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Report on Geotechnical Investigation

School Upgrades
Hunter River High School, 36 Elkin Avenue, Heatherbrae

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

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Table of Contents

Page

1. Introduction....1
2. Proposed Development....2
3. Site Description and Regional Geology....3
4. Field Work....4
   - 4.1 Field Work Methods....4
   - 4.2 Field Work Results....4
5. Laboratory Testing....5
   - 5.1 Geotechnical Laboratory Testing....5
   - 5.2 Acid Sulfate Soil Testing....6
6. Comments....8
   - 6.1 Soil Permeability....8
   - 6.2 Excavation Conditions and Batter Slopes....8
   - 6.3 Site Preparation and Earthworks....9
   - 6.4 Retaining Walls....9
   - 6.5 Site Classification....10
   - 6.6 Earthquake Site Sub-Soil Classification and Hazard Factor....11
   - 6.7 Upper Level Footings....11
   - 6.8 Piles....11
     - 6.8.1 Construction....11
     - 6.8.2 Vertical Design (Driven and CFA Piles)....12
     - 6.8.3 Steel Screw Piles....13
   - 6.9 Preliminary Flexible Pavement Design....13
     - 6.9.1 Subgrade....13
     - 6.9.2 Design Traffic Loading....13
     - 6.9.3 Flexible Pavement Thickness Design....14
     - 6.9.4 Material Quality and Compaction Requirements....14
   - 6.10 Soil Aggressivity....15
   - 6.11 Acid Sulfate Soils....15
7. References....16
8. Limitations....16

Appendix A:	About This Report Terminology, Symbols and Abbreviations Soil Descriptions Sampling, Testing and Excavation Methodology Cone Penetration Testing
Appendix B:	Field Work Results
Appendix C:	Laboratory Test Results
Appendix D:	Drawing R.001.D.001 – Site and Test Location Plan

Report on Geotechnical Investigation
School Upgrades
Hunter River High School, 36 Elkin Avenue, Heatherbrae

1. Introduction

This report presents the results of a geotechnical investigation undertaken in connection with proposed school upgrades at Hunter River High School, 36 Elkin Avenue, Heatherbrae. The investigation was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal 216008.00.P.001.Rev0 dated 15 June 2022 and acceptance received from Elisa Tanaka from Department of Education through School Infrastructure NSW on 5 July 2022.

The aim of the investigation was to assess the subsurface soil and groundwater conditions at the field test locations to provide comments on:

- Indicative soil permeability;
- Site classification in accordance with AS 2870 (2011);
- Suitable foundation types;
- Geotechnical footing design parameters, including allowable bearing capacity and estimated settlements;
- Excavation conditions;
- Suitability of site won soils for re-use as controlled fill material;
- Earthworks preparation measures and material compaction requirements;
- Geotechnical retaining wall design parameters, including earth pressure coefficients
- Safe batter slopes for temporary and permanent batter slopes;
- Subgrade design CBR values and flexible pavement thickness design;
- Site hazard factor and site sub-soil class in accordance with AS 1170.4 – Earthquake loading; and
- Preliminary acid sulfate soil assessment.

The investigation included the drilling of seven boreholes and six cone penetration tests (CPTs). Details of the field and laboratory work are presented in this report, together with comments and recommendations on the items listed above.

This report must be read in conjunction with the attached notes ‘About This Report’ in Appendix A, and any other attached explanatory notes, and should be kept in its entirety without separation of individual pages or sections.

2. Proposed Development

It is understood that the upgrade of Hunter River High School is to include the following:

- New arrival / entry works, including a 14-space visitor car park, bus only internal road connecting the existing roundabout off Elkin Avenue to Adelaide Street, and a service road from Adelaide Street along the south-eastern and south-western school boundary (refer Figure 1, below);
- Single storey Staff Administration Building between the existing 'Block R' and the internal road;
- Double height Gymnasium between the existing 'Block Q' and the proposed regulation rugby field;
- Single storey Support Learning Hub Facilities building between the existing 'Block U' and the proposed regulation rugby field;
- 48 space staff car park in the southern corner of the school grounds;
- Refurbishment of selected classrooms and buildings; and
- Re-orientation of the existing sporting fields.

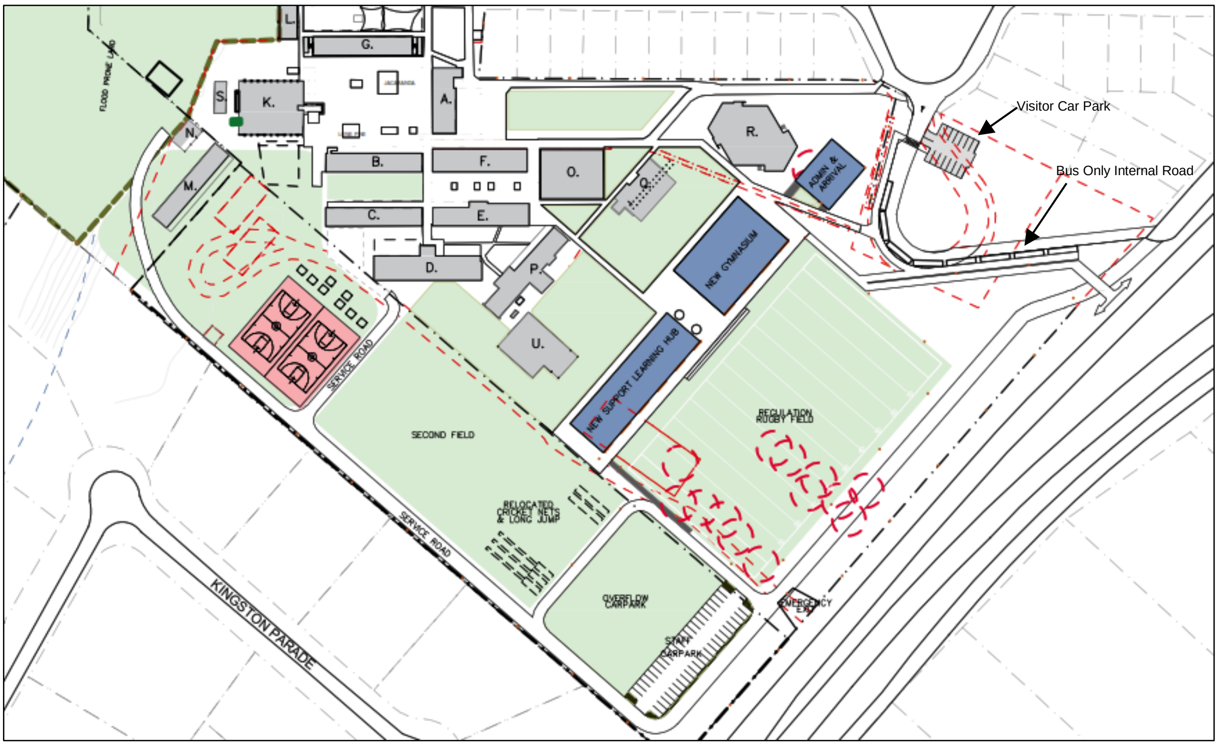

Figure 1: Proposed development, with proposed new buildings in blue. From EJE Architecture Drawing "Overall Site Plan", Drawing No. A001 Rev A, dated May 2022, provided by APP.

For the purpose of the investigation, the client provided the following Option 5 concept drawings from SHAC, dated 21 December 2021:

- "1:2000 Proposed Site Plan", Drawing No. SK3034 Rev G;
- "1:1000 Proposed Site Plan – Ground Floor", Drawing No. SK3035 Rev H;
- "1:1000 Proposed Site Plan – First Floor", Drawing No. SK3036 Rev F;
- "1:2000 Proposed Site Plan – Carpark & Exterior Works", Drawing No. SK3041 Rev C;

- “Ground Floor Plan – Support Learning”, Drawing No. SK3130 Rev C;
- “Ground Floor Plan – Gymnasium”, Drawing No. SK3131 Rev C;
- “Ground Floor Plan – Administration”, Drawing No. SK3132 Rev C;
- “Demolition Plan”, Drawing No. SK9026 Rev B; and
- “Access, Security and Circulation Strategy”, Drawing No. SK9025 Rev B.

At the time of the investigation building and /or column loads were not provided.

3. Site Description and Regional Geology

The site is situated within the south-eastern and south-western grounds of the Hunter River High School campus, located at 36 Elkin Avenue, Heatherbrae. The site is bordered to the south-east by the Pacific Highway, to the north-west by existing school buildings, and to the north-east and south-west by residential and rural land (refer to Figure 2 on the following page and Drawing R.001.D.001 in Appendix D).

The majority of the proposed development (new support learning hub, gymnasium, staff car park and service road) are proposed in areas currently used as sporting fields. The area proposed for the admin building is currently used as a staff car park.

At the time of investigation, the site was predominantly surfaced with short grass in the sports fields, and covered by asphalt in the staff car park. The site was relatively flat and level with surface levels ranging from 6.7 AHD to 7.1 AHD at field test locations.

Figure 2: Aerial photo of the site, proposed building footprints in red, and proposed car parks and internal roads in blue. Source – Metromap (19 September 2021).

Reference to the NSW Seamless Geology Map prepared by The Geological Survey of NSW indicates that the site is underlain by Quaternary aged coastal sand.

Reference to the acid sulfate soil risk mapping prepared by The Department of Land and Water Conservation indicates that the Hunter River High School site is mapped to have a low probability of acid sulfate soils at greater than 3 m depth below the surface.

4. Field Work

4.1 Field Work Methods

The field work was undertaken on 12 July 2022 and comprised the following at the locations indicated on Drawing 1, attached:

- Drilling of seven bores (designated Bores 101 to 107) using a 3 t excavator with a 300 mm diameter short flight auger to depths between 1.95 m and 3 m, within proposed building and car park footprints; and
- Six CPTs (designated CPTs 106 to 111) to 15 m depth within proposed building footprints.

The location of CPT 106 and 107 were undertaken within about 1 m to 2 m of Bores 106 and 107, respectively.

Dynamic cone penetrometer tests (DCPs) were undertaken adjacent to each bore up to 1.2 m depth to provide information on the strength consistency of the subgrade soils. 'Disturbed' samples were collected for laboratory testing purposes. The subsurface conditions encountered in the bores were logged and sampled by a geotechnical engineer from DP.

The bores were reinstated with drilled spoil at the completion of drilling and sampling, which was compacted in layers using hand tools within about 1 m of the surface.

