Tonkin & Taylor

Our Ref: 750321
14 May 2001

Azusa Sekkei Co., Ltd.
Mitsui-Seimei Gotanda Bldg.,
2-27-3 Nishi-Gotanda, Shinagawa-ku,
Tokyo 141-8536
Japan

Attention: Mr Koike

Dear Sir

Golf Link Rd, Vatuwaqa, Fiji
Geotechnical Investigation Report

1.0 Introduction

Tonkin & Taylor (Fiji) Ltd was engaged by Mr Yamamoto of Azusa Sekkei Co., Ltd. (Japan) to undertake geotechnical investigations for the development of the proposed Fiji Pharmaceutical Services Centre at Vatuwaqa, Suva, Fiji. The scope of the geotechnical investigations and analysis included the following:

- A general assessment of site conditions and local geology of the area
- Four hand-augered boreholes with in-situ strength testing and soil logging
- Two Scala Penetrometer Tests
- Four Machine Drilled boreholes and associated strength testing
- Engineering Analysis and preparation of the geotechnical report.

The purpose of the investigation work was to provide geotechnical recommendations and design parameters for the proposed building.

Our investigations concluded that the site is suitable for the proposed development. Foundation solutions include driven or bored piles, with shallow footings possible for lightly loaded foundations.

2.0 Site Conditions

The site proposed for development is a grassed, level area located on Golf Link Road, Vatuwaqa. The site is presently used as a playing field area and, at the time of inspection, had

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large amounts of surface water and ponding across the site. Golf Link Road borders the site to the east, while the western edge of the site is at the toe of an east-facing slope. Open channel drains surround the area (as shown on Drawing 750321-01) which are in turn connected to the sea.

The site and land bordering the site is noticeably higher (1.0m to 2.0m) in elevation than the surrounding land to the east and south. We understand that the site was previously a mangrove swamp that has been filled to create the playing field area. The fill is likely to have been placed 6 to 10 years ago and derives from excavations to construct nearby infrastructure.

3.0 Proposed Development

We understand the proposed development consists of the construction of a large warehouse structure approximately 66m by 80m in plan area, along with associated carparking to service the development. The warehouse is to be of steel beam and column construction, with steel panel walls and roof.

4.0 Published Geology

Published geology of the area[1] and information from the Tonkin & Taylor geotechnical database indicates that the dominant rock type in the Suva Peninsula area is Suva Marl, a sedimentary formation belonging to the Mendrausuthu Group (of Miocene – Pliocene age). The Suva Marl (known locally as soapstone in the past) comprises grey very weak thinly interbedded siltstone with thin mudstone, fine grained sandstone and thin sandy tuff beds. While the tuff beds are commonly found as weakly cemented silts and fine sands, the tuffs are in places coarser grained and the degree of cementation is also noted to vary. The wet marl was known as soapstone for its tendency to become slippery when wet. Geological maps also show deposits of alluvium to be present underlying regions along the eastern coast of the Suva Peninsula.

5.0 Site Investigations

The two-phase investigation involved field testing undertaken by an engineer from Tonkin and Taylor, followed by the drilling of four deep machine boreholes. Testing locations are shown on the attached Drawing 750321-01.

Four hand augered boreholes were put down at the locations indicated on the attached site plan. Undrained shear strength testing was undertaken at regular intervals and all soils encountered were logged. Borehole depths ranged from 3.5 to 3.9 m below existing ground level. Summary borehole logs are appended to this report. Subgrade CBR testing, comprising

[1] From R.B. Band (1968).

a total of two (2) Scala Penetrometer tests, was also carried out to the east of the proposed building footprint.

A total of 4 machine drilled boreholes were each drilled to a depth of 20 metres. Soil testing comprised Standard Penetration Tests (SPT) at regular intervals in the boreholes.

All soils have been described in accordance with the NZ Geomechanics guidelines on soil and rock description. Copies of the borehole logs are appended.

6.0 Subsurface Conditions

Field investigation data indicates the site is underlain by a layer of FILL, overlying recent alluvial sediments, and Suva Marl which becomes less weathered with depth. Our investigations generally confirm the published geology and records for the area.

FILL overlies the site to depths of 1.5 to 2.2 metres and comprises soils which are likely to have originated from a local borrow area of Suva Marl. The fill generally comprised red, brown and grey clays and silts, with weathered siltstone gravels generally in the range 1mm to 50mm in diameter. The fill was found to be stiff to very stiff, with undrained shear strength measurements of 180 to over 210 kPa, and SPT 'N' values of 1 to 6. Scala Penetrometer testing carried out in the fill found the upper layers (up to 0.5m) of fill to be loose / soft to firm with 0 to 1 blows per 50mm. Generally readings were in the range 2 to 4 blows per 50mm.

The alluvial sediments underlying the fill material were generally found to be soft to firm organic SILTS, with varying clay and sand content. The sediments were generally dark brown / grey, wet and odorous, with frequent root and decomposing wood inclusions throughout the stratum. Undrained shear strength measurements undertaken within the alluvial sediments ranged between 30 kPa and 80 kPa, with SPT 'N' values of 0 to 3. The alluvium was found to extend to a depth of 3 to 9 metres, deepening to the south-east of the site. Odorous grey sandy silts with varying organic content were encountered underlying the softer silts in HA3 and HA4 which are also likely to be alluvial materials.

A mantle of weathered Suva Marl soils (approximately 2 metres in thickness) comprising hard grey silts were encountered underlying the alluvium that exhibited undrained shear strength measurements of over 200kPa. These silts became harder with depth and graded to extremely weak to weak, unweathered Suva Marl comprising blue/grey SILTSTONE. The less weathered Suva Marl exhibited SPT 'N' values ranging from 10 to over 50, generally increasing with depth.

