Geotechnical Interpretative Ground Investigation Report

Kyeemagh Infants School, Corner of Jacobson Avenue and Beehag Street, Kyeemagh NSW

5017190151

Prepared for

DWP Australia Pty Ltd

23 January 2019

Cardno

Contact Information

Cardno (NSW/ACT) Pty Ltd
ABN 95 001 145 035

Level 9 - The Forum
203 Pacific Highway
St Leonards NSW 2065
Australia

www.cardno.com
Phone +61 2 9496 7700
Fax +61 2 9439 5170

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Author(s):

Jhan-Paule Arbizo
Graduate Engineering Geologist

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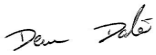

Deven Date
Senior Geotechnical Engineer

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1 INTRODUCTION

1.1 Background

Cardno (NSW/ACT) Pty Ltd ("Cardno") was engaged by DWP Australia Pty Ltd ("the Client") to undertake a detailed Geotechnical Investigation Report (GIR) for the proposed redevelopment of Kyeemagh Infants School, Corner of Jacobson Avenue and Beehag Street, Kyeemagh NSW 2216 ("the Site"). It is understood the Department of Education is proposing to redevelop the Site to increase its current capacity as a K-2 capable school to a K-6 capable school. The proposed redevelopment has been assessed as State Significant Development.

The subject site is legally identified as parts of Lot 1 within Deposited Plan (DP) 335734 and Lot 1 within DP 120095, where the infant school encapsulates the entirety of the DP, however the pre-school facility in the eastern portion of the Site is excluded from the scope of investigation. The location and features of the site are presented in **Figures 1** and **2** in **Appendix A.** This GIR has been prepared in accordance with the scope presented in Cardno's proposal revised 29 November 2018.

This report provides the results of the geotechnical investigatory works and interpretation of data only to facilitate development design, the DSI ground investigation report is contained in a subsidiary reports, as follows;

> Ref: 80818157, Titled: *"Detailed Site Investigation, Kyeemagh Infants School, Corner of Jacobson Avenue and Beehag Street, Kyeemagh NSW*", dated *23 January 2019*, by *Cardno (NSW/ACT) Pty Ltd.*

> *Ref: 80818157, Titled; "Remedial Action Plan, Kyeemagh Infants School, Corner of Jacobson Avenue and Beehag Street, Kyeemagh NSW*", dated 23 *January 2019*, by *Cardno (NSW/ACT) Pty Ltd.*

1.2 Purpose, Objectives and Scope

The purpose of the investigation was to provide the Client with geotechnical advice on the in-situ subsurface conditions encountered, for the proposed development works, scope was as follows;

- Determine the suitability of the land for continued use as a school;
- Provide geotechnical information to inform design;

Cardno has been informed that the development will consist primarily of a two-storey building with associated ancillary structures, open and landscaped areas. Based on available information intrusive investigation to depths of up to 15 metres below ground level (mBGL) is required to facilitate footing design. While the development may disturb the majority of the site to depths of approximately 1 to 2 mBGL.

The following conceptual drawings were provided;

> Schematic Design Drawings, Drg No; "CS002", Project: "Kyeemagh Public School", location; Jacobson Ave, Kyeemagh, NSW 2216; by dwp dated 22-jan-19.

2 SITE DESCRIPTION

2.1 Site Description

The site is described as Kyeemagh Infants School, Jacobson Avenue, Kyeemagh, NSW, approximately 8km southwest of the Sydney CBD. A site location and site plan are provided in **Appendix A** with further site details presented in **Table 2-1**.

The site is legally identified as Lot 1 DP120095 and Lot 1 DP335734 and is approx. 1.3ha in size. The site resides under the Local Government Area (LGA), as detailed below;

Table 2-1 Site Definition and Details

Item	Details
Site Address	Corner of Jacobson Avenue and Beehag Street, Kyeemagh NSW 2216
Approximate Site Area (ha)	1.3 ha
Title Details	Lot 1 DP 335734 and Lot 1 DP 120095
Local Government Area	Bayside City Council
Parish and County	St George, Cumberland
Current Site Owners	The Department of Education
Current Site Zoning	R2 Low Density Residential

2.2 Topography and Drainage

Site elevation is approximately 5 m AHD and is relatively level. Local topography is generally level with minor undulations and mounds. Drainage in surrounding streets is expected to be through pits and pipe network via street guttering.

2.3 Flood Potential

Cardno undertook a review of available flood mapping of the area surrounding the school in order to provide flooding advice (Cardno, 2018). The Cooks River Flood Study undertaken by Parsons Brinckerhoff for Sydney Water in 2008 indicates that the Site is unlikely to be affected by the 1% AEP or PMP flood events.

2.4 Regional Geology

The Soil Landscapes Map of Sydney 1:100,000 sheet indicates that the Site soils are comprised of Quaternary quartz sands with minor shell content, silt and fine sands (Qhbr). The NSW Office of Environment and Heritage eSPADE online GIS tool indicates that the site is characterised as part of the Tuggerah Soil Landscape, which is an Aeolian landscape with deep sandy soils with pH values ranging from 4.5 (strongly acidic) to 7.0 (neutral).

The subsurface profile encountered generally during the DSI (Cardno 2019a) consisted of topsoil and fill material consisting of sands and silty sands to a maximum depth of 1.2 metres below ground level (mBGL), with filling generally observed to be less than 1 m deep. Natural soils encountered generally consisted of sands and silty sands, with intermittent sandy clays present at greater depths.

The site is underlain by the Botany Sands Aquifer which is extensive, porous and highly productive. Groundwater flow is expected to be to the east towards the Cooks River or south towards Botany Bay with local variations in gradient. Static Water Levels (SWLs) gauged during the DSI (Cardno 2019a) from three monitoring wells on-site ranged between 3.8 and 3.9 metres below top of casing (ground level). Due to the proximity of the Site to Muddy Creek, the Cooks River and Botany Bay, groundwater at the Site may be tidally influenced.

3 INVESTIGATORY WORKS

3.1 Objectives and Scope of Site Investigations

The objective of the geotechnical investigation was to provide sufficient information for the suitability of ground conditions for design and construction consideration of the proposed development, as discussed in **Section 1** of this report. The purpose of the works was to collect soil samples at various locations across the building area to establish the current soil conditions.

3.2 Borehole Locations

The ground co-ordinates of boreholes are listed in **Table 3-1** below. At the time of investigation, boreholes were located with GPS based on the proposed site boundary area for selection of investigatory locations.

Upon completion of works all boreholes were picked up with GPS to determine the ground co-ordinate mars and collar elevation, making reference to GDA94 Zone 56 and AHD respectively.

Table 3-1 Borehole Co-ordinates

Borehole ID	Easting	Northing	Elevation (m AHD)
BH01	330215	6241985	3.48
BH02	330177	6242025	4.60
BH03	330181	6241985	3.83
BH04	330149	6241929	4.38
BH05	330123	6241978	4.56

3.3 Fieldworks

3.3.1 Underground Service Search

A Dial before You Dig (DBYD) underground service search was conducted by Cardno for the nominated BH locations and surrounding area prior to the fieldworks. A qualified underground service locator cleared the borehole locations from utilities, with the use of a pipe/cable locator & transmitter and ground-penetrating radar (GPR) prior to excavation.

3.3.2 Geotechnical Drilling

Investigatory drilling was undertaken with the use of a Ute mounted drilling rig operated by Stratacore Drilling Pty Ltd.

All boreholes were drilled vertically (90 degrees from the horizontal). Drilling through the soil was carried out using solid flight auger with tungsten Carbide “TC” – bit, until target depth or refusal was reached, whichever came first. Standard penetration tests (SPT) were undertaken through the soil profile at 1.50m intervals, proceeding from 1.0 m below surface level.

3.3.3 Fieldwork Activities

Fieldwork for the investigation was carried out on the 10th and 17th November 2018, due to current school activities during the week, and comprised of the following sequence of activities;

- A Dial Before You Dig (DBYD) underground service search was conducted by Cardno for the nominated BH location and surrounding area prior to the fieldworks. A qualified underground service locator cleared the borehole locations from utilities, with the use of a pipe/cable locator & transmitter and ground-penetrating radar (GPR) prior to excavation.
- Drilling of five (5) boreholes using a Ute-mounted drill rig equipped with; solid flight auger and TC- bit;

- Installation of three (3) groundwater monitoring wells, for continual monitoring of groundwater fluctuating levels;
- Standard Penetration Tests (SPT) were undertaken within the soil profile at 1.5m intervals;
- Collection of disturbed soil samples for laboratory testing;
- Collection of various soil samples were undertaken from all investigatory locations for laboratory submission and analytical testing for potential contaminants
- Survey of all boreholes using a Topcon – GPS Rover.

All fieldworks, including logging of the subsurface profile, installation of wells and collection of disturbed / undisturbed samples, was undertaken by Geotechnical Engineers from Cardno. The locations of the completed geotechnical investigations are shown on the borehole location plan, attached to this report in **Appendix A**.

Subsurface conditions encountered are summarised in section 4 and detailed in engineering logs of bores (borehole logs) attached in **Appendix B**, together with explanatory notes.

Fieldwork was carried out in accordance with Australian Standard, AS1726-2017 '*Australian Standard – Geotechnical Investigations*'.

3.3.4 Laboratory Works

3.3.4.1 Geotechnical Testing

Samples of representative strata were recovered and returned to NATA accredited laboratory. The following tests were carried out on selected samples:

- Five (5) Atterberg Limits and Five (5) Particle Size Distribution (PSD) tests to aid material classification;
- Two (2) California Bearing Ratio (CBR) tests to aid bulk density, swell potential and subgrade stiffness;
- Seven (7) Soil aggressivity tests to aid footing design;

Where variable ground conditions were encountered during investigatory works, soil sampling for laboratory assessment was restricted due to various factors; i.e. where intermittent stratums were encountered at varying depths, limited subsurface soil / environmental samples could be obtained.

The Laboratory test results for soils are included in **Appendix C**, along with environmental test results included in **Appendix D**. Laboratory testing was carried out in accordance with Australian Standard AS1289 '*Laboratory Testing for Engineering Purposes'.*

3.3.4.2 Groundwater Wells

Groundwater monitoring well installation was undertaken in accordance with the following methodology:

1. Wells were constructed using a combination of 50 mm Class 18 PVC flush-jointed, threaded well screen and blank casing.
2. The wells were backfilled with sand up to about 0.5m BGL followed by a bentonite plug (0.4 m thick). The annuluses of wells were backfilled with clean material from the surface to the plug.
3. The wells were completed with expansion caps and ground monuments.

4 GROUND CONDITIONS ENCOUNTERED

A brief summary of the typical sub-surface conditions encountered within each investigatory locality is provided below. For full description of the sub-surface profiles encountered at each investigatory location, reference can be made to the borehole logs contained in **Appendix B**.

4.1 Subsurface Strata

The subsurface profile encountered across the site was as follows;

- A relatively thin topsoil composing of silty sands with varying thicknesses of between 0.10m to 0.20m, was encountered from surface, except within BH04, asphalt was encountered as a paved surface, overlying;
- Fill, composed of Gravelly Sand was encountered with varying thicknesses from 0.10m to 0.50m , underlain by;
- Naturally occurring Marine Sand interbedded with Clayey Sands / Sandy Clays

The subsurface profiles are summarized below in **Table 4-1** and presented in the engineering logs attached in **Appendix B** together with explanatory notes.

Table 4-1 Subsurface Profile Summary

Soil Description / Depth (m)							
BH No.	Topsoil / Asphalt	Fill	Natural Soil (Marine)		TD (m)	Stand pipe Installed	GW encountered – Depth BSL (m)
	Silty Sand	Gravelly Sand	Sand/ Silty Sand	Sandy Clay			
BH01	0.00 - 0.10	0.10 – 0.30	0.30 - 7.38, 11.50 - 13.00,14.60 - TD	7.38 - 11.50, 13.00 - 14.60	16.45	Y	3.00
BH02	0.00 - 0.10	-	0.10 - 8.50, 14.50 - 16	8.50 - 14.50, 16.00 – TD	17.95	Y	4.15
BH03	0.00 - 0.10	-	0.10 - 8.20, 11.20 - TD	8.20 - 11.20	13.45	N	4.0
BH04	0.00 – 0.13	0.13 - 0.50	0.50 - RD	-	4.00	N	NE
BH05	0.00 - 0.20	-	0.20 - TD		5.50	Y	NE

Notes;

a) All depths measured in metres below ground surface level (Refer to Table 3-1) at the time of the investigation.
b) Refer to attached Soil Description, Rock Description and Glossary of Terms on appendix B for a full list of symbols and terms.
c) Soil Classification follows United Soil Classification system (USCS).
d) Rock Classification follows AS1726
e) TD = Termination Depth.
f) BSL – Below Surface Level
g) NE = Not encountered

4.2 Groundwater and permeability

Groundwater inflow was encountered at BH01, BH02 and BH03 at depths of 3.00m, 4.15m and 4.0m respectively at the time of investigation. Due to the low lying elevation and proximity of the site towards the coast, this may indicate that the groundwater table across the area is shallow which also coincides with AHD level of the site being just 3 to 4m above sea level.

Post investigatory works, groundwater levels were measured within the standpipes installed, where the following, groundwater levels were recorded.

Table 4-2 Monitoring Well Construction

Monitoring Well ID	Installation Date	Total Depth (mBGL)	Screening Interval (mBGL)	Depth to water (m)
MW01 (BH05)	10/11/2018	5.5	2.0-5.0	3.870
MW02 (BH02)	17/11/2018	17.95	2.0-5.0	3.981
MW03 (BH01)	10/11/2018	16.45	2.0-5.0	3.850

It should be noted that groundwater level may fluctuate depending on the time of the year and following periods of wet weather.