The CPTs were conducted using a purpose built truck mounted CPT rig. A 35 mm diameter instrumented cone and friction sleeve assembly was hydraulically thrust into the soil at a rate of 2 cm / sec. Cone tip resistance, depth and sleeve friction were recorded by a computer data acquisition system for subsequent plotting and analysis. The remnant CPT holes were dipped to measure the depth to water or hole collapse.

The UTM coordinates and surface levels at the bores and CPTs were recorded using a differential GPS, which has a horizontal and vertical accuracy of approximately 0.1 m.

4.2 Field Work Results

The subsurface conditions encountered in the bores and inferred in the CPTs, are detailed on the attached borehole logs and cone penetration test plots. These should be read in conjunction with the attached notes About this Report and the explanatory notes which comment on the sampling methods, soil descriptions, and symbols and abbreviations used in their preparation.

The subsurface conditions are summarised below:

- **Asphalt:** Encountered in Bore / CPT 106 only to 0.04 m depth.
- **Fill:** Apparently moderately well compacted, typically comprising sand, gravelly sand or clayey sand fill, encountered in Bores/CPTs 106 and 107 and CPTs 108 to 111 up to 0.7 m depth. The sand fill encountered in Bore 107 included medium to coarse gravel with ash inclusions.
- **Fill / Topsoil:** Silty sand or sand with silt, encountered in Bores 101 to 105 to between 0.2 m and 0.3 m depth.
- **Sand / Silty Sand:** Generally loose, then medium dense, with density generally increasing with depth, encountered in all bores and CPTs to the limit of investigation. The sand increases in density to dense from depths of about 4.5 m to 7.7 m.

An exception to the above general profile was encountered at Bore 102 where sand fill was encountered to the depth of investigation. At this bore, the sand to 1.9 m was relatively consistent with the surrounding natural sand at other bore locations but gravel and iron cemented fill material from 1.9 m resulted in borehole refusal at 1.95 m depth.

Free groundwater was not observed in the bores while they remained open. Groundwater was measured at depths between 3.7 m and 4.0 m following withdrawal of the CPT rods It should be noted that groundwater depths and ground moisture conditions are affected by climatic conditions and soil permeability, and will therefore vary with time. Field work was undertaken immediately following a period of heavy and prolonged rainfall, and as such groundwater levels may be elevated.

5. Laboratory Testing

5.1 Geotechnical Laboratory Testing

Geotechnical laboratory testing was carried out on selected samples retrieved from the boreholes and comprised the following:

- Three aggressivity tests (pH, EC, SO_4, Cl); and
- Two standard compactions / California bearing ratio (CBR) tests.

For the CBR testing each sample was compacted to approximately 100% standard dry density ratio at the estimated optimum moisture content (OMC) and then soaked for four (4) days under a surcharge loading of 4.5 kg prior to testing.

The laboratory test results are presented in Table 1 and Table 2. Detailed laboratory report sheets are attached in Appendix C.

Table 1: Results of pH, EC, Chloride and Sulfate Testing

Bore	Depth (m)	pH	EC (µS/cm)	Sulfate, as SO_4 (mg/kg)	Chloride (mg/kg)	Primary Description
105	2.0	6.5	6	<10	<10	SAND
106	3.0	5.9	5	<10	<10	SAND
107	1.5	5.8	13	20	<10	SAND

Table 2: Results of Laboratory Testing - CBR and Standard Compaction

Bore	Depth (m)	Description	FMC (%)	OMC (%)	SMDD (t/m^3)	CBR (%)	Swell During Soaking Phase (%)
102	0.5 – 0.7	FILL / SAND	5.2	16.5	1.67	20	-0.5
104	0.6 – 0.8	SAND	4.4	15.0	1.67	25	0.0

Notes to Table 2:
FMC - Field Moisture Content
SMDD - Maximum Dry Density (Standard)
OMC - Optimum Moisture Content (Standard)
CBR - California Bearing Ratio

5.2 Acid Sulfate Soil Testing

Screening and analytical testing for actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS) were carried out with reference to ASS Manual (Stone, Ahern, & Blunden, 1998), ASS Laboratory Methods Guidelines in Queensland (Ahern, McElnea, & Sullivan, 2004) and Queensland ASS Technical Manual (Dear, et al., 2014).

17 soil samples collected from Bores 101, 105, 106 and 107 were screened by measuring pH after the addition of distilled water (pH_F) and peroxide (pH_{FOX}). The pH_F tests preliminarily indicate past oxidation of sulfides resulting in the possible presence of AASS. The pH_{FOX} tests preliminarily indicate the possible presence of unoxidised sulfides and therefore PASS.

Based on the screening test results and visual inspection of the samples, no samples were subjected to more rigorous chromium suite testing. The screening test results (pH_F and pH_{FOX}) are presented in Table 3 below and comments are provided in Section 6.11 below.

Table 3: Acid Sulfate Soil Screening Test Results

Borehole	Sample Depth (m)	Depth to Groundwater (m bgl)	Sample Description	Screening Test Results			
				pH			Strength of Reaction [a]
				pH_F	pH_{FOX}	pH_F - pH_{FOX}	
101	0.5	4.0	SAND (pale brown grey)	6.4	6.1	0.3	1
101	1.0	4.0	SAND (brown orange)	6.4	5.9	0.5	1
105	0.5	4.0	SAND (pale grey)	6.3	5.7	0.6	1
105	0.7	4.0	SAND (pale grey, pale brown)	6.3	5.9	0.4	1
105	1.0	4.0	SAND (pale grey, pale brown). Trace iron oxide nodules	6.3	6.1	0.2	1
105	1.5	4.0	SAND (pale grey, pale brown)	6.5	6.3	0.2	1
105	2.0	4.0	SAND (yellow brown)	6.5	6.4	0.1	1
106	0.5	4.0	SAND (pale brown)	6.6	7.1	-0.5	1
106	1.0	4.0	SAND (pale grey yellow)	6.7	7.0	-0.3	1
106	1.5	4.0	SAND (pale grey yellow)	6.8	6.9	-0.1	1
106	2.0	4.0	SAND (pale yellow)	6.7	7.8	-1.1	1
106	2.5	4.0	SAND (pale yellow)	6.7	6.7	0.0	1
106	3.0	4.0	SAND (pale yellow)	6.4	6.5	-0.1	1
107	0.5	4.0	SAND (brown orange)	6.3	7.1	-0.8	1
107	1.0	4.0	SAND (brown orange)	6.7	6.4	0.3	1
107	1.5	4.0	SAND (brown orange)	6.1	5.8	0.3	1
107	2.0	4.0	SAND (yellow brown)	6.5	5.9	0.6	1
Guideline		Coarse sands, poorly buffered Coarse sands to loamy sands and peats Medium sandy loams to light clays Fine medium to heavy clays & silty clays		<4[b]	<3.5[c]	≥1[c]	-

Notes to Table 3:

a Strength of Reaction
- 1 denotes no or slight reaction
- 2 denotes moderate reaction
- 3 denotes high reaction
- 4 denotes very vigorous reaction
- F denotes bubbling/frothy reaction indicative of organics
- V denotes vapours generated
- B denotes bubbles generated
- H denotes heat generated

b For actual acid sulphate soils (ASS)

c Indicative value only for Potential Acid Sulphate Soils (PASS)

Bold results indicative of Potential ASS conditions

pH_F - Soil pH Test (1:5 soil:distilled w ater)

pH_{FOX} - Soil Peroxide pH Test (1:4 soil:distilled w ater follow ing oxidation of soil w ith 30% hydrogen peroxide (H202))

6. Comments

6.1 Soil Permeability

The ability of the subsurface profile to accept infiltration is influenced by several factors, including the following:

- The subsurface profile within the infiltration area;
- The presence of less permeable layers (ie silt, clay or indurated sands) within the soil profile; such layers may lower the permeability (hydraulic conductivity) of the subsurface profile by several orders of magnitude;
- Climatic conditions;
- The presence of groundwater table; and
- Prediction of infiltration rate during storm events is difficult and some run-off may be expected.

The boreholes indicate that the subsurface conditions generally comprised granular fill (sand, gravelly sand or clayey sand) or topsoil (silty sand or sand with silt) over sand with varying fines proportions, to the investigation depth of 1.95 m to 3.0 m.

Fetter (1994) indicates the following typical permeability values for sand and silty sand:

- Silty sands, fine sands: 10^{-7} m/s to 10^{-5} m/s.
- Well-sorted sands: 10^{-5} m/s to 10^{-3} m/s.

It should be noted that the method used in estimation of permeability of the soil often over-predicts actual infiltration during storm periods, and runoff can be expected from time to time following extreme storm events. In addition, consideration should also be given to the clogging of the pores within the sand by silt from runoff. Based on previous experience, the clogging of pores within the sand can reduce the permeability of the sand by at least two orders of magnitude over time.

6.2 Excavation Conditions and Batter Slopes

Relatively straightforward conditions are anticipated for excavations up to 1.5 m deep at the site. Based on the results of the investigation, the cut material will vary from apparently well compacted fill to loose or medium dense silty sand and sand. These materials are likely to be readily removable with conventional earthmoving equipment, such as hydraulic backhoes or excavators, of at least 8 tonnes operating mass.

Temporary and permanent dry unshored or unretained excavations up to a maximum 1.5 m deep, should be battered to a slope of no steeper than 2H:1V and 2.5H:1V, respectively in the sands. If elevated groundwater is encountered at the time of excavation, such that it seeps from the batter face, additional geotechnical advice should be sought. Batters profiled at 3H:1V or flatter are generally required where maintenance of the slopes are required.

The adoption of such temporary batter slopes will also be dependent upon all surcharge, such as from spoil heaps, equipment and traffic, being kept well back (or at least the vertical excavation depth) from the slope crest.

6.3 Site Preparation and Earthworks

Prior to any earthworks at the site, any deleterious materials and vegetation should be stripped from within building envelopes and either removed from site or stockpiled for possible re-use, if applicable.

The shallow fill material and naturally occurring silty sand and sand excavated from the site could be suitable for re-use as structural fill, provided that it is free from deleterious materials such as topsoil, vegetation and particles greater than 150 mm in size. It is noted that the silty sand will require careful moisture conditioning as it can become difficult to compact if it is too wet.

Imported fill, if required, should comprise free draining cohesionless sand with less than 5% by weight of particles passing a 0.075 mm sieve. The material should be free from organic matter and large particles.

