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4 July 2017
Ref: 939-A

GJW Consulting
P.O. Box 3107
St Pauls LPP NSW 2031

Attention: Gary Watts

Dear Gary,

Re: Geotechnical Matters
Proposed Redevelopment
Dee Why Bowling Club

I refer to the above subject and your recent advice of planned changes to the development. Accordingly, I have sighted the revised development plans that have been forwarded to me by Group N architects.

Based upon my review of the new plans, I am of the opinion that the geotechnical issues, which principally relate to excavation, dewatering, basement walls and building foundations, are not significantly different to the original development requirements, and therefore my earlier recommendations still apply.

If you have any queries regarding the above please do not hesitate to call me.

Regards,

Don Katauskas

cc: Jessica Hartany

D. Katauskas
Consulting Geotechnical Engineer
Katauskas Family Trust T/A D.Katauskas Geotechnical Consultant
ABN 59 442 991 347

127B Campbell Drive
Wahroonga NSW 2076
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8 January 2016
Ref: 939

GJW Consulting
P.O. Box 3107
St Pauls LPP NSW 2031

Attention: Gary Watts

Dear Gary,

Re: Geotechnical Investigation
Proposed Development
Dee Why Bowling Club
Fisher Road North, Dee Why

Introduction

This report presents the results of the above geotechnical Investigation, the specific purpose of which was to determine the nature of the subsurface soil and groundwater conditions in order that comments and recommendations on relevant geotechnical aspects could be presented.

The matters pertinent to the development are considered to be related to the following:

a. Necessary site preparation and earthworks.
b. Basement excavation, shoring, support and groundwater issues.
c. Suitable foundation schemes, design bearing pressures and foundation settlement considerations.

A Phase 1 Contamination Assessment was also completed with the findings to be reported upon under separate cover by Sullivan Environmental Services Pty Ltd.

Field Investigation

The fieldwork for the investigation was carried out over a period of two days commencing on 23 November 2015, and comprised the following:

- Drilling of seven boreholes to depths ranging from approximately 5 to 10 metres.
- Completion of Standard Penetration Tests to evaluate the strength of the insitu soils.
- Installation of three PVC standpipes for groundwater observations.

The boreholes were positioned to suit the prevailing site access conditions and their locations are shown on the attached Figure 1.

The fieldwork was supervised on a full-time basis by the undersigned.

Site Description and Geology

The site has a irregular shape, covering a plan area of 1.15ha, and is located near the tail end of an old, natural infilled gully associated with the Dee Why Lagoon system to the east. The western end of the gully is flanked by rising ground slopes which ascend to the Hawkesbury Sandstone ridges and plateaus.

In view of the geological and topographic setting, relatively deep colluvial soil deposits could be expected and were proven to underlie the site.

Investigation Findings

It is apparent that modifications to the original topography have occurred to facilitate the existing site improvements, which include buildings, bowling greens and drainage. These improvements have resulted in a variable depth of fill forming the surface soil cover over the site. The fill, which generally comprises clayey sands and ripped sandstone derivatives, ranges up to 2.5 metres in thickness and appears to be associated with earthworks connected with the drainage easement pipes and open channel.

The natural soils below the fill generally comprised an interlayered sequence of clayey sands, sands and sandy clays. Where sandy or cohesionless, the strength varied from a loose to medium state of compaction. Where the layering was predominantly clayey or of a cohesive nature, the strength varied from stiff to very stiff consistency, with occasional hard bands.

Reference should be made to the attached Borehole Logs and Explanatory Notes for a detailed description and sequence of the various strata encountered at the site.

Groundwater

Groundwater was encountered at most borehole locations, at depths from between 2 to 3 metres below ground surface. The water level observation standpipes were installed in BHs1, 3 and 6, during the site investigations of 23 and 24 November 2015. The groundwater levels measured in the standpipes on 29 November 2015 varied from approximately 1.1m in

BHs 1 and 3, to 1.7m below ground level in BH6, which is situated at a slightly higher ground elevation than the other installations. A summary of the groundwater level observations made during and after the completion of the investigation is shown on the attached Borehole Logs.

COMMENTS AND RECOMMENDATIONS

Proposed Development

It is understood that the proposed development of the site will involve the construction of a Clubhouse with ground level carparking provisions and Independent Living apartment blocks which are provided with basement carparking. Also it is proposed to relocate a section of the existing easement so as to minimize any impact on the new works.