4.2.2 In-situ permeability test results

Two (2) in-situ permeability tests were undertaken within the proposed area of the underground water storage area. Test results were interpreted using the basic time lag method as described by the attached in house spreadsheets. The In-situ test results are presented in **Table 4-3** below.

Table 4-3 Soil Infiltration Test Results

Monitoring Well ID	Material Type	Absorption Time for 20L	Calculated Ksat-value (m/sec)
MW03 (BH01)	Marine Sand	Immediate	2.4 x 10-04
(BH04)	Marine Sand	Immediate	6.5 x 10-05

The results were interpreted using the basic time lag method (Horsley, 1951). The basic time lag is defined as the time required for a full natural logarithmic cycle head drop. It is obtained graphically by plotting H/H 0 on a log scale versus time. The intercept to the linear trend line at H/H 0 =0.37 provides the basic time lag. The shape factors are were taken from Chapais (1989). For all of the tests the time lag was extrapolated.

4.3 Laboratory Test Results

4.3.1 Soil Properties and classification

The results of material classification testing on selected samples are summarized below in **Table 4-4** to **4-6** below.

Table 4-4 Geotechnical Laboratory Test Results – Soils

Particle Size Distribution, Atterberg Limits, Linear Shrinkage							
BH ID	Depth(m BSL)	Sand & Gravel (%)	Clay & Silt (%)	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
BH02	1.5-2.0	98	1	3.9	NO	NO	NP
BH03	0.2-0.5	99	1	3.9	NO	NO	NP
BH03	2.0-2.5	99	1	2.1	NO	NO	NP
BH04	1.0-1.2	99	1	0.1	NO	NO	NP
BH04	2.0-2.45	100	0	1.5	NO	NO	NP

Table 4-5 California Bearing Ratio (CBR) Test Results

CBR Test Results					
BH ID	Depth (m BSL)	SMDD[1] (t/m^3)	OMC[2] (%)	CBR (%)	Swell (%)
TP12	0.5-1.0	1.63	12.5	11	0.0
BH05	1.5-2.0	1.66	15.0	14	0.0

Notes:
1. Standard Maximum Dry Density
2. Optimum Moisture Content

CBR testing was undertaken on remoulded specimens compacted to a target 100% standard maximum dry density with a surcharge of 4.5 kg and soaked for four (4) days. Subgrade strength is moisture and density

dependent and where the existing subgrade is compacted to less than 100% standard compaction and moistures above OMC exist, the in situ CBR values may be less than the above tested values.

4.3.2 Environmental Soil Aggressivity Results

Results of soil aggressivity tests on selected samples obtained from select borehole and considered representative of the soil profiles encountered across the site are summarized below in **Table 4-6**.

Table 4-6 Soil Aggressivity Results

Soil Aggressivity									
BH ID	Depth (m BSL)	Chloride (mg/kg)	pH	Conductivity (µS/cm)	Sulphate (mg/kg)	Moisture (%)	Resistivity (ohm. M)	Exposure Classification[1] (AS 3600 – 2009)	Exposure Classification[2] (AS2159 – 2009)
BH01	2.50-2.95	6.6	6.3	18	4.7	13.6	560	A2	Mild
BH02	1.00-1.45	2.8	7.6	33	3.9	7.1	300	A2	Mild
BH02	5.50-5.95	7.7	8.1	54	7.3	16.1	180	A2	Mild
BH03	4.00-4.50	11	7.7	72	7.9	16.0	140	A2	Mild
BH03	7.00-7.45	11	7.2	370	15	20.8	27	A2	Mild
BH04	0.50-0.95	2.2	6.1	53	12	0.9	190	A2	Mild
BH05	3.00-3.45	10	6.5	38	6.4	10.3	260	A2	Mild

Note:

1. Exposure classification for buried reinforced concrete based on Tables 4.8.1 and 4.8.2 of AS 3600 (2009).
2. Based on AS 2159-2009 and groundwater condition mentioned above in table 6.4.2

5 PROPOSED DEVELOPMENTS

Proposed developments are currently being considered, as part of a major upgrade of school facility, to enhance Kyeemagh Infant school ability to support future activities. As per the project brief the following facilities are proposed as part of upgrade works

- Learning areas
- Community Hall
- Library facility
- Absorption and Underground Storage Tanks
- Games courts
- Commuter car park

6 GEOTECHNICAL COMMENTS AND DESIGN PARAMETERS

6.1 Subsurface Conditions / Geology

The general ground conditions encountered on site have been discussed in section 4 of this report. In summary the ground conditions encountered comprised of shallow depths of fill, overlying deep marine sands and clays with minor shell content, which is consistent with the regional geology as discussed in **Section 2.4** above.

6.2 Geotechnical Parameters

Based on the borehole logs and the results of laboratory tests, geotechnical design parameters are presented to assist with geotechnical design.

Table 6-1 Material Strength Parameters

Material	Unit Weight (KN/m^3)	Undrained Shear Strength Cu (kPa)	Cohesion C' (kPa)	Internal Angle of friction Φ	Young's Modulus E (MPa)
FILL, Gravelly / Silty SAND	NR	NR	NR	NR	NR
Marine, Clayey SAND / SAND (Loose)	18	0	0	27	10
Marine, Clayey SAND / SAND (Medium Dense)	18	0	0	30	35
Marine, Clayey SAND / SAND (Dense)	18	0	0	35	60
Marine, Silty / Sandy Clay (Very Soft)	16	5	0	20	1
Marine, Silty / Sandy Clay (Firm)	18	25	0	24	4
Marine, Silty / Sandy Clay (Stiff)	19	50	0	26	8

Notes;

a) N/A = No geotechnical parameters have been assigned to manmade fill layers due to potential variability. Relative density of natural granular layers, if any, shall be assessed based on SPT N values. All manmade (i.e. fill) layers are recommended to be considered loose (for granular soils) or soft (for fine grained soils).

6.3 Geotechnical Model

Ground models for geotechnical analysis and design include geotechnical stratigraphy and soil mass parameters.

A representative geotechnical model for each feature are derived based on available geotechnical information. Subsurface conditions are described using each borehole taking into consideration potential for geological variation based on engineering judgement and local knowledge.

Geotechnical parameters adopted for design are summarised in Section 6.2 of this report. Where deemed appropriate by geotechnical designer, the design values may be adjusted based on test results at a particular location by taking into account local variation in geotechnical conditions.

Considering the classification systems above, the soil classification for each borehole is summarized in **Table 6-2** below.

Table 6-2 Classification of Soils at Borehole Locations

BH No;	Depth from SL (m)	RL Depth (m)	Thickness (m)	Strength
BH01	0.00 – 0.30	3.48 – 3.18	0.30	N/R
	0.30 – 4.00	3.18 – 0.01	3.70	MD
	4.00 – 7.00	0.01 – (-2.99)	3.00	D
	7.00 – 7.38	(-2.99) – (-3.37)	0.38	L
	7.38 – 11.50	(-3.37) – (-7.49)	4.12	VS
	11.50 – 14.50	(-7.49) – (10.49)	3.00	MD
	14.50 – 16.45	(10.49) – (-12.44)	1.95	D
BH02	0.0 – 1.00	4.60 – 3.60	1.00	N/R
	1.00 – 2.50	3.60 – 2.10	1.50	MD
	2.50 – 4.00	2.10 – 0.60	1.50	L
	4.00 – 7.00	0.60 – (-2.40)	3.00	MD
	7.00 – 8.50	(-2.40) – (-3.90)	1.50	L
	8.50 – 11.50	(-3.90) – (-6.90)	3.00	VS
	11.50 – 13.00	(-6.90) – (-8.40)	1.50	F
	13.00 – 14.50	(-8.40) – (-9,9)	1.50	ST
	14.50 – 16.00	(-9.90) – (-11.40)	1.50	VD
	16.00 – 17.50	(-11.40) – (-12.90)	1.50	ST
	17.50 – 17.95	(-12.90) – (-13.35)	0.45	D
BH03	0.0 – 1.50	3.83 – 2.33	1.50	N/R
	1.50 – 4.00	2.33 – (-0.17)	2.50	MD
	4.00 – 7.00	(-0.17) – (-3.17)	3.00	D
	7.00 – 8.20	(-3.17) – (-4.37)	1.20	MD
	8.20 – 11.20	(-4.37) – (-7.37)	3.00	VS
	11.20 – 13.00	(-7.37) – (-9.17)	1.80	D
	13.00 – 13.45	(-9.17) – (-9.62)	0.45	MD
BH04	0.0 – 0.50	4.38 – 3.88	0.50	N/R
	0.50 – 1.50	3.88 – 2.88	1.00	VL
	1.50 – 4.00	3.88 – 1.38	2.50	MD
BH05	0.0 – 0.20	4.56 – 4.36	0.20	N/R
	0.20 – 5.50	4.36 - (-0.95)	5.30	MD

6.4 Earthworks

6.4.1 Excavatability

When considering excavation at any of the sites, the findings and recommendations presented in the Contamination Assessment report should also be considered. It is anticipated that minor excavations would be required across the majority of the proposed development area. However some significant bulk excavations maybe proposed for larger developments, with basement tiers.

Where excavation is required, e.g. for levelling purposes etc., it can be achieved with conventional earthmoving equipment. Excavations for services trenches, if required, similarly will be able to be achieved with excavators based on the findings of the investigation.

6.4.2 Excavation Support

For deeper excavations, the options for lateral support that may be considered are tabulated below:

Table 6-3 Excavation Supports

Wall Type	Advantages	Disadvantages	Additional Comments
Open Cut excavation	Simple / Cheap Option	Dependent on batter slope / space	Consideration of groundwater table required. Base and slope instability and dewatering to be assessed.
Soil Nails	Simple / Relatively cheap option	Phased works within open cut	Consideration of groundwater table required. Base and slope instability and dewatering to be assessed.
Sheet pile wall	Provides an economic embedded wall No arising's to be removed Suitable as a water retaining system	Potential declutching in coarse grained soil	Use of tie back anchors (soil strength and space considerations). Cantilever sheet piles to be evaluated. Groundwater table and tanking to be considered.
Secant Piles	A permanent water-retaining wall Installed using standard piling plant with high torque rigs	Depth is limited by the vertical tolerance, which may determine the depth of scanting	Use of tie back anchors (soil strength and space considerations). Cantilever option to be evaluated. Groundwater table and tanking to be considered.
Contiguous piles	The cheapest form of concrete piled wall	Not a water retaining solution Not a permanent solution in any soil due to gaps between piles unless structural face is applied	The presence of a shallow groundwater table makes this option unlikely.

Considering the above options, pros and cons, the following recommendations are given.

1. Where excavation is not along another property, use open excavation technique.
2. Where excavation is along another property the following two options should be considered.
    a. Use a tied back sheetpile wall. This requires negotiated agreement with the property owner for right to install tiebacks into their property.
    b. Use an internally braced sheetpile wall where structures sensitive to settlement / horizontal movement are located within 15m from the excavation. Elsewhere, use cantilevered sheetpile walls with provision for remedial works on the adjacent property.
    c. Alternative to the above Item b, install secant piles (depth of piles to be designed by others) and use them as part of the permanent basement wall.

6.4.3 Excavation Batters

Deep excavation is not expected to be required across the majority of the development. However should deep excavations be required, they will not be able to be battered due to shallow groundwater encountered. Should this be required, temporary batters above the groundwater table of 2H: 1V may be considered. The temporary batters should be protected in the short term from erosion caused by heavy rain. This will have to be investigated further during detailed design. Any temporary slopes should be inspected for signs of instability on a regular basis by a geotechnical engineer.

6.4.4 Structural Fill

Structural fill may be required to be placed at the sites. Where this is found to be necessary, the use of high clay content fills should be avoided, in order to minimise the potential for post compaction volume change as

a result of moisture content variations. Where the use of high clay content fill is unavoidable, fill should be placed in loose layers not greater than 200mm thick at a moisture content in the range -2% to +3% of the standard optimum moisture content, and be compacted to a minimum dry density ratio of 98% standard compaction as per AS3798-2007, Table 5.1.

Measures should be adopted to ensure that the clay bearing fill material is not allowed to dry out prior to the placement of succeeding layers of fill and final covering with building slabs and pavements.

Conversely, any structural free draining sand fill should be placed in loose layers not greater than 200mm thick, and compacted to a minimum density index of 75% as per AS1289 5.5.1 using a suitable compaction equipment.

It is recommended that the placement of all structural fill be inspected and tested by geotechnician to a Level 1 requirement during the earthworks operations to ensure that all fill is placed in a *'controlled manner'*, in accordance with AS3798-2007.

6.4.5 Working Platforms and Subgrade

Gravelly / Silty sand is expected to be exposed during excavation on site. Which is considered preferable as a working platform. Adequate drainage should be provided to reduce the risk of this horizon becoming wet / slippery in adverse weather conditions.

6.4.6 Pavements

As presented in **Table 4-5**, laboratory soaked CBR tests indicates that the subgrade material has swell of 0.0%. The material therefore has a "low" expansiveness for pavement design purposes. The test result for the specimens indicate CBR values in the range 11% to 14%. Taking this into consideration, a pavement design CBR of 11.0% is recommended for the site locality.

Should field conditions at the time of construction indicate that field CBR is less than 11.0%, Cardno should be consulted to provide additional advice.

6.4.7 Aggressiveness Classification

In accordance with AS3600 (2009), exposure classification for concrete 'A2' for the subsurface materials across the investigated areas. Future concrete structures should be designed in accordance with the concrete cover specifications in AS 3600 (2009) for an exposure classification of 'A2'.

6.5 Foundation Options

Both shallow and deep options of foundations could be adopted for the proposed sequence of dwelling proposed, where deep retaining structures may be required for larger structures, depending on loading conditions. Parameters for both shallow and deep footing options are provided below;

6.5.1 Shallow / Pad Footings

It is assessed that there is less than 200mm depth of fill across the majority of the subject site, which in the absence of any construction records should be considered as 'uncontrolled' in accordance with AS2870-2011 Design of Footings and Slabs for Residential Construction.

