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Report on
Geotechnical and Acid Sulfate Soil Assessment

Gosford RSL Club Redevelopment
2-22 Yallambee Ave, West Gosford

Prepared for
Gosford RSL Club

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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Report on Geotechnical and Acid Sulfate Soil Assessment
Gosford RSL Club Redevelopment
2-22 Yallambee Ave, West Gosford

1. Introduction

This report presents the results of a geotechnical and acid sulfate soil assessment undertaken for the Gosford RSL Club Redevelopment at 2-22 Yallambee Ave, West Gosford. The investigation was commissioned in an email dated 18 January 2018 received from Brendan Fisher of APP Corporation Pty Ltd on behalf of Gosford RSL Club and was undertaken in accordance with Douglas Partners Pty Ltd (DP)'s proposal CCT170145 dated 12 January 2018.

It is understood that redevelopment of the Gosford RSL is proposed and this will initially comprise the construction of a new building to the north of the existing club building. The proposed building will have a footprint of approximately 3,800 m^2 and will occupy an area that is currently occupied by an on-grade carpark and the 'Galaxy Motel Reception Building'.

The new building is understood to comprise three storeys, with part of the ground level comprising an on-grade carpark. Due to potential flooding, the area of the proposed development will also be raised, and it is understood that this will require the placement of between 0.5 m and 1.0 m of filling over the entire area.

In addition to the development within the northern portion of the Gosford RSL site, following completion of the proposed building, it is understood that the existing club building would be demolished to make way for a new on-grade carpark. Based on information provided by Lindsay Dynan, civil and structural designers for the project, the proposed carpark is intended to comprise a similar flexible pavement to that currently present in the northern carpark.

The aim of the investigation was to assess the subsurface soil and groundwater conditions at the test locations in order to provide information on the following:

- acid sulfate soil (ASS) conditions;
- footing design parameters;
- subgrade design parameters;
- thickness design for both flexible (asphalt) and rigid (concrete) pavements; and
- Comment on site preparation and earthworks, including placement of additional filling to raise the site above flood levels.

The investigation included the drilling of five boreholes and five cone penetration tests (CPT), followed by laboratory testing of selected samples. The details of the field work are presented in this report, together with comments and recommendations on the issues listed above.

A contamination assessment was also completed concurrently and reported separately. This report and the contamination assessment will be used to support the development application (DA).

2. Site Identification and Location

2.1 Site Identification and Information

The site comprises part of 2-22 Yallambee Avenue, West Gosford (Lot 22 of DP1201808). The site is zoned B5 Business Development.

The site (development area) covers an area of 7,000 m^2 (0.7 ha).

2.2 Site Location

The site location and boundaries are shown on Drawings 1 and 2, Appendix A.

The site is bounded by the Central Coast Highway to the north and commercial properties north of the Highway, public recreational space and the Narara Creek to the east, the existing Club building and carpark to the south, and Yallambee Avenue and then commercial properties to the west. Broadly, the site comprises the northern carpark of the Gosford RSL club together with part of the 'Galaxy Motel' which is immediately to the east of the carpark.

The site is located within the Local Government Area of Central Coast Council, formerly Gosford City Council.

3. Site Description

At the time of the investigation (29 January 2018), the site was occupied by an on-grade sealed carpark with the Motel Reception located in the south-eastern corner. Minor landscaping occupied the north and western boundaries plus a strip of landscaping north of the Motel Reception building.

The majority of the surface was asphalt paved and appeared to be in relatively good condition. The site surface had a slight slope down toward the east, in the direction of Narara Creek.

Photographs 1 to 4 are presented in Appendix A.

4. Geology, Topography and Hydrogeology

Geological mapping (1:100,000 Gosford-Lake Macquarie Geology Series Sheet) indicates that the site is underlain by Quaternary aged alluvial sediment which is characterised by channel and flood plain alluvium, gravel, sand, silt and clay.

Soil Landscape mapping (1:100,000 Gosford-Lake Macquarie Soils Landscape Series Sheet) indicates that the site is underlain by Wyong Alluvial landscape group. The Wyong Alluvial soil landscape group has dominant soils described as podzolic soils, soloths with some humus podzols and lake edges. Limitations to development associated with Wyong Alluvial landscape group include flooding, seasonal waterlogging, foundation hazard, localised permanent waterlogging, localise stream back erosion, localised acid sulfate soil potential, strongly acidic, poorly drained, impermeable soils of very low fertility with saline subsoils.

According to a survey plan provided by the client (produced by Barry Hunt Associates and dated 2015, CAD REF:55086YALLAMBEE), the site levels range between 1.2 and 2.2 m AHD, sloping down toward the east, south-east, toward the creek.

The mapping also indicates Narara Creek east of the site and Coorumbine creek south of the site. Both Creeks flow into Brisbane Waters, which is located further south of the site.

According to the Gosford ASS Risk Map, the site is within an area identified as disturbed terrain with soil investigations required to assess the site for ASS.

5. Field Work Methods

5.1 Test Locations

The field work was undertaken between 29 and 30 January 2018 and included the drilling of five boreholes (Boreholes 1, 2, 3, 4 and 6) and four cone penetration tests (CPT) (CPT 1 to 5). The approximate test locations are shown on Drawing 2 in Appendix A.

The borehole and CPT locations were set out by a geotechnical engineer from DP with reference to client supplied drawings and locations of underground services.

The locations of the boreholes and CPTs were recorded using a hand held GPS which generally has an accuracy of about ±5 m depending on satellite coverage and surrounding site conditions, to Map Grid of Australia (MGA).

Surface levels were interpolated from the Barry Hunt Associates Drawing, dated 2015, CAD REF:55086YALLAMBEE) and are therefore approximate only.

5.2 Boreholes

The boreholes were drilled to depths of between 1.8 m and 3.3 m using a utility mounted push tube rig fitted with 60 mm diameter sampling tubes.

A geologist from DP logged the subsurface profile in each borehole and collected regular samples for laboratory testing and identification purposes.

5.3 Cone Penetration Tests

CPT involves pushing an instrumented cone and friction sleeve assembly of 35 mm diameter into the ground. The cone was advanced at a constant rate of approximately 20 mm / second and a digital data acquisition system recorded cone tip resistance, friction sleeve resistance, inclination from vertical and encoded depth at measurement intervals of 20 mm.

6. Field Work Results

The borehole logs and CPT results are provided in Appendix B along with notes on descriptive terms and symbols.

The subsurface conditions encountered in the boreholes are summarised as follows:

- Asphalt: encountered in all boreholes, except Bore 6, to depths of between 0.07 m and 0.08 m;
- Filling: grey, orange brown, red brown gravelly / sandy and clay filling, some ripped sandstone filling encountered in all bores to depths of between 0.2 m and 1.3 m;
- Filling: dark brown woodchip / sawdust organic material / possibly peat encountered in Bore 3 to a depth of 1.3 m;
- Alluvium: silt, sand, sandy silt, sandy clay / clayey sand encountered in all bores to depths of between 0.6 m and 3.3 m.

The interpreted CPT results indicate the following strata beneath that observed in the boreholes:

- Silty sand / sandy silt: very loose to medium dense to depths of between 3.2 m and 4.2 m;
- Clay: stiff to very stiff to depths of between 5.0 m and 5.3 m;
- Sand: very dense to depths of between 6.4 m and 7.5 m;
- Clay and silty clay / clayey silt: stiff to hard to depths of between 12.4 m and 16.5 m;
- Sand: dense to depths of between 13.3 m and 18.0 m;
- Clay: stiff with some clay bands to depths of between 21.0 m and 24.7 m; and
- Sand: medium dense to dense bands, although loose in parts to the end of CPT at depths of between 27.94 m and 31.76 m.

Groundwater was encountered in all boreholes at depths of between 1.1 m and 1.8 m. Groundwater was observed at depths of between 1.5 m and 1.8 m after withdrawal of CPT rods. It should be noted that groundwater levels are dependent on climatic conditions and soil permeability and therefore vary with time.

7. Laboratory Testing

7.1 Geotechnical Testing

Standard compaction / 4-day soaked California bearing ratio (CBR) testing was undertaken on two samples collected at the site as follows. The samples were obtained from hand excavated pits.

- Grey and red brown sandy clay / clayey sand filling, trace gravel collected form Borehole 1 at a depth of 0.2-0.6 m; and
- Orange brown sandy clay / clay filling collected from Borehole 6 at a depth of 0.3-0.5 m.

The detailed results of the laboratory testing are included in Appendix C and are summarised in Table 1.

Table 1: Summary of Geotechnical Testing

Bore	Depth (m)	SOMC (%)	SMDD (%)	CBR (%)
1	0.2-0.6	14.5	1.85	10
6	0.3-0.5	15.0	1.80	12

Notes to Table: SOMC – Standard Optimum Moisture Content; SMDD – Standard Maximum Dry Density;
CBR – California Bearing Ratio

7.2 Acid Sulfate Soils

To assess for the presence of acid sulfate soils, 36 soil samples collected from the boreholes were tested in DP's laboratory using a calibrated pH meter for measurement of pH in water (pH_F) and pH following oxidation in hydrogen peroxide (pH_{FOX}) in accordance with the ASSMAC Guidelines (Ref 1).

Based on the results of the screening tests, five samples were selected and forwarded to Envirolab Services Pty Ltd to undergo Chromium Reducible Sulfur Suite (S_{Cr}) testing. The results of these tests are summarised in Table 2.

Table 2: Results of Acid Sulfate Soil Screening and Laboratory Testing

Bore	Sample Depth [a] (m)	Sample Description	Soil Textural Classification	Screening Test Results				Laboratory Results				
				pH			Strength of Reaction[b]	pH_{KCL}	S_{cr} (%S)	Titratable Actual Acidity (TAA) [%sulfur]	Acid Neutralising Capacity (ANC) [%sulfur]	Net Acidity (%sulfur)
				pH_F	pH_{FOX}	pH_F - pH_{FOX}						
1	0.1	Orange brown gravelly sand filling, ripped sandstone	Coarse	6.8	6.5	0.3	1F	-	-	-	-	-
	0.5	Grey and red brown sandy clay / clayey sand filling	Medium to coarse	6.5	4.7	**1.8**	1		-	-	-	-
	0.8	Brown sand filling	Coarse	6.2	3.7	**2.5**	2F		-	-	-	-
	1.2	Dark brown silt, abundant organics	Medium	7.2	**2.3**	**4.9**	2	5.3	0.12	0.06	0.18	**0.18**
	1.5	Grey sand, trace organics	Coarse	6.7	3.8	**2.9**	2F	-	-	-	-	-
2	0.1	Orange brown gravelly sand filling, ripped sandstone	Coarse	6.0	4.6	**1.4**	2F	-	-	-	-	-
	0.5	Grey and red brown sandy clay / clayey sand filling	Medium to coarse	6.0	4.8	**1.2**	2F	-	-	-	-	-
	0.7	Brown sand filling	Coarse	6.4	**3.4**	**3.0**	2F	5.2	<0.005	<0.01	<0.005	<0.005
	1.1	Dark brown silt, abundant organics	Medium	6.7	3.7	**3.0**	2F	-	-	-	-	-
	1.2	Grey sand, trace organics	Coarse	7.0	**2.8**	**4.2**	2F	-	-	-	-	-
	1.5			6.5	**2.9**	**3.6**	2F	-	-	-	-	-
ASSMAC Indicators		Coarse Texture: Sands to loamy sands		**<4**	**<3.5**	**>1**	-	-	-	-	-	0.03
		Medium Texture: Sandy loams to light clays										0.06
		Fine Texture: Medium to heavy clays										0.1

Bore	Sample Depth [a] (m)	Sample Description	Soil Textural Classification	Screening Test Results				Laboratory Results				
				pH			Strength of Reaction[b]	pH_{KCL}	S_{cr} (%S)	Titratable Actual Acidity (TAA) [%sulfur]	Acid Neutralising Capacity (ANC) [%sulfur]	Net Acidity (%sulfur)
				pH_F	pH_{FOX}	pH_F - pH_{FOX}						
3	0.1	Orange brown gravelly sand filling, ripped sandstone	Coarse	5.0	4.0	1.0	1F	-	-	-	-	-
	0.5	Brown and grey gravelly sand / sandy clay filling	Medium to coarse	6.0	3.6	**2.4**	1F	-	-	-	-	-
	1.0			5.9	4.0	**1.9**	1	-	-	-	-	-
	1.5	Grey sand, trace organics	coarse	6.5	**3.1**	**3.4**	1	5.7	<0.005	<0.01	0.008	0.008
	1.8			6.2	**2.7**	**3.5**	1	-	-	-	-	-
ASSMAC Indicators		Coarse Texture: Sands to loamy sands		**<4**	**<3.5**	**>1**	-	-	-	-	-	0.03
		Medium Texture: Sandy loams to light clays										0.06
		Fine Texture: Medium to heavy clays										0.1

Bore	Sample Depth [a] (m)	Sample Description	Soil Textural Classification	Screening Test Results				Laboratory Results				
				pH			Strength of Reaction[b]	pH_{KCL}	S_{cr} (%S)	Titratable Actual Acidity (TAA) [%sulfur]	Acid Neutralising Capacity (ANC) [%sulfur]	Net Acidity (%sulfur)
				pH_F	pH_{FOX}	pH_F - pH_{FOX}						
4	0.1	Brown mottled red brown sandy gravel filling, ripped sandstone	Coarse	6.1	4.7	**1.4**	1F	-	-	-	-	-
	0.4	Red brown mottled light grey sandy gravelly clay / clayey gravelly sand filling, ripped sandstone	Medium to coarse	4.9	4.2	0.7	1F	-	-	-	-	-
	0.9	Dark grey sand, trace organics and shell fragments	coarse	5.8	**2.8**	**3.0**	1F	-	-	-	-	-
	1.25			6.4	**2.9**	**3.5**	1F	-	-	-	-	-
	1.5			6.8	6.2	0.6	1F	-	-	-	-	-
	1.75			7.7	**2.1**	**5.6**	2	-	-	-	-	-
	2.0			7.6	**2.4**	**5.2**	2F	-	-	-	-	-
	2.25	Grey mottled light brown sandy clay / clayey sand	Medium to coarse	7.7	**3.4**	**4.3**	1F	6.8	<0.005	<0.01	<0.005	<0.005
	2.5			7.6	5.7	**1.9**	2F	-	-	-	-	-
	2.7	Light grey sand, some silt	Coarse	7.8	6.0	**1.8**	2	-	-	-	-	-
	3.0	Light grey sandy clay, trace organics	Medium	8.1	7.5	0.6	2F	-	-	-	-	-
	3.25			7.7	7.6	0.1	1F	-	-	-	-	-
ASSMAC Indicators		Coarse Texture: Sands to loamy sands		**<4**	**<3.5**	**>1**	-	-	-	-	-	0.03
		Medium Texture: Sandy loams to light clays										0.06
		Fine Texture: Medium to heavy clays										0.1

Bore	Sample Depth [a] (m)	Sample Description	Soil Textural Classification	Screening Test Results				Laboratory Results				
				pH			Strength of Reaction[b]	pH_{KCL}	S_{cr} (%S)	Titratable Actual Acidity (TAA) [%sulfur]	Acid Neutralising Capacity (ANC) [%sulfur]	Net Acidity (%sulfur)
				pH_F	pH_{FOX}	pH_F - pH_{FOX}						
6	0.1	Orange brown gravelly sand filling, ripped sandstone	Coarse	8.2	7.6	0.6	1F	-	-	-	-	-
	0.4	Orange brown sandy clay / clay filling	Medium	7.9	4.8	**3.1**	1	-	-	-	-	-
	0.6	Dark brown silty sand, some organics	Coarse	8.0	**3.0**	**5.0**	4F	4.7	<0.005	0.05	0.06	**0.06**
	1.0	Grey sand	Coarse	7.7	**3.3**	**4.4**	2F	-	-	-	-	-
	1.5			8.0	**2.9**	**5.1**	2F	-	-	-	-	-
	2.5	Grey clayey sand, trace organics	Coarse	7.5	**2.4**	**5.1**	1F	-	-	-	-	-
	2.8	Brown sandy clay	Medium	8.6	5.9	**2.7**	1	-	-	-	-	-
ASSMAC Indicators		Coarse Texture: Sands to loamy sands		**<4**	**<3.5**	**>1**	-	-	-	-	-	0.03
		Medium Texture: Sandy loams to light clays										0.06
		Fine Texture: Medium to heavy clays										0.1

Notes:

a Depth below ground surface

b Strength of Reaction

1: denotes no or slight reaction

2: denotes moderate reaction

3: denotes violent reaction

4: denotes "volcano" ie. Very rigorous effervescence, gas evolution and heat

F after number indicates a bubbling/frothy reaction (organics)

Bold denotes exceedance of net acidity action criteria or ASSMAC indicator

7.3 Aggressivity Testing

Aggressivity testing was completed on three soils samples and one groundwater sample. The groundwater sample was a ''grab'' sample which was collected during the drilling of Borehole 4.