It is recommended that naturally occurring sands at this site and imported fill be placed in loose lift thickness of not more than 300 mm, with each layer compacted to at least 98% Standard maximum dry density ratio or 80% density index.

Density testing of sand layers would probably require placement of a second layer to allow confinement, with the testing undertaken through the upper layer into the underlying layer.

During construction, some loosening of the surface sands in foundation excavations is expected. Therefore, the base of any excavation should be re-compacted using a vibratory plate compactor prior to constructing any footings.

If fill is to be used for the support of structural loads, earthworks testing and inspections should be carried out under controlled 'Level 1' inspection and testing, as defined in Section 8 of AS 3798.

6.4 Retaining Walls

Design parameters for estimating long-term earth pressures on retaining walls with level back fill (i.e. no slopes) are shown in Table 4. These values are unfactored hence a suitable factor of safety should be used in design.

It is recommended that a factor of safety of 2 be adopted for overturning and sliding stability, and 1.5 for global stability. Guidance on the selection of material strength partial factors is provided in Section 5.2 of AS 4678 (2002) and is dependent upon the nature of the soils affecting the wall.

Table 4: Design Parameters for Retaining Structures

Material		Effective Unit Weight (kN/m³)	Moist Bulk Unit Weight (kN/m³)	Lateral Earth Pressure Coefficient (K)		
				K_a	K_o	K_p
Fill (controlled)		10	18	0.31	0.47	3.25
Granular soils (sand / gravel)	Loose	10	16	0.33	0.50	3.00
	Medium dense	10	18	0.31	0.47	3.25
	Dense	10	20	0.26	0.41	3.85

Notes to Table 4:
K_a - coefficient of active earth pressure
K_o - coefficient of 'at-rest' earth pressure
K_p - coefficient of passive earth pressure

The use of active pressure coefficients (K_a) requires that there will be sufficient deflection of the retaining system during construction to reach active conditions. If lateral deflections are inhibited, at-rest coefficients (K_o) should be used. The parameters given above are based on full drainage behind the retaining wall.

Additional pressures should be allowed for where surcharging of the wall system results from adjacent buildings, construction equipment and proposed buildings.

Drainage is to be provided in the backfill behind all of the retaining walls and should include 100 mm diameter slotted pipe at the toe, with single sized (either 10 mm or 20 mm) aggregate extending over the full height of the wall. This should all be encapsulated in geofabric. The pipe should discharge to a formal drainage system.

6.5 Site Classification

The presence of 'uncontrolled' filling up to 0.6 m depth as well as the loose sands inferred from CPTs 107 to 111 up to 2.4 m depth, triggers the classification of the site as 'Class P' which requires the footings to be designed in accordance with engineering principles.

If the fill was to be recompacted in accordance with the earthworks guidelines (AS 3798, 2007) and the recommendations presented in this report, it is considered that the footing system should be designed to accommodate relative characteristic surface movements (y_s) commensurate with a 'Class S' classification to account for the variable in situ densities of the sand across the proposed building footprints.

In addition, it should be noted that the above y_s values do not take into account settlement induced by footing loading of the foundation soils.

6.6 Earthquake Site Sub-Soil Classification and Hazard Factor

AS 1170.4 (2007) provides site sub-soil classifications for general structures based on simplified soil profiles. The site is predominantly underlain by moderately well compacted granular fill (to between 0.2 m and 0.7 m depth), then loose or denser sand; therefore a site sub-soil classification of Class Ce is suggested.

Figure 3.2(A) of AS 1170.4 – Amendment 2 (2018) indicates a hazard factor (Z) of 0.11 for the Heatherbrae area.

6.7 Upper Level Footings

Upper level conventional pad and strip footings founding within the natural sands below the fill layer are considered suitable for lightly loaded structures.

For founding at depths not less than 0.7 m (through the fill layer and loose surficial sands) in natural loose to medium dense sands, the design of conventional small pad footings up to 1 m wide and strip footings between 0.3 m and 0.6 m wide should be based on a maximum allowable bearing pressure of 150 kPa. It is important that the founding depth for narrow (0.3 m wide) strip footings should be founded below 0.7 m in order to develop sufficient overburden pressure to achieve the recommended allowable bearing pressures.

Estimated settlements for an isolated 1 m square pad or 0.6 m strip footing designed to the above allowable bearing pressure are estimated to up to about 10 mm.

Geotechnical inspection and testing is recommended during construction to confirm loose to medium dense sands to depths of at least twice the footing width below the base of the footing excavations.

6.8 Piles

6.8.1 Construction

An alternative to shallow footing systems, would be the use of piles.

The presence of clean ‘cohesionless’ sands would preclude the use of conventional uncased bored piles. Piled foundation options for this site could comprise driven piles, continuous flight auger (CFA) piles and steel screw piles. Ground vibrations and noise associated with the installation of driven piles could be disruptive to nearby buildings, students and staff and should be given consideration in conjunction with comments from specialist piling contractors. The methods for installation of CFA grout injected piles or steel screw piles are essentially vibration-free.

Driven piles should be installed to a predetermined resistance or set, with measurements recorded during pile installation. The capacity of driven piles should then be further checked using an acknowledged pile driving formulae, such as the Hiley equation, or more sophisticated dynamic testing methods, such as CAPWAP or PDA. Borehole logs and CPT report sheets should be checked when a founding set has been achieved to verify sufficient thickness of adequate founding material beneath the pile toe (at least four pile diameters).

For design purposes it is accepted practice to adopt lower bound values for the soil strengths to be conservative. When driving however, the pile behaviour will be governed by the actual soil strength. Therefore, the possibility of the pile refusing before the target depth defined by calculation is reached must be recognised. This will be especially true if an undersized hammer is used. To minimize this risk, a hammer capable of driving against the minimum required capacity (including testing requirements) should be selected such that if premature refusal occurs, adequate capacity should still be obtained (at least for compressive criteria). Nevertheless, selection of an appropriate piling hammer should be the responsibility of the piling contractor.

As an alternative to driven piles, cast in-situ CFA piles could be considered, although these are likely to be significantly more expensive than driven piles. CFA piles founding a minimum of three pile diameters into the nominated founding strata (below approximately 5.5 m depth) can be preliminary designed using the allowable values given in Table 5.

6.8.2 Vertical Design (Driven and CFA Piles)

The ultimate parameters provided in Table 5 are suggested for the preliminary static design of driven piles subject to vertical compressive and uplift loads, with at least four pile diameters embedment into the founding strata and a consistent founding stratum extending to at least four pile diameters below the toe of the pile. The values provided for the sand layers are based on using buoyant unit weight in the calculation of effective stress.

A factor of safety of 2.5 should be applied to all ultimate values for working stress analysis. Alternatively, a basic geotechnical strength reduction factor (ϕ_{gb}) of 0.48 is recommended for limit state design of piles in accordance with AS 2159 (2009). This is based on the data presented in this report, the method of soil strength assessment used in this investigation and after assessing the overall design average risk rating (ARR) for the site, design and installation risk factors anticipated for a low redundancy piling system. Higher values of ϕ_{gb} may be applied if additional investigation is carried out at the site, or higher geotechnical strength reduction factor (ϕ_g) may be adopted if selected piles are subjected to confirmatory load testing.

It is recommended that the contribution of skin friction in the upper 1.0 m of soil and any shaft length that has been disturbed be ignored in any pile capacity calculations.

Table 5: Ultimate Unfactored Pile Design Parameters – Vertical Load (Driven and CFA)

Material Description	Ultimate Unfactored Pressure, $R_{d,ug}$ (kPa)	
	Shaft Adhesion	End Bearing
Loose sand / silty sand	$4H_2^{*\#}$	-
Medium dense sand / silty sand	$5H_2^{*\#}$	$500H_1$
Dense sand / silty sand	$10H_2^{*\#}$ (80 kPa Max)	$900H_1$

Notes to Table 5:
H_1 – depth to pile toe (in metres), limited to eight or 15 times pile diameter for medium dense and dense sands, respectively
H_2 – depth to centre of pile shaft within sand layer (in metres), limited to eight or 15 times pile diameter for medium dense and dense sands, respectively
* – shaft adhesion in compression only, reduce by 50% for uplift
# value should be reduced by 50% for CFA

6.8.3 Steel Screw Piles

The use of steel screw piles with a pile cap could be adopted as an alternative pile design on the site. Screw piles founding in medium dense (or denser) silty sand / sand at depths greater than 4 m should be based on an allowable end bearing pressure of 500 kPa.

It is important that the installation of steel screw piles be carefully controlled in the field to ensure the pile does not meet refusal prior to meeting its termination depth. In this scenario, advancement of the pile will cease, causing over rotation and disturbance of the overburden soils above the helix. This phenomenon is often encountered where steel screw piles encounter an underlying harder stratum (such as dense sand) and the toe penetration is considerably reduced in comparison to the string rotation. Where over-rotation occurs, the bearing capacity for the helix would be substantially reduced and/or pile movements incurred.

The actual capacity of steel screw piles depends not only on the soil conditions but also on structural considerations of the piles such as the strength of the helix and the helix/shaft joint. It is considered that the structural section capacity as well as geotechnical capacity will need to be considered where the required load carrying capacity of individual steel screw piles is greater than (say) 600 kN. Measurement of installation torque should not be relied upon to indicate pile capacity, as it has been documented that significantly misleading results can be obtained. For this reason, piling contractors would be responsible for assessment of actual pile capacities for their piles.

Structural capacity of the steel screw pile should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Lateral capacity of steel screw piles could be increased by constructing concrete pile caps or by using proprietary head attachments which are dragged into the soil providing additional lateral resistance at the pile head. The lateral support is generally limited and is generally suited to non-critical structures that can accommodate some lateral movement such as light poles, signs and small towers.

6.9 Preliminary Flexible Pavement Design

6.9.1 Subgrade

Based on the results of the investigation, the subgrade soils within the proposed car park areas are expected to comprise predominantly silty sand fill and natural sand at subgrade level.

Laboratory testing undertaken on a sample of sand fill from Bore 102 and natural sand from Bore 104 returned CBRs of 20% and 25% which are on average slightly higher than expected based on local experience. The samples did not swell.

Based on the results of the site investigation, and experience with similar material in the Heatherbrae area, a subgrade CBR of 10% is considered appropriate.

6.9.2 Design Traffic Loading

The following design traffic loadings were provided by the client:

- Access Road: 3×10^5 Equivalent Standard Axles (ESA); and

- Bus drop off road extension: 5×10^5 ESA.