However, it is deemed that all footings would be founded on natural soil through fill, and to be compliant with the scope of AS2870. Due to footings being installed below the shallow 'uncontrolled 'fill, within medium dense sands, the site should be treated as Class S (slightly reactive) in accordance with AS2870-2011. The site reactivity in terms of surface movement would be similar to Class S with a potential surface movement up to 20mm.

For the proposed structures pad / raft footings maybe a feasible option provided the footings are founded into a natural competent stratum. Due to the unknown loads and footing systems, no specified allowable bearing capacities can be determined at this time. Once specific loadings have been ascertained, Cardno can assist to optimise the footing size and depth to suit the loading on the founding material.

The following parameters are provided for preliminary sizing of shallow footings of ancillary structures. Bearing capacity of footings in soil needs to be subjected to geotechnical checking considering footing size, depth, slope (ground surface and/or footing base) and loadings (i.e. bearing capacity is not a soil property but is dependant of footing size, depth, slope and loadings). A footing subjected to pull out forces should be further geotechnical assessment in addition to bearing capacity, overturning and sliding.

Table 6-4 Shallow / Pad Footing Design Parameters

Cohesive Soil		Non Cohesive Soils	
Material (Natural or Engineered Fill)	Nominal Embedment depth (m)	Nominal Footing (m)	Ultimate Bearing Capacity (kPa)[1,2,3]
Fill	NR	NR	NR
Marine – Sand (loose)	0.5	1m x 1m	NR
Marine – Sand (Medium Dense)	0.5	1m x 1m	140
Marine – Sand (Dense)	0.5	1m x 1m	320

Note;

1. Ultimate bearing capacity tabulated above assuming eccentricity of 1/6 x footing width
2. Horizontal ground is assumed
3. Settlement analysis should also be taken into consideration, due to the presence of very soft clays, and loose sands, at depth

It is suggested that all footing and slab loads for the proposed dwellings be supported on footings founded in competent natural strata around the entire perimeter of the building. This may be achieved by backhoe excavated pedestals/short bored piers or an over excavated trench founded at least 0.50m into natural strata (the allowable bearing capacity at this level would be at least 140 kPa).

6.6 Deep Foundations

Where larger structures are proposed, carrying larger structural loads, deeper footing would be required due to the variability of loose sands and very soft clays encountered across the site. Due to the poor ground conditions encountered across the subject site, deep foundations are considered the most economical option that could be adopted

Table 6-5 provides feasible foundation options that are appropriate for the subject sites, discussion and comments being noted;

Table 6-5 Foundation Options

Foundation Type	Advantages	Disadvantages	Additional Comments
Screw Piles	▪ Quiet / No vibration ▪ Can be loaded to full capacity after installation	▪ Not suitable for use in very hard or gravelly soils ▪ Can sustain damage on granular stratums if encountered	Installation of screw piles Is dependent on sizing and torque resistance being achieved at top of screw
Bored Piles	▪ Quiet / No vibration ▪ Greater lengths can be installed	▪ Requires the use of liners and possibly slurry. ▪ Requires additional plant (cranes, etc.)	It is possible that pile lengths will be greater with this option

Suitable design parameters for the proposed options discussed above, are presented in the proceeding sections.

6.7 Screw Pile Design Parameters

Screw piles are commonly used in the founding stratums that that have been investigated and pre-determined to be suitable for screw pile installation. The suitability of screw piles, however depend on magnitude of loading and loading conditions (such as moment, lateral loading etc.). In hard ground the installation of screw piles may prove to be difficult due to limited torsional capacity of screw piles.

Based on the borehole logs and the results of laboratory tests, geotechnical design parameters are presented to assist with geotechnical design. **Table 6-1** presents interpreted geotechnical strength and deformation parameters for soil stratum.

6.8 Bored Pile Design Parameters

It is considered that the most viable foundation option, may also comprise of Bored (or CFA) piles. Bored piles would require to be socketed within the hard clays / very dense sands / weathered rock strata, to achieve sufficient lateral and axial capacities for the proposed structure. No information to classify bedrock, was encountered during field investigatory works.

The following parameters presented below, have been determined, based on the ground conditions encountered during investigatory works

The number of piles and dimensions should be determined by the geotechnical and structural design engineers in accordance with the recommended design parameters provided in **Table 6-6**. These parameters may be used for pile foundation design purposes only.

Table 6-6 Limit State design parameters

Rock Mass /Soil Classification	Ultimate End Bearing (MPa)	Ultimate Shaft Adhesion (kPa)	Elastic Modulus (MPa) #3	Spring Constant Ks (kN/m) #1,2,3
FILL, Gravelly / Silty SAND	N/R	N/R	N/R	N/R
Marine, Clayey SAND / SAND (Loose)	N/R	N/R	10	7,000
Marine, Clayey SAND / SAND (Medium Dense)	N/R	10	30	20,000
Marine, Clayey SAND / SAND (Dense)	N/R	15	100	70,000
Marine, Silty / Sandy Clay (Very Soft)	N/R	-	1	2,000
Marine, Silty / Sandy Clay (Firm)	N/R	20	4	3,000
Marine, Silty / Sandy Clay (Stiff)	N/R	35	8	6,000

Notes;

1. The spring constants given above are for one metre wide structure element with springs spaced at 1m interval. For different structure element widths the above spring constants should be modified. The simplified modification formula may be used.

   Ksm = Ks_1 / width of structure element, m

   Where Ksm = spring constant modified

   Ks1 = spring constant for 1m wide structure element

2. It is recommended to undertake sensitivity assessments using 50% to 200% of spring constant values.
3. For structural modelling purposes, spring constants are provided for the different soil/rock units. Spring constants are given per unit deflection. The spring constants should only be used as an initial estimate of soil structure interaction behaviour. Detailed design of pile foundations will involve an iterative process between Structural and Geotechnical Engineers to model lateral behaviour of piles considering soil yielding phenomenon.
4. No springs should be assigned for soil depths from 0m to 1.5 x pile diameter. The springs for soils from 1.5 x pile diameter to 3 x pile diameter, linearly increases from 0kN/m3 to value of spring constant assigned in Table 5-4.
5. N/R = Not Recommended
6. In accordance with the requirements of AS2159-2009, a geotechnical reduction factor is to be applied to the ultimate geotechnical strength to obtain the design geotechnical strength. We have determined that an average risk rating ARR=2.59 (corresponding to a low to moderate overall risk category) and a geotechnical reduction factor $\phi g = 0.52$ can be adopted for this project. This is based on the following assumptions:

   a) Detailed level of construction control is required with professional geotechnical supervision, construction processes that are well established and relatively straightforward

   b) No performance monitoring of the supported structure during and after construction is proposed

   c) No pile load testing is proposed

6.9 Seismic Activity

Current Australian standards AS5100 and AS4678 both refer to AS1170.4-1993 for earthquake actions, notwithstanding the latest revision of AS1170.4 is 2007.

As required in AS1170.4-1993 a site factor (S) of 1.25 and an acceleration coefficient (a) of 0.08 are recommended.

7 CONSTRUCTION INSPECTIONS

It is recommended that placement of all structural fill and footing excavations be inspected, tested and certified where necessary, by a suitably qualified geotechnical engineer to ensure recommendations made in this report have been adhered to.

Should subsurface conditions other than those described in this report be encountered, Cardno should be consulted immediately and appropriate modifications developed and implemented if necessary

8 LIMITATION OF THE REPORT

Reference should be made to the 'General Notes' at the end of this report.

The information is site and project specific in the location investigated and therefore was provided for our client's sole use in accordance with a specific purpose; as such they do not necessarily address all aspects of ground behaviour on the subject site. The responsibility of Cardno Pty Ltd is solely to its client. It is not intended that any third party rely upon this report. No liability will be accepted to any third party.

9 SUMMARY AND CONCLUSION OF WORKS

The following is a summary of the conclusions and recommendations with regard to the geotechnical investigation that was performed for Kyeemagh Infants School, Corner of Jacobson Avenue and Beehag Street, Kyeemagh, NSW. The following conclusions can be drawn from Cardno's geotechnical investigatory works.

9.1 Conclusions

1. Geotechnical and contamination investigation works were undertaken at the site, for the proposed redevelopment of the school grounds as part of a Department of Education Program.
2. Geotechnical fieldworks comprised of five (5) investigatory boreholes undertaken down to between four (4) and seventeen (17) metres depth with collection of soil samples for interpretation and analysis, as described in **Section 4** of this report. Records of borehole logs are provided in **Appendix B**.
3. The subsurface conditions encountered across the subject site were relatively consistent, with shallow depths of fill overlying deep seated sands, with intermittent clay seams, of very soft / loose consistency, depicted as Marine Sands, in accordance with the regional geology.
4. Groundwater was encountered in the installed groundwater monitoring wells at depths ranging between 3.8 to 3.9m BSL. Groundwater should be considered in construction scheduling, general excavations and bored piling works.

9.2 Recommendations;

1. Recommended preliminary bearing capacity parameters for geotechnical design purposes are provided in **Section 6.5**. However, we note that the recommended bearing capacity values should be reviewed / revised considering adopted footing type and site specific foundation material.

2. **Table 6-4** & **6-6** presents recommended soil strength and deformation parameters for both shallow and deep footings options.

9.3 Closure

We appreciate the opportunity to work collaboratively with you on this project. Our team looks forward to bringing our high level of expertise to deliver successful outcomes in your future projects.

Your attention is drawn to the appended document titled "*Important Information about this Geotechnical Report".* This document is intended to clarify to the reader what the realistic expectations of this report should be, and what is the correct use of the document. Misinterpretation of geotechnical information presents significant risk to projects: The document includes a discussion on general limitations of geotechnical services, which by nature, are based extensively on opinion and judgement.

The statements included in this document are not intended to be exculpatory clauses or to reduce the general responsibility accepted by Cardno, but rather to identify where Cardno and our Client's responsibilities lie. The statements ensure that all parties that may rely on the report are aware of their respective responsibilities.

For further enquiries, please do not hesitate to contact Cardno on the information supplied.

Important Information about this Geotechnical Report

Scope of Work

The purpose of this report and any associated documentation is expressly stated in the document. This document does not form a complete assessment of the site, and no implicit determinations about Cardno's scope can be taken if not specifically referenced. Whilst this report is intended to reduce geotechnical risk, no level of detail or scope of work can entirely eliminate risk.

The nature of geotechnical data typically precludes auxiliary environmental assessment without undertaking specific methods in the investigation. Therefore, unless it is explicitly stated in the scope of work, this report does not provide any contamination or environmental assessment of the site or adjacent sites, nor can it be inferred or implied from any component of the document.

The scope of work, geotechnical information, and assessments made by Cardno may be summarised in the report; however, all aspects of the document, including associated data and limitations should be reviewed in its entirety.

Standard of care

Cardno have undertaken investigations, performed consulting services, and prepared this report based on the Client's specific requirements, data that was available or was collected, and previous experience.

Cardno's findings and assessment represent its reasonable judgment, diligence, skill, with sound professional standards, within the time and budget constraints of its commission. No warranty, expressed or implied, is made as to the professional advice included in this report.

Data sources

In preparing this document, or providing any consulting services during the commission, Cardno may have relied on information from third parties including, but not limited to; sub-consultants, published data, and the Client including its employees or representatives. This data may not be verified and Cardno assumes no responsibility for the adequacy, incompleteness, inaccuracies, or reliability of this information.

Cardno does not assume any responsibility for assessments made partly, or entirely based on information provided by third parties.

Variability in conditions and limitations of data

Subsurface conditions are complex and can be highly variable; they cannot be accurately defined by discrete investigations. Geotechnical data is based on investigation locations which are explicitly representative of the specific sample or test points. Interpretation of conditions between such points cannot be assumed to represent actual subsurface information and there are unknowns or variations in ground conditions between test locations that cannot be inferred or predicted.

The precision and reliability of interpretive assessment between discrete points is dependent on the uniformity of the subsurface strata, as well as the frequency, detail, and method of sampling or testing.

Subsurface conditions are formed by various natural and anthropogenic processes and therefore are subject to change over time. This is particularly relevant with changes to the site ownership or usage, site boundary or layout, and design or planning modifications. Aspects of the site may also not be able to be determined due to physical or project related constraints and any information provided by Cardno cannot apply following modification to the site, regulations, standards, or the development itself.

It is important to appreciate that no level of detail in investigation, or diligence in assessment, can eliminate uncertainty related to subsurface conditions and thus, geotechnical risk. Cardno cannot and does not provide unqualified warranties nor does it assume any liability for site conditions not observed or accessible during the investigations.

Verification of opinions and recommendations

Geotechnical information, by nature, represents an opinion and is based extensively on judgment of both data and interpretive assessments or observation. This report and its associated documentation are provided explicitly based on Cardno's opinion of the site at the time of inspection, and cannot be extended beyond this.

Any recommendations or design are provided as preliminary until verified on site during project implementation or construction. Inspection and verification on site shall be conducted by a suitably qualified geotechnical consultant or engineer, and where subsurface conditions or interpretations differ from those provided in this document or otherwise anticipated, Cardno must be notified and be provided with an opportunity to review the recommendations.