The detailed results of the laboratory testing are included in Appendix C and are summarised in Table 3.

Table 3: Summary of Aggressivity Testing

Bore	Depth (m)	Description	Concrete Structure				Steel Structures			
			pH	Sulfates (SO_4)		Chlorides in Water (ppm)	pH	Chlorides (Cl)		Resistivity (ohm.cm)
				In Soil (ppm)	In Water (ppm)			In Soil (ppm)	In Water (ppm)	
4	0.9	Dark grey sand	6.0	180	-	-	6.0	620	-	1537
4	3.0	Light grey sandy clay	8.4	320	-	-	8.4	2300	-	600
4	-	GROUNDWATER	7.1	-	820	8700	7.1	-	8700	-
6	1.5	Grey sand	5.6	320	-	-	5.6	10	-	5000

	Non Aggressive
	Mildly Aggressive
	Moderately Aggressive
	Severely Aggressive
	Very Severely Aggressive
-	Not Tested / Not Applicable

Notes to Table: Scale of aggressivity based on threshold values given in AS 2159 – 2009 (Ref 5)

8. Proposed Development

It is understood that redevelopment of the Gosford RSL is proposed and this will initially comprise the construction of a new building to the north of the existing club building. The proposed building will have a footprint of approximately 3,800 m^2 and will occupy an area that is currently occupied by an on-grade carpark and the 'Galaxy Motel Reception Building'.

The new building is understood to comprise three storeys, with part of the ground level comprising an on-grade carpark. Due to potential flooding, the area of the proposed development will also be raised, and it is understood that this will require the placement of between 0.5 m and 1.0 m of filling over the entire area. Reference should be made to Drawings 1 to 3 contained in Appendix A for the area of the proposed development and the indicative layout of the proposed building.

In addition to the development within the northern portion of the Gosford RSL site, following completion of the proposed building, it is understood that the existing club building would be demolished to make way for a new on-grade carpark. Based on information provided by Lindsay Dynan, civil and structural designers for the project, the proposed carpark is intended to comprise a similar flexible pavement to that currently present in the northern carpark.

9. Comments

9.1 Geotechnical Assessment

9.1.1 Foundation Systems

Based on the size and number of storeys of the proposed building, it is estimated that the column working loads for the proposed building are likely to be in the range 1,000 kN to 1,500 kN.

Due to the presence of relatively weak near-surface soils, and based on the anticipated magnitude of the structural loads that would be imposed by the proposed building, shallow footings are unlikely to be practical due to the risk of settlement. It is therefore considered that piled footings will be required to support the building.

It considered that grout-injected (CFA) piles taken into the medium dense to dense sand and stiff to very stiff clay between 7 m and 16 m or the deeper medium dense to dense sand between 22 m and 25 m would be appropriate for this project. Other pile types, including concrete screw cast piles, cased bored concrete piles, driven piles (concrete or timber), jacked piles and steel screw piles may also be technically feasible, although each has certain limitations in regard to this site.

Piles that carry loads both in shaft adhesion and end bearing (eg CFA and driven piles) would be preferred over piles that are purely end bearing (e.g. steel screw piles).

As such, it is considered that CFA piles would be best suited to the ground conditions and the range of structural loads to be carried. Precast concrete driven piles and steel screw piles have also been assessed for this project, however, these would generally carry lower loads in comparison to the CFA piles.

9.1.2 Geotechnical Design Strength Reduction Factor

The design geotechnical strength of a pile ($R_{d,g}$) is the ultimate geotechnical strength ($R_{d,ug}$) multiplied by the geotechnical strength reduction factor (ϕ_g), such that:

$R_{d,g} = \phi_g . R_{d,ug}$

The calculated design geotechnical strength ($R_{d,g}$) must equal or exceed the structural design action effect (E_d). Further reference can be made to AS 2159 – 2009 (Ref 7) regarding these terms and the design procedure.

Selection of the basic geotechnical strength reduction factor (ϕ_g) is based on a series of individual risk ratings (IRR) which are weighted and lead to an average risk rating (ARR). The individual risk ratings and final value of ϕ_g depend on the following factors:

- Site: the type, quantity and quality of testing;
- Design: design methods and parameter selection;
- Installation: construction control and monitoring;
- Pile testing regime; testing benefit factor based on percentage of piles tested and the type of testing; and,
- Redundancy: whether other piles can take up load if a given pile settles of fails.

Using the methodology outlined in the piling code, an average risk rating of 3.21 has been calculated, which relates to a 'moderate' overall risk category. A basic geotechnical strength reduction factor, ϕ_{gb}, of 0.48 is applicable for low redundancy (i.e. single piles) whereas this would increase to 0.56 for a high redundancy pile arrangement (e.g. pile groups). For design purposes, the basic geotechnical strength reduction factor has been adopted as the geotechnical strength reduction factor (ie $\phi_g = \phi_{gb}$) with $\phi_g = 0.48$.

9.1.3 Pile Capacities

An in-house program, Cone Pile version 5.9.1, which utilises the CPT information gathered during testing and applies static theory, was used to estimate geotechnical capacities for grout-injected piles (continuous flight auger), precast driven concrete and steel screw piles.

Grout-injected Piles (Continuous Flight Auger Piles)
Analysis of 600 mm and 750 mm diameter CFA piles founding either within the upper medium dense and dense sand and or stiff to very stiff clay or the deeper medium dense to dense sand was carried out using the data from each of the five CPTs.

Table 4: Geotechnical Strengths for CFA Piles

Pile Diameter (mm)	Target Founding Strata	Approximate Founding Depth (m)	Design Geotechnical Strength * ($R_{d,g}$) (kN)
600	Upper medium dense and dense sand and or stiff to very stiff clay	7 m to 16 m depth	450-600
	Deeper medium dense to dense sand	Below 22 m to 25 m depth	700-1200
750	Upper medium dense and dense sand and or stiff to very stiff clay	7 m to 16 m depth	500-750
	Deeper medium dense to dense sand	Below 22 m to 25 m depth	1100-2000

* Design geotechnical strength based on ϕ_g = 0.48

It is noted that the available CPT data indicates that the geotechnical strength of the piles taken below 7 m would continue to increase, and that significantly higher loads could be possible for piles taken to depths of about 22 m.

Founding conditions cannot readily be verified by visual inspection during drilling of the CFA piles unless drilling is fully instrumented. Furthermore, pile performance cannot be quantified through measurable characteristics of physical performance such as a pile 'set'. The technique is essentially a 'blind' method that relies heavily on comprehensive investigation data to acquire target depths prior to commencement of installation. It is therefore recommended that inspections be carried out during the installation of the piles in order to confirm that the piles are taken to the appropriate strata and that investigation CPTs are conducted at a frequency of approximately one test for every 3 to 5 piles (depending on number and layout of piles).

Concrete Driven Piles

Consideration could also be given to installing concrete driven piles. Concrete driven piles tend to develop higher capacities. The piling rigs have better instrumentation and sensitivity allowing appropriate depths in the sand layer to be targeted more accurately with less risk of over/under installing.

The capacity of a concrete driven pile with a width of 350 mm is presented in Table 5.

Table 5: Geotechnical Strengths for Precast Concrete Driven Piles

Pile Width	Target Founding Strata	Approximate Founding Depth (m)	Design Geotechnical Strength * ($R_{d,g}$) (kN)
350 mm	Upper medium dense and dense sand and or stiff to very stiff clay	13 m to 24 m depth	600
	Deeper medium dense to dense sand	Below 22 m to 30 m depth	1000

* Design geotechnical strength based on ϕ_g = 0.48

Higher geotechnical strengths may be achievable for concrete driven piles that are taken to depths between about 22 m and 30 m, and further assessment would therefore be necessary.

With any driven pile type there is a risk that the vibration during installation could impact nearby structures and services. The contractor should assess the risks and if necessary implement mitigation measures such as pre-drilling through the filling or using lower energy driving techniques. It is also suggested that a dilapidation survey be undertaken of potentially affected structures prior to commencing pile installation.

Steel Screw Piles

Analysis of 500 mm and 600 mm diameter steel screw piles founding either within the upper medium dense and dense sand and or stiff to very stiff clay or the deeper medium dense to dense sand was carried out using the data from each of the five CPTs.

Steel screw piles are a proprietary product, the design of which is usually undertaken by specialist contractors based on their own database of load testing experience. They are a solely end bearing piles with design parameters generally similar to that of bored or other non-displacement pile types. Notwithstanding the above, the settlement and bearing capacity of steel screw piles are dependent on both the strength of the bearing stratum and the structural strength of the helix. For large diameters, bending of the helix plate may govern. The ratio of helix outstand (radius) to plate thickness should preferably be at least 10. It is noted that some contractors rely on in-house correlations between torque and pile capacity, although the experience of DP is that such relationships are often invalid for layered soil profiles. Static load testing is the only reliable way of confirming steel screw pile capacity.

The steel pile material needs to last at least as long as the design life of the structure. Consideration should be given to providing additional corrosion protection to the steel pile sections to be located above the water table, to the pile helix and to any sections of the pile likely to be subjected to abrasive conditions during installation or aggressive soil/water conditions in service.

The estimated capacities of steel screw piles with dimensions of 500 mm and 700 mm are presented in Table 6.

Table 6: Geotechnical Strengths for Steel Screw Piles

Pile Diameter (mm)	Target Founding Strata	Approximate Founding Depth (m)	Design Geotechnical Strength * ($R_{d,g}$) (kN)
500	Upper medium dense and dense sand and or stiff to very stiff clay	7 m to 16 m depth	100-125
	Deeper medium dense to dense sand	Below 22 m to 25 m depth	500
600	Upper medium dense and dense sand and or stiff to very stiff clay	7 m to 16 m depth	150-200
	Deeper medium dense to dense sand	Below 22 m to 25 m depth	200-600

* Design geotechnical strength based on ϕ_g = 0.48

It is noted that the available CPT data indicates that the geotechnical strength of the piles taken below 22 m would continue to increase, and that significantly higher loads could be possible for piles taken to depths of about 25 m. It is noted, however, the depth of the scope of the present investigation was not able to verify the uniformity of the medium dense to dense sands, therefore, further investigation testing would be needed should piles be taken below 25 m depth.

Founding conditions cannot readily be verified by visual inspection during drilling of the steel screw piles unless drilling is fully instrumented. Furthermore, pile performance cannot be quantified through measurable characteristics of physical performance such as a pile 'set'. The technique is essentially a 'blind' method that relies heavily on comprehensive investigation data to acquire target depths prior to commencement of installation. It is therefore recommended that investigation CPTs are conducted at a frequency of approximately one test for every 3 to 5 piles (depending on number and layout of the piles).

For these two reasons (high pile capacity at greater depth, and increased frequency of data capture), it is suggested that further investigation be carried out prior to final selection of the piles.

9.1.4 Pile Settlements

Individual piles designed for the loads described in Section 9.2.1 of this report are expected to settle by less than about 1% of the diameter of the pile. For example, settlements for a 350 mm diameter concrete driven pile founding on the medium dense and dense sand layer and loaded to subject to a load of 1500 kN are expected to be less than 4 mm. Specific settlement analysis should be undertaken if pile groups are proposed.

9.1.5 Pile Testing

AS 2159 (Ref 7) states that where the basic geotechnical strength reduction factor is greater than 0.4, testing of a selection of the piles shall be undertaken. Table 8.2.4(a) of AS 2159 indicates that, for the 'moderate' overall risk category, at least 2% of the piles installed at the site are to be tested for serviceability. Testing is also required to verify the integrity of the pile shafts, and this could comprise either high-strain dynamic pile testing or other methods of integrity testing. The ratio of piles that require shaft integrity testing would depend on the type of pile to be installed amongst other factors. Reference should be made to Section 8 of AS 2159 for guidance on testing requirements.

9.1.6 Earthquake Design Parameters

Sections 3 and 4 of AS 1170.4 – 2007: *Structural Design Actions – Part 4 Earthquake Actions in Australia* (Ref 6) provides details regarding hazard factors and site sub-soil classes.

Reference to Table 3.2 of AS 1170.4 (Ref 6) indicates that a hazard factor, Z, of 0.10 would be applicable for earthquake design at this site, as the site would fall under the location of "Wyong".

Conditions encountered in the boreholes indicate a soil profile that included stiff and very stiff clays and medium dense through to very dense sand, with bedrock at about 30 m to 40 m depth. No very soft clay or very loose sand was encountered in the boreholes or CPTs. Based on these conditions, reference to Section 4 of AS 1170.4 then indicates that the site would be classed as a "shallow soil site", for which a sub-soil Class C_e would apply.

9.1.7 Pavements

9.1.7.1 Subgrade Conditions

Given that the area of the proposed new club building will be raised by approximately 0.5 m to 1.0 m due to potential flooding for of Narara Creek, pavement support conditions will largely be governed by the materials that are to be used to raise the area. No significant excavations are proposed for the redevelopment project; it will, therefore, be necessary to imported filling materials to site. A specific source or quality of material has not yet been determined, so pavement designs for this project are based on assumed material properties.

For the purpose of providing an indicative thickness design for the proposed pavements, it is assumed that the overall subgrade profile would comprise a combination of compacted imported filling overlying existing near surface materials. A soaked CBR value of 5% has been adopted provided that the imported material is appropriately assessed and confirmed to satisfy this design value. In the event that substandard materials are to be imported, then thickness designs should be reviewed and amended as appropriate.

