

29 January 2016

Document Ref: AKL2016_0303AB Rev 1

Neil Construction Limited Level 3, Building B 8 Nugent Street Grafton Auckland

Attention: David Page

RE: PRELIMINARY GEOTECHNICAL REPORT FOR WHENUAPAI WATERFRONT BLOCK, MCKEAN & TOTARA ROADS, WHENUAPAI

1 INTRODUCTION AND SCOPE

CMW Geosciences (NZ) Limited (CMW) has been engaged to undertake a preliminary geotechnical investigation for a pre purchase due diligence assessment at the Whenuapai waterfront block on McKean and Totara Roads. This work has been carried out in accordance with our fee proposal referenced AKL2016_0303AA Rev 0 dated 14 January 2016.

It is understood that the findings and recommendations of this report will be used to assess the geotechnical risk associated with this site as part of a pre purchase due diligence.

2 SITE DESCRIPTION

The site covers 4 freehold titles legally described as Lot 1 DP 72379, Lot 1 DP 92316, Lot 3 DP 77541 and Lot 1 DP 170291. In total the land comprises approximately 15ha and is bound to the south by McKean Road, to the east by Totara Road, to the west by Rarawara Creek and to the north by the neighbouring farm land before the waters of the Waitemata Harbour.

The topography comprises a relatively consistent, flat ground profile falling from approximately RL 15m in the south east corner where McKean Road meets Totara Road to approximately RL5m at the creek and harbour boundaries in the west. Beyond the western boundary coastal banks up to 5 metres in height are present. Mature pine trees are present above this bank and mature mangroves exist at the toe of the slope within the tidal zone.

The majority of the site is open grass pasture with mature tree hedge lines. A number of drains have been formed on the property to direct storm and surface water off the land and in to Waitemata Harbour and Rarawara Creek. One of these drains has been cut in a horse shoe shape in the west of the site. Another has been cut in a west to east trending direction before heading north feeding into a gully feature before entering Rarawara Creek. Large mature pine trees exist around the majority of the coastal boundary. It is understood that part of the land has previously been used for rose cultivation.

A number of existing residential dwellings and sheds are located on the property, associated roads and access ways link these structures to the either McKean or Totara Road.

3 DEVELOPMENT PROPOSALS

Although no firm proposals have been supplied to CMW, we understand that early conceptual development proposals are to subdivide the site into approximately 356 residential lots, public reserve areas and the creation of a stormwater retention pond adjacent to the foreshore in the west.

We anticipate that the majority of the lots will be formed using a combination of earthwork cuts and fills. Minor retaining walls are also expected to be adopted in the development scheme.

4 RELATED REPORTS

CMW completed a geotechnical walk over and desk top appraisal for this block on land in September 2015. Please refer to our report titled '*Desktop Geotechnical Appraisal and Site Walkover for Whenuapai Waterfront Block, McKean and Totara Roads, Whenuapai*' referenced AKL2016_0201AA revision 0 for our initial review of the block, including geological setting and our initial site walkover review and geotechnical risks.

5 SITE INVESTIGATION

Our field work was undertaken on 19 and 20 January 2016 and comprised drilling 16 hand auger boreholes to depths of up to 5m below the current ground levels. In situ strength testing was carried out in our boreholes at approximately 400mm intervals using a hand held shear vane.

A cross section was also measured down slope over the coastal bank in the north east corner of the site to gain an understanding of likely set-back requirements.

Our boreholes encountered topsoil to depths of up to 0.40m underlain by clays, silts and sands of the Tauranga and Waitemata Groups. Bedrock was inferred in our boreholes where the geology was too hard to penetrate. Vane shear strengths varied largely across the site with strengths ranging from 14kPa, in the tidal foreshore zone, to in excess of 211kPa which is the maximum reading of our shear vane. Typically the soils encountered across the site were stiff to hard. Peak vane shear strengths compared to residual vane shear strengths indicated that moderate to sensitive soils were present across most of the site. A layer of extremely sensitive soils was only encountered in borehole HA03-16, drilled in the base of the existing gully feature.

No significant fill deposits were identified during our investigation. However fill deposits existing on this site should not be discounted.

Significant organic deposits were only encountered as follows:

- HA02-16 & HA03-16 organic gully deposits to depths of 0.9m and 1.2m respectively.
- HA16-16 organic stained deposits in the tidal foreshore to depth of 1.0m.

Standing groundwater was encountered at varying depths across the site. Shallow groundwater (less than 1.0m depth) was encountered in HA02-16, HA03-16 and HA16-16. These boreholes however were drilled in lower lying areas such as gully features and the tidal zone. Typically groundwater across the site was at depths greater than 2.0m.

