17 February 2022 Job No: 64872#GE eTrack No: 200040703

Highbrook Living Limited

Att: Matt Doughney

RE: HIGHBROOK LIVING – GEOTECHNICAL APPRAISAL FOR PLAN CHANGE

1 INTRODUCTION

Highbrook Living Limited has engaged Babbage Consultants Ltd (Babbage) to provide a geotechnical assessment to support its Private Plan Change (PPC) Request to rezone land which forms part of the property at 8 Sparky Road Otara (the site) as high-density residential end use.

This geotechnical assessment is limited in scope to the area identified on the attached Site Plan. It is a preliminary geotechnical appraisal based on a desk study to inform the Private Plan Change Request 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 Otara and is bound by Highbrook Drive to the south-east, Tamaki River (estuary) to the north and the Southern Motorway to the west as shown in the site plan attached in Appendix A.

The plan change area ("the site") and surroundings are summarised below:

- The site forms part of the former Ōtāhuhu power station site.
- The site is located in the Light Industry Zone area in Ōtara. The residential area and town centre of Ōtara are to the south-east, and Highbrook Business Park is on the opposing side of Ōtara Creek to the north-east.
- The majority of the site is relatively flat at around 8mRL, with the exception of the slope from ~7mRL down to the shoreline along Tamaki River. This slope typically less than 45 degrees (1V:1H), however is locally as steep as ~56 degrees (1.5V:1H).
- There are some low points present on the site, including a pond in the northwest corner adjacent to State Highway 1 (SH1) which was used as an erosion and sediment pond during construction of Highbrook Drive and the widening of SH1.

2.2 Historic Aerial Photography

Historic aerial photography from AC Geomaps and Retrolens[i] was reviewed as part of this assessment. Key changes to land use since 1940 include:

- 1958: Southern Motorway built across Curlew Bay to the west. Largely agricultural land.
- 1967-1969: Large liquid storage tanks under construction on north of site (likely associated with old power station). Stopbank built at edge of Curlew Bay adjacent Southern Motorway. Reclamation filling between stop bank and natural waterline beginning.
- 2003-2004: Removal of the liquid storage tanks.
- 2006: Construction of Highbrook Drive and widening of Southern Motorway in progress.

2.3 Published Geology

The geological map[ii] (see Figure 1) indicates the south and centre of the site is 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 underlain 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.

A small area of reclaimed land (hf) is present in the southwest corner, adjacent to the jetty.

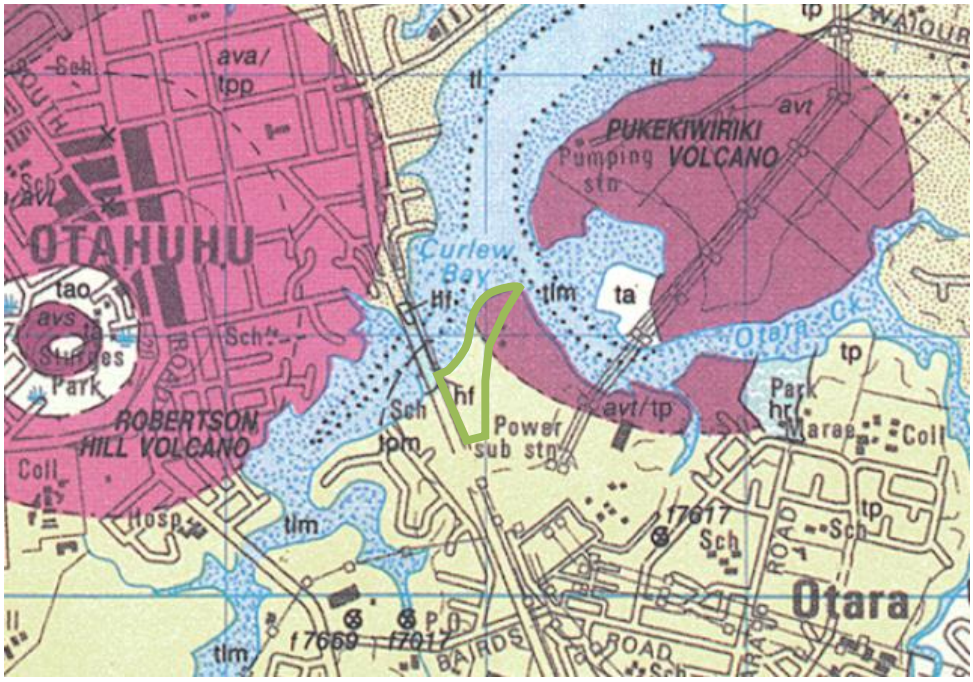

Figure 1: Excerpt of the Auckland Urban Area Geology Map (1:50,000)

2.4 Nearby Investigation Data

The NZ Geotechnical Database[iii] contains several historic investigations carried out close to the site. These included machine-drilled boreholes, Cone Penetrometer Tests (CPTs) and test pits carried out in 2003-2004 for Highbrook Drive and the Southern Motorway widening (refer NZGD site plan below in Figure 2). The borehole logs considered in this assessment are attached to this letter.

Figure 2: Available data on the NZGD (accessed 10 December 2021)

3 SUMMARY OF ANTICIPATED GROUND CONDITIONS

Based on the findings from the desk study, ground conditions are expected to comprise clay, silt and sand of the Puketoka formation, overlain in part by tuff and other AVF deposits and/or surficial fill. The Puketoka formation is anticipated to comprised mostly stiff to hard clay and silt over the top 8-15m, with some loose to dense silty sand lenses. Competent Kaawa Formation sediments are expected between 15m and 22m below ground level. The lower lying reclamation area in the north-west corner of the site appears to comprise ~1.0m of well compacted aggregate separated from the underlying alluvium by a geotextile.

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 NZS1170.0:2002 and NZS1170.5:2004.

4.1.2 Liquefaction Susceptibility

With respect to the liquefaction potential of the site, the anticipated ground conditions comprise predominantly stiff to hard cohesive material for the majority of the soil profile. Thin lenses of silty sand and sandy silt may be present which are more susceptible to liquefaction, however considering the relatively low peak ground accelerations associated with the design earthquake events, and the competent cohesive material present in the upper profile acting as a non-liquefiable 'crust', surface manifestation of liquefaction if considered highly unlikely.