Investigation drilling has not been carried out in the area of the existing club building (i.e. immediately south of the proposed new building), therefore subgrade conditions here are not known. Notwithstanding this, due to the proximity of the site to Narara Creek, the relatively low relief through the local area, and that filling up to 1.3 m depth was encountered in all of the boreholes in the northern area, it is expected that some filling materials would also be present in the area of the current building. Consequently, it is anticipated that subgrade conditions in that area would be similar to those in the area of the northern carpark, albeit demolition works are likely to result in a high degree of disturbance

of the near surface soils. Due to the uncertainty regarding existing subsurface profile and the potential for disturbance, it is recommended that further assessment be undertaken following demolition. It is also noted that further advice regarding subgrade preparation measures may also be required, beyond that provided in this current report.

Subgrade preparation for pavements in the northern portion of the site should be carried out in accordance with Section 9.2.8 of this report.

Subsurface drainage should be installed at approximately 0.3 m to 0.5 m below subgrade level adjacent to pavements. Particular attention should be made to locating subsurface drainage around landscaped areas. Preparation of subgrade surfaces should be such that adequate crossfalls for surface drainage are achieved across the final pavement.

9.1.7.2 Design Traffic

Carpark and access pavements are proposed over the majority of the site. These will include a carpark on the lower level of the proposed new building and driveways around the building as part of the first stage of the site redevelopment. Following demolition of the existing club building, a flexible carpark pavement is proposed to be constructed over this portion of the site.

At the time of reporting, a design traffic loading for the proposed vehicular pavements had not been advised to DP, therefore, for the purpose of providing indicative pavement thickness designs, a design traffic loading of 4×10^4 Equivalent Standard Axle repetitions (ESAs) has been assumed. This design loading equates to a street type described as “Local access with no buses” as per Austroads (Ref 10) based on a 20 year design life.

For rigid pavements subject to the same traffic spectrum and design life, a design traffic loading of 1.3×10^5 Heavy Vehicle Axle Groups (HVAGs) would be appropriate.

9.1.7.3 Pavement Thickness Designs

Table 7, below, shows the suggested minimum layer thickness for new flexible pavements based on the assumed traffic loadings given in Section 9.2.7.2 of this report. The thickness design for the flexible pavement is based on the procedures outlined in Austroads 2017 (Ref 10) and a design CBR of 5%. This assumes that the subgrade is prepared in accordance with Section 9.1.8 of this report.

Table 7: Flexible Pavement Thickness Design Summary

Pavement	Design Traffic (ESA)	Design CBR (%)	Minimum Pavement Thickness (mm)	Layer Component		
				AC Wearing Course (mm)	Unbound Basecourse (mm)	Subbase Course (mm)
Carpark and Driveways ('Local Access with No Buses')	4×10^4	5	280	30mm AC over a 7mm primer seal	100	150

Notes: *Minimum thickness design does not include the primer seal

Thickness design for concrete pavements is presented in Table 8, below. This is based on the design procedures outlined in Austroads 2017 (Ref 10) and a design subgrade CBR of 5%. The design is also based on a load safety factor (LSF) of 1.05 which relates to a project design reliability of 85% for dowelled or continuously reinforced concrete pavements.

Table 8: Rigid Pavement Thickness Design

Pavement	Design Traffic Loading (HVAGs)	Shoulder Construction	Pavement Thickness Design (mm)	Layer Component	
				Concrete Base (mm)	Unbound Subbase (mm)
Carpark and Driveways ('Local Access with No Buses')	1.3×10^5	Without Concrete Shoulders	280	180	100
		With Concrete Shoulders	250	150	100

The base should comprise 32 MPa concrete and include either SL 82 reinforcing mesh where concrete shoulders are provided, or SL 92 mesh where no shoulders are provided. Detailing of the joints would need to be done by others. Subbase material should comprise DGS20 (20 mm sized dense graded subbase) gravel or better.

9.1.8 Site Preparation

Subgrade preparation for the carpark and ground floor slab should be carried out in general accordance with the following methodology:

- Strip the existing pavement wearing course from the carpark and any soils containing significant organic matter (as expected to be present in garden beds);
- Adjust the moisture content of the exposed subgrade within the pavement areas surrounding the proposed building. Moisture contents should be within 2% of the optimum moisture content (OMC) for Standard compaction. This process may require tyning of the exposed surface to a depth of about 250 mm;

- Proof roll the exposed area with at least six passes of a roller having a deadweight of at least 6 tonnes. A final pass should be carried out in the presence of a geotechnical engineer to allow detection and treatment of any soft or compressible zones;
- Compact the subgrade to a density ratio of at least 98% relative to Standard compaction with moisture contents within 3% dry to 1% wet of OMC, or to at least 100% Standard compaction if within 300 mm of design subgrade level;
- Place additional filling in horizontal layers not thicker than 250 mm loose thickness and compact each layer to at least 100% Standard compaction with moisture contents within 3% dry to 1% wet of OMC (this may be required for the carpark surrounding the building depending on final design levels);
- It is recommended that material having relatively low reactivity be placed nearest the surface in order to reduce the potential for swelling of the subgrade soils. Furthermore, imported filling should have a 4 day soaked CBR value of at least 5% (refer to comments in Section 9.1.7.1 earlier in this report).

It is recommended that filling for vehicular pavements be placed under Level 2 conditions as defined in AS 3798 – 2007 (Ref 8). A temporary hardstand pavement of about 0.3 m to 0.4 m thick is likely to be required for construction traffic.

It is noted that the site preparation measures described here include the removal of the existing asphalt seal. Where filling materials are intended to be placed directly over the wearing course, there is the risk that seepage will be impeded and water will become perched within the new filling, leading to prolonged saturation of the subgrade for new pavements. Such conditions can result in premature failure of pavements. If the wearing course is to remain on site, then, rather than leave it intact, it is recommended that this be milled to produce a granular material that has good drainage characteristics. Filling could then be placed over the milled asphalt layer.

9.1.9 Working Platforms

Piling rigs, cranes and other large tracked plant are likely to be required for construction of this project. Reference should be made to BRE470 Working Platforms for Tracked Plant (Ref 4) for further guidance on the safe trafficking of such rigs. Prospective piling contractors are likely to be familiar with this document and may prefer to undertake their own appraisal of trafficking conditions.

Depending on the weight and configuration of the piling rig, and the quality of the subgrade materials, it is common for granular working platforms in the order of 400 – 800 mm thick to be required. Douglas Partners can assist with the analysis and design of a working platform once details of the proposed piling rig are known.

9.1.10 Aggressive Soil Conditions

The results of the laboratory testing undertaken to determine sulfate and chloride, as detailed in Table 3, indicate the following:

- The soil tested is mildly aggressive to buried concrete structures and non-aggressive to severely aggressive to buried steel structures; and
- The groundwater tested at Bore 4 is moderately aggressive to buried concrete structures.

It is, therefore, recommended that design of concrete elements within the foundations should be based on the presence of 'mildly tp moderately aggressive' soils and 'moderately aggressive' groundwater. The design of steel elements, however, should be based on the presence of 'non- aggressive' soils.

The aggressiveness categories provided above are based on threshold values given in AS 2159 (Ref 7). Reference should also be made to AS 2159 for the required concrete strength and reinforcement cover for concrete structures (Table 6.4.3) and corrosion allowances for steel structures (Table 6.5.3) where no corrosion protection is provided.

9.2 Acid Sulfate Soil Assessment

The results of the screening tests for pH in H_2O (pH_F) were in the range 4.9 to 8.6 pH units. ASSMAC (Ref 1) suggests that actual acid sulfate soils (AASS) may be present if pH_F is less than 4 pH units. This condition did not occur in any of the samples screened.

The results of the screening tests for pH following the addition of H_2O_2 (pH_{Fox}) were in the range of 2.1 to 7.6 pH units. ASSMAC (Ref 1) suggests that potential acid sulfate soil (PASS) conditions may be present where pH in H_2O_2 (pH_{Fox}) is less than 3.5 pH units. This occurred in 15 of the 35 samples screened.

ASSMAC (Ref 1) also suggests that potential acid sulfate soil conditions may be present where the difference between pH in H_2O (pH_F) and pH in H_2O_2 (pH_{Fox}) is greater than one pH unit. This condition occurred in 28 of the 36 samples screened. Trace or abundant organics were found in 16 of the 35 samples tested.

Screening tests are generally considered as indicative only and can be affected by the presence of organic material. Definitive and quantitative results are obtained from laboratory testing by either Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) or Chromium Reducible Sulfur Suite (S_{Cr}) methods. S_{Cr} testing was carried out on five samples that exceeded the above indicators of acid sulfate soils. The results of these tests are presented in Table 1.

As outlined in *The Soil Management Guidelines* (Ref 2) the action criteria which define the requirement for management of acid sulfate soils vary depending on the amount of soil disturbed and the textural classification of the soil.

The method for determining net acidity (or existing and potential acidity) has been derived from SMG (Ref 2) and LMG (Ref 3) and can be summarised as follows:

- When $4.5 \leq pH_{KCL} < 5.5$, Sum of existing and potential acidity = Scr + $_s$-TAA; and
- When $pH_{KCL} < 4.5$, Sum of existing and potential acidity = Scr + $_s$-TAA + s-$S_{NAS.}$

Where: S_{Cr} = Chromium Reducible Sulfur
pH_{KCL}= Potassium chloride suspension pH
$_S$-*TAA = Titratable Actual Acidity*
S_{NAS} = Net acid Soluble sulphur

It is anticipated that less than 1,000 tonnes of soil will be disturbed during the redevelopment of the RSL Club.

Based on the results of the analytical testing, the following comments are made:

- The following samples are considered to be acid sulfate soils:
    - Sample of dark brown silt with abundant organics collected from 1.2 m depth in Bore 1; and
    - Sample of dark brown silty sand with some organics collected from 0.6 m depth in Bore 6.
- The other three samples which were tested for the chromium reducible sulfur suite (Bore 2 / 0.7 m, Bore 3 / 1.5 m and Bore 4 / 2.25 m) are not considered to be acid sulfate soil.

Based on the conditions encountered in the boreholes, the results of the screening and laboratory tests indicate that acid sulfate soils are present in the following strata:

- Dark brown silt with organics, such as encountered in Bore 1 between 1.1 m and 1.4 m and in Bore 2 between 1.0 m and 1.15 m; and
- Dark brown silty sand with organics, such as encountered in Bore 6 between 0.5 m and 0.8 m.

Given that proposed excavations for services and pavements are likely to disturb the acid sulfate soils found at the site, an acid sulfate management plan (ASSMP) is required. The ASSMP is included in Section 10 of this report.

10. Acid Sulfate Soil Management Plan

10.1 Overview

The results of the ASS investigation indicate that acid sulfate soils are present in the following strata:

- Dark brown silt with organics, such as encountered in Bore 1 between 1.1 m and 1.4 m and in Bore 2 between 1.0 m and 1.15 m; and
- Dark brown silty sand with organics, such as encountered in Bore 6 between 0.5 m and 0.8 m.

Given that proposed excavations for services and pavements are likely to disturb the acid sulfate soils found at the site, an acid sulfate management plan (ASSMP) is required.

The exact extent of acid sulfate soils should be confirmed through inspection and testing during the construction work by a suitably qualified professional.

DP was not advised of the proposed depth of disturbance (excavation) at the time of preparing this report; however, it has been assumed the maximum depth would be limited to approximately 1.0 - 1.5 m for the installation of underground services and / or pavements. Furthermore, it is understood that groundwater extraction for dewatering of excavations will not be required.

Disturbance of acid sulfate soils must be managed to avoid the release of acid and associated metal contaminants into the environment.

Based on the results of the laboratory chromium suite testing, liming of the excavated soils is required. This is in order to neutralise acid generated by the oxidation of pyritic material contained within the soil when released into aerobic conditions. It follows that, where lime neutralisation treatment is to be undertaken, it will require management in a controlled environment, in a bunded and lined pad with perimeter drainage and a sump. This is to enable the collection and separate treatment of any acid leachate formed during the soil drying and liming process.

It should be noted that saturated soil cannot be neutralised effectively with lime, particularly where it is cohesive (i.e. comprises a majority of silt / clay sized particles). This is because the lime must be well mixed into the soil and this cannot be performed when the soil is overly wet and ‘sticky’. Hence, the excavated soil must be dried back on a limed pad, before effective mixing can take place with earthmoving machinery. Wet weather will thus have a potential to delay the lime treatment process.

All water draining from the soil, once it is removed from the excavation, should be considered as potentially acidic and should be separated in a controlled area, such as the above referred bunded and lined pad, and not allowed to flow back into waterways or stormwater until it has been tested for pH and other environmental tests as outlined in Section 10.6. All leachate generated from the drying pads must be tested and treated prior to release to meet the criteria presented in Table 7 of Section 10.6.

10.2 Liming Rates

Table 9 provides indicative liming rates for neutralisation of the acid sulfate soils likely to be disturbed.

Different soil types and depth ranges are suggested to broadly differentiate between liming rates. Geotechnical inspections during earthworks would assist in identifying the relevant strata.

Table 9: Indicative Liming Rates

Material	Highest Net Acidity (%S)	'Ag' Lime Application Rate for Treatment	
		Guard Layers[#] (kg/m^2 per m height)	Stockpiled Soil* (kg/m^3)
Dark brown silt with organics	0.18	5	9
Dark brown silty sand with organics	0.06	5	3

[#] Refer to Figure 1
* As per ELS Report.

Control of the excavation process will be necessary to separate the various material types and to ensure that the appropriate level of lime neutralisation treatment is applied to the corresponding material.

10.3 Neutralisation Pads and Treatment of Soil

Neutralisation of ASS should be carried out as follows:

- Prepare a liming pad / stockpile site of appropriate area for the volume of soil to be treated. The pad should be prepared on relatively level or gently sloping ground to minimise the risk of any potential instability issues, with a natural (or shaped) fall to the local drainage sump.
- Where the subgrade soils are other than low permeability clays, the surface of the pad should be lined with selected approved compacted clay (at least two layers to a combined compacted thickness of 0.5m) or a geosynthetic liner (refer Fig 1 below). Where the subgrade soils comprise low permeability clay, no clay or geosynthetic lining will be required.
- A guard layer of fine agricultural lime ('ag' lime) should be applied over the clay subgrade or compacted clay liner, to neutralise downward seepage. This guard layer of lime should be applied at a rate appropriate to the material to be treated (refer Table 9 above) for every 1 m height of stockpiled soil.
- The excavated soil should then be spread onto the guard layer in layers of 200 mm to 300 mm thickness, leaving a 1 m flat area between the toe of the spread soil and the containment bund or drain. When spreading the first soil layer, care should be taken not to churn up the lime guard layer.
- Let the soil dry back to facilitate lime mixing (if too wet, then adequate mixing of lime cannot be undertaken).
- Apply 'ag' lime to the stockpiled soil, at the indicative liming rate in Table 9 above, over each spread layer and harrow for thorough mixing prior to spreading the next layer. Two significantly different soil horizons of ASS have been identified during the investigation and the liming rates required to neutralise these soils are summarised in Table 9.
- The results of validation testing (refer Section 10.6) should confirm that the ASS has been adequately neutralised in each layer prior to placement of the next layer to be treated.
- Continue the spreading / liming / harrowing / verification testing cycle until excavation is finished.