A summary of the results of the hand auger boreholes is shown in Table 1 below:

	DEPTH	GROUNDWATER	SHEA STREN	R VANE GTH (kPa)	SENS	ΙΤΙVΙΤΥ	TOPSOIL
	(m)	DEPTH (m)	MIN	MAX	MIN	MAX	DEPTH (m)
HA01-16	4.00	3.80	90	198+	Ι	S	0.30
HA02-16	4.00	0.70	53	211+	I	М	0.15
HA03-16	2.80	0.50	25	UTP	М	ES	0.00
HA04-16	3.60	2.10	112	UTP	М	S	0.20
HA05-16	4.00	NE	56	192+	I	S	0.40
HA06-16	2.80	2.60	56	UTP	Ι	S	0.40
HA07-16	4.00	NE	113	211+	Ι	М	0.30
HA08-16	4.00	NE	69	187	Ι	М	0.10
HA09-16	4.00	NE	71	178	Ι	S	0.30
HA10-16	4.00	NE	90	UTP	М	S	0.20
HA11-16	4.00	NE	191+	UTP	N/A	N/A	0.20
HA12-16	4.00	2.00	68	192+	I	S	0.30
HA13-16	4.00	NE	191+	UTP	N/A	N/A	0.20
HA14-16	4.70	NE	48	UTP	М	S	0.10
HA15-16	2.60	NE	UTP	UTP	N/A	N/A	0.30
HA16-16	1.90	0.30	14	UTP	М	S	0.00
	nsensitive	Key: UTP - Unabl	e to Penetra	ate, NE – No	t Encounter	ed Sensitive O	- Ouick

 Table 1: Hand Auger Borehole Summary:

Full borehole records and the approximate locations of the boreholes are shown on the site plan appended to this report.

6 ANALYSIS

CMW have completed a stability analysis, using the proprietary computer software Slide and the Morgenstern-Price method, on the existing ground levels along the cross-section alignment shown on the appended site plan (A-A') through the bank adjacent to the estuary. The profile used to create the ground model analysed was measured on site. Soil strength parameters were given to the different unit layers by interpreting the results of the investigation and our knowledge of the soil conditions.

Groundwater profiles were based on the site investigation data and the anticipated worst case transient elevated conditions.

Auckland Council Code of Practice for Land Development and Subdivision requires a minimum Factor of Safety of 1.5 for long term slope stability under prevailing groundwater conditions, 1.3 for short term elevated groundwater conditions and 1.2 under seismic loading.

7 PROJECT EVALUATION AND GEOTECHNICAL RISKS

7.1 General

On the basis of our investigation and understanding of the geology in this area we consider that the geotechnical nature of the site is suitable for future residential subdivision, although further comments which should be considered are provided below.

7.2 Deep Topsoil

Topsoil depths of up to 0.4m were encountered in our boreholes across the site. Typically the average topsoil depth across the site observed was 0.2m to 0.3m. Topsoil depths exceeding 0.4m are also possible and could be expected in localised areas of this site. During any development of the site, these soils will need to be cut, stockpiled and replaced with engineered clean fill.

7.3 Organic Soils

As mentioned above, significantly organic soils were limited to a few specific locations encountered in some our boreholes across the site. Due to mainly being observed in the gully features these soils will require mucking out and stockpiling.

7.4 Soft and Sensitive Soils in Earthworks and Foundations

Our investigation found no indication of significant or extensive deposits of soft or sensitive soils that could be expected to impact significantly on earthworks, civil works or future building development.

7.5 Slope Instability

Our stability analyses completed on the cross section A-A' indicated that the coastal bank has stability factors of safety less what is required by Auckland Council standards for residential sub divisions. Current and required factors of safety are shown on the stability printouts appended to this report.

The appended stability print outs indicate that a safe set back of at least 10m (Elevated Groundwater Conditions) from the crest of the coastal bank is required to meet Auckland Council Standards. Any development proposed within this set back must be subject to further stability analysis and possible remedial works.

This proposed set back is only for this section of the coastal bank and further stability analysis may be required to assess other sections of the coastal bank. We would however expect similar set back requirements for the remaining sections of coastal banks.

This analysis has also assumed that no erosion is occurring at the toe of the slope. However the presence of mangroves and the location of the bank indicates a low energy environment in which we would not expect significant erosion.

7.6 Stormwater Pond

Hand auger HA13-16 was completed in the position that has been indicated that a stormwater pond may be constructed. Very stiff to hard silts were observed at depths below 1.2m at this location during our investigation. Although no construction detail has been provided we have assumed that deep (greater than 1.2m) cuts will be required to form the stormwater pond. Any excavations into the silt material to form the proposed pond will require to be undercut and lined with high plasticity clays which should be available onsite.

