GEOTECHNIQUE®
PTY LTD

ABN 64 002 841 063

Job No: 20307/1
Our Ref: 20307/1-AA
22 February 2023

Northern Beaches Council
c/- Bonus + Associates
Level 1, 597 Darling Street
ROZELLE NSW 2039
Email: geoff.bonus@bonusarch.com

Attention: Mr G Bonus

Dear Sir

re: **Proposed Alterations and Additions**
Freshwater Surf Club - Core Street, Freshwater
Geotechnical Investigation

This report provides the results of a Geotechnical Investigation carried out at Freshwater Surf Club, Core Street, Freshwater, hereafter referred to as the site. This investigation was carried out in general accordance with Australian Standard AS1726 (Reference 1).

Following documents were provided by the client to understand the proposed development:

- 'Architectural Drawings' prepared by Bonus + Associates, Ref No.: 1104, DWG No.: DA200 to DA218, Rev P1, dated 8/12/2022.

We understand that the proposed development at the above site includes partial/selective demolition of walls, windows, doors, and floor slabs, for proposed alterations and additions to the existing club house. Major upgrade is extension of building via western side with new footing, walls, and floor slabs at all levels. The western boundary of the site requires approximately of 3.5m to 4.0m of excavation. This report provides geotechnical recommendations on design of floor slabs, footings, groundwater monitoring and retention support for the proposed development.

Background Information

Based on the Geological Map of Sydney (1:100,000), the site geology consists of Quaternary (Holocene) well sorted medium to fine marine sand predominantly coarse quartz sands with varying amounts of shell fragments. Hawkesbury Sandstone, comprising medium to coarse grained quartz sandstone, very minor shale and laminite lenses is present underlying the marine sand.

Reference to the Soil Landscape Map (1:100,000) of Sydney indicates that the landscape at the site belongs to the Narrabeen Group, which is characterised by beaches and coastal foredunes on marine sands. Beach plains with relief to 6m slopes <3%; foredunes with relief <20m and slope gradients up to 45%. Spinifex grassland/herbland to closed-scrub on foredunes. The sub-surface soils are usually deep (>200cm) Calcareous Sands on beaches, Siliceous Sands, and occasional calcareous compressed sands on foredunes.

Field Work

Field work for the geotechnical investigation was carried out on 25th January 2023 and consisted of the following:

- A walkover survey to assess general site conditions.
- Review services plans obtained from "Dial Before You Dig" to ascertain that underground services were not present at the proposed borehole locations.
- Scanning the proposed borehole locations for underground services to ensure that investigation works would not damage existing underground services. We engaged a specialist services locator for this purpose.
- Drilling three boreholes (BH1 to BH3) using an all terrain track mounted drilling rig, Comacchio Geo 205 fully equipped for geotechnical investigation. Borehole locations were nominated considering minimal damage to existing structure and away from buried services. All the boreholes were terminated on target depth. Approximate borehole locations are indicated on the attached Drawing No 20307/1-AA1. Borehole logs, Monitoring Well logs and explanatory notes are also attached.
- Carry out Standard Penetration Tests (SPT) in the boreholes at regular depth intervals, to assess the strength characteristics of the sub-surface soils.
- Install piezometer at three (3) locations for ground water monitoring for the site.
- Collect soil samples from boreholes for visual classification and laboratory testing.
- Measure depths to groundwater level in boreholes, if encountered.

Field work was supervised by a Geotechnical Engineer from this company, responsible for nominating the borehole locations, installing monitoring well, sampling and preparation of field logs.

Site Conditions

The site is rectangular in shape, consisting of two separate blocks connected to form Freshwater Surf Club. Eastern block is the oldest structure with two storied club house, which was extended to northwest block with three storey brick masonry building including a semi basement. The site is bounded by Freshwater beach from East beyond which is Pacific Ocean. From all the other sides is open park area with pedestrian walkway, grass bed with few scattered trees and bushes.

Southwest side has bushes and trees with sand dunes. Walking track leading to the beach. Beyond is Moore Road, flexible pavement.

West, open park area with scattered trees with recreation spot. Beyond with is Gore Street, two asphalt road.

North, extension of the open park space, beyond which is Kooloora Avenue and public car park area.

Ground surface elevation along the western site boundary is relatively flat ranging from RL7.6m to RL 8.0m AHD approximate. The site is gently sloping towards the oceans west to east.

Sub-surface profiles encountered in the boreholes are detailed in the attached borehole logs and summarised below in Table 1: Subsurface Profiles encountered in .

Table 1: Subsurface Profiles encountered in Boreholes.

Borehole No	Ground RL (m) AHD	Termination Depth (m)	Topsoil/Fill (m)	Natural Soil (m)	Bedrock (m)
BH1	7.634	6.45	0.0 - 1.0	1.0 - >6.45	NE
BH2	7.265	6.50	0.0 – 1.1	1.1 - >6.50	NE
BH3	7.898	6.00	0.0 – 2.0	2.0 - >6.0	NE

Note: NE = Not Encountered

Table 1 indicates that the sub-surface profile across the site comprises a sequence of topsoil and fill underlain by sandy natural soils. Fill comprises silty sand with clay and organic material. Fill is about 1.0m thick in boreholes BH1 and BH2 and about 2.0m thick in BH3. Bedrock was not encountered up to boreholes termination depths.