- Liming pads should be bunded off, and a circumference drain excavated to collect and localise leachate. The drain and inner bund slopes should be covered with a layer of fine lime applied to neutralise any possible leachate migrating from the stockpiled material.
- When testing indicates that lime neutralisation is complete, then the stockpiled soil may be removed from the liming / neutralisation pad. Note that if the treated material is to be moved off site, it would classify at least as General Solid Waste and should be taken to a suitably licensed facility.

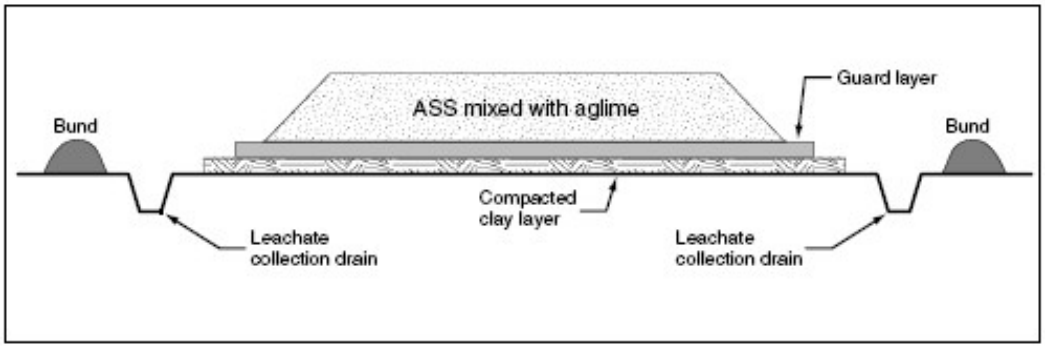

Figure 1: Schematic cross section of treatment pad, from SMG (Ref 3)

Allowances should be made during construction planning to resume sufficient land to allow for these liming pads. Leachate collection location, lining and construction should be similarly pre-planned.

10.4 Neutralising Materials

Agricultural lime ('ag' lime) should be used as the preferred neutralisation material for the management of ASS as it is usually the cheapest and most readily available product for soil neutralisation. This material is strongly alkaline (pH of 8.5 to 9), it is of low solubility, and does not present any handling problems. The 'ag' lime comprises calcium carbonate, typically made from limestone that has been finely ground and sieved to a fine powder.

The 'ag' lime purity should preferably be 95% or better, (ie. NV >95, where NV is the neutralising value, a term used to rate the neutralising power of different forms of materials relative to pure, fine calcium carbonate which is designated NV = 100). 'Ag' lime is typically sold at an NV of 95% to 98%. There could be economic justification for using a less pure grade of ag lime; however, under these circumstances, the individual lime dosing rates should be increased by a factor of 100 / NV.

Due to its low solubility in water, 'ag' lime is not suitable for the neutralisation of leachate, which requires a product with a very quick reaction and high solubility. The most suitable neutralising agent for leachate and retained drainage water is slaked lime or quicklime (calcium hydroxide). This is made by treating burnt lime (calcium oxide) with water (slaking) and comes as a fine white powder. It has a typical NV of about 135. Due to its very strong alkalinity (pH of about 12.5 to 13), slaked lime or quicklime should not be allowed to come into contact with the skin or be inhaled.

10.5 Risk Categorisation

The SMG (Ref 3) relate environmental risk from ASS by the treatment level and volume of disturbance of ASS. This document indicates that the proposed disturbance of the relatively shallow (0.0 m to 1.5 m) soils is likely to be considered "Category L" or low level of treatment.

The Soil Management Guidelines (Ref 3) confirm that a formal ASS Management Plan is required as part of the proposed development, and that the following practices are to be included:

- Segregation of non-acid sulfate soils ASS;
- Verification that the ASS have been appropriately treated and that 'ag' lime has been thoroughly mixed with the soil;
- Substantial bunding of the treatment area using non-ASS material (refer Section 10.3 above);
- Monitoring of pH of any pools of water collected within the bund, particularly after rain, and treatment of water to maintain pH values within 6.5 to 8.5 pH units for the site (refer Section 10.6); and
- Prevent infiltration passing through ASS to groundwater and apply an extra guard layer of 'ag' lime to intercept any infiltration from ASS (refer Section 10.3).

10.6 Verification Testing

Based on a "Category L" treatment level, verification testing of the soil and drainage water is required to be conducted after the addition of lime to test whether or not mixing has been adequate, and to reduce the risk of acidic water being returned to nearby waterways. Based on the amount of soil to be treated (assumed to be less than approximately t tonne / 1,000 m^3 *in situ*), the original intensity of testing during investigation, and the net acidity of the soil prior to treatment, validation samples of soil should be collected and tested for field pH screening and chromium suite, at a frequency of approximately one per material type (refer to Table 9 above) or per 1,000 m^3 of treated soil (whichever is the greater frequency). In addition to this, however, at least one sample should be taken per 200 mm to 300 mm deep soil stockpile layer per bunded area and may result in a greater number of samples than indicated above.

In addition, the pH of all ponded drainage water around the confines of the treatment bunds should be measured daily and results assessed against the criteria provided in Table 10. The soil and water contained within the bunded treatment area should not be removed until the target values presented in Table 10 below have been achieved. Similarly, additional layers of soil should not be added to the bunded stockpile for treatment until the underlying layers have been validated.

Table 10: Target Levels of Neutralised Soil and Water

Test	Component	Target Level
Monitoring of water	pH	6.5 < pH < 8.5
	Turbidity	To comply with either values determined in consultation with the Authority (i.e. CCC) or less than local background levels (baseline monitoring required).
	Aluminium (Al) and Iron (Fe)	Establish local water quality data prior to site disturbance and ensure that these values are not exceeded.
	Dissolved Oxygen	To comply with either values determined in consultation with the Authority (i.e. CCC) or less than local background levels (baseline monitoring required).
Field screening of soil	pH_F	$5.5 < pH_F \leq 8.5$
Acid based accounting of soil (Chromium Suite test method)*	Net acidity (using appropriate fine factor)	Zero or negative
	pH_{KCL}	$pH_{KCL} \geq 6.5$
	TAA	Zero

* Based on Section 3.6 of Chapter A (Overview) of the LMG (Ref 4)

It should be noted that chromium suite tests will require at least four days turnaround, possibly longer, and hence sufficient time should be allowed in the treatment programme for such verification testing. Only appropriately skilled staff, such as available through DP, should collect and test verification samples. In addition to normal daily supervision of the soil management process, it is suggested that regular formal inspections be undertaken.

Water should not be discharged off site without the appropriate regulatory permits or approvals in place and water quality meeting the required criteria.

10.7 Emergency Response Procedures (Contingency Plan)

Construction activities which may cause potential environmental threats are summarised in Table 11 below together with recommendations for “Emergency Response Procedures”.

Table 11: Emergency Response Procedures

Construction Activity	Potential Environmental Threat	Emergency Response
Excavations	Flooding of open excavation causing adjacent groundwater levels to rise, leading to potential acid leachate once the excavation is drained	• Inform site foreman and project manager / environmental officer; • Determine pH of groundwater / floodwater in excavation; • Correct groundwater / floodwater pH by application of slaked lime to bring pH in range of 6.5 to 8.5; • Drain pit to tanks / ponds for water quality assessment prior to discharge.
Stockpiling / Neutralisation	Stockpile washes or slips outside of bunded lime pad	• Inform site foreman and project manager / environmental officer; • Estimate volume of material breeching bund; • Conduct pH analysis of adjacent watercourses (if any); • Remove breeched soil into a bunded limed pad; • Over-excavate contaminated area to 0.2 m depth, apply and mix lime at rate as for guard layers (5kg to 6kg lime per m^2 of surface).
	Breach in stockpile containment bund	• Inform site foreman and project manager/ environmental officer; • Close breach in bund; • Conduct pH analysis of adjacent watercourses (if any); • Correct pH in any adjacent watercourse (if required).
Work in Exclusion Zone	Disturbance of acid sulfate soils in environmentally sensitive zone	• Stop work; • Inform site foreman and project manager/ environmental officer; • Reinstate any unapproved works to minimise potential for environmental impact; • Contact appropriately skilled staff, such as available through DP, should collect and test verification samples

For all construction activities / incidents which pose an environmental threat, an incident report must be completed in order that:

- The cause of the incident may be determined; determine how the incident occurred;
- Additional control measures may be implemented; and
- Work procedures may be modified to reduce the likelihood of the incident re-occurring.

11. References

1. *Acid Sulfate Soil Manual*, NSW Acid Sulfate Soil Management Advisory Committee (ASSMAC), August 1998
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10. AUSTROADS: *Guide to Pavement Technology Part 2: Pavement Structural Design,* 2017.

12. Limitations

Douglas Partners (DP) has prepared this report for the Gosford RSL Club Redevelopment at 2-22 Yallambee Ave, West Gosford in accordance with DP's proposal CCT170145.Rev1 dated 12 January 2018 and acceptance received from Brendan Fisher from APP Corporation Pty Ltd on behalf of Gosford RSL Club dated 18 January 2018. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of APP Corporation Pty Ltd and Gosford RSL Club for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and / or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and / or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological

processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and / or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this investigation / report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About This Report

Drawings 1 to 3

Photographs 1 to 4

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

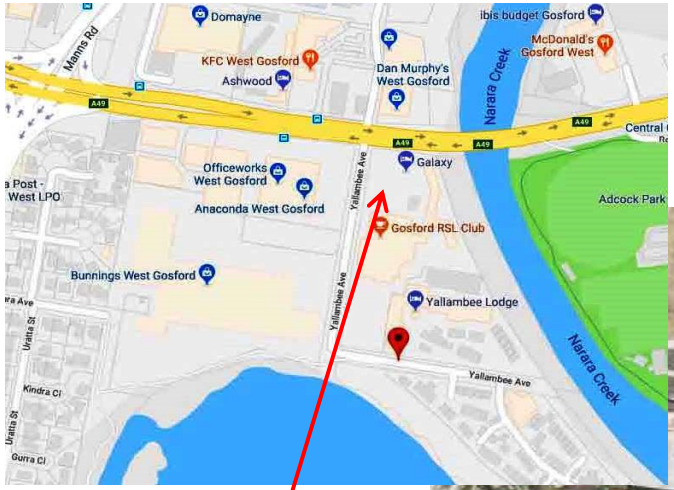
Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

N



Images sourced from Google Maps and SIX Maps

Site Location

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Gosford RSL Club	**Site Location**	PROJECT: 83326.00
	OFFICE: Central Coast	**2-22 Yallambee Avenue**	DWG No: 1
	DATE: 6 Feb 2018	**West Gosford**	REVISION: 0

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Gosford RSL Club	**Test Location Plan**	PROJECT: 83326.00
	OFFICE: Central Coast	**2-22 Yallambee Avenue**	DWG No: 2
	DATE: 6 Feb 2018	**West Gosford**	REVISION: 0

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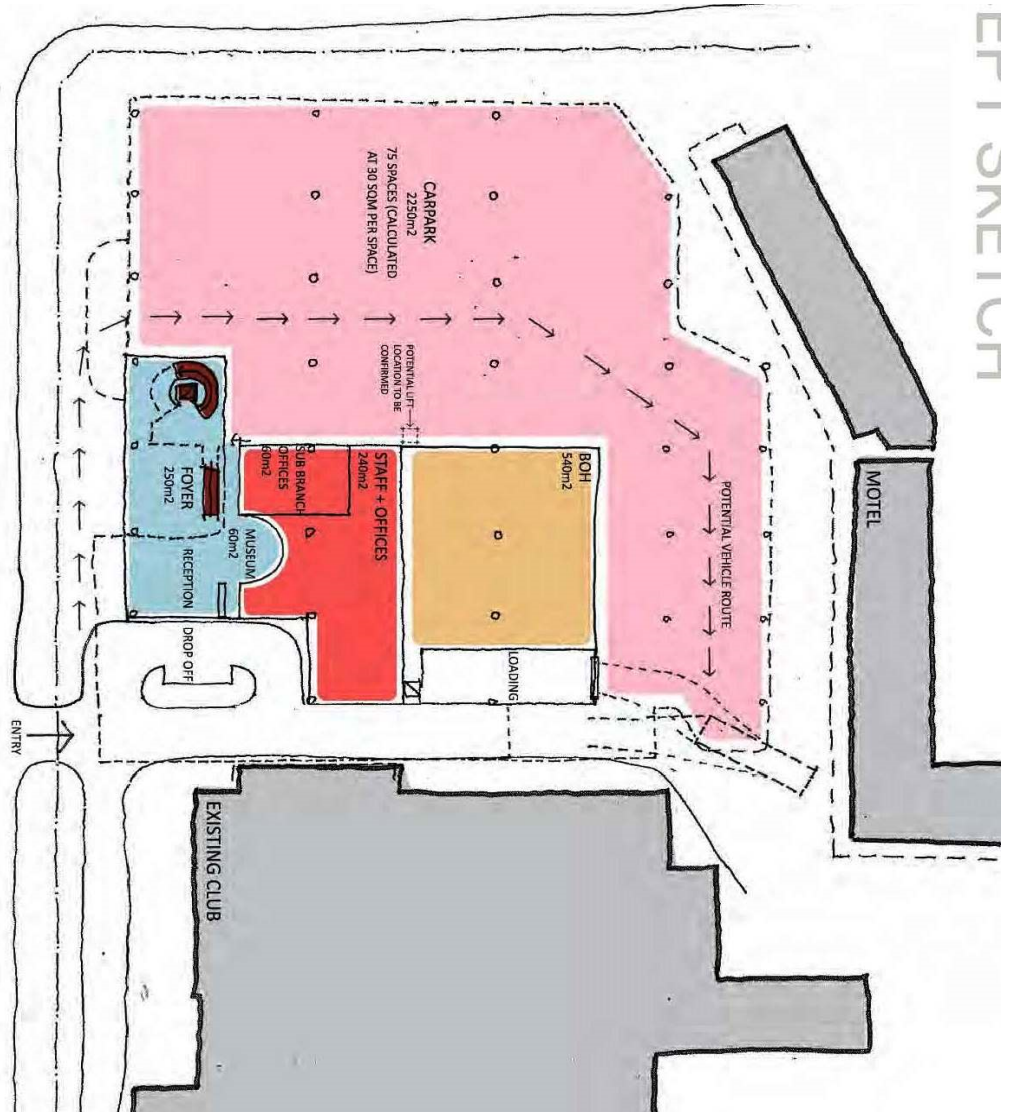


Image sourced from Concept Design WMK Floorplan

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Gosford RSL Club	**Proposed Development**	PROJECT: 83326.00
	OFFICE: Central Coast	**2-22 Yallambee Avenue**	DWG No: 3
	DATE: 7 Feb 2018	**West Gosford**	REVISION: 0

Photo 1 - Site, looking toward the north, minor oil staining on asphalt pavement, 29 Jan 2018.