Groundwater levels were found to be between 0.5m and 1.2m depth.

7.0 Geotechnical Issues

7.1 General

Recommendations and opinions contained in this report are based on field tests at the four borehole locations. The nature and continuity of the subsoil away from these locations is inferred but it must be appreciated that actual conditions may vary from the assumed model.

7.2 Settlement

The alluvial sediments have a high water content, are compressible and typically significant consolidation settlement of the material can be expected.

We expect significant consolidation of the alluvial soils has already occurred following placement of the fill between 6 to 10 years ago. It is unknown whether an adequate drainage blanket has been constructed below the fill material, and the permeability of the underlying dense Suva Marl is likely be low; accordingly the rate of consolidation is likely to be low. We estimate that the alluvium could take between 5 and 15 years from the time of fill placement to reach 90% consolidation. Accordingly, in some areas the consolidation settlements will be essentially complete (i.e. where deep deposits of alluvium are present) while elsewhere consolidation settlement may be ongoing (albeit at a reducing rate).

Consolidation settlements in the order of 50mm may be expected following the construction of the warehouse. This assumes a 20kPa loading due to the development, and accounts for estimated ongoing settlement due to previous fill placement. Differential settlements are also likely to be high due to the variation in thickness of alluvium across the site but current investigation data does not allow this to be quantified.

Further analysis and laboratory testing of fill material could be carried out if specific settlement estimates are required.

7.3 Foundations

We expect settlement issues may require the use of piled foundations, which would need to be embedded in competent Suva Marl underlying the site. We expect the most appropriate solution to be driven steel piled foundations, given the varying depth of founding rock and potential for settlement of the alluvial sediments. Shallow foundations may be used for footings with light loads provided they are founded on an adequate depth of the hard / dense fill. In any case, we recommend the use of piles for heavily loaded foundations. Piled foundations may either be driven steel or precast concrete piles, or bored cast in-situ concrete piles. We consider that piled foundations can be founded in the hard / dense Suva Marl that occurs at depths of approximately 4 to 10 metres.

7.3.1 Driven Pile Design

We recommend the following end bearing and skin friction capacities for driven pile design.

Table 1
Driven Pile Design Parameters

Soil type	Ultimate end bearing capacity (kPa)	Ultimate skin friction (kPa)
Fill	-	-
Recent Alluvium	-	-
Suva Marl (N>50)	8,000	200

Appropriate Factors of Safety for driven piles are 3.0 and 2.2 when compared with working (Serviceability Limit State) loads or factored (Ultimate Limit State) loads respectively.

It is recommended that the pile capacity be designed in part with an appropriate pile driving formula (e.g. wave equation or Hiley) and confirmed on site by pile testing. Both end of drive and redrive tests should be undertaken on at least 10 percent of piles to confirm capacity and determine whether less conservative geotechnical strength reduction factors may be used for design. PDA (Pile Dynamic Analyser) equipment could be used with at least 2 tests on each pile type.

7.3.2 Bored Pile Design

An alternative pile foundation option involves bored cast in situ concrete piles. We expect casings would be required for excavation through the materials above the Suva Marl.

The following end bearing capacities and skin friction values are recommended for bored pile design (Table 2).

Table 2
Bored Cast In Situ Pile Design Parameters

Soil type	Ultimate end bearing capacity (kPa)	Ultimate skin friction (kPa)
Fill	-	-
Recent Alluvium	-	-
Suva Marl (N>50)	6,000	200

The piles should be embedded a minimum depth of 3D (D - diameter of pile) into the less weathered Suva Marl.

Based on the fieldwork results and adjacent site information, we expect that drilled pile lengths are likely to vary greatly due to the ground conditions. Pile lengths would need to be confirmed by site inspection. Appropriate safety factors to be applied to the design capacities are as follows:

For comparison with working loads (Serviceability Limit State), apply safety factors of 3.0 and 2.0 for end bearing and skin friction respectively.

For comparison with factored loads (Ultimate Limit State), apply safety factors of 2.2 and 1.5 for end bearing and skin friction respectively.

7.3.3 Shallow Foundations

Shallow foundations may be utilised provided an adequate depth of fill is proven to underlie the foundations. We recommend at least 1 metre of hard / dense fill should be present below the underside of shallow footings.

We recommend an Ultimate Bearing Capacity of 300 kPa for isolated shallow foundations, which corresponds to Factored (Ultimate Limit State) and Working (Serviceability Limit State) bearing capacities of 150 kPa and 100 kPa respectively.

Local strengthening of soft zones of subsoils may be required, and could be achieved by way of subexcavation and backfilling with engineered hardfill. We also recommend proof rolling across the full building footprint before the foundation construction commences to highlight potential soft spots.

Inspection will be required following excavation for the footings to confirm subsurface conditions and the above design bearing capacities.

7.4 Pavement Design

Our investigations indicate the upper 0.5m of fill material is loose. We recommend stripping of this loose material, followed by replacement with suitable hardfill compacted to engineered standards. Subgrade conditions should be checked when the site is opened up to confirm actual CBR values, and to ascertain the extent of stripping required.

For the car park pavement design following this remedial work, a preliminary subgrade CBR of 5% can be assumed.

8.0 Applicability

This report has been prepared for the benefit of Azusa Sekkei Co., Ltd. with respect to the particular brief given to us and may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

During construction, the site should be examined by an engineer competent to judge whether exposed subsoils are compatible with those inferred in this report. Tonkin & Taylor would be happy to provide this service and believe your project would benefit from the continuity.

We trust this report covers your present requirements. If you have any further queries please feel free to contact David Linton or the undersigned on 355-6000.