7.7 Drains

We have been informed that the drains observed on site, including the horse shoe shaped drain toward the west of the site, are man-made. Other than possible areas of fill in close proximity to these drains, due to their formation, we do not expect these features to cause significant issues to future earthworks operations. Depending on proposed finished ground levels, gully muck outs may be required and any fill encountered may need to be reworked.

7.8 Earthworks and Building Foundations

From our observations of the subsoils encountered in the boreholes completed, the majority of the site should be suitable for standard earthwork operations and practices. Following completion of the earthworks the building platforms should be suitable for the normal range of shallow and deep foundation options. At this stage the expansive nature of the soils has not been assessed, but from our experience it is likely to be in the moderately (M) to high (H1) range.

8 FUTURE WORK

Once development proposals are finalised, CMW should be engaged to review the proposed plans to make comment on any further geotechnical risk that may be present. This may include completing further stability analysis and geotechnical comment of proposed developments in close proximity to the coastal banks present on site.

9 LIMITATIONS

This report has been prepared for use by our client Neil Construction Limited. Liability for its use is limited to these parties and to the scope of work for which it was prepared as it may not contain sufficient information for other parties or for other purposes.

It should be noted that factual data for this report has been obtained from discrete locations using normal geotechnical investigation techniques. As such investigation methods by their nature only provide information about a relatively small volume of subsoils, there may be special conditions pertaining to this site which have not been disclosed by the investigation and which have not been taken into account in the report. If variations in the subsoils occur from those described or assumed to exist then the matter should be referred back to CMW immediately.

10 CLOSURE

We trust this report meets your requirements.

Should you require any further information or clarification regarding the information provided in this report, please do not hesitate to contact the undersigned.

For and on behalf of CMW Geosciences (NZ) Ltd

Tim Lepper Engineering Geologist

Distribution:

1 copy to Neil Construction Limited (electronic)

Af Knowles

Richard Knowles Principal Geotechnical Engineer

Original held by CMW Geosciences NZ Ltd



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	S P	ite A rojec	ddres	s: W AKL	/henu .2016	uapai S_0303				Chapman Mortor	Geosciences	
	B	ate. oreh	ole Lo	ocati	on: S	See Site Plan				1:25	Sheet 1 of 1	
	Lo	ogge heck	ed by:	JMJ ∕∙ ⊤i		Position: (Estimated On Site)	Ele\ Dati	atio	n:	Hole Dia Angle fro	meter: 50mm	
l Init		Broundwater	RL (m)	Depth (m)	Sraphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm)	Comments	
		0		-		OL: TOPSOIL						
Tonsc	200			-			D to					
_				-		CL: Silty CLAY: grey with orange streaks. Very stiff, dry to moist,	м		V-211+		-	
				-	×	Becoming orange, high plasticity, moist			V 2111			
				-	×							
				-	× X				V-211+			
				1 -							-	
				-				10	V 166(101)		-	
				-		Becomina arev		15	V-100(121)		-	
				-	× ×						-	
				-				IS	V-166(128)		-	
				-								
2	2			-	× ××							
Pro-				2 -	×			IS	V-166(121)			
rands	201			-			м					
L I				-				IS	V-159(98)		-	
				-								
				-	×						-	
				-		Becoming with minor fine sand		MS	V-113(48)		-	
				3 -	×							
				-	×	December over 20		MS	V-159(75)			
				-		Deconning orange						
				-	×	Becoming grey with some fine sand					-	
				-				MS	V-162(78)			
				-								
				4 -	×	Develople terminated at 4.0m		MS	V-166(75)			
				-		borenoie terminated at 4.0M		-	()			
				-							-	
				-							-	
				-								
				-								
				-								
			tier	5 -		areat Douth Decahod						
	er	mna	auon r	easo	on: I	arger Depth Reached						
	Re	mar	ks: G	roun	d wa	ter not encountered						
						This report is based on the attached field description for soil and rock	k, New	Zeal	and, Geotechnical	Society Inc 2005.		