Photo 2 - Site, looking toward the south, existing RSL Club Building at the rear, 29 Jan 2018.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Gosford RSL Redevelopment** **Yallambee Ave, West Gosford**	PROJECT: 83326.00 PLATE No: 1 REV: 0
	CLIENT: Gosford RSL Club	DATE: 31-Jan-18

Photo 3 - Hotel Reception Building, looking toward the south-east, 29 Jan 2018.

Photo 4 - Hotel Receptioon Building, looking toward the south-west, 29 Jan 2018.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Gosford RSL Redevelopment** **Yallambee Ave, West Gosford**	PROJECT: 83326.00 PLATE No: 2 REV: 0
	CLIENT: Gosford RSL Club	DATE: 31-Jan-18

Appendix B

Descriptive Notes

Borehole Logs

CPT Results

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Symbols & Abbreviations

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

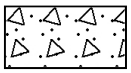
Symbols & Abbreviations

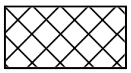
Graphic Symbols for Soil and Rock

General

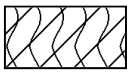

Asphalt


Road base


Concrete


Filling

Soils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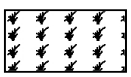
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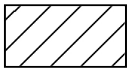
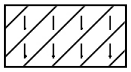
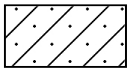
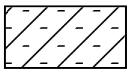
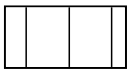

Clay


Silty clay


Sandy clay


Gravelly clay


Shaly clay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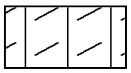
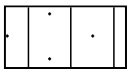
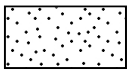

Clayey silt


Sandy silt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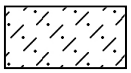
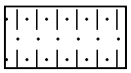
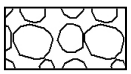
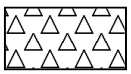

Clayey sand


Silty sand


Gravel

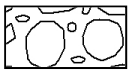

Sandy gravel


Cobbles, boulders

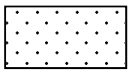

Talus

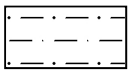
Sedimentary Rocks

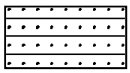

Boulder conglomerate

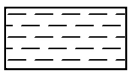

Conglomerate


Conglomeratic sandstone

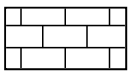

Sandstone


Siltstone

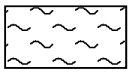

Laminite

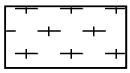

Mudstone, claystone, shale

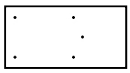

Coal


Limestone

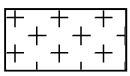
Metamorphic Rocks

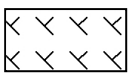

Slate, phyllite, schist

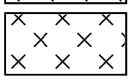

Gneiss

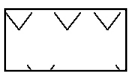

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Cone Penetration Tests

Douglas Partners

Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination (from vertical) i
- Depth below ground z

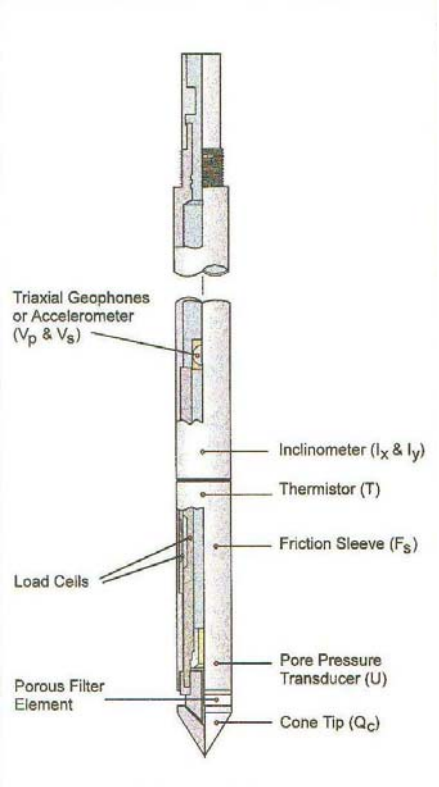


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.

Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (q_c, f_s, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V_s), compression wave velocity (V_p), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration Tests

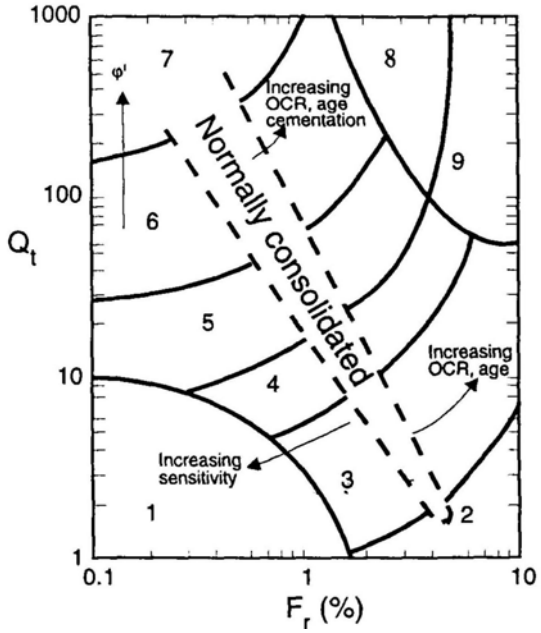


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation. The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G_0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

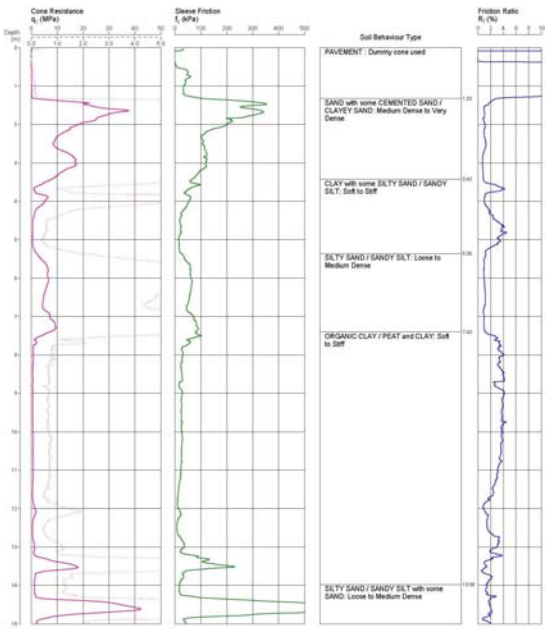


Figure 4: Sample Cone Plot

BOREHOLE LOG

CLIENT: Gosford RSL Club
PROJECT: Gosford RSL Redevelopment
LOCATION: 2-22 Yallambee Avenue, West Gosford

SURFACE LEVEL: 1.9mAHD*
EASTING: 343980
NORTHING: 6300000
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 83326.00
DATE: 29/1/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.07	ASPHALT		D/E	0.1		PID = <1 ppm		
	0.23	FILLING: Generally comprising, orange brown gravelly sand ripped sandstone), damp			0.23				
		FILLING: Generally comprising, grey and red brown sandy clay/clayey sand with trace gravel, damp		B D/E	0.5		PID= <1 ppm		
	0.6	FILLING: Generally comprising, brown sand with trace ironstone gravel, damp			0.6				
				D/E	0.8		PID= <1 ppm		
1		- clayey sand band filling at 1.0m							1
	1.1	SILT: Firm, dark brown silt with abundant decomposed organics, moist		D/E	1.2		PID= <1 ppm		
	1.4	SAND: Loose to medium dense, grey sand with trace decomposed organics, wet		D/E	1.5		PID= <1 ppm	▼	
2									2
	2.8	Bore discontinued at 2.8m . Limit of investigation							
3									3
4									4

RIG: Toyota 4WD **DRILLER:** M Harrison **LOGGED:** M Harrison **CASING:** Nil

TYPE OF BORING: 60mm ≤ ϕ Dynamic Push Tube (continuous sample)

WATER OBSERVATIONS: Free Groundwater Observed at 1.6m

REMARKS: QA1 collected at 0.5m. Drilling completed to 2.8m however no sample recovered past 1.8m. *Levels interpolated from Barry Hunt Associates Dwg dated 2015

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Gosford RSL Club
PROJECT: Gosford RSL Redevelopment
LOCATION: 2-22 Yallambee Avenue, West Gosford

SURFACE LEVEL: 1.7mAHD*
EASTING: 344010
NORTHING: 6299999
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 83326.00
DATE: 29/1/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.07	ASPHALT							
	0.2	FILLING: Generally comprising, orange brown gravelly sand ripped sandstone), damp		D/E	0.1		PID = <1 ppm		
		FILLING: Generally comprising, orange and red brown sandy clay/clayey sand with trace gravel		D/E	0.5		PID= <1 ppm		
	0.6	FILLING: Generally comprising, brown sand with trace ironstone gravel, damp		D/E	0.7		PID= <1 ppm		
1	1.0	SILT: Firm, dark brown silt with abundant decomposed organics, moist		D/E	1.1		PID= <1 ppm		1
	1.15	SAND: Loose to medium dense, grey sand with trace decomposed organics, wet		D/E	1.2		PID= <1 ppm		
				D/E	1.5		PID= <1 ppm	▼	
2									2
	2.8	Bore discontinued at 2.8m . Limit of investigation							
3									3
4									4

RIG: Toyota 4WD **DRILLER:** M Harrison **LOGGED:** M Harrison **CASING:** Nil

TYPE OF BORING: 60mm ≤ ϕ Dynamic Push Tube (continuous sample)

WATER OBSERVATIONS: Free Groundwater Observed at 1.6m

REMARKS: Drilling completed to 2.8m however no sample recovered past 1.8m. *Levels interpolated from Barry Hunt Associates Dwg dated 2015

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Gosford RSL Club
PROJECT: Gosford RSL Redevelopment
LOCATION: 2-22 Yallambee Avenue, West Gosford

SURFACE LEVEL: 1.7mAHD*
EASTING: 343970
NORTHING: 6299961
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 83326.00
DATE: 29/1/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.08	ASPHALT		D/E	0.05		PID = <1 ppm		
		FILLING: Generally comprising, orange brown gravelly sand (ripped sandstone)		D/E	0.1				
	0.3	FILLING: Generally comprising, brown and grey gravelly sand/sandy clay, moist		D/E	0.5		PID= <1 ppm		
	1			D/E	1.0		PID= <1 ppm		1
	1.15	FILLING: Generally comprising, dark brown material. Material has consistency of dark brown sawdust							
	1.3	SAND: Loose to medium dense, grey sand with trace decomposed organics, wet		D/E	1.5		PID= <1 ppm	▼	
	1.8	Bore discontinued at 1.8m . Limit of investigation		D/E	1.8		PID= <1 ppm		
	2								2
	3								3
	4								4

RIG: Toyota 4WD **DRILLER:** M Harrison **LOGGED:** M Harrison **CASING:** Nil

TYPE OF BORING: 60mm ≤ ϕ Dynamic Push Tube (continuous sample)

WATER OBSERVATIONS: Free Groundwater Observed at 1.6m

REMARKS: *Levels interpolated from Barry Hunt Associates Dwg dated 2015

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Gosford RSL Club
PROJECT: Gosford RSL Redevelopment
LOCATION: 2-22 Yallambee Avenue, West Gosford

SURFACE LEVEL: 1.4mAHD*
EASTING: 343998
NORTHING: 6299978
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 83326.00
DATE: 30/1/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.07	ASPHALT							
		FILLING: Generally comprising, brown mottled red brown sandy gravel filling (ripped sandstone), humid/damp		DE	0.1		PID = <1 ppm		
	0.3	FILLING: Generally comprising, red brown mottled light grey sandy gravelly clay/clayey gravelly sand filling (ripped sandstone), M<Wp/damp		DE	0.4		PID= <1 ppm		
	0.55	SANDY SILT: Soft to firm, dark grey sandy silt with trace organics, M<Wp		E	0.6		pp = 60-80		
	0.63			E	0.7				
	0.74	ORGANICS		E	0.75		pp = 100-110		
	0.8	SANDY SILT: Firm, dark grey sandy silt with trace organics, M<Wp		DE	0.9		PID= <1 ppm		
1		SAND: Loose to medium dense, dark grey sand with some silt and trace organics and shell fragments, wet		D	1.25		PID= <1 ppm		1
				DE	1.5		PID= <1 ppm		
				D	1.75		PID= <1 ppm	▼	
		- saturated from 1.83m							
2				DE	2.0		PID= <1 ppm		2
	2.2	SANDY CLAY/CLAYEY SAND: Soft to firm, grey mottled light brown sandy clay/clayey sand, M>Wp/saturated		DE	2.25		PID= <1 ppm		
					2.4		pp = 50-60		
				DE	2.5		PID= <1 ppm		
	2.55	SAND: Loose to medium dense, light grey sand with some silt, saturated		DE	2.7		PID= <1 ppm		
	2.8	SANDY CLAY: Firm, light grey sandy clay with trace organics, M>Wp							
3				DE	3.0		PID= <1 ppm		3
					3.1		pp = 60-80		
				D	3.25		PID= <1 ppm		
	3.3	Bore discontinued at 3.3m . Limit of investigation							
4									4

RIG: Toyota 4WD **DRILLER:** T Warriner **LOGGED:** T Warriner **CASING:** Nil

TYPE OF BORING: 60mm ≤ ϕ Dynamic Push Tube (continuous sample)

WATER OBSERVATIONS: Free Groundwater Observed at 1.8m

REMARKS: Hole collapsing back to 2.2m. *Levels interpolated from Barry Hunt Associates Dwg dated 2015

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Gosford RSL Club
PROJECT: Gosford RSL Redevelopment
LOCATION: 2-22 Yallambee Avenue, West Gosford

SURFACE LEVEL: 1.5mAHD*
EASTING: 344020
NORTHING: 6299957
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 83326.00
DATE: 29/1/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	FILLING: Generally comprising, grey gravelly sand		D/E	0.1		PID = <1 ppm		
	0.3	FILLING: Orange brown gravelly sand filling (ripped sandstone)			0.3				
		FILLING: Orange brown sandy clay/clay, M<Wp		B D/E	0.4 0.5		PID= <1 ppm		
	0.5	SILTY SAND: Loose to medium dense, dark brown silty sand with some decomposed organics, moist		D/E	0.6		PID= <1 ppm		
	0.8	SAND: Loose to dense, grey sand, moist							
	1			D/E	1.0		PID= <1 ppm	▼	1
	2			D/E	2.0		PID= <1 ppm		2
		- trace shells at 2.1m							
	2.3	CLAYEY SAND: Loose to dense, grey clayey sand with trace decomposed organics, wet		D/E	2.5		PID= <1 ppm		
	2.55	SANDY CLAY: Firm, brown, sandy clay, M=Wp							
	2.8	Bore discontinued at 2.8m . Limit of investigation		D/E	2.8		PID= <1 ppm		
	3								3
	4								4

RIG: Toyota 4WD **DRILLER:** M Harrison **LOGGED:** M Harrison **CASING:** Nil

TYPE OF BORING: 60mm ≤ ϕ Dynamic Push Tube (continuous sample)