Groundwater level was not encountered during auger drilling until termination depth for BH1 and BH3. Seepage was encountered at 5.20m from existing ground level in BH2 location. Three monitoring well up to 6.0m depth were installed to for monitoring of groundwater table and carry out permeability tests. Groundwater was not detected in monitoring wells during monitoring period of about two weeks. It should be noted that the site is within 100m of Freshwater Beach and groundwater levels might vary due to rainfall, temperature, and other factors not evident during fieldwork.

Laboratory Testing

Representative soil samples recovered from the borehole were tested in NATA accredited laboratory of SGS Environmental Services, in accordance with relevant Australian Standards, to determine chemical properties including Electrical Conductivity (EC), pH and Sulphate.

Detailed results of chemical properties determination are attached, and summary is presented below in Table 2.

Table 2: Results of Chemical Properties Tests

Borehole No	Depth (m)	EC (µS/cm)	Resistivity (ohm cm)	pH	Sulphate (mg/kg)	Chloride (mg/kg)
BH1	3.0-3.45	110	8800	8.3	11	14
BH2	1.5-1.95	65	15000	8.4	1.5	1.1
BH2	4.5-4.95	65	15000	8.2	2.8	1.6
BH3	0.5-0.95	65	15000	8.3	2.1	1.2
BH3	3.0-3.45	38	26000	7.9	3.9	1.9
BH3	4.5-4.95	110	9400	7.2	20	9.3

Note: EC = Electrical Conductivity

Discussion and Recommendations

Soil Salinity

Soil salinity is generally assessed by measuring Electrical Conductivity (EC) of a soil sample made up of 1:5 soil water suspension. Thus, determined EC is multiplied by a factor varying from 6 to 23, based on the texture of the soil sample, to obtain Corrected Electrical Conductivity designated as ECe (Reference 3). Alternatively, ECe may be directly measured in soil saturation extracts. Soils are classified as saline if ECe of the saturated extracts exceed 4.0dS/m.

The criteria for assessment of soil salinity classes are shown in the following Table 3 (Reference 2).

Table 3: Criteria for Soil Salinity Classification

Classification	EC_e (dS/m)	Comments
Non-saline	<2	Salinity effects mostly negligible
Slightly saline	2 – 4	Yields of very sensitive crops may be affected
Moderately saline	4 – 8	Yields of many crops affected
Very saline	8 – 16	Only tolerant crops yield satisfactorily
Highly saline	>16	Only a few tolerant crops yield satisfactorily

Electrical conductivity (EC) values for representative soil samples are summarised in **Error! Reference source not found.**. For soils encountered across the site, appropriate multiplying factor is assumed to vary from 14 to 17. Even for a factor of 17, ECe for representative soil samples are estimated to be less than 2.0dS/m. Therefore, it is our assessment that the soils across the site are non-saline.

Australian Standard AS2870 (Reference 3) provides guidelines to assess for saline and sulphate soils. Table 4 below provides Salinity Classification based on ECe and Table 5 provides classification for sulphate soils.

Table 4: Exposure Classifications for Saline Soils

Electrical Conductivity, EC_e (dS/m)	Exposure Classification	Salinity Classification
<2	A1	Non-saline
2 – 4	A1	Slightly saline
4 – 8	A2	Moderately saline
8 – 16	B1	Very saline
>16	B2	Highly saline

Table 5: Exposure Classifications for Sulphate Soils

Sulphate expressed as SO_3		pH	Salinity Classification*	
In Soil (ppm)	In Groundwater (ppm)		Soil Condition A	Soil Condition B
<5000	<1000	>5.5	A2	A1
5000-10000	1000-3000	4.5-5.5	B1	A2
10000-20000	3000-10000	4.0-4.5	B2	B1
>20000	>10000	<4.0	C2	B2

Approximately 100ppm of SO_4 = 80ppm of SO_3
*Soil Condition A = high permeability soils (e.g. sands and gravels) which are below groundwater
*Soil Condition B = low permeability soils (e.g. silts and clays) and all soils above groundwater

Soils across the site are predominantly sandy and therefore appropriate Soil Condition is "Condition A". Therefore, based on laboratory test results presented in Table 2 and guidelines on Salinity Classifications presented in Table 4 and 5, the Salinity Classifications for the soils across the site generally belong to Class A1 or A2.

Therefore, we recommend that the proposed development works use construction materials (such as concrete, bricks) and construction methods appropriate for Class A2.

Aggressivity Classification

The Aggressivity Classification of soil and groundwater applicable to iron/steel and concrete piles, in accordance with Australian Standard AS2159 (Reference 3), are given below in Table 6 and Table 7.

Table 6: Aggressivity Classification for Steel/Iron

Chloride		pH	Resistivity (ohm cm)	Soil Condition A*	Soil Condition B#
In Soil (ppm)	In Water (ppm)				
<5000	<1000	>5.0	>5000	Non-aggressive	Non-aggressive
5000-20000	1000-10000	4.0-5.0	2000-5000	Mild	Non-aggressive
20000-50000	10000-20000	3.0-4.0	1000-2000	Moderate	Mild
>50000	>20000	<3.0	<1000	Severe	Moderate

*Soil Condition A = high permeability soils (e.g. sands and gravels) which are below groundwater
#Soil Condition B = low permeability soils (e.g. silts and clays) and all soils above groundwater

Table 7: Aggressivity Classification for Concrete

Sulphate expressed as SO_4		pH	Chloride in Water (ppm)	Soil Condition A	Soil Condition B
In Soil (ppm)	In Groundwater (ppm)				
<5000	<1000	>5.5	<6000	Mild	Non-aggressive
5000-10000	1000-3000	4.5-5.5	6000-12000	Moderate	Mild
10000-20000	3000-1000	4.0-4.5	12000-30000	Severe	Moderate
>20000	>10000	<4.0	>30000	Very Severe	Severe

As indicated above in this report, appropriate Soil Conditions is "Soil Conditions A". Therefore, based on laboratory test results presented in **Error! Reference source not found.** and guidelines on Aggressivity Classifications presented in Tables 6 and 7, the subsurface soil across the site is assessed to be Non-aggressive to steel piles and Mildly Aggressive to concrete piles.

