

REPORT ON GEOTECHNICAL INVESTIGATION

GARDENS TENNIS – TENNIS COURT CRACKING ASSESSMENT

Reference: U23991



Prepared for
Gardens Tennis

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Document Control

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Letter of Transmittal

Gardens Tennis
Darwin Tennis Association
GPO Box 2514
DARWIN NT 0801

Attention: Charles Webb

Dear Charles,

A geotechnical investigation was undertaken by Cardno Ullman & Nolan Geotechnic (Cardno UNG) at the Gardens Tennis Complex, Gilruth Avenue, The Gardens NT (herein referred to as 'the site').

The objectives of the investigation was to identify the subsurface conditions at the location and ascertain the underlying causes that are causing the failure and degradation of the playing surface. On development of a conceptual ground model Cardno has provided recommendations on appropriate remedial/redevelopment works.

In total, eight (8) boreholes were positioned across the site and drilled using auger techniques to target depths ranging between 3 and 7.5 metres below existing ground level. Based on the field investigation undertaken, the site is generally underlain by topsoil overlying silty sand.

The consistency of the profile generally comprised of loose to medium dense sands, the consistency generally increasing with depth. However in BH04, BH05, BH06 and BH07 very loose to loose sands were encountered to depths up to 1.2 to 2.3mbgl.

This report provides comments on the geotechnical characteristics of the site and presents geotechnical parameters considered appropriate for future design and construction. The recommendations are based on the results of the field investigation and laboratory testing.

Based on the findings of the field investigation, the high proportion of sandy soils encountered the site, we consider that the site may be classified as a **Class P** in accordance with AS2870.

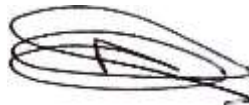
The possible causes of the pavement failure are discussed with options provided for rehabilitation and repair.

We trust this report meets your requirements. Should you wish to discuss any matters raised in the report, please do not hesitate to contact the undersigned.

Kind regards,



Matthew Thorogood
Engineering Geologist
BEng (Hons), FGS
For **Cardno Ullman & Nolan Geotechnic (NT)**



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1 Introduction

Cardno Ullman & Nolan Geotechnic (Cardno UNG) were commissioned by Darwin Tennis Association / Gardens Tennis to undertake a geotechnical investigation at the site of the Gardens Tennis Complex situated along Gilruth Avenue in the Gardens, Darwin NT. The site location is defined in the figure below and on the site plan presented in Appendix A.



Figure 1 Location of the study site (red) Gilruth Avenue, The Gardens, Darwin NT (Nearmap.com)

The objectives of this investigation was to investigate the subsurface geological conditions within the site and provide geotechnical interpretation as to the underlying cause of the failure across the tennis courts and to make recommendations on appropriate remedial/redevelopment works.

The geotechnical investigation undertaken by Cardno UNG comprised:

- > Review of project documentation provided and relevant geological literature;
- > Drilling of boreholes and *insitu* testing;
- > Laboratory testing of selected samples; and
- > Analysis of field and laboratory test results and compiling this geotechnical report.

The field investigation, laboratory testing and geotechnical assessment were undertaken with reference to the following Australian Standards:

- > Australian Standard AS1726 – Geotechnical Site Investigations;
- > Australian Standards AS1289 – Methods of Testing Soil for Engineering Purposes;
- > Australian Standards AS2870 – Residential Slabs and Footings; and
- > Australian Standard AS3798 – Guidelines on Earthworks for Commercial and Residential Developments.

2 Scope of Work

The commission has been carried out to the agreed scope of work set out by Cardno UNG, with reference to the Cardno UNG fee proposal, referenced WG15122, dated 17 August 2015.

2.1 Field Investigation

In discussion with the client representatives test locations were positioned across the site, taking into account general site coverage, areas prone to water ponding, and previous failure as well as buried service locations. At the time of the field investigation, test locations were recorded using a hand-held GPS to an accuracy of ± 4.0 metres.

Subsurface conditions beneath the site were investigated by drilling eight (8) boreholes (nominated BH01 to BH08) and the development of four (4) piezometer standpipes for groundwater monitoring. Boreholes were advanced to target depths ranging between 3.0 and 7.5 metres below existing ground level (mbgl). Boreholes were advanced using the Cardno trailer mounted IH3100 drill rig with a 100mm diameter solid-stem auger.

Adjacent to each borehole, Dynamic Cone Penetration (DCP) testing was carried out from the surface to a target depth of 1.5m. Limited additional testing in the form of Standard Penetration Tests (SPTs) were carried out at within the boreholes.

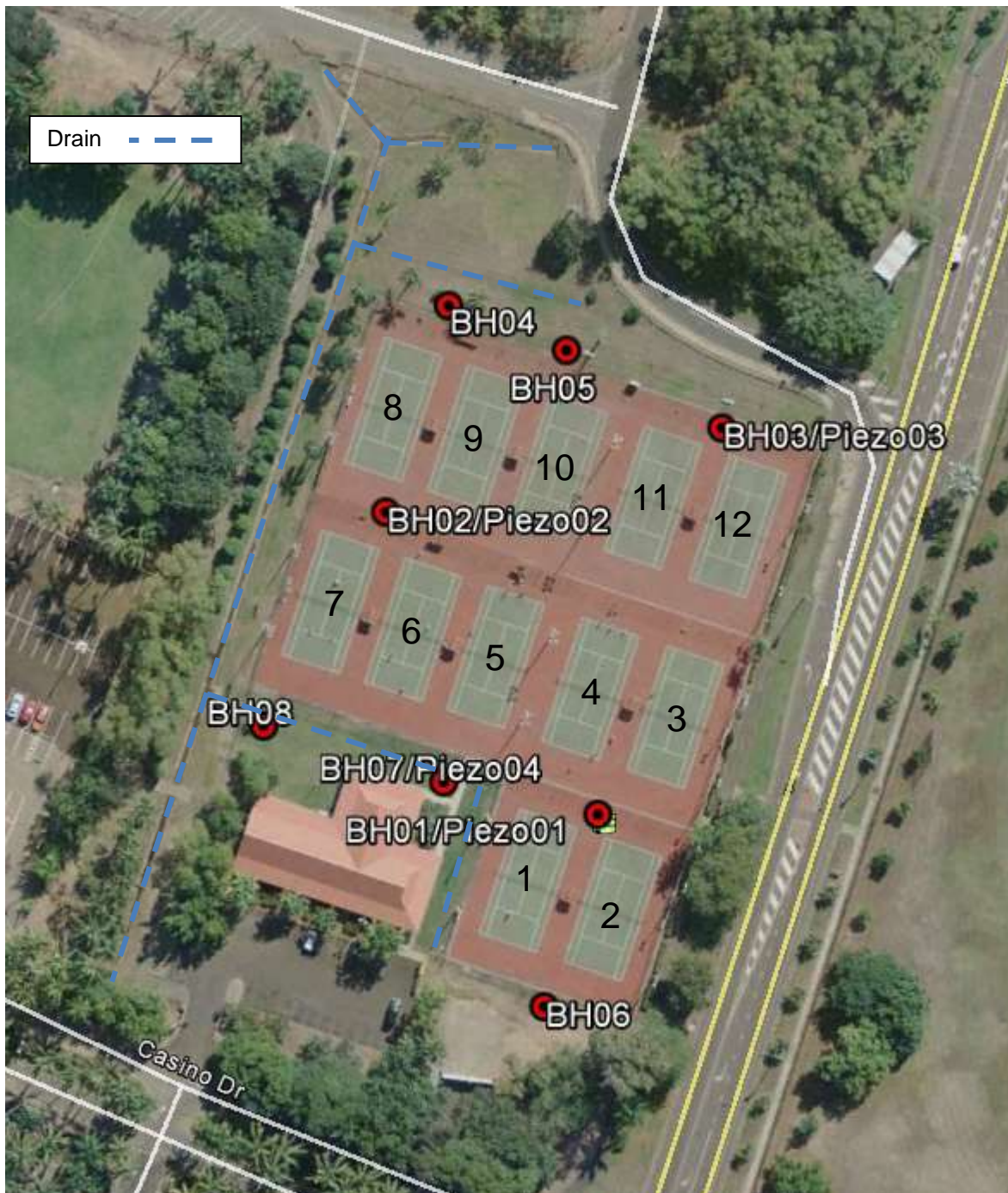
Materials encountered during the investigation were visually classified and logged on site by the supervising Engineering Geologist in accordance with AS1726. At this time, representative samples were collected from the recovered material and transported to our Darwin laboratory for testing.

A site plan showing the borehole locations, together with descriptive borehole logs and DCP test results are presented in Appendix A to C respectively.

Borehole locations are summarised in Table 2-1 below and are shown on the figure on the next page.

Table 2-1 Summary of subsurface material sequence

Location	Orientation onsite
BH01/Piezo01	On court surface at northern end of 1 & 2
BH02/Piezo02	On court surface at southern end of 8
BH03/Piezo03	On court surface at northern end of 11 & 12
BH04	Off court surface at northern end of 8 on raised embankment, adjacent to large drain
BH05	Off court surface at northern end of 10 on raised embankment, adjacent to large drain
BH06	Off court surface at southern end of 1 & 2
BH07/Piezo04	Off court surface at southern end of 5 adjacent to large drain
BH08	Off court surface at southern end of 7 adjacent to junction between two large drains



2.2 Laboratory Testing

Laboratory testing of selected samples is undertaken to provide geomechanical data for engineering assessment, and to validate the material properties described in the geologists logs. Subsurface characteristics such as composition, strength and mechanical properties are evaluated through a range of laboratory testing.

Selected samples recovered from the boreholes at the time of the field investigation were submitted for the following laboratory tests:

- > Particle size distribution (AS1289.3.6.1);
- > Atterberg limits and linear shrinkage (AS1289.3.1.1, AS1289.3.2.1, AS1289.3.3.1, AS1289.3.4.1,);
- > Modified maximum dry density and optimum moisture content (AS1289.5.2.1); and
- > 4-day soaked California Bearing Ratio at 95% modified maximum dry density (AS1289.6.1.1).

The classification testing was carried out at our NATA accredited Darwin laboratory. Laboratory test results are summarised in Table 4-1 with the laboratory test reports presented in Appendix D.

2.3 Groundwater Monitoring

Groundwater monitoring was undertaken at selected boreholes, with piezometer (standpipes) groundwater monitoring wells installed at four (4) of the borehole locations. Groundwater level monitoring was undertaken on several occasions following the installation of the piezometers to provide data on groundwater level variation to assess the likelihood of tidal or seasonal influence and the potential of fluctuating groundwater impacting on the subgrade of the tennis courts. The results are shown in Table 3.2 on page 11.

3 Site Conditions

3.1 Regional Geology

The regional geology of the area is described in the published map and information from the Northern Territory Geological Survey (NTGS), 1:100,000 Geological Map Series titled Darwin and associated map, Sheet 5073.

The region exhibits numerous units from a range of geological formations. Principally the area is underlain by the Darwin Member which underlies most of Darwin City (Basal member of the Bathurst Island Formation) of the Early Cretaceous period (~100Mya) overlying the Burrell Creek Formation (Finniss River Group). The Darwin Member consists of claystones (radiolarian and sandy), sandstones (clayey, quartzitic, and ferruginous/glaucconitic), and basal conglomerate units, deposited under shallow marine to paralic (coastal) environments. The formation is commonly referenced as being flat-lying, horizontal beds with a regional dip of 1° to the north; however, strata dip greater than this and striking in varying directions locally.

Within the Darwin Member, at depth, the claystone is montmorillonitic and commonly calcareous. Deep lateritic weathering has changed primary montmorillonitic clay to kaolin with the dissolution and redeposition of iron oxidise and silica (duricrusts). Exposures of the Darwin Member show wide colour variation and mottling due to selective leaching and redeposition of iron oxides (laterite). Silicification in places has produced a moderately hard silcrete-duricrust which is referred to locally as porcellanite.

An unconformity exists between the Darwin Member and the underlying Burrell Creek Formation. The Burrell Creek Formation comprises steeply dipping Proterozoic (~1,700Ma) metasediments. This highly weathered siltstone member was identified at the base of the cliff face along the length of Emery Court. This material was identified as low strength, highly micaceous phyllite and was notably weaker than the overlying conglomerate and porcellanite.

Recent Tertiary (Cainozoic) deposits of unconsolidated sand, clayey sand, ferruginous clayey sand and laterite profiles occur as a thin cover over the lower Burrell Creek and Bathurst Island Formations.

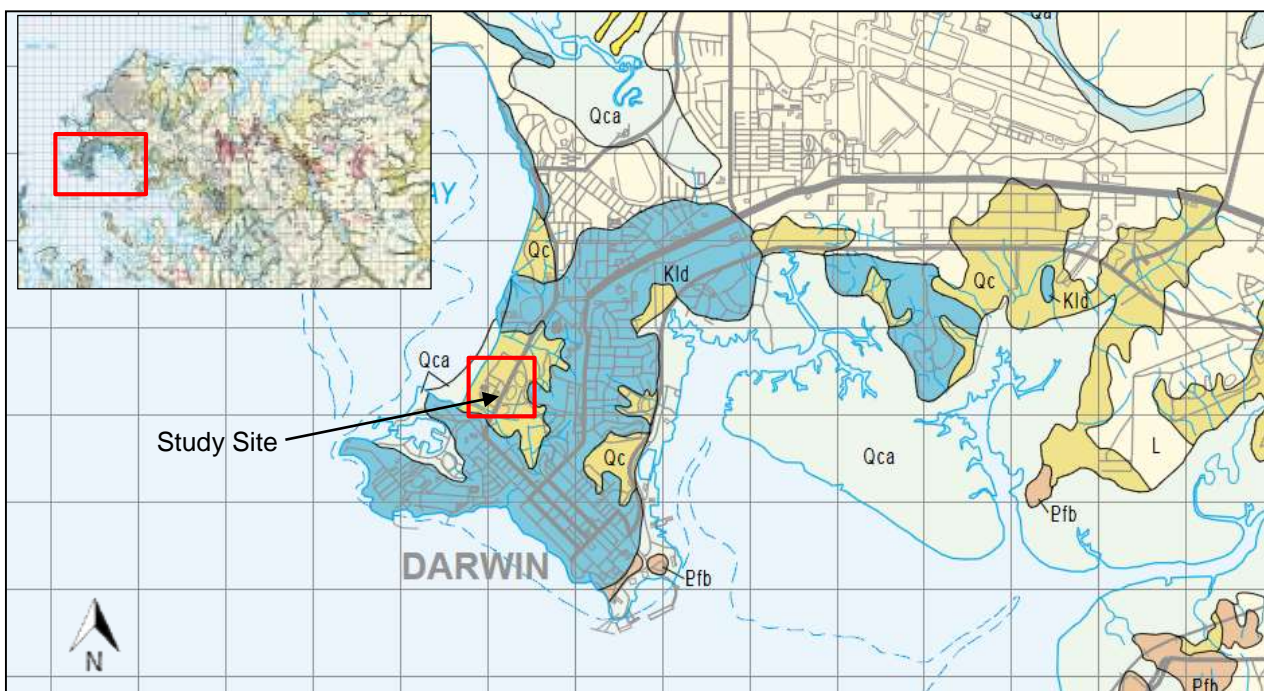


Figure 2 Regional geology of the Darwin Area (Extractive Geology from the Outer Darwin Area 1:100k geological map, part sheets 5072, 5073, 5172 and 5173).