WATER OBSERVATIONS: Free Groundwater Observed at 1.1m

REMARKS: Bore conducted on elevated garden bed. *Levels interpolated from Barry Hunt Associates Dwg dated 2015

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: GOSFORD RSL CLUB

PROJECT: WEST GOSFORD GEOTECH & CONTAM ASSESSMENT

LOCATION: 2-20 YALLAMBEE AVENUE, WEST GOSFORD

REDUCED LEVEL: 1.9

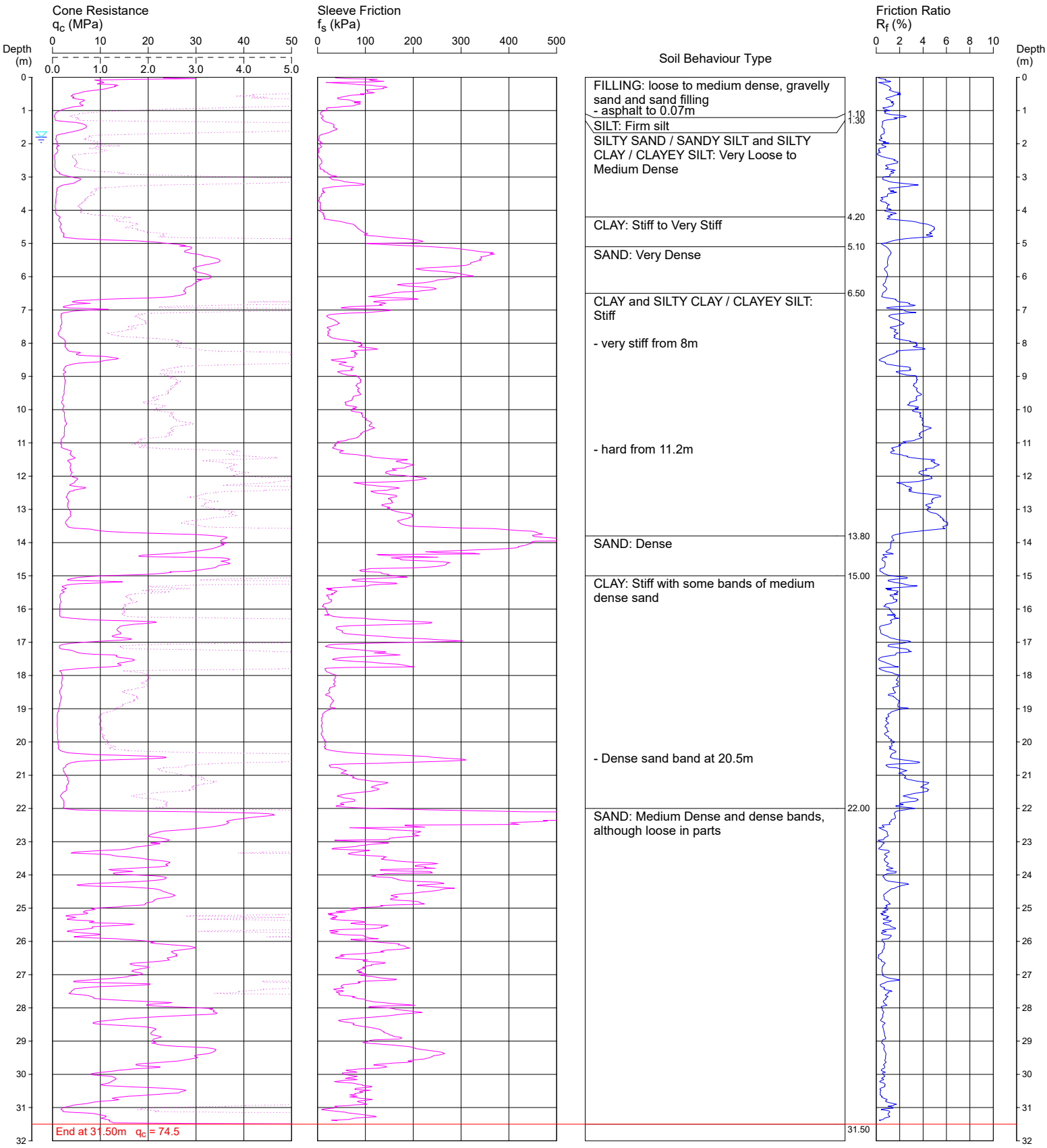
COORDINATES: 343980E 6300000N

CPT1

Page 1 of 1

DATE 30/01/2018

PROJECT No: 83326



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL
GROUNDWATER OBSERVED AT 1.8 m DEPTH AFTER WITHDRAWAL OF RODS

Water depth after test: 1.80m depth (assumed)

File: P:\83326.00 - WEST GOSFORD, Geotech & Contam.Assess\4.0 Field Work\CPT1.CP5

Cone ID: 160626 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: GOSFORD RSL CLUB

PROJECT: WEST GOSFORD GEOTECH & CONTAM ASSESSMENT

LOCATION: 2-20 YALLAMBEE AVENUE, WEST GOSFORD

REDUCED LEVEL: 1.7

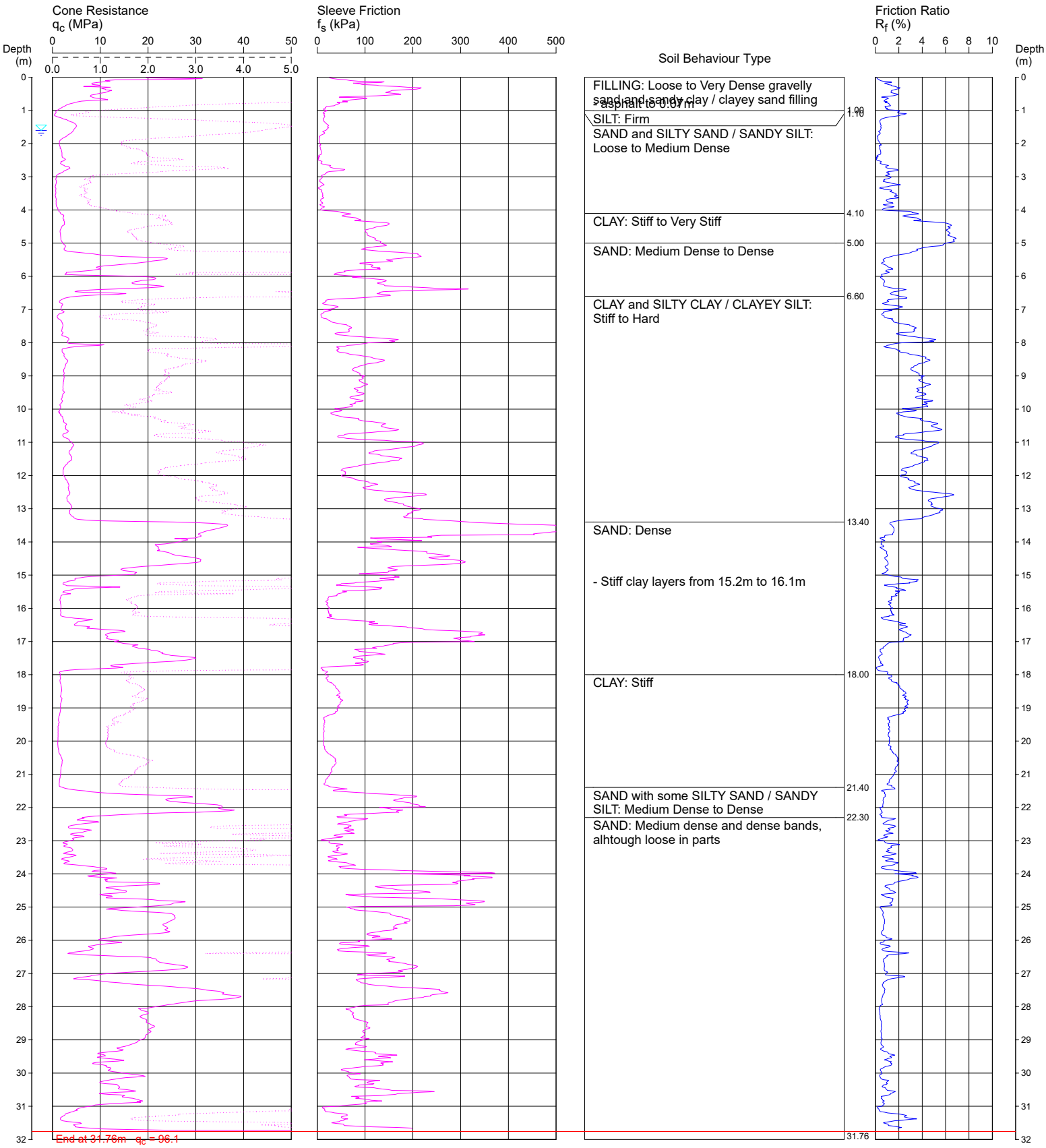
COORDINATES: 344010E 6299999N

CPT2

Page 1 of 1

DATE 30/01/2018

PROJECT No: 83326



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL
GROUNDWATER OBSERVED AT 1.6 m DEPTH AFTER WITHDRAWAL OF RODS

Water depth after test: 1.60m depth (assumed)

File: P:\83326.00 - WEST GOSFORD, Geotech & Contam.Assess\4.0 Field Work\CPT2.CP5

Cone ID: 160626 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: GOSFORD RSL CLUB

PROJECT: WEST GOSFORD GEOTECH & CONTAM ASSESSMENT

LOCATION: 2-20 YALLAMBEE AVENUE, WEST GOSFORD

REDUCED LEVEL: 1.7

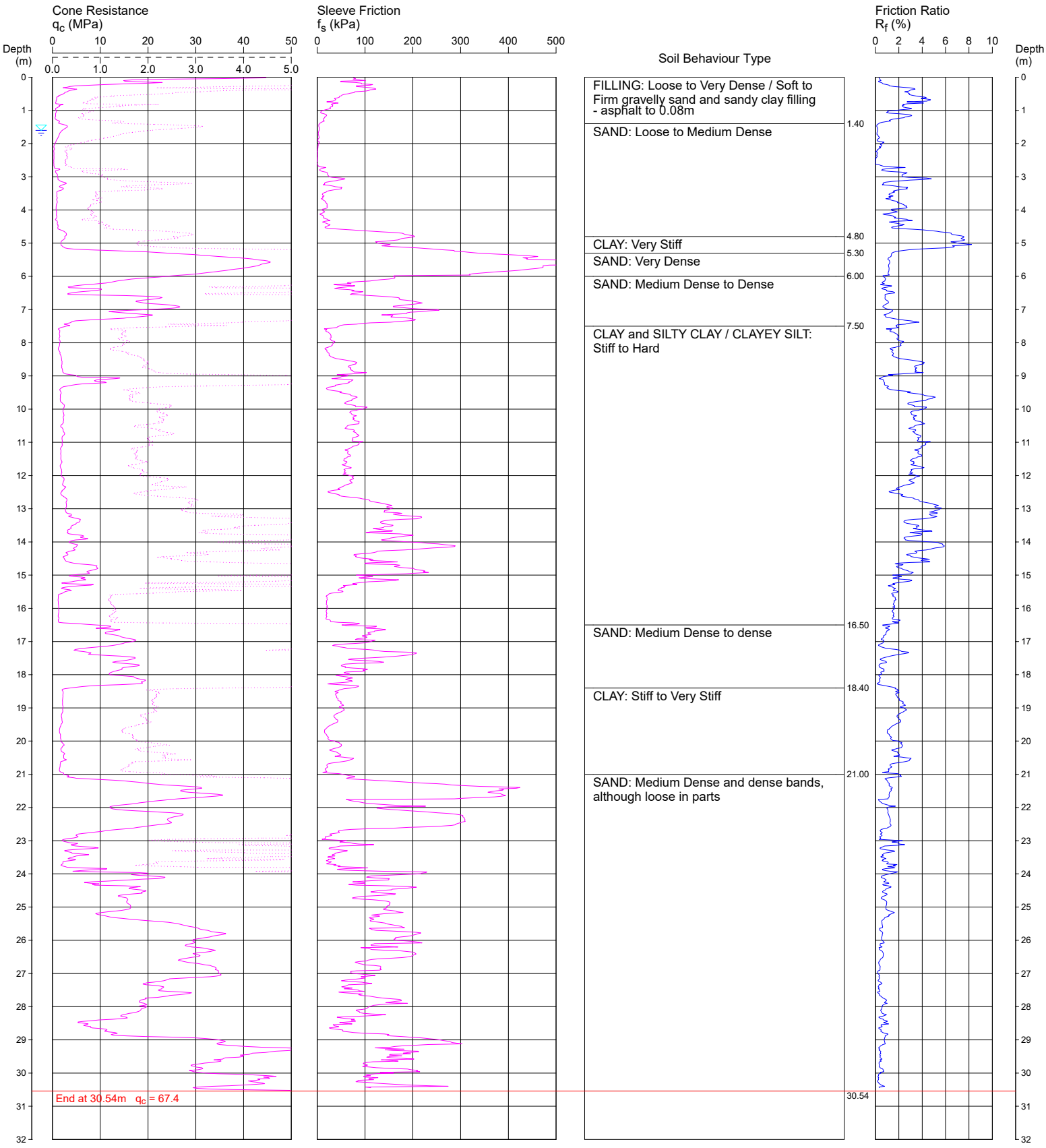
COORDINATES: 343970E 6299961N

CPT3

Page 1 of 1

DATE 30/01/2018

PROJECT No: 83326



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL
GROUNDWATER OBSERVED AT 1.6 m DEPTH AFTER WITHDRAWAL OF RODS

Water depth after test: 1.60m depth (assumed)

File: P:\83326.00 - WEST GOSFORD, Geotech & Contam.Assess\4.0 Field Work\CPT3.CP5

Cone ID: 160626 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: GOSFORD RSL CLUB