6.9.3 Flexible Pavement Thickness Design

The indicative flexible pavement thickness design is in accordance with Austroads (2019) and also takes into account avoiding construction issues with placing thin layers of gravel (<180 mm thick) over clean sand. The suggested thicknesses are presented in Table 6, below.

Table 6: Flexible Pavement Thickness

Pavement Layer	Thickness (mm)	
	3×10^5 ESA	5×10^5 ESA
Wearing Course	40(1)	40(1)
Basecourse	230	240
Subbase	-	-
Total	270	280

Notes to Table 6:
(1) Thickness of AC10. A 7 mm prime seal should be placed over the basecourse prior to placement of the AC.

Any changes in overall pavement thickness between adjoining sections of road should be transitioned and not abruptly stepped.

The pavement thicknesses presented above are dependent on the provision and maintenance of adequate surface and subsurface drainage. Suitable permanent surface and subsurface drainage measures should be installed and maintained at the site to protect the foundation strata from saturation. If the subgrade soils can become wet (i.e. inadequate drainage), there is an increased risk of damage to the pavement, particularly if traffic is allowed on the pavement while the subgrade is saturated.

It is noted that selection of an appropriate asphalt mix design should account for the high shear / torsional forces that may be exhibited by tightly turning vehicles, such as buses and / or small delivery trucks.

If cracks appear in the asphalt wearing course, they should be promptly sealed to prevent the ingress of water and potential softening of the subgrade.

6.9.4 Material Quality and Compaction Requirements

The recommended material quality and compaction requirements for sealed flexible pavement are presented in Table 7, below.

Table 7: Material Quality and Compaction Requirements – Sealed Flexible Pavements

Pavement Layer	Material Quality	Compaction
Basecourse	CBR > 80%, PI ≤ 6%, Grading in accordance with TfNSW 3051 (2020) or Port Stephens Council specifications	Compact to at least 98% dry density ratio modified (AS 1289.5.2.1)
Subbase	CBR > 30%, PI ≤ 12%, Grading in accordance with TfNSW 3051 (2020) or Port Stephens Council specifications	Compact to at least 95% dry density ratio modified (AS 1289.5.2.1)
Subgrade	CBR≥ 10%	Compact to at least 100% dry density ratio standard (AS1289.5.1.1) or 80% density index

Notes to Table 7:
CBR – California bearing ratio (4 day soaked)
PI – Plasticity Index

Geotechnical inspections and testing should be performed during construction.

6.10 Soil Aggressivity

Based on the results of laboratory aggressivity testing (Table 1), the soils tested from the upper 3 m of the soil profile would be deemed to have a "non-aggressive" exposure classification for buried concrete or steel for high permeability soils above the water table in accordance with AS 2159 (2009).

AS 2159 provides appropriate minimum concrete strengths and minimum cover to reinforcing steel for various exposure classifications.

6.11 Acid Sulfate Soils

The criteria used to assess the results of the screening tests (pH_F and pH_{FOX}) as possibly indicative of AASS or PASS were based on the QASSIT Guidelines as follows:

- pH_F < 4 indicates oxidation has occurred in the past and that AASS may possibly be present.
- pH_{FOX} < 3, plus a pH_{FOX} reading at least one pH unit below pH_F, plus a strong reaction with peroxide, strongly indicates the possible presence of PASS.

The current laboratory testing indicates that all pH_F test results were equal to or greater than pH 6.1; and that all pH_{FOX} test results were greater than pH 5.7. None of the samples tested exhibited a pH_{FOX} reading less than or equal to one pH unit below pH_F, and none of the samples showed a strong reaction with hydrogen peroxide (i.e. reaction 3) (refer to Table 3 for the detailed tabulated results).

It follows from the above that an ASSMP will not be required prior to any construction works or earthworks being conducted at this site within the limit of sampling (3 m). Where soil disturbance greater than 3 m depth is proposed (ie bored piles), further investigation will be required to determine if an ASSMP is required.

7. References

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8. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Hunter River High School, 36 Elkin Avenue, Heatherbrae in accordance with DP’s proposal 216008.00.P.001.Rev0 dated 15 June 2022 and acceptance received from Elisa Tanaka from Department of Education through School Infrastructure NSW on 5 July 2022. The work was carried out under Part D - Standard Form Agreement SINSW03421/22, dated 5 July 2022. This report is provided for the exclusive use of NSW Department of Education for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

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

The assessment of atypical safety hazards arising from this advice is restricted to the (geotechnical / environmental / groundwater) components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

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

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

Douglas Partners Pty Ltd

Appendix A

About This Report
Terminology, Symbols and Abbreviations
Soil Descriptions
Sampling, Testing and Excavation Methodology
Cone Penetration Testing

About this Report

August 2020

Introduction

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

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

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

continued next page

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

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Introduction to Terminology, Symbols and Abbreviations

Douglas Partners' reports, investigation logs, and other correspondence may use terminology which has quantitative or qualitative connotations. To remove ambiguity or uncertainty surrounding the use of such terms, the following sets of notes pages may be attached Douglas Partners' reports, depending on the work performed and conditions encountered:

- Soil Descriptions;
- Rock Descriptions; and
- Sampling, insitu testing, and drilling methodologies

In addition to these pages, the following notes generally apply to most documents.

Abbreviation Codes

Site conditions may also be presented in a number of different formats, such as investigation logs, field mapping, or as a written summary. In some of these formats textual or symbolic terminology may be presented using textual abbreviation codes or graphic symbols, and, where commonly used, these are listed alongside the terminology definition. For ease of identification in these note pages, textual codes are presented in these notes in the following style `XW`. Code usage conforms with the following guidelines:

- Textual codes are case insensitive, although herein they are generally presented in upper case; and
- Textual codes are contextual (i.e. the same or similar combinations of characters may be used in different contexts with different meanings (for example `PL` is used for plastic limit in the context of soil moisture condition, as well as in `PL(A)` for point load test result in the testing results column)).

Data Integrity Codes

Subsurface investigation data recorded by Douglas Partners is generally managed in a highly structured database environment, where records "span" between a top and bottom depth interval. Depth interval "gaps" between records are considered to introduce ambiguity, and, where appropriate, our practice guidelines may require contiguous data sets. Recording meaningful data is not always appropriate (for example assigning a "strength" to a concrete pavement) and the following codes may be used to maintain contiguity in such circumstances.

Term	Description	Abbreviation Code
Core loss	No core recovery	`KL`
Unknown	Information was not available to allow classification of the property. For example, when auguring in loose, saturated sand auger cuttings may not be returned.	`UK`
No data	Information required to allow classification of the property was not available. For example if drilling is commenced from the base of a hole predrilled by others	`ND`
Not Applicable	Derivation of the properties not appropriate or beyond the scope of the investigation. For example providing a description of the strength of a concrete pavement	`NA`

Graphic Symbols

Douglas Partners' logs contain a "graphic" column which provides a pictorial representation of the basic composition of the material. The symbols used are directly representing the material name stated in the adjacent "Description of Strata" column, and as such no specific graphic symbology legend has been provided in these notes.

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Introduction

All materials which are not considered to be "in-situ rock" are described in general accordance with the soil description model of AS 1726-2017 Part 6.1.3, and can be broken down into the following description structure:

classification | name | detailed description

(SW) Clayey SAND, trace silt; grey, fine to medium grained

The "classification" comprises a two character "group symbol" providing a general summary of dominant soil characteristics. The "name" summarises the particle sizes within the soil which most influence it's behaviour. The detailed description presents more information about the soil's composition, condition, structure, and origin.

Classification, naming and description of soils requires the relative proportion of particles of different sizes within the whole soil mixture to be considered.

Particle size designation and Behaviour Model

Solid particles within a soil are differentiated on the basis of size.

The engineering behaviour properties of a soil can subsequently be modelled to be either "fine grained" (also known as "cohesive" behaviour) or "coarse grained" ("non cohesive" behaviour), depending on the relative proportion of fine or coarse fractions in the soil mixture.

Particle Size Fraction	Particle Size (mm)	Behaviour Model: Behaviour	Behaviour Model: Approximate Dry Mass
Boulder	>200	Excluded from particle behaviour model as "oversize"	
Cobble	63 - 200		
Gravel[1]	2.36 - 63	Coarse	>65%
Sand[1]	0.075 - 2.36		
Silt	0.002 - 0.075	Fine	>35%
Clay	<0.002		

[1] – refer grain size subdivision descriptions below

The behaviour model boundaries defined above are not precise, and the material behaviour should be assumed from the name given to the material (which considers the particle fraction which dominates the behaviour, refer "component proportions" below), rather than strict observance of the proportions of particle sizes. For example, if a material is named a "Sandy CLAY", this is indicative that the material exhibits fine grained behaviour, even if the dry mass of coarse grained material may exceed 65%.

Component proportions

The relative proportion of the dry mass of each particle size fraction is assessed to be a "primary", "secondary", or "minor" component of the soil mixture, depending on it's influence over the soils behaviour.

Component Proportion Designation	Definition[1]	Relative Proportion: In Fine Grained Soil	Relative Proportion: In Coarse Grained Soil
Primary	The component (particle size designation, refer above) which dominates the engineering behaviour of the soil	The clay/silt component with the greater proportion	The sand/gravel component with the greater proportion
Secondary	Any component which is not the primary, but is significant to the engineering properties of the soil	Any component with greater than 30% proportion	Any granular component with greater than 30%; or Any fine component with greater than 12%
Minor[2]	Present in the soil, but not significant to it's engineering properties	All other components	All other components

[1] – As defined in AS1726-2017 6.1.4.4

[2] – in the detailed material description, minor components are split into two further sub categories. Refer "identification of minor components" below

Composite Materials

In certain situations a lithology description may describe more than one material, for example, collectively describing a layer of interbedded sand and clay. In such a scenario, the two materials would be described independently, with the names preceded or followed by a statement describing the arrangement by which the materials co-exist. For example "INTERBEDDED Silty CLAY AND SAND".

Classification

The soil classification comprises a two character group symbol. The first symbol identifies the primary component. The second symbol identifies either the grading or presence of fines in a coarse grained soil, or the plasticity in a fine grained soil. Refer AS1726-2017 6.1.6 for further clarification.

Soil Name

For most soils the name is derived with the primary component included as the noun (in upper case), preceded by any secondary components stated in an adjective form. In this way the soil name also describes the general composition and indicates the dominant behaviour of the material.