ŀ	HAND AUGER BOREHOLE - HA08-16 Client: Neil Construction Limited Project: Totara and McKean Roads										
F	Proje	ct: Tot	ara a	and N	McKean Roads				— — —		
S	Site A	ddres	s: W	/henu					CMV	(NZ) Ltd	
	Date:	19/01	/201	-2016 16	5_0303				Chapman Mortor	Woodward	
E	Boreh	ole Lo	ocati	ion: S	See Site Plan				1:25	Sheet 1 of 1	
	.ogge	ed by:	ML		Position: (Estimated On Site)	Elev	atio	n:	Hole Dia	ameter: 50mm	
	fec	Neu Dy	/. TL	D	Material Description						
lnit	idwai	(E)	th (m	lic Lo	Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity: sensitivity: additional comments	isture	sitivity	Shear Strengths (kPa)	Penetrometer	Comments	
	Brour	RL	Dep	Grapl	Rock: Weathering; colour; fabric; rock name; strength; additional	Mo Cor	Sen	Peak (Residual)	5 10 15 20		
Top soil	0		-		OL: TOPSOIL					-	
			-	$\times \times$	ML: SILT: orange. Very stiff, moist, low plasticity						
			-		CL: Silty CLAY: orange. Very stiff, moist, low plasticity					-	
			-				MS	V-187(57)		-	
					CH: CLAY: light grey mottled orange. Very stiff, moist, high plasticity						
			-	<u>E-</u>							
			-	<u> </u>			MS	V-149(67)		-	
			- 1 –		0						
				<u>-</u>	Becoming light grey						
			-	E			IS	V-127(72)		-	
			-	<u> </u>							
				<u> </u>							
			-				IS	V-127(78)		-	
			-	<u> </u>							
roup			-	<u> </u>							
ga G			2 -	<u> </u>		м	MS	V-90(42)			
uran			-								
100			-	E	Becoming dark grey						
			-	<u></u>			IS	V-107(63)		-	
			-								
			-								
			-	E-1	Becoming stiff		MS	V-91(45)		-	
			3 -		Recoming with minor fine cand, becoming arey						
			-	=	becoming with minor line sand, becoming grey						
			-	F			IS	V-69(37)		-	
			-	E						-	
			-	1							
			-	<u> </u>	Becoming very stiff		MS	V-116(43)			
			-	<u>E-</u>							
			-	<u> </u>							
			4 -		Borehole terminated at 4.0m		MS	V-109(45)			
			-	-							
			-								
			-							-	
			-								
			-								
			5 -	1							
Те	rmina	ation r	easo	n: T	arget Depth Reached						
P	emar	·ke· Ci	nun	d we	ter not encountered						
	cinal	NJ. U	Jui	u vva							
					This report is based on the attached field description for soil and rock	, New	Zeal	and, Geotechnical	Society Inc 2005.		

	HAND AUGER BOREHOLE - HA09-16 Client: Neil Construction Limited Project: Totara and McKean Roads												
	Proj	ect	: Tota	ara a	and N	AcKean Roads							
	Site Proj	Ad ect	dres: No:	s: W AKL	/neni .2016	Japai 5_0303				C	\mathbf{N}		Geosciences
	Date Bore	e: 1 eho	9/01. le Lo	/201 cati	l6 on: S	See Site Plan				Chap	man 1:25	Mortor 5	1 Woodward Sheet 1 of 1
	Log	ged	l by:	ML		Position: (Estimated On Site)	Elev	atio	n:		Но	le Dia	imeter: 50mm
	Che	cke	ed by	: TL	bc	Survey Source: Material Description	Dati	um:		Dyn	Ang	gle fro Cone	om horizontal: 90°
Unit	Groundwa		RL (m)	Depth (m	Graphic Lo	Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Per (Blov 5	netron w/100 10 15	neter mm)	Comments
<u>i</u>				-		OL: TOPSOIL							
Tops				-									
				-		CL: Silty CLAY: light brown. Very stiff, dry to moist, low plasticity	D to M	s	V-178(30)				
				-		CH: CLAY: orange with grey streaks. Very stiff, moist, high							-
				-		plasticity		IS	V-112(62)				
				- 1 —									
				-				IS	V-130(71)				
				-									
				-				IS	V-110(67)				
				-									
d d				-				10	V 440(00)				
a Gro				2 -			IVI	15	V-110(66)				
urang				-									
Ta				-		Becoming stiff		IS	V-82(52)				
				-									
				-				10	1/ 74/44				-
				-				15	V-7 I(4 I)				
				3 -	<u> </u>	Becoming dark green						-	
				-				IS	V-71(41)				
				-		.Becomina moist to wet							
				-		······································		19	V-82(47)				
				-			M to W	10	V 02(+7)				
				-									
	_			4 -		Borehole terminated at 4.0m		MS	V-82(41)				
				-									
				-									
				-	-								
				-									
				-									
	_			5 -									
Te	ermi	nati	ion re	easo	on: T	arget Depth Reached	I	I	1				1
F	Rem	ark	s: Gr	oun	d wa	ter not encountered							
					-	This report is based on the attached field description for soil and rock	, New	Zeal	and, Geotechnical	Societ	y Inc	2005.	