Excavation Condition

It is anticipated that the proposed development will involve up to about 3.5m to 4.0m deep excavation on western boundary of the site as part of extension. Therefore, materials to be excavated are anticipated to comprise topsoil, fill and sandy marine soil. No rock excavation is anticipated. It is our assessment that excavation of topsoil, fill and marine soil can be achieved using conventional earthmoving equipment such as excavators and dozers.

Groundwater seepage was encountered at 5.2m at BH2 location only during the fieldwork. However, monitoring well indicates that the depth to groundwater level is likely to be more than 5.0m from existing ground level, deeper than depth of proposed excavation. Fluctuations in the level of groundwater and/or seepage might occur due to variations in rainfall, high tide and/or other factors not observed during fieldwork day. Therefore, it is unlikely to encounter groundwater inflow within the excavation depth. Minor groundwater inflow could be managed by a conventional sump and pump method. However, we suggest that a specialist contractor is engaged to design an appropriate dewatering system if significant groundwater inflow is encountered.

It is our assessment that removal of concrete slabs and excavation of fill can be achieved using conventional earthmoving equipment, such as excavators and dozers. No rock excavation is anticipated. Therefore, impact from ground vibration during site preparation is anticipated to be tolerable for existing structures in the vicinity of the site.

Fill Placement

We anticipate site preparation for the proposed development works will involve removal of loose sandy soil and replaced with controlled fill. The following procedures are recommended for placement of controlled fill, where required:

- Strip topsoil and existing fill materials separately for possible future uses or dispose off the site. Topsoils may be used in landscaping and fill materials may be selectively used in controlled fill.
- Strip loose sandy soil, anticipated to be 1.0m to 4.0m thick and stockpile separately for possible future uses in controlled fill. Observations in boreholes indicated that the depth to groundwater level varies from 5.0m to 5.5m. This is lower than the proposed bulk excavation, hence it is our opinion that groundwater might not be encountered during excavation up to bulk excavation level.
- Controlled fill should be placed in horizontal layers of 200mm to 250mm maximum loose thickness and compacted to a Minimum Dry Density Ratio (MDDR) of 98% Standard at moisture content within 2% of Optimum Moisture Content (OMC) for cohesive soils or Minimum Density Index of 75% for Sandy Soils.
- Fill placement should be supervised to ensure that materials quality, layer thickness, testing frequency and compaction criteria conform to the specifications. We recommend “Level 2” supervision, in accordance with Australian Standard AS3798- (Reference 4).

Batter Slopes and Retaining Structures

It is anticipated that the proposed development works will involve up to about 4.0m deep excavations along northwest, northeast, and southwest boundary of the existing building. The ground level at the west of the site is about RL 7.760m and proposed bulk excavation level is RL 4.0m AHD.

Proposed development involves excavation near the western boundary of the existing building to expose the existing footing, demolition of external wall for extension or retrofitting. As mentioned on Table 1, the site consists of fill layer followed by marine sand. Excavation should be battered for stability or retained by engineered retaining structures. If battering is the preferred option, the recommended batter slopes are as follows:

- Batter slope for short term stability during construction stage = 1 vertical to 2.0 horizontal.
- Batter slope for long term (permanent) stability = 1 vertical to 2.5 horizontal.

If batter slopes steeper than those recommended in the above are required, the excavation faces should be retained by engineered retaining structures. Appropriate retaining structures for the proposed development could comprise sheet pile or gravity wall.

Earth pressure distribution on such retaining walls is assumed to be triangular and estimated as follows:

$$p_h = \gamma kH$$

If the retaining walls are strutted, the earth pressure distribution on such retaining structures is assumed to be rectangular and estimated as follows:

$$p_h = 0.65\gamma kH$$

Where,

p_h	= Horizontal active pressure (kN/m^2)
γ	= Total density of materials to be retained (kN/m^3)
k	= Coefficient of earth pressure (k_a or k_o)
H	= Retained height (m)

Distribution of passive pressure, if retaining walls are embedded below the base of excavation, may also be assumed triangular and estimated as follows:

$$p_p = \gamma_1 k_p h$$

Where,

p_p	= Horizontal passive pressure (kN/m^2)
γ_1	= Wet density of materials below base of excavation (kN/m^3)
k_p	= Coefficient of passive earth pressure
h	= Wall embedment depth below base of excavation (m)

For design of flexible retaining structures, where some lateral movement is acceptable, an active earth pressure coefficient (k_a) 0.40 is recommended. If it is critical to limit the horizontal deformation of a retaining structure, use of an earth pressure coefficient at rest (k_0) 0.55 should be considered.

Above coefficients are based on the assumptions that ground level behind the retaining structure is horizontal and the retained material is effectively drained. If materials are subjected to groundwater pressure and other surcharge loads (structures and traffic in the vicinity of the site), additional earth pressures resulting from groundwater and surcharge loads should also be allowed for in the design of retaining structures.