Yours faithfully
TONKIN & TAYLOR (FIJI) LTD

Nick Rogers for
Pratap Singh
MANAGING DIRECTOR

Appendices: Site Plan
Machine Borehole Logs
Hand Auger Borehole Logs
Scala Penetrometer Test Results
Photographs

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BOREHOLE LOG

BOREHOLE No: BH1
Hole Location: Refer to Site Plan
SHEET 1 OF 2

PROJECT: Warehouse Development	LOCATION: Golf Link Road, Vatuwaqa		JOB No: 750321
CO-ORDINATES mN / mE	DRILL TYPE: HQTT	HOLE STARTED:	09/05/01
	DRILL METHOD: Machine Auger	HOLE FINISHED:	14/05/01
R.L. m		DRILLED BY:	Radial Drilling
DATUM	DRILL FLUID: N/A	LOGGED BY: Radial	CHECKED: Dec L

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.
FILL						• 1 1 0 N=1			1		ML	M	F/St				CLAY, silty, firm to stiff, grey.
ALLUVIUM									2		OL		S				SILT, clayey, soft to firm, dark brown with roots/vegetation.
WEATHERED SUVA MARL			N/A	ROTARY CORE	N/A	• 10 10 13 N=23			3		ML	HW	St/H				SILT, clayey, stiff to hard, grey with soft pockets.
						• 8 14 17 N=31			4								
						• 9 13 12 N=25			5			MW	W				SILTSTONE [SUVA MARL] light grey to greenish grey, weak.
									6								
									7								
						• 7 11 15 for 100mm hammer bouncing			8								
									9								
									10								

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TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH1
Hole Location: Refer to Site Plan
SHEET 2 OF 2

PROJECT: Warehouse Development	LOCATION: Golf Link Road, Vatuwaqa		JOB No: 750321
CO-ORDINATES mN mE	DRILL TYPE: HQTT	HOLE STARTED:	09/05/01
	DRILL METHOD: Machine Auger	HOLE FINISHED:	14/05/01
R.L. m		DRILLED BY:	Radial Drilling
DATUM	DRILL FLUID: N/A	LOGGED BY: Radial	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	WEATHERING / MOISTURE 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.
			N/A	ROTARY CORE	N/A	• 8 14 20 N=34			11								11
						• 9 13 17 N=30			12								12
									13								13
									14								14
						• 15 8 for 50mm hammer bouncing			15			SW	MSt				becomes harder, fractured at times. 15
						• 14 for 30mm hammer bouncing			16								16
									17								17
									18								18
						• 15 5 for 50mm hammer bouncing			19								19
						• 8 17 10 for 50mm hammer bouncing											END OF BOREHOLE AT 20.0m

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TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH2
Hole Location: Refer to Site Plan
SHEET 1 OF 2

PROJECT: Warehouse Development	LOCATION: Golf Link Road, Vatuwaqa		JOB No: 750321
CO-ORDINATES mN / mE	DRILL TYPE: HQTT	HOLE STARTED:	15/05/01
	DRILL METHOD: Machine Auger	HOLE FINISHED:	16/05/01
R.L. m		DRILLED BY:	Radial Drilling
DATUM	DRILL FLUID: N/A	LOGGED BY: Radial	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	WEATHERING / MOISTURE 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.
FILL		23/04/01							0		ML	D/M	VSt				SILT/CLAY, stiff to very stiff, red/brown with grey gravels, disturbed appearance, light brown silt inclusions.
												M					
									1		GP		D				-becomes grey/brown gravel with large grey siltstone fragments and some grey SILT.
												W					
									2								
ALLUVIUM											OL	M	F				SILT with some clay (organic) with some sand, firm with root/wood inclusions, moist, odourous.
									3			W	VSt				-becomes very soft, sandy silt.
			N/A	ROTARY CORE	N/A	• 1 0 0 N=0											-very little sample recovered.
									4								-recovered as soft wet, dark brown silt.
									5								
						• 1 1 2 N=3			6								
									7								
						• N=3			8								
WEATHERED SUVA MARL									9			HW	VWk/MS				SILTSTONE [SUVA MARL] grey, weak to moderately strong.
									10								

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TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH2
Hole Location: Refer to Site Plan
SHEET 2 OF 2

PROJECT: Warehouse Development | LOCATION: Golf Link Road, Vatuwaqa | JOB No: 750321

CO-ORDINATES mN mE | DRILL TYPE: HQTT | HOLE STARTED: 15/05/01

R.L. m | DRILL METHOD: Machine Auger | HOLE FINISHED: 16/05/01

DATUM | DRILL FLUID: N/A | DRILLED BY: Radial Drilling | LOGGED BY: Radial | 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.

DEPTH (m)	TESTS	CORE RECOVERY	METHOD	CASING	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION
11	N=50	N/A	ROTARY CORE	N/A	VWk/MSt	
12	• N=25+					
13	• N=25+					
14						
15	• N=23					
16	• 9 20 for 100mm hammer bouncing				SW	
17						
18	• 16 15 for 80mm hammer bouncing					
19	• 15 19 3 for 20mm hammer bouncing					

END OF BOREHOLE AT 20.0m

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TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH3
Hole Location: Refer to Site Plan
SHEET 1 OF 2