PROJECT: WEST GOSFORD GEOTECH & CONTAM ASSESSMENT

LOCATION: 2-20 YALLAMBEE AVENUE, WEST GOSFORD

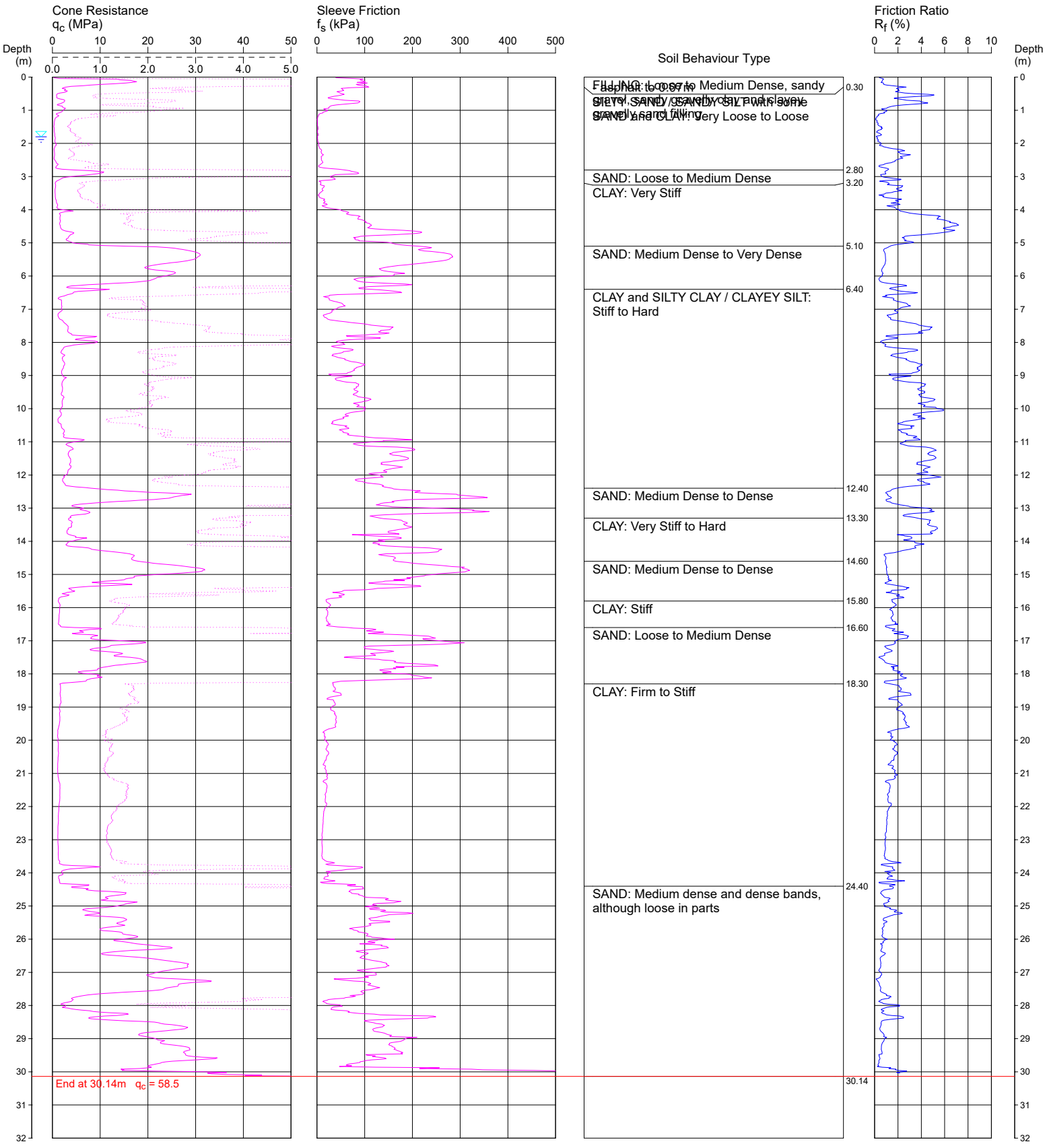
REDUCED LEVEL: 1.4

COORDINATES: 343998E 6299978N

CPT4

DATE 30/01/2018

PROJECT No: 83326



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL
GROUNDWATER OBSERVED AT 1.8 m DEPTH AFTER WITHDRAWAL OF RODS

Water depth after test: 1.80m depth (assumed)
File: P:\83326.00 - WEST GOSFORD, Geotech & Contam.Assess\4.0 Field Work\CPT4.CP5
Cone ID: 160626 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: GOSFORD RSL CLUB

PROJECT: WEST GOSFORD GEOTECH & CONTAM ASSESSMENT

LOCATION: 2-20 YALLAMBEE AVENUE, WEST GOSFORD

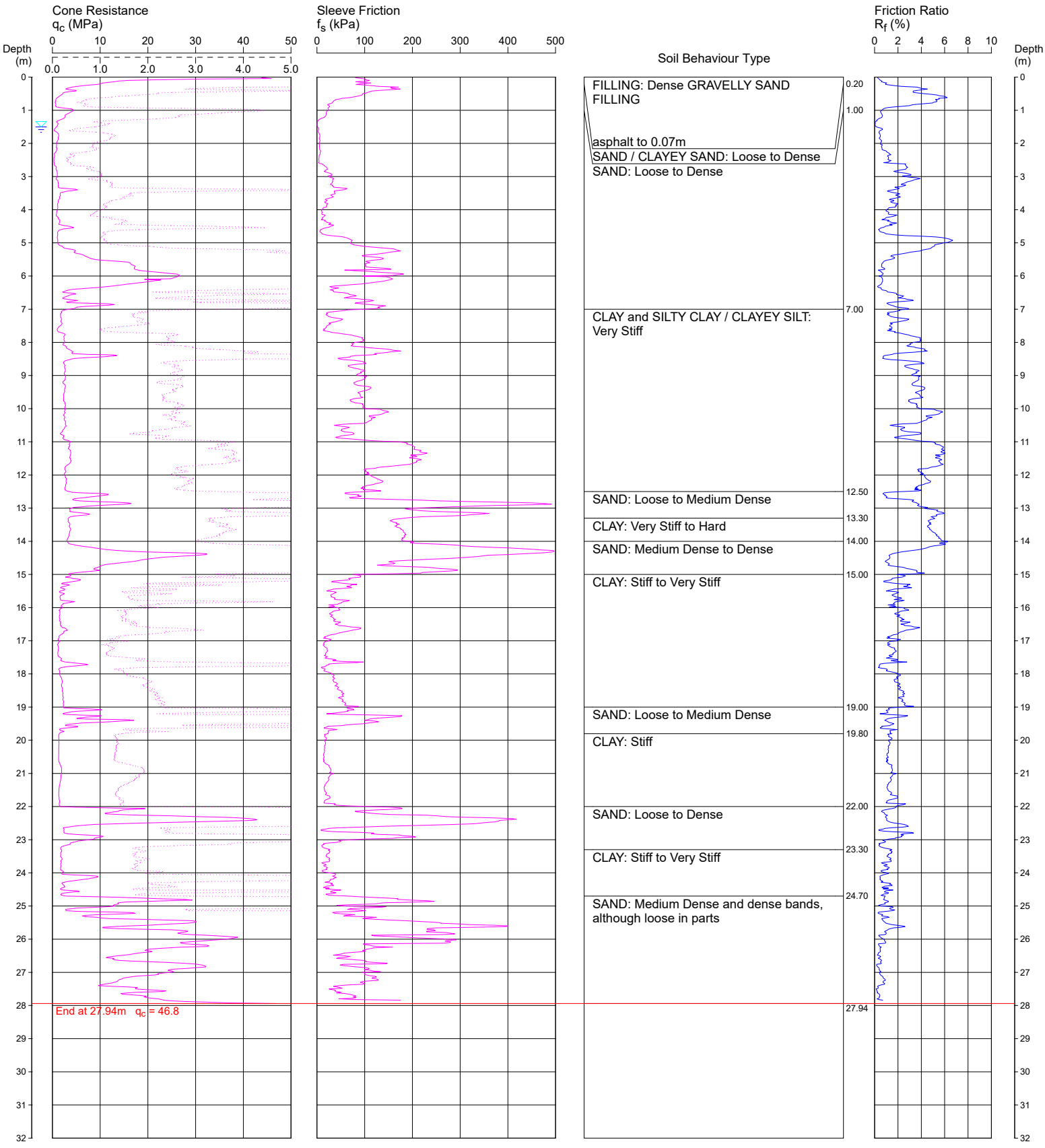
REDUCED LEVEL: 1.6

COORDINATES: 344013E 6299952N

CPT5

DATE 30/01/2018

PROJECT No: 83326



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL
GROUNDWATER OBSERVED AT 1.5 m DEPTH AFTER WITHDRAWAL OF RODS

Water depth after test: 1.50m depth (assumed)

File: P:\83326.00 - WEST GOSFORD, Geotech & Contam.Assess\4.0 Field Work\CPT5.CP5

Cone ID: 160626 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

Appendix C

Laboratory Test Results

Material Test Report

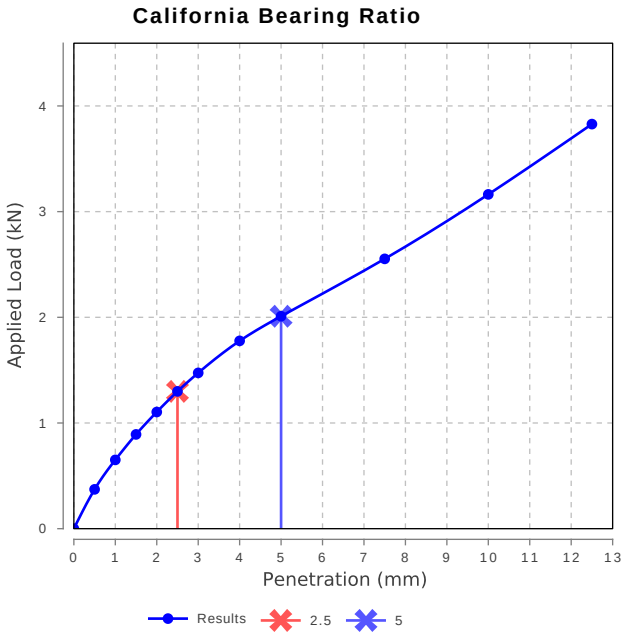
Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Central Coast Laboratory
Unit 5/3 Teamster Close Tuggerah NSW 2259
Phone: (02) 4351 1422
Fax: (02) 4351 1422
Email: dan.byrnes@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Dan Byrnes
Laboratory Manager
NATA Accredited Laboratory Number: 828

Report Number: **83326.00-1**
Issue Number: 1
Date Issued: 13/02/2018
Client: Gosford RSL Club
26 Central Coast Highway, West Gosford NSW 2250
Contact: Russell Cooper
Project Number: 83326.00
Project Name: Gosford RSL Redevelopment
Project Location: 2-20 Yallambee Avenue, West Gosford
Work Request: 701
Sample Number: 18-701A
Date Sampled: 29/01/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **1 (0.2-0.6m)**
Material: Grey and red brown Sandy CLAY

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**10**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.85		
Optimum Moisture Content (%)	14.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	99.5		
Dry Density after Soaking (t/m^3)	1.86		
Field Moisture Content (%)	13.5		
Moisture Content at Placement (%)	14.6		
Moisture Content Top 30mm (%)	15.3		
Moisture Content Rest of Sample (%)	16.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

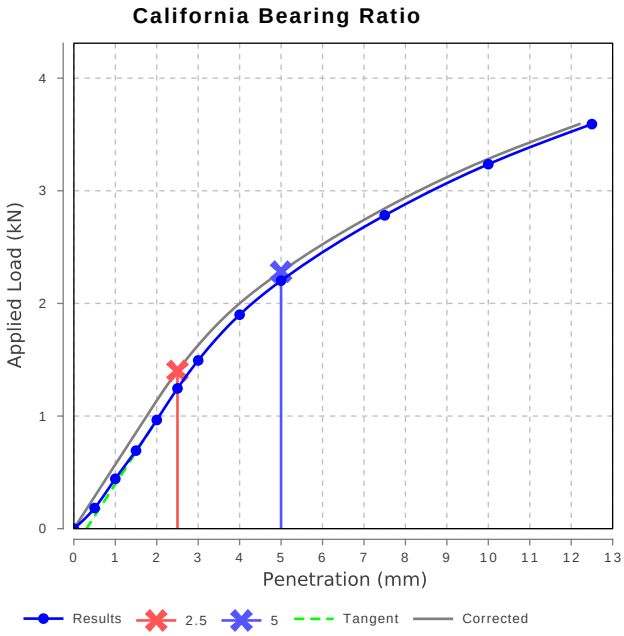
Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Central Coast Laboratory
Unit 5/3 Teamster Close Tuggerah NSW 2259
Phone: (02) 4351 1422
Fax: (02) 4351 1422
Email: dan.byrnes@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Dan Byrnes
Laboratory Manager
NATA Accredited Laboratory Number: 828

Report Number: **83326.00-1**
Issue Number: 1
Date Issued: 13/02/2018
Client: Gosford RSL Club
26 Central Coast Highway, West Gosford NSW 2250
Contact: Russell Cooper
Project Number: 83326.00
Project Name: Gosford RSL Redevelopment
Project Location: 2-20 Yallambee Avenue, West Gosford
Work Request: 701
Sample Number: 18-701B
Date Sampled: 29/01/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **6 (0.3-0.5m)**
Material: Orange brown Sandy CLAY

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**12**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.80		
Optimum Moisture Content (%)	15.0		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.79		
Field Moisture Content (%)	15.0		
Moisture Content at Placement (%)	14.9		
Moisture Content Top 30mm (%)	18.9		
Moisture Content Rest of Sample (%)	16.5		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	1.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



CHAIN OF CUSTODY

Douglas Partners
Geotechnics | Environment | Groundwater

Client: Douglas Partners	**Project Number** 83326.00	**To:**	Envirolab Services
Contact Person: Jessica Paulsen	**Project Name:** Gosford RSL Club	**Contact Person:**	Aileen Hie
Project Mgr: Jessica Paulsen	**PO No.:** Nil	**Address:**	12 Ashley Street
	lab Quote No. : 2016-2017 List		Chatswood NSW 2068
Address: 5/3 Teanster Cl	**Date results required:** STANDARD	**Phone:**	02 9910 6200
Tuggerah NSW 2259	*Note: Inform lab in advance if urgent turnaround is required - surcharges apply*	**Fax:**	02 9910 6201
		Email:	ahie@envirolab.com.au
Phone: 4351 1422 **Mob:**	**Report format:** Esdat/PDF / Excel	**Laboratory Report No:**	
Email: jessica.paulsen@douglaspartners.com.au	**Comments:**	**Lab Comments:**	

ELS Ref 184286A
Due: 7/3/18
Std TAT

Sample information						Tests Required											Comments
Lab Sample ID	Field Sample ID	Depth	Date sampled	Container Type	Type of sample	Aggressivity Cl, SO4, pH & EC										Combo	Provide as much information about the sample as you can
1	4	0.9	30/01/2018	G	S	1											4/0.9 Already at ELS
2	4	3.0	30/01/2018	G	S	1											(From Order No.
4	6	1.5	29/01/2018	G	S	1											184286)
3	4	water	30/01/2078	G	W	1											

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 186152
Date Received: 28/2/18
Time Received: 11:00
Received by: MT
Temp: Cool/Ambient 13.7
Cooling: Ice/Icepack
Security: Intact/Broken/None

Relinquished by: Douglas Partners	**Sample Receipt**	***Lab use only:***
Courier (by whom)	**Received by (Company):** ES	**Samples Received:** Cool or Ambient (circle one)
Condition of Sample at dispatch Cool or Ambient (circle)	**Print Name:** MT	**Temperature Received at:** 13.7 (if applicable)
Temperature (if Applicable):	**Date & Time:** 28/2/18 11:00	**Transported by:** Hand delivered / courier
Print Name: Jessica Paulsen	**Signature:**	
Date & Time:		
Signature: 27/2/2018.		

