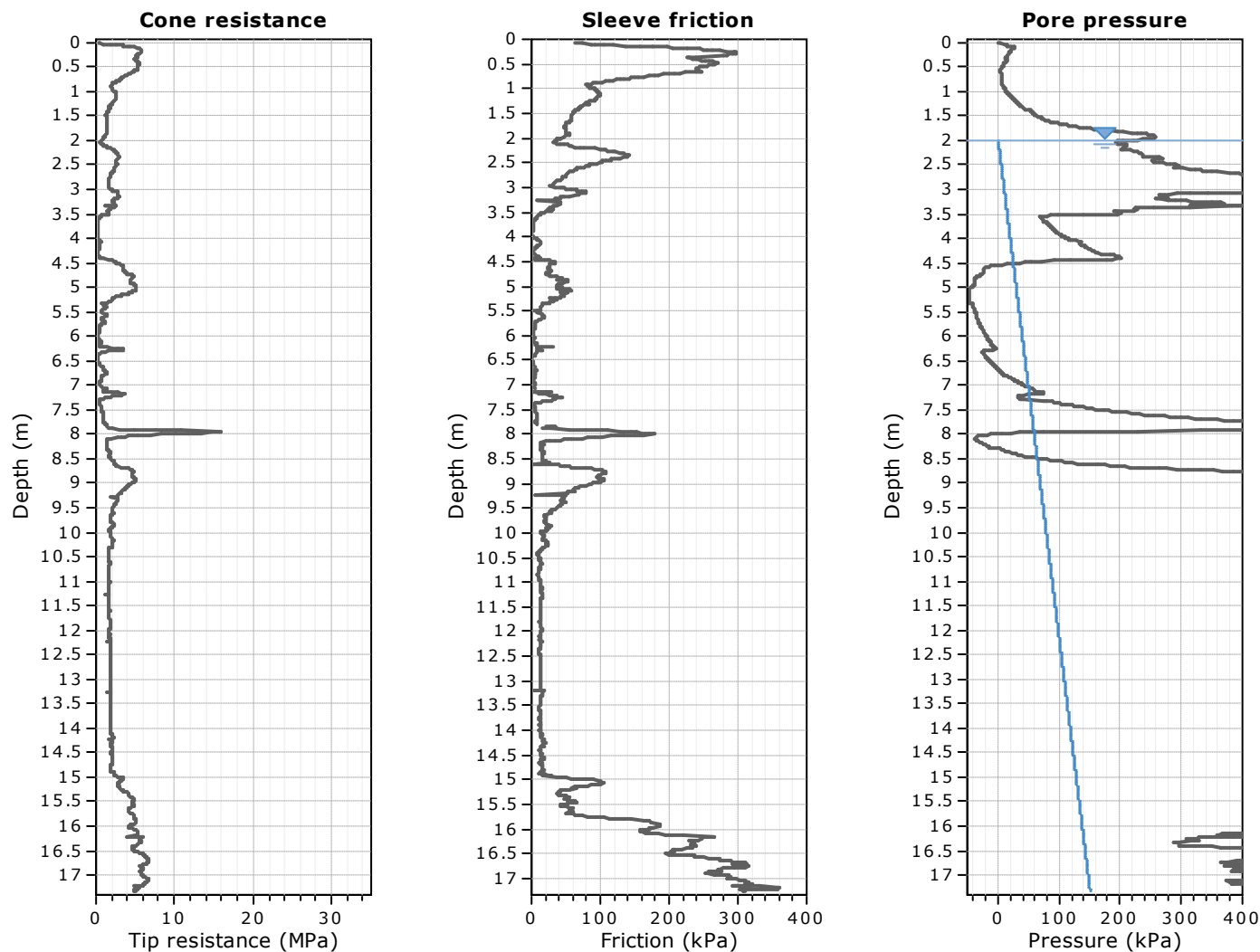


The plot below presents the cross correlation coefficient between the raw q_c and f_s values (as measured on the field). X axes presents the lag distance (one lag is the distance between two successive CPT measurements).