The geological map provided as figure 2 indicates the site falls within proximity of the Darwin Formation (K_{ld}), coastal alluvium deposits (Q_{ca}) and slope wash deposits (Q_c). The Burrell Creek Formation (phyllite) and the Darwin Member (the overlying porcellanite) are associated with higher ground of The gardens and Larrakeyah areas.

3.2 Site Description

The Gardens Tennis complex is situated along Gilruth Avenue between the Sky City casino access and Mindil Beach, The Gardens, Darwin NT, approximately 2km northwest of the Darwin CBD. With the exception of the Casino, the local area is generally undeveloped, comprising of golf course, Mindil beach, little Mindil and the Gardens Oval AFL fields. The tennis complex comprises of clubhouse with large covered patio area, small paved carpark and twelve (12) fenced tennis courts.

The general presentation of the tennis courts seems to be in reasonable condition though representatives of Gardens Tennis identified several courts that are currently considered unsafe to play and localised depressions at the surface where ponding occurs.

The topography of the site and immediate surrounding area comprises of gently sloping to level ground. The low-lying area of the tennis complex and The Gardens is downslope within a distinct water catchment that drains via Mindil Beach to the sea. As previously mentioned the area is generally undeveloped and underlain by sandy soils.

The existing drainage system appears to be inadequate to manage the heavy rainfall events associated with the wet season. During the investigation (February – mid wet season) the site was visited following considerable rainfall events. On several occasions it was noted that the surrounding drainage was inundated and not running. It is likely that the site drainage is being saturated by water running into the area from elsewhere within the catchment. This inundation can be exacerbated by the presence of high tides resulting in localised tide locking of drains or even tidal inundation. Selected site photographs are presented in Appendix E.

3.3 Subsurface Profile

The subsurface profile was investigated by drilling a total of eight (8) boreholes (nominated as BH01 to BH08) across the site. Boreholes were advanced to a target depth of 3.0m though at three locations BH01, BH05 and BH06 target depths were extended to 3.5mbgl, 7.5mbgl and 4.95mbgl respectively. All boreholes were conducted as proposed, however at piezometer 4 was developed in BH07 rather than BH08 due to unfavourable ground conditions being encountered. Unexpectedly a redundant service trench was encountered within BH02 composed of stabilised sand with old copper cable between 0.5 and 1.0mbgl. Additional SPTs were conducted within some boreholes to support the geologist's logs.

The material sequence encountered in the boreholes generally comprised topsoil or fill overlying marine sand (beach sand) and silty sand (mangrove deposits) to termination. Insitu testing and drilling observations indicate the consistency of soils as loose to medium dense, with sporadic harder and softer layers throughout.

The subsurface conditions encountered at each borehole location is summarised in Table 3-1 on the following page.

Table 3-1 Summary of subsurface material sequence

Location	Strata				
	Topsoil / subsoil	Fill (pavement/court construction)	Fill (other)	Sand (beach deposits)	Silty Sand (mangrove mud)
BH01	-	0.00 – 0.80	-	0.80 – 2.50	2.50 – 3.50*
BH02	-	0.00 – 0.45	0.45 – 1.00	1.00 – 1.50	1.50 – 3.00*
BH03	-	0.00 – 0.50	-	0.50 – 2.40	2.40 – 3.00*
BH04	0.00 – 0.10	-	0.10 – 1.50	1.50 – 1.65	1.65 – 3.00*
BH05	0.00 – 0.10	-	0.10 – 0.95	0.95 – 1.55	1.55 – 7.50*
BH06	0.00 – 0.55	-	-	0.55 – 2.80	2.80 – 4.95*
BH07	0.00 – 0.15	-	0.15 – 1.05	1.05 – 1.40	1.40 – 3.00*
BH08	-	-	0.00 – 0.50	0.50 – 1.40	1.40 – 3.00*

* Termination depth

- Not encountered

3.4 Groundwater

At the time of the investigation (February – mid wet season), groundwater was encountered at each of the borehole locations within 1.00m of the existing ground surface. Throughout the year, the groundwater table is likely to fluctuate significantly as a result of changes in seasonal weather conditions. Typical groundwater levels within the Darwin area can vary as much as 8 to 9m between the dryer and wetter months, with a mean groundwater level around 5 to 7m. However, localised groundwater level is influenced by several components; including rainfall intensity and duration, soil permeability, surface and sub-surface drainage, proximity to water bodies, tides etc.

It is also likely that perched water may occur, following periods of intense rainfall, over less permeable clayey layers or an interface between soil and rock.

Four (4) groundwater monitoring wells (piezometers) were constructed as part of this investigation. Monitoring was undertaken following during wetter and dryer periods at high and low tide in an attempt to identify the key influences on groundwater.

Table 3-2 Summary of groundwater monitoring results

Date / Time	Approximate Tide Level	Location, GW Level mbgl			
		BH01 / PIEZO01	BH02 / PIEZO02	BH03 / PIEZO03	BH07 / PIEZO04
11/03/16					
08:10	7.62	0.78	0.63	0.70	0.73
10:05	5.54	0.75	0.43	0.61	0.50
12:10	2.20	0.73	0.43	0.63	0.51
22/03/16					
10:10	3.00	0.63	0.59	0.54	0.62
12:15	1.93	0.635	0.585	0.54	0.63
14:15	3.21	0.63	0.59	0.54	0.62

A review of the Northern Territory Government Department of Land Resource Management groundwater database was undertaken to identify the registered wells within the general area of the site. The database identified the closest groundwater well to the study site being situated 9km northeast of the site within Marrara, NT. However within this well, monitoring of groundwater level was only carried out for a 10 month period in 1981. Details of this registered well and recorded groundwater data (m below measured reference point) is summarised in Figure 3 below.

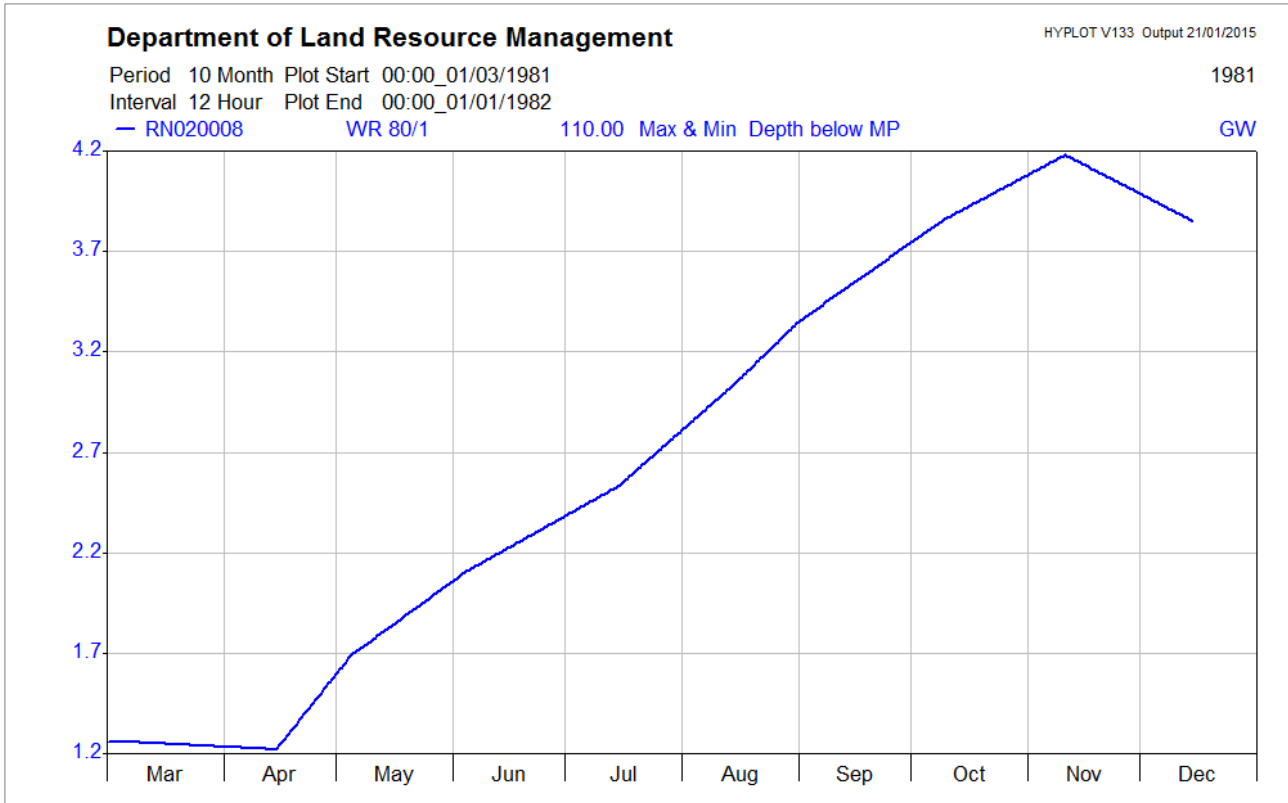


Figure 3: Recorded groundwater levels for registered well RN020008 between March and December 1981 (Department of Land Resource Management, www.lrm.nt.gov.au)

This is considered a typical groundwater depth curve for this part of Darwin. However, some wet seasons can be heavier resulting in protracted shallower depths.

4 Engineering Assessment

The engineering assessment presented herein has been based on observation made during the site investigation, the material succession encountered within the boreholes together with the field and laboratory test results.

4.1 Laboratory Test Results

A summary of the laboratory test result is provided in Table 4-1 below. Full laboratory test reports are presented in Appendix D.

Table 4-1 Summary of laboratory test results

Borehole	Depth (m)	Material Description (Classification)	Grading		Atterberg Limits (%)		OMC (%)	MMDD (t/m ³)	CBR ¹ (%)
			Sieve Size (mm)	Passing (%)	LL	PL			
BH05	1.90 – 2.30	Clayey gravelly sand (SC)	19.0	100	LL	33	-	-	-
			4.75	92	PL	25			
			2.36	87	PI	8			
			0.075	10	LS	3.5			
BH06	0.30 – 0.55		19.0	100	LL	N/O	14.0	1.88	35
			4.75	100	PL	N/O			
			2.36	98	PI	N/P			
			0.075	26	LS	0.00			
BH06	4.50 – 4.95		19.0	100	LL	N/O	-	-	-
			4.75	96	PL	N/O			
			2.36	90	PI	N/P			
			0.075	12	LS	0.0			

Legend:

Grading	=	Particle Size Distribution	OMC	=	Optimum Moisture Content
LL	=	Liquid Limit	MMDD	=	Modified Maximum Dry Density
PL	=	Plastic Limit	CBR ¹	=	California Bearing Ratio @ 95% MMDD
PI	=	Plasticity Index			
LS	=	Linear Shrinkage			

4.2 The Existing Court Pavement and Remediation Strategy

The tennis courts show surface cracking and distress in many areas with probably the worst area being around BH1. The distress comprises cracking (without vertical displacement) and some pitting and surface break-up. The boreholes have shown that the pavement thicknesses vary as do the materials used in the pavement. This may be a result of the somewhat sporadic development of the facility. It is therefore likely that the materials will vary in the different stages of court development.

The quality of the pavement materials have not been specifically tested during the investigation but may have contributed as a cause to the breakdown of the surface.

The main likely cause of the pavement cracking and break-up is moisture change in the subgrade causing seasonal changes in movement. Although the soils are predominantly sand, the significant fluctuations in the groundwater table can cause pavements to crack. Corrosion in the aggregates in the pavement may also be a cause.

The drainage is regarded as poor across the whole tennis court area and overland flow may also contribute to water occasionally ponding in some areas,

4.2.1 **Remediation Options**

Superficial, yet cheaper, surface applications of new playing surfaces is regarded as a short term fix only. In the more distressed area we consider the best option will be to remedy the root causes of the problem namely improve the court surface and subsurface drainage. Also replacing and reprofiling the court surfaces should be considered to enhance the drainage and to strengthen the pavement. This will involve replacing some or all of the pavements.

4.3 **Site Reactivity and Classification**

The proposed structure may be outside the intent of AS2870-Residential Slabs and Footings, but the site classification may still be used as a guide to the predicted ground surface movement as a result of soil moisture variations.

Based on the findings of the field investigation where fill was found around BH1 to 3 up to 800mm, then this area is classed as P in terms of AS2870. The remainder of the site did not show obvious fill and based on the low proportion of low-plasticity soils found in the upper stratum of the site, we consider that this area of the site may be classified as a Class S. A characteristic ground surface movement as a result of moisture variation (γ_s) in the order of 10 to 15mm has been estimated for the subsurface profile encountered.

4.4 **Allowable Bearing Pressure**

Although this assessment is not principally related to new structures this may be needed for future developments. Dynamic Cone Penetrometer tests (DCPs) and Standard Penetration Tests (SPTs) were undertaken at the time of the investigation to assess the consistency of the underlying soil and rock profile. An allowable bearing capacity assessment using material descriptions and strengths obtained from the geologist's borehole logs and field test results has been carried out for shallow foundations. This assessment has assumed 1.0m wide pad footing with groundwater at shallow levels. The summary of allowable bearing capacity with depth is presented in Table 4-2 below.

Table 4-2 Summary of allowable bearing capacities

Strata	Depth (m)	Allowable Bearing Capacity (kPa)
Fill (other)	0.00 – 0.8	50
Sand (beach deposits)	0.50 – 2.80	100
Silty Sand (mangrove mud)	1.40 – 3.00	Not advised

The soils are basically beach sands overlying mangrove mud hence any heavy structures or earthworks could cause settlement or consolidation of the lower horizons.