Client and copyright

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Kyeemagh Infants School, Corner of Jacobson Avenue and Beehag Street, Kyeemagh NSW

APPENDIX A

SITE INVESTIGATION PLANS

Kyeemagh Infants School

Detailed Site Investigation

REGION & VICINITY

LOCATION DIAGRAM NOT TO SCALE

Legend

Site Boundary

FIGURE 1

1:20,000 Scale at A3

m
0 200 400 600 800

N

Cardno

Map Produced by NSW/ACT (WNE)
Date: 2018-12-11 | Project: 80818157
Coordinate System: GDA 1994 MGA Zone 56
Map: 80818157-GS-001-Location.mxd 01
Imagery supplied by nearmap 2018

Kyeemagh Infants School

Detailed Site Investigation

SITE PLAN &
INTRUSIVE LOCATIONS

Legend

- Site Boundary
- Borehole / Test Pit Locations
- Excluded Area

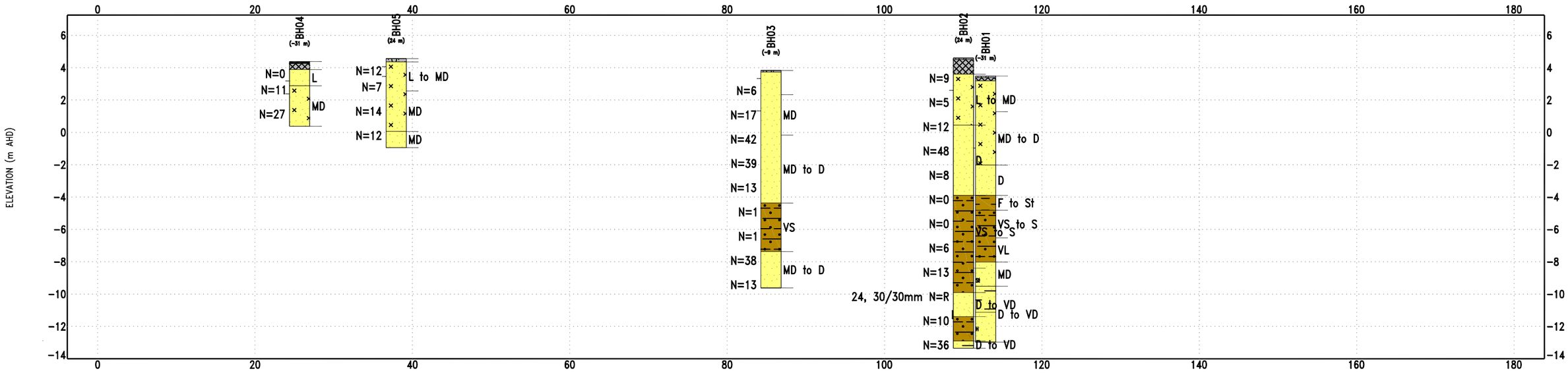
FIGURE 2

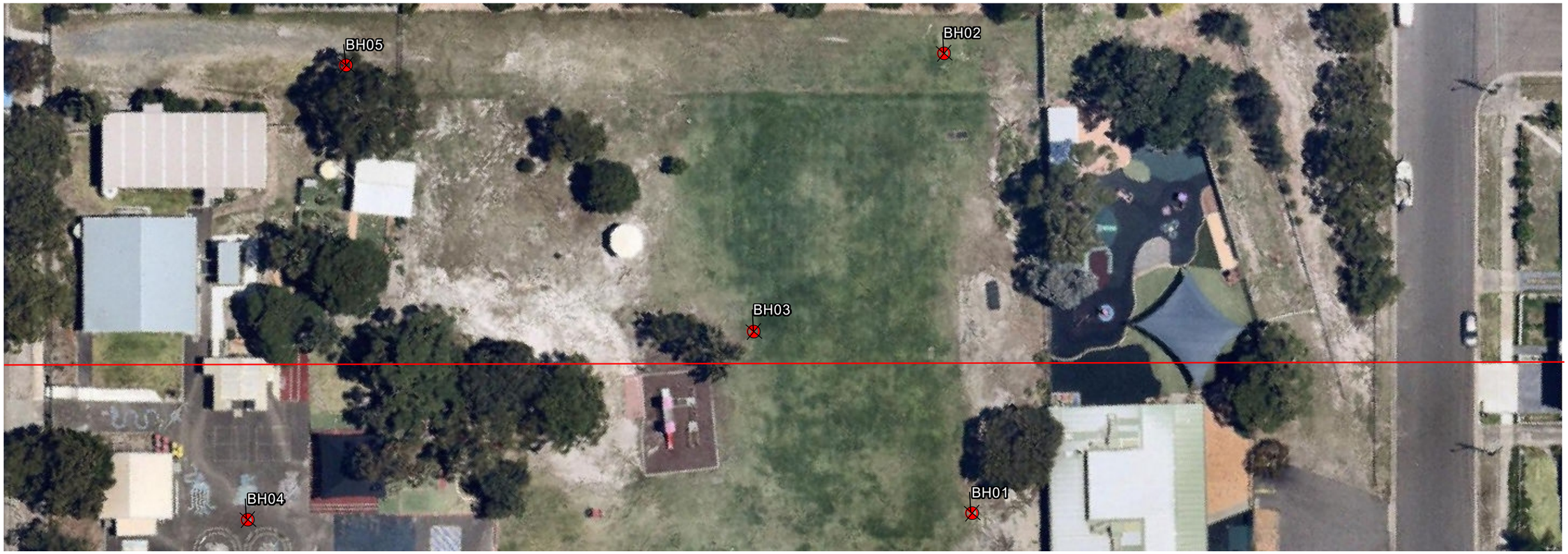
1:800 Scale at A3

m
0 5 10 15 20

Cardno

Map Produced by NSW/ACT (WNE)
Date: 2018-12-11 | Project: 80818157
Coordinate System: GDA 1994 MGA Zone 56
Map: 80818157-GS-002-SitePlan.mxd 01
Imagery supplied by nearmap October, 2018





H 1:500

0 5 10 15 20 25m

V 1:250

0 2 4 6 8 10m

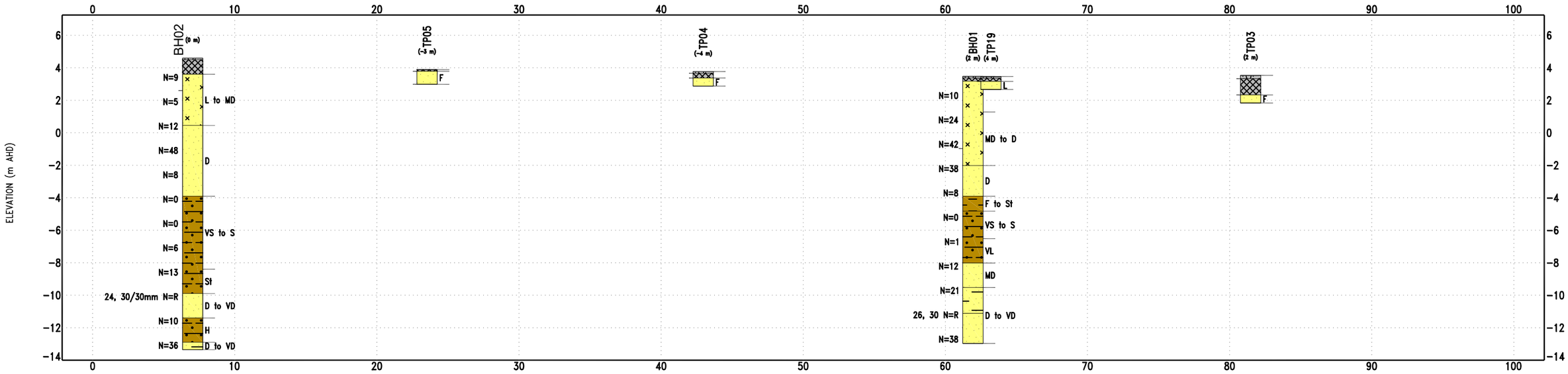
Coord.System: MGA94 Zone 56 Height Datum: AHD

MATERIAL GRAPHIC

- TOPSOIL
- FILL
- Silty SAND
- SAND
- CLAY
- Sandy CLAY
- Clayey SAND
- ASPHALTIC CONCRETE

INDICATIVE GEOLOGICAL CROSS SECTION
KYEEMAGH INFANTS SCHOOL

Cardno



H 1:300
0 2 4 6 8 10m
V 1:250
0 2 4 6 8 10m
Coord.System: MGA94 Zone 56 Height Datum: AHD

MATERIAL GRAPHIC

- TOPSOIL
- FILL
- Silty SAND
- SAND
- Silty CLAY
- Sandy CLAY
- Clayey SAND

INDICATIVE GEOLOGICAL CROSS SECTION
KYEEMAGH INFANTS SCHOOL

Cardno

TWO STOREY RESIDENTIAL

AUTOMATIC ENTRY GATE

CAR PARK
20 CARS

ACCESSIBLE CARPARK

INTERCOM

WASTE PAD

BOOSTER ASSEMBLY

PUMP ROOM

GARDEN STORE

MANUAL GATE ENTRY

AUTOMATIC ACCESS GATE

GAMES COURT

FUTURE HOMEBASE

UNDERGROUND WATER STORAGE (30,000L)

STORMWATER PUMP

AUTOMATIC COMMUNITY ENTRY

AUTOMATIC MAIN ENTRY

BUS STOP

CROSSING

BIKE PARKING

PRE-SCHOOL

MANUAL GATE ENTRY

COMMUNITY GARDEN LOCATION

COMMUNITY ENTRY MANUAL GATE

JACOBSON AVENUE

A B C D E F G H J

6150 5160 6000 6000 6000 5160 6000 6150

13000 16940 5400 6500 4600 3140 6150 5160 5999 6001 6000

4376

7490 8030 2140 9500 4865 2221 7490 8030 7490

Notes

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Verify all dimensions and levels on site and report any discrepancies to dwp for direction prior to the commencement of work.

Drawings are to be read in conjunction with all other contract documents.

Use figured dimensions only. Do not scale from drawings. dwp cannot guarantee the accuracy of content and format for copies of drawings issued electronically. The completion of the Issue Details Checked and Authorised section is confirmation of the status of the drawing. The drawing shall not be used for construction unless endorsed 'For Construction' and authorised for issue.

- HOME BASE
- PRACTICAL LEARNING SPACES
- ADMINISTRATION
- GROUP WORK
- HARD PAVING
- HALL

CONCEPT DESIGN
NOT TO BE USED DURING CONSTRUCTION

Issue	Description	Date	Chk	Auth
P	CONCEPT DESIGN REPORT	24.08.18	DD	RS
N	CONSULTANTS REVIEW	13.08.18	DD	RS
M	PRG REVIEW	10.08.18	DD	RS
L	UPDATED LAYOUTS	02.07.18	DD	RS
K	PRG MEETING	04.07.18	DD	RS
J	CONCEPT DESIGN	29.06.18	DD	RS
H	CONSULTANTS REVIEW	25.06.18	DD	RS
G	PRG REVIEW	21.06.18	DD	RS
F	CONSULTANTS REVIEW	18.06.18	DD	RS
E	PRG MEETING	06.06.18	DD	RS
D	CONSULTANTS REVIEW	29.05.18	DD	RS
C	LAYOUT TO INCLUDE OHSC	21.05.18	DD	RS
B	EFSG PRESENTATION	26.04.18	DD	RS
A	EFSG PRELIMINARY REVIEW	19.04.18	DD	RS

Architect/ Designer
dwp
www.dwp.com

Client
NSW Dept of Education & School Infrastucture NSW

CAR PARK

Project
KYEEMAGH PUBLIC SCHOOL

Location
JACOBSON AVE, KYEEMAGH NSW 2216

Project Number
AUSYD-17-0774

Drawing
GROUND FLOOR

Scale (A1) As indicated
Date Printed 19-Oct-18 3:16:32 PM

Drawing Number CS002
Issue P

File Name: BIM 360://dwp_17-0774 KYEEMAGH PUBLIC SCHOOL/AUSYD-17-0774_kyeemagh Public School.rvt

1 A401 GROUND FLOOR 1 : 200

Kyeemagh Infants School, Corner of Jacobson Avenue and Beehag Street, Kyeemagh NSW

APPENDIX

B

BOREHOLE REPORTS WITH CORE PHOTOS & EXPLANATORY NOTES FOR LOGS

Explanatory Notes

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS1726-2017 Geotechnical Site Investigations. Material descriptions are deduced from field observation or engineering examination, and may be appended or confirmed by in situ or laboratory testing. The information is dependent on the scope of investigation, the extent of sampling and testing, and the inherent variability of the conditions encountered.

Subsurface investigation may be conducted by one or a combination of the following methods.

Method	
Test Pitting: excavation/trench	
BH	Backhoe bucket
EX	Excavator bucket
R	Ripper
H	Hydraulic Hammer
X	Existing excavation
N	Natural exposure
Manual drilling: hand operated tools	
HA	Hand Auger
Continuous sample drilling	
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
Hammer drilling	
AH	Air hammer
AT	Air track
Spiral flight auger drilling	
AS	Auger screwing
AD/V	Continuous flight auger: V-bit
AD/T	Continuous spiral flight auger: TC-Bit
HFA	Continuous hollow flight auger
Rotary non-core drilling	
WB	Washbore drilling
RR	Rock roller
Rotary core drilling	
PQ	85mm core (wire line core barrel)
HQ	63.5mm core (wire line core barrel)
NMLC	51.94mm core (conventional core barrel)
NQ	47.6mm core (wire line core barrel)
DT	Diatube (concrete coring)

Sampling is conducted to facilitate further assessment of selected materials encountered.

Sampling method	
Soil sampling	
B	Bulk disturbed sample
D	Disturbed sample
C	Core sample
ES	Environmental soil sample
SPT	Standard Penetration Test sample
U	Thin wall tube ‘undisturbed’ sample
Water sampling	
WS	Environmental water sample

Field testing may be conducted as a means of assessment of the in situ conditions of materials.

Field testing	
SPT	Standard Penetration Test
HP/PP	Hand/Pocket Penetrometer
Dynamic Penetrometers (blows per noted increment)	
DCP	Dynamic Cone Penetrometer
PSP	Perth Sand Penetrometer
MC	Moisture Content
VS	Vane Shear
PBT	Plate Bearing Test
IMP	Borehole Impression Test
PID	Photo Ionization Detector

If encountered, refusal (R), virtual refusal (VR) or hammer bouncing (HB) of penetrometers may be noted.