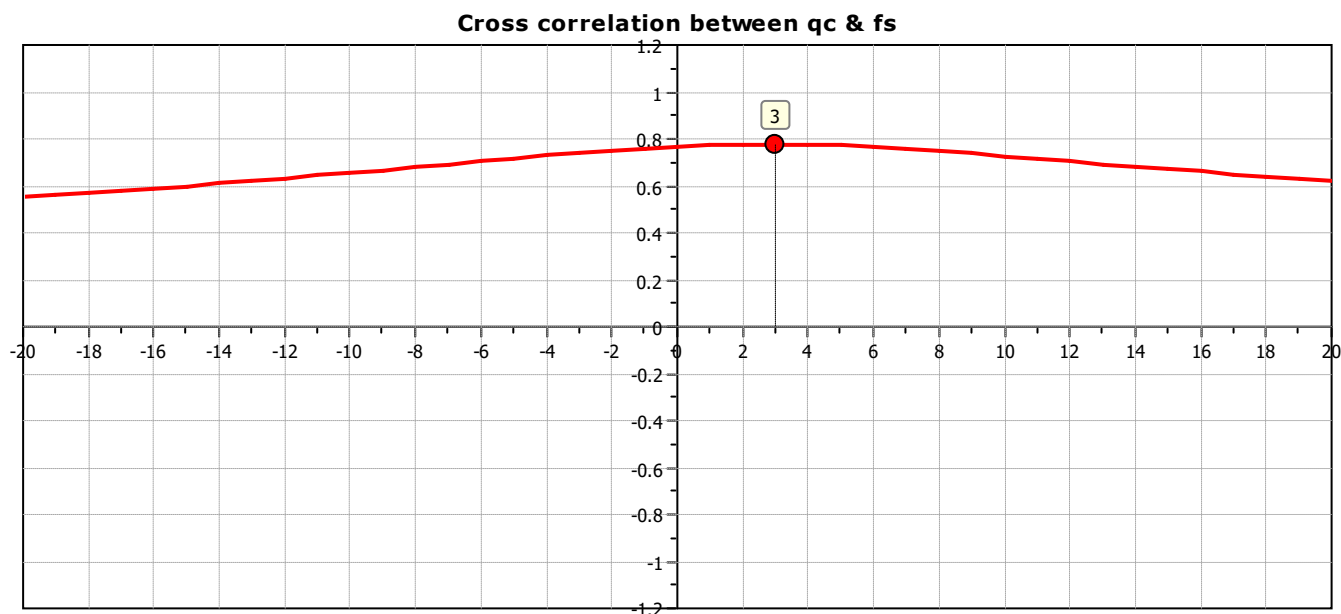


Project: Wiri SPCA

Location: 485 Puihinui Road, Papatoetoe

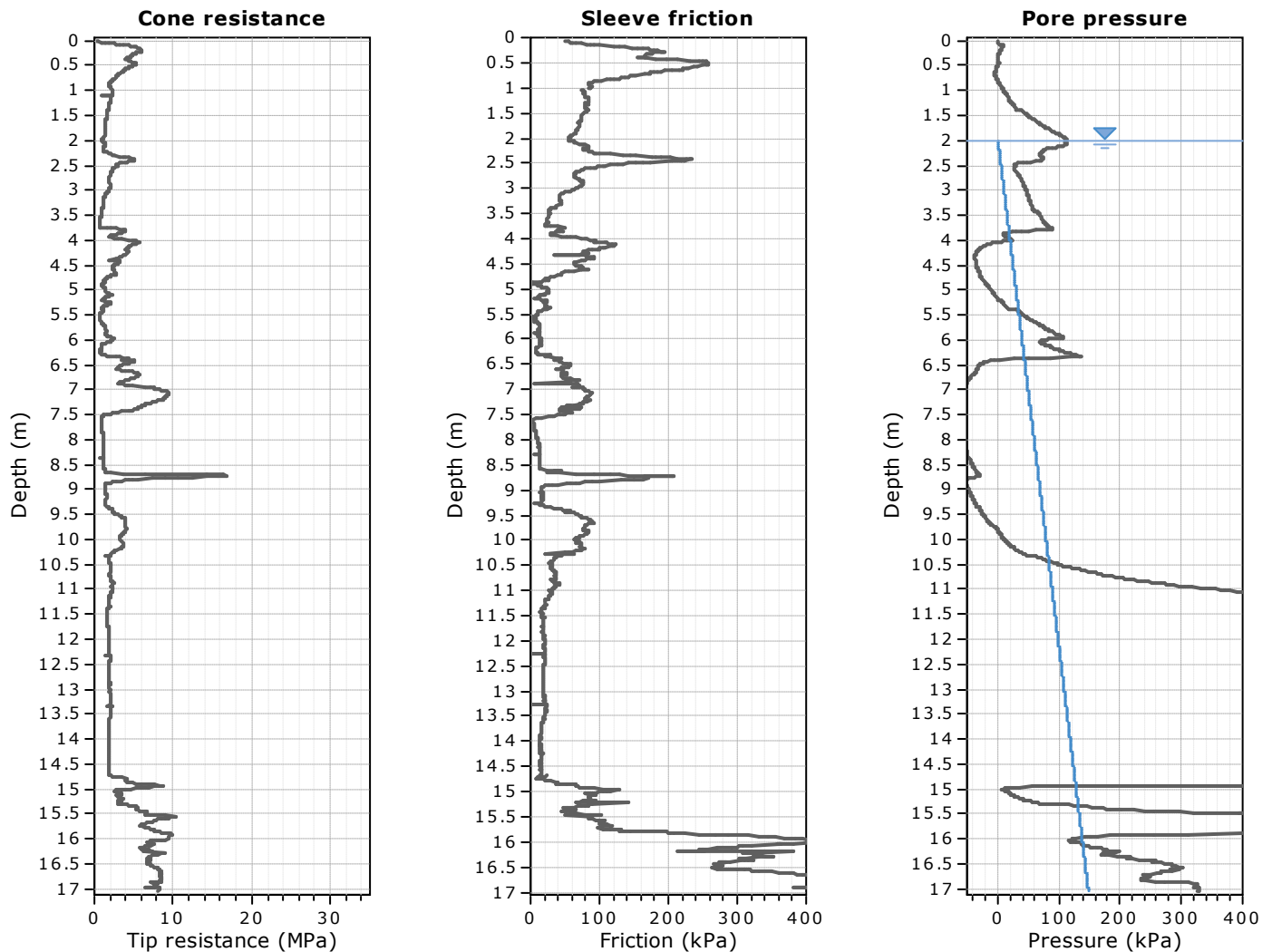


The plot below presents the cross correlation coefficient between the raw q_c and f_s values (as measured on the field). X axes presents the lag distance (one lag is the distance between two successive CPT measurements).

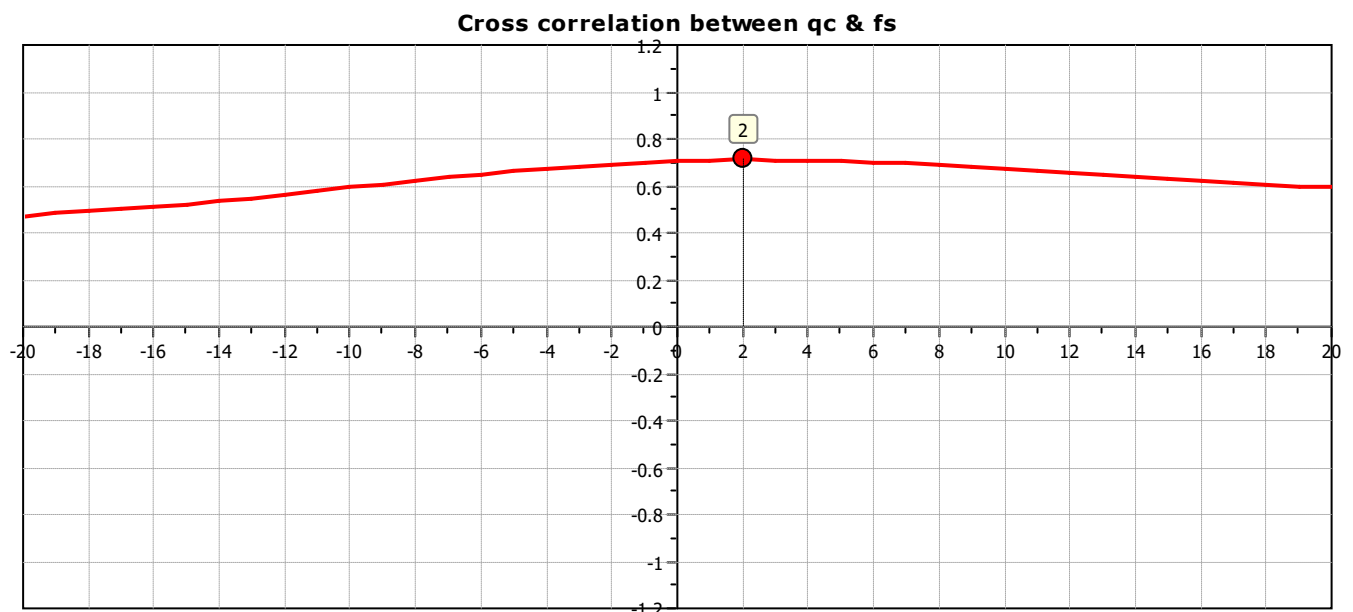


Project: Wiri SPCA

Location: 485 Puihinui Road, Papatoetoe



The plot below presents the cross correlation coefficient between the raw q_c and f_s values (as measured on the field). X axes presents the lag distance (one lag is the distance between two successive CPT measurements).