It has been assumed that the new structure will be of up to three storeys (including basement) and therefore the wall line and column loads are estimated to be in the normal range for such buildings.

The site groundwater regimen is expected to have an impact on the basement provisions, the implications of which are discussed later.

Basement

It is estimated that excavation to depths of approximately 3 metres below existing ground level may encounter groundwater which will impact on the works. In order to minimize any impact on the excavation subgrade, preparation and construction of a basement wall and temporary dewatering will be required. This may be achieved using wells and /or spear point methods. It is recommended that specific advice on dewatering methods be sought from specialist dewatering contractors.

No problems are envisaged with excavating the insitu sandy and clayey soils. Subject to appropriate site dewatering, temporary excavation batters of 1.5H:1V ,may be used, as there appears to be sufficient space for this.

In the event that the basement footprint is positioned close to any existing greens or structures, then the excavation in this situation should be provided with shoring and support using either temporary driven sheet piles or contiguous concrete bored pier walls.

The shoring walls may be installed as cantilever walls, subject to complying with acceptable deflection criteria at the crest of the wall. In the design of permanent and temporary shoring of basement walls the following parameters may be used.

Active Earth Pressure Coefficient	Ka	0.3
Passive Earth Pressure Coefficient	Kp	0.33
At Rest Earth Pressure Coefficient	Ks	0.5
Soil Unit Weight	γ	20KN/m^3

The basement should be designed as a tanked installation, and the resistance to uplift forces provided from either gravitational loads or tension piles.

Building Foundations

The accommodation buildings may be supported on strip and pad footings founded at basement invert levels in the underlying very stiff natural clayey soils or medium dense sands, using an allowable bearing pressure of 150 kPa.

The new clubhouse may also be designed as above, subject to the reinstatement of any fill and the top 0.3 metres of subgrade to at least a density ratio of 98% of Standard Maximum Dry Density.

As an alternative to the above high level foundation solution the structure may be supported on friction piles such as CFA type, using the following parameters:

Allowable Shaft Friction	30 kPa
Allowable End Bearing Pressure	400 kPa

In the event that changes to the proposed buildings occur that result in substantial increases in structure wall and column loadings, then it may be desirable to verify the pile load-carrying capacity from dynamic pile load testing procedures on at least two test piles.

Site Preparation

It is recommended that under all proposed pavement and building footprints, excluding basement areas, any fill be cut back, and the subgrade be proofrolled and be compacted to at least a density ratio of 98% of Standard Maximum Dry Density. All subsequent fill up to the final subgrade levels should be compacted as above.