Component[1]	Prominence in Soil Name
Primary	Noun (eg "CLAY")
Secondary	Adjective modifier (eg "Sandy")
Minor	No influence

[1] – for determination of component proportions, refer component proportions on previous page

For materials which cannot be disaggregated, or which are not comprised of rock or mineral fragments, the names "ORGANIC MATTER" or "ARTIFICIAL MATERIAL" may be used, in accordance with AS1726-2017 Table 14.

Commercial or colloquial names are not used for the soil name where a component derived name is possible (for example "Gravelly SAND" rather than "CRACKER DUST").

Identification of minor components

Minor components are identified in the soil description immediately following the soil name. The minor component fraction is usually preceded with a term indicating the relative proportion of the component.

Minor Component Proportion Term	Relative Proportion	
	In Fine Grained Soil	In Coarse Grained Soil
With	All fractions: 15-30%	clay/silt: 5-12% sand/gravel: 15-30%
Trace	All fractions: 0-15%	clay/silt: 0-5% sand/gravel: 0-15%

Soil Composition

Plasticity

Descriptive Term	Laboratory liquid limit range	
	Silt	Clay
Non-plastic materials	Not applicable	Not applicable
Low plasticity	≤50	≤35
Medium plasticity	Not applicable	>35 and ≤50
High plasticity	>50	>50

Note, Plasticity descriptions generally describe the plasticity behaviour of the whole of the fine grained soil, not individual fine grained fractions.

Grain Size

Type		Particle size (mm)
Gravel	Coarse	19 - 63
	Medium	6.7 - 19
	Fine	2.36 – 6.7
Sand	Coarse	0.6 - 2.36
	Medium	0.21 - 0.6
	Fine	0.075 - 0.21

Grading

Grading Term	Particle size (mm)
Well	A good representation of all particle sizes
Poorly	An excess or deficiency of particular sizes within the specified range
Uniformly	Essentially of one size
Gap	A deficiency of a particular particle size with the range

Note, AS1726-2017 provides terminology for additional attributes not listed here.

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Soil Condition

Moisture

The moisture condition of soils is assessed relative to the plastic limit for fine grained soils, while for coarse grained soils it is assessed based on the appearance and feel of the material. The moisture condition of a material is considered to be independent of stratigraphy (although commonly these are related), and this data is presented in its own column on logs.

Applicability	Term	Tactile Assessment	Abbreviation code
Fine	Dry of plastic limit	Hard and friable or powdery	<PL
	Near plastic limit	Can be moulded	≈PL
	Wet of plastic limit	Water residue remains on hands when handling	>PL
	Near liquid limit	“oozes” when agitated	≈LL
	Wet of liquid limit	“oozes”	>LL
Coarse	Dry	Non-cohesive and free running	D
	Moist	Feels cool, darkened in colour, particles may stick together	M
	Wet	Feels cool, darkened in colour, particles may stick together, free water forms when handling	W

The abbreviation code NDF, meaning “not-assessable due to drilling fluid use” may also be used.

Note, observations relating to free ground water or drilling fluids are provided independent of soil moisture condition.

Consistency/Density/Compaction/Cementation/Extremely Weathered Rock

These concepts give an indication of how the material may respond to applied forces (when considered in conjunction with other attributes of the soil). This behaviour can vary independent of the composition of the material, and on logs these are described in an independent column and are generally mutually exclusive (i.e it is inappropriate to describe both consistency and compaction at the same time). The method by which the behaviour is described depends on the behaviour model and other characteristics of the soil as follows:

- In fine grained soils, the “consistency” describes the ease with which the soil can be remoulded, and is generally correlated against the materials undrained shear strength;
- In granular materials, the relative density describes how tightly packed the particles are, and is generally correlated against the density index;
- In anthropogenically modified materials the compaction of the material is described qualitatively;
- In cemented soils (both natural and anthropogenic), the cemented “strength” is described qualitatively, relative to the difficulty with which the material is disaggregated; and
- In soils of extremely weathered rock origin, the engineering behaviour may be governed by relic rock features, and expected behaviour needs to be assessed based the overall material description

Quantitative engineering performance of these materials may be determined by laboratory testing, or estimated by correlated field tests (for example penetration or shear vane testing), or by tactile methods, as appropriate.

Consistency (fine grained soils)

Consistency Term	Tactile Assessment	Undrained Shear Strength (kPa)	Abbreviation Code
Very soft	Extrudes between fingers when squeezed	<12	VS
Soft	Mouldable with light finger pressure	>12 - ≤25	S
Firm	Mouldable with strong finger pressure	>25 - ≤50	F
Stiff	Cannot be moulded by fingers	>50 - ≤100	ST
Very stiff	Indented by thumbnail	>100 - ≤200	VST
Hard	Indented by thumbnail with difficulty	>200	H
Friable	Easily crumbled or broken into small pieces by hand	-	FR

Relative Density (coarse grained soils)

Tactile assessment of relative density is difficult, and generally requires penetration testing, hence a tactile assessment guide is not provided.

Relative Density Term	Density Index	Abbreviation Code
Very loose	<15	VL
Loose	>15-≤35	L
Medium dense	>35-≤65	MD
Dense	>65-≤85	D
Very dense	>85	VD

Compaction (anthropogenically modified soil)

Compaction Term	Abbreviation Code
Well compacted	WC
Poorly compacted	PC
Moderately compacted	MC
Variably compacted	VC

Cementation (natural and anthropogenic)

Cementation Term	Abbreviation Code
Moderately cemented	MCE
Weakly cemented	WKCE
Cemented	CE
Strongly bound	SB
Weakly bound	WB
Unbound	UB

Extremely Weathered Rock

AS1726-2017 considers weathered rock material to be soil if the unconfined compressive strength is less than 0.6 MPa (i.e. very low strength rock). These materials may be identified as “extremely weathered rock” in reports and by the abbreviation code XWR on log sheets. This identification is not correlated to any specific qualitative or quantitative behaviour, and the engineering properties of this material must therefore be assessed according to engineering principles with reference to any relic rock structure, fabric, or texture described in the description.

Soil Origin

Term	Description	Abbreviation Code
Residual	Derived from in-situ weathering of the underlying rock	RES
Extremely weathered material	Formed from in-situ weathering of geological formations. Has strength of less than ‘very low’ as per as1726 but retains the structure or fabric of the parent rock.	XWM
Alluvial	Deposited by streams and rivers	ALV
Estuarine	Deposited in coastal estuaries	EST
Marine	Deposited in a marine environment	MAR
Lacustrine	Deposited in freshwater lakes	LCS
Aeolian	Carried and deposited by wind	AEO
Colluvial	Soil and rock debris transported down slopes by gravity	COL
Topsoil	Mantle of surface soil, often with high levels of organic material	TOP
Fill	Any material which has been moved by man	FILL
Littoral	Deposited on the lake or sea shore	LIT
Unidentifiable	Not able to be identified	UID

Cobbles and Boulders

The presence of particles considered to be “oversize” may be described using one of the following strategies:

- Oversize encountered in a minor proportion (when considered relative to the wider area) are noted in the soil description; or
- Where a significant proportion of oversize is encountered, the cobbles/boulders are described independent of the soil description, in a similar manner to composite soils (described above) but qualified with “MIXTURE OF”.

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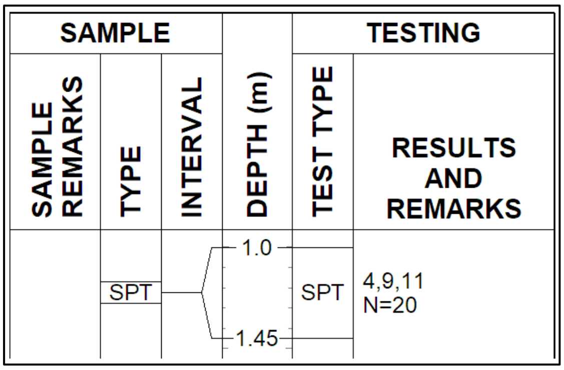
Sampling, Testing and Excavation Methodology

Terminology
Symbols
Abbreviations

August 2020

Sampling and Testing

A record of samples retained and field testing performed is usually shown on a Douglas Partners' log with samples appearing to the left of a depth scale, and selected field and laboratory testing (including results, where relevant) appearing to the right of the scale, as illustrated below:



Sampling

The type or intended purpose for which a sample was taken is indicated by the following abbreviation codes.

Sample Type	Code
Auger sample	A
Acid sulfate sample	ASS
Bulk sample	B
Core sample	C
Disturbed sample	D
Sample from SPT test	SPT
Environmental sample	E
Gas sample	G
Jar sample	J
Undisturbed tube sample	U[1]
Water sample	W
Piston sample	P
Core sample for unconfined compressive strength testing	UCS

[1] – numeric suffixes indicate tube diameter/width in mm

The above codes only indicate that a sample was retained, and not that testing was scheduled or performed.

Field and Laboratory Testing

A record that field and laboratory testing was performed is indicated by the following abbreviation codes.

Test Type	Code
Pocket penetrometer (kpa)	PP
Photo ionisation detector	PID
Standard Penetration Test	SPT
Shear vane (kpa)	V
Unconfined compressive strength, (MPa)	UCS
Point load test, axial (A), diametric (D), irregular (I)	PLT(_)

Field and laboratory testing (continued)

Test Type	Code
Dynamic cone penetrometer, followed by blow count penetration increment in mm (cone tip, generally in accordance with AS1289.6.3.2)	DCP/150
Perth sand penetrometer, followed by blow count penetration increment in mm (flat tip, generally in accordance with AS1289.6.3.3)	PSP/150

Groundwater Observations

▷	seepage/inflow
▽	standing or observed water level
NFGWO	no free groundwater observed
OBS	Observations obscured by drilling fluids

Drilling or Excavation Methods/Tools

The drilling/excavation methods used to perform the investigation may be shown either in a dedicated column down the left hand edge of the log, or stated in the log footer. In some circumstances abbreviation codes may be used.