Appendix E

Liquefaction Analysis Results

LIQUEFACTION ANALYSIS REPORT

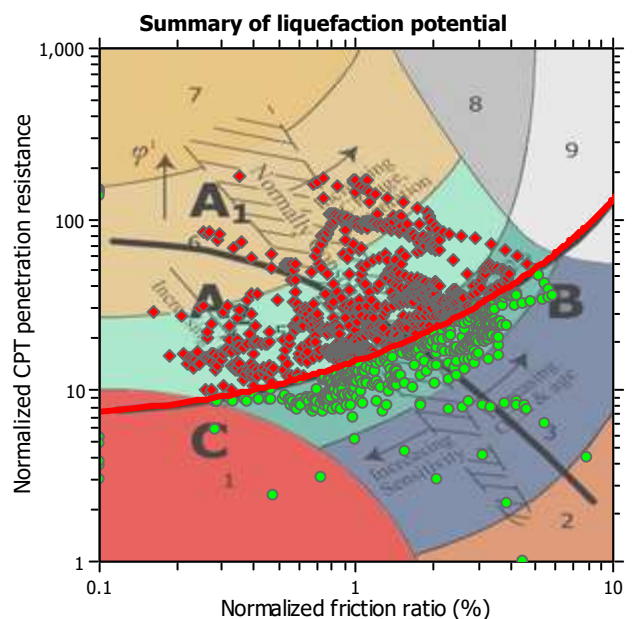
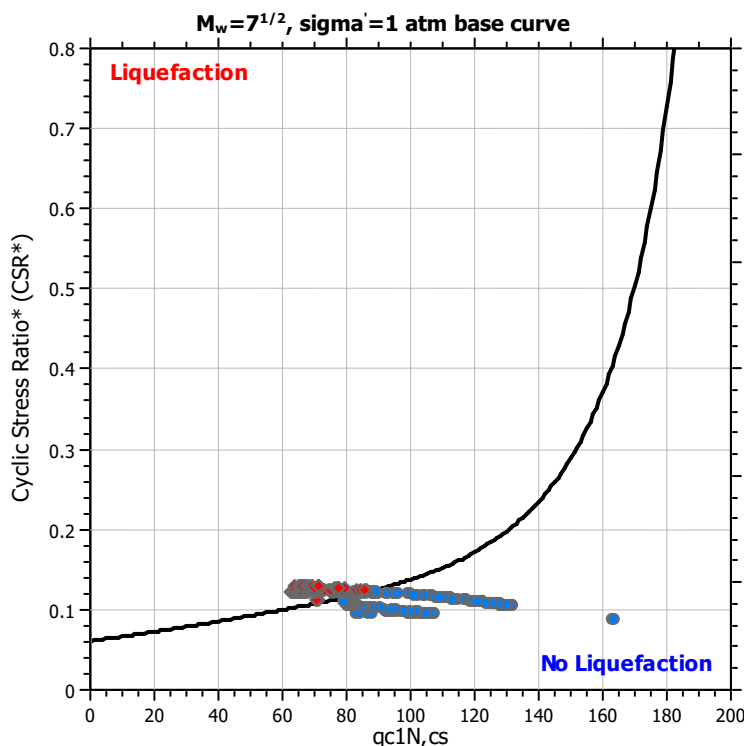
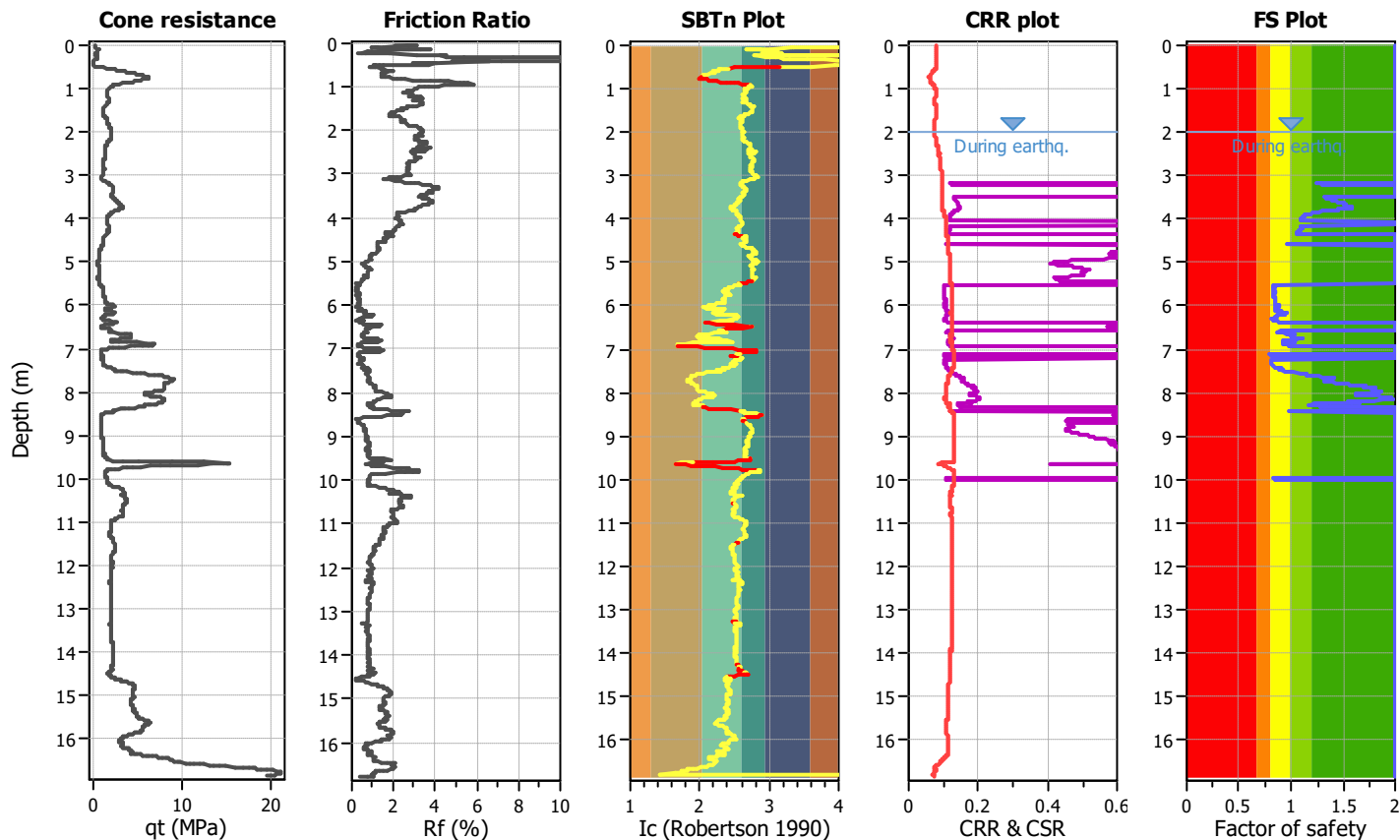
Project title : Wiri SPCA