Access Pavements

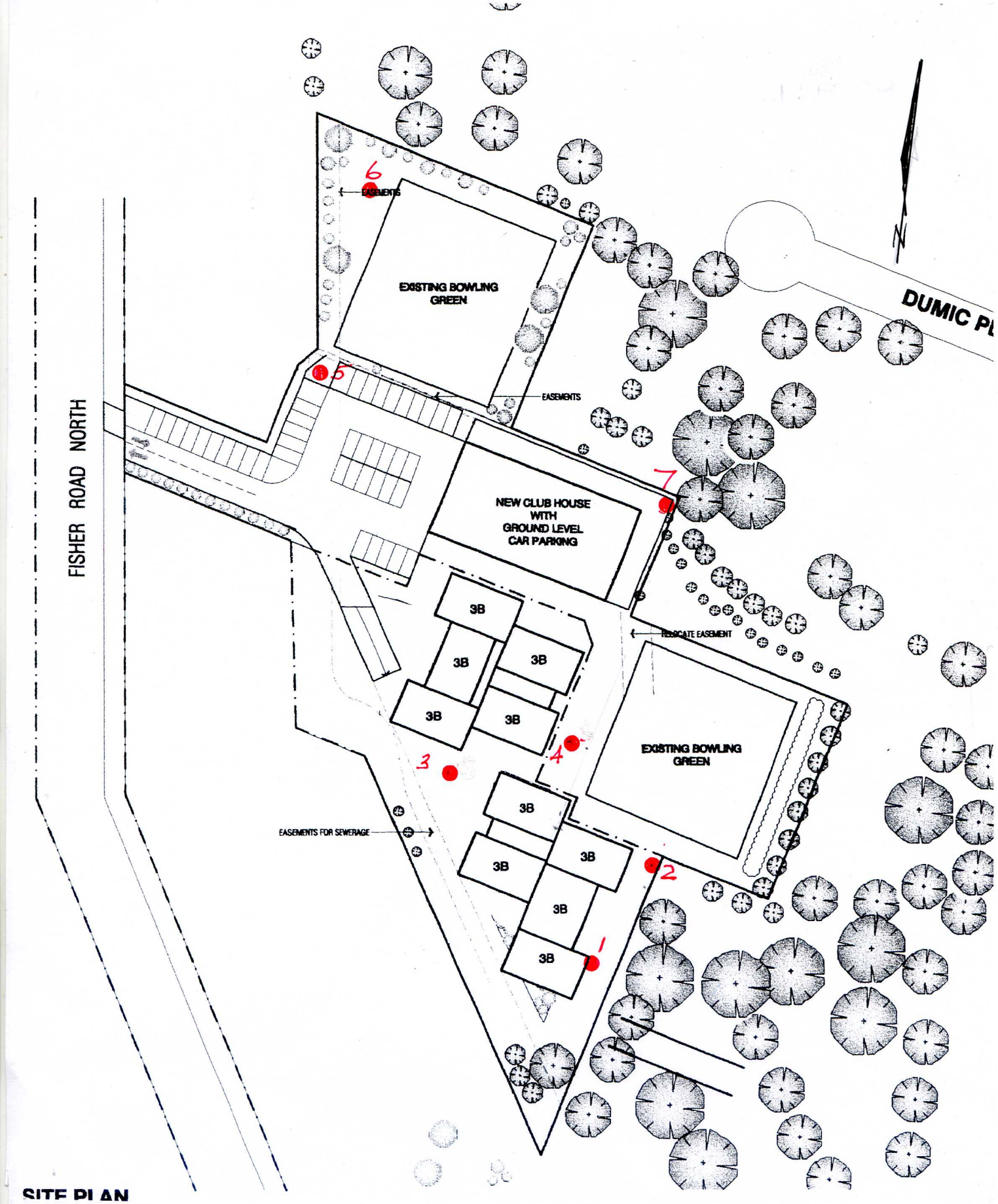
A provisional CBR of 3% is recommended in determining the pavement thickness requirements. This should be confirmed, once final subgrade levels have been determined.

If you have any queries regarding the above please do not hesitate to call me.

Regards,

Don Katauskas

encl: Figure 1- Site Plan & Test Locations
Borehole Logs
Explanatory Notes



SITE PLAN

INDEPENDENT LIVING APARTMENTS
DEEWHY BOWLING CLUB

221-223 FISHER ROAD NORTH, DEE WHY, NSW

25 SEPTEMBER 2014

D. Katauskas Geotechnical Consultant Client: GJW Consulting Proposed Bowling Club Development Fisher Rd North, Dee Why NSW Site Plan & Test Locations	JOB NO. FIGURE NO:	939 1
	TEST LOCATION: SCALE:	● 1:1000

BOREHOLE LOG

No: 1

D. Katauskas
Consulting Geotechnical Engineer

Client:	GJW Consultancy	**Date:**	23 & 24/11/2015
Project:	Proposed New Development	**Job No:**	939
Location:	Dee Why Bowling Club, 221-223 Fisher Rd Nth, Dee Why		
Method:	Geoprobe 205 Auger Drill Rig	**RL:** / **Datum:**	
Logged:	DK	**Checked:**	DK

Groundwater Record	Sample	Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition / Weathering	Strength/ Relative Density	Hand Penetrometer Readings (kPa)	Remarks
			1			FILL: mixture of clayey sand with sandstone gravel (generally ripped sandst.)				
After 3 Days		N=3 (2,1,2)	2			SILTY SAND: grading to CLAYEY SAND: dark grey then light grey	VL	VL		
						grading to:				
		N=15 (4,6,9)	3		CL/CH	SILTY CLAY: medium to high plasticity: grey with red brown mottling	M≥PL	Vst.		
During Drilling			4							
						grading to:				
		N=11 (8,4,7)	5		SC	CLAYEY SAND: grey with red brown mottling		MD		
			6							
		N=5 (2,3,2)	7			grading to:				
					SP	SAND: medium grained grey & brown		D		
		N=45 (10,20,25)	8							
						grading to:				
			9		CL	SANDY CLAY: medium plasticity grey & brown	M≤PL	H		
			10							
						END BH @ 10.0 m				
			11							
			12							