PROJECT: Warehouse Development	LOCATION: Golf Link Road, Vatuwaqa		JOB No: 750321
CO-ORDINATES mN mE	DRILL TYPE: HQTT	HOLE STARTED:	16/05/01
		HOLE FINISHED:	17/05/01
R.L. m	DRILL METHOD: Machine Auger	DRILLED BY:	Radial Drilling
DATUM	DRILL FLUID: N/A	LOGGED BY: Radial	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.
FILL									0		ML	M	VSt				SILT, clayey, orange/brown/red.
											GP		D				-becomes grey with fine to coarse hard siltstone gravels.
									1			W					
						• 2 2 4 N=6			2		ML	M/W	H				SILT, hard, brown.
ALLUVIUM											OL		S/F				SILT, organic with some clay, soft to firm, frequent roots/wood inclusions, odourous.
									3				S				-becomes SILTY/SANDY. -becomes softer, lots of roots.
											ML		H				SILT, sandy, hard, odourous with trace of clay, with minor organic flecks.
WEATHERED SUVA MARL						• 1 1 8 N=9			4			HW	EWk/Wk				SILTSTONE [SUVA MARL] blue/grey, softer patches, broken.
		N/A							5								
			ROTARY CORE			• 9 11 12 N=23			6								SILTSTONE [SUVA MARL] light grey, weak.
					N/A				7								
						• 9 9 16 N=25			8								
									9								
									10								

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TONKIN & TAYLOR LTD

BOREHOLE LOG

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

PROJECT: Warehouse Development	LOCATION: Golf Link Road, Vatuwaqa		JOB No: 750321
CO-ORDINATES mN mE	DRILL TYPE: HQTT	HOLE STARTED:	16/05/01
		HOLE FINISHED:	17/05/01
R.L. m	DRILL METHOD: Machine Auger	DRILLED BY:	Radial Drilling
DATUM	DRILL FLUID: N/A	LOGGED BY: Radial	CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS: N/A
WATER: N/A
CORE RECOVERY: ROTARY CORE
METHOD: ROTARY CORE
CASING: N/A
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 2 5 10 20 50 100 200
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.

DEPTH (m)	TESTS	
11	8 10 14 N=24	
12	• 9 16 10 for 80mm hammer bouncing	-becoming stronger, light grey.
13		
14	• 14 7 for 70mm hammer bouncing	
15		
16	• 16 16 7 for 60mm hammer bouncing	
17		
18	• 12 14 16 for 120mm hammer bouncing	becomes dark grey.
19	• 13 15 21 for 140mm hammer bouncing	END OF BOREHOLE AT 20.0m

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BOREHOLE LOG

BOREHOLE No: BH4
Hole Location: Refer to Site Plan
SHEET 1 OF 2

PROJECT: Warehouse Development | LOCATION: Golf Link Road, Vatuwaqa | JOB No: 750321

CO-ORDINATES mN / mE | DRILL TYPE: HQTT | HOLE STARTED: 18/05/01

R.L. m | DRILL METHOD: Machine Auger | HOLE FINISHED: 19/05/01

DATUM | DRILL FLUID: N/A | DRILLED BY: Radial Drilling | LOGGED BY: Radial | 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.
FILL									0		ML	M	VSt				SILT, clayey, stiff to very stiff with fine to coarse weathered siltstone gravels, brown/grey/red.
									1			W					
ALLUVIUM											OL		VSt				SILT (organic) with minor clay and some sand, very soft, dark brown with fibrous rootlets and shell fragments.
						• 0 0 1 N=1			2			M					
WEATHERED SUVA MARL									3		ML	HW	H				SILT, clayey, hard, blue/grey.
						• 9 14 15 for 110mm hammer bouncing			4			MW					-becomes light grey.
		N/A		ROTARY CORE	N/A				5								
						• 6 15 19 N=34			6				EWk/Wk				-grading to extremely weak to weak SILTSTONE [SUVA MARL] light grey.
						• 7 11 12 N=23			7								
									8								
									9								
									10								

BORELOG 750321_M.GPJ 05-06-01

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH4
Hole Location: Refer to Site Plan
SHEET 2 OF 2

PROJECT: Warehouse Development		LOCATION: Golf Link Road, Vatuwaqa	JOB No: 750321
CO-ORDINATES mN / mE		DRILL TYPE: HQTT	HOLE STARTED: 18/05/01
		DRILL METHOD: Machine Auger	HOLE FINISHED: 19/05/01
R.L. m			DRILLED BY: Radial Drilling
DATUM		DRILL FLUID: N/A	LOGGED BY: Radial 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.
		N/A	ROTARY CORE	N/A		10 16 19 N=35			11								-becomes blue/green.
						• 9 for 100mm hammer bouncing			12								
									13								
						• 14 10 for 80mm hammer bouncing			14								-difficult to drill due to high strength.
									15								
						• 10 for 120mm hammer bouncing			16								
									17								
						• 11 13 14 N=27			18								
									19								
						• 9 10 for 90mm hammer bouncing											END OF BOREHOLE AT 20.0m

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TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: HA1
Hole Location: Refer to Site Plan
SHEET 1 OF 1

PROJECT: Warehouse Development	LOCATION: Golf Link Road, Vatuwaqa	JOB No:	750321
CO-ORDINATES mN mE	DRILL TYPE: 50mm diameter Auger	HOLE STARTED:	23/04/01
	DRILL METHOD: Handauger	HOLE FINISHED:	23/04/01
R.L. m		DRILLED BY:	D.G.L
DATUM	DRILL FLUID: N/A	LOGGED BY: D.G.L	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.
FILL		23/04/01	N/A	HANDAUGER	N/A	• UTP			1		ML	M	St/H				FILL, clay, silty, red/brown, stiff to very stiff with grey siltstone fragments.
						• 204+kPa							H				
											GP						-with fine course, hard siltstone gravels (orange to brown to grey) in a light brown silt matrix.
						• 204+kPa						W					-with sand, (fine to medium) and large dark grey siltstone (20mm diameter) fragments, wet. 1
						• 195/9kPa											
ALLUVIUM						• 79/47kPa			2		OL	M	VSft/S				SILT with some clay, soft to firm, dark brown with minor fine sand and fibrous root inclusions, organic, odourous. 2
						• 204+kPa			3		ML		H				SILT, grey, with minor clay, very stiff to hard with large siltstone fragments. 3
						• UTP											-with hard bands and bands of very stiff grey SILT.
						• 204+kPa											
						• UTP											-purple staining.
																	END OF BOREHOLE AT 4.0m