4.5 **General Earthworks Recommendations**

This section applies to all earthworks required for any construction preparation for the project. It is recommended that all earthworks on site are carried out in accordance with the project specifications and drawings, with reference to AS3798-*Guidelines on Earthworks for Commercial and Residential Developments*.

4.5.1 **Stripping Requirements**

It is recommended that all topsoil and uncontrolled fill be stripped from within the future court footprint and either removed from site or stockpiled for landscaping purposes. Unsuitable material should be defined in the design specification. Any soft or loose areas that are identified at foundation level may need to be removed and replaced with more competent material.

4.5.2 Site Filling

It is recommended that any earthworks are carried out with consideration to Section 8.2 of AS 3798 and in strict accordance with compaction, supervision and testing requirements specified in the project specifications and drawings.

Any proposed fill should be placed in layers not exceeding 200mm (loose thickness) and compacted to a dry density ratio of not less than 95% of Modified Maximum Dry Density (MMDD) and no more than $\pm 2.0\%$ of Optimum Moisture Content (OMC).

Where excavated material is to be re-used onsite, conformance testing should also be carried out at regular intervals during construction to ensure specified material properties have been achieved. Testing should comprise of Particle Size Distribution, Atterberg Limits, Linear Shrinkage and California Bearing Ratio (CBR incl MMDD) as a minimum.

4.5.3 Excavatability

Based on the field investigation and testing, we can estimate the excavatability using the Kirsten's Classification System (Table 4-3).

A summary of the excavatability of various materials encountered at each of the investigation sites is considered to be Class 1 to 2.

Table 4-3 Definition of Eight Point Excavation Classification System for Soil and Rock

Material Type	Material Excavation Classification ⁽¹⁾		Description of excavatability
	Class	Class index boundaries	
Soil / Detritus	1	$N < 0.01$	Hand spade
	2	$0.01 < N < 0.1$	Hand pick and spade
	3	$0.1 < N < 1.0$	Power tools
Rock	4	$1.0 < N < 10$	Easy ripping
	5	$10 < N < 100$	Hard ripping
	6	$100 < N < 1,000$	Very hard ripping
	7	$1,000 < N < 10,000$	Extremely hard ripping/blasting
	8	$N < 10,000$	Blasting

Note: ⁽¹⁾ Kirsten Classification System

5 Limitations

Geotechnical services are provided by Cardno UNG in accordance with generally accepted professional engineering and geological practice in the area where these services are rendered. The client acknowledges that the present standard in the engineering, geological and environmental profession does not include a guarantee of perfection, and no other warranty, expressed or implied, is extended by Cardno UNG.

It is the reader's responsibility to verify the correct interpretation and intention of the recommendations presented herein. Cardno UNG assumes no responsibility for misunderstandings or improper interpretations that result in unsatisfactory or unsafe work products. It is the reader's further responsibility to acquire copies of any supplemental reports, addenda or responses to public agency reviews that may supersede recommendations in this report.


The findings presented in this report have been based on the investigation described herein. There are always some variations in subsurface conditions across a site, which cannot be fully defined by investigation. It is unlikely that the measurements and values obtained from sampling and testing during the investigation will represent the extremes of conditions that may exist within the site. Hence it is recommended that if any ground conditions significantly different to those described in this report are encountered during construction, further advice should be immediately sought from Cardno UNG.

This report has been prepared specifically for Darwin Tennis Association "Gardens Tennis". Information contained in this report should not be construed as appropriate for other purposes or other users.

APPENDIX A

Site Plan



Job No. U23991 UNG DWG No. 23991_1A Date 1/04/2016	Checked ML	Notes <small>© Cardno (Qld) Pty Ltd All Rights Reserved 2005.</small> Copyright in the whole and every part of this drawing belongs to Cardno (Qld) Pty Ltd and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or on any media, to any person other than by agreement with Cardno (Qld) Pty Ltd. This document is produced by Cardno (Qld) Pty Ltd solely for the benefit of and use by the client in accordance with the terms of the retainer. Cardno (Qld) Pty Ltd does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by third party on the content of this document.	 Cardno Ullman & Nolan Geotechnic Pty Ltd ACN: 103 205 205 71 Connors Road, Mackay 4740 P.O. Box 5630, Mackay 4741 Email: soils@cardno.com.au Phone (07) 4952 5255 Fax (07) 4952 5455	Gardens Tennis	Scale at A4 NTS
	Date 14/04/2016			Approximate Borehole Location Plan Gardens Tennis Complex Gilruth Ave, The Gardens NT	Drawing No. Figure 1

APPENDIX B

Descriptive Engineering Borehole Logs

Client : Gardens Tennis	Hole Commenced : 12.2.16	Contractor : Cardno
Project : Geotechnical Investigation	Hole Completed : 12.2.16	Drill Rig : IH3100 Drill Rig
Job No : U23991	Logged By : MT	Mounting : Trailer
Site : Gardens Tennis Complex	Checked By : AW	Diameter: 100 mm
Location : Refer to Figure	Surface R.L. (m) : AHD	Coords : GDA 94 52L

STRATA				VISUAL SOIL DESCRIPTION			DRILLING			TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Method & Bit	Support	Sampling	Testing
0.06			Pt			Court surface; (PAVEMENT)				
			SP	M		Gravelly Sand; pale brown, fine to coarse grained, fine to coarse, sub-rounded gravel, with silt (SELECT FILL) MPS 8 LL 15 P75 10				
0.5										
0.80										
1.0					MD - D	Silty Sand; very pale brown with pale grey and yellow flecks, fine to coarse grained, trace fine to medium, rounded to sub-rounded gravel, shell fragments throughout (MARINE DEPOSITS) MPS 5 LL 15 P75 5				
1.5			SW							
2.0				W						
2.5										
3.0			SM			Silty Sand; dark green/brown/grey, fine to coarse grained, shell fragments throughout MPS 3 LL 15 P75 15	A T	N	3.00m	
3.5						BH01 TERMINATED AT 3.50 m Target depth Groundwater encountered at 0.8mbgl Borehole stable Located off court between courts 1-4 Photos Taken				SPT 1, 0, 1 N=1

CU_LIB_06.GLB_Log_BOREHOLE WITH DCF U23986 LOGS.GPJ <-DrawingFiles> 24/03/2016 16:09 8.30.003 Developed by Datgel

Moisture	Consistency	Visual Description	Method	Bit	Support	Sampling
D Dry	VS very soft	MPS Maximum particle size	A Auger	R Roller	C Casing	U Undisturbed Sample & Size in mm
M Moist	S soft	LL Liquid Limit	W Washbore	B Blank	M Mud	D Disturbed Sample
W Wet	F firm	P75 % passing 75um sieve	P Percussion	V V bit	N Nil	N Standard Penetration Test & Result
	St stiff		H Hammer	T TC bit		PP Pocket Penetrometer Value
	VSt very stiff		C Core	D Diamond		B Bulk Sample
	H hard		R Rotary air flush			ES Environmental Sample
	VL very loose		V Vibrocore			LAB Sample sent to Lab
	L loose					DUP Duplicate Sample
	MD medium dense					SPLIT Split Sample
	D dense					
	VD very dense					

Client : Gardens Tennis
Project : Geotechnical Investigation
Job No : U23991
Site : Gardens Tennis Complex
Location : Refer to Figure

Hole Commenced : 12.2.16
Hole Completed : 12.2.16
Logged By : MT
Checked By : AW
Surface R.L. (m) : AHD

Contractor : Cardno
Drill Rig : IH3100 Drill Rig
Mounting : Trailer
Diameter: 100 mm
Coords : GDA 94 52L

STRATA				VISUAL SOIL DESCRIPTION			DRILLING			TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Method & Bit	Support	Sampling	Testing
0.06			Pt			Court surface; (PAVEMENT)				
			GC			Clayey Sandy Gravel; pale red/brown mottled grey and purple, fine to coarse grained, sub-angular to sub-rounded, fine to coarse sand (SELECT FILL) MPS 14 LL 30 P75 15				
0.45				M		Sand; grey/brown, fine to coarse grained, (STABILISED SAND) (FILL) MPS 2 LL 0 P75 10				
0.5			SW							
1.0			SW		D	Sand; brown, fine to coarse grained, shell fragments throughout (MARINE DEPOSITS) MPS 2 P75 0				
1.25			SM			Silty Sand; brown, fine to coarse grained, shell fragments throughout MPS 2 LL 20 P75 15				
1.5						Silty Sand; dark green/brown/grey, fine to coarse grained, shell fragments throughout MPS 2 LL 20 P75 15	A T	N		
2.0			SM	W	MD					
2.5										
3.0					D					
3.5						BH02 TERMINATED AT 3.00 m Target depth Groundwater encountered at 1.0mbgl Borehole stable Located off court between courts 6-9 Photos Taken				






CU_LIB_06.GLB_Log_BOREHOLE WITH DCF_U23986 LOGS.GPJ <-DrawingFiles> 24/03/2016 16:09 8.30.003 Developed by Datgel

Moisture	Consistency	Visual Description	Method	Bit	Support	Sampling
D Dry	VS very soft	MPS Maximum particle size	A Auger	R Roller	C Casing	U Undisturbed Sample & Size in mm
M Moist	S soft	LL Liquid Limit	W Washbore	B Blank	M Mud	D Disturbed Sample
W Wet	F firm	P75 % passing 75um sieve	P Percussion	V V bit	N Nil	N Standard Penetration Test & Result
	St stiff		H Hammer	T TC bit		PP Pocket Penetrometer Value
	VSt very stiff		C Core	D Diamond		B Bulk Sample
	H hard		R Rotary air flush			ES Environmental Sample
	VL very loose		V Vibrocore			LAB Sample sent to Lab
	L loose					DUP Duplicate Sample
	MD medium dense					SPLIT Split Sample
	D dense					
	VD very dense					

Client : Gardens Tennis
Project : Geotechnical Investigation
Job No : U23991
Site : Gardens Tennis Complex
Location : Refer to Figure

Hole Commenced : 12.2.16
Hole Completed : 12.2.16
Logged By : MT
Checked By : AW
Surface R.L. (m) : AHD

Contractor : Cardno
Drill Rig : IH3100 Drill Rig
Mounting : Trailer
Diameter: 100 mm
Coords : GDA 94 52L

STRATA				VISUAL SOIL DESCRIPTION			DRILLING			TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Method & Bit	Support	Sampling	Testing
0.10			Pt			Court surface; (PAVEMENT)				
			GC	M		Clayey Sandy Gravel Brown; brown, fine to coarse grained, sub-angular to sub-rounded, fine to coarse sand (SELECT FILL) MPS 25 LL 30 P75 15				
0.5					D	Sand Dark yellow brown; dark yellow/brown, fine to coarse grained, trace fine to medium, sub-rounded gravel, trace silt, Shell fragments throughout (MARINE DEPOSITS) MPS 7 LL 15 P75 5				
1.0										
1.5			SP				A	N		
2.0				W			T			
2.40										
2.5			SM		MD - D	Silty Sand Green/brown/grey; dark green/brown/grey, fine to coarse grained, Shell fragments throughout, Flowing sands below the GW table MPS 2 LL 15 P75 15				
3.0						BH03 TERMINATED AT 3.00 m Target depth Groundwater encountered at 0.8mbgl Borehole stable Located off court between courts 11 & 12 Photos Taken				
3.5										

CU_LIB_06.GLB_Log_BOREHOLE WITH DCF_U23986 LOGS.GPJ <-DrawingFiles> 24/03/2016 16:09 8_30_003 Developed by Datigel

Moisture	Consistency	Visual Description	Method	Bit	Support	Sampling
D Dry	VS very soft	MPS Maximum particle size	A Auger	R Roller	C Casing	U Undisturbed Sample & Size in mm
M Moist	S soft	LL Liquid Limit	W Washbore	B Blank	M Mud	D Disturbed Sample
W Wet	F firm	P75 % passing 75um sieve	P Percussion	V V bit	N Nil	N Standard Penetration Test & Result
	St stiff		H Hammer	T TC bit		PP Pocket Penetrometer Value
	VSt very stiff		C Core	D Diamond		B Bulk Sample
	H hard		R Rotary air flush			ES Environmental Sample
	VL very loose		V Vibrocore			LAB Sample sent to Lab
	L loose					DUP Duplicate Sample
	MD medium dense					SPLIT Split Sample
	D dense					
	VD very dense					

Client : Gardens Tennis
Project : Geotechnical Investigation
Job No : U23991
Site : Gardens Tennis Complex
Location : Refer to Figure

Hole Commenced : 12.2.16
Hole Completed : 12.2.16
Logged By : MT
Checked By : AW
Surface R.L. (m) : AHD

Contractor : Cardno
Drill Rig : IH3100 Drill Rig
Mounting : Trailer
Diameter: 100 mm
Coords : GDA 94 52L

STRATA				VISUAL SOIL DESCRIPTION			DRILLING			TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Method & Bit	Support	Sampling	Testing
0.10			CI			Gravelly Sandy Clay ; dark brown, fine to coarse sand, fine to coarse, sub-angular to sub-rounded gravel (TOPSOIL) MPS 15 LL 30 P75 55				
0.5				M	MD - D	Silty Gravelly Sand ; pale brown mottled red and brown, fine to coarse grained, fine to coarse, sub-angular to sub-rounded gravel (SELECT FILL) MPS 14 LL 30 P75 15				
1.0			SM							
1.5					MD	Sand ; dark yellow/brown, fine to coarse grained, trace fine to medium, sub-rounded gravel, trace silt (MARINE DEPOSITS) MPS 7 LL 15 P75 5	A T	N		
1.65			SP							
2.0				W		Silty Sand ; dark green/brown/grey, fine to coarse grained MPS 2 LL 15 P75 15				
2.5			SM		L					
3.0					D					
3.0						BH04 TERMINATED AT 3.00 m Target depth Groundwater encountered at 1.3mbgl Borehole stable Located off courts 8 & 9 on nearby grass mount Photos Taken				
3.5										

CU_LIB_06.GLB Log BOREHOLE WITH DCF U23986 LOGS.GPJ <-DrawingFiles> 24/03/2016 16:09 8.30.003 Developed by Datgel