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 184286-A

Client Details

Client	Douglas Partners Tuggerah
Attention	Jessica Paulsen
Address	Unit 5, 3 Teamster Close, Tuggerah, NSW, 2259

Sample Details

Your Reference	**83326, Gosford RSL Club**
Number of Samples	Additional Testing on 1 Soil
Date samples received	01/02/2018
Date completed instructions received	28/02/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	07/03/2018
Date of Issue	06/03/2018

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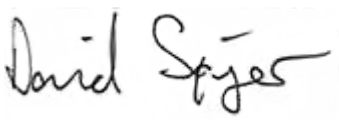
Asbestos Approved By
Analysed by Asbestos Approved Identifier: Lucy Zhu
Authorised by Asbestos Approved Signatory: Paul Ching

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By



David Springer, General Manager

Soil Aggressivity		
Our Reference		184286-A-7
Your Reference	UNITS	4
Depth		0.9
Date Sampled		30/01/2018
Type of sample		Soil
pH 1:5 soil:water	pH Units	6.0
Electrical Conductivity 1:5 soil:water	µS/cm	540
Chloride, Cl 1:5 soil:water	mg/kg	620
Sulphate, SO4 1:5 soil:water	mg/kg	180

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Soil Aggressivity						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	103	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	99	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	105	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	112	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details

Client	Douglas Partners Tuggerah
Attention	Jessica Paulsen

Sample Login Details

Your reference	83326, Gosford RSL Club
Envirolab Reference	184286-A
Date Sample Received	01/02/2018
Date Instructions Received	28/02/2018
Date Results Expected to be Reported	07/03/2018

Sample Condition

Samples received in appropriate condition for analysis	YES
No. of Samples Provided	Additional Testing on 1 Soil
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	14.2
Cooling Method	Ice Pack
Sampling Date Provided	YES

Comments

Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

Sample ID	Soil Aggressivity	On Hold
1-0.5		✓
1-0.8		✓
2-0.1		✓
2-0.7		✓
3-0.5		✓
3-1.5		✓
4-0.9	✓	
6-0.4		✓
QA1		✓

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.
Requests for longer term sample storage must be received in writing.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 184391

Client Details

Client	Douglas Partners Tuggerah
Attention	Jessica Paulsen
Address	Unit 5, 3 Teamster Close, Tuggerah, NSW, 2259

Sample Details

Your Reference	**83326, Gosford RSL Club**
Number of Samples	5 Soil
Date samples received	02/02/2018
Date completed instructions received	06/02/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	13/02/2018
Date of Issue	13/02/2018

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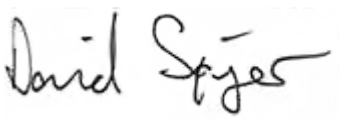
Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By



David Springer, General Manager

Chromium Suite						
Our Reference		184391-1	184391-2	184391-3	184391-4	184391-5
Your Reference	UNITS	1	2	3	4	6
Depth		1.2	0.7	1.5	2.25	0.6
Date Sampled		29/01/2018	29/01/2018	29/01/2018	30/01/2018	29/01/2018
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
pH $_{kcl}$	pH units	5.3	5.2	5.7	6.8	4.7
s-TAA pH 6.5	%w/w S	0.06	<0.01	<0.01	<0.01	0.05
TAA pH 6.5	moles H^+ /t	39	<5	<5	<5	34
Chromium Reducible Sulfur	%w/w	0.12	<0.005	<0.005	<0.005	<0.005
a-Chromium Reducible Sulfur	moles H^+ /t	74	<3	<3	<3	<3
S_{HCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
S_{KCl}	%w/w S	0.007	<0.005	0.010	0.017	<0.005
S_{NAS}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
ANC_{BT}	% $CaCO_3$	<0.05	<0.05	<0.05	<0.05	<0.05
s-ANC_{BT}	%w/w S	<0.05	<0.05	<0.05	<0.05	<0.05
s-Net Acidity	%w/w S	0.18	<0.005	0.0080	<0.005	0.060
a-Net Acidity	moles H^+ /t	110	<5	5.0	<5	34
Liming rate	kg $CaCO_3$ /t	8.5	<0.75	<0.75	<0.75	2.6
a-Net Acidity without ANCE	moles H^+ /t	110	<5	5.0	<5	34
Liming rate without ANCE	kg $CaCO_3$ /t	8.5	<0.75	<0.75	<0.75	2.6
s-Net Acidity without ANCE	%w/w S	0.18	<0.005	0.0080	<0.005	0.060

Method ID	Methodology Summary
Inorg-068	Chromium Reducible Sulfur - Hydrogen Sulfide is quantified by iodometric titration after distillation to determine potential acidity. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

QUALITY CONTROL: Chromium Suite						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			08/02/2018	1	08/02/2018	08/02/2018		08/02/2018	[NT]
Date analysed	-			08/02/2018	1	08/02/2018	08/02/2018		08/02/2018	[NT]
pH $_{kcl}$	pH units		Inorg-068	[NT]	1	5.3	5.3	0	94	[NT]
s-TAA pH 6.5	%w/w S	0.01	Inorg-068	<0.01	1	0.06	0.07	15	[NT]	[NT]
TAA pH 6.5	moles H^+ /t	5	Inorg-068	<5	1	39	41	5	105	[NT]
Chromium Reducible Sulfur	%w/w	0.005	Inorg-068	<0.005	1	0.12	0.11	9	101	[NT]
a-Chromium Reducible Sulfur	moles H^+ /t	3	Inorg-068	<3	1	74	70	6	[NT]	[NT]
S_{HCl}	%w/w S	0.005	Inorg-068	<0.005	1	<0.005	<0.005	0	[NT]	[NT]
S_{KCl}	%w/w S	0.005	Inorg-068	<0.005	1	0.007	0.007	0	[NT]	[NT]
S_{NAS}	%w/w S	0.005	Inorg-068	<0.005	1	<0.005	<0.005	0	[NT]	[NT]
ANC_{BT}	% $CaCO_3$	0.05	Inorg-068	<0.05	1	<0.05	<0.05	0	[NT]	[NT]
s-ANC_{BT}	%w/w S	0.05	Inorg-068	<0.05	1	<0.05	<0.05	0	[NT]	[NT]
s-Net Acidity	%w/w S	0.005	Inorg-068	<0.005	1	0.18	0.18	0	[NT]	[NT]
a-Net Acidity	moles H^+ /t	5	Inorg-068	<5	1	110	110	0	[NT]	[NT]
Liming rate	kg $CaCO_3$ /t	0.75	Inorg-068	<0.75	1	8.5	8.4	1	[NT]	[NT]
a-Net Acidity without ANCE	moles H^+ /t	5	Inorg-068	<5	1	110	110	0	[NT]	[NT]
Liming rate without ANCE	kg $CaCO_3$ /t	0.75	Inorg-068	<0.75	1	8.5	8.4	1	[NT]	[NT]
s-Net Acidity without ANCE	%w/w S	0.005	Inorg-068	<0.005	1	0.18	0.18	0	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

CHAIN OF CUSTODY

Douglas Partners
Geotechnics | Environment | Groundwater

Client: Douglas Partners	**Project Number** 83326	**To:**	Envirolab Services
Contact Person: Jessica Paulsen	**Project Name:** Gosford RSL Club	**Contact Person:**	Aileen Hie
Project Mgr: Jessica Paulsen	**PO No.:** Nil	**Address:**	12 Ashley Street
	lab Quote No. : 2016-2017 List		Chatswood NSW 2068
Address: 5/3 Teanster Cl	**Date results required:** STANDARD	**Phone:**	02 9910 6200
Tuggerah NSW 2259		**Fax:**	02 9910 6201
	Note: Inform lab in advance if urgent turnaround is required - surcharges apply	**Email:**	ahie@envirolab.com.au
Phone: 4351 1422 **Mob:**	**Report format:** Esdat/PDF / Excel	**Laboratory Report No:**	
Email: jessica.paulsen@douglaspartners.com.au	**Comments:**	**Lab Comments:**	

Sample information						Tests Required											Comments
Lab Sample ID	Field Sample ID	Depth	Date sampled	Container Type	Type of sample	Chromium Reducible Suite										Combo	Provide as much information about the sample as you can
1	1	1.2	29/01/2018	Bag	Soil	1											Please hold all samples until I confirm this COC. Thanks. Jessica Paulsen
2	2	0.7	29/01/2018	Bag	Soil	1											
3	3	1.5	29/01/2018	Bag	Soil	1											
4	4	2.25	30/01/2018	Bag	Soil	1											
5	6	0.6	29/01/2018	Bag	Soil	1											
6																	

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 184391

Date Received: 2/2/18
Time Received: 10:30
Received by: MT
Temp: Cool/Ambient 13.3
Cooling: Ice/Icepack
Security: Intact/Broken/None

Relinquished by: Douglas Partners	**Sample Receipt**	***Lab use only:***	
Courier (by whom) TNT	**Received by (Company):** ES	**Samples Received** Cool or Ambient (circle one)	
Condition of Sample at dispatch Cool or Ambient (circle) Frozen	**Print Name:** MT	**Temperature Received at:** 13.3 (if applicable)	
Temperature (if Applicable):	**Date & Time:** 2/2/18 10:30	**Transported by:** Hand delivered / courier	
Print Name: Jessica Paulsen	**Signature:**		
Date & Time: 1/02/2018			
Signature:			

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details

Client	Douglas Partners Tuggerah
Attention	Jessica Paulsen

Sample Login Details

Your reference	83326, Gosford RSL Club
Envirolab Reference	184391
Date Sample Received	02/02/2018
Date Instructions Received	06/02/2018
Date Results Expected to be Reported	13/02/2018

Sample Condition

Samples received in appropriate condition for analysis	YES
No. of Samples Provided	5 Soil
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	13.3
Cooling Method	Ice Pack
Sampling Date Provided	YES

Comments

Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

Sample ID	Chromium Suite
1-1.2	✓
2-0.7	✓
3-1.5	✓
4-2.25	✓
6-0.6	✓

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.
Requests for longer term sample storage must be received in writing.

Envirolab Services Pty Ltd
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12 Ashley St Chatswood NSW 2067
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customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 186152

Client Details

Client	Douglas Partners Tuggerah
Attention	Jessica Paulsen
Address	Unit 5, 3 Teamster Close, Tuggerah, NSW, 2259

Sample Details

Your Reference	**83326.00, Gosford RSL Club**
Number of Samples	2 soil, 1 water
Date samples received	28/02/2018
Date completed instructions received	28/02/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

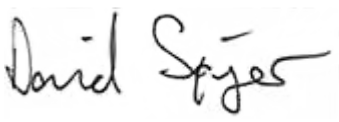
Date results requested by	07/03/2018
Date of Issue	05/03/2018

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By



David Springer, General Manager

Soil Aggressivity			
Our Reference		186152-1	186152-2
Your Reference	UNITS	4	6
Depth		3.0	1.5
Date Sampled		30/01/2018	29/01/2018
Type of sample		soil	soil
pH 1:5 soil:water	pH Units	8.4	5.6
Electrical Conductivity 1:5 soil:water	µS/cm	1,600	200
Resistivity by calculation	ohm m	6.0	50
Chloride, Cl 1:5 soil:water	mg/kg	2,300	10
Sulphate, SO4 1:5 soil:water	mg/kg	320	320

Miscellaneous Inorganics		
Our Reference		186152-3
Your Reference	UNITS	4
Depth		-
Date Sampled		30/01/2018
Type of sample		water
Date prepared	-	28/02/2018
Date analysed	-	28/02/2018
pH	pH Units	7.1
Electrical Conductivity	µS/cm	27,000
Chloride, Cl	mg/L	8,700
Sulphate, SO4	mg/L	820
Resistivity by calculation	ohm m	<0.1

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Soil Aggressivity					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	103	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	102	[NT]
Resistivity by calculation	ohm m	0.1	Inorg-002	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	98	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	106	[NT]

QUALITY CONTROL: Miscellaneous Inorganics					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			28/02/2018	[NT]	[NT]	[NT]	[NT]	28/02/2018	[NT]
Date analysed	-			28/02/2018	[NT]	[NT]	[NT]	[NT]	28/02/2018	[NT]
pH	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	103	[NT]
Chloride, Cl	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	98	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	100	[NT]
Resistivity by calculation	ohm m	0.1	Inorg-002	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
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PQL	Practical Quantitation Limit
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Spikes for Physical and Aggregate Tests are not applicable.

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Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

CHAIN OF CUSTODY

Douglas Partners
Geotechnics / Environment / Groundwater

Client: Douglas Partners	**Project Number** 83326.00	**To:**	Envirolab Services
Contact Person: Jessica Paulsen	**Project Name:** Gosford RSL Club	**Contact Person:**	Aileen Hie
Project Mgr: Jessica Paulsen	**PO No.:** Nil	**Address:**	12 Ashley Street
	lab Quote No. : 2016-2017 List		Chatswood NSW 2068
Address: 5/3 Teanster Cl	**Date results required:** STANDARD	**Phone:**	02 9910 6200
Tuggerah NSW 2259		**Fax:**	02 9910 6201
	Note: Inform lab in advance if urgent turnaround is required - surcharges apply	**Email:**	ahie@envirolab.com.au
Phone: 4351 1422 **Mob:**	**Report format:** Esdat/PDF / Excel	**Laboratory Report No:**	
Email: jessica.paulsen@douglaspartners.com.au	**Comments:**	**Lab Comments:**	

Sample information						Tests Required											Comments
Lab Sample ID	Field Sample ID	Depth	Date sampled	Container Type	Type of sample	Aggressivity Cl, SO4, pH & EC										Combo	Provide as much information about the sample as you can
1	4	0.9	30/01/2018	G	S	1											4/0.9 Already at ELS
2	4	3.0	30/01/2018	G	S	1											(From Order No.
3	6	1.5	29/01/2018	G	S	1											184286)
4	4	water	30/01/2078	G	W	1											

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 186152
Date Received: 28/2/18
Time Received: 11:00
Received by: MT
Temp: Cool/Ambient 13.7
Cooling: Ice/Icepack
Security: Intact/Broken/None

Relinquished by: Douglas Partners	**Sample Receipt**	***Lab use only:***
Courier (by whom)	**Received by (Company):** ELS	**Samples Received:** Cool or Ambient (circle one)
Condition of Sample at dispatch Cool or Ambient (circle)	**Print Name:** MT	**Temperature Received at:** 13.7 (if applicable)
Temperature (if Applicable):	**Date & Time:** 28/2/18 11:00	**Transported by:** Hand delivered / courier
Print Name: Jessica Paulsen	**Signature:**	
Date & Time:		
Signature: 27/2/2018.		

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details

Client	Douglas Partners Tuggerah
Attention	Jessica Paulsen

Sample Login Details

Your reference	83326.00, Gosford RSL Club
Envirolab Reference	186152
Date Sample Received	28/02/2018
Date Instructions Received	28/02/2018
Date Results Expected to be Reported	07/03/2018

Sample Condition

Samples received in appropriate condition for analysis	YES
No. of Samples Provided	2 soil, 1 water
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	13.7
Cooling Method	Ice
Sampling Date Provided	YES

Comments

Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

Sample ID	Soil Aggressivity	pH	Electrical Conductivity	Chloride, Cl	Sulphate, SO4	Resistivity by calculation
4-3.0	✓					
6-1.5	✓					
4		✓	✓	✓	✓	✓

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.
Requests for longer term sample storage must be received in writing.