BORELOG 750321.GPJ 05/06/01

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: HA2
Hole Location: Refer to Site Plan
SHEET 1 OF 1

PROJECT: Warehouse Development		LOCATION: Golf Link Road, Vatuwaqa	JOB No: 750321
CO-ORDINATES	mN mE	DRILL TYPE: 50mm diameter Auger	HOLE STARTED: 23/04/01
		DRILL METHOD: Handauger	HOLE FINISHED: 23/04/01
R.L.	m		DRILLED BY: D.G.L
DATUM		DRILL FLUID: N/A	LOGGED BY: D.G.L 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
FILL		23/04/01	N/A	HANDAUGER	N/A	• 184/43kPa • 204kPa • UTP • UTP	2		1 2		ML GP	D/M M W	VSt D				SILT/CLAY, stiff to very stiff, red/brown with grey gravels, disturbed appearance, light brown silt inclusions. -becomes grey/brown gravel with large grey siltstone fragments and some grey SILT.
ALLUVIUM						• 73/17kPa • 29/17kPa • 47/17kPa • 73kPa	3 4 5		3 4		OL	M W	F VSt				SILT with some clay (organic) with some sand, firm with root/wood inclusions, moist, odourous. -becomes very soft, wet, sandy silt. -very little sample recovered. -recovered as soft wet, dark brown silt.
																	END OF BOREHOLE AT 4.5m Pushed Shear Vane to 5.2m. Still soft to firm.

BORELOG 750321.GPJ 05/06/01

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: HA3
Hole Location: Refer to Site Plan
SHEET 1 OF 1

PROJECT: Warehouse Development		LOCATION: Golf Link Road, Vatuwaqa	JOB No: 750321
CO-ORDINATES mN mE		DRILL TYPE: 50mm diameter Auger	HOLE STARTED: 24/04/01
		DRILL METHOD: Handauger	HOLE FINISHED: 24/04/01
R.L. m			DRILLED BY: D.G.L
DATUM		DRILL FLUID: N/A	LOGGED BY: D.G.L 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.
FILL		24/04/01	N/A	HANDAUGER	N/A	• UTP					ML	M	VSt				SILT, clayey, orange/brown/red.
						• UTP					GP		D				-becomes grey with fine to coarse, hard siltstone gravels.
						• UTP			1			W					1
						• UTP											
						• UTP											
						• UTP			2		ML	M/W	H				SILT, hard, brown. 2
ALLUVIUM											OL	M/W	S/F				SILT, organic with some clay, soft to firm, frequent roots/wood inclusions, odourous.
						• 73/44kPa											-becomes SILTY/SANDY.
						• 47/20kPa			3				S				-becomes softer, lots of roots. 3
						• UTP					ML		H				SILT, sandy, hard, odourous with trace of clay, with minor organic flecks.
						• UTP			4								END OF BOREHOLE AT 4.0m

BORELOG 750321.GPJ 05/06/01

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: HA4
Hole Location: Refer to Site Plan
SHEET 1 OF 1

PROJECT: Warehouse Development	LOCATION: Golf Link Road, Vatuwaqa		JOB No: 750321
CO-ORDINATES mN mE	DRILL TYPE: 50mm diameter Auger	HOLE STARTED:	25/04/01
		HOLE FINISHED:	25/04/01
R.L. m	DRILL METHOD: Handauger	DRILLED BY:	D.G.L
DATUM	DRILL FLUID: N/A	LOGGED BY:	D.G.L 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.
FILL		25/04/01				• UTP					ML	M	VSt				SILT, with some clay, very stiff with fine loose gravels, brown/grey/red.
						• UTP					GP						-mainly large (soapstone) gravels in a silt matrix (up to 40mm diameter)
						• UTP			1			W					
						• UTP											-very hard, likely to be a large rock.
ALLUVIUM			N/A	HANDAUGER	N/A	• 35/15kPa	6				OL		Vsoft				SILT, organic with minor clay and some sand, soft, dark brown with frequent fibrous root inclusions, odourous.
						• 44/26kPa											
						• 58/32kPa			2			M					
						• 80/29kPa											-with pockets of medium grain grey/blue sand.
						• UTP											
						• UTP	7		3		ML		H				SILT, hard, clayey, grey, slight odour.
						• UTP											-becomes very hard silt extremely weak rock.
																	END OF BOREHOLE AT 3.8m
									4								