Moisture	Consistency	Visual Description	Method	Bit	Support	Sampling
D Dry	VS very soft	MPS Maximum particle size	A Auger	R Roller	C Casing	U Undisturbed Sample & Size in mm
M Moist	S soft	LL Liquid Limit	W Washbore	B Blank	M Mud	D Disturbed Sample
W Wet	F firm	P75 % passing 75um sieve	P Percussion	V V bit	N Nil	N Standard Penetration Test & Result
	St stiff		H Hammer	T TC bit		PP Pocket Penetrometer Value
	VSt very stiff		C Core	D Diamond		B Bulk Sample
	H hard		R Rotary air flush			ES Environmental Sample
	VL very loose		V Vibrocore			LAB Sample sent to Lab
	L loose					DUP Duplicate Sample
	MD medium dense					SPLIT Split Sample
	D dense					
	VD very dense					

Client : Gardens Tennis
Project : Geotechnical Investigation
Job No : U23991
Site : Gardens Tennis Complex
Location : Refer to Figure

Hole Commenced : 12.2.16
Hole Completed : 12.2.16
Logged By : MT
Checked By : AW
Surface R.L. (m) : AHD

Contractor : Cardno
Drill Rig : IH3100 Drill Rig
Mounting : Trailer
Diameter: 100 mm
Coords : GDA 94 52L

STRATA				VISUAL SOIL DESCRIPTION			DRILLING		TESTING	
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Method & Bit	Support	Sampling	Testing
0.10			SC	M	L - MD	Clayey Gravelly Sand ; dark brown, fine to coarse grained, fine to medium, sub-angular to sub-rounded gravel, rootlets throughout (TOPSOIL) MPS 20 LL 30 P75 15	A T	N	1.90m D-PI/PSD	
0.5			SC			Clayey Gravelly Sand ; pale brown mottled red/brown, fine to coarse grained, fine to medium, sub-angular to sub-rounded gravel (SELECT FILL) MPS 20 LL 30 P75 15				
0.95 1.0			CH	W		Sandy Clay ; very dark grey/black, fine to coarse grained, fine to coarse sand, with fine to medium, sub-angular to sub-rounded gravel, subtle organic odour (MARINE DEPOSITS) MPS 12 LL 60 P75 55				
1.25			SC			Clayey Gravelly Sand ; very dark brown, fine to coarse grained, fine to medium, sub-angular to sub-rounded gravel MPS 9 LL 30 P75 20				
1.5 1.55			SC		L	Clayey Sand ; dark gree/brown/grey, fine to coarse grained, with fine to medium, sub-angular to sub-rounded gravel MPS 5 LL 30 P75 20				
2.0										
2.5			SC		D					
3.0										
3.5										

CU_LIB_06.GLB_Log_BOREHOLE WITH DCF_U23986 LOGS.GPJ <-DrawingFiles> 24/03/2016 16:09 8.30.003 Developed by Datgel

Moisture	Consistency	Visual Description	Method	Bit	Support	Sampling
D Dry	VS very soft	MPS Maximum particle size	A Auger	R Roller	C Casing	U Undisturbed Sample & Size in mm
M Moist	S soft	LL Liquid Limit	W Washbore	B Blank	M Mud	D Disturbed Sample
W Wet	F firm	P75 % passing 75um sieve	P Percussion	V V bit	N Nil	N Standard Penetration Test & Result
	St stiff		H Hammer	T TC bit		PP Pocket Penetrometer Value
	VSt very stiff		C Core	D Diamond		B Bulk Sample
	H hard		R Rotary air flush			ES Environmental Sample
	VL very loose		V Vibrocore			LAB Sample sent to Lab
	L loose					DUP Duplicate Sample
	MD medium dense					SPLIT Split Sample
	D dense					
	VD very dense					

Client : Gardens Tennis
Project : Geotechnical Investigation
Job No : U23991
Site : Gardens Tennis Complex
Location : Refer to Figure

Hole Commenced : 12.2.16
Hole Completed : 12.2.16
Logged By : MT
Checked By : AW
Surface R.L. (m) : AHD

Contractor : Cardno
Drill Rig : IH3100 Drill Rig
Mounting : Trailer
Diameter: 100 mm
Coords : GDA 94 52L

STRATA				VISUAL SOIL DESCRIPTION			DRILLING			TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Method & Bit	Support	Sampling	Testing
4.5			SC	W		Clayey Sand ; dark gree/brown/grey, fine to coarse grained, with fine to medium, sub-angular to sub-rounded gravel MPS 5 LL 30 P75 20	A T	N		
5.0										
5.5										
6.0										
6.5										
7.0										
7.5						BH05 TERMINATED AT 7.50 m Target depth Groundwater encountered at 1.05mbgl Borehole stable Located off court 10 on nearby grass mound Photos Taken				

CU_LIB_06.GLB Log BOREHOLE WITH DCF U23986 LOGS.GPJ <-DrawingFiles> 24/03/2016 16:09 8.30.003 Developed by Datgel

Moisture		Consistency		Visual Description		Method		Bit		Support		Sampling	
D	Dry	VS	very soft	MPS	Maximum particle size	A	Auger	R	Roller	C	Casing	U	Undisturbed Sample & Size in mm
M	Moist	S	soft	LL	Liquid Limit	W	Washbore	B	Blank	M	Mud	D	Disturbed Sample
W	Wet	F	firm	P75	% passing 75um sieve	P	Percussion	V	V bit	N	Nil	N	Standard Penetration Test & Result
		St	stiff			H	Hammer	T	TC bit			PP	Pocket Penetrometer Value
		VSt	very stiff			C	Core	D	Diamond			B	Bulk Sample
		H	hard			R	Rotary air flush					ES	Environmental Sample
		VL	very loose			V	Vibrocore					LAB	Sample sent to Lab
		L	loose									DUP	Duplicate Sample
		MD	medium dense									SPLIT	Split Sample
		D	dense										
		VD	very dense										

Client : Gardens Tennis
Project : Geotechnical Investigation
Job No : U23991
Site : Gardens Tennis Complex
Location : Refer to Figure

Hole Commenced : 12.2.16
Hole Completed : 12.2.16
Logged By : MT
Checked By : AW
Surface R.L. (m) : AHD

Contractor : Cardno
Drill Rig : IH3100 Drill Rig
Mounting : Trailer
Diameter: 100 mm
Coords : GDA 94 52L

STRATA				VISUAL SOIL DESCRIPTION			DRILLING		TESTING	
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Method & Bit	Support	Sampling	Testing
0.35			SP	M	MD	Silty Sand ; pale brown, fine to coarse grained, with fine to medium, sub-angular to sub-rounded gravel (TOPSOIL) MPS 12 LL 20 P75 10			0.30m	
0.5			SP			Silty Sand ; brown, fine to coarse grained (NATURAL) MPS 2 LL 15 P75 10			B-CBR	
0.55						Gravelly Sand ; very pale brown with pale grey and yellow flecks, fine to coarse grained, fine, sub-angular to sub-rounded gravel, trace silt, shell fragments throughout (MARINE DEPOSITS) MPS 5 LL 15 P75 5				
1.0					L					
1.5			SW	W			A T	N		
2.0					MD					
2.5										
2.80			SM			Silty Sand ; dark green/brown/grey, fine to coarse grained, trace fine, sub-angular to sub-rounded gravel, shell fragments throughout MPS 3 LL 15 P75 10				

CU_LIB_06.GLB_Log_BOREHOLE WITH DCF U23986 LOGS.GPJ <<DrawingFiles>> 24/03/2016 16:09 8.30.003 Developed by Datgel

Moisture	Consistency	Visual Description	Method	Bit	Support	Sampling
D Dry	VS very soft	MPS Maximum particle size	A Auger	R Roller	C Casing	U Undisturbed Sample & Size in mm
M Moist	S soft	LL Liquid Limit	W Washbore	B Blank	M Mud	D Disturbed Sample
W Wet	F firm	P75 % passing 75um sieve	P Percussion	V V bit	N Nil	N Standard Penetration Test & Result
	St stiff		H Hammer	T TC bit		PP Pocket Penetrometer Value
	VSt very stiff		C Core	D Diamond		B Bulk Sample
	H hard		R Rotary air flush			ES Environmental Sample
	VL very loose		V Vibrocore			LAB Sample sent to Lab
	L loose					DUP Duplicate Sample
	MD medium dense					SPLIT Split Sample
	D dense					
	VD very dense					

Client : Gardens Tennis
Project : Geotechnical Investigation
Job No : U23991
Site : Gardens Tennis Complex
Location : Refer to Figure

Hole Commenced : 12.2.16
Hole Completed : 12.2.16
Logged By : MT
Checked By : AW
Surface R.L. (m) : AHD

Contractor : Cardno
Drill Rig : IH3100 Drill Rig
Mounting : Trailer
Diameter: 100 mm
Coords : GDA 94 52L

STRATA				VISUAL SOIL DESCRIPTION				DRILLING			TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Method & Bit	Support	Sampling	Testing	
3.5				W		Silty Sand ; dark green/brown/grey, fine to coarse grained, trace fine, sub-angular to sub-rounded gravel, shell fragments throughout MPS 3 LL 15 P75 10	A T	N			
4.0			SM								
4.5									4.50m D-PI/PSD	SPT 3, 3, 7 N=10	
4.95						BH06 TERMINATED AT 4.95 m Target depth Groundwater encountered at 0.55mbgl Borehole stable Located off courts 1 & 2 on nearby grass Photos Taken					
5.0											
5.5											




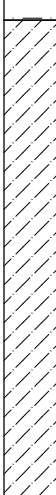
CU_LIB_06.GLB_Log_BOREHOLE WITH DCF U23986 LOGS.GPJ <<DrawingFiles>> 24/03/2016 16:09 8.30.003 Developed by Datgel

Moisture		Consistency		Visual Description		Method		Bit		Support		Sampling	
D	Dry	VS	very soft	MPS	Maximum particle size	A	Auger	R	Roller	C	Casing	U	Undisturbed Sample & Size in mm
M	Moist	S	soft	LL	Liquid Limit	W	Washbore	B	Blank	M	Mud	D	Disturbed Sample
W	Wet	F	firm	P75	% passing 75um sieve	P	Percussion	V	V bit	N	Nil	N	Standard Penetration Test & Result
		St	stiff			H	Hammer	T	TC bit			PP	Pocket Penetrometer Value
		VSt	very stiff			C	Core	D	Diamond			B	Bulk Sample
		H	hard			R	Rotary air flush					ES	Environmental Sample
		VL	very loose			V	Vibrocore					LAB	Sample sent to Lab
		L	loose									DUP	Duplicate Sample
		MD	medium dense									SPLIT	Split Sample
		D	dense										
		VD	very dense										

Client : Gardens Tennis
Project : Geotechnical Investigation
Job No : U23991
Site : Gardens Tennis Complex
Location : Refer to Figure

Hole Commenced : 12.2.16
Hole Completed : 12.2.16
Logged By : MT
Checked By : AW
Surface R.L. (m) : AHD

Contractor : Cardno
Drill Rig : IH3100 Drill Rig
Mounting : Trailer
Diameter: 100 mm
Coords : GDA 94 52L

STRATA				VISUAL SOIL DESCRIPTION			DRILLING			TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Method & Bit	Support	Sampling	Testing
0.15			CI	M	MD	Gravelly Sandy Clay ; dark brown, fine to coarse sand, fine to medium, sub-angular to sub-rounded gravel, rootlets throughout (TOPSOIL) MPS 8 LL 30 P75 55	A T	N		
0.5			GC			Clayey Sandy Gravel ; brown mottled orange/brown, fine to coarse grained, sub-angular to sub-rounded, fine to coarse sand, cobbles of quartz recovered (FILL) MPS 22 LL 35 P75 20				
1.0 1.05			SW	VL - L		Sand ; dark yellow/brown, fine to coarse grained, trace fine, sub-angular to sub-rounded gravel, trace silt, shell fragments throughout (MARINE DEPOSITS) MPS 5 LL 15 P75 5				
1.40 1.5			SM			Silty Sand ; dark green/brown/grey, fine to coarse grained, shell fragments throughout MPS 2 LL 25 P75 20				
2.0				W						
2.5					MD - D					
3.0						BH07 TERMINATED AT 3.00 m Target depth Groundwater encountered at 1.05mbgl Borehole stable Located off courts 1 & 5 on nearby grass slope Photos Taken				
3.5										





CU_LIB_06.GLB_Log_BOREHOLE WITH DCF U23986 LOGS.GPJ <-DrawingFiles> 24/03/2016 16:09 8_30_003 Developed by Datgel

Moisture	Consistency	Visual Description	Method	Bit	Support	Sampling
D Dry	VS very soft	MPS Maximum particle size	A Auger	R Roller	C Casing	U Undisturbed Sample & Size in mm
M Moist	S soft	LL Liquid Limit	W Washbore	B Blank	M Mud	D Disturbed Sample
W Wet	F firm	P75 % passing 75um sieve	P Percussion	V V bit	N Nil	N Standard Penetration Test & Result
	St stiff		H Hammer	T TC bit		PP Pocket Penetrometer Value
	VSt very stiff		C Core	D Diamond		B Bulk Sample
	H hard		R Rotary air flush			ES Environmental Sample
	VL very loose		V Vibrocore			LAB Sample sent to Lab
	L loose					DUP Duplicate Sample
	MD medium dense					SPLIT Split Sample
	D dense					
	VD very dense					

Client : Gardens Tennis
Project : Geotechnical Investigation
Job No : U23991
Site : Gardens Tennis Complex
Location : Refer to Figure

Hole Commenced : 12.2.16
Hole Completed : 12.2.16
Logged By : MT
Checked By : AW
Surface R.L. (m) : AHD

Contractor : Cardno
Drill Rig : IH3100 Drill Rig
Mounting : Trailer
Diameter: 100 mm
Coords : GDA 94 52L

STRATA				VISUAL SOIL DESCRIPTION			DRILLING			TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Method & Bit	Support	Sampling	Testing
0.5			GC	M		Clayey Sandy Gravel ; orange/brown mottled brown, fine to coarse grained, sub-angular to sub-rounded, fine to coarse sand, rubble/debris including part of old oil/fuel can (FILL) MPS 20 LL 30 P75 15	A T	N		
1.0			SM		L	Silty Sand ; pale brown, fine to coarse grained, shell fragments throughout (MARINE DEPOSITS) MPS 2 LL 15 P75 15				
1.5			W		MD	Clayey Sand ; dark green/brown/grey, fine to coarse grained, shell fragments throughout MPS 3 LL 35 P75 20				
2.0			SC							
3.0						BH08 TERMINATED AT 3.00 m Target depth Groundwater encountered at 0.50mbgl Borehole stable Located off court 7 on nearby grass adjacent to drain Photos Taken				
3.5										