Floor Slabs and Footings

We anticipate that the ground floor slabs for the proposed additions and alterations will be bearing on natural soils at the ground surface to match existing ground slabs or at base of about 4.0m deep basement excavations. Therefore, floor slabs for the proposed additions and alterations may be designed as ground bearing slabs or suspended slabs supported by footings. For design of floor slabs bearing on sandy natural soils at existing ground surface and at the base of excavation, we recommend a Modulus of Subgrade Reaction Value of 20kPa/mm and 30kPa/mm respectively.

Loading conditions from the proposed alterations and additions are not known. However, we consider that appropriate footings for the proposed structure would include shallow footings (pad and strip) founded at the base of excavation and/or screw piers or bored piers socketed into marine sand below the base of proposed excavation. The recommended allowable bearing pressures for design of footings are presented in the following Table 8.

Table 8: Recommended Allowable Bearing Pressures

Founding Material	Founding Depth from Ground Surface* (m)	Allowable End Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)
Possible Controlled Fill	0.3-2.0	100.0	Ignore
Natural Soil	2.0-4.0	125.0	Ignore
Natural Soil	4.0-6.0	150.0	Ignore
Natural Soils	>6.0	200.0	2.0

*Approximate only from existing ground surface

Design of footings should be based on allowable bearing pressures for the foundation materials and acceptable total and differential footing settlements. For footings founded in sandy soils, the total settlement is estimated to be about 2.0% of minimum footing dimension or pier diameter. The differential settlement is anticipated to be about half the total settlement.

As depths to sandy soils with recommended allowable bearing pressures could vary across the site and between boreholes, the founding depths of footing could also vary. Therefore, founding level at a specific location will have to be confirmed by an experienced Geotechnical Engineer, on the basis of assessment made during footing excavation or pier hole drilling. The engineer should ensure that the design strength of soil and rock are achieved.

Infiltration Assessment

Three (3) monitoring well were installed, one each in three boreholes, to observe the groundwater level. All the monitoring well were installed up to 6m depth, casing 3m and screen 3m sealed with cement grout and covered by Gatic Cover. No groundwater was measured in the monitoring well during the time of fieldwork on 25 January 2023. Site visit was conducted on 10 February 2023 to measure the monitoring well, but no groundwater encountered. Hence, it can be confirmed that the groundwater table is well below the bulk excavation level of proposed development. Thus, infiltration assessment could not be performed due to absence of water inside the monitoring well.

However, estimate of permeability of the sandy soils encountered at the site are soil presented below in Table 9.

Table 9: Approximate Hydraulic Conductivity

Founding Material	Founding Depth from Existing Ground Surface* (m)	Approximate hydraulic conductivity, K (m/sec)
Fill and Natural Soils	0.0 to 4.0	$1x10^{-4}$ to $1x10^{-5}$
Natural Soils	4.0 to >6.0	$1x10^{-3}$ to $1x10^{-4}$

*Varies as per borehole location, check borehole logs to obtain exact depth.

General

The site assessment and recommendations presented in this report are based on information from only three boreholes and site observation. Although we believe that the sub-surface profile presented in this report is indicative of the general profile across the site, it is possible that the sub-surface profile across the site could differ from that encountered in three boreholes. This is also the case with groundwater. Therefore, we recommend that this company is contacted for further advice if actual site conditions encountered during construction differ from those presented in this report.

If you have any questions, please do not hesitate to contact the undersigned.

Yours faithfully
GEOTECHNIQUE PTY LTD

For KUSHAL BAJRACHARYA
Geotechnical Engineer

INDRA JWORCHAN
Principal Geotechnical Engineer

Attached Drawing No 20307/1-AA1 – Borehole Location Plan
Borehole Logs and Explanatory Notes

References

1. *Australian Standard – Geotechnical Site Investigation, AS1726-1993.*
2. *Lillicrap, A and McGhie, S., Site Investigation for Urban Salinity, Department of Land and Water Conservation, 2002.*
3. *Standard Australia. (2009). AS2159-2009 Piling – Design & Installation.*
4. *Standard Australia. (2007). AS3798-2007 Guidelines on Earthworks for commercial and Residential Developments, 2007.*

Imagery ©2023 NearMap.com

LEGEND

- Borehole/Monitoring Well
- DCP Test

0 10 20 30 40 50m

Scale 1:1000

GEOTECHNIQUE ® PTY LTD

PO Box 880
Penrith NSW 2750
Tel: 02 4722 2700

e-mail:info@geotech.com.au
www.geotech.com.au

NOTES

1. Site features are indicative and are not to scale.
2. This drawing has been produced using a base plan provided by others to which additional information e.g test pits, borehole locations or notes have been added. Some or all of the plan may not be relevant at the time of producing this drawing

Bonus + Associates
Proposed Alterations and Additions
Freshwater Surf Club
Gore Street, Freshwater

Borehole/Monitoring Well and DCP Test Locations

Drawing No: 20307/1-AA1
Job No: 20307/1
Drawn By: MH
Date: 7 February 2023
Checked By: KB