BORELOG 750321.GPJ 05/06/01

TONKIN & TAYLOR LTD
19 MORGAN ST NEWMARKET AUCKLAND NEW ZEALAND
TELEPHONE (09) 3556000 FAX (09) 3070265

SCALA PENETROMETER LOG

Site : Golf Link Road, Vatuwaga **Job No. :** 750321

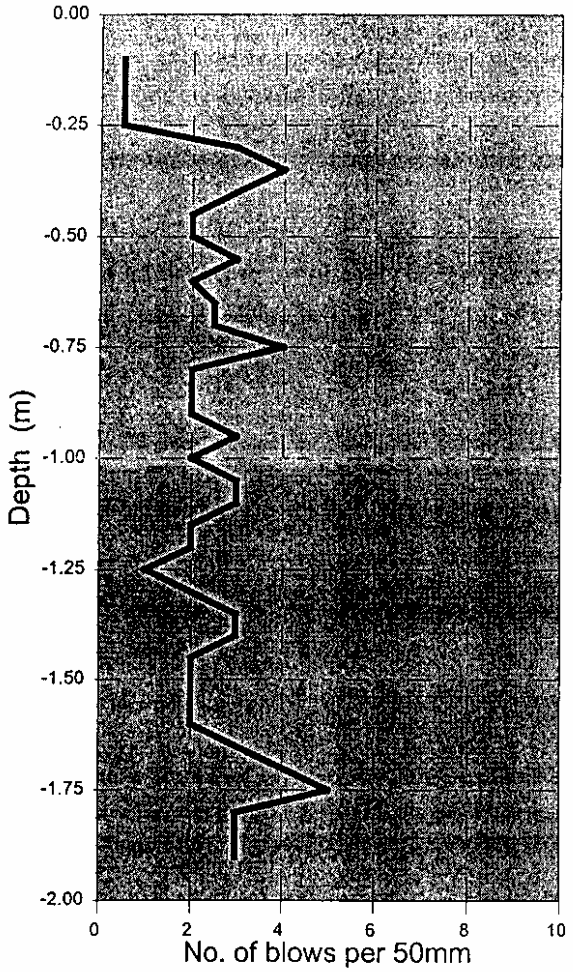
TEST METHOD USED :NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

Test No. : SC1

R.L. of ground surface : (m)
Depth from ground surface
to commencement of penetration: 0.0 (m)

Location plan : Refer Site Plan.

mm Driven	No. Blows	mm Driven	No. Blows
50	0	2050	
100	0.5	2100	
150	0.5	2150	
200	0.5	2200	
250	0.5	2250	
300	3	2300	
350	4	2350	
400	3	2400	
450	2	2450	
500	2	2500	
550	3	2550	
600	2	2600	
650	2.5	2650	
700	2.5	2700	
750	4	2750	
800	2	2800	
850	2	2850	
900	2	2900	
950	3	2950	
1000	2	3000	
1050	3	3050	
1100	3	3100	
1150	2	3150	
1200	2	3200	
1250	1	3250	
1300	2	3300	
1350	3	3350	
1400	3	3400	
1450	2	3450	
1500	2	3500	
1550	2	3550	
1600	2	3600	
1650	3	3650	
1700	4	3700	
1750	5	3750	
1800	3	3800	
1850	3	3850	
1900	3	3900	
1950		3950	
2000		4000	



Tested by: D.G.L Date : 25/04/01 Checked by : D.G.L Date : 08/05/01

Form No. F17T

TONKIN & TAYLOR LTD
19 MORGAN ST NEWMARKET AUCKLAND NEW ZEALAND
TELEPHONE (09) 3556000 FAX (09) 3070265

SCALA PENETROMETER LOG

Site : Golf Link Road, Vatuwaga **Job No. :** 750321

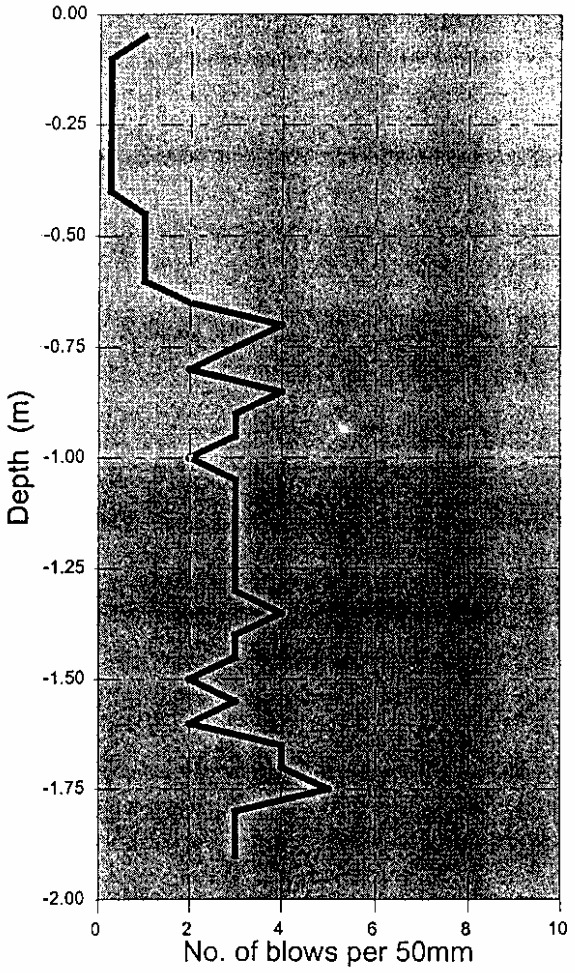
TEST METHOD USED :NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

Test No. : SC2

R.L. of ground surface : (m)
Depth from ground surface
to commencement of penetration: 0.0 (m)