CU_LIB_06.GLB Log BOREHOLE WITH DCF U23986 LOGS.GPJ <-DrawingFiles> 24/03/2016 16:09 8.30.003 Developed by Datgel

Moisture		Consistency		Visual Description		Method		Bit		Support		Sampling	
D	Dry	VS	very soft	MPS	Maximum particle size	A	Auger	R	Roller	C	Casing	U	Undisturbed Sample & Size in mm
M	Moist	S	soft	LL	Liquid Limit	W	Washbore	B	Blank	M	Mud	D	Disturbed Sample
W	Wet	F	firm	P75	% passing 75um sieve	P	Percussion	V	V bit	N	Nil	N	Standard Penetration Test & Result
		St	stiff			H	Hammer	T	TC bit			PP	Pocket Penetrometer Value
		VSt	very stiff			C	Core	D	Diamond			B	Bulk Sample
		H	hard			R	Rotary air flush					ES	Environmental Sample
		VL	very loose			V	Vibrocore					LAB	Sample sent to Lab
		L	loose									DUP	Duplicate Sample
		MD	medium dense									SPLIT	Split Sample
		D	dense										
		VD	very dense										

APPENDIX C

Dynamic Cone Penetrometer Results



CARDNO ULLMAN & NOLAN
GEOTECHNIC PTY LTD
71 CONNORS ROAD MACKAY QLD
DYNAMIC CONE PENETROMETER

GEO_OF_UNGR92 G

(-/05/14)

Page 1 of 1

Mackay Laboratory

CLIENT: Gardens Tennis **JOB NO:** U23991 **LAB REF NO:** 16-556CD
PROJECT: Geotechnical Investigation, Gardens Tennis **TESTED BY:** MT **DATE:** 12.02.16
LOCATION: Gardens Tennis Club, Darwin NT **CHECKED BY:** DH **DATE:** 17.02.16
TEST PROCEDURES : AS 1289.6.3.2 **CLIENT REF:** -

Test No.: C			Test No.: D		
Test Location/Chainage : BH02			Test Location/Chainage : BH03		
Ground Surface R.L. (m) : -			Ground Surface R.L. (m) : -		
Depth Below Ground			Depth Below Ground		
Surface at start of Test (mm): 500			Surface at start of Test (mm): 300		
Soil Description : Refer to logs			Soil Description : Refer to logs		
Soil Moisture Condition: Refer to logs			Soil Moisture Condition: Refer to logs		
Depth to Groundwater (m) : Refer to logs			Depth to Groundwater (m) : Refer to logs		
Cumulative No. of Blows	Depth Below Starting Level (mm)	Penetration Rate (mm/blow)	Cumulative No. of Blows	Depth Below Starting Level (mm)	Penetration Rate (mm/blow)
0	0	0	0	0	0
21	100	5	7	100	14
37	200	6	26	200	5
45	300	13	40	300	7
56	400	9	49	400	11
65	500	11	65	500	6
77	600	8	75	600	10
87	700	10	79	700	25
95	800	13	89	800	10
105	900	10	99	900	10
115	1000	10	110	1000	9
121	1100	17	114	1100	25
127	1200	17	127	1200	8
133	1300	17	152	1280	3
136	1400	33		Refusal	
140	1500	25			
144	1600	25			
148	1700	25			
153	1800	20			
158	1900	20			
168	2000	10			
179	2100	9			
191	2200	8			
204	2300	8			
217	2400	8			
230	2500	8			
	Terminated				



Accredited No. 910
Certificate No. 16-0556C
Date of Issue 17.02.16

Accredited for compliance with ISO/IEC 17025. The results of the tests, calibrations and/or measurements included in this document are traceable to Australia national standards.

Authorised Signatory *D. Hoskins*

D. Hoskins



CARDNO ULLMAN & NOLAN
GEOTECHNIC PTY LTD
71 CONNORS ROAD MACKAY QLD
DYNAMIC CONE PENETROMETER

GEO_OF_ UNGR92 G
 (-/05/14)

Page 1 of 1

Mackay Laboratory

CLIENT: Gardens Tennis **JOB NO:** U23991 **LAB REF NO:** 16-556GH
PROJECT: Geotechnical Investigation, Gardens Tennis **TESTED BY:** MT **DATE:** 12.02.16
LOCATION: Gardens Tennis Club, Darwin NT **CHECKED BY:** DH **DATE:** 17.02.16
TEST PROCEDURES : AS 1289.6.3.2 **CLIENT REF:** -

Test No.: G			Test No.: H		
Test Location/Chainage : BH04			Test Location/Chainage : BH05		
Ground Surface R.L. (m) : -			Ground Surface R.L. (m) : -		
Depth Below Ground			Depth Below Ground		
Surface at start of Test (mm): 1100			Surface at start of Test (mm): 0		
Soil Description : Refer to logs			Soil Description : Refer to logs		
Soil Moisture Condition: Refer to logs			Soil Moisture Condition: Refer to logs		
Depth to Groundwater (m) : Refer to logs			Depth to Groundwater (m) : Refer to logs		
Cumulative No. of Blows	Depth Below Starting Level (mm)	Penetration Rate (mm/blow)	Cumulative No. of Blows	Depth Below Starting Level (mm)	Penetration Rate (mm/blow)
0	0	0	0	0	0
6	100	17	3	100	33
13	200	14	10	200	14
15	300	50	22	210	1
18	400	33	HB	Refusal	
26	500	13			
33	600	14			
40	700	14			
47	800	14			
51	900	25			
53	1000	50			
55	1100	50			
57	1200	50			
59	1300	50			
62	1400	33			
64	1500	50			
66	1600	50			
69	1700	33			
78	1800	11			
89	1900	9			
	Terminated				



Accredited No. 910
 Certificate No. 16-0556G
 Date of Issue 17.02.16

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Authorised Signatory *D. Hoskins*

D. Hoskins



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 71 CONNORS ROAD MACKAY QLD
DYNAMIC CONE PENETROMETER

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 (-/05/14)

Page 1 of 1

Mackay Laboratory

CLIENT: Gardens Tennis **JOB NO:** U23991 **LAB REF NO:** 16-556IJ
PROJECT: Geotechnical Investigation, Gardens Tennis **TESTED BY:** MT **DATE:** 12.02.16
LOCATION: Gardens Tennis Club, Darwin NT **CHECKED BY:** DH **DATE:** 17.02.16
TEST PROCEDURES : AS 1289.6.3.2 **CLIENT REF:** -

Test I			Test J		
Test No.: I			Test No.: J		
Test Location/Chainage : BH05			Test Location/Chainage : BH06		
Ground Surface R.L. (m) : -			Ground Surface R.L. (m) : -		
Depth Below Ground			Depth Below Ground		
Surface at start of Test (mm): 1000			Surface at start of Test (mm): 0		
Soil Description : Refer to logs			Soil Description : Refer to logs		
Soil Moisture Condition: Refer to logs			Soil Moisture Condition: Refer to logs		
Depth to Groundwater (m) : Refer to logs			Depth to Groundwater (m) : Refer to logs		
Cumulative No. of Blows	Depth Below Starting Level (mm)	Penetration Rate (mm/blow)	Cumulative No. of Blows	Depth Below Starting Level (mm)	Penetration Rate (mm/blow)
0	0	0	0	0	0
5	100	20	5	100	20
14	200	11	13	200	13
15	300	100	20	300	14
17	400	50	24	400	25
27	500	10	27	500	33
29	600	50	30	600	33
31	700	50	38	700	13
33	800	50	43	800	20
34	900	100	45	900	50
35	1000	100	46	1000	100
36	1100	100	47	1100	100
38	1200	50	48	1200	100
39	1300	100	49	1300	100
41	1400	50	56	1400	14
42	1500	100	62	1500	17
43	1600	100	82	1600	5
47	1700	25	90	1700	13
58	1800	9	97	1800	14
70	1900	8	104	1900	14
84	2000	7	111	2000	14
	Terminated		114	2100	33
			117	2200	33
			125	2300	13
			132	2400	14
			137	2500	20
			141	2600	25
			149	2700	13
			156	2800	14
			165	2900	11
			173	3000	13
				Terminated	



Accredited No. 910
 Certificate No. 16-0556I
 Date of Issue 17.02.16

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Authorised Signatory *D. Hoskin*

D. Hoskin

APPENDIX D

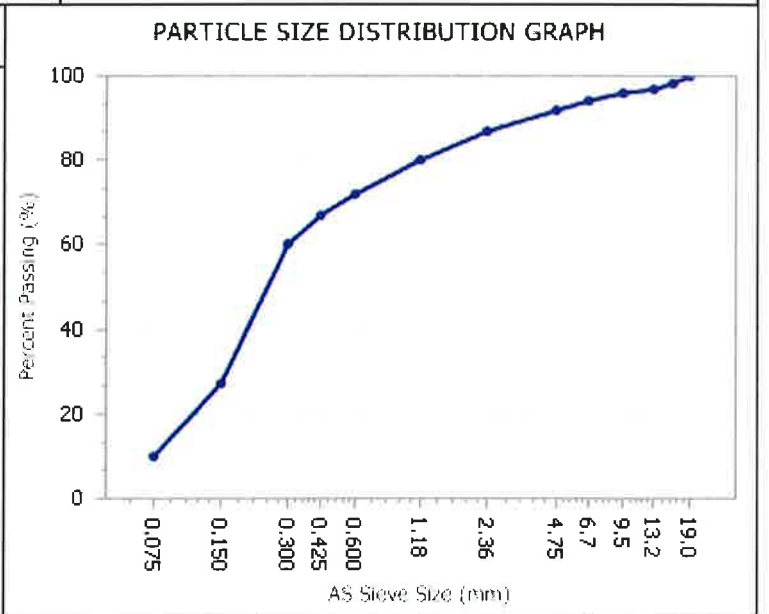
Laboratory Test Results

QUALITY OF MATERIALS REPORT

Client: Cardno Ullman And Nolan	Report Number: 21791/R/10286-2
Client Address: Level 6, 93 Mitchell Street, Darwin	Project Number: 21791/P/206
Project: Geotechnical Investigations	Lot Number: Tennis Court
Location: Darwin	Internal Test Request: 21791/T/4669
Component:	Client Reference/s: U23991 / PO# 14795
Area Description: Gardens Tennis	Report Date / Page: 30/03/2016 Page 1 of 3



Test Procedures AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.2.1.1, AS 1289.3.3.1	
Sample Number 21791/S/33871	Location 1 BH05
Sampling Method AS1289.1.2.1 CI 6.5.2	Location 2 1.90-2.30
Date Sampled 16/02/2016	Location 3
Sampled By Client Sampled	Location 4
Date Tested 17/02/2016	Material Source Insitu
Att. Drying Method Air Dried	Material Type Existing
Atterberg Preparation Dry Sieved	Material Description -

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
19.0		100	
16.0		98	
13.2		97	
9.5		96	
6.7		94	
4.75		92	
2.36		87	
1.18		80	
0.600		72	
0.425		67	
0.300		60	
0.150		27	
0.075		10	



Test Result	Specification Minimum	Result	Specification Maximum	Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		33		0.075/0.425 Fines Ratio		0.15	
Plastic Limit (%)		25		PI x 0.425 Ratio (%)		536.0	
Plastic Index (%)		8		LS x 0.425 Ratio (%)		234.5	
Linear Shrinkage (%)		3.5		Particle Size Dist. Moisture Content (%)		27.1	
Linear Shrinkage Defects	Crack						

Remarks Re-Issued Report Replaces Report No 21791/R/10286-1.

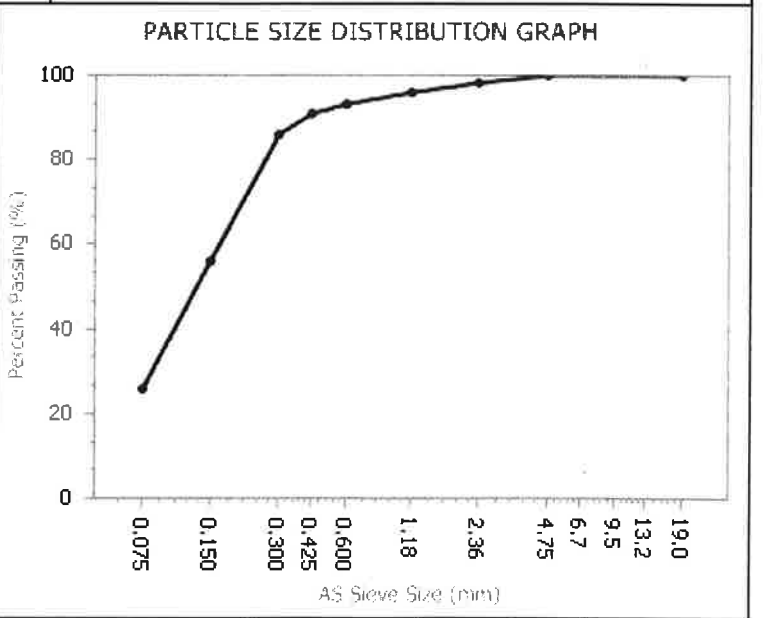
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QUALITY OF MATERIALS REPORT

Client: Cardno Ullman And Nolan Client Address: Level 6, 93 Mitchell Street, Darwin Project: Geotechnical Investigations Location: Darwin Component: Area Description: Gardens Tennis	Report Number: 21791/R/10286-2 Project Number: 21791/P/206 Lot Number: Tennis Court Internal Test Request: 21791/T/4669 Client Reference/s: U23991 / PO# 14795 Report Date / Page: 30/03/2016 Page 2 of 3
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Test Procedures AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS 1289.3.3.1	
Sample Number 21791/S/33872 Sampling Method AS1289.1.2.1 CI 6.5.2 Date Sampled 16/02/2016 Sampled By Client Sampled Date Tested 17/02/2016 Att. Drying Method - Atterberg Preparation -	Location 1 BH06 Location 2 4.50-4.95 Location 3 Location 4 Material Source Insitu Material Type Existing Material Description Sand

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
19.0		100	
4.75		100	
2.36		98	
1.18		96	
0.600		93	
0.425		91	
0.300		86	
0.150		56	
0.075		26	



Test Result	Specification Minimum	Result	Specification Maximum	Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		Not Obtainable		0.075/0.425 Fines Ratio		0.29	
Plastic Limit (%)		Not Obtainable		PI x 0.425 Ratio (%)		-	
Plastic Index (%)		Non Plastic		LS x 0.425 Ratio (%)		0.0	
Linear Shrinkage (%)		0.0		Particle Size Dist. Moisture Content (%)		24.2	
Linear Shrinkage Defects		-					

Remarks Re-Issued Report Replaces Report No 21791/R/10286-1.