	HA	ND	A	UC	SER BOREHOLE - HA10-16							
	2lient Proje	:: Neil ct: Tot	Con ara a	struc	tion Limited AcKean Roads					_		
5	Site A	ddres	s: W	/henu					C	\wedge		(NZ) Ltd
	Date:	19/01	/201	16	5_0000				Chap	man	Mortor	Woodward
E	Boreh	ole Lo	ocati MB	ion: S	See Site Plan Position: (Estimated On Site)	Flev	vatio	n.		1:2 Ho	5 Ne Dia	Sheet 1 of 1
(Chec	ked by	/: TL		Survey Source:	Dat	um:			Ar	igle fro	om horizontal: 90°
Unit	Broundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dyn Per (Blo 5	amic netroi w/10 10 1	Cone meter 0 mm) 5 20	Comments
soil	0				OL: TOPSOIL:				Ť			
Top	-				CH: CLAY: with some silt: orange. Verv stiff to hard, drv. high	-						-
					plasticity.			\/_101+				
			-			D		V-1511				-
			-				MS	V-177(68)				
			1 –		CL: Silty CLAY: grey mottled orange. Very stiff, moist, low		MS	V-152(61)				-
					pilotoky.			V 102(01)				
٩							MS	V-174(46)				
Grou					With interdeds of clayey silt, moist, very stiff, grey.							
ranga			-				MS	V-159(73)				
Tau			-		With some fine sand							
						м						
			2 -				s	V-90(23)				
			-	$(\times \times $	ML: Sandy SILT: with some clay; grey. Stiff to very stiff, moist, low to no plasticity. Sand is fine to medium grained.							
								V 404 -				-
			-	$(\times \times)$				V-191+				
				$(\times \times $								-
	-				100mm wet layer ML: SILT: with trace fine sand: orange brown. Hard, moist, non	W		V-UTP				
			- - -	$(\times \times)$	plastic.							
			3 -	$(\times \times)$								
Broup				$\langle \times \times \\ \times \times \rangle$				V-UTP				
nata ($(\times \times)$		м						
Vaiten			-	$(\times \times)$								
				$(\times \times)$								
				$\langle \times \times \\ \times \times \rangle$								
			4 -	$\hat{\mathbf{x}}$	Borehole terminated at 4.0m		-	V-UTP				
				-								
			-	-								
			-									
												-
			-									
-		tion	5 -	1	aract Donth Decebor				1	1	1 1	
le	1111112	auon h	eas(ווע. ו יו								
R	emar	ks: Gi	oun	dwat	er not encountered							
				-	This report is based on the attached field description for soil and rock	k, New	v Zeal	land, Geotechnical	Socie	ty Inc	2005.	

	HA Client	ND Neil	Con	UC struc	GER BOREHOLE - HA11-16							
F S F	Proje Site A Proje	ct: Tot ddres ct No:	ara a s: W AKL	and N henu 2016	ИсКean Roads Japai 5_0303				C			Geosciences
	Date: 19/01/2016 Chapman Morton Woodward											
	Logged by: MB Position: (Estimated On Site) Elevation: Hole Diameter: 50mm											
0	Chec	ked by	: TL		Survey Source:	Dat	um:			Ar	igle f	from horizontal: 90°
Unit	Broundwater	RL (m)	Depth (m)	Sraphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dyn Pei (Blo 5	namic netroi w/10 10 1	Cone meter 0 mm) 5 20) Comments
ioi	0		-		OL: TOPSOIL:				Ť	+		
Tops					ML: SILT: with some clay; orange. Hard, dry, low plasticity.	D		V-191+				
					CH: CLAY: with some silt; orange brown. Hard, moist, high		-	V 101				
	Image: splasticity. Image: splasticity. Image: splasticity. Image: splasticity. Image: splasticity. Image: splasticity.											
	M V-191+											
					Alternating between silty clay and sandy silt			V-UTP				
auranga Group			2		ML: Sandy SILT: light orange. Hard, dry, non plastic.		-	V-UTP				
1			-			D		V-UTP				
					CL: Silty CLAY: light grey mottled orange. Hard, moist, low plasticity.,			V-UTP				
			3		With some fine sand			V-191+ V-191+				
	M V-191+											
	4 Borehole terminated at 4.0m V-191+											
Tei Re	Termination reason: Target Depth Reached											
				-	This report is based on the attached field description for soil and roch	, New	/ Zeal	and, Geotechnical	Socie	ty Inc	: 2005	i.