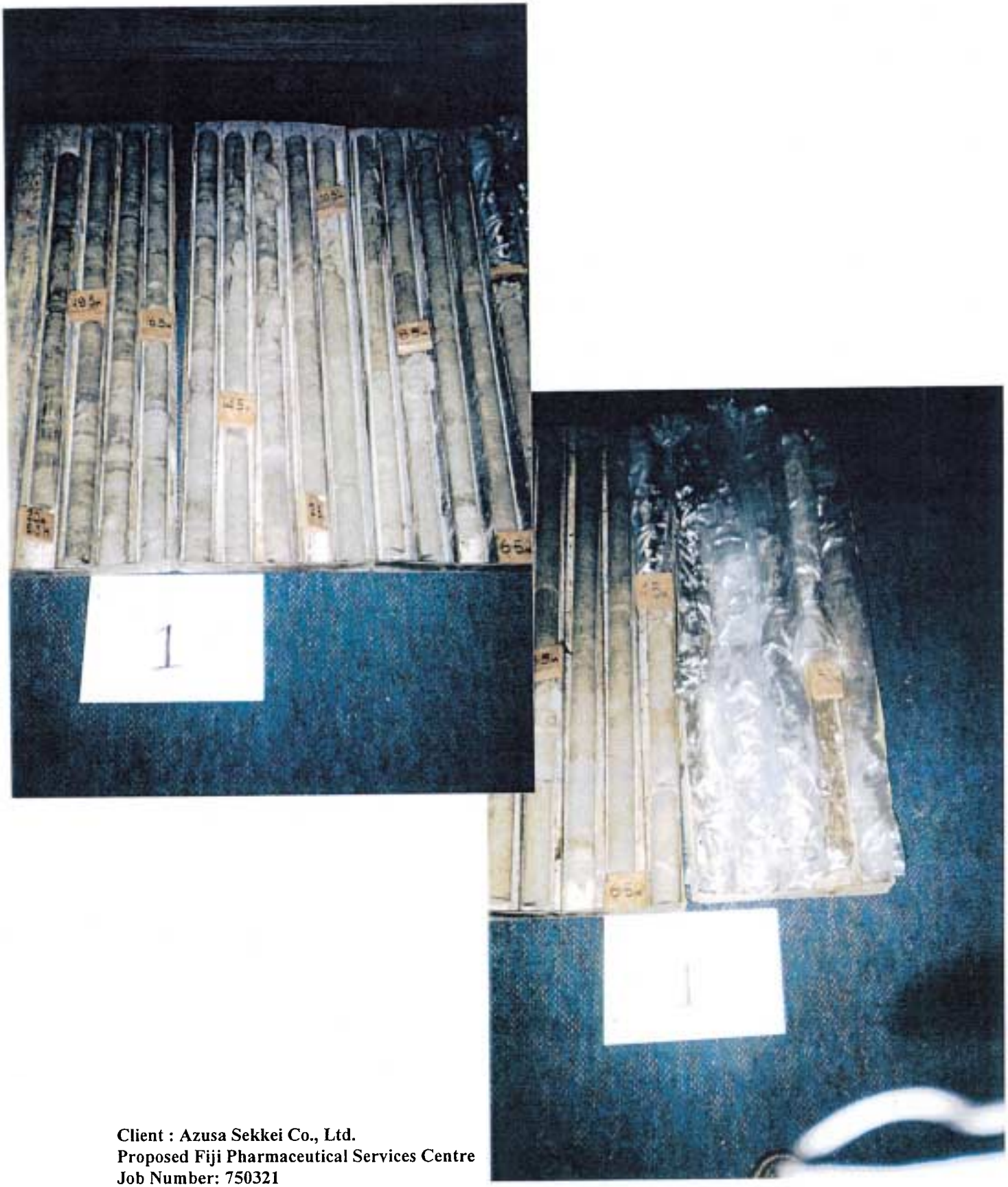
Location plan : Refer Site Plan.

mm Driven	No. Blows	mm Driven	No. Blows
50	1	2050	
100	0.25	2100	
150	0.25	2150	
200	0.25	2200	
250	0.25	2250	
300	0.25	2300	
350	0.25	2350	
400	0.25	2400	
450	1	2450	
500	1	2500	
550	1	2550	
600	1	2600	
650	2	2650	
700	4	2700	
750	3	2750	
800	2	2800	
850	4	2850	
900	3	2900	
950	3	2950	
1000	2	3000	
1050	3	3050	
1100	3	3100	
1150	3	3150	
1200	3	3200	
1250	3	3250	
1300	3	3300	
1350	4	3350	
1400	3	3400	
1450	3	3450	
1500	2	3500	
1550	3	3550	
1600	2	3600	
1650	4	3650	
1700	4	3700	
1750	5	3750	
1800	3	3800	
1850	3	3850	
1900	3	3900	
1950		3950	
2000		4000	



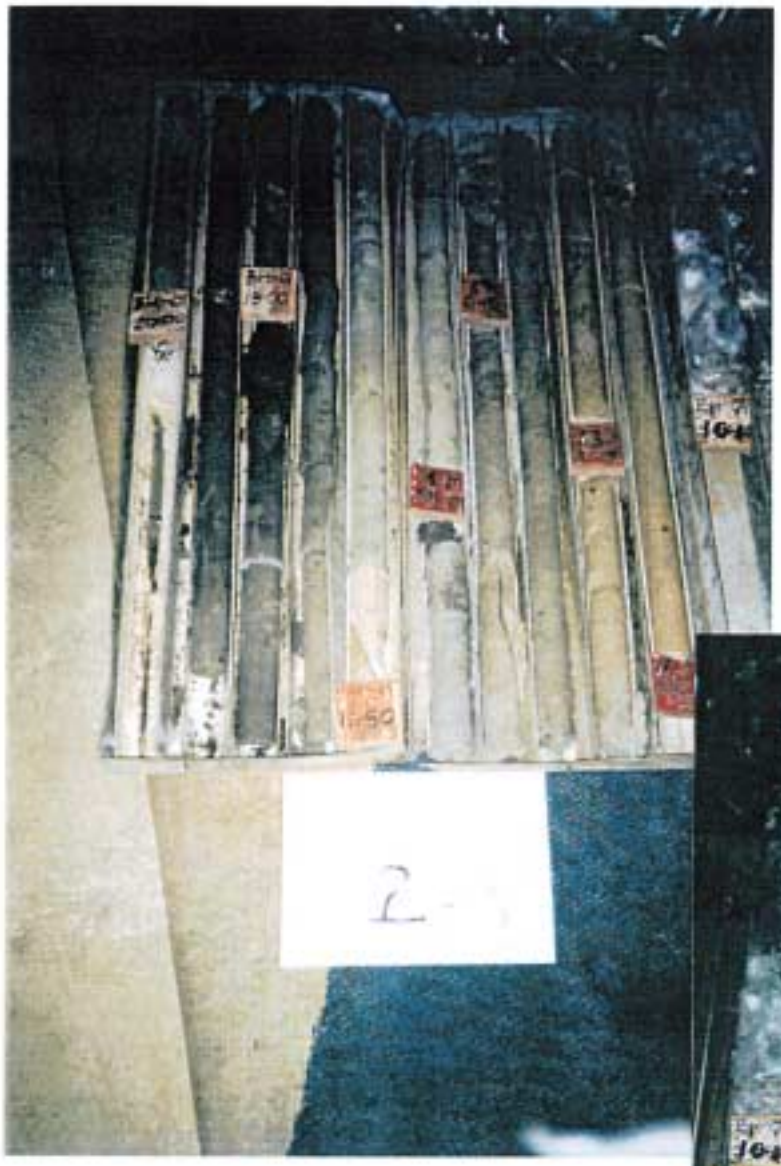
Tested by: D.G.L Date : 25/04/01 Checked by : D.G.L Date : 08/05/01