File No: 20307-1
Layers: 0, AA1

GEOTECHNIQUE PTY LTD

engineering log - borehole

Client :	Bonus + Associates	**Job No. :**	20307/1
Project :	Proposed Alterations and Additions	**Borehole No. :**	BH1
Location :	Freshwater Surf Club Gore Street, Freshwater	**Date :**	25/01/2023
		Logged/Checked by:	KB

drill model and mounting : Geo Commacchio 205 **slope :** deg. **R.L. surface :** 7.634

hole diameter : mm **bearing :** deg. **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
AD/T						0			TOPSOIL: Silty Sand, fine to medium grained, pale brown, with fine to medium sub-rounded gravel, traces organic material				Topsoil
				SPT	N=17 3.9.12				FILL: Sand, fine to medium grained, pale brown (yellow), traces of fine to medium sub-rounded gravel @0.8m, concrete slab (100mm), auger refusal	M	MD		Fill Due to auger refusal, switch to coring
NMLC						1		SP	SAND, fine to medium grained, pale brown	M	L		Possible Natural Soil (Marine) @1.8m, switch to wash bore/tricon rotary flush
WB				SPT	N=9 3,3,6	2							
				SPT	N=10 3,4,6	3							
				SPT	N=25 13,14,11	4					MD		
	DRY			SPT	N=18 8,9,9	6							
						7			Borehole BH1 terminated at 6.45m Target Depth reached				
						8							
						9							

GEOTECHNIQUE PTY LTD

engineering log - borehole

Client : Bonus + Associates
Project : Proposed Alterations and Additions
Location : Freshwater Surf Club, Gore Street, Freshwater

Job No. : 20307/1
Borehole No. : BH2
Date : 25/01/2023
Logged/Checked by: KB

drill model and mounting : Geo 205 Comacchio **slope :** deg. **R.L. surface :** 7.265
hole diameter : mm **bearing :** deg. **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
AD/T						0			TOPSOIL: Silty Sand, fine to medium grained, dark brown/grey, trace of organic material	M			
									FILL: Sand, fine to medium grained, brown to pale brown, with fine to medium sub-rounded gravel and fill material	M	MD		Fill
				SPT	N=29 10,16,13								
						1		SP	SAND, medium grained, brown to yellow brown	D	MD		Natural
				SPT	N=22 4,12,10								
						2			@2.0m, dark brown and brown	M			
				SPT	N=7 2,3,4	3					L		
						4							
				SPT	N=10 3,4,6								
	▶ (5.2m)					5			@5.0m, dark brown	W			Seepage encountered at 5.2m (approx)
				SPT	N=10 2,3,7	6							
									Borehole BH2 terminated at 6.5m Target Depth reached				
						7							
						8							
						9							

GEOTECHNIQUE PTY LTD

engineering log - borehole

Client : Bonus + Associates
Project : Proposed Alterations and Additions
Location : Freshwater Surf Club, Gore Street, Freshwater

Job No. : 20307/1
Borehole No. : BH3
Date : 25/01/2023
Logged/Checked by: KB

drill model and mounting : Geo 205 Comacchio **slope :** deg. **R.L. surface :** 7.898
hole diameter : mm **bearing :** deg. **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
AD/T						0			TOPSOIL: Silty Sand, fine grained, dark grey and brown, traces of clay and organic material	D			Topsoil
				SPT	N=23 5,10,13				FILL: Silty Sand, fine to medium grained sand, pale brown, traces of clay and organics	M	MD		Possilbe Fill (controlled fill)
				SPT	N=6 2,3,3	1			FILL: Sandy Clay/Clay, medium plasticity, red-brown, fine to medium grained sand	M≥PL	F		
						2			SAND, fine to medium grained, pale brown (yellow)	M	L		Natural Soil (Marine)
				SPT	N=6 2,4,2	3			@3.0m, pale grey to grey				
				SPT	N=16 5,7,9	4			Clayey SAND, fine to medium grained, red brown mottled grey	M-W	MD		
						5			SAND, fine to medium grained, pale grey to pale brown	M			Approx (5.0-5.3)m seepage encountered
						6			Borehole BH3 terminated at 6.0m Target Depth reached				SPT not performed as sand caved
						7							
						8							
						9							

GEOTECHNIQUE PTY LTD

engineering log - monitoring well

Client :	Bonus + Associates	**Job No. :**	20307/1
Project :	Proposed Alterations and Additions	**Borehole No. :**	BH1
Location :	Freshwater Surf Club Gore Street, Freshwater	**Date :**	25/01/2023
		Logged/Checked by:	KB
drill rig :	Geo Commacchio 205	**R.L. surface :**	7.634 **AHD**

groundwater	samples	PID Reading (ppm)	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	MONITORING WELL Graphic Log	MONITORING WELL Description
			0			TOPSOIL: Silty Sand, fine to medium grained, pale brown, with fine to medium sub-rounded gravel, traces organic material		Concrete and sand Casing
	SPT	N=17 3.9.12				FILL: Sand, fine to medium grained, pale brown (yellow), traces of fine to medium sub-rounded gravel @0.8m, concrete slab (100mm), auger refusal		
			1		SP	SAND, fine to medium grained, pale brown		Bentonite
	SPT	N=9 3,3,6	2					Sand
	SPT	N=10 3,4,6	3					Screen
			4					
	SPT	N=25 13,14,11	5					
	SPT	N=18 8,9,9	6					
			7			Borehole BH1 terminated at 6.45m Target Depth reached		
			8					
			9					