The quality of the rock can be assessed by the degree of natural defects/fractures and the following.

Rock quality description	
TCR	Total Core Recovery (%) (length of core recovered divided by the length of core run)
RQD	Rock Quality Designation (%) (sum of axial lengths of core greater than 100mm long divided by the length of core run)

Notes on groundwater conditions encountered may include.

Groundwater	
Not Encountered	Excavation is dry in the short term
Not Observed	Water level observation not possible
Seepage	Water seeping into hole
Inflow	Water flowing/flooding into hole

Perched groundwater may result in a misleading indication of the depth to the true water table. Groundwater levels are also likely to fluctuate with variations in climatic and site conditions.

Notes on the stability of excavations may include.

Excavation conditions	
Stable	No obvious/gross short term instability noted
Spalling	Material falling into excavation (minor/major)
Unstable	Collapse of the majority, or one or more face of the excavation

Explanatory Notes: General Soil Description

The methods of description and classification of soils used in this report are based on Australian Standard AS1726-2017 Geotechnical Site Investigations. In practice, a material is described as a soil if it can be remoulded by hand in its field condition or in water. The dominant component is shown in upper case, with secondary components in lower case. In general descriptions cover: soil type, plasticity or particle size/shape, colour, strength or density, moisture and inclusions.

In general, soil types are classified according to the dominant particle on the basis of the following particle sizes.

Soil Classification		Particle Size (mm)
CLAY		< 0.002
SILT		0.002 0.075
SAND	fine	0.075 to 0.21
	medium	0.21 to 0.6
	coarse	0.6 to 2.36
GRAVEL	fine	2.36 to 6.7
	medium	6.7 to 19
	coarse	19 to 63
COBBLES		63 to 200
BOULDERS		> 200

Soil types may be qualified by the presence of minor components on the basis of field examination methods and/or the soil grading.

Terminology	In coarse grained soils		In fine soils
	% fines	% coarse	% coarse
Trace	≤5	≤15	≤15
With	>5, ≤12	>15, ≤30	>15, ≤30

The strength of cohesive soils is classified by engineering assessment or field/lab testing as follows.

Strength	Symbol	Undrained shear strength
Very Soft	VS	≤12kPa
Soft	S	12kPa to ≤25kPa
Firm	F	25kPa to ≤50kPa
Stiff	St	50kPa to ≤100kPa
Very Stiff	VSt	100kPa to ≤200kPa
Hard	H	>200kPa

Cohesionless soils are classified on the basis of relative density as follows.

Relative Density	Symbol	Density Index
Very Loose	VL	<15%
Loose	L	15% to ≤35%
Medium Dense	MD	35% to ≤65%
Dense	D	65% to ≤85%
Very Dense	VD	>85%

The plasticity of cohesive soils is defined by the Liquid Limit (LL) as follows.

Plasticity	Silt LL	Clay LL
Low plasticity	≤ 35%	≤ 35%
Medium plasticity	N/A	> 35% ≤ 50%
High plasticity	> 50%	> 50%

The moisture condition of soil (*w*) is described by appearance and feel and may be described in relation to the Plastic Limit (PL), Liquid Limit (LL) or Optimum Moisture Content (OMC).

Moisture condition and description	
Dry	Cohesive soils: hard, friable, dry of plastic limit. Granular soils: cohesionless and free-running
Moist	Cool feel and darkened colour: Cohesive soils can be moulded. Granular soils tend to cohere
Wet	Cool feel and darkened colour: Cohesive soils usually weakened and free water forms when handling. Granular soils tend to cohere

The structure of the soil may be described as follows.

Zoning	Description
Layer	Continuous across exposure or sample
Lens	Discontinuous layer (lenticular shape)
Pocket	Irregular inclusion of different material

The structure of soil layers may include: defects such as softened zones, fissures, cracks, joints and root-holes; and coarse grained soils may be described as strongly or weakly cemented.

The soil origin may also be noted if possible to deduce.

Soil origin and description	
Fill	Anthropogenic deposits or disturbed material
Topsoil	Zone of soil affected by roots and root fibres
Peat	Significantly organic soils
Colluvial	Transported down slopes by gravity/water
Aeolian	Transported and deposited by wind
Alluvial	Deposited by rivers
Estuarine	Deposited in coastal estuaries
Lacustrine	Deposited in freshwater lakes
Marine	Deposits in marine environments
Residual soil	Soil formed by in situ weathering of rock, with no structure/fabric of parent rock evident
Extremely weathered material	Formed by in situ weathering of geological formations, with the structure/fabric of parent rock intact but with soil strength properties

The origin of the soil generally cannot be deduced solely on the appearance of the material and the inference may be supplemented by further geological evidence or other field observation. Where there is doubt, the terms ‘possibly’ or ‘probably’ may be used

Explanatory Notes: General Rock Description

The methods of description and classification of rocks used in this report are based on Australian Standard AS1726-2017 Geotechnical Site Investigations. In practice, if a material cannot be remoulded by hand in its field condition or in water, it is described as a rock. In general, descriptions cover: rock type, grain size, structure, colour, degree of weathering, strength, minor components or inclusions, and where applicable, the defect types, shape, roughness and coating/infill.

Rock types are generally described according to the predominant grain or crystal size, and in groups for each rock type as follows.

Rock type	Groups
Sedimentary	Deposited, carbonate (porous or non), volcanic ejection
Igneous	Felsic (much quartz, pale), Intermediate, or mafic (little quartz, dark)
Metamorphic	Foliated or non-foliated
Duricrust	Cementing minerology (iron oxides or hydroxides, silica, calcium carbonate, gypsum)

Reference should be made to AS1726 for details of the rock types and methods of classification.

The classification of rock weathering is described based on definitions in AS1726 and summarised as follows.

Term and symbol		Definition
Residual Soil	RS	Soil developed on rock with the mass structure and substance of the parent rock no longer evident
Extremely weathered	XW	Weathered to such an extent that the rock has 'soil-like' properties. Mass structure and substance still evident
Distinctly weathered	DW	The strength is usually changed and may be highly discoloured. Porosity may be increased by leaching, or decreased due to deposition in pores. May be distinguished into MW (Moderately Weathered) and HW (Highly Weathered).
Slightly weathered	SW	Slightly discoloured; little or no change of strength from fresh rock
Fresh Rock	FR	The rock shows no sign of decomposition or staining

The rock material strength can be defined based on the point load index as follows.

Term and symbol		Point Load Index I_s50 (MPa)
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1.0
High	H	1.0 to 3
Very High	VH	3 to 10
Extremely High	EH	> 10

It is important to note that the rock material strength as above is distinct from the rock mass strength which can be significantly weaker due to the effect of defects.

A preliminary assessment of rock strength may be made using the field guide detailed in AS1726, and this is conducted in the absence of point load testing.

The defect spacing measured normal to defects of the same set or bedding, is described as follows.

Definition	Defect Spacing (mm)
Thinly laminated	< 6
Laminated	6 to 20
Very thinly bedded	20 to 60
Thinly bedded	60 to 200
Medium bedded	200 to 600
Thickly bedded	600 to 2000
Very thickly bedded	> 2000

Terms for describing rock and defects are as follows.

Defect Terms			
Joint	JT	Sheared zone	SZ
Bedding Parting	BP	Seam	SM
Foliation	FL	Vein	VN
Cleavage	CL	Drill Lift	DL
Crushed Seam	CS	Handling Break	HB
Fracture Zone	FZ	Drilling Break	DB

The shape and roughness of defects in the rock mass are described using the following terms.

Planarity		Roughness	
Planar	PR	Very Rough	VR
Curved	CU	Rough	RF
Undulose	UN	Smooth	S
Irregular	IR	Slickensided	SL
Stepped	ST	Polished	POL
Discontinuous	DIS		

The coating or infill associated with defects in the rock mass are described as follows.

Infill and Coating		
Clean	CN	
Stained	SN	
Carbonaceous	X	
Minerals	MU	Unidentified mineral
	MS	Secondary mineral
	KT	Chlorite
	CA	Calcite
	Fe	Iron Oxide
	Qz	Quartz
Veneer	VNR	Thin or patchy coating
Coating	CT	Infill up to 1mm

Graphic Symbols Index

CLAY	SILT	SAND	GRAVEL
Silty CLAY	Clayey SILT	Clayey SAND	Clayey GRAVEL
Sandy CLAY	Sandy SILT	Silty SAND	Silty GRAVEL
Gravelly CLAY	Gravelly SILT	Gravelly SAND	Sandy GRAVEL
Silty Gravelly CLAY	Clayey Sandy SILT	Clayey Silty SAND	Clayey Silty GRAVEL
Silty Sandy CLAY	Clayey Gravelly SILT	Clayey Gravelly SAND	Clayey Sandy GRAVEL
Sandy Gravelly CLAY	Sandy Gravelly SILT	Silty Gravelly SAND	Silty Sandy GRAVEL


COBBLES & BOULDERS


PEAT, highly organic soil


TOPSOIL


FILL


FILL: Asphalt or Bituminous Seal


FILL: Ballast


FILL: Concrete


FILL: Roadbase


Sedimentary rock: fine, mostly clay (CLAYSTONE)


Sedimentary rock: fine, mostly silt (SILTSTONE)


Sedimentary rock: fine, silt and clay (MUDSTONE, SHALE, LAMINITE)


Sedimentary rock: medium (SANDSTONE, GREYWACKE)


Sedimentary rock: fine to coarse, angular (BRECCIA)


Sedimentary rock: coarse, rounded (CONGLOMERATE)


Sedimentary rock: Organic (COAL)


Sedimentary rock: Carbonate (LIMESTONE, DOLOMITE)


Sedimentary rock: Volcanic (TUFF, VOLCANIC BRECCIA, AGGLOMERATE)


Igneous rock: Felsic, fine (RHYOLITE)


Igneous rock: Felsic, coarse (GRANITE)


Igneous rock: Mafic, fine to medium (BASALT, DOLERITE)


Igneous rock: Mafic, coarse (GABBRO)


Metamorphic rock: Foliated, fine to medium (SLATE, PHYLLITE, SHIST)


Metamorphic rock: Foliated, coarse (GNEISS)


Metamorphic rock: Non-foliated (QUARTZITE, HORNFELS, MARBLE)

Cardno

BOREHOLE LOG SHEET

Client: DWP Australia
Project: Detailed Site Investigation and Geotechnical Investigation
Location: Kyeemagh Infants School, Kyeemagh, NSW

Hole No: BH01

Job No: 5017190157 **Sheet:** 1 of 2

Position: E330215.509 N6241986.553 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 3.480 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** Light Vehicle **Driller:** TR
Casing Diameter: **Contractor:** Stratacore
Data Started: 10/11/18 **Date Completed:** 10/11/18 **Logged By:** DD **Checked By:** JB

Drilling			Water	Sampling & Testing	RL (m AHD)	Depth (m)	Material Description					
Method	Resistance	Casing		Sample or Field Test			Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	F-H		10/11/18	SPT 1.00 - 1.45 m 4, 4, 6 N=10	3	0			0.10m Silty SAND: fine grained, grey, with organics	D		TOPSOIL
						0.30m			FILL: Gravelly SAND: fine grained, grey, fine to medium grained gravel			FILL
									Silty SAND: fine grained, grey yellow			MARINE
					2	1						
				SPT 2.50 - 2.95 m 5, 9, 15 N=24	1	2			2.20m Silty SAND: fine to medium grained, white yellow	M		
					0	3		SP			MD to D	
WB				ES 4.00 - 4.45 m BH01 4.00-4.45 ASS SPT 4.00 - 4.45 m 8, 16, 26 N=42	-1	4						
					-2	5			5.50m SAND: fine to medium grained, pale grey, trace fine grained rounded gravel	W	D	
				5.50 - 5.95 m BH01 5.50-5.95 ASS SPT 5.50 - 5.95 m 17, 19, 19 N=38	-3	6		SP				
					-4	7			7.38m Silty CLAY: medium plasticity, black, trace fine grained gravel, trace of shells		F to St	7.40 m: HP = 100 Kpa
				7.00 - 7.45 m BH01 7.00-7.45 ASS SPT 7.00 - 7.45 m 5, 5, 3 N=8	-5	8		CI	8.30m Sandy CLAY: low to medium plasticity, black, fine grained sand, with shell fragments		VS to S	
				8.50 - 8.95 m BH01 8.50-8.95 ASS SPT 8.50 - 8.95 m 0, 0, 0 N=0	-6	9		CL-CI	10.00m			

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
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U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

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CARDNO (NSW/ACT) PTY LTD

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BOREHOLE LOG SHEET

Client: DWP Australia
Project: Detailed Site Investigation and Geotechnical Investigation
Location: Kyeemagh Infants School, Kyeemagh, NSW

Hole No: BH01

Job No: 5017190157 **Sheet:** 2 of 2

Position: E330215.509 N6241986.553 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 3.480 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** Light Vehicle **Driller:** TR
Casing Diameter: **Contractor:** Stratacore
Data Started: 10/11/18 **Date Completed:** 10/11/18 **Logged By:** DD **Checked By:** JB

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
WB	F-H			10.00 - 10.45 m BH01 10.00-10.45 ASS SPT 10.00 - 10.45 m 1, 0, 1 N=1	-7	11		CL-CI	Clayey CLAY: fine to medium, black, low plasticity clay		VL	MARINE
				SPT 11.50 - 11.95 m 4, 5, 7 N=12	-8	12		SP	11.50m SAND: medium grained, yellow grey		MD	
				SPT 13.00 - 13.45 m 4, 7, 14 N=21	-9	13		SP	13.00m Clayey SAND: fine grained, grey, low plasticity clay	W		
				SPT 14.50 - 14.80 m 26, 30 N=R	-10	14		SP	14.60m SAND: fine to medium grained, grey yellow		D to VD	WEATHERED ROCK
				SPT 16.00 - 16.45 m 0, 8, 30 N=38	-11	15		SP	16.45m			
					-12	16						
					-13	17			TERMINATED AT 16.45 m Target depth			
					-14	18						
					-15	19						
					-16							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
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E Easy
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WATER
Water Level on Date shown
water inflow
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Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