Form No. F17T



Client : Azusa Sekkei Co., Ltd.
Proposed Fiji Pharmaceutical Services Centre
Job Number: 750321

Tonkin & Taylor Ltd - Environmental & Engineering Consultants, 19 Morgan St, Newmarket, Auckland, New Zealand
PO Box 5271, Wellesley St, Auckland 1036, Ph: 64-9-355 6000, Fax: 64-9-307 0265, Email: auck@tonkin.co.nz, Website: www.tonkin.co.nz



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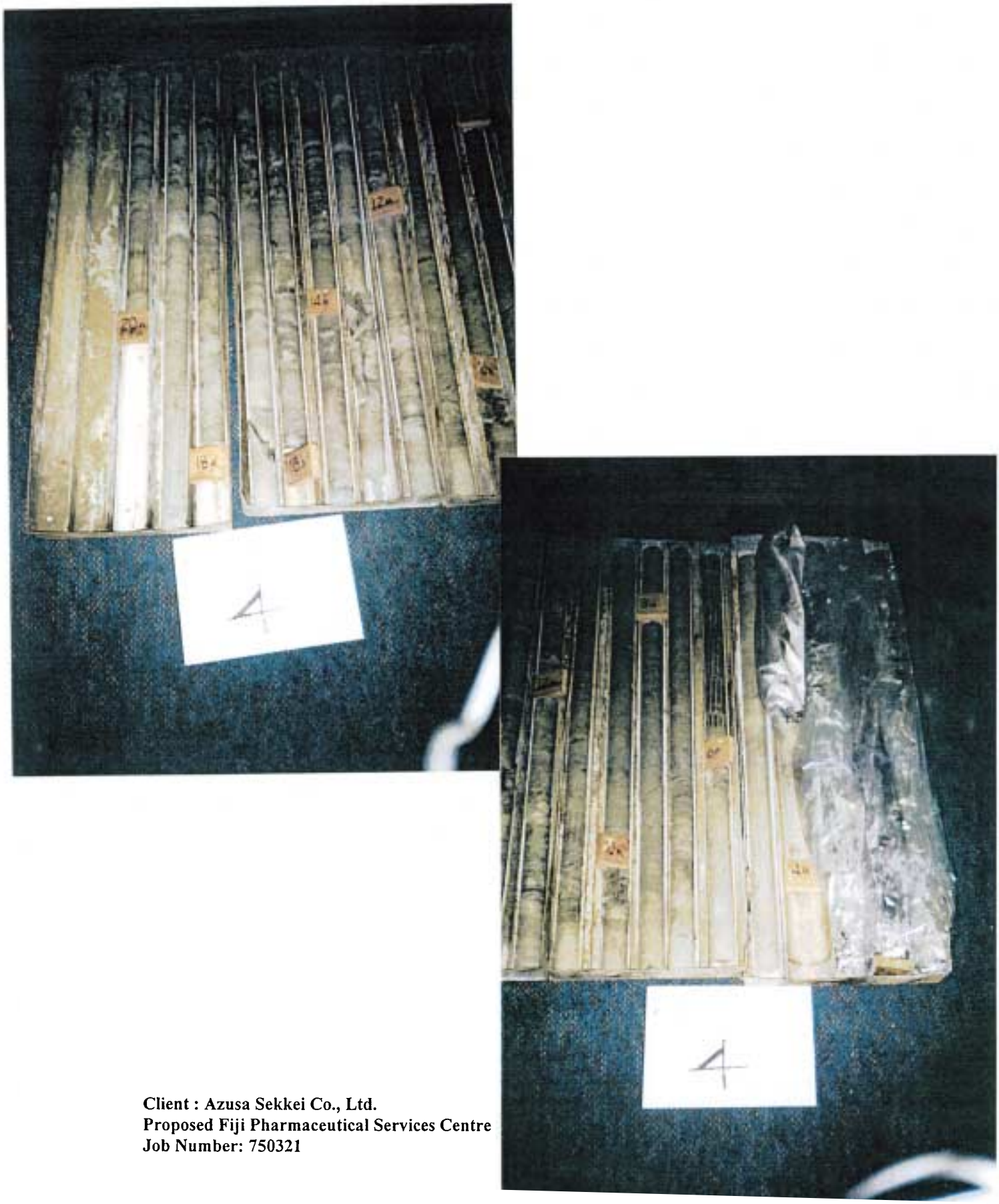

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