BOREHOLE LOG

No: 2

D. Katauskas
Consulting Geotechnical Engineer

Client:	GJW Consultancy	**Date:**	23 & 24/11/2015
Project:	Proposed New Development	**Job No:**	939
Location:	Dee Why Bowling Club, 221-223 Fisher Rd Nth, Dee Why		
Method:	Geoprobe 205 Auger Drill Rig	**RL:** / **Datum:**	
Logged:	DK	**Checked:**	DK

Groundwater Record	Sample	Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition / Weathering	Strength/ Relative Density	Hand Penetrometer Readings (kPa)	Remarks
			1			FILL: clayey sand, silty sand & ripped sandstone brown & grey				Poorly compacted
			2							
During Drilling			3		CL	SANDY CLAY: low to medium plasticity: grey	M≈PL	VSt		
		N=11 (3,6,5)				grading to:				
			4		SP	SAND: medium grained: light br.		MD		
		N=12 (3,6,6)				grading to:				
			5		CL	SANDY CLAY: medium plasticity	M≈PL	VSt		
			6			grading to:				
		N=27 (10,12,15)			SC	CLAYEY SAND:		MD		
			7			END BH@ 6.5m				
			8							
			9							
			10							
			11							
			12							

BOREHOLE LOG

No: 3

D. Katauskas
Consulting Geotechnical Engineer

Client:	GJW Consultancy	**Date:**	23 & 24/11/2015
Project:	Proposed New Development	**Job No:**	939
Location:	Dee Why Bowling Club, 221-223 Fisher Rd Nth, Dee Why		
Method:	Geoprobe 205 Auger Drill Rig	**RL:** / **Datum:**	
Logged:	DK	**Checked:**	DK

Groundwater Record	Sample	Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition / Weathering	Strength/ Relative Density	Hand Penetrometer Readings (kPa)	Remarks
				XXX		FILL: recycled concrete gravel				Driveway
			1		SC	CLAYEY SAND: light grey fines non plastic to low plasticity		L		
		N=7 (3,3,4)	2							
During Drilling						grading to:				
			3		CL	SANDY CLAY: low plasticity	M&PL	VSt		
		N=11 (8,5,6)								
			4			grading to:				
		N=8 (3,4,4)	5			as above but medium plasticity	M>PL	VSt		
			6			grading to:				
		N=15 (8,7,8)			SC	CLAYEY SAND: grey with brown mottling.		MD		
			7			END BH @ 6.5m				
			8							
			9							
			10							
			11							
			12							

BOREHOLE LOG

No: 4

D. Katauskas
Consulting Geotechnical Engineer

Client:	GJW Consultancy	**Date:**	23 & 24/11/2015
Project:	Proposed New Development	**Job No:**	939
Location:	Dee Why Bowling Club, 221-223 Fisher Rd Nth, Dee Why		
Method:	Geoprobe 205 Auger Drill Rig	**RL:** / **Datum:**	
Logged:	DK	**Checked:**	DK

Groundwater Record	Sample	Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition / Weathering	Strength / Relative Density	Hand Penetrometer Readings (kPa)	Remarks
						CONCRETE				APRON
						FILL: Clayey sand grey				
			1		SC	CLAYEY SAND: dark grey then light grey	M to W	L/MD		
		N=11 (4,5,6)	2							
▼ During Drilling						Grading to:				
					CL	SANDY CLAY: low to medium plasticity: grey with yellow brown mottling with interlayering clayey sand bands	MC>PL	VSt		
		N=10 (4,7,3)	3							
			4			Grading to: interlayered clayey sand & sandy clay				
		N=8 (4,3,5)	5							
						Grading to:				
		N=18 (9,11,7)	6		SP	SAND: medium grained Pinkish brown	W	MD		
			7			END BH@ 6.5m				
			8							
			9							
			10							
			11							
			12							

BOREHOLE LOG

No: 5

D. Katauskas
Consulting Geotechnical Engineer

Client:	GJW Consultancy	**Date:**	23 & 24/11/2015
Project:	Proposed New Development	**Job No:**	939
Location:	Dee Why Bowling Club, 221-223 Fisher Rd Nth, Dee Why		
Method:	Geoprobe 205 Auger Drill Rig	**RL:** / **Datum:**	
Logged:	DK	**Checked:**	DK