Accordingly, liquefaction-induced ground damage during a ULS event for Importance Level 2 structures is assessed to be in the None to Minor category as defined by the Planning and Engineering Guidance for Potentially Liquefaction Prone Land (MBIE, 2017) document, and the site designated to have a Low Liquefaction Vulnerability. During an SLS event, the risk of liquefaction-induced ground damage is considered negligible.

Further assessment of the site's liquefaction susceptibility will be required during subsequent design stages.

4.2 Slope Stability

The majority of the site is flat, and therefore not considered susceptible to slope stability issues. However, development in close proximity to the northern slopes will require further consideration. Provisionally, a Building Restriction Line (BRL) set 10m back from the slope crest is recommended. It is understood that an esplanade reserve along the riverfront will be incorporated into future development plans, which will readily accommodate the setback zone.

A Building Restriction Line does not preclude development extending beyond; however, it would likely need to be accompanied by slope stabilization works such as in-ground retaining walls to ensure minimum factors of safety against instability as defined in the Auckland Council (2003) Code of Practice for Land Development and Subdivision are achieved.

The requirement for and position of the BRL will be assessed following quantitative stability analyses during subsequent design stages.

4.3 Coastal Erosion

Wave action is not expected in the Tamaki River, and therefore the risk of erosion affecting the proposed development is considered highly unlikely. Nevertheless, the proposed esplanade reserve and any requirements for a Building Restriction Line will ensure building platforms are not detrimentally affected by coastal erosion processes.

4.4 Building Foundations

Foundation selection will largely depend on structural loads. Medium- or high-rise structures are likely to require piling. Ground conditions are anticipated to be suitable for shallow foundations for smaller buildings (standalone or terraced housing) in general accordance with NZS 3604 or NZS 4229, subject to future investigation confirming the ground bearing capacity and soil reactivity class in line with AS 2870[iv] and NZ Building Code Clause B1[v].

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.

5 CLOSING

This assessment has been prepared for Highbrook Living Limited to support a Private Plan Change Request. In general, the site is considered geotechnically suitable for the new proposed land use.

Further geotechnical assessment and site-specific geotechnical investigations will be required to support resource and/or building consent application. Investigation locations should focus on any retaining walls and proposed building locations once a concept design is established.

Please contact Babbage Consultants Limited with any questions relating to this assessment.

Yours sincerely

Jordan Moll
Geotechnical Engineering Manager

Babbage Consultants Ltd

Attachments: Applicability and Limitations
Site Plan
Borehole Logs (NZGD)

REFERENCES

[i] Retrolens Aerial Photography, sourced from http://retrolens.nz and licensed by LINZ CC-BY 3.0 retrieved October 2021.

[ii] 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.

[iii] NZ Geotechnical Database: https://www.nzgd.org.nz/, retrieved October 2021.

[iv] AS 2870:2011 "Residential Slabs and Footings", 17 January 2011. Standards Australia: Sydney.

[v] Ministry of Business, Innovation and Employment (2019): *Acceptable Solutions and Verification Methods for New Zealand Building Code Clause B1 Structure*. Amendment 19, 28 November 2019. MBIE: Wellington.

APPLICABILITY AND LIMITATIONS

This report has been prepared solely for the benefit of Highbrook Living 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.

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CLIENT / PROJECT

Highbrook Private Plan Change

MAP TITLE

Map No 1. Site Plan

MAP REVISIONS

15/10/2021	Initial version by TT.

Legend

- Highbrook Site Boundary
- Contours Line (RL)
  - 0.5

NOTES
Aerial Images - LINZ Basemap

DISCLAIMER:
This map/plan is not an engineering draft.
This map/plan is illustrative only and all information should be independently verified on site before taking any action.

SCALE

1:3,000 @ A3

MAP NO.

64872#BEE02 01

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH3
Hole Location: Refer to Site Plan
SHEET 1 OF 3

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061.010

CO-ORDINATES 791996.28 mN, 408475.40 mE
R.L. 7.89 m
DATUM
DRILL TYPE: Edson MRA260
DRILL METHOD: Rotary
DRILL FLUID: Water
HOLE STARTED: 23/09/03
HOLE FINISHED: 24/09/03
DRILLED BY: Prodrill (Cameron)
LOGGED BY: D.L.R CHECKED:

GEOLOGICAL / ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE / WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
TOPSOIL			100%	OB				7			OL	M	MD				SILT, moist, dark brown, organics, roots.
PUMICEOUS ALLUVIUM (PUKETOKA FORMATION)		26/11/03	100%	OB					1		SP		L/MD				SAND, fine, pumiceous, light whitish brown. 1
			100%	OB													
			100%	SPT		0/0/1 N=1	1	6	2		Pt	W	F				PEAT, clayey, wet, high plasticity, dark brownish black, organic. 2
ESTUARINE ALLUVIAL SEDIMENTS (PUKETOKA FORMATION)			100%	TUBE													NO CORE RECOVERED.
			100%	OB		• 62/6kPa		5	3		MH		St				SILT, very sandy (fine to medium), wet, moderate to high plasticity, dark slightly greenish grey, minor carbonaceous particles, thickly bedded. 3
											CH						CLAY, silty, stiff, wet, highly plastic, dark grey, some carbonaceous particles.
						• 58/9kPa		4	4				F				- firm. 4
			100%	OB		• 27/3kPa		3	5								5
			100%	OB		• 39/6kPa											
			93%	OB		• 39/3kPa	2	2	6								NO CORE RECOVERED 6
			100%	TUBE									St				- stiff.
			100%	OB		• 56/12kPa		1	7								7
						• 53/9kPa											- sandy.
																	- silty.
			93%	OB		• 53/12kPa		0	8								8
						• 64/10kPa											
								-1	9		GP		L				9
											CH		St				100mm thick layer of GRAVEL, medium sub-angular clasts, light brown. CLAY, as 3.2m, stiff.
			87%	OB				-2	10		SP	S	L-MD				SAND, medium, saturated, dark grey, thinly bedded, minor carbonaceous laminations.