Location : 485 Puhinui Road, Papatoetoe

CPT file : Soil&Rock211197_CPT01

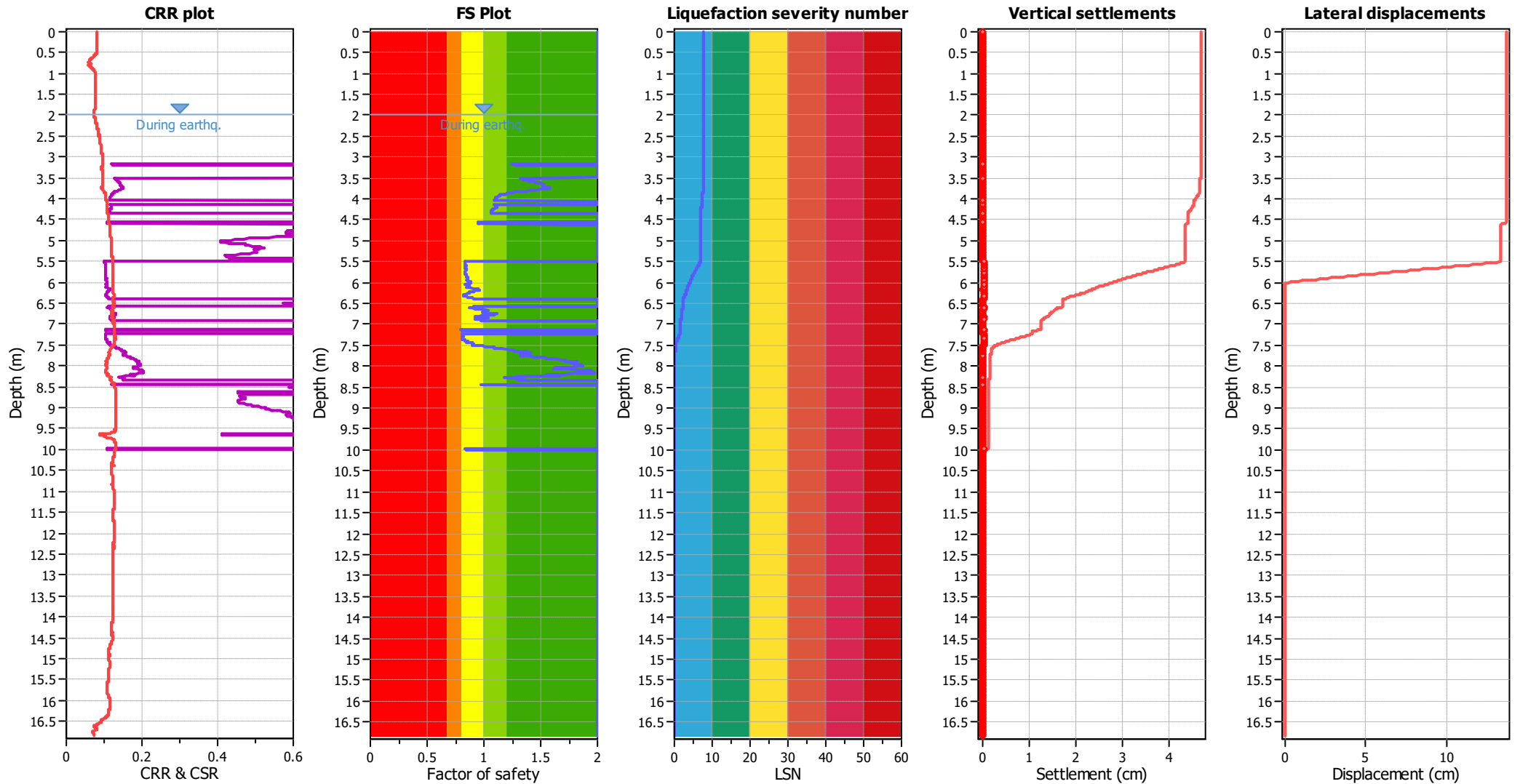
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 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 :	5.75	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.15	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _s applied:	Yes
Earthquake magnitude M _w :	5.75	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.15	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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

LSN color scheme

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

LIQUEFACTION ANALYSIS REPORT

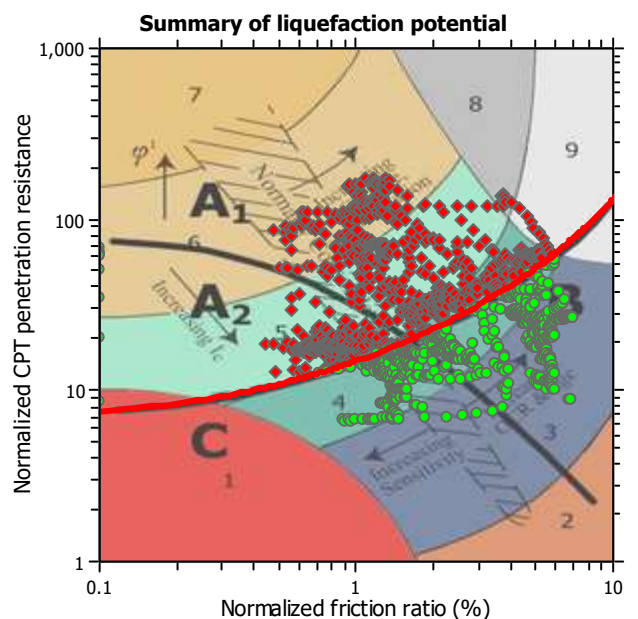
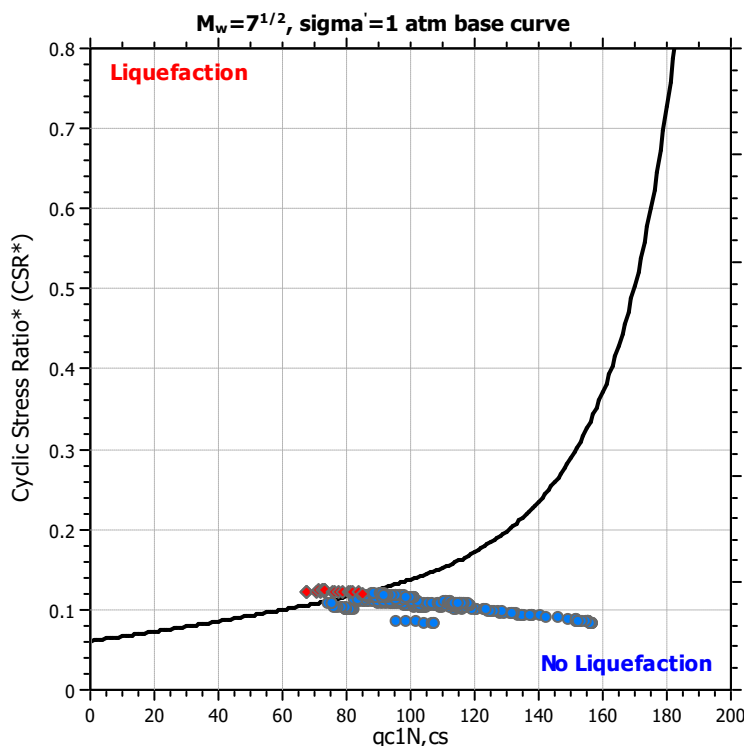
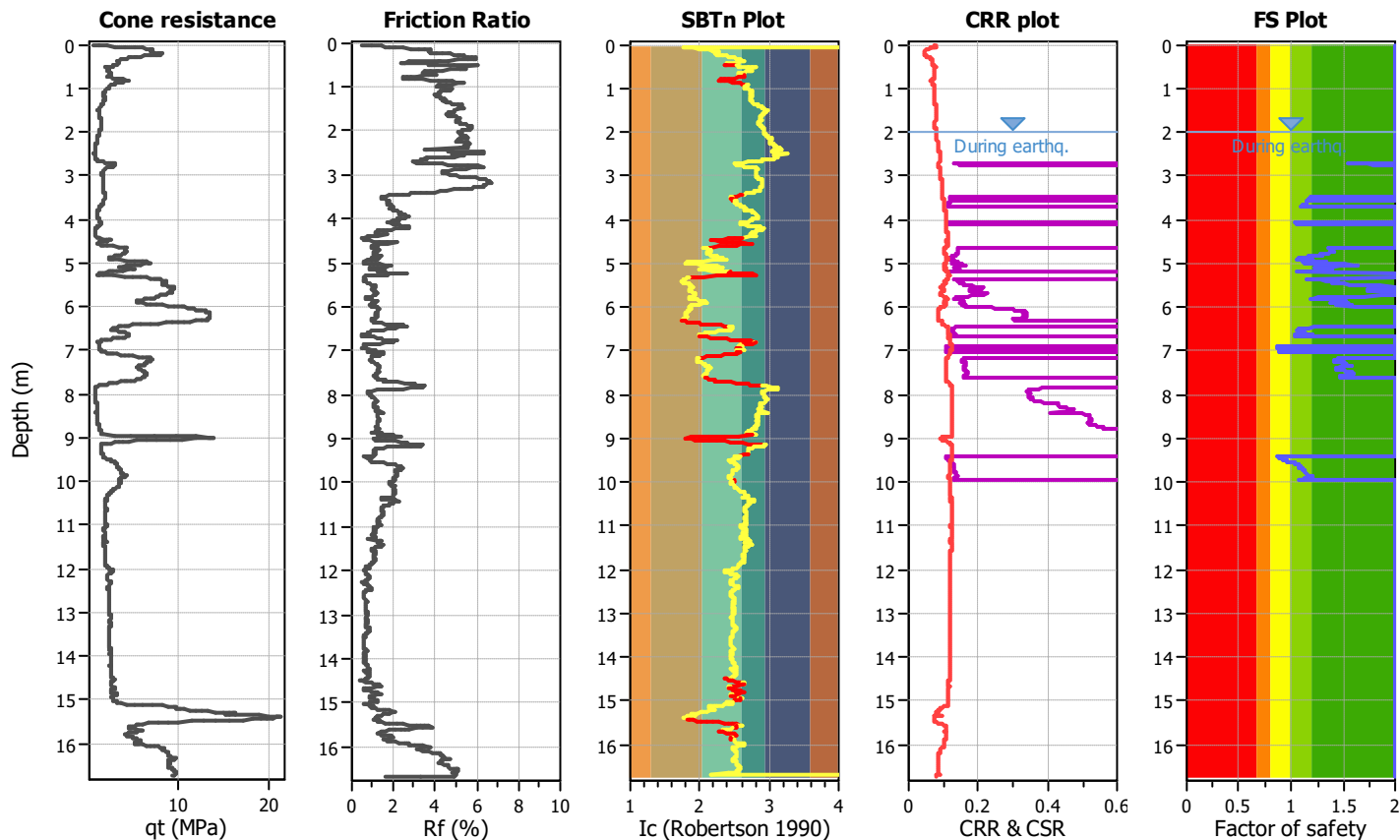
Project title : Wiri SPCA