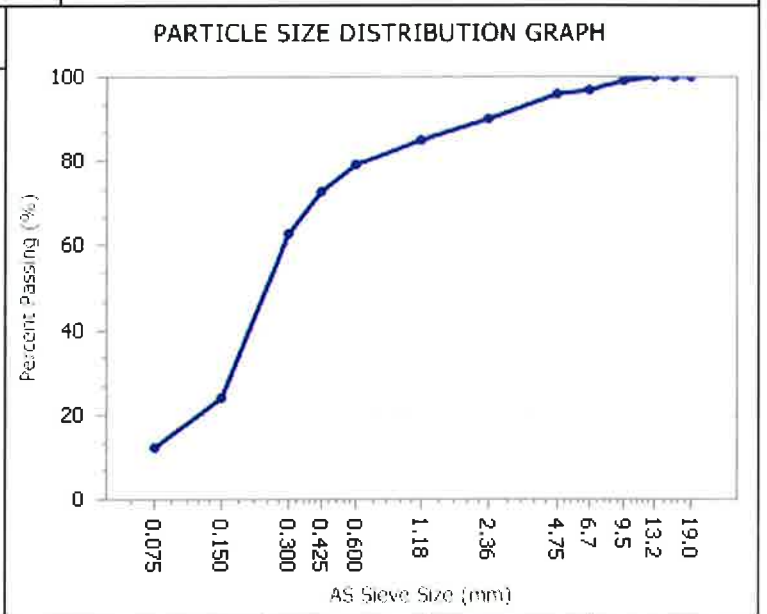
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QUALITY OF MATERIALS REPORT

Client: Cardno Ullman And Nolan	Report Number: 21791/R/10286-2
Client Address: Level 6, 93 Mitchell Street, Darwin	Project Number: 21791/P/206
Project: Geotechnical Investigations	Lot Number: Tennis Court
Location: Darwin	Internal Test Request: 21791/T/4669
Component:	Client Reference/s: U23991 / PO# 14795
Area Description: Gardens Tennis	Report Date / Page: 30/03/2016 Page 3 of 3



Test Procedures AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS 1289.3.3.1	
Sample Number 21791/S/33873	Location 1 BH06
Sampling Method AS1289.1.2.1 CI 6.5.2	Location 2 0.30-0.55
Date Sampled 16/02/2016	Location 3
Sampled By Client Sampled	Location 4
Date Tested 17/02/2016	Material Source Insitu
Att. Drying Method -	Material Type Existing
Atterberg Preparation -	Material Description In-situ

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
19.0		100	
16.0		100	
13.2		100	
9.5		99	
6.7		97	
4.75		96	
2.36		90	
1.18		85	
0.600		79	
0.425		73	
0.300		63	
0.150		24	
0.075		12	



Test Result	Specification Minimum	Result	Specification Maximum	Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		Not Obtainable		0.075/0.425 Fines Ratio		0.16	
Plastic Limit (%)		Not Obtainable		PI x 0.425 Ratio (%)		-	
Plastic Index (%)		Non Plastic		LS x 0.425 Ratio (%)		0.0	
Linear Shrinkage (%)		0.0		Particle Size Dist. Moisture Content (%)		16.7	
Linear Shrinkage Defects		-					

Remarks Re-Issued Report Replaces Report No 21791/R/10286-1.

	<p style="text-align: center;">The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025</p> <p>Accreditation Number: 1986 Corporate Site Number: 21791</p>	 <p>Approved Signatory: Christopher White Form ID: W85MCRRep Rev 1</p>
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SHRINK SWELL INDEX



Client:	Cardno Ullman And Nolan	Report Number:	21791/R/10288-2
Client Address:	Level 6, 93 Mitchell Street, Darwin	Project Number:	21791/P/206
Project:	Geotechnical Investigations	Lot Number:	Tennis Court
Location:	Darwin	Internal Test Request:	21791/T/4669
Component:		Client Reference/s:	U23991 / PO# 14795
Area Description:	Gardens Tennis	Report Date / Page:	30/03/2016 Page 1 of 1

Test Procedures:	AS1289.7.1.1, AS1289.2.1.1	Location 1	BH06
Sample Number	21791/S/33872	Location 2	4.50-4.95
Sampling Method	AS1289.1.2.1 Cl 6.5.2	Location 3	
Date Sampled	16/02/2016	Location 4	
Sampled By	Client Sampled	Material Source	In situ
Date Tested	27/02/2016	Material Type	Existing

Soil Description:	Sand		
Cracking / Crumbling:	Slight		
Estimated Inert Inclusions (%):	0.00	Swell Pre-Soak Moisture Content (%)	12.1
Shrinkage Moisture Content (%):	16.5	Swell Post-Soak Moisture Content (%)	12.5

Shrinkage Strain (%)	0.0	Shrink / Swell Index	0.0
Swell Strain (%)	0.0		

Remarks	Re-Issued Report Replaces Report No 21791/R/10288-1.
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	The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025		 Approved Signatory: Christopher White Form ID: W21Rep Rev 1
	Accreditation Number:	1986	
	Corporate Site Number:	21791	

SHRINK SWELL INDEX


Client: Cardno Ullman And Nolan	Report Number: 21791/R/10321-1
Client Address: Level 6, 93 Mitchell Street, Darwin	Project Number: 21791/P/206
Project: Geotechnical Investigations	Lot Number: Tennis Court
Location: Darwin	Internal Test Request: 21791/T/4669
Component:	Client Reference/s: U23991 / PO# 14795
Area Description: Gardens Tennis	Report Date / Page: 4/03/2016 Page 1 of 1

Test Procedures: AS1289.7.1.1, AS1289.2.1.1	Location 1 BH06
Sample Number 21791/S/33872	Location 2
Sampling Method AS1289.1.2.1 Cl 6.5.2	Location 3
Date Sampled 16/02/2016	Location 4
Sampled By Client Sampled	Material Source Insitu
Date Tested 27/02/2016	Material Type Existing

Soil Description: Sand	
Cracking / Crumbling: Slight	
Estimated Inert Inclusions (%): 0.00	Swell Pre-Soak Moisture Content (%) 12.1
Shrinkage Moisture Content (%): 16.5	Swell Post-Soak Moisture Content (%) 12.5

Shrinkage Strain (%)	0.0	Shrink / Swell Index	0.0
Swell Strain (%)	0.0		

Remarks

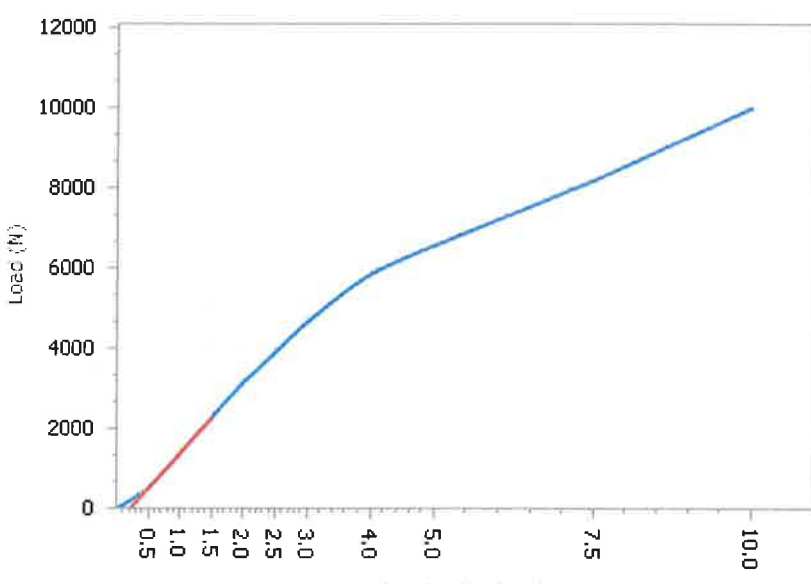


Verified By: Drew Cooper
Form ID: W21Rep Rev 1



CALIFORNIA BEARING RATIO REPORT

Client: Cardno Ullman And Nolan	Report Number: 21791/R/10320-2
Client Address: Level 6, 93 Mitchell Street, Darwin	Project Number: 21791/P/206
Project: Geotechnical Investigations	Lot Number: Tennis Court
Location: Darwin	Internal Test Request: 21791/T/4669
Component:	Client Reference/s: U23991 / PO# 14795
Area Description: Gardens Tennis	Report Date / Page: 30/03/2016 Page 1 of 1

Test Procedures AS1289.6.1.1, AS1289.5.2.1, AS1289.2.1.1	
Sample Number 21791/S/33873	Sample Location
Sampling Method AS1289.1.2.1 Cl 6.5.2	Location 1 BH06
Date Sampled 16/02/2016	Location 2 0.30-0.55
Sampled By Client Sampled	Location 3
Date Tested 23/02/2016	Location 4
Material Source Insitu	Material Limit Start -
Material Type Existing	Material Limit End -
Client Reference -	Compactive Effort Modified

Material Description In-situ		
Maximum Dry Density (t/m ³):	1.88	<div style="text-align: center;"> CBR PENETRATION PLOT  </div>
Optimum Moisture Content (%):	14.0	
Field Moisture Content (%):	16.7	
Sample Percent Oversize (%):	0.0	
Oversize Included / Excluded	Excluded	
Target Density Ratio (%):	95	
Target Moisture Ratio (%):	100	
Placement Dry Density (t/m ³):	1.78	
Placement Dry Density Ratio (%):	94.5	
Placement Moisture Content (%):	14.1	
Placement Moisture Ratio (%):	99.5	
Test Condition / Soaking Period:	Soaked / 4 Days	
CBR Surcharge (kg)	4.5	
Dry Density After Soak (t/m ³):	1.77	
Moisture (top 30mm) After Soak (%):	17.1	
Moisture (remainder) After Soak (%):	16.6	
CBR Swell (%):	0.0	
Minimum CBR Specification (%):	-	
CBR Value @ 5.0mm (%):	35	

Remarks Re-Issued Report Replaces Report No 21791/R/10320-1.

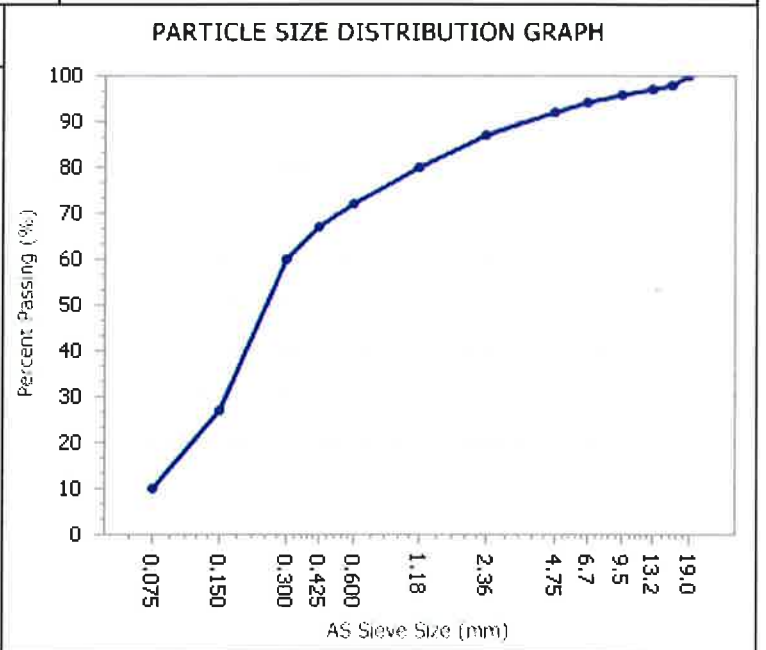
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QUALITY OF MATERIALS REPORT

Client: Cardno Ullman And Nolan	Report Number: 21791/R/10319-2
Client Address: Level 6, 93 Mitchell Street, Darwin	Project Number: 21791/P/206
Project: Geotechnical Investigations	Lot Number: Tennis Court
Location: Darwin	Internal Test Request: 21791/T/4669
Component:	Client Reference/s: U23991 / PO# 14795
Area Description: Gardens Tennis	Report Date / Page: 30/03/2016 Page 1 of 3



Test Procedures AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.2.1.1, AS 1289.3.3.1	
Sample Number 21791/S/33871	Location 1 BH05
Sampling Method AS1289.1.2.1 CI 6.5.2	Location 2 1.90-2.30
Date Sampled 16/02/2016	Location 3
Sampled By Client Sampled	Location 4
Date Tested 17/02/2016	Material Source Insitu
Att. Drying Method Air Dried	Material Type Existing
Atterberg Preparation Dry Sieved	Material Description -

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
19.0		100	
16.0		98	
13.2		97	
9.5		96	
6.7		94	
4.75		92	
2.36		87	
1.18		80	
0.600		72	
0.425		67	
0.300		60	
0.150		27	
0.075		10	



Test Result	Specification Minimum	Result	Specification Maximum	Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		33		0.075/0.425 Fines Ratio		0.15	
Plastic Limit (%)		25		PI x 0.425 Ratio (%)		536.0	
Plastic Index (%)		8		LS x 0.425 Ratio (%)		234.5	
Linear Shrinkage (%)		3.5		Linear Shrinkage Defects	Crack		

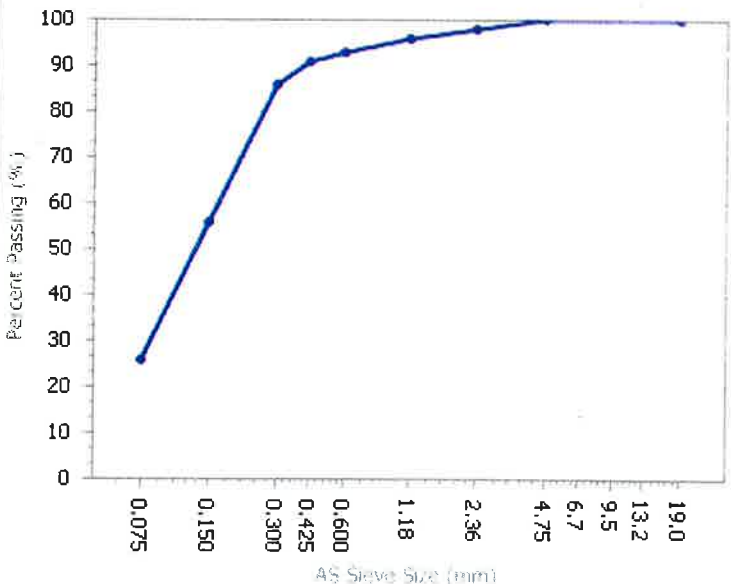
Remarks Re-issued Report Replaces Report No 21791/R/10319-1.