NZGD ID: BH_65553

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH3
Hole Location: Refer to Site Plan
SHEET 2 OF 3

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061.010

CO-ORDINATES 791996.28 mN, 408475.40 mE
R.L. 7.89 m
DATUM
DRILL TYPE: Edson MRA260
DRILL METHOD: Rotary
DRILL FLUID: Water
HOLE STARTED: 23/09/03
HOLE FINISHED: 24/09/03
DRILLED BY: Prodrill (Cameron)
LOGGED BY: D.L.R CHECKED:

GEOLOGICAL / ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
ESTUARINE ALLUVIAL SEDIMENTS (PUKETOKA FORMATION)						136/36kPa		-3	11		CH	S	VSt				CLAY, silty, stiff to very stiff, saturated, highly plastic, dark grey, some carbonaceous laminations, thinly bedded.
											SP		L				SAND, fine to medium, saturated, dark grey.
			28%	OB				-4	12		ML		St				SILT, sandy, stiff, saturated, moderately plastic, light bluish grey.
											SP		L				SAND, as 10.4m, recovered as very loose.
											Pt		F				PEAT, as 1.6m.
						• 145/80kPa		-5	13		SP		L				SAND, fine to medium, saturated, dark grey.
			40%	OB				-6	14		ML		F				SILT, very sandy, firm, moderately plastic, light bluish grey with some shiny speckles, possible uphole debris.
											ML		VSt				SILT, sandy, stiff to very stiff, saturated, moderately plastic, light bluish grey.
						• 110/34kPa		-7	15		SW		L/MD				SAND, fine, clayey, saturated, dark grey with black and white grains, thickly bedded.
			93%	OB				-8	16		MH		St				SILT, clayey, stiff, saturated, highly plastic, dark grey with minor shiny speckles.
						• 53/3kPa							VSt				- becomes very stiff.
						• 130/53kPa					SP		VSt/H/MD				SAND, medium, pumiceous, saturated, dark orangey yellow, lower contact at 25°.
			93%	OB				-9	17		MH						SILT, clayey, very stiff to hard, saturated, highly plastic, light bluish grey with minor shiny speckles.
																	- sandy.
								-10	18		CL						Grades to CLAY, very sandy, very stiff, saturated, dark grey, thinly bedded.
			0%	SPT		16/19/23 N=42											NO CORE RECOVERED
			100%	HQ3				-11	19		CH		H				CLAY, slightly silty, hard, wet, highly plastic, dark grey with minor shiny speckles.
																	- extremely weak.
KAAWA FORMATION			0%	SPT		11/20/30 fo 140mm N>50		-12	20								NO CORE RECOVERED

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH3
Hole Location: Refer to Site Plan
SHEET 3 OF 3

PROJECT: Waiouru Peninsula to SH1 Link | LOCATION: East Tamaki/Otahuhu | JOB No: 21061.010

CO-ORDINATES 791996.28 mN, 408475.40 mE | DRILL TYPE: Edson MRA260 | HOLE STARTED: 23/09/03 | HOLE FINISHED: 24/09/03

R.L. 7.89 m | DRILL METHOD: Rotary | DRILLED BY: Prodrill (Cameron)

DATUM | DRILL FLUID: Water | LOGGED BY: D.L.R | CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE / WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
KAAWA FORMATION			100%	HQ3		RQD=100%		-13	21		CL	SW	H/VD				MUDSTONE, SW, extremely weak, dark grey.
			0%	SPT		18/22/23 N=45											
			100%	HQ3		RQD=100%		-14	22								- 3J80°,Planar, smooth, tight, spacing 10mm - B0°,Planar, smooth, tight
			0%	SPT		50 for 110mm N>50		-15	23								- B0°,Planar, smooth, tight
			100%	HQ3		RQD=100%		-16	24								
								-17	25								**END OF BOREHOLE AT 24.0m** 32mm diameter UPVC standpipe installed in base of hole.
								-18	26								
								-19	27								
								-20	28								
								-21	29								
								-22	30								

NZGD ID: BH_65553

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH12
Hole Location: Refer to Site Plan
SHEET 1 OF 3

PROJECT: Waiouru Peninsula to SH1 Link		LOCATION: East Tamaki/Otahuhu	JOB No: 21061
CO-ORDINATES mN mE		DRILL TYPE: Edson MRA 260	HOLE STARTED: 10/10/03
		DRILL METHOD: Rotary	HOLE FINISHED: 13/10/03
R.L. m			DRILLED BY: Prodrill Ltd
DATUM		DRILL FLUID: Water	LOGGED BY: L.A CHECKED: A.S

GEOLOGICAL — ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
HARDFILL			100%	OB					0		GW	M	MD				GRAVELS to 40mm.
FILL											GM						GRAVELS, silty/light brown SILT with angular gravels to 25mm.
ALLUVIUM (PUKETOKA FORMATION)			100%	OB		• 107/50kPa	1		1		ML		VSt				SILT, slightly sandy, light grey and yellow with fibrous, decomposed roots. 1
		26/11/03	100%	TUBE							SW		L/MD				SAND, slightly silty, grey with organic flecks. 2
			60%	OB			2		2								
			100%	TUBE		• 59/22kPa			3								3
PUMICEOUS ALLUVIUM (PUKETOKA FORMATION)			5%	OB							SW		MD				-grey, pumiceous SAND, high core loss
			100%D0%	HQ3$PT		50/150mm	3		4		ML		H				SILT, slightly sandy, light grey, pumiceous. 4
ESTUARINE SEDIMENTS (PUKETOKA FORMATION)			100%	HQ3					5		ML		VSt				SILT, sandy, dark grey. 5 -with very thin clayey layers.
			100%	TUBE		• 78/34kPa	4		6		ML		St				SILT, clayey, grey. 6
			100%	OB		• 92/38kPa			7								7
			100%	TUBE		• 96/42kPa	5										
			100%	OB		• 110/31kPa			8				VSt				8 -with brown organic stain.
			100%	OB		• 116/42kPa			9								9
			100%	OB		• 116/27kPa					SW		L				-thin, coarse, grey SAND layer.
						• 113/26kPa			10		PT		VSt				PEAT, compressed amorphous, dark brown.