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BOREHOLE LOG SHEET

Client: DWP Australia
Project: Detailed Site Investigation and Geotechnical Investigation
Location: Kyeemagh Infants School, Kyeemagh, NSW

Hole No: BH02

Job No: 5017190157 **Sheet:** 1 of 2

Position: E330177.733 N6242026.438 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 4.600 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** Light Vehicle **Driller:** TR
Casing Diameter: **Contractor:** Stratacore
Data Started: 17/11/18 **Date Completed:** 17/11/18 **Logged By:** DD **Checked By:** JB

Drilling			Water	Sampling & Testing	RL (m AHD)	Depth (m)	Material Description					
Method	Resistance	Casing		Sample or Field Test			Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	E			SPT 1.00 - 1.45 m 3, 4, 5 N=9	4	0			0.10m Silty SAND: fine to medium grained, black brown, with organics FILL: Gravelly SAND: fine grained, grey brown, fine to medium grained gravel turning orange brown in colour	M		TOPSOIL FILL
				D 1.50 - 2.00 m	3	1			1.00m Silty SAND: fine grained, pale brown	D to M		MARINE
				SPT 2.50 - 2.95 m 2, 3, 2 N=5	2	2		SP			L to MD	
				SPT 4.00 - 4.45 m 2, 4, 8 N=12	1	3			4.15m SAND: fine to medium grained, yellow white			
WB			07/11/18	SPT 5.50 - 5.95 m 10, 18, 30 N=48	0	4			trace of shell fragments			
				SPT 7.00 - 7.45 m 21, 4, 4 N=8	-1	5		SP	potential ass odour	W	D	
				SPT 8.50 - 8.95 m 0, 0, 0 N=0	-2	6			8.50m Sandy CLAY: low plasticity, black brown, fine grained sand			
					-3	7		CL			VS to S	
					-4	8						
					-5	9						

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

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CARDNO (NSW/ACT) PTY LTD

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BOREHOLE LOG SHEET

Client: DWP Australia
Project: Detailed Site Investigation and Geotechnical Investigation
Location: Kyeemagh Infants School, Kyeemagh, NSW

Hole No: BH02

Job No: 5017190157 **Sheet:** 2 of 2

Position: E330177.733 N6242026.438 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 4.600 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** Light Vehicle **Driller:** TR
Casing Diameter: **Contractor:** Stratacore
Data Started: 17/11/18 **Date Completed:** 17/11/18 **Logged By:** DD **Checked By:** JB

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	RL (m AHD)	Depth (m)	Material: Graphic Log	Material: Classification	Material: SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Material: Moisture Condition	Material: Consistency Relative Density	Material: STRUCTURE & Other Observations
WB	E			SPT 10.00 - 10.45 m 0, 0, 0 N=0	-6	11			Sandy CLAY: low plasticity, black brown, fine grained sand *(continued)*			MARINE
				SPT 11.50 - 11.95 m 20, 2, 4 N=6	-7	12		CL			VS to S	
				SPT 13.00 - 13.45 m 2, 5, 8 N=13	-8	13			13.00m Sandy CLAY: low to medium plasticity, grey, fine grained sand			
				SPT 14.50 - 14.68 m 24, 30/30mm N=R	-9	14		CL-CI		W	St	
				SPT 16.00 - 16.45 m 7, 5, 5 N=10	-10	15			14.50m SAND: medium grained, grey			
					-11	16		SP			D to VD	
					-12	17			16.00m Sandy CLAY: medium to high plasticity, fine grained sand			
				SPT 17.50 - 17.95 m 16, 19, 17 N=36	-13	18		CI-CH			H	
					-14	19			17.50m Clayey SAND: fine to medium grained, grey, low plasticity clay			
					-15			SP	17.95m TERMINATED AT 17.95 m Target depth		D to VD	

METHOD
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R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
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CARDNO (NSW/ACT) PTY LTD

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BOREHOLE LOG SHEET

Client: DWP Australia
Project: Detailed Site Investigation and Geotechnical Investigation
Location: Kyeemagh Infants School, Kyeemagh, NSW

Hole No: BH03

Job No: 5017190157 **Sheet:** 1 of 2

Position: E330229.353 N6241972.538 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 3.830 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** Light Vehicle **Driller:** TR
Casing Diameter: **Contractor:** Stratacore
Data Started: 17/11/18 **Date Completed:** 17/11/18 **Logged By:** DD **Checked By:** JB

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T				D 0.20 - 0.50 m	3	1			0.10m SAND: fine to medium grained, dark brown, with organics			TOPSOIL
									SAND: fine to medium grained, pale brown			MARINE
				SPT 1.00 - 1.45 m 1, 3, 3 N=6								
					2	2			1.50m SAND: fine to medium grained, yellow brown	D to M		
				B 2.00 - 2.50 m								
				SPT 2.50 - 2.95 m 2, 7, 10 N=17	1	3		SP			MD	
WB	E-F		07/11/18	SPT 4.00 - 4.45 m 6, 20, 22 N=42	0	4			4.00m SAND: fine to medium grained, white yellow			
				SPT 5.50 - 5.95 m 3, 12, 27 N=39	-1	5			medium grained sand			
					-2	6		SP			MD to D	
				SPT 7.00 - 7.45 m 7, 7, 6 N=13	-3	7			turning grey in colour	W		
				SPT 8.50 - 8.95 m 0, 0, 1 N=1	-4	8			8.20m Sandy CLAY: low plasticity, grey, fine to medium grained sand			
					-5	9		CL			VS	
					-6							

METHOD
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R Ripper
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AH Air hammer
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CARDNO (NSW/ACT) PTY LTD

Cardno

BOREHOLE LOG SHEET

Client: DWP Australia
Project: Detailed Site Investigation and Geotechnical Investigation
Location: Kyeemagh Infants School, Kyeemagh, NSW

Hole No: BH03

Job No: 5017190157 **Sheet:** 2 of 2

Position: E330229.353 N6241972.538 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 3.830 m AHD
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Casing Diameter: **Contractor:** Stratacore
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WB	E-F			SPT 10.00 - 10.45 m 0, 1, 0 N=1	-7	11		CL	Sandy CLAY: low plasticity, grey, fine to medium grained sand *(continued)*		VS	MARINE
									11.20m SAND: fine to medium grained, brown			
				SPT 11.50 - 11.95 m 12, 20, 18 N=38	-8	12		SP		W	MD to D	
				SPT 13.00 - 13.45 m 12, 5, 8 N=13	-9	13			13.45m TERMINATED AT 13.45 m Target depth			
					-10	14						
					-11	15						
					-12	16						
					-13	17						
					-14	18						
					-15	19						
					-16							

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CARDNO (NSW/ACT) PTY LTD

Cardno

BOREHOLE LOG SHEET

Client: DWP Australia
Project: Detailed Site Investigation and Geotechnical Investigation
Location: Kyeemagh Infants School, Kyeemagh, NSW

Hole No: BH04

Job No: 5017190157 **Sheet:** 1 of 1

Position: E330149.299 N6241929.836 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 4.380 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** Light Vehicle **Driller:** TR
Casing Diameter: **Contractor:** Stratacore
Data Started: 10/11/18 **Date Completed:** 10/11/18 **Logged By:** DD **Checked By:** JB

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
					4	0			0.13m ASPHALT: corase grained gravel, black FILL: SAND: fine to medium grained, grey			PAVEMENT FILL
				SPT 0.50 - 0.95 m 0, 0, 0 N=0					0.50m SAND: fine to medium grained, pale brown			MARINE
				B 1.00 - 1.20 m	3	1		SP			L	
				B 1.50 - 2.00 m SPT 1.50 - 1.95 m 3, 5, 6 N=11					1.50m Silty SAND: fine to medium grained, brown	D		
	E		Not Encountered		2	2		SP			MD	
				SPT 3.00 - 3.45 m 5, 12, 15 N=27	1	3			Turning white/ pale brown in colour			
						4			4.00m	D to M		
					0	5			TERMINATED AT 4.00 m Refusal Borehole Refusal Depth Collapse at 4.0m 10/11/18 at 16:20			
					-1	6						
					-2	7						
					-3	8						
					-4	9						
					-5							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

Cardno

BOREHOLE LOG SHEET

Client: DWP Australia
Project: Detailed Site Investigation and Geotechnical Investigation
Location: Kyeemagh Infants School, Kyeemagh, NSW

Hole No: BH05

Job No: 5017190157 **Sheet:** 1 of 1

Position: E330122.818 N6241979.746 56 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 4.560 m AHD
Rig Type: Ute Mounted Drill Rig **Mounting:** Light Vehicle **Driller:** TR
Casing Diameter: **Contractor:** Stratacore
Data Started: 10/11/18 **Date Completed:** 10/11/18 **Logged By:** DD **Checked By:** JB

Drilling			Water	Sampling & Testing	RL (m AHD)	Depth (m)	Material Description					
Method	Resistance	Casing		Sample or Field Test			Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T			Not Encountered	D 0.20 - 0.50 m	4	0			0.20m Gravelly SAND: fine grained, black			TOPSOIL
				SPT 0.50 - 0.95 m 3, 6, 6 N=12					Silty SAND: fine grained, dark grey			MARINE
				D 1.00 - 1.10 m	3	1		SP		D	L to MD	
				SPT 1.50 - 1.95 m 2, 3, 4 N=7	2	2			2.00m Silty SAND: fine grained, brown			
				SPT 3.00 - 3.45 m 3, 5, 9 N=14	1	3		SP		D to M	MD	
				SPT 4.50 - 4.95 m 2, 3, 9 N=12	0	4			4.50m SAND: fine to medium grained, pale brown	M		
					-1	5		SP	5.50m TERMINATED AT 5.50 m Target depth		MD	
					-2	6						
					-3	7						
					-4	8						
					-5	9						

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

Kyeemagh Infants School, Corner of Jacobson Avenue and Beehag Street, Kyeemagh NSW

APPENDIX C

LABORATORY TEST RESULTS - SOILS

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 2/4 Kellogg Road,
Glendenning NSW 2761

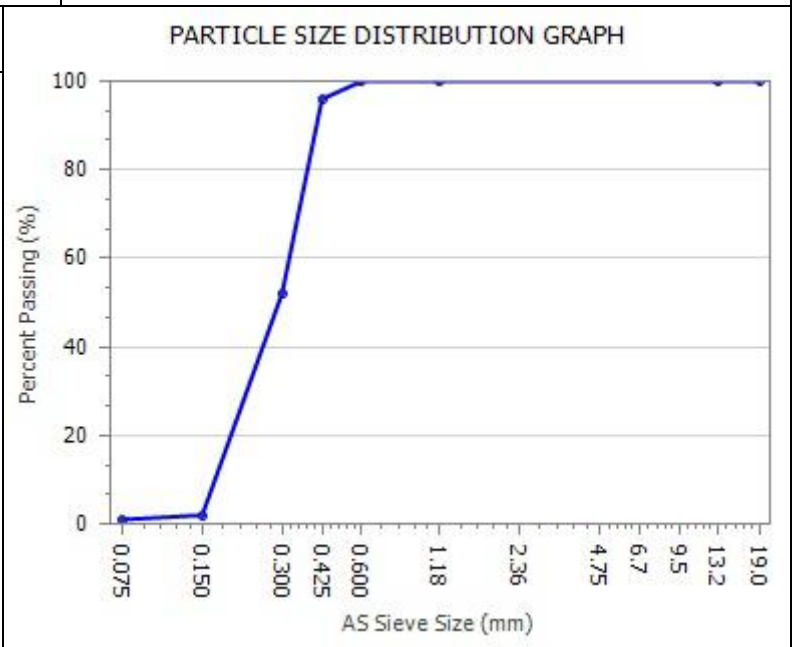
Laboratory: Glendenning Laboratory
Phone: 02 4577 3555
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

QUALITY OF MATERIALS REPORT

Client:	Construction Sciences - Professional Services	Report Number:	12385/R/139285-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	12385/P/1172
Project:	Detail Site Investigation and (GI) - Kyeemagh Infants School,	Lot Number:	Not Supplied
Location:	Seven Hills	Internal Test Request:	12385/T/66510
Supplied To:	deven.date@constructionsciences.net	Client Reference/s:	5017190151
Area Description:		Report Date / Page:	5/12/2018 Page 1 of 5

Test Procedures	AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS 1289.3.3.1			
Sample Number	12385/S/540568	Borehole		BH03
Sampling Method	AS1289.1.2.1 Cl 6.5.3	Depth	(m)	2.00-2.50
Date Sampled	17/11/2018			
Sampled By	Deven Date			
Date Tested	26/11/2018	Material Source		In-Situ
Att. Drying Method	-	Material Type		Sand
Atterberg Preparation	-	Material Description		brown sand

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
19.0		**100**	
13.2		**100**	
1.18		**100**	
0.600		**100**	
0.425		**96**	
0.300		**52**	
0.150		**2**	
0.075		**1**	



Test Result	Specification Minimum	Result	Specification Maximum	Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		**Not Obtainable**		0.075/0.425 Fines Ratio		**0.01**	
Plastic Limit (%)		**Not Obtainable**		PI x 0.425 Ratio (%)		**-**	
Plastic Index (%)		**Non Plastic**		LS x 0.425 Ratio (%)		**-**	
Linear Shrinkage (%)				Particle Size Dist. Moisture Content (%)		2.1	
Linear Shrinkage Defects							

Remarks

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 - Testing

Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Michel Naylor
Form ID: W85MCRep Rev 1

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Unit 2/4 Kellogg Road,
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Email: Sydney@constructionsciences.net