Groundwater Record	Sample	Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition / Weathering	Strength / Relative Density	Hand Penetrometer Readings (kPa)	Remarks
						TOPSOIL: clayey sand grey				
			1		SC	CLAYEY SAND: grey		L		
						grading to:				
					CL	SANDY CLAY: medium plasticity: grey	M>PL	St		
		N=11 (3,4,7)	2							
						grading to:				
▼ During Drilling			3		SC	CLAYEY SAND: mottled red brown & grey	W	VD		
		N=45 (9,19,26)								
			4			grading to:				
					CL	SANDY CLAY: low to medium plasticity: brown & grey	M≈PL	St		
		N=5 (5,2,3)	5							
						grading to				
			6		SC	CLAYEY SAND: mottled red brown & grey		MD		
		N=16 (5,7,9)								
			7			END BH@ 6.5m				
			8							
			9							
			10							
			11							
			12							

BOREHOLE LOG

No: 6

D. Katauskas
Consulting Geotechnical Engineer

Client:	GJW Consultancy	**Date:**	23 & 24/11/2015
Project:	Proposed New Development	**Job No:**	939
Location:	Dee Why Bowling Club, 221-223 Fisher Rd Nth, Dee Why		
Method:	Geoprobe 205 Auger Drill Rig	**RL:** / **Datum:**	
Logged:	DK	**Checked:**	DK

Groundwater Record	Sample	Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition / Weathering	Strength/ Relative Density	Hand Penetrometer Readings (kPa)	Remarks
						Topsoil over FILL: silty sand & clayey sand grey				
			1		SC	CLAYEY SAND: darkish grey	M	VL		
▼ After 3 Days		N=7 (1,3,4)	2			Grading to:				
					CL	SANDY CLAY: medium plasticity grey	M≥PL	VSt		
▼ During Drilling		N=21 (5,8,13)	3			Grading to:				
					SC	CLAYEY SAND: fines of Low plasticity	W	MD		
			4			Grading to:				
		N=10 (3,4,6)	5		CL	SANDY CLAY: medium plasticity grey	M≥PL	VSt		
			6							
		N=18 (4,7,11)								
			7			Grading to:				
					SC	SCLAYEY SAND: grey & red brown		MD		
			8							
						END BH @ 8.0m.				
			9							
			10							
			11							
			12							

BOREHOLE LOG

No: 7

D. Katauskas
Consulting Geotechnical Engineer

Client: GJW Consultancy **Date:** 23 & 24/11/2015
Project: Proposed New Development **Job No:** 939
Location: Dee Why Bowling Club, 221-223 Fisher Rd Nth, Dee Why
Method: Geoprobe 205 Auger Drill Rig **RL:** **Datum:** **Logged:** DK **Checked:** DK

Groundwater Record	Sample	Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition / Weathering	Strength/ Relative Density	Hand Penetrometer Readings (kPa)	Remarks
			1			FILL: sandy clay & clayey sand: dark grey				Poorly compacted
		N=10 (1, 4, 6)	2		SC	CLAYEY SAND: dark grey then grey	W	VL / L		
During Drilling		N=10 (4, 4, 6)	3		CL	Grading to: SANDY CLAY: low to medium Plasticity: light grey Some clayey sand bands	M≈PL	VSt		
		N=20 (2, 11, 9)	4		SC	Grading to: CLAYEY SAND: interlaced with sandy clay bands mottled grey & red brown		VSt (MD)		
			5							
			6							
			7			END BH@6.5m				
			8							
			9							
			10							
			11							
			12							

D. Katauskas
Consulting Geotechnical Engineer

LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record	▼	Standing water level. Time delay following completion of drilling may be shown.
	►	Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated
	DS	Small disturbed bag sample taken over depth indicated.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' noted below
	N_c = 5 . 7 . 3R	Dynamic Cone Penetration Test performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of Undrained Shear Strength
	PID = 100	Photoionization detector reading in ppm (Soil sample headspace test)
Moisture Condition (Cohesive Soils)	MC > PL	Moisture content estimated to be greater than plastic limit.
	MC = PL	Moisture content estimated to be approximately equal to plastic limit.
	MC < PL	Moisture content estimated to be less than plastic limit.
(Cohesionless Soils)	D	DRY - runs freely through fingers
	M	MOIST - does not run freely but no free water visible on soil surface
	W	WET - free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT - Unconfined compressive strength less than 25 kPa.
	S	SOFT - Unconfined compressive strength 25 – 50 kPa.
	F	FIRM - Unconfined compressive strength 50 – 100 kPa
	St	STIFF - Unconfined compressive strength 100 – 200 kPa
	VSt	VERY STIFF - Unconfined compressive strength 200 – 400 kPa
	H	HARD - Unconfined compressive strength greater than 400 kPa.
	( )	Bracketted symbol indicates estimated consistency based on tactile examination or other tests.