Method	Abbreviation Code
Excavator/backhoe bucket	B[1]
Toothed bucket	TB[1]
Mud/blade bucket	MB[1]
Ripping tyne/ripper	RT
Rock breaker/hydraulic hammer	RB
Hand auger	HA[1]
NMLC series coring	NMLC
HMLC series coring	HMLC
NQ coring	NQ
HQ coring	HQ
PQ coring	PQ
Push tube	PT [1]
Rock roller	RR[1]
Solid flight auger. Suffixes (TC) and (V) indicate tungsten carbide or v-shaped tip respectively	SFA[1]
Sonic drilling	SON[1]
Vibrocore	VC[1]
Wash bore (unspecified bit type)	WB[1]
Existing exposure	X
Hand tools (unspecified)	HT
Predrilled	PD
Specialised bit (refer report)	SPEC[1]
Diatube	DT[1]
Hollow flight auger	HFA[1]
Vacuum excavation	VE

[1] – numeric suffixes indicate tool diameter/width in mm

Cone Penetration Testing

August 2020

Introduction

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

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

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

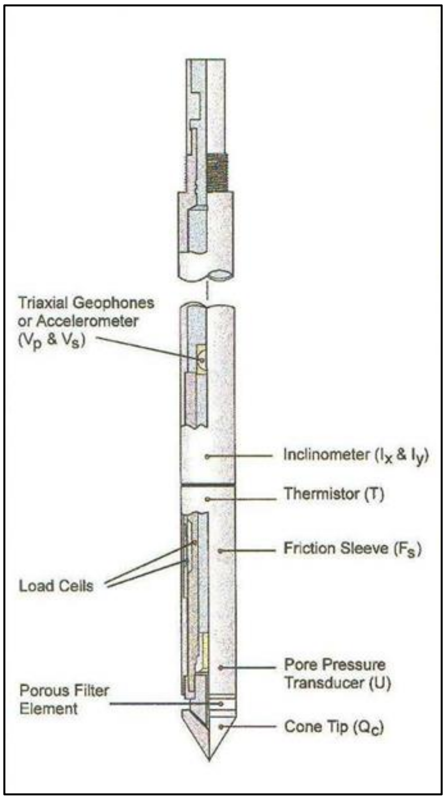


Figure 1: Cone Diagram

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

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

Figure 2: Purpose built CPT rig

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

Types of CPTs

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

Type	Measures
Standard	Basic parameters (qc, fs, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (□) plus basic parameters
Seismic	Shear wave velocity (Vs), compression wave velocity (Vp), plus basic parameters

Strata Interpretation

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

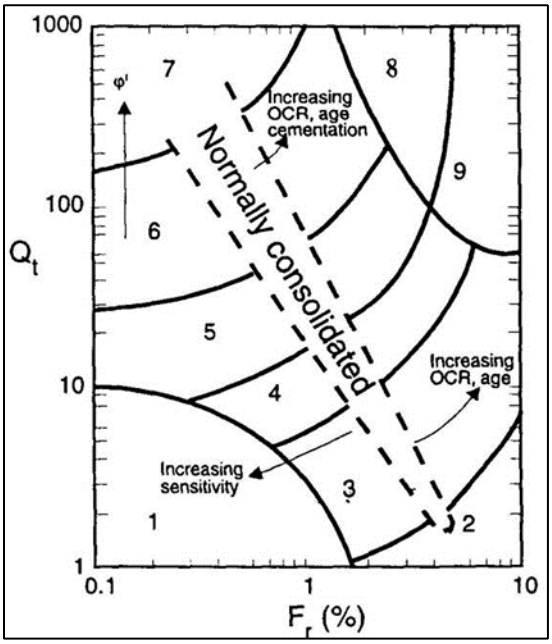


Figure 3: Soil Classification Chart

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

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

Engineering Applications

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

Settlement

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

Pile Capacity

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

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

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

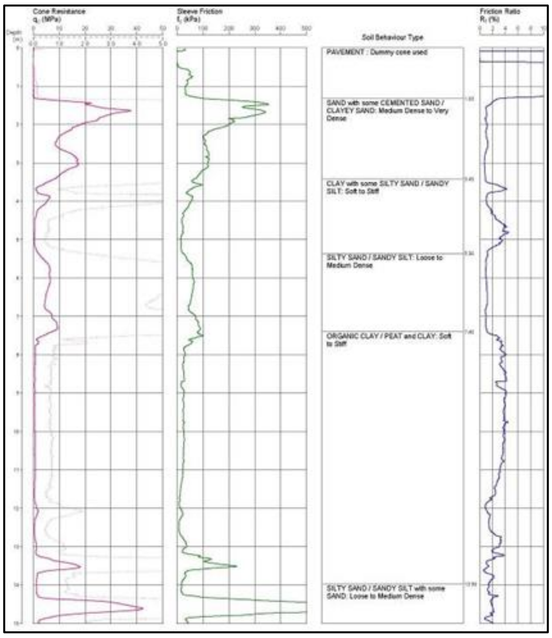


Figure 4: Sample Cone Plot

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Appendix B

Field Work Results

BOREHOLE LOG

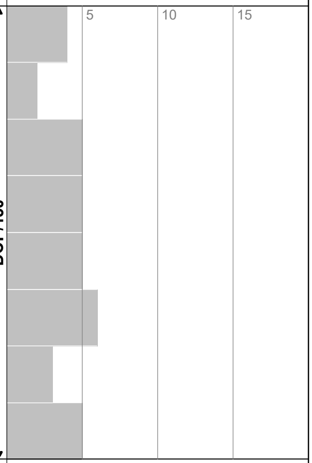
CLIENT: NSW Department of Education
PROJECT: School Upgrades
LOCATION: Hunter River High School, 36 Elkin Ave, Heatherbrae

SURFACE LEVEL: 7.1 AHD
COORDINATE E:381562 **N:** 6372176
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 101
PROJECT No: 216008.00
DATE: 12/07/22
SHEET: 1 of 1

CONDITIONS ENCOUNTERED | **SAMPLE** | **TESTING AND REMARKS**

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
No free groundwater observed	7	0.0	FILL/TOPSOIL/ (SP-SM) SAND, with silt, trace gravel; dark brown grey; sand fraction fine to medium; gravel fraction fine to coarse, sub-angular to sub-rounded; with rootlets, trace plastics		FILL and TOP	NA	M		ASS		0.01	DCP/150	
		0.2	(SP) SAND, trace silt; pale grey; fine to medium 0.3-0.9m: pale brown grey		ALV	MD	M		ASS		0.5		
											0.85		
	6	0.9	(SP-SC) SAND, trace clay; brown orange; sand fraction fine to medium; clay fraction medium plasticity		ALV	MD	M		B ASS		1.0 1.1		
		1.3	(SP) SAND, trace silt, trace shell; pale brown yellow; sand fraction fine to medium; shell fraction fine		ALV	(MD)	M		D		1.5		
	5	2.0	Borehole discontinued at 2.00m depth Limit of investigation						D		2.0		
	4	3									3		



NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 3T Excavator
METHOD: 300mm Auger
REMARKS: Coordinates obtained using a differential GPS unit typically accurate to ±0.1m

OPERATOR: Francis
CASING:
LOGGED: Chaplin

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BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: School Upgrades
LOCATION: Hunter River High School, 36 Elkin Ave, Heatherbrae

SURFACE LEVEL: 7 AHD
COORDINATE E:381448 **N:** 6372001
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 102
PROJECT No: 216008.00
DATE: 12/07/22
SHEET: 1 of 1

Groundwater	RL (m)	Depth (m)	Description of Strata	Graphic	Origin(#)	Consis.(*) / Density(*)	Moisture	Sample Remarks	Sample Type	Sample Depth (m)	Test Type	Results and Remarks
No free groundwater observed		0.0	FILL/TOPSOIL/ (SM) Silty SAND; dark brown; fine to medium; abundant rootlets		FILL and TOP	NA	M		D	0.01	DCP/150	
		0.25	(SP-SM) SAND, with silt; grey; fine to medium		ALV	MD	M		D	0.3		
		0.45	(SP-SM) SAND, with silt, trace clay; brown orange; fine to medium 1.5m: Trace coarse gravel sized ferrous nodules		ALV	MD	M		D B D D	0.5 0.5–0.7 1.0 1.5		
		1.9			ALV	SCM	NA		D	1.9		
		1.95	(SP) SAND, with gravel; dark brown orange; fine to medium; fine sub-angular to angular gravel sized quartz and sub-rounded to rounded ferrous nodules						D	1.95		
			Borehole discontinued at 1.95m depth refusal on strongly iron cemented sub-litharenite									

RL scale: 6 (1 m), 5 (2 m), 4 (3 m). DCP scale: 5, 10, 15.

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 3T Excavator **OPERATOR:** Francis **LOGGED:** Chaplin
METHOD: 300mm Auger **CASING:**
REMARKS: Coordinates obtained using a differential GPS unit typically accurate to ±0.1m

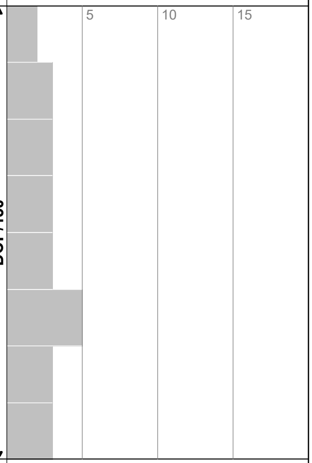
BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: School Upgrades
LOCATION: Hunter River High School, 36 Elkin Ave, Heatherbrae

SURFACE LEVEL: 7 AHD
COORDINATE E:381418 **N:** 6371969
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 103
PROJECT No: 216008.00
DATE: 12/07/22
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
No free groundwater observed		0.0	FILL/TOPSOIL/ (SM) Silty SAND; dark brown; fine to medium; with rootlets		FILL and TOP	NA	M		D		0.01	DCP/150	
		0.3	(SP-SM) SAND, with silt; grey; fine to medium 0.45-0.7m: becoming pale grey		ALV	L	M		D B D		0.45–0.5 0.6 0.7		
	6	0.7	(SP-SM) SAND, with silt, trace clay; brown orange; fine to medium		ALV	L TO MD	M		D		1.5		
		1.7	(SP) SAND, trace silt; yellow orange; fine to medium		ALV	NA	M						
	5	2.0	Borehole discontinued at 2.00m depth Limit of investigation						D		2.0		
	4	3									3		



NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 3T Excavator
METHOD: 300mm Auger
REMARKS: Coordinates obtained using a differential GPS unit typically accurate to ±0.1m

OPERATOR: Francis
CASING:

LOGGED: Chaplin

Refer to explanatory notes for symbol and abbreviation definitions

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: School Upgrades
LOCATION: Hunter River High School, 36 Elkin Ave, Heatherbrae