NZGD ID: BH_65560

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BOREHOLE LOG

BOREHOLE No: BH12
Hole Location: Refer to Site Plan
SHEET 2 OF 3

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061

CO-ORDINATES mN mE
DRILL TYPE: Edson MRA 260
HOLE STARTED: 10/10/03
HOLE FINISHED: 13/10/03
DRILL METHOD: Rotary
DRILLED BY: Prodrill Ltd

R.L. m
DATUM
DRILL FLUID: Water
LOGGED BY: L.A CHECKED: A.S

GEOLOGICAL / ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
ESTUARINE SEDIMENTS (PUKETOKA FORMATION)			100%	TUBE		• 73/34kPa			11		Pt	M	VSt				
			100%	OB		• 102/46kPa					ML		St				SILT, clayey, brown, organic stained. 11
			100%	OB		• 130/50kPa			12		ML		VSt				SILT, slightly clayey, slightly sandy, green. 12 -grey with green.
						• 194/104kPa											-grey with few organic flecks.
			100%	OB		• 107/34kPa			13								13
						• 124/38kPa											
			100%	OB		• 102/28kPa			14								14 -with sandy pockets.
						• 110/32kPa					MH						-very clayey layer.
			100%	OB		• 119/32kPa			15		SW						15 -very thin SAND layer.
						• 123/52kPa					ML						SILT, clayey, light green with few sandy pockets.
KAAWA FORMATION			100%	OB		• UTP			16		ML		H				16 SILT, slightly sandy, grey, compact, uncemented.
			100%	SPT		• UTP 21 32 20/70mm N>50	6						H/VD				-sandy with very thin clayey layers.
			100%	HQ3					17								17
									18								18
			100%	HQ3													-thin dark brown organic stained layer.
									19								19 -clayey with thin sandy layers.
			0%	SPT		32 50/140mm N>100											
									20								

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH12
Hole Location: Refer to Site Plan
SHEET 3 OF 3

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061

CO-ORDINATES mN
mE
R.L. m
DATUM

DRILL TYPE: Edson MRA 260
DRILL METHOD: Rotary
DRILL FLUID: Water

HOLE STARTED: 10/10/03
HOLE FINISHED: 13/10/03
DRILLED BY: Prodrill Ltd
LOGGED BY: L.A CHECKED: A.S

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	WEATHERING: MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 10 25 50 100 250	DEFECT SPACING (mm) 60 200 600 2000	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
KAAWA FORMATION			100%	HQ3					21		ML	M	H/VD				-grey with layers of faint brown organic stain.
			100%	HQ3					22								
			0%	SPT		50/110mm N>100											
									23								**END OF BOREHOLE AT 22.61m** 32mm dia uPVC standpipe installed in base of hole
									24								
									25								
									26								
									27								
									28								
									29								
									30								

NZGD ID: BH_65560

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH13
Hole Location: Refer to Site Plan
SHEET 1 OF 2

PROJECT: Waiouru Peninsula to SH1 Link | LOCATION: East Tamaki/Otahuhu | JOB No: 21061

CO-ORDINATES mN / mE | DRILL TYPE: Edson MRA 260 | HOLE STARTED: 13/10/03

R.L. m | DRILL METHOD: Rotary | HOLE FINISHED: 13/10/03

DATUM | DRILL FLUID: Water | DRILLED BY: Prodrill Ltd | LOGGED BY: L.A | CHECKED: A.S

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
TOPSOIL			100%	WASHOB		UTP					OL	M					SILT, organic.
FILL			100%	OB		102/46kPa					GM/ML		MD/VSt				SILT, gravelly, yellow with brick and concrete gravels to 0.3m.
		13/10/03	100%	OB		18/6kPa			1		ML						SILT, light brown and grey with occasional gravels to 25mm. 1
RECENT ALLUVIUM			0%	TUBE							ML		VS				SILT, dark grey with dark brown stain, slightly organic. -dark grey with pieces of decomposed wood. 2
			100%	OB		106/52kPa			2		ML		VSt				
			100%	OB		92/40kPa							St				SILT, clayey, grey. 3
ESTUARINE SEDIMENTS (PUKETOKA FORMATION)			100%	OB		98/50kPa	1										
			100%	TUBE					3								
			100%	OB		102/46kPa							VSt				-grey/green with minor organic stain. 4
			100%	OB		106/52kPa			4								
			100%	OB		108/44kPa	2										-organic stained. 5
			100%	TUBE					5								
			100%	OB		121/39kPa	3				OL						SILT, organic, dark brown. 6
			100%	TUBE					6		Pt						PEAT, amorphous, black, compressed. 7
			100%	OB		133/62kPa					ML						SILT, clayey, organic stained with flecks of decomposed wood. -grey. 8
						104/30kPa			7								
						148/65kPa					ML						
			100%	OB					8								SILT, slightly sandy, grey/green. -grey. 9
						103/74kPa											
						119/36kPa			9								
			100%	OB		116/41kPa			10								

NZGD ID: BH_65561

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH13
Hole Location: Refer to Site Plan
SHEET 2 OF 2

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061

CO-ORDINATES mN
mE
R.L. m
DATUM

DRILL TYPE: Edson MRA 260
DRILL METHOD: Rotary
DRILL FLUID: Water

HOLE STARTED: 13/10/03
HOLE FINISHED: 13/10/03
DRILLED BY: Prodrill Ltd
LOGGED BY: L.A CHECKED: A.S

GEOLOGICAL / ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE / WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
ESTUARINE SEDIMENTS (PUKETOKA FORMATION)			100%	OB		• 104/36kPa			11		ML	M	VSt				11
			100%	TUBE		• 132/44kPa	4										
			100%	OB		• 136/38kPa			12		ML						-brown, organic stained layer. 12
						• 163/52kPa											-grey/green.
			100%	OB		• 122/38kPa			13								-slightly clayey. 13
						• 163/70kPa											-occasional organic flecks.
			100%	OB		• 58/10kPa			14		SW		L				SAND, slightly silty, grey with shell pieces. 14
KAAWA FORMATION						• UTP	5				ML		H				SILT, grey, very compact.
			100%	SPT		17 26 25/90mm N>50			15								15
			100%	HQ3													-weakly cemented.
			100%	HQ3					16								16
		0%	0%	SPT		30 20/60mm N>100			17								17
			100%	HQ3													
			100%	HQ3			6 7		18								18
			100%	HQ3					19								19
		0%	0%	SPT		50/110mm N>100			20								END OF BOREHOLE AT 19.81m

SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.