GEOTECHNIQUE PTY LTD

engineering log - monitoring well

Client :	Bonus + Associates	**Job No. :**	20307/1
Project :	Proposed Alterations and Additions	**Borehole No. :**	BH2
Location :	Freshwater Surf Club Gore Street, Freshwater	**Date :**	25/01/2023
		Logged/Checked by:	KB
drill rig :	Geo 205 Comacchio	**R.L. surface :**	7.265 **AHD**

groundwater	samples	PID Reading (ppm)	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.
			0			TOPSOIL: Silty Sand, fine to medium grained, dark brown/grey, trace of organic material
						FILL: Sand, fine to medium grained, brown to pale brown, with fine to medium sub-rounded gravel and fill material
	SPT	N=29 10,16,13				
			1			
					SP	SAND, medium grained, brown to yellow brown
	SPT	N=22 4,12,10				
			2			@2.0m, dark brown and brown
			3			
	SPT	N=7 2,3,4				
			4			
	SPT	N=10 3,4,6				
			5			@5.0m, dark brown
▶						
			6			
	SPT	N=10 2,3,7				
						Borehole BH2 terminated at 6.5m Target Depth reached
			7			
			8			
			9			

MONITORING WELL

Graphic Log	Description
	Concrete and sand Casing
	Bentonite
	Sand
	Screen

form no. MW01 version 05 - 11/11

GEOTECHNIQUE PTY LTD

engineering log - monitoring well

Client : Bonus + Associates
Project : Proposed Alterations and Additions
Location : Freshwater Surf Club, Gore Street, Freshwater

Job No. : 20307/1
Borehole No. : BH3
Date : 25/01/2023
Logged/Checked by: KB

drill rig : Geo 205 Comacchio
R.L. surface : 7.898 **AHD**

groundwater	samples	PID Reading (ppm)	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION: soil type, plasticity or particle characteristic, colour, secondary and minor components.	MONITORING WELL: Graphic Log	MONITORING WELL: Description
			0			TOPSOIL: Silty Sand, fine grained, dark grey and brown, traces of clay and organic material		Gatic cover Concrete Casing
	SPT	N=23 5,10,13				FILL: Silty Sand, fine to medium grained sand, pale brown, traces of clay and organics		
			1			FILL: Sandy Clay/Clay, medium plasticity, red-brown, fine to medium grained sand		
	SPT	N=6 2,3,3						Bentonite
			2			SAND, fine to medium grained, pale brown (yellow)		Sand
	SPT	N=6 2,4,2	3			@3.0m, pale grey to grey		Screen
						Clayey SAND, fine to medium grained, red brown mottled grey		
			4					
	SPT	N=16 5,7,9				SAND, fine to medium grained, pale grey to pale brown		
			5					
			6			Borehole BH3 terminated at 6.0m Target Depth reached		
			7					
			8					
			9					

Log Symbols & Abbreviations (Non-cored Borehole Log)

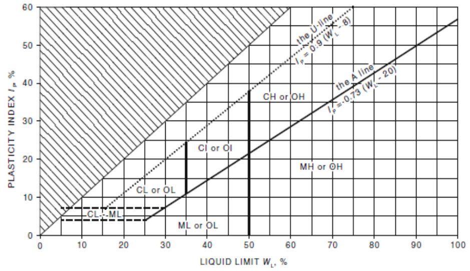
Log Column	Symbol/Value	Description
Drilling Method	V-bit	Hardened steel 'V' shaped bit attached to auger
	TC-bit	Tungsten Carbide bit attached to auger
	RR	Tricone (Rock Roller) bit
	DB	Drag bit
	BB	Blade bit
Groundwater	Dry	Groundwater not encountered to the drilled or auger refusal depth
		Groundwater level at depths shown on log
		Groundwater seepage at depths shown on log
Environment Sample	GP	Glass bottle and plastic bag sample over depths shown on log
	G	Glass bottle sample over depths shown on log
	P	Plastic bag sample over depths shown on log
PID Reading	100	PID reading in ppm
Geotechnical Sample	DS	Disturbed Small bag sample over depths shown on log
	DB	Disturbed Bulk sample over depths shown on log
	U_{50}	Undisturbed 50mm tube sample over depths shown on log
Field Test	N=10 3,5,5	Standard Penetration Test (SPT) 'N' value. Individual numbers indicate blows per 150mm penetration.
	N=R 10,15/100	'R' represents refusal to penetration in hard/very dense soils or in cobbles or boulders. The first number represents10 blows for 150mm penetration whereas the second number represents 15 blows for 100mm penetration where SPT met refusal
	DCP/PSP: 5 6 R/10	Dynamic Cone Penetration (DCP) or Perth Sand Penetrometer (PSP). Each number represents blows per 100mm penetration. 'R/10' represents refusal after 10mm penetration in hard/very dense soils or in gravels or boulders.
Classification	GP	Poorly Graded GRAVEL
	GW	Well graded GRAVEL
	GM	Silty GRAVEL
	GC	Clayey GRAVEL
	SP	Poorly graded SAND
	SW	Well graded SAND
	SM	Silty SAND
	SC	Clayey SAND
	ML	SILT / Sandy SILT / clayey SILT, low plasticity
	MI	SILT / Sandy SILT / clayey SILT, medium plasticity
	MH	SILT / Sandy SILT / clayey SILT, high plasticity
	CL	CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, low plasticity
	CI	CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, medium plasticity
	CH	CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, high plasticity
Moisture Condition Cohesive soils	M<PL	Moisture content less than Plastic Limit
	M=PL	Moisture content equal to Plastic Limit
	M>PL	Moisture content to be greater than Plastic Limit
Cohesionless soils	D	Dry - Runs freely through hand
	M	Moist - Tends to cohere
	W	Wet - Tends to cohere