SURFACE LEVEL: 6.9 AHD
COORDINATE E:381291 **N:** 6372095
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 104
PROJECT No: 216008.00
DATE: 12/07/22
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	SAMPLE REMARKS	SAMPLE TYPE	SAMPLE DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
No free groundwater observed		0.0	FILL/TOPSOIL/ (SP-SM) SAND, with silt; dark brown; fine to medium; with rootlets		FILL and TOP	NA	M		D	0.01	DCP/150	
		0.25	(SP-SM) SAND, with silt; grey; fine to medium 0.5m: becoming pale grey		ALV	MD	M		D B D	0.5 0.6–0.8 1.0		
		1.2	(SP-SM) SAND, with silt, trace clay; brown orange; fine to medium		ALV	NA	W		D D	1.5 2.0		
		2.0	Borehole discontinued at 2.00m depth Limit of investigation									

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 3T Excavator
METHOD: 300mm Auger
REMARKS: Coordinates obtained using a differential GPS unit typically accurate to ±0.1m

OPERATOR: Francis
CASING:

LOGGED: Chaplin

Refer to explanatory notes for symbol and abbreviation definitions

Douglas Partners
Geotechnics / Environment / Groundwater

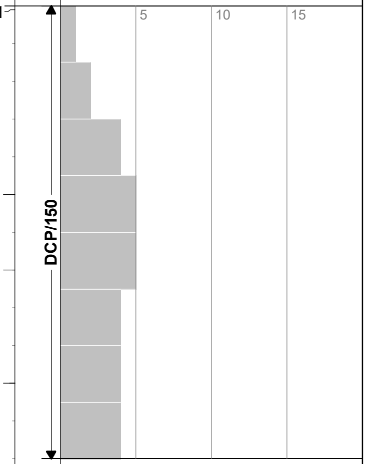
BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: School Upgrades
LOCATION: Hunter River High School, 36 Elkin Ave, Heatherbrae

SURFACE LEVEL: 6.8 AHD
COORDINATE E:381484 **N:** 6372139
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 105
PROJECT No: 216008.00
DATE: 12/07/22
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
No free groundwater observed		0.0	FILL/TOPSOIL/ (SC) Clayey Silty SAND; dark brown; fine to medium; with rootlets		FILL and TOP	NA	M		ASS		0.01	DCP/150	
		0.25	(SP-SM) SAND, with silt; pale grey; fine to medium 0.6-1.7m: becoming pale grey, pale brown 1.0-1.3m: trace iron oxide nodules 1.7-2.0m: yellow brown		ALV	MD	M		ASS ASS ASS ASS ASS		0.5 0.7 1.0 1.5 2.0		
		2.0	Borehole discontinued at 2.00m depth Limit of investigation										



RL (m) scale: 6, 5, 4, 3

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 3T Excavator
METHOD: 300mm Auger
OPERATOR: Francis
CASING:
LOGGED: Chaplin
REMARKS: Coordinates obtained using a differential GPS unit typically accurate to ±0.1m

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Refer to explanatory notes for symbol and abbreviation definitions

Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: School Upgrades
LOCATION: Hunter River High School, 36 Elkin Ave, Heatherbrae

SURFACE LEVEL: 7 AHD
COORDINATE E:381519 **N:** 6372164
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 106
PROJECT No: 216008.00
DATE: 12/07/22
SHEET: 1 of 1

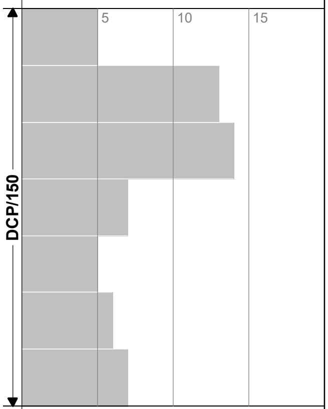
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	ORIGIN(#)	CONSIS.(*) / DENSITY(*)	MOISTURE
No free groundwater observed		0.04	FILL/ ASPHALTIC CONCRETE; black	FILL	NA	NA
		0.3	FILL/ (SC) Gravelly SAND, with clay; brown; sand fraction fine to coarse; gravel fraction fine to medium, sub-angular	FILL	NA	M
		0.34	FILL/ (SP-SM) SAND, with silt; dark brown; fine to medium	FILL	NA	M
		0.8	(SP-SM) SAND, with silt; pale brown; fine to medium	ALV	MD TO D	M
	6	1	(SP) SAND, trace silt; pale grey yellow; fine to medium 1.4m: trace roots 1.8m: pale yellow below	ALV	MD	M
	5	2				
	4	3.0	Borehole discontinued at 3.00m depth Limit of investigation			

SAMPLE

TYPE	DEPTH (m)
ASS	0.1
ASS	0.5
ASS	1.0
ASS	1.5
ASS	2.0
ASS	2.5
ASS	3.0

TESTING AND REMARKS

TEST TYPE	RESULTS AND REMARKS
DCP/150	0.5 m – 1.5 m



NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

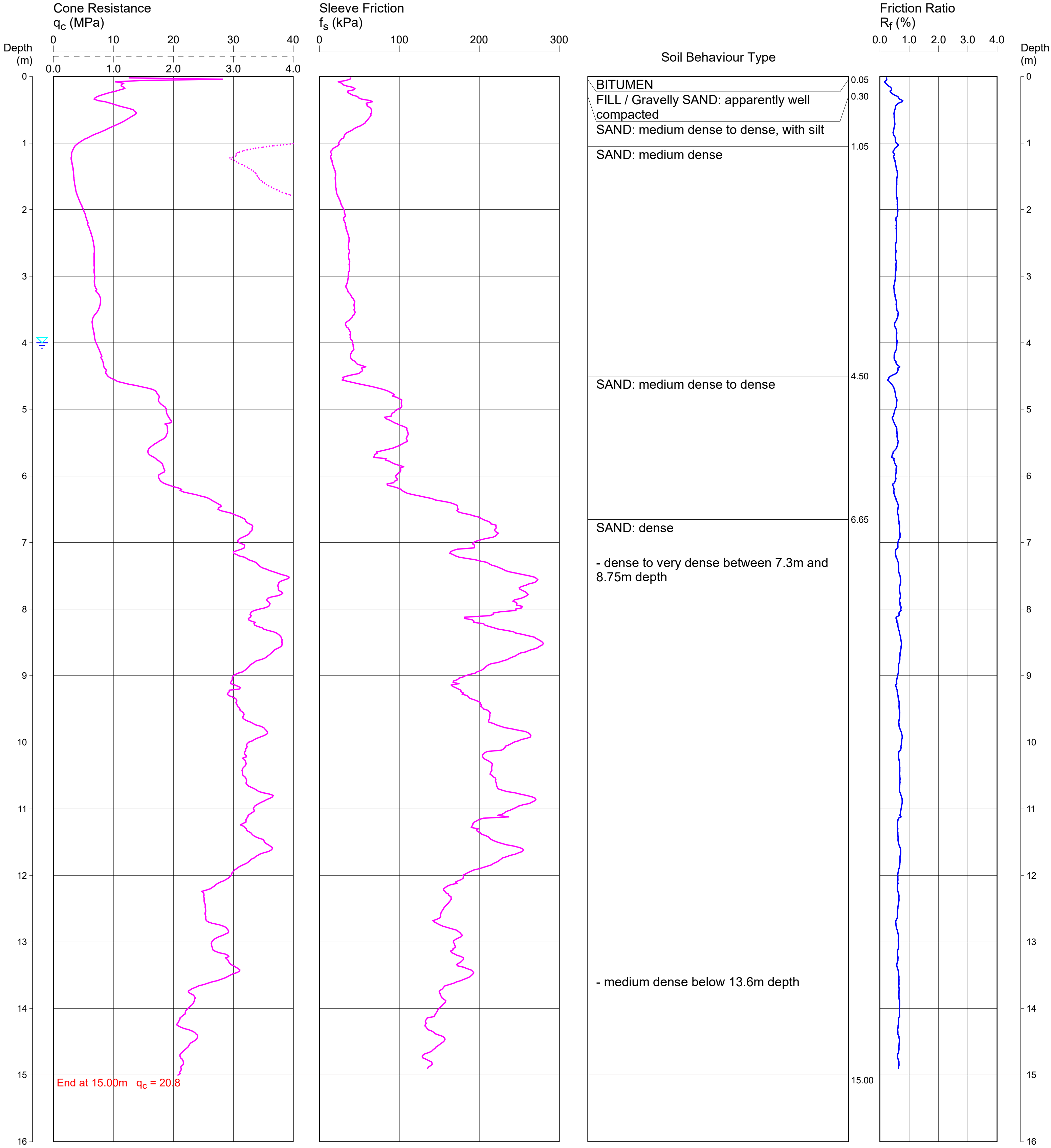
PLANT: 3T Excavator
METHOD: 300mm Auger
REMARKS: Coordinates obtained using a differential GPS unit typically accurate to ±0.1m

OPERATOR: Francis
CASING:

LOGGED: Chaplin

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION	**LOCATION:** HUNTER RIVER HIGH SCHOOL, 36 ELKIN AVENUE, HEATHERBRAE	**CPT106**
PROJECT: SCHOOL UPGRADES	**REDUCED LEVEL:** 7.0 AHD	Page 1 of 1
		DATE 12/07/2022
	COORDINATES: 381519E 6372164N MGA94 Zone 56	**PROJECT No:** 216008



REMARKS: TEST DISCONTINUED DUE TO TARGET DEPTH REACHED.
GROUNDWATER LEVEL MEASURED AT 4.0M AFTER WITHDRAWAL OF RODS.