NZGD ID: BH_65561

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH14
Hole Location: Refer to Site Plan
SHEET 1 OF 3

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061

CO-ORDINATES mN
mE
R.L. m
DATUM

DRILL TYPE: Edson MRA 260
DRILL METHOD: Rotary
DRILL FLUID: Water

HOLE STARTED: 14/10/03
HOLE FINISHED: 15/10/03
DRILLED BY: Prodrill Ltd
LOGGED BY: L.A CHECKED: A.S

GEOLOGICAL

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

TOPSOIL
FILL

ALLUVIUM (PUKETOKA FORMATION)

ESTUARINE SEDIMENTS (PUKETOKA FORMATION)

FLUID LOSS | WATER | CORE RECOVERY | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m)

26/11/03

CORE RECOVERY	METHOD	CASING
100%	OB	
100%	OB	
100%	OB	
40%	TUBE	
50%	OB	
60%	TUBE	
100%	OB	
100%	TUBE	
60%	OB	
100%	OB	
100%	TUBE	
100%	OB	
100%	OB	
100%	TUBE	

TESTS
- 124/46kPa
- 135/96kPa
- 111/52kPa
- 70/38kPa
- 80/26kPa
- 86/28kPa
- 104/30kPa
- 89/21kPa
- 104/26kPa
- 95/30kPa
- 111/30kPa
- 101/28kPa
- 126/60kPa

SAMPLES: 1, 2, 3, 4, 5

ENGINEERING DESCRIPTION

GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE / WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)
	OL	M	VSt			
	ML					
	ML		St			
	SW		L			
	ML		St			
	ML					
			VSt			
	Pt					

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

SILT, organic.

SILT, clayey, light brown and yellow with gravels to 25mm.

SILT, clayey, dark yellow.

-slightly clayey, light grey and yellow.

SILT, clayey, grey and yellow.

SAND, medium grained, grey.

SILT, pumiceous, light grey.

SILT, clayey, grey.

-with faint organic stain.

-organic stained with thin sandy layers.

PEAT, compressed, dark brown/black.

NZGD ID: BH_65562

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH14
Hole Location: Refer to Site Plan
SHEET 2 OF 3

PROJECT: Waiouru Peninsula to SH1 Link | LOCATION: East Tamaki/Otahuhu | JOB No: 21061

CO-ORDINATES mN / mE | DRILL TYPE: Edson MRA 260 | HOLE STARTED: 14/10/03

DRILL METHOD: Rotary | HOLE FINISHED: 15/10/03

R.L. m | DRILLED BY: Prodrill Ltd

DATUM | DRILL FLUID: Water | LOGGED BY: L.A | CHECKED: A.S

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
ESTUARINE SEDIMENTS (PUKETOKA FORMATION)			100%	OB		• 102/28kPa			11		ML	M	VSt				SILT, clayey, grey with organic stain.
						• 132/52kPa					ML						SILT, slightly clayey, slightly sandy, grey/green.
			100%	OB		• 121/60kPa			12								-grey.
						• 141/58kPa											
			100%	OB		• 110/40kPa			13								
						• 118/36kPa											
			100%	OB		• 124/38kPa			14								-green.
						• 118/42kPa											
			100%	OB		• 133/46kPa			15								-with flecks of decomposed wood.
						• 145/58kPa											
KAAWA FORMATION			100%	OB		• UTP					ML		H				SILT, slightly sandy, grey, compact.
						• UTP			16		SW		VD				SAND, slightly silty, weakly cemented, grey with white.
			0%	SPT		30 20/85mm N>100	6										
			100%	HQ3			7		17								-with very thin clay layers.
			100%	HQ3					18								
			0%	SPT		29 30 20/70mm N>100											
			100%	HQ3					19		ML		H				SILT, clayey, grey, weakly cemented.
											SW						-faint, organic stain.
									20								

SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH14
Hole Location: Refer to Site Plan
SHEET 3 OF 3

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061

CO-ORDINATES mN
mE
R.L. m
DATUM

DRILL TYPE: Edson MRA 260
DRILL METHOD: Rotary
DRILL FLUID: Water

HOLE STARTED: 14/10/03
HOLE FINISHED: 15/10/03
DRILLED BY: Prodrill Ltd
LOGGED BY: L.A CHECKED: A.S

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE / WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 200	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
			0%	SPT		21/150mm ~~50/130mm~~ N>100											**END OF BOREHOLE AT 20.28m** 32mm diameter UPVC standpipe installed in base of hole.

BORELOG_TT 21061.003.GPJ 04/12/03

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH103
Hole Location: Refer to Site Plan
SHEET 1 OF 3

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061.010

CO-ORDINATES 40.00 mN, 40.00 mE
R.L. 1.00 m
DATUM

DRILL TYPE: Barge Mounted
DRILL METHOD: Rotary
DRILL FLUID: Water

HOLE STARTED: 09/10/03
HOLE FINISHED: 09/10/03
DRILLED BY: Prodrill (Dave)
LOGGED BY: D.L.R CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
ESTUARINE MUD ESTUARINE SEDIMENTS PUKETOKA FORMATION			100%	OB		• UTP		0	1		CH ML	S	S H				CLAY, soft, saturated, highly plastic, dark grey, many shells and shell fragments.
			100%	OB													SILT, slightly clayey, hard, dark greenish grey, thinly bedded. 1
			0%	SPT		20 22 8 for 40mm N>50		-1	2		SP		D				SAND, fine, saturated, light greenish grey, weakly cemented. 2 - becomes medium grained.
			53%	HQ3				-2	3		CH		H				CLAY, hard, dark grey. 3 - Joint 70°,Planar, Smooth, Tight.
			100%	HQ3				-3	4		Pt						Grades over 100mm to PEAT, silty, saturated, moderately plastic, dark brown. 4
			100%	HQ3				-4	5		ML						SILT, slightly sandy, hard, dark brownish grey with few shiny speckles. - becomes sandy and dark greenish grey with shiny speckles. 5
			100%	HQ3				-5	6								6
			100%	HQ3				-6	7								7
			100%	HQ3							SP		D				SAND, fine to medium, saturated, dark grey with few shiny speckles.
			90%	HQ3				-7	8		CH		H				CLAY, silty, hard, saturated, highly plastic, dark grey. 8
			0%	SPT		4 7 28 N=35		-8	9		SP		D				SAND, fine to medium, saturated, dark greenish grey with shiny speckles and shell fragments throughout. 9
									10								

BORELOG_TT 21061.010.GPJ 04/12/03

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH103
Hole Location: Refer to Site Plan
SHEET 2 OF 3