	ŀ	ΙA	ND	Α	UC	SER BOREHOLE - HA12-16					
	Client: Neil Construction Limited Project: Totara and McKean Roads										
	Site Address: Whenuapai Project No: AKL2016_0303 Date: 19/01/2016										
	Barehole Location: See Site Plan1:25Sheet 1 of 1										
	Logged by: ML Position: (Estimated On Site) Elevation: Hole Diameter: 50mm Checked by: TL Survey Source: Datum: Angle from horizontal: 90°										
1 Init		Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm) 5 10 15 20	Comments
Toneoil	0000					OL: TOPSOIL					
						SC: Clayey SAND: light brown. Very stiff, dry, low plasticity		s	V-190(27)		
						Becoming pale yellow and light grey with orange streaks	D		V-192+		
				1 -		Becoming moist					
								MS	V-129(34)		
				-			м	MS	V-126(52)		
Group	4000	◄		2 -		With ground water seepage, becoming moist to wet		s	V-122(27)		
Tauranda	2010			-				MS	V-110(33)		
				-		SC: Clayey SAND: grey. Very stiff, moist to wet, high plasticity	-				
				3 -			M to W	MS	V-170(66)		
				-		Becoming stiff		IS	V-68(41)		
						Becoming very stiff		MS	V-144(55)		
				4 —		Borehole terminated at 4 0m		MS	V-110(41)		
					-						
				-	-						
				-	-						
-											
-	Termination reason: Target Depth Reached										
	Re	mar	ks: Gi	roun	dwat	er encountered at 2meters					
					-	This report is based on the attached field description for soil and rock	, New	Zeal	and, Geotechnical	Society Inc 2005.	

	HAND AUGER BOREHOLE - HA13-16										
	Project: Totara and McKean Roads										
	Site Address: Whenuapai Project No: AKL2016_0303										
	Date: 19/01/2016 Chapman Morton Woodward Borehole Location: See Site Plan 1:25										
	Logged by: MBPosition: (Estimated On Site)Elevation:Hole Diameter: 50mm										
	Checl ັ້ຍ	ked by	/: TL	- 0	Survey Source: Material Description	Dati	um:		Angle fro	om horizontal: 90°	
Unit	Image: Section 1 Image: Section 2 Image: Section 2 <td< td=""><td>Sensitivity</td><td>Shear Strengths (kPa) Peak (Residual)</td><td>Penetrometer (Blow/100 mm) 5 10 15 20</td><td>Comments</td></td<>						Sensitivity	Shear Strengths (kPa) Peak (Residual)	Penetrometer (Blow/100 mm) 5 10 15 20	Comments	
psoil					OL: TOPSOIL:						
4					CL: Silty CLAY: orange. Hard, dry, low plasticity.						
				×				V-191+			
				××				V-191+			
								1011			
			1 -	× ××							
					ML: SILT: orange and light grey. Hard, dry, low plasticity.	-		V-UTP			
			-					V-UTP			
										-	
dno					Becoming orange with some fine sand						
ga Gro			2 -		With some Sandy SILT interbeds	D		V-UTP			
auran										-	
								V-UTP			
			-								
								V-UTP		-	
			3 -								
				× × ; < × × × × ;				V-UTP			
			-					V-UTP			
			4 -	$\times \times $	Borehole terminated at 4.0m			V-UTP			
				-							
			-								
				-							
			5 -								
Te	Termination reason: Target Depth Reached										
R	emar	ks: Gi	roun	idwat	er not encountered						
	This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.										

	H CI	IA ient	ND : Neil	A Con	UC struc	SER BOREHOLE - HA14-16					
	Pr Si Pr	ojeo te A oieo	ct: Tot ddres ct No:	ara a s: W AKL	and N /henu .2016	ΛcKean Roads μapai δ−0303				CMV	Geosciences
	Date: 19/01/2016 Chapman Morton Woodward										
_	Logged by: MLPosition: (Estimated On Site)Elevation:Hole Diameter: 50mm										
	Cł	neck	ked by	/: TL		Survey Source:	Dat	um:		Angle fr	om horizontal: 90°
Unit		Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm) 5 10 15 20	Comments
Top	sol			-							
	CL: Fine Sandy CLAY: with some silt, light grey. Very stiff, moist, low plasticity								v-209+		
				- - - - - - - - - - - - - -	× × × × × × × × × × × ×				UTP		
				-		MH: Clavev SILT: with some fine sand, grev. Verv stiff, moist.	м		UTP		
	high plasticity										
0				2 —				MS	V-149(42)		
Tauranda Grou	5			-		CL: Fine Sandy CLAY: with some silt, light grey. Very stiff, wet, low plasticity		MS	V-131(42)		
				3 –		ML: Sandy SILT: with minor clay, dark grey. Very stiff, wet, low plasticity	W	MS	V-151(40)		
				-	× × > (× × × × > (× × × × >	Becoming saturated		MS	V-163(57)		
						MH: Clayey SILT: dark brown. Stiff, saturated, high plasticity	-	MS MS	V-48(24) V-52(22)		
				4 —		CH: CLAY: With minor fine sand, light grey. Stiff, saturated, high plasticity, with trace decomposed wood inclusion	s	MS	V-54(27)		
				-				MS	V-155(42)		
						Borehole terminated at 4.7m		-	UTP		
T	err	nina	ation r	easo	n: T	oo Hard To Auger Further					
	Re	mar	ks: G	roun	d wa	ter not encountered					
					-	This report is based on the attached field description for soil and rock	. Nev	/ Zeal	land, Geotechnical	Society Inc 2005.	