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QUALITY OF MATERIALS REPORT

Client: Cardno Ullman And Nolan Client Address: Level 6, 93 Mitchell Street, Darwin Project: Geotechnical Investigations Location: Darwin Component: Area Description: Gardens Tennis	Report Number: 21791/R/10319-2 Project Number: 21791/P/206 Lot Number: Tennis Court Internal Test Request: 21791/T/4669 Client Reference/s: U23991 / PO# 14795 Report Date / Page: 30/03/2016 Page 2 of 3
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Test Procedures AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS 1289.3.3.1	
Sample Number 21791/S/33872 Sampling Method AS1289.1.2.1 CI 6.5.2 Date Sampled 16/02/2016 Sampled By Client Sampled Date Tested 17/02/2016 Att. Drying Method - Atterberg Preparation -	Location 1 BH06 Location 2 4.50-4.95 Location 3 Location 4 Material Source Insitu Material Type Existing Material Description Sand

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum	PARTICLE SIZE DISTRIBUTION GRAPH			
19.0		100					
4.75		100					
2.36		98					
1.18		96					
0.600		93					
0.425		91					
0.300		86					
0.150		56					
0.075		26					
Test Result	Specification Minimum	Result	Specification Maximum	Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		Not Obtainable		0.075/0.425 Fines Ratio		0.29	
Plastic Limit (%)		Not Obtainable		PI x 0.425 Ratio (%)		-	
Plastic Index (%)		Non Plastic		LS x 0.425 Ratio (%)		0.0	
Linear Shrinkage (%)		0.0		Linear Shrinkage Defects		-	

Remarks: Re-Issued Report Replaces Report No 21791/R/10319-1.

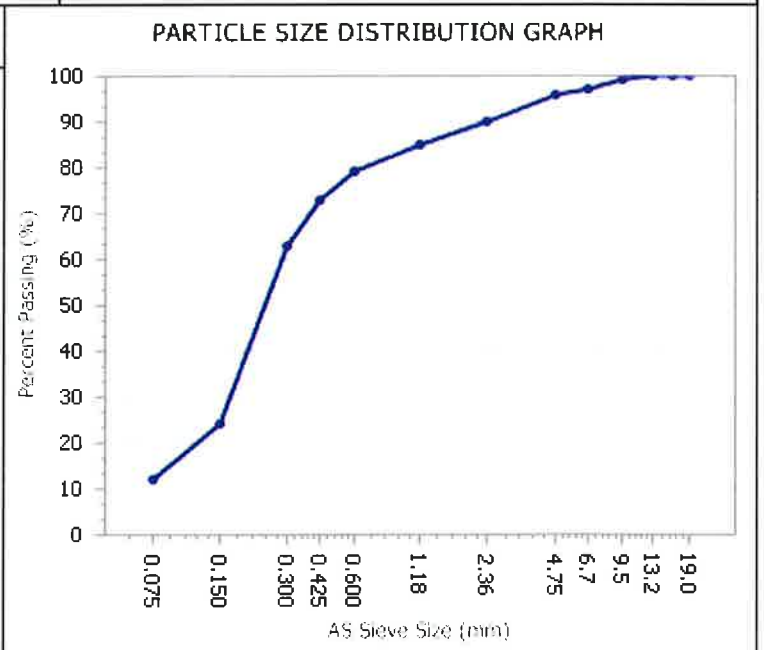
	The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025 Accreditation Number: 1986 Corporate Site Number: 21791	 Approved Signatory: Christopher White Form ID: W85Rep Rev 1
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QUALITY OF MATERIALS REPORT

Client: Cardno Ullman And Nolan	Report Number: 21791/R/10319-2
Client Address: Level 6, 93 Mitchell Street, Darwin	Project Number: 21791/P/206
Project: Geotechnical Investigations	Lot Number: Tennis Court
Location: Darwin	Internal Test Request: 21791/T/4669
Component:	Client Reference/s: U23991 / PO# 14795
Area Description: Gardens Tennis	Report Date / Page: 30/03/2016 Page 3 of 3



Test Procedures AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS 1289.3.3.1	
Sample Number 21791/S/33873	Location 1 BH06
Sampling Method AS1289.1.2.1 Cl 6.5.2	Location 2 0.30-0.55
Date Sampled 16/02/2016	Location 3
Sampled By Client Sampled	Location 4
Date Tested 17/02/2016	Material Source Insitu
Att. Drying Method -	Material Type Existing
Atterberg Preparation -	Material Description In-situ

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
19.0		100	
16.0		100	
13.2		100	
9.5		99	
6.7		97	
4.75		96	
2.36		90	
1.18		85	
0.600		79	
0.425		73	
0.300		63	
0.150		24	
0.075		12	



Test Result	Specification Minimum	Result	Specification Maximum	Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		Not Obtainable		0.075/0.425 Fines Ratio		0.16	
Plastic Limit (%)		Not Obtainable		PI x 0.425 Ratio (%)		-	
Plastic Index (%)		Non Plastic		LS x 0.425 Ratio (%)		0.0	
Linear Shrinkage (%)		0.0		Linear Shrinkage Defects		-	

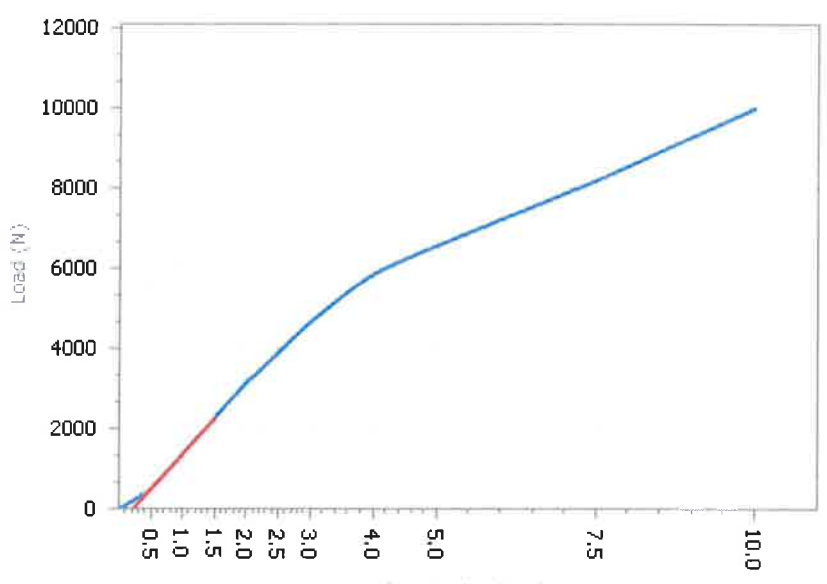
Remarks Re-Issued Report Replaces Report No 21791/R/10319-1.

	<p style="text-align: center; font-size: small;">The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025</p> <p>Accreditation Number: 1986 Corporate Site Number: 21791</p>	 <p>Approved Signatory: Christopher White Form ID: W85Rep Rev 1</p>
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CALIFORNIA BEARING RATIO REPORT

Client: Cardno Ullman And Nolan	Report Number: 21791/R/10320-1
Client Address: Level 6, 93 Mitchell Street, Darwin	Project Number: 21791/P/206
Project: Geotechnical Investigations	Lot Number: Tennis Court
Location: Darwin	Internal Test Request: 21791/T/4669
Component:	Client Reference/s: U23991 / PO# 14795
Area Description: Gardens Tennis	Report Date / Page: 4/03/2016 Page 1 of 1

Test Procedures AS1289.6.1.1, AS1289.5.2.1, AS1289.2.1.1	
Sample Number 21791/S/33873	Sample Location
Sampling Method AS1289.1.2.1 Cl 6.5.2	Location 1 BH06
Date Sampled 16/02/2016	Location 2
Sampled By Client Sampled	Location 3
Date Tested 23/02/2016	Location 4
Material Source Insitu	Material Limit Start -
Material Type Existing	Material Limit End -
Client Reference -	Compactive Effort Modified

Material Description In-situ																																							
<table style="width: 100%; border-collapse: collapse;"> <tr><td>Maximum Dry Density (t/m³):</td><td style="text-align: right;">1.88</td></tr> <tr><td>Optimum Moisture Content (%):</td><td style="text-align: right;">14.0</td></tr> <tr><td>Field Moisture Content (%):</td><td style="text-align: right;">16.7</td></tr> <tr><td>Sample Percent Oversize (%):</td><td style="text-align: right;">0.0</td></tr> <tr><td>Oversize Included / Excluded</td><td style="text-align: right;">Excluded</td></tr> <tr><td>Target Density Ratio (%):</td><td style="text-align: right;">95</td></tr> <tr><td>Target Moisture Ratio (%):</td><td style="text-align: right;">100</td></tr> <tr><td>Placement Dry Density (t/m³):</td><td style="text-align: right;">1.78</td></tr> <tr><td>Placement Dry Density Ratio (%):</td><td style="text-align: right;">94.5</td></tr> <tr><td>Placement Moisture Content (%):</td><td style="text-align: right;">14.1</td></tr> <tr><td>Placement Moisture Ratio (%):</td><td style="text-align: right;">99.5</td></tr> <tr><td>Test Condition / Soaking Period:</td><td style="text-align: right;">Soaked / 4 Days</td></tr> <tr><td>CBR Surcharge (kg)</td><td style="text-align: right;">4.5</td></tr> <tr><td>Dry Density After Soak (t/m³):</td><td style="text-align: right;">1.77</td></tr> <tr><td>Moisture (top 30mm) After Soak (%):</td><td style="text-align: right;">17.1</td></tr> <tr><td>Moisture (remainder) After Soak (%):</td><td style="text-align: right;">16.6</td></tr> <tr><td>CBR Swell (%):</td><td style="text-align: right;">0.0</td></tr> <tr><td>Minimum CBR Specification (%):</td><td style="text-align: right;">-</td></tr> <tr><td>CBR Value @ 5.0mm (%):</td><td style="text-align: right;">35</td></tr> </table>	Maximum Dry Density (t/m ³):	1.88	Optimum Moisture Content (%):	14.0	Field Moisture Content (%):	16.7	Sample Percent Oversize (%):	0.0	Oversize Included / Excluded	Excluded	Target Density Ratio (%):	95	Target Moisture Ratio (%):	100	Placement Dry Density (t/m ³):	1.78	Placement Dry Density Ratio (%):	94.5	Placement Moisture Content (%):	14.1	Placement Moisture Ratio (%):	99.5	Test Condition / Soaking Period:	Soaked / 4 Days	CBR Surcharge (kg)	4.5	Dry Density After Soak (t/m ³):	1.77	Moisture (top 30mm) After Soak (%):	17.1	Moisture (remainder) After Soak (%):	16.6	CBR Swell (%):	0.0	Minimum CBR Specification (%):	-	CBR Value @ 5.0mm (%):	35	<h3>CBR PENETRATION PLOT</h3> 
Maximum Dry Density (t/m ³):	1.88																																						
Optimum Moisture Content (%):	14.0																																						
Field Moisture Content (%):	16.7																																						
Sample Percent Oversize (%):	0.0																																						
Oversize Included / Excluded	Excluded																																						
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Dry Density After Soak (t/m ³):	1.77																																						
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Moisture (remainder) After Soak (%):	16.6																																						
CBR Swell (%):	0.0																																						
Minimum CBR Specification (%):	-																																						
CBR Value @ 5.0mm (%):	35																																						

Remarks

	<p>The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025</p>	
	<p>Accreditation Number: 1986 Corporate Site Number: 21791</p>	<p>Approved Signatory: Drew Cooper Form ID: W7Rep Rev 1</p>

MOISTURE CONTENT REPORT



Client: Cardno Ullman And Nolan Client Address: Level 6, 93 Mitchell Street, Darwin Project: Geotechnical Investigations Location: Darwin Component: Area Description: Gardens Tennis	Report Number: 21791/R/10292-2 Project Number: 21791/P/206 Lot Number: Tennis Court Internal Test Request: 21791/T/4669 Client Reference/s: U23991 / PO# 14795 Report Date / Page: 30/03/2016 Page 1 of 1
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Test Procedures:	AS1289.2.1.1
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Sample Number	21791/S/33873			
ID / Client ID	-			
Lot Number	Tennis Court			
Date / Time Sampled	16/02/2016			
Date Tested	17/02/2016			
Material Source	Insitu			
Material Type	Existing			
Location 1	BH06			
Location 2	0.30-0.55			
Location 3				
Location 4				
Moisture Content (%)	19.3			
Sample Description	In-situ			

Sample Number				
ID / Client ID				
Lot Number				
Date / Time Sampled				
Date Tested				
Material Source				
Material Type				
Location 1				
Location 2				
Location 3				
Location 4				
Moisture Content (%)				
Sample Description				

Remarks	Re-Issued Report Replaces Report No 21791/R/10292-1.
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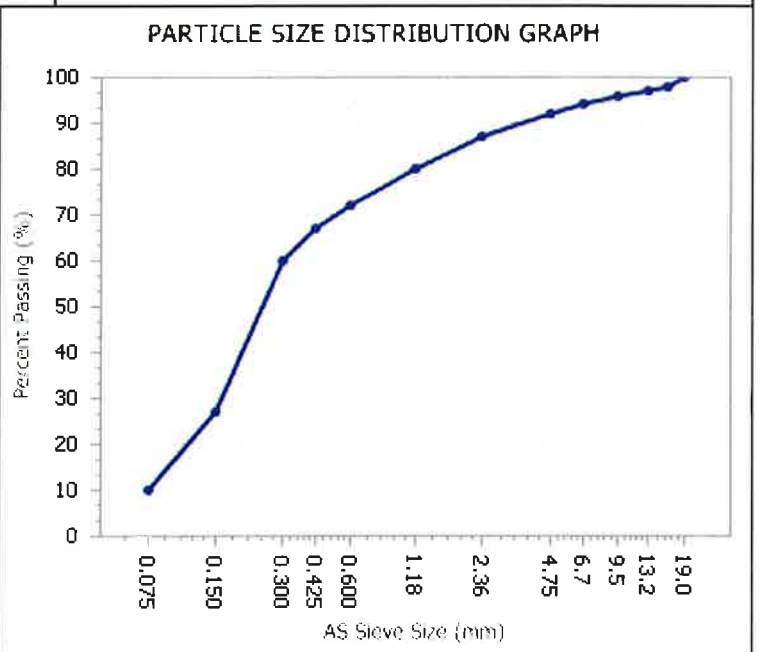
	<p style="text-align: center; font-size: small;">The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025</p> <p>Accreditation Number: 1986 Corporate Site Number: 21791</p>	 Approved Signatory: Christopher White Form ID: W95Rep Rev 1
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QUALITY OF MATERIALS REPORT