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061.010

CO-ORDINATES 40.00 mN, 40.00 mE
DRILL TYPE: Barge Mounted
HOLE STARTED: 09/10/03
HOLE FINISHED: 09/10/03
DRILL METHOD: Rotary
DRILLED BY: Prodrill (Dave)
R.L. 1.00 m
DATUM
DRILL FLUID: Water
LOGGED BY: D.L.R CHECKED:

GEOLOGICAL / ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	ENGINEERING DESCRIPTION
KAAWA FORMATION			100%	HQ							SM	MW	VD				SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
			0%	SPT		50 for 130mm N>100		-10	11								SANDSTONE, medium, moderately weathered, extremely weak, dark grey with red black and white flecks, many shell fragments throughout, moderately thinly bedded.
			100%	HQ3		RQD = 100%		-11	12								-Joint 65°, Curved, Rough, Tight.
			95%	HQ3		RQD = 85%		-12	13								-Joint40°,Planar, Rough, Partly open (0.5mm) - very weak.
			100%	HQ3		RQD = 100%		-13	14								
			80%	HQ3		RQD = 90%		-14	15		CL	HW	H				MUDSTONE, highly weathered, extremely weak to hard, light grey.
			100%	HQ3		RQD = 90%		-15	16			MW	VD				SANDSTONE, as 10.2m, but medium to coarse grained. - weak and slightly weathered.
								-16	17			SW					- shells no longer present.
		40 l/min	80%	HQ3		RQD = 70%		-17	18								- Joint25°, slightly curved, Rough, Tight. - Joint75°, Curved) , Rough, Open (0.6mm) - Joint 30°, Slightly Curved, Rough, Tight. - Joint 60°, Slightly Curved, Rough , Open (0.6mm)
								-18	19								- artesian water flowing at 40 l/min. - Joint 65°, Slightly Curved , Rough, Tight.
									20								

NZGD ID: BH_65570

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH103
Hole Location: Refer to Site Plan
SHEET 3 OF 3

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061.010

CO-ORDINATES 40.00 mN, 40.00 mE
R.L. 1.00 m
DATUM
DRILL TYPE: Barge Mounted
DRILL METHOD: Rotary
DRILL FLUID: Water
HOLE STARTED: 09/10/03
HOLE FINISHED: 09/10/03
DRILLED BY: Prodrill (Dave)
LOGGED BY: D.L.R CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 20 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 60 200 600 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

			90%	HQ3		RQD = 90%		-20	21								
																END OF BOREHOLE AT 21m	
								-21	22								22
								-22	23								23
								-23	24								24
								-24	25								25
								-25	26								26
								-26	27								27
								-27	28								28
								-28	29								29
									30								

NZGD ID: BH_65570

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH104
Hole Location: Refer to Site Plan
SHEET 1 OF 3

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061.010

CO-ORDINATES 60.00 mN, 60.00 mE
R.L. 1.00 m
DATUM

DRILL TYPE: Edson MRA260
DRILL METHOD: Rotary
DRILL FLUID: Water

HOLE STARTED: 09/10/03
HOLE FINISHED: 10/10/03
DRILLED BY: Prodrill (Ant)
LOGGED BY: D.L.R CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION	WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
Engineered FILL			80%	OB				0	1		GW	W		TP				GRAVEL, fine, some coarse sand, wet, dark greyish brown.
			80%	OB														1
ESTUARINE/ALLUVIAL SEDIMENTS - PUKETOKA FORMATION			70%	OB							MH			VSt				SILT, minor coarse sand, very stiff, wet, highly plastic, light greyish green.
											SP			L				SAND, very fine, wet, light grey with orangey brown streaks, thinly bedded.
			70%	OB				-1	2		MH	S		VSt				SILT, slightly sandy, very stiff, saturated, highly plastic, dark grey with minor shell fragments. 2
						• 49/13kPa					CH			St				CLAY, silty, stiff, saturated, highly plastic, dark grey.
			100%	OB		• 57/11kPa		-2	3									3
						• 57/11kPa												
			90%	OB				-3	4		SW			D				SAND, coarse, silty, dark grey with rare light greenish grey pebbles.
											ML			H				SILT, sandy, hard, moderately plastic, dark greyish green, thinly bedded. 4
			0%	SPT		19 19 20 N=39		-4	5									5
			100%	HQ3														- becomes very sandy.
			47%	HQ3				-5	6		SW			D				SAND, fine, very silty, saturated, light brownish grey with minor shiny speckles, minor carbonaceous laminations. 6
								-6	7									7
			100%	HQ3							Pt							PEAT, sandy, saturated, not plastic, dark blackish brown.
								-7	8		MH			VSt				SILT, sandy, very stiff, saturated, highly plastic, light brownish grey, rare carbonaceous particles. 8
											ML							SILT, very sandy, very stiff, saturated, moderately plastic, light greenish grey with shiny speckles.
								-8	9									9
			100%	HQ3														- low plasticity.
									10									

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH104
Hole Location: Refer to Site Plan
SHEET 2 OF 3

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061.010

CO-ORDINATES 60.00 mN, 60.00 mE
R.L. 1.00 m
DATUM

DRILL TYPE: Edson MRA260
DRILL METHOD: Rotary
DRILL FLUID: Water

HOLE STARTED: 09/10/03
HOLE FINISHED: 10/10/03
DRILLED BY: Prodrill (Ant)
LOGGED BY: D.L.R CHECKED:

GEOLOGICAL									ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
ESTUARINE/ALLUVIAL SEDIMENTS - PUKETOKA FORMATION			100%	HQ3				-10 / 11		ML	S	VSt				
										MH						- high plasticity. - very clayey.
			100%	HQ3				-11 / 12								- slightly sandy.
								-12 / 13								
										MH		H				SILT, clayey, hard, saturated, highly plastic, light bluish grey with shiny speckles.
KAAWA FORMATION			100%	HQ3				-13 / 14		CH						CLAY, hard, saturated, highly plastic, dark grey, thinly bedded, minor carbonaceous laminations.
			100%	HQ3				-14 / 15								
								-15 / 16								
			100%	HQ3				-16 / 17								
										ML	MW					SILTSTONE, moderately weathered, extremely weak, dark grey, few carbonaceous laminations.
			100%	HQ3				-17 / 18								
								-18 / 19								- Joint 70°, Planar, Smooth, Tight. 19 - 19.6m - sandy - Joint30°, Planar, Rough, Tight.
								20								- Joint40°, Planar, Smooth, Tight.