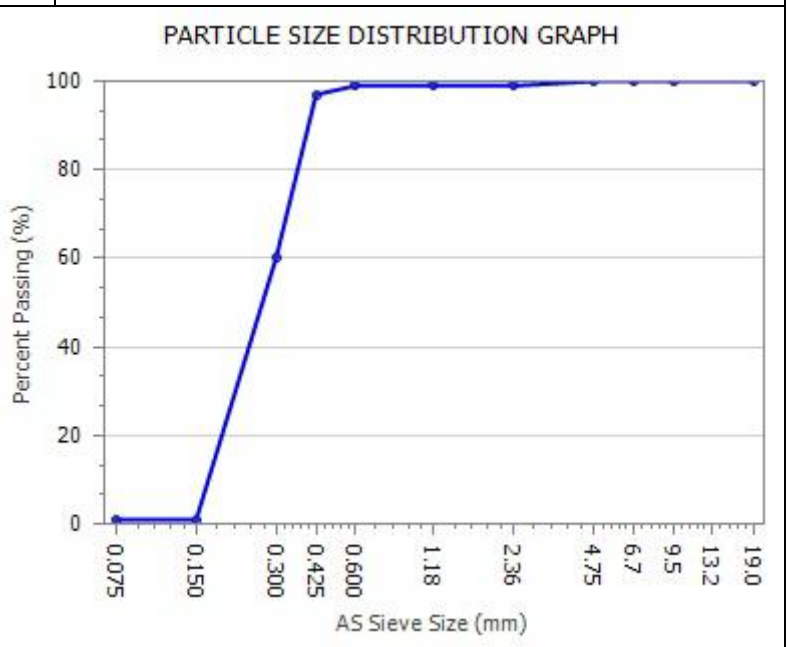
QUALITY OF MATERIALS REPORT

Client:	Construction Sciences - Professional Services	Report Number:	12385/R/139285-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	12385/P/1172
Project:	Detail Site Investigation and (GI) - Kyeemagh Infants School,	Lot Number:	Not Supplied
Location:	Seven Hills	Internal Test Request:	12385/T/66510
Supplied To:	deven.date@constructionsciences.net	Client Reference/s:	5017190151
Area Description:		Report Date / Page:	5/12/2018 Page 2 of 5

Test Procedures	AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS 1289.3.3.1

Sample Number	12385/S/540569	Borehole	BH04
Sampling Method	AS1289.1.2.1 Cl 6.5.3	Depth (m)	1.00-1.20
Date Sampled	10/11/2018		
Sampled By	Deven Date		
Date Tested	26/11/2018	Material Source	In-Situ
Att. Drying Method	-	Material Type	Sand
Atterberg Preparation	-	Material Description	light grey sand, trace gravel

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
19.0		**100**	
9.5		**100**	
6.7		**100**	
4.75		**100**	
2.36		**99**	
1.18		**99**	
0.600		**99**	
0.425		**97**	
0.300		**60**	
0.150		**1**	
0.075		**1**	



Test Result	Specification Minimum	Result	Specification Maximum	Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		**Not Obtainable**		0.075/0.425 Fines Ratio		**0.01**	
Plastic Limit (%)		**Not Obtainable**		PI x 0.425 Ratio (%)		**-**	
Plastic Index (%)		**Non Plastic**		LS x 0.425 Ratio (%)		**-**	
Linear Shrinkage (%)				Particle Size Dist. Moisture Content (%)		0.1	
Linear Shrinkage Defects							

Remarks

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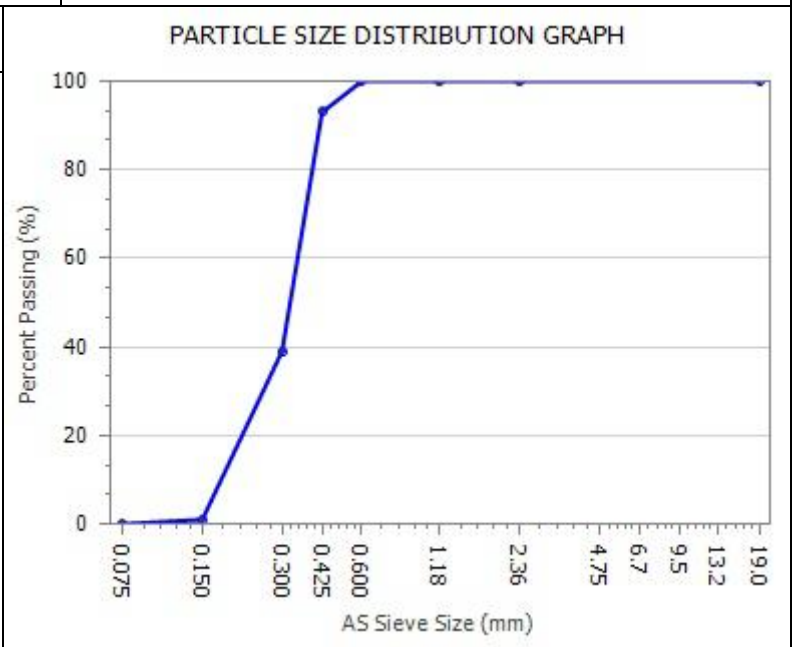
QUALITY OF MATERIALS REPORT

Client:	Construction Sciences - Professional Services	Report Number:	12385/R/139285-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	12385/P/1172
Project:	Detail Site Investigation and (GI) - Kyeemagh Infants School,	Lot Number:	Not Supplied
Location:	Seven Hills	Internal Test Request:	12385/T/66510
Supplied To:	deven.date@constructionsciences.net	Client Reference/s:	5017190151
Area Description:		Report Date / Page:	5/12/2018 Page 3 of 5

Test Procedures	AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS 1289.3.3.1

Sample Number	12385/S/540570	Borehole	BH04
Sampling Method	AS1289.1.2.1 Cl 6.5.3	Depth (m)	2.00-2.45
Date Sampled	10/11/2018		
Sampled By	Deven Date		
Date Tested	26/11/2018	Material Source	In-Situ
Att. Drying Method	-	Material Type	Sand
Atterberg Preparation	-	Material Description	brown sand

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
19.0		**100**	
2.36		**100**	
1.18		**100**	
0.600		**100**	
0.425		**93**	
0.300		**39**	
0.150		**1**	
0.075		**0**	



Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		**Not Obtainable**	
Plastic Limit (%)		**Not Obtainable**	
Plastic Index (%)		**Non Plastic**	
Linear Shrinkage (%)			
Linear Shrinkage Defects			

Test Result	Specification Minimum	Result	Specification Maximum
0.075/0.425 Fines Ratio		**0.01**	
PI x 0.425 Ratio (%)		**-**	
LS x 0.425 Ratio (%)		**-**	
Particle Size Dist. Moisture Content (%)		1.5	

Remarks

NATA

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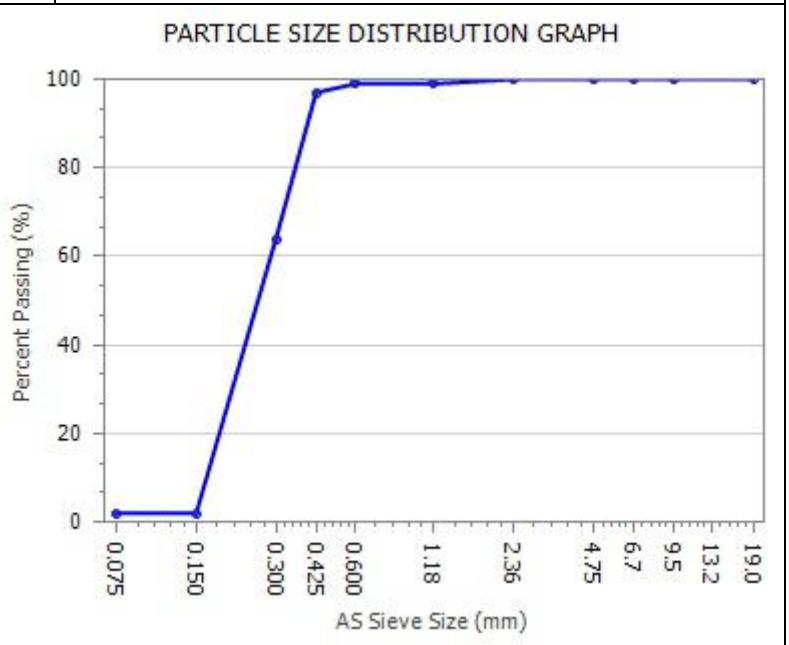
Client:	Construction Sciences - Professional Services	Report Number:	12385/R/139285-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	12385/P/1172
Project:	Detail Site Investigation and (GI) - Kyeemagh Infants School,	Lot Number:	Not Supplied
Location:	Seven Hills	Internal Test Request:	12385/T/66510
Supplied To:	deven.date@constructionsciences.net	Client Reference/s:	5017190151
Area Description:		Report Date / Page:	5/12/2018 Page 4 of 5

Test Procedures	AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS 1289.3.3.1

Sample Number	12385/S/540571	Borehole	BH02
Sampling Method	AS1289.1.2.1 Cl 6.5.3	Depth (m)	1.50-2.00
Date Sampled	17/11/2018		
Sampled By	Deven Date		
Date Tested	26/11/2018	Material Source	In-Situ
Att. Drying Method	-	Material Type	Sand
Atterberg Preparation	-	Material Description	brown sand

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
19.0		**100**	
9.5		**100**	
6.7		**100**	
4.75		**100**	
2.36		**100**	
1.18		**99**	
0.600		**99**	
0.425		**97**	
0.300		**64**	
0.150		**2**	
0.075		**2**	



Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		**Not Obtainable**	
Plastic Limit (%)		**Not Obtainable**	
Plastic Index (%)		**Non Plastic**	
Linear Shrinkage (%)			
Linear Shrinkage Defects			

Test Result	Specification Minimum	Result	Specification Maximum
0.075/0.425 Fines Ratio		**0.02**	
PI x 0.425 Ratio (%)		**-**	
LS x 0.425 Ratio (%)		**-**	
Particle Size Dist. Moisture Content (%)		3.9	

Remarks

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Corporate Site Number: 12385

Approved Signatory: Michel Naylor
Form ID: W85MCRep Rev 1

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ABN: 74 128 806 735

Address:
Unit 2/4 Kellogg Road,
Glendenning NSW 2761

Laboratory: Glendenning Laboratory
Phone: 02 4577 3555
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

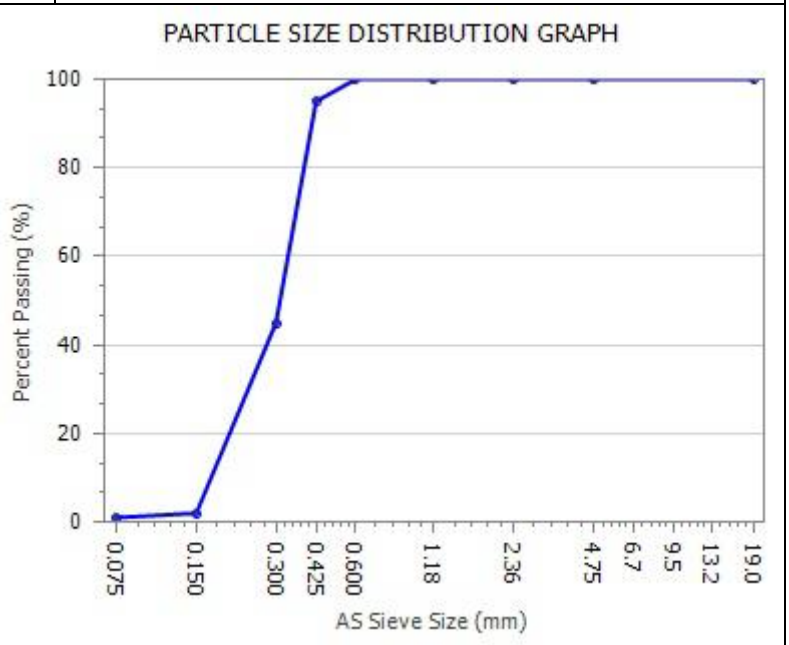
QUALITY OF MATERIALS REPORT

Client:	Construction Sciences - Professional Services	Report Number:	12385/R/139285-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	12385/P/1172
Project:	Detail Site Investigation and (GI) - Kyeemagh Infants School,	Lot Number:	Not Supplied
Location:	Seven Hills	Internal Test Request:	12385/T/66510
Supplied To:	deven.date@constructionsciences.net	Client Reference/s:	5017190151
Area Description:		Report Date / Page:	5/12/2018 Page 5 of 5

Test Procedures	AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS 1289.3.3.1

Sample Number	12385/S/540572	Borehole	BH03
Sampling Method	AS1289.1.2.1 Cl 6.5.3	Depth (m)	0.20-0.50
Date Sampled	17/11/2018		
Sampled By	Deven Date		
Date Tested	26/11/2018	Material Source	In-Situ
Att. Drying Method	-	Material Type	Sand
Atterberg Preparation	-	Material Description	light brown sand

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
19.0		**100**	
4.75		**100**	
2.36		**100**	
1.18		**100**	
0.600		**100**	
0.425		**95**	
0.300		**45**	
0.150		**2**	
0.075		**1**	



Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		**Not Obtainable**	
Plastic Limit (%)		**Not Obtainable**	
Plastic Index (%)		**Non Plastic**	
Linear Shrinkage (%)			
Linear Shrinkage Defects			

Test Result	Specification Minimum	Result	Specification Maximum
0.075/0.425 Fines Ratio		**0.01**	
PI x 0.425 Ratio (%)		**-**	
LS x 0.425 Ratio (%)		**-**	
Particle Size Dist. Moisture Content (%)		3.9	

Remarks

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Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Michel Naylor
Form ID: W85MCRep Rev 1

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ABN: 74 128 806 735

Address:
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Laboratory: Glendenning Laboratory
Phone: 02 4577 3555
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