	HA Client Proje Site A Proje	ND t: Neil ct: Tot ddres	Con ara a s: W	UC struc and N /henu 2016	GER BOREHOLE - HA15-16 tion Limited McKean Roads Japai 0.0303				C		N Geoscier	(NZ) Ltd
	Date: 19/01/2016 Chapman Morton Woodward											
	Borehole Location: See Site Plan 1:25 Sheet 1 of 1											
	Checked by: TL Survey Source: Datum: Angle from horizontal: 90°											
Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Shear Strengths (kPa) Peak (Residual)	Dyna Pene (Blow 5 1	mic Cone etrometer //100 mm 0 15 20	e r n) Commer	nts		
oi			-		OL: TOPSOIL:							-
Tops			-									-
			-		ML: SILT: with trace fine sand; brown. Hard, dry, low to no plasticity.			V-UTP				
auranga Group	non-open endormed by the some rootlets non-open endotes non-open endotes non-open endotes non-open endotes non-open endotes non-open endotes non-open endotes non-open endotes non-open endotes											
			-					V-UTP				
			-	×	With fine grained rounded siltstone gravel and limonite cementation							-
			2 -	$(\times \times)$				V-UTP				
dno			-		CL: Silty CLAY: with some fine sand. Hard, dry to moist, low							-
iitemata Gr			-	× × × × ×	μαδιίζι			V-UTP				
Wa	-		-	. × . ?	SM: Silty SAND: dark grey. "Dense" dry, sand is fine grained. Borehole terminated at 2.6m							-
			-									-
			-									-
			3 -									_
			-									-
			-									-
			-									-
			-									-
			-									-
			-									-
			4 -								_	_
			-									-
			-									
			-									
			-									-
			-									-
Te	_ ermina	l ation r	easo	n: T	oo Hard To Auger Further							
F	Remai	ˈks: G	roun	dwat	er not encountered							
					This report is based on the attached field description for soil and rock	, New	Zeal	and, Geotechnical	Society	Inc 2005	5.	

	HAND AUGER BOREHOLE - HA16-16											
	Client: Neil Construction Limited Project: Totara and McKean Roads											
	Site Address: Whenuapai Project No: AKL2016_0303											
	Date: 19/01/2016 Chapman Morton Woodward											
	Borehole Location: See Site Plan 1:25 Sheet 1 of 1											
	Chec	ked by	/: TL		Survey Source:	Dati	um:	····		Ar	ngle fro	om horizontal: 90°
Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dy Pe (Bl	namic enetro ow/10 10 1	Cone meter 0 mm)	Comments
			-		CH: Organic stained CLAY: with some sand; brown. Soft, wet, high plasticity.							-
9			-		Ground water seenage							
a Groi			-				s	V-22(5)				
Iranga			-			vv						
Tat			-									
			-				MS	V-14(5)				
	_		1 -		CL: Silty CLAY: dark grey. Hard, moist, low plasticity.							
			-					V-UTP				
Group			-									
nata (-	×_×		м						
Vaiter			-					V-UTP				
			-									
			-	×	Borehole terminated at 1.9m			V-UTP				
			2 -									
			-									-
			-									
			-									
			-									
			-									
			-									
			3 -									
			-									
			-									
			-									
			-									
			-									
			-									
			4 -									
			-									
			-									
Т	Termination reason: Too Hard To Auger Further											
	.cmu		Jun	-					. .		000-	
					i his report is based on the attached field description for soil and rock	k, New	/ ∠eal	and, Geotechnical	Soci	ety Ind	2005.	