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH104
Hole Location: Refer to Site Plan
SHEET 3 OF 3

PROJECT: Waiouru Peninsula to SH1 Link | LOCATION: East Tamaki/Otahuhu | JOB No: 21061.010

CO-ORDINATES 60.00 mN, 60.00 mE | DRILL TYPE: Edson MRA260 | HOLE STARTED: 09/10/03

DRILL METHOD: Rotary | HOLE FINISHED: 10/10/03

R.L. 1.00 m | DRILLED BY: Prodrill (Ant)

DATUM | DRILL FLUID: Water | LOGGED BY: D.L.R CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE / WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
			100%	HQ3							ML	MW	H				- very weak. - Joint 50°, Slightly Curved, Smooth, Tight.
			0%	SPT		50 for 90mm N>100		-20	21								
								-21	22								END OF BOREHOLE AT 21.1m
								-22	23								
								-23	24								
								-24	25								
								-25	26								
								-26	27								
								-27	28								
								-28	29								
									30								

SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.

NZGD ID: BH_65571

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH105
Hole Location: Refer to Site Plan
SHEET 1 OF 2

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061.010

CO-ORDINATES 80.00 mN, 80.00 mE
R.L. 1.00 m
DATUM

DRILL TYPE: Barge Mounted
DRILL METHOD: Rotary
DRILL FLUID: Water

HOLE STARTED: 10/10/03
HOLE FINISHED: 10/10/03
DRILLED BY: Prodrill (Dave)
LOGGED BY: D.L.R CHECKED:

GEOLOGICAL / ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE / WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	ENGINEERING DESCRIPTION
ESTUARINE MUD			0%	OB				0	1		CL	S	VS				CLAY, very soft, saturated, moderately plastic, dark grey, some shell layers.
ESTUARINE SEDIMENTS (PUKETOKA FORMATION)			100%	OB							ML	W	VSt/H				SILT, sandy, very stiff to hard, wet, moderate plasticity, light greenish grey with minor dark greenish grey mottles, thinly bedded. 1
			100%	OB				-1	2		SW		MD				SAND, fine, silty, wet, light greenish grey. 2 - minor fine gravel.
			100%	OB		• 181/33kPa		-2	3		ML		VSt/H				SILT, sandy, very stiff, wet, light brownish grey, very thinly bedded. 3
						• 156/39kPa		-3	4		CH						CLAY, slightly silty, very stiff, wet, highly plastic, light bluish grey. 4 - minor carbonaceous laminations.
			100%	OB				-4	5		Pt						PEAT, silty, very stiff, wet, dark brown/black. 5
											MH						SILT, clayey, very stiff, wet, highly plastic, light greyish brown, minor carbonaceous particles.
			100%	OB		• UTP		-5	6		SW		MD				SAND, silty, wet, light greenish grey with shiny speckles. 6
						• 89/33kPa		-6	7		MH		St				SILT, stiff to very stiff, wet, highly plastic, light greenish grey with shiny speckles. 7
			100%	OB		• 116/18kPa							VSt				
						• 121/22kPa		-7	8								- becomes sandy. 8
			100%	OB				-8	9		MH	S					SILT, clayey, very stiff, saturated, highly plastic, light grey. 9
KAAWA FORMATION											SW		MD				SAND, fine to medium, silty, dark greyish green, minor shell fragments.
			0%	SPT		28 22 for 45mm			10			MW	VD				SANDSTONE, medium, moderately weathered, very weak to weak, dark green with red and white flecks. Thin dark grey

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH105
Hole Location: Refer to Site Plan
SHEET 2 OF 2

PROJECT: Waiouru Peninsula to SH1 Link
LOCATION: East Tamaki/Otahuhu
JOB No: 21061.010

CO-ORDINATES 80.00 mN, 80.00 mE
R.L. 1.00 m
DATUM

DRILL TYPE: Barge Mounted
DRILL METHOD: Rotary
DRILL FLUID: Water

HOLE STARTED: 10/10/03
HOLE FINISHED: 10/10/03
DRILLED BY: Prodrill (Dave)
LOGGED BY: D.L.R CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
KAAWA FORMATION			80%	HQ3		N>100 RQD = 0		-10	11			MW	VD				beds with red and white flecks, beds oriented at many different angles up to 40°. - 10 - 11m - recovered as medium gravel. - dark grey with red, white and black flecks.
			90%	HQ3		RQD = 20		-11	12			SW					- 11 - 14m - many defects present. Orientations include 40°, 30°, 70°, 80°, all Slightly Curved, Rough, Open (0.6mm) - Joint 70°, Slightly Curved, Rough, Tight. - 12 - 14m - some coarse sand sized white and pinky grey grains. - minor fine gravel sized pebbles. - Joint 80°, Slightly Curved, Rough, Open (1mm) - vein of calcite, 75°, curved, 2mm thick.
			100%	HQ3		RQD = 0		-12	13								
								-13	14								**END OF BOREHOLE AT 14m** Piezometer installed. See sheet BH105P.
								-14	15								
								-15	16								
								-16	17								
								-17	18								
								-18	19								
									20								

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BOX 4241 PH 379-1200 AUCKLAND