Water depth after test: 4.00m depth (measured)

File: P:\216008.00 - HUNTER RIVER and IRRAWANG, High Schools\4.0 Field Work\4.2 Testing\CPT106.CP5
Cone ID: 170705 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

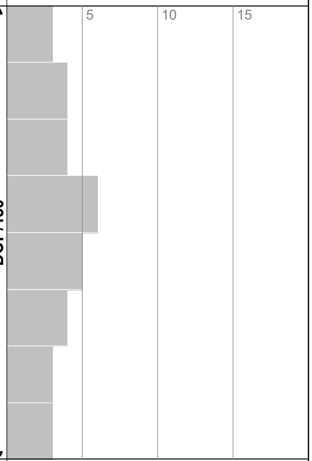
BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: School Upgrades
LOCATION: Hunter River High School, 36 Elkin Ave, Heatherbrae

SURFACE LEVEL: 6.7 AHD
COORDINATE E:381428 **N:** 6372083
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 107
PROJECT No: 216008.00
DATE: 12/07/22
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) ▩ DENSITY.(*) ▨	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
No free groundwater observed		0.0	FILL/ (SW-SM) SAND, with silt; dark brown; fine to coarse; with rootlets, black grey white medium to coarse sub-angular gravel sized ash inclusions		FILL	NA	M		ASS		0.1	DCP/150	
		0.2	(SP-SM) SAND, with silt, trace clay; brown orange; fine to medium		ALV	MD	M		ASS		0.5		
	6								ASS		1.0		
									ASS		1.5		
	5		1.8-2.0m: becoming yellow brown				W		ASS		2.0		
		2.0	Borehole discontinued at 2.00m depth Limit of investigation										
	4												
	3	3									3		



NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 3T Excavator
METHOD: 300mm Auger
REMARKS: Coordinates obtained using a differential GPS unit typically accurate to ±0.1m

OPERATOR: Francis
CASING:

LOGGED: Chaplin

Refer to explanatory notes for symbol and abbreviation definitions

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: SCHOOL UPGRADEs

LOCATION: HUNTER RIVER HIGH SCHOOL, 36 ELKIN AVENUE, HEATHERBRAE

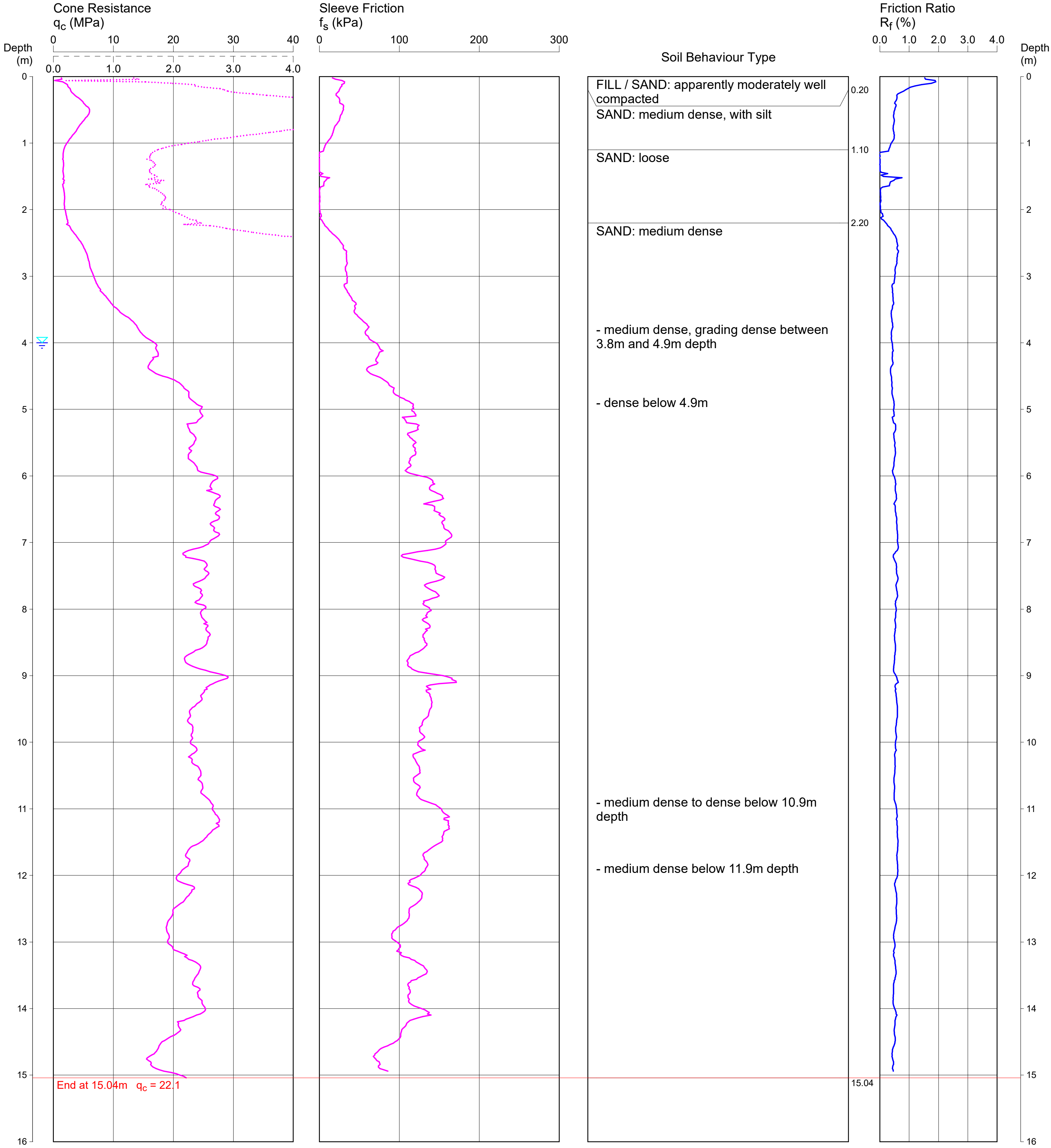
REDUCED LEVEL: 6.7 AHD

COORDINATES: 381428E 6372083N MGA94 Zone 56

CPT107

DATE 12/07/2022

PROJECT No: 216008



REMARKS: TEST DISCONTINUED DUE TO TARGET DEPTH REACHED.
HOLE COLLAPSED AT 6.0M AFTER WITHDRAWAL OF RODS.

Water depth after test: 4.00m depth (assumed)

File: P:\216008.00 - HUNTER RIVER and IRRAWANG, High Schools\4.0 Field Work\4.2 Testing\CPT107.CP5
Cone ID: 170705 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: SCHOOL UPGRADES

LOCATION: HUNTER RIVER HIGH SCHOOL, 36 ELKIN AVENUE, HEATHERBRAE

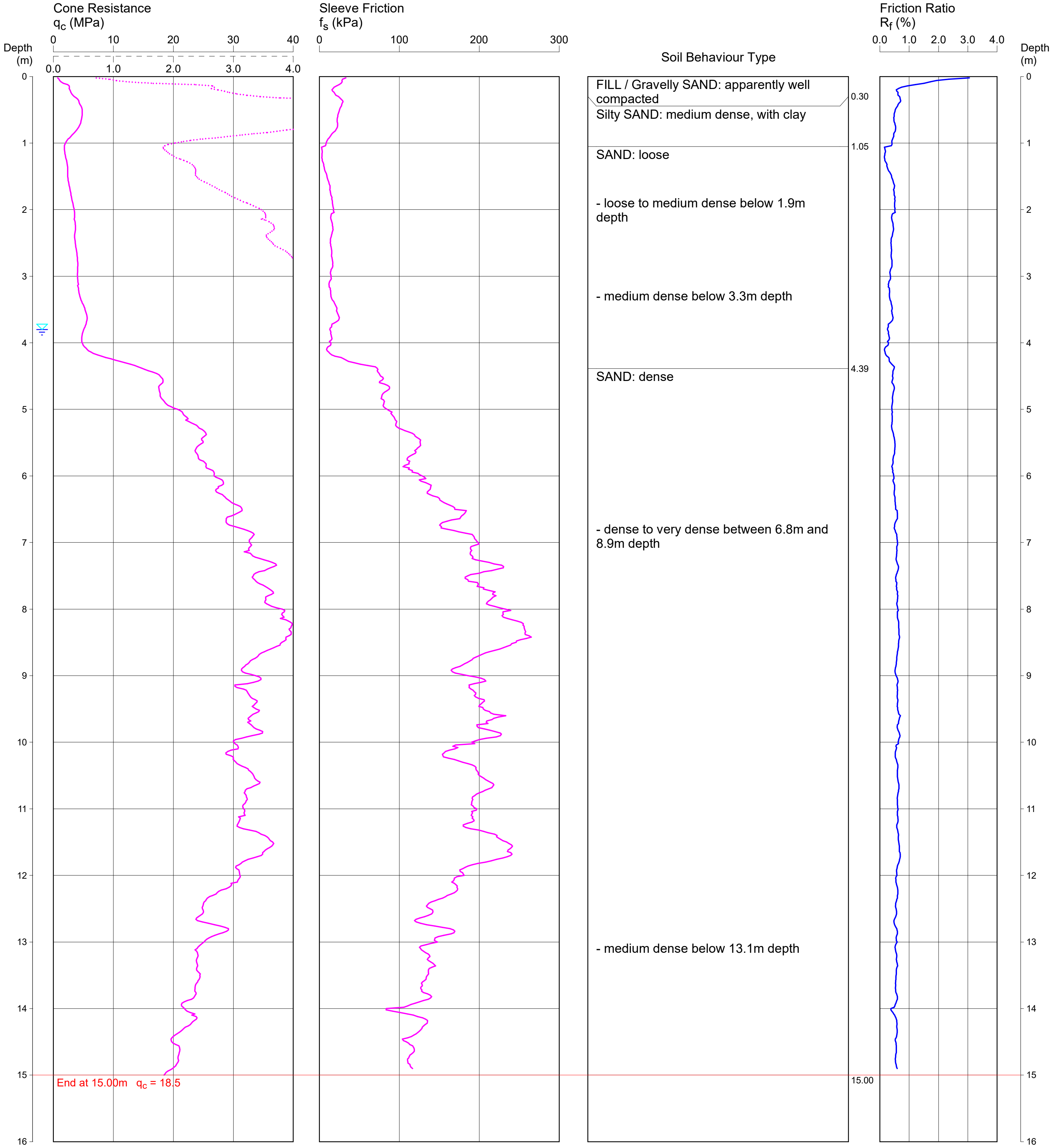
REDUCED LEVEL: 6.9 AHD

COORDINATES: 381481E 6372149N MGA94 Zone 56

CPT108

DATE 12/07/2022

PROJECT No: 216008



REMARKS: TEST DISCONTINUED DUE TO TARGET DEPTH REACHED.
GROUNDWATER OBSERVED AT 3.8M AFTER WITHDRAWAL OF RODS.

Water depth after test: 3.80m depth (measured)

File: P:\216008.00 - HUNTER RIVER and IRRAWANG, High Schools\4.0 Field Work\4.2 Testing\CPT108.CP5
Cone ID: 170705 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: SCHOOL UPGRADES

LOCATION: HUNTER RIVER HIGH SCHOOL, 36 ELKIN AVENUE, HEATHERBRAE