Location : 485 Puhinui Road, Papatoetoe

CPT file : Soil&Rock211197_CPT02

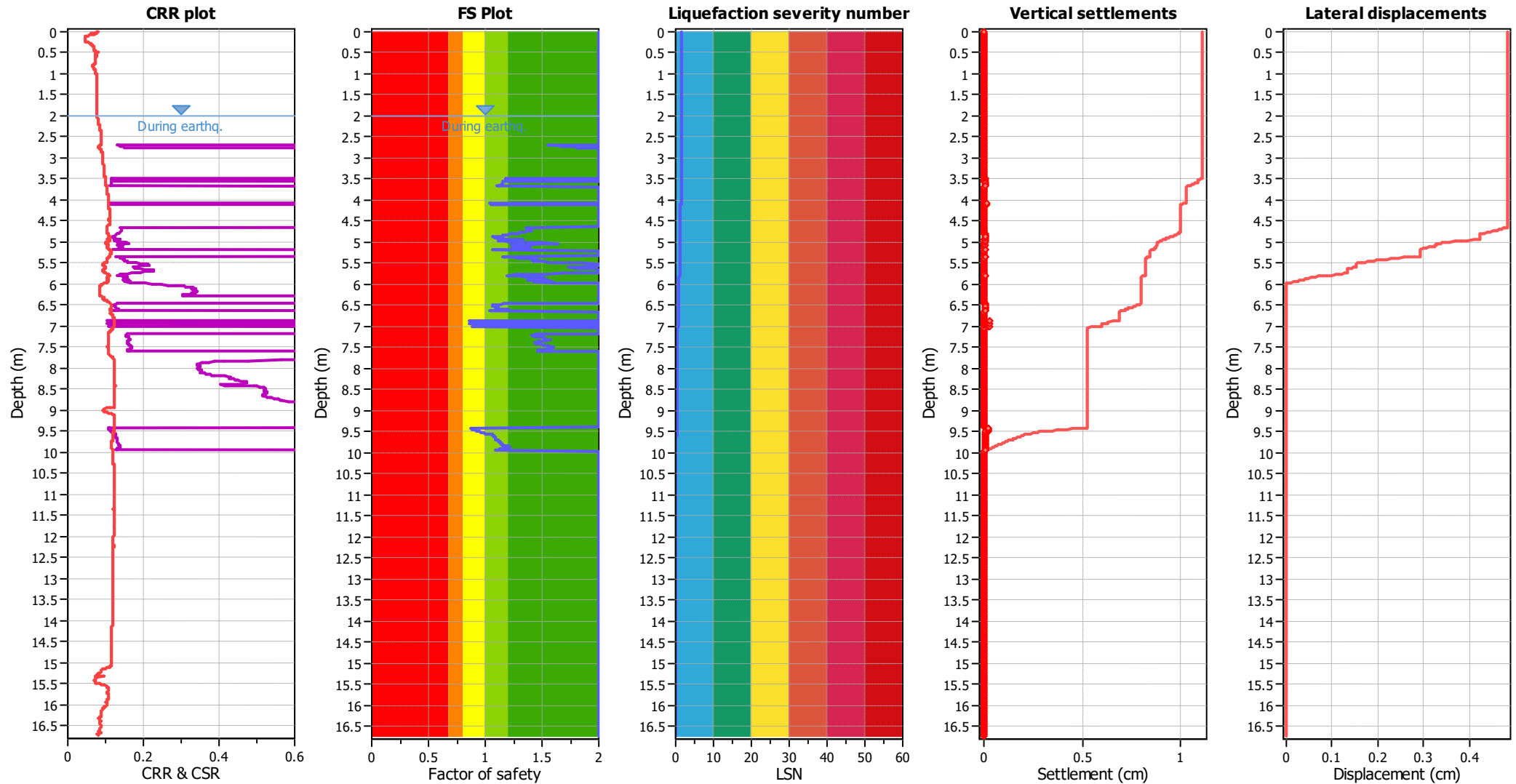
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 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 :	5.75	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.15	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
 Fines correction method: B&I (2014)
 Points to test: Based on I_c value
 Earthquake magnitude M_w : 5.75
 Peak ground acceleration: 0.15
 Depth to water table (insitu): 2.00 m

Depth to GWT (earthq.): 2.00 m
 Average results interval: 3
 I_c cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Fill weight: N/A
 Transition detect. applied: Yes
 K_σ applied: Yes
 Clay like behavior applied: Sand & Clay
 Limit depth applied: Yes
 Limit depth: 10.00 m