NZ GEOTECHNICAL SOCIETY INC SOIL > field guide sheet FIELD DESCRIPTION OF SOIL

SEQUENCE OF TERMS - fraction - colour - structure - strength - moisture - bedding - plasticity - sensitivity - additional

GRAIN SIZE CRITERIA

			C	DARSE					FI	NE	ORGANIC
				Gravel			Sand	-			
TYPE	Boulders	Cobbles	coarse	medium	fine	coarse	medium	fine	Silt	Clay	Organic Soil
Size Range (mm)	2	00 6	02	06	6 2	2 0	.6 0.	.2 0.	.06 0.0) 02	
Graphic Symbol				398	388 388				× × × × × × × × × × × ×		张 侯 泰 承 承 承 承 承 承 承 承 承 承 承 承 承 承 承 報 報 報 報

PROPORTIONAL TERMS DEFINITION (COARSE SOILS)

	•		
Fraction	Term	% of Soil Mass	Example
Major	() [UPPER CASE]	≥ 50 [major constituent]	GRAVEL
Subordinate	() y [lower case]	20 – 50	Sandy
Minor	with some … with minor …	12 - 20 5 - 12	with some sand with minor sand
	with trace of (or slightly)	< 5	with trace of sand (slightly sandy)



DENSITY INDEX (RELATIVE DENSITY) TERMS

Descriptive Term	Density Index (R _D)	SPT "N" value (blows / 300 mm)	Dynamic Cone (blows / 100 mm)			
Very dense	> 85	> 50	> 17			
Dense	65 – 85	30 – 50	7 – 17			
Medium dense	35 – 65	10 – 30	3 – 7			
Loose	15 – 35	4 – 10	1 – 3			
Very loose < 15 < 4 0 - 2						
Note: • No correlation is implied between Standard Penetration Test (SPT) and Dynamic Cone Test values. • SPT "N" values are uncorrected • Dynamic Cone Penetrometer (Scala)						

ORGANIC SOILS/ DESCRIPTORS

Term	Description
Topsoil	Surficial organic soil layer that may contain living matter. However topsoil may occur at greater depth, having been buried by geological processes or man- made fill, and should then be termed a buried topsoil.
Organic clay, silt or sand	Contains finely divided organic matter; may have distinctive smell; may stain; may oxidise rapidly. Describe as for inorganic soils.
Peat	Consists predominantly of plant remains. <i>Firm</i> : Fibres already compressed together <i>Spongy</i> : Very compressible and open stucture <i>Plastic</i> : Can be moulded in hand and smears in fingers <i>Fibrous</i> : Plant remains recognisable and retain some strength <i>Amorphous</i> : No recognisable plant remains
Roolets	Fine, partly decomposed roots, normally found in the upper part of a soil profile or in a redeposited soil (e.g. colluvium or fill)
Carbonaceous	Discrete particles of hardened (carbonised) plant material.

PLASTICITY (CLAYS & SILTS)

Term	Description
High plasticity	Can be moulded or deformed over a wide range of moisture contents without cracking or showing any tendency to volume change
Low plasticity	When moulded can be crumbled in the fingers; may show quick or dilatant behaviour

CONSISTENCY TERMS FOR COHESIVE SOILS

0011010121		
Descriptive Term	Undrained Shear Strength (kPa)	Diagnostic Features
Very soft	< 12	Easily exudes between fingers when squeezed
Soft	12 – 25	Easily indented by fingers
Firm	25 - 50	Indented by strong finger pressure and can be indented by thumb pressure
Stiff	50 - 100	Cannot be indented by thumb pressure
Very stiff	100 - 200	Can be indented by thumb nail
Hard	200 - 500	Difficult to indent by thumb nail

MOISTURE CONDITION

Condition	Description	Granular Soils	Cohesive Soils
Dry	Looks and feels dry	Run freely through hands	Hard, powdery or friable
Moist	Feels cool, darkened in colour	Tend to cohere	Weakened by moisture, but no free water on hands when remoulding
Wet			Weakened by moisture, free water forms on hands when handling
Saturated	Feels cool, darkened in colour and free water is present on the sample		

GRADING (GRAVELS & SANDS)

Term	Description		
Well graded	Good representation of all particle sizes from largest to smallest		
Poorly graded	Limited representation of grain sizes - further divided into:		
	Uniformly graded	Most particles about the same size	
	Gap graded	Absence of one or more intermediate sizes	

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This field sheet has been taken from and should be used and read with reference to the document FIELD DESCRIPTION OF SOIL AND ROCK. Guideline For the Field Classification and Description of Soil and Rock for Engineering Purposes. NZ Geotechnical Society Inc, December 2005. **www.nzgeotechsoc.org.nz**