CALIFORNIA BEARING RATIO REPORT

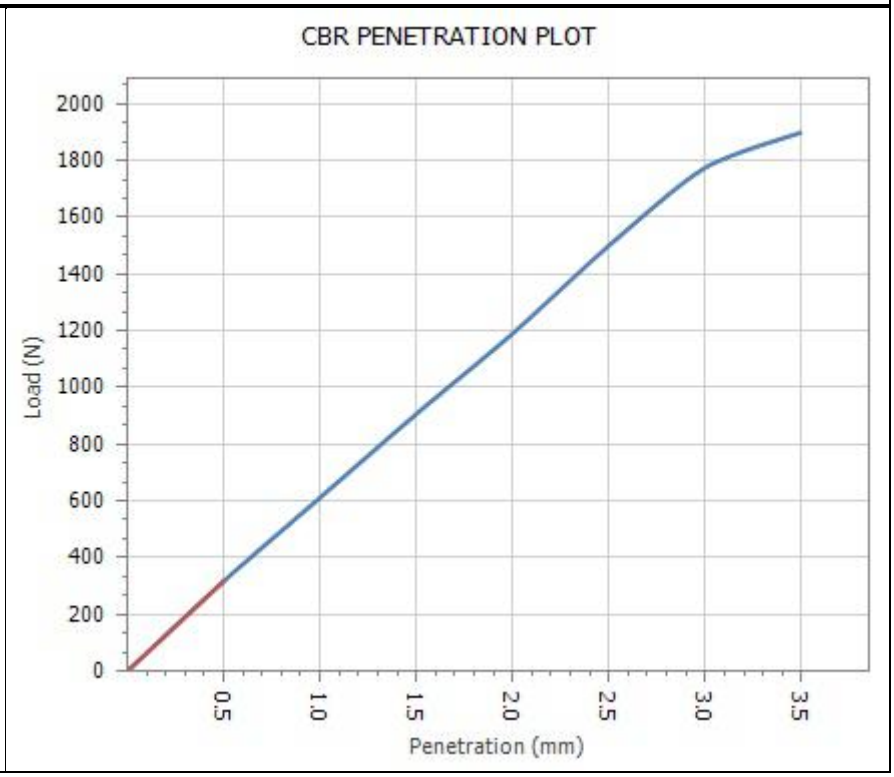
Client:	Construction Sciences - Professional Services	Report Number:	12385/R/139286-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	12385/P/1172
Project:	Detail Site Investigation and (GI) - Kyeemagh Infants School,	Lot Number:	Not Supplied
Location:	Seven Hills	Internal Test Request:	12385/T/66510
Supplied To:	deven.date@constructionsciences.net	Client Reference/s:	5017190151
Area Description:		Report Date / Page:	5/12/2018 Page 1 of 2

Test Procedures	AS1289.6.1.1, AS1289.5.1.1, AS1289.2.1.1

Sample Number	12385/S/540566	Sample Location	
Sampling Method	AS1289.1.2.1 Cl 6.5.3	Borehole	TP12
Date Sampled	10/11/2018	Depth (m)	0.50-1.00
Sampled By	Deven Date		
Date Tested	4/12/2018		
Material Source	In-Situ	Material Limit Start	-
Material Type	Sand	Material Limit End	-
Client Reference	-	Compactive Effort	Standard

Material Description	Brown Sand

Maximum Dry Density (t/m³):	1.63
Optimum Moisture Content (%):	12.5
Field Moisture Content (%):	3.6
Sample Percent Oversize (%)	1.0
Oversize Included / Excluded	Excluded
Target Density Ratio (%):	98
Target Moisture Ratio (%):	100
Placement Dry Density (t/m³):	1.60
Placement Dry Density Ratio (%):	98.0
Placement Moisture Content (%):	12.1
Placement Moisture Ratio (%):	97.0
Test Condition / Soaking Period:	Soaked / 4 Days
CBR Surcharge (kg)	4.5
Dry Density After Soak (t/m³):	1.60
Total Curing Time (hrs)	22.1
Liquid Limit Method	Estimation
Moisture (top 30mm) After Soak (%)	18.6
Moisture (remainder) After Soak (%)	17.4
CBR Swell (%):	0.0
Minimum CBR Specification (%):	-
CBR Value @ 2.5mm (%):	**11**



Remarks

NATA

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Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Michel Naylor
Form ID: W2ASRep Rev2

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 2/4 Kellogg Road,
Glendenning NSW 2761

Laboratory: Glendenning Laboratory
Phone: 02 4577 3555
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

CALIFORNIA BEARING RATIO REPORT

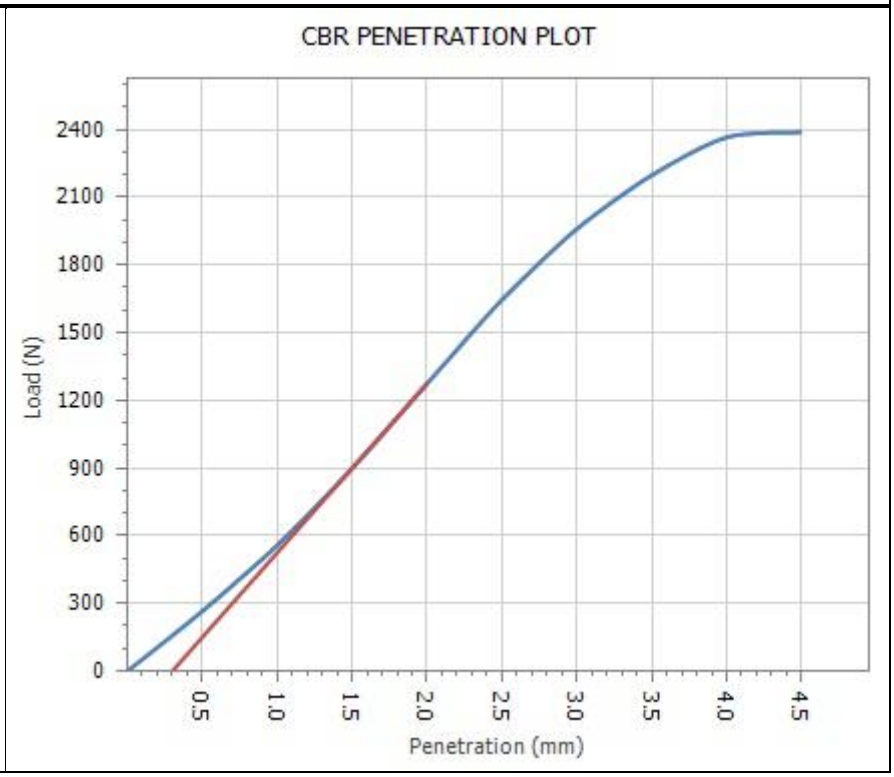
Client:	Construction Sciences - Professional Services	Report Number:	12385/R/139286-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	12385/P/1172
Project:	Detail Site Investigation and (GI) - Kyeemagh Infants School,	Lot Number:	Not Supplied
Location:	Seven Hills	Internal Test Request:	12385/T/66510
Supplied To:	deven.date@constructionsciences.net	Client Reference/s:	5017190151
Area Description:		Report Date / Page:	5/12/2018 Page 2 of 2

Test Procedures	AS1289.6.1.1, AS1289.5.1.1, AS1289.2.1.1

		Sample Location		
Sample Number	12385/S/540567	Borehole		BH05
Sampling Method	AS1289.1.2.1 Cl 6.5.3	Depth	(m)	1.50-2.00
Date Sampled	10/11/2018			
Sampled By	Deven Date			
Date Tested	4/12/2018			
Material Source	In-Situ	Material Limit Start		-
Material Type	Sand	Material Limit End		-
Client Reference	-	Compactive Effort		Standard

Material Description	Brownish Sand

Maximum Dry Density (t/m³):	1.66
Optimum Moisture Content (%):	15.0
Field Moisture Content (%):	14.8
Sample Percent Oversize (%)	0.0
Oversize Included / Excluded	Excluded
Target Density Ratio (%):	98
Target Moisture Ratio (%):	100
Placement Dry Density (t/m³):	1.61
Placement Dry Density Ratio (%):	97.0
Placement Moisture Content (%):	15.6
Placement Moisture Ratio (%):	102.5
Test Condition / Soaking Period:	Soaked / 4 Days
CBR Surcharge (kg)	4.5
Dry Density After Soak (t/m³):	1.61
Total Curing Time (hrs)	20.9
Liquid Limit Method	Estimation
Moisture (top 30mm) After Soak (%)	18.5
Moisture (remainder) After Soak (%)	17.9
CBR Swell (%):	0.0
Minimum CBR Specification (%):	-
CBR Value @ 2.5mm (%):	**14**



Remarks

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 - Testing

Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Michel Naylor
Form ID: W2ASRep Rev2

Kyeemagh Infants School, Corner of Jacobson Avenue and Beehag Street, Kyeemagh NSW

APPENDIX

D

LABORATORY TEST RESULTS - ENVIRONMENTAL

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Jhan-Paule Arbizo
Client	CONSTRUCTION SCIENCES PTY LTD
Address	31 ANVIL ROAD SEVEN HILLS NSW 2147
Telephone	61 2 86462000
Facsimile	(Not specified)
Email	jhan-paule.arbizo@constructionsciences.net
Project	**5017190151 Site Invest of Kyeemagh Schl**
Order Number	(Not specified)
Samples	7

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE186499 R0**
Date Received	21/11/2018
Date Reported	27/11/2018

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(4354).

SIGNATORIES

Dong Liang
Metals/Inorganics Team Leader

Huong Crawford
Production Manager

pH in soil (1:2) [AN101] Tested: 23/11/2018

PARAMETER	UOM	LOR	BH01 2.50-2.95 SOIL - 10/11/2018 SE186499.001	BH02 1.00-1.45 SOIL - 17/11/2018 SE186499.002	BH03 4.00-4.50 SOIL - 17/11/2018 SE186499.003	BH04 0.50-0.95 SOIL - 10/11/2018 SE186499.004	BH05 3.00-3.45 SOIL - 10/11/2018 SE186499.005
pH (1:2)	pH Units	-	6.3	7.6	7.7	6.1	6.5

PARAMETER	UOM	LOR	BH02 5.50-5.95 SOIL - 17/11/2018 SE186499.006	BH03 7.00-7.45 SOIL - 17/11/2018 SE186499.007
pH (1:2)	pH Units	-	8.1	7.2

Conductivity (1:2) in soil [AN106] Tested: 23/11/2018

PARAMETER	UOM	LOR	BH01 2.50-2.95 SOIL - 10/11/2018 SE186499.001	BH02 1.00-1.45 SOIL - 17/11/2018 SE186499.002	BH03 4.00-4.50 SOIL - 17/11/2018 SE186499.003	BH04 0.50-0.95 SOIL - 10/11/2018 SE186499.004	BH05 3.00-3.45 SOIL - 10/11/2018 SE186499.005
Conductivity (1:2) @25 C*	µS/cm	1	18	33	72	53	38
Resistivity (1:2)*	ohm cm	-	56000	30000	14000	19000	26000

PARAMETER	UOM	LOR	BH02 5.50-5.95 SOIL - 17/11/2018 SE186499.006	BH03 7.00-7.45 SOIL - 17/11/2018 SE186499.007
Conductivity (1:2) @25 C*	µS/cm	1	54	370
Resistivity (1:2)*	ohm cm	-	18000	2700

Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography [AN245] Tested: 26/11/2018

PARAMETER	UOM	LOR	BH01 2.50-2.95 SOIL - 10/11/2018 SE186499.001	BH02 1.00-1.45 SOIL - 17/11/2018 SE186499.002	BH03 4.00-4.50 SOIL - 17/11/2018 SE186499.003	BH04 0.50-0.95 SOIL - 10/11/2018 SE186499.004	BH05 3.00-3.45 SOIL - 10/11/2018 SE186499.005
Chloride	mg/kg	0.25	6.6	2.8	11	2.2	10
Sulfate	mg/kg	0.5	4.7	3.9	7.9	12	6.4

PARAMETER	UOM	LOR	BH02 5.50-5.95 SOIL - 17/11/2018 SE186499.006	BH03 7.00-7.45 SOIL - 17/11/2018 SE186499.007
Chloride	mg/kg	0.25	7.7	11
Sulfate	mg/kg	0.5	7.3	15

Moisture Content [AN002] Tested: 23/11/2018

PARAMETER	UOM	LOR	BH01 2.50-2.95 SOIL - 10/11/2018 SE186499.001	BH02 1.00-1.45 SOIL - 17/11/2018 SE186499.002	BH03 4.00-4.50 SOIL - 17/11/2018 SE186499.003	BH04 0.50-0.95 SOIL - 10/11/2018 SE186499.004	BH05 3.00-3.45 SOIL - 10/11/2018 SE186499.005
% Moisture	%w/w	0.5	13.6	7.1	16.0	0.9	10.3

PARAMETER	UOM	LOR	BH02 5.50-5.95 SOIL - 17/11/2018 SE186499.006	BH03 7.00-7.45 SOIL - 17/11/2018 SE186499.007
% Moisture	%w/w	0.5	16.1	20.8

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:2 and the pH determined and reported on the extract after 1 hour extraction (pH 1:2) or after 1 hour extraction and overnight aging (pH (1:2) aged). Reference APHA 4500-H+.
AN106	Conductivity : Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos /cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:2 and the EC determined and reported on the extract basis after the 1 hour extraction (EC(1:2)) or after the 1 hour extraction and overnight aging (EC(1:2) aged). Reference APHA 2510 B.
AN106	Resistivity of the extract is reported on the extract basis and is the reciprocal of conductivity. Salinity and TDS can be calculated from the extract conductivity and is reported back to the soil basis.
AN245	Anions by Ion Chromatography: A water sample or extract is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
		NVL	Not validated.	LOR	Limit of Reporting.
**	Indicative data, theoretical holding time exceeded.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/ Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

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