F.S. color scheme

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

LSN color scheme

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

LIQUEFACTION ANALYSIS REPORT

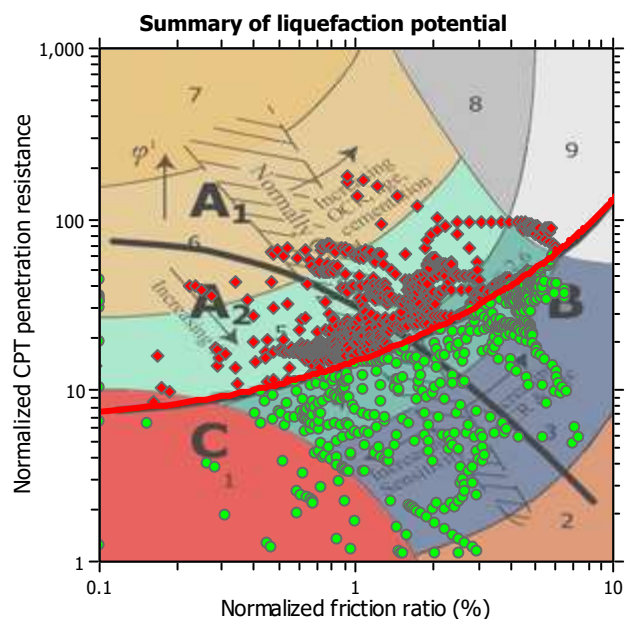
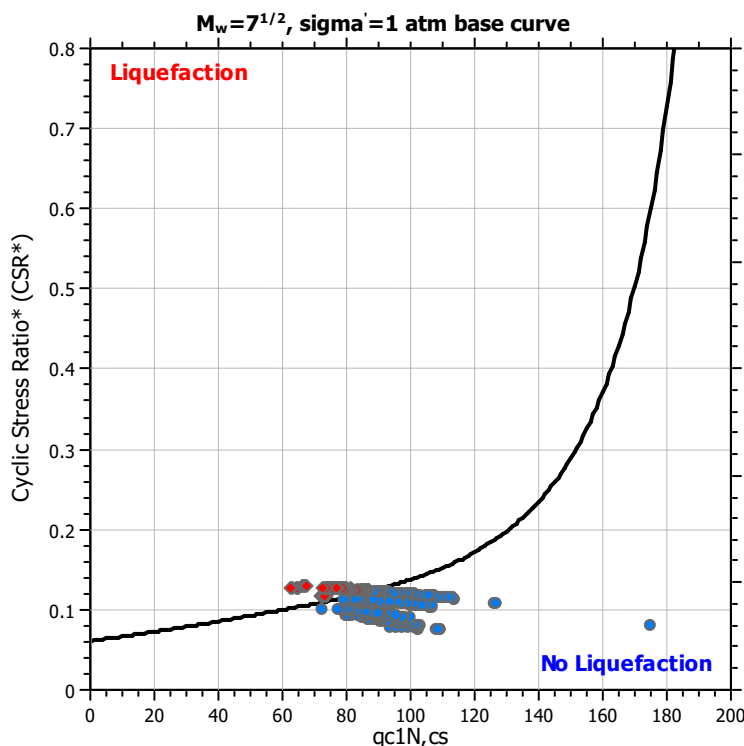
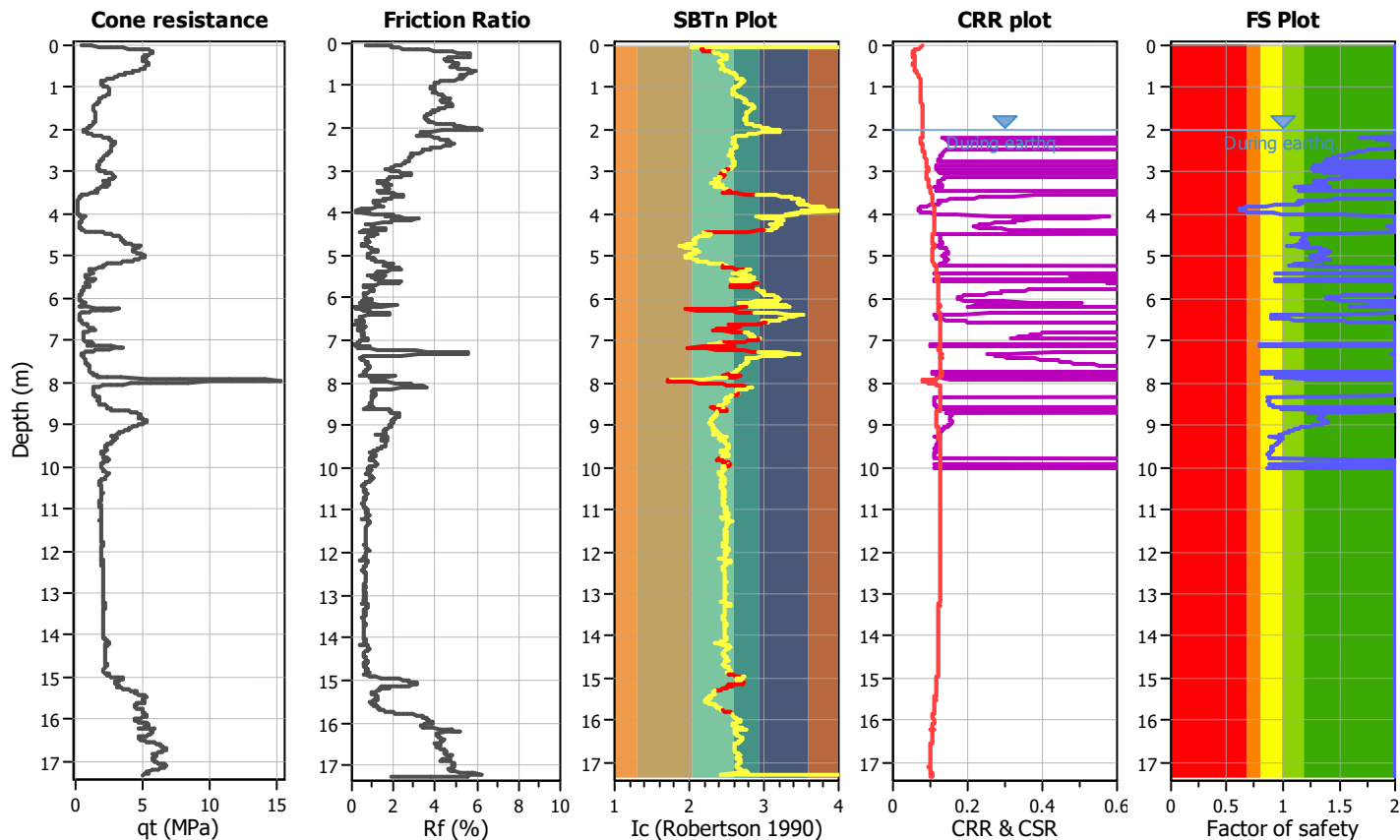
Project title : Wiri SPCA