LOG OF DRILLHOLE

PROJECT Otahuhu C Power Station

HOLE No. DH-OC2

FEATURE Foundations LOCATION Hellaby Road CO-ORDINATES N 692100 E 308587

ANGLE FROM HORIZONTAL 90° DIRECTION N/A R.L.COLLAR 8.63m

DESCRIPTION OF CORE (WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc.), STRATIGRAPHIC UNIT)	SPT	ROCK WEATHERING (SW, MW, HW)	RELATIVE STRENGTH (S, MS, MW, W)	TEST RESULT	CORE LOSS/ LIFT % (0 - 100)	DEPTH m	GRAPHIC LOG	SPACING OF NATURAL DEFECTS (cm) (50, 10, 5, 1 individual)	DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY- attitude, spacing, continuity, roughness, infilling, etc.) SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)	PIEZOMETER	DRILL WATER LOSS % (0-100)	DRILLING METHOD
Fill											
Fill/ Reworked Ash	1/2/1			N=3		1			Orange brown, CLAYEY SILT, moist, firm, some volcanic GRAVEL clasts up to 10mm diam. to white, mottled greyish SANDY SILT, some CLAY, firm to stiff, non-plastic, moist			HQTT
									some thin, brown organic zones, plastic			SPT
Fill - dredging, some estuarine sand and shell fragments, some inorganic (wire, concrete slabs) material, woody material	1/2/3			N=5		2			Brown, dark orange SILTY SAND, minor CLAY inclusions, moist, firm to stiff, volcanic clasts up to 20mm, shell fragments			HQTT
						3						SPT
						4			grades to fine to medium SAND, medium dense, moist, loose, soft to firm, minor brown SILT inclusions			HQTT
						5			Concrete slab			
									Tube Sample			Shelby
Tauranga Group Alluvium	1/1/2			N=3		6			Dark grey, SILT, some fine SAND, occasional GRAVEL clasts 15mm, firm			SPT
									Light grey, greenish SANDY SILT, slightly organic			HQTT
Peaty SILT	0/1/5			N=6		7			Dark brown CLAYEY SILT, organic, soft to firm, zone of peaty SILT Poor Recovery			
						8			Tube Sample			Shelby
									Grey SILT to fine SAND, moist, firm to stiff, woody material, mica			SPT
Peaty SILT						9			becomes peaty SILT, soft, wet, plastic, some coarse SAND			HQTT
									Tube Sample			Shelby
Peaty SILT						10			Dark grey, banded dark brown, peaty, organic SILT, thinly bedded, moist, plastic, firm to stiff, some mica specks			HQTT
	1/2/5			N=7		11						SPT
												HQTT
						12			some thin SANDY layers			
	0/2/3			N=5					becomes light grey CLAYEY SILT, with			SPT

Tauranga Group

DRILLER Drillwell

STARTED 10/1/01

FINISHED 10/2/01

DRILL Tractor

WEATHERING
UW - Unweathered
SW - Slightly weathered
MW - Moderately weathered
HW - Highly weathered
CW - Completely weathered
RW - Residually weathered

RELATIVE STRENGTH
VS - Very strong
S - Strong
MS - Moderately strong
MW - Moderately weak
W - Weak
VW - Very weak
EW - Extremely weak

PIEZOMETER LEGEND
DRILL CUTTINGS
BENTONITE SEAL
FILTER PACK
SLOTTED SCREEN

EXPLANATION
SPTs bag sampled
Push Tube Samples at
5.2 - 5.7m
7.7 - 8.2m
9.2 - 9.7m
UCS Sample at
21.7 - 21.9m
H_2O levels 12/10 → 3.9m

VANE SHEAR STRENGTH TEST
50/15 peak/remoulded
UTP - unable to penetrate
SUOW - sunk under own weight
Sst - Sandstone
Zst - Siltstone

PROJECT 25 120 02C
LOGGED BP
DATE 10/1/01
TRACED BP
CHECKED TND
LENGTH 23m
CORE BOXES 5
SHEET 1 OF 2

DRILLING METHOD
OB - 100mm Open Barrel
NQTT - NQ Triple Tube
HQTT - HQ Triple Tube
PQTT - PQ Triple Tube
SPT - Standard Penetration Test
PERC - Percussion (air) Drilling
RC - Reverse Circulation
Shelby - Tube Sample

Pilcon Miniature Shear Vane
DR No. Blade No.
Factor.
Vane Shear Strength per NZGS Guideline.

TONYS DRILLHOLE OTAHUHUC.GPJ TONY_LOG.GDT 17/10/01

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BOX 4241 PH 379-1200 AUCKLAND

LOG OF DRILLHOLE

PROJECT Otahuhu C Power Station | HOLE No. DH-OC2

FEATURE Foundations | LOCATION Hellaby Road | CO-ORDINATES N 692100 E 308587

ANGLE FROM HORIZONTAL 90° | DIRECTION N/A | R.L.COLLAR 8.63m

DESCRIPTION OF CORE (WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc.), STRATIGRAPHIC UNIT)	SPT	ROCK WEATHERING (SW, MW, HW)	RELATIVE STRENGTH (S, MS, MW, W)	TEST RESULT	CORE LOSS/ LIFT % (0 - 100)	DEPTH m	GRAPHIC LOG	SPACING OF NATURAL DEFECTS (cm) (50, 10, 5, 1)	DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY- attitude, spacing, continuity, roughness, infilling, etc.) / SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)	PIEZOMETER	DRILL WATER LOSS % (0-100)	DRILLING METHOD
Tauranga Group Alluvium						13			organic inclusions, stiff Dark grey, banded dark brown, peaty, organic SILT, thinly bedded, moist, plastic, firm to stiff, some mica specks			HQTT
Tamaki Sandstone: HW Tamaki SANDSTONE, Greenish grey SILTSTONE and fine SANDSTONE, thinly to moderately thinly bedded, minor carbonaceous material	4/6/10			N=16		14			Greenish grey, fine to medium SAND, very stiff, mica, some decomposed rootlets			SPT
												HQTT
	2/4/5			N=9		15			becomes alternating SILT and fine to medium SAND layers, thinly bedded, subhorizontal			SPT
						16			SILT beds become moderately thin, very stiff to hard			HQTT
	2/2/4			N=6		17			possible bioturbation infilled with coarse SAND			SPT
SW/MW Tamaki Sandstone, SANDY SILTSTONE with brown fine SANDSTONE in thin beds, very weak	20/52			N>50		18			Greenish blue SANDY SILT, occasional fine SAND, thinly bedded, some brown organic banding			HQTT
												SPT
SW Coarse SANDSTONE, very weak to weak, some brittle zones						19			Dark grey, coarse SAND, homogenous, well cemented, massive			HQTT
becomes weak	19/50			N>50		20						SPT
												HQTT
	22/39			N>50		21						SPT
						22						HQTT
SILTSTONE, weak	18/50			N>50					SILT bed, thin, subhorizontal			SPT
						23			End of Hole 23m			
						24						

DRILLER: Drillwell
STARTED: 10/1/01
FINISHED: 10/2/01
DRILL: Tractor

WEATHERING
UW - Unweathered
SW - Slightly weathered
MW - Moderately weathered
HW - Highly weathered
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PIEZOMETER LEGEND
DRILL CUTTINGS
BENTONITE SEAL
FILTER PACK
SLOTTED SCREEN

EXPLANATION
SPTs bag sampled
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PROJECT 25 120 02C
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TRACED BP
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LENGTH 23m
CORE BOXES 5
SHEET 2 OF 2

DRILLING METHOD
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