Log Column	Symbol/Value	Term	Undrained shear strength, C_u (kPa)	Hand Penetrometer (Qu)
Consistency Cohesive soils	VS	Very Soft	≤12	<25
	S	Soft	>12 & ≤25	25 – 50
	F	Firm	>25 & ≤50	50 – 100
	St	Stiff	>50 & ≤100	100 – 200
	VSt	Very Stiff	>100 & ≤200	200 – 400
	H	Hard	>200	>400

Log Column	Symbol/Value	Term	Density Index, I_D (%)	SPT 'N' (blows/300mm)
Density Index Cohesionless soils	VL	Very Loose	≤15	≤5
	L	Loose	>15 & ≤35	>5 & ≤10
	M	Medium Dense	>35 & ≤65	>10 & ≤30
	D	Dense	>65 & ≤85	>30 & ≤50
	VD	Very Dense	>85	>50

Log Column	Symbol/Value	Description
Hand Penetrometer	100 200	Unconfined compressive strength (q_u) in kPa determined using pocket penetrometer, at depths shown on log
Remarks		Geological origin of soils
	Residual	Residual soils above bedrock
	Alluvium	River deposited Alluvial soils
	Colluvial	Gravity deposited Colluvial soils
	Aeolian	Wind deposited Aeolian soils
	Marine	Marine Soils

AS1726 : 2017– Unified Soil Classification System

Major Divisions		Particle size (mm)	Group Symbol	Typical Names	Field Identifications Sand and Gravels			Laboratory classification					
								Use the gradation of material passing 63mm for classification of fractions according to the criteria given in 'Major Divisions'	% Fines (2)	Plasticity of Fine Fraction	$C_u = D_{60}/D_{10}$	$C_c = (D_{30})^2/(D_{10}D_{60})$	Notes
OVERSIZE	BOULDERS	>200											
	COBBLES	63											
COARSE GRAINED SOIL (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm)	Coarse 19	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength				≤5	-	>4	between 1 and 3	1. Identify lines by the method given for fine grained soils
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength				≤5	-	Fails to comply with above		
		Medium 6.7	GM	Silty gravels, gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength				≥12	Below 'A' line or I_p<4	-	-	2. Borderline classifications occur when the percentage of fines (fraction smaller than 0.075mm size) is greater than 5% and less than 12%. Borderline classifications require the use of dual symbols e.g. SP-SM, GW-GC
		Fine 2.36	GC	Clayey gravels, gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength				≥12	Above 'A' line or I_p>7	-	-	
	SAND (more than half of coarse fraction is smaller than 2.36mm)	Coarse 0.6	SW	Well-graded sands, gravelly sands, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength				≤5	-	>6	between 1 and 3	
		Medium 0.21	SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength				≤5	-	Fails to comply with above		
			SM	Silty sands, sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength				≥12	Below 'A' line or I_p<4	-	-	
		Fine 0.075	SC	Clayey sand, sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength				≥12	Above 'A' line of I_p>7	-	-	
FINE GRAINED SOIL (more than 35% of soil excluding oversize fraction is less than 0.075mm)	SILT (0.075mm to 0.002mm) & CLAY (<0.002mm) Liquid Limit<50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	**Dry Strength**	**Dilatancy**	**Toughness**						
					None to low	Slow to rapid	Low		More than 35% passing 0.075mm	Below 'A' line			
			CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium to high	None to very slow	Medium			Above 'A' line			
			OL	Organic silts and organic silty clays of low plasticity	Low to medium	Slow	Low			Below 'A' line			
	SILT (0.075mm to 0.002mm) & CLAY (<0.002mm) Liquid Limit>50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Low to medium	None to slow	Low to medium			Below 'A' line			
			CH	Inorganic clays of medium to high plasticity, fat clays	High to very high	None	High			Above 'A' line			
			OH (1)	Organic clays of medium to high plasticity, organic silts	Medium to high	None to very slow	Low to medium			Below 'A' line			
	HIGHLY ORGANIC SOILS		Pt (1)	Peat and highly organic soils	Identified by colour, odour, spongy feel and generally by fibrous texture				Effervesces with H_2O_2				

Log Symbols & Abbreviations (Cored Borehole Log)