Location : 485 Puhinui Road, Papatoetoe

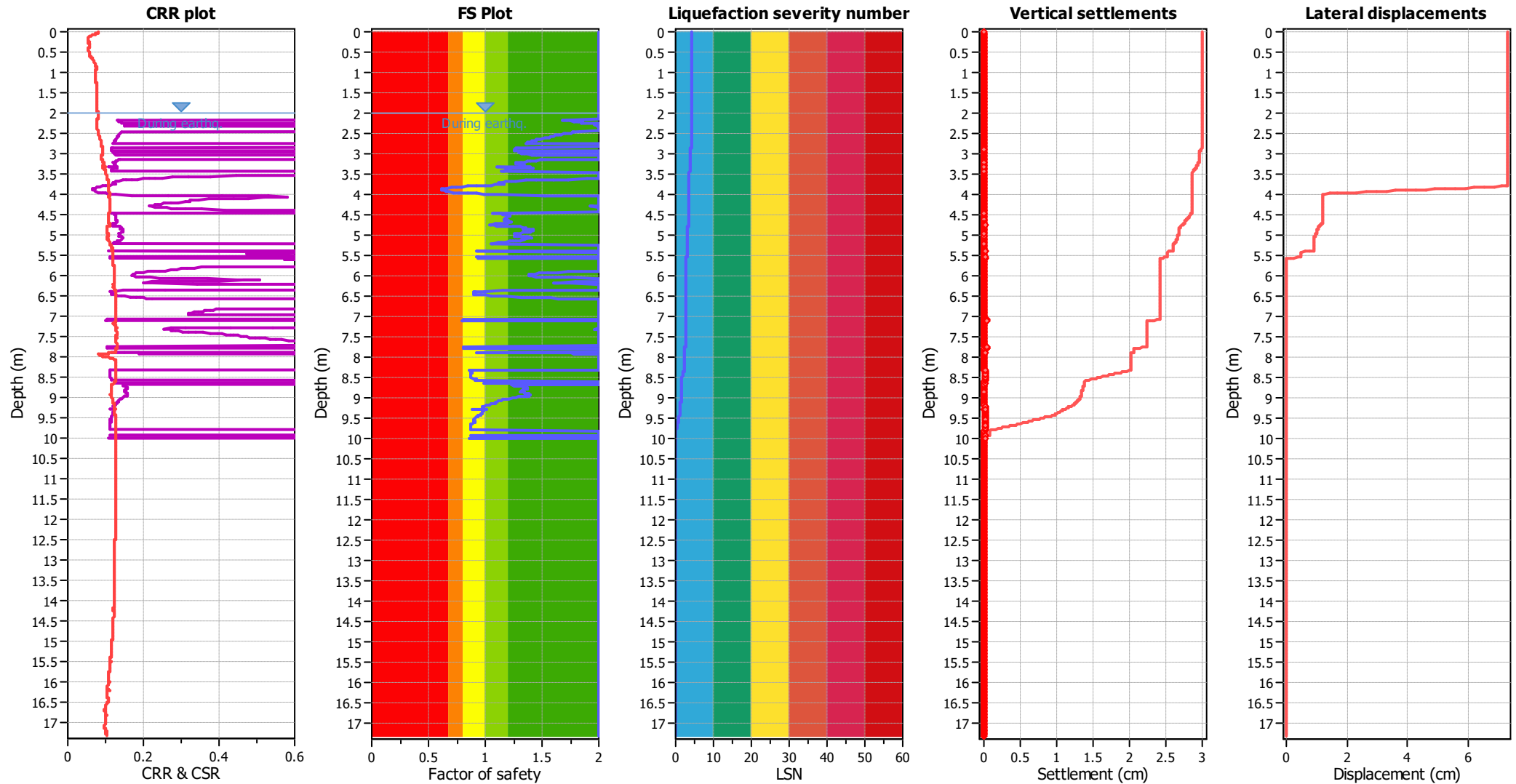
CPT file : Soil&Rock211197_CPT03

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 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 :	5.75	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.15	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.75	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.15	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LSN color scheme

Red	Severe damage
Orange	Major expression of liquefaction
Yellow	Moderate to severe exp. of liquefaction
Light Green	Moderate expression of liquefaction
Dark Green	Minor expression of liquefaction
Blue	Little to no expression of liquefaction

LIQUEFACTION ANALYSIS REPORT

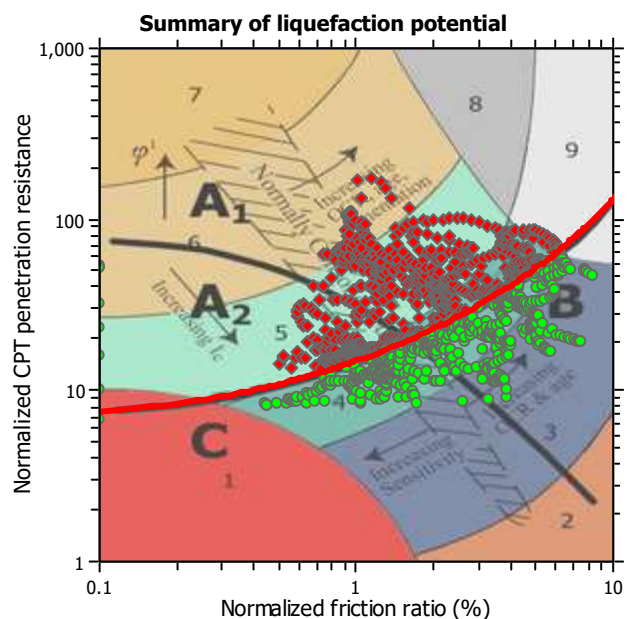
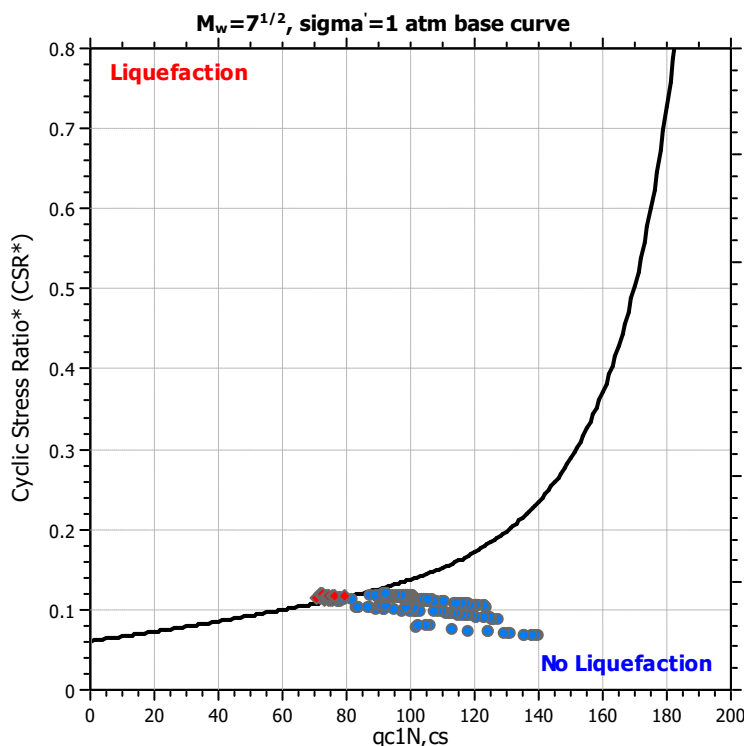
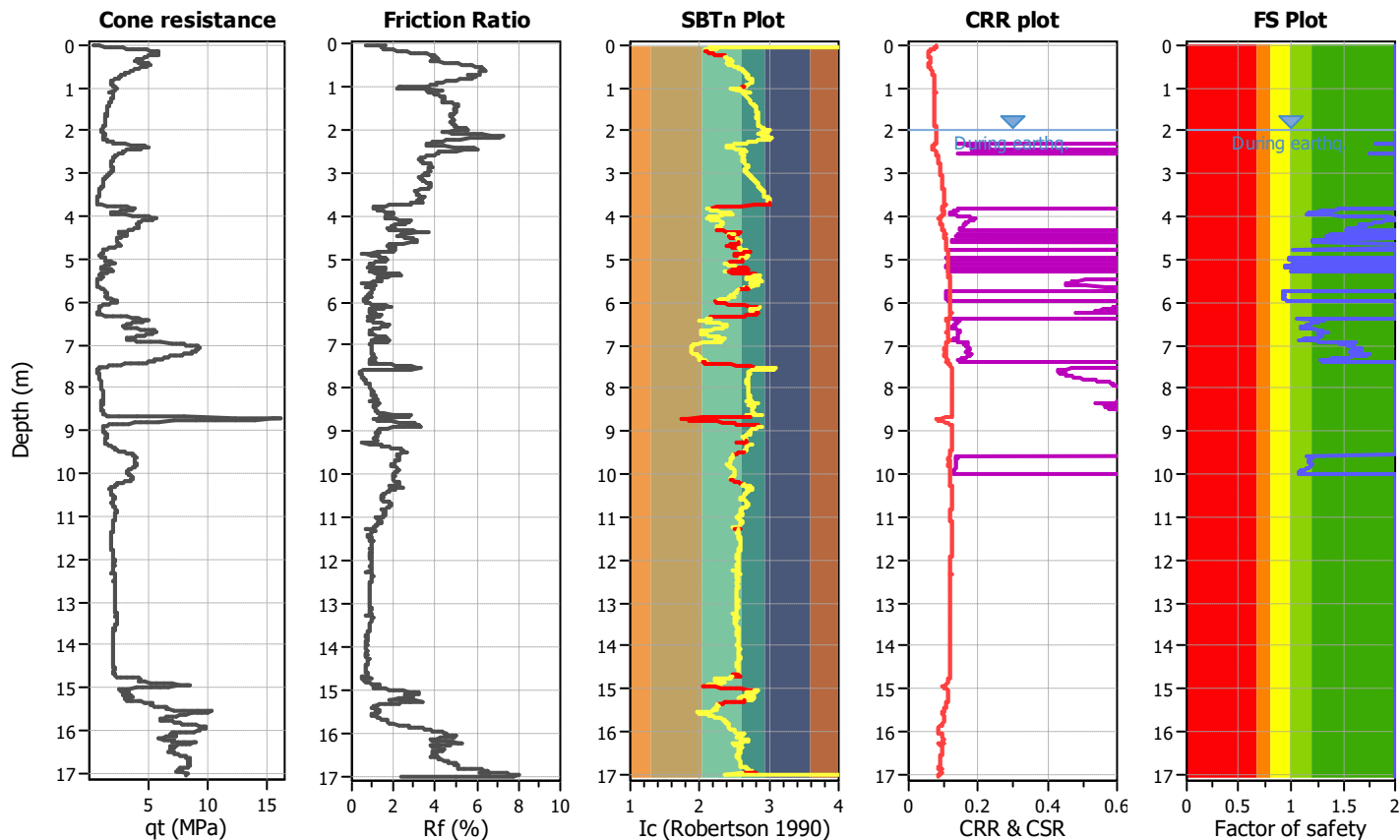
Project title : Wiri SPCA