Density Index/ Relative density (Cohesionless Soils)		Density Index (I_D)	Range (%)	SPT 'N' Value range (Blows/ 300mm)
	VL	Very loose	<15	0 – 4
	L	Loose	15 – 35	4 – 10
	MD	Medium Dense	35 – 65	10 – 30
	D	Dense	65 – 85	30 – 50
	VD	Very Dense	>85	>50
	( )	Bracketted symbol indicates estimated density based on ease of drilling or other tests		

Hand Penetrometer Readings	300 250	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise.
Remarks	'V' bit	Hardened steel 'V' bit
	'TC' bit	Tungsten carbide wing bit
	T 60	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.

D. Katauskas
Consulting Geotechnical Engineer

GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS

SOIL


FILL


TOPSOIL


CLAY (CL, CH)


SILT (ML, MH)


SAND (SP, SW)


GRAVEL (GP, GW)


SANDY CLAY (CL, CH)


SILTY CLAY (CL, CH)


CLAYEY SAND (SC)


SILTY SAND (SM)


GRAVELLY CLAY (CL, CH)


CLAYEY GRAVEL (GC)


SANDY SILT (ML)


PEAT AND ORGANIC SOILS

ROCK


CONGLOMERATE


SANDSTONE


SHALE


SILTSTONE, MUDSTONE, CLAYSTONE


LIMESTONE


PHYLLITE, SCHIST


TUFF


GRANITE, GABBRO


DOLERITE, DIORITE


BASALT, ANDESITE


QUARTZITE

DEFECTS AND INCLUSIONS


CLAY SEAM


SHEARED OR CRUSHED SEAM


BRECCIATED OR SHATTERED SEAM/ZONE


IRONSTONE GRAVEL


ORGANIC MATERIAL

OTHER MATERIALS


CONCRETE

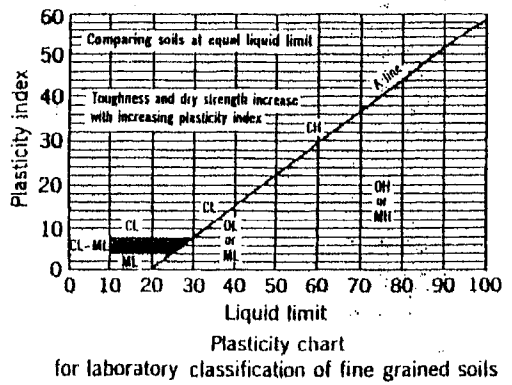

BITUMINOUS CONCRETE, COAL


COLLUVIUM

D. Katauskas
Consulting Geotechnical Engineer

UNIFIED SOIL CLASSIFICATION TABLE

Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights)						Group Symbols[a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils: More than half of material is *larger* than 75 μm sieve size[b] (The 75 μm sieve size is about the smallest particle visible to naked eye)	Gravels: More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	Use grain size curve in identifying the fractions as given under field identification Determine percentages of gravel and sand from grain size curve Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows: Less than 5%: *GW, GP, SW, SP* More than 12%: *GM, GC, SM, SC* 5% to 12%: *Borderline* cases requiring use of dual symbols
			Predominantly one size or a range of sizes with some intermediate sizes missing			*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)			*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)			*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		
	Sands: More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes			*SW*	Well graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *GW* Atterberg limits below "A" line, or *PI* less than 4 Atterberg limits above "A" line, with *PI* greater than 7 Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Predominantly one size or a range of sizes with some intermediate sizes missing			*SP*	Poorly graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *SW* Atterberg limits below "A" line or *PI* less than 5 Atterberg limits above "A" line with *PI* greater than 7 Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)			*SM*	Silty sands, poorly graded sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)			*SC*	Clayey sands, poorly graded sand-clay mixtures		
Fine-grained soils: More than half of material is *smaller* than 75 μm sieve size (The 75 μm sieve size is about the smallest particle visible to naked eye)	Identification Procedures on Fraction Smaller than 380 μm Sieve Size:		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)				
	Silts and clays: liquid limit less than 50		None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)	
			Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity		
	Silts and clays: liquid limit greater than 50		Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays		
			Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity		
Highly Organic Soils			Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils		



Plasticity chart
for laboratory classification of fine grained soils

NOTE: 1) Soils possessing characteristics of two groups are designated by combinations of group symbols (e.g. GW-GC, well graded gravel-sand mixture with clay fines).

2) Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.