Log Column	Symbol / Abbreviation	Description	
Core Size		Nominal Core Size (mm)	
	NQ	47	
	NMLC	52	
	HQ	63	
Water Loss	——◀	Complete water loss	
	——◁	Partial water loss	
Weathering (AS1726:2017)	RS	Residual Soil	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported
	XW	Extremely Weathered	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
	HW	Highly Weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
	MW	Moderately Weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable, but shows little or no change of strength from fresh rock
	SW	Slightly Weathered	Rock is partially discoloured with staining or bleaching along joints but shows little or no change in strength from fresh rock
	FR	Fresh	Rock shows no sign of decomposition of individual minerals or colour changes
		Note : Where it is not possible to distinguish between HW and MW rock the term Distinctly Weathered (DW) may be used. DW is defined as 'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased by deposition of weathering products in pores'	
Strength (AS1726:2017)		**Term**	**Point Load Strength Index (I_{s50}, MPa)**
	VL	Very Low	≥0.03 ≤0.1
	L	Low	>0.1 ≤0.3
	M	Medium	>0.3 ≤1
	H	High	>1 ≤3
	VH	Very High	>3 ≤10
	EH	Extremely High	>10
Defect Spacing		**Description**	**Spacing (mm)**
		Extremely closely spaced	<20
		Very closely spaced	20 to 60
		Closely spaced	60 to 200
		Medium spaced	200 to 600
		Widely spaced	600 to 2000
		Very widely spaced	2000 to 6000
		Extremely widely spaced	>6000
Defect Description (AS1726:2017) Type			
	Pt	Parting	
	Jo	Joint	
	Sh	Sheared Surface	
	Sz	Sheared Zone	
	Ss	Sheared Seam	
	Cs	Crushed Seam	
	Is	Infilled Seam	
	Ews	Extremely Weathered Seam	
Macro-surface geometry	St	Stepped	
	Cu	Curved	
	Un	Undulating	
	Ir	Irregular	
	Pl	Planar	
Micro-surface geometry	Vro	Very Rough	
	Ro	Rough	
	Sm	Smooth	
	Po	Polished	
	Sl	Slickensided	
Coating or infilling	cn	clean	
	sn	stained	
	vn	veneer	
	cg	coating	

GEOTECHNIQUE PTY LTD

AS1726 – Identification of Sedimentary Rocks for Engineering Purposes

Grain Size mm		Bedded rocks (mostly sedimentary)								
More than 20	20	Grain Size Description				At least 50% of grains are of carbonate			At least 50% of grains are of fine-grained volcanic rock	
	6 2	RUDACEOUS		CONGLOMERATE Rounded boulders, cobbles and gravel cemented in a finer matrix Breccia Irregular rock fragments in a finer matrix		LIMESTONE and DOLOMITE (undifferentiated)	Calcirudite		Fragments of volcanic ejecta in a finer matrix Rounded grains AGGLOMERATE Angular grains VOLCANIC BRECCIA	SALINE ROCKS Halite Anhydrite
	0.6 0.2 0.06	ARENACEOUS	Coarse Medium Fine	SANDSTONE Angular or rounded grains, commonly cemented by clay, calcite or iron minerals Quartzite Quartz grains and siliceous cement Arkose Many feldspar grains Greywacke Many rock chips			Calcarenite		Cemented volcanic ash TUFF	Gypsum
	0.002	ARGILLACEOUS		MUDSTONE	SILTSTONE Mostly silt	Calcareous Mudstone	Calcisiltite	CHALK	Fine-grained TUFF	
	Less than 0.002			SHALE Fissile	CLAYSTONE Mostly clay		Calcilutite		Very fine-grained TUFF	
Amorphous or crypto-crystalline				Flint: occurs as hands of nodules in the chalk Chert: occurs as nodules and beds in limestone and calcareous sandstone						COAL LIGNITE
				Granular cemented – except amorphous rocks						
				SILICEOUS		CALCAREOUS			SILICEOUS	CARBONACEOUS
				SEDIMENTARY ROCKS Granular cemented rocks vary greatly in strength, some sandstones are stronger than many Igneous rocks. Bedding may not show in hand specimens and is best seen in outcrop. Only sedimentary rocks, and some metamorphic rocks derived from them, contain fossils Calcareous rocks contain calcite (calcium carbonate) which effervesces with dilute hydrochloric acid						

AS1726 – Identification of Metamorphic and Igneous Rocks for Engineering Purposes

Obviously foliated rocks (mostly metamorphic)		Rocks with massive structure and crystalline texture (mostly igneous)						Grain size (mm)
Grain size description			Grain size description	Pegmatite			Pyrosenite	More than 20 20
COARSE	GNEISS Well developed but often widely spaced foliation sometimes with schistose bands Migmatite Irregularly foliated: mixed schists and gneisses	MARBLE QUARTZITE Granulite HORNFELS Amphibolite Serpentine	COARSE	GRANITE These rocks are sometimes phorphyritic and are then described, for example, as porphyritic granite	Diorite	GABBRO	Peridorite	6 2
MEDIUM	SCHIST Well developed undulose foliation; generally much mica		MEDIUM	Micorgranite These rocks are sometimes phorphyritic and are then described as porphyries	Microdiorite	Dolerite		0.6 0.2 0.06
FINE	PHYLLITE Slightly undulose foliation; sometimes 'spotted' SLATE Well developed plane cleavage (foliation)		FINE	RHYOLITE These rocks are sometimes phorphyritic and are then described as porphyries	ANDESITE	BASALT		0.002 Less than 0.002
	Mylonite Found in fault zones, mainly in igneous and metamorphic areas			Obsidian	Volcanic glass			Amorphous or cryptocrystalline
CRYSTALLINE				Pale<-->Dark				
SILICEOUS		Mainly SILICEOUS		ACID Much quartz	INTERMEDIATE Some quartz	BASIC Little or no quartz	ULTRA BASIC	
METAMORPHIC ROCKS Most metamorphic rocks are distinguished by foliation which may impart fissility. Foliation in gneisses is best observed in outcrop. Non-foliated metamorphics are difficult to recognize except by association. Any rock baked by contact metamorphism is described as 'hornfels' and is generally somewhat stronger than the parent rock Most fresh metamorphic rocks are strong although perhaps fissile			IGNEOUS ROCKS Composed of closely interlocking mineral grains. Strong when fresh; not porous Mode of occurrence : 1 Batholith; 2 Laccoliths; 3 Sills; 4 Dykes; 5 Lava Flows; 6 Veins					