Location : 485 Puhinui Road, Papatoetoe

CPT file : Soil&Rock211197_CPT04

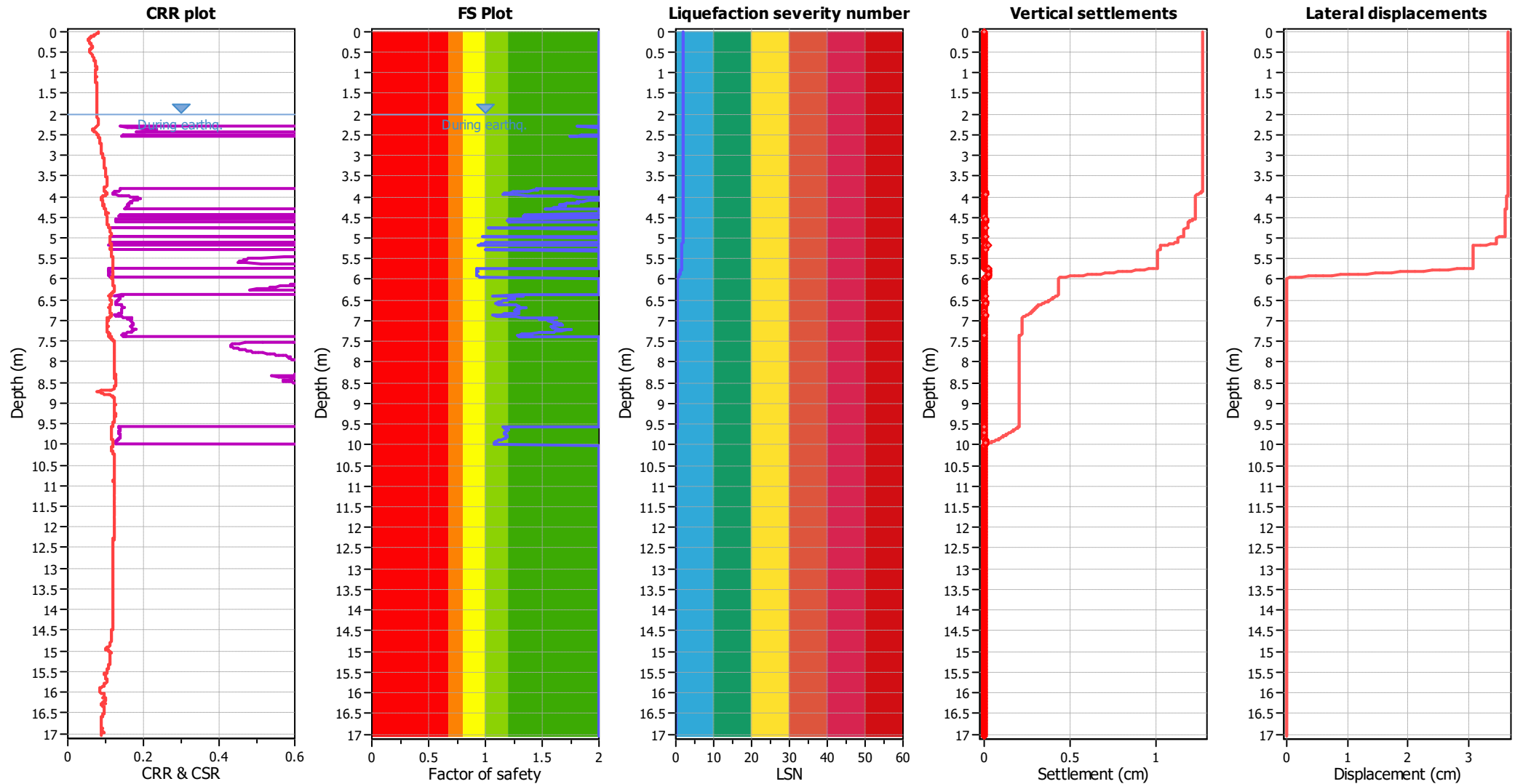
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 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 :	5.75	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.15	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_G applied:	Yes
Earthquake magnitude M_w :	5.75	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.15	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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

LSN color scheme

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