Client: Cardno Ullman And Nolan	Report Number: 21791/R/10319-1
Client Address: Level 6, 93 Mitchell Street, Darwin	Project Number: 21791/P/206
Project: Geotechnical Investigations	Lot Number: Tennis Court
Location: Darwin	Internal Test Request: 21791/T/4669
Component:	Client Reference/s: U23991 / PO# 14795
Area Description: Gardens Tennis	Report Date / Page: 4/03/2016 Page 1 of 3

Test Procedures AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.2.1.1, AS 1289.3.3.1	
Sample Number 21791/S/33871	Location 1 BH05
Sampling Method AS1289.1.2.1 CI 6.5.2	Location 2
Date Sampled 16/02/2016	Location 3
Sampled By Client Sampled	Location 4
Date Tested 17/02/2016	Material Source Insitu
Att. Drying Method Air Dried	Material Type Existing
Atterberg Preparation Dry Sieved	Material Description -

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
19.0		100	
16.0		98	
13.2		97	
9.5		96	
6.7		94	
4.75		92	
2.36		87	
1.18		80	
0.600		72	
0.425		67	
0.300		60	
0.150		27	
0.075		10	



Test Result	Specification Minimum	Result	Specification Maximum	Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		33		0.075/0.425 Fines Ratio		0.16	
Plastic Limit (%)		25		PI x 0.425 Ratio (%)		534.4	
Plastic Index (%)		8		LS x 0.425 Ratio (%)		233.8	
Linear Shrinkage (%)		3.5		Linear Shrinkage Defects	Crack		

Remarks

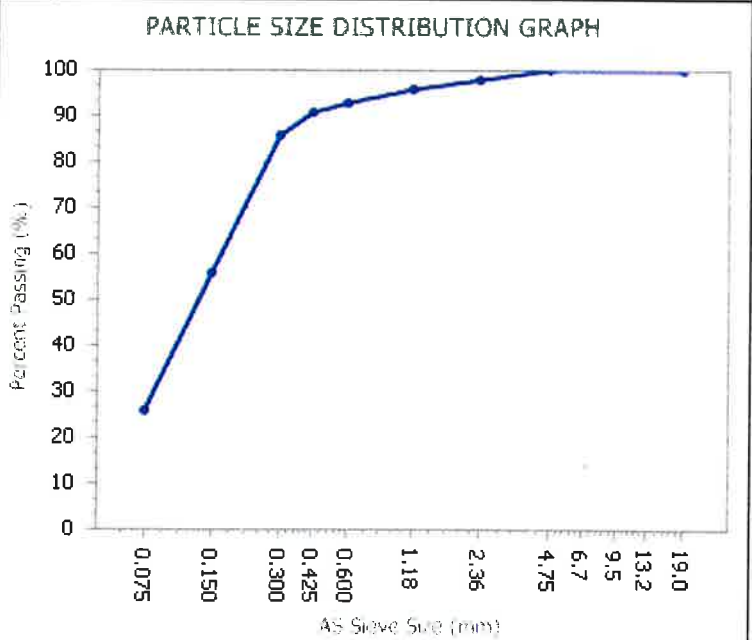

 Verified By: Drew Cooper
 Form ID: W85Rep Rev 1

QUALITY OF MATERIALS REPORT

Client: Cardno Ullman And Nolan	Report Number: 21791/R/10319-1
Client Address: Level 6, 93 Mitchell Street, Darwin	Project Number: 21791/P/206
Project: Geotechnical Investigations	Lot Number: Tennis Court
Location: Darwin	Internal Test Request: 21791/T/4669
Component:	Client Reference/s: U23991 / PO# 14795
Area Description: Gardens Tennis	Report Date / Page: 4/03/2016 Page 2 of 3


Test Procedures AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS 1289.3.3.1	
Sample Number 21791/S/33872	Location 1 BH06
Sampling Method AS1289.1.2.1 CI 6.5.2	Location 2
Date Sampled 16/02/2016	Location 3
Sampled By Client Sampled	Location 4
Date Tested 17/02/2016	Material Source Insitu
Att. Drying Method -	Material Type Existing
Atterberg Preparation -	Material Description Sand

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
19.0		100	
4.75		100	
2.36		98	
1.18		96	
0.600		93	
0.425		91	
0.300		86	
0.150		56	
0.075		26	



Test Result	Specification Minimum	Result	Specification Maximum	Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		Not Obtainable		0.075/0.425 Fines Ratio		0.29	
Plastic Limit (%)		Not Obtainable		PI x 0.425 Ratio (%)		-	
Plastic Index (%)		Non Plastic		LS x 0.425 Ratio (%)		0.0	
Linear Shrinkage (%)		0.0		Linear Shrinkage Defects		-	

Remarks

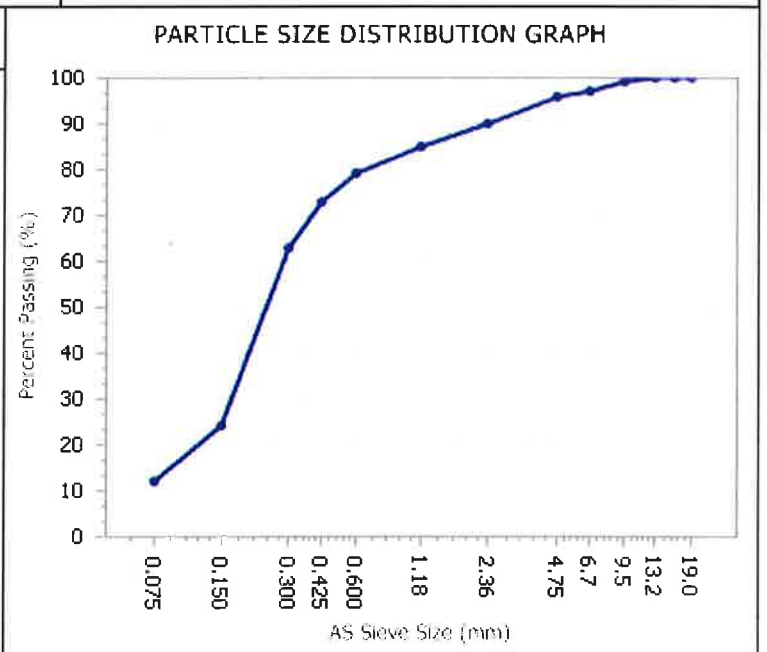

 Verified By: Drew Cooper
 Form ID: W85Rep Rev 1

QUALITY OF MATERIALS REPORT

Client: Cardno Ullman And Nolan	Report Number: 21791/R/10319-1
Client Address: Level 6, 93 Mitchell Street, Darwin	Project Number: 21791/P/206
Project: Geotechnical Investigations	Lot Number: Tennis Court
Location: Darwin	Internal Test Request: 21791/T/4669
Component:	Client Reference/s: U23991 / PO# 14795
Area Description: Gardens Tennis	Report Date / Page: 4/03/2016 Page 3 of 3

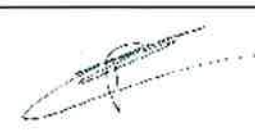
Test Procedures AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS 1289.3.3.1	
Sample Number 21791/S/33873	Location 1 BH06
Sampling Method AS1289.1.2.1 CI 6.5.2	Location 2
Date Sampled 16/02/2016	Location 3
Sampled By Client Sampled	Location 4
Date Tested 17/02/2016	Material Source Insitu
Att. Drying Method -	Material Type Existing
Atterberg Preparation -	Material Description In-situ

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
19.0		100	
16.0		100	
13.2		100	
9.5		99	
6.7		97	
4.75		96	
2.36		90	
1.18		85	
0.600		79	
0.425		73	
0.300		63	
0.150		24	
0.075		12	



Test Result	Specification Minimum	Result	Specification Maximum	Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		Not Obtainable		0.075/0.425 Fines Ratio		0.17	
Plastic Limit (%)		Not Obtainable		PI x 0.425 Ratio (%)		-	
Plastic Index (%)		Non Plastic		LS x 0.425 Ratio (%)		0.0	
Linear Shrinkage (%)		0.0		Linear Shrinkage Defects		-	

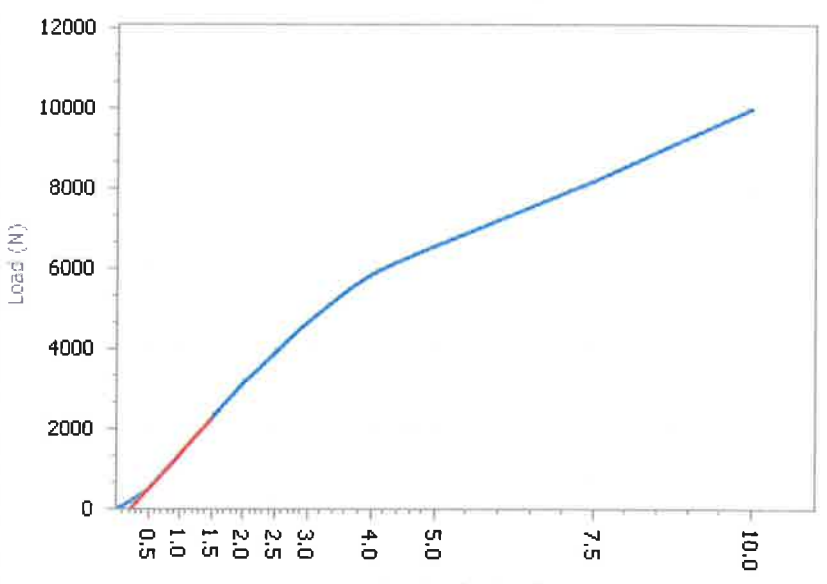
Remarks


 Verified By: Drew Cooper
 Form ID: W85Rep Rev 1



CALIFORNIA BEARING RATIO REPORT

Client: Cardno Ullman And Nolan	Report Number: 21791/R/10289-2
Client Address: Level 6, 93 Mitchell Street, Darwin	Project Number: 21791/P/206
Project: Geotechnical Investigations	Lot Number: Tennis Court
Location: Darwin	Internal Test Request: 21791/T/4669
Component:	Client Reference/s: U23991 / PO# 14795
Area Description: Gardens Tennis	Report Date / Page: 30/03/2016 Page 1 of 1

Test Procedures AS1289.6.1.1, AS1289.5.2.1, AS1289.2.1.1	
Sample Number 21791/S/33873	Sample Location
Sampling Method AS1289.1.2.1 Cl 6.5.2	Location 1 BH06
Date Sampled 16/02/2016	Location 2 0.30-0.55
Sampled By Client Sampled	Location 3
Date Tested 23/02/2016	Location 4
Material Source Insitu	Material Limit Start -
Material Type Existing	Material Limit End -
Client Reference -	Compactive Effort Modified

Material Description In-situ	
Maximum Dry Density (t/m ³): 1.88 Optimum Moisture Content (%): 14.0 Field Moisture Content (%): 16.7 Sample Percent Oversize (%): 0.0 Oversize Included / Excluded Excluded Target Density Ratio (%): 95 Target Moisture Ratio (%): 100 Placement Dry Density (t/m ³): 1.78 Placement Dry Density Ratio (%): 94.5 Placement Moisture Content (%): 14.1 Placement Moisture Ratio (%): 99.5 Test Condition / Soaking Period: Soaked / 4 Days CBR Surcharge (kg): 4.5 Dry Density After Soak (t/m ³): 1.77 Moisture (top 30mm) After Soak (%): 17.1 Moisture (remainder) After Soak (%): 16.6 CBR Swell (%): 0.0 Minimum CBR Specification (%): - CBR Value @ 5.0mm (%): 35	<h3>CBR PENETRATION PLOT</h3> 

Remarks Re-issued Report Replaces Report No 21791/R/10289-1.

	<p>The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025</p> <p>Accreditation Number: 1986 Corporate Site Number: 21791</p>	 Approved Signatory: Christopher White Form ID: W7Rep Rev 1
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SHRINK SWELL INDEX



Client: Cardno Ullman And Nolan Client Address: Level 6, 93 Mitchell Street, Darwin Project: Geotechnical Investigations Location: Darwin Component: Area Description: Gardens Tennis	Report Number: 21791/R/10321-2 Project Number: 21791/P/206 Lot Number: Tennis Court Internal Test Request: 21791/T/4669 Client Reference/s: U23991 / PO# 14795 Report Date / Page: 30/03/2016 Page 1 of 1
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Test Procedures: AS1289.7.1.1, AS1289.2.1.1 Sample Number: 21791/S/33872 Sampling Method: AS1289.1.2.1 Cl 6.5.2 Date Sampled: 16/02/2016 Sampled By: Client Sampled Date Tested: 27/02/2016	Location 1: BH06 Location 2: 4.50-4.95 Location 3: Location 4: Material Source: Insitu Material Type: Existing
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Soil Description: Sand	
Cracking / Crumbling: Slight	
Estimated Inert Inclusions (%): 0.00	Swell Pre-Soak Moisture Content (%): 12.1
Shrinkage Moisture Content (%): 16.5	Swell Post-Soak Moisture Content (%): 12.5

Shrinkage Strain (%)	0.0	Shrink / Swell Index	0.0
Swell Strain (%)	0.0		

Remarks: Re-issued Report Replaces Report No 21791/R/10321-1.

	<p>The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025</p> <p>Accreditation Number: 1986 Corporate Site Number: 21791</p>	 Approved Signatory: Christopher White Form ID: W21Rep Rev 1
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APPENDIX E

Site Photographs



Photo 1: Typical Cracking



Photo 2: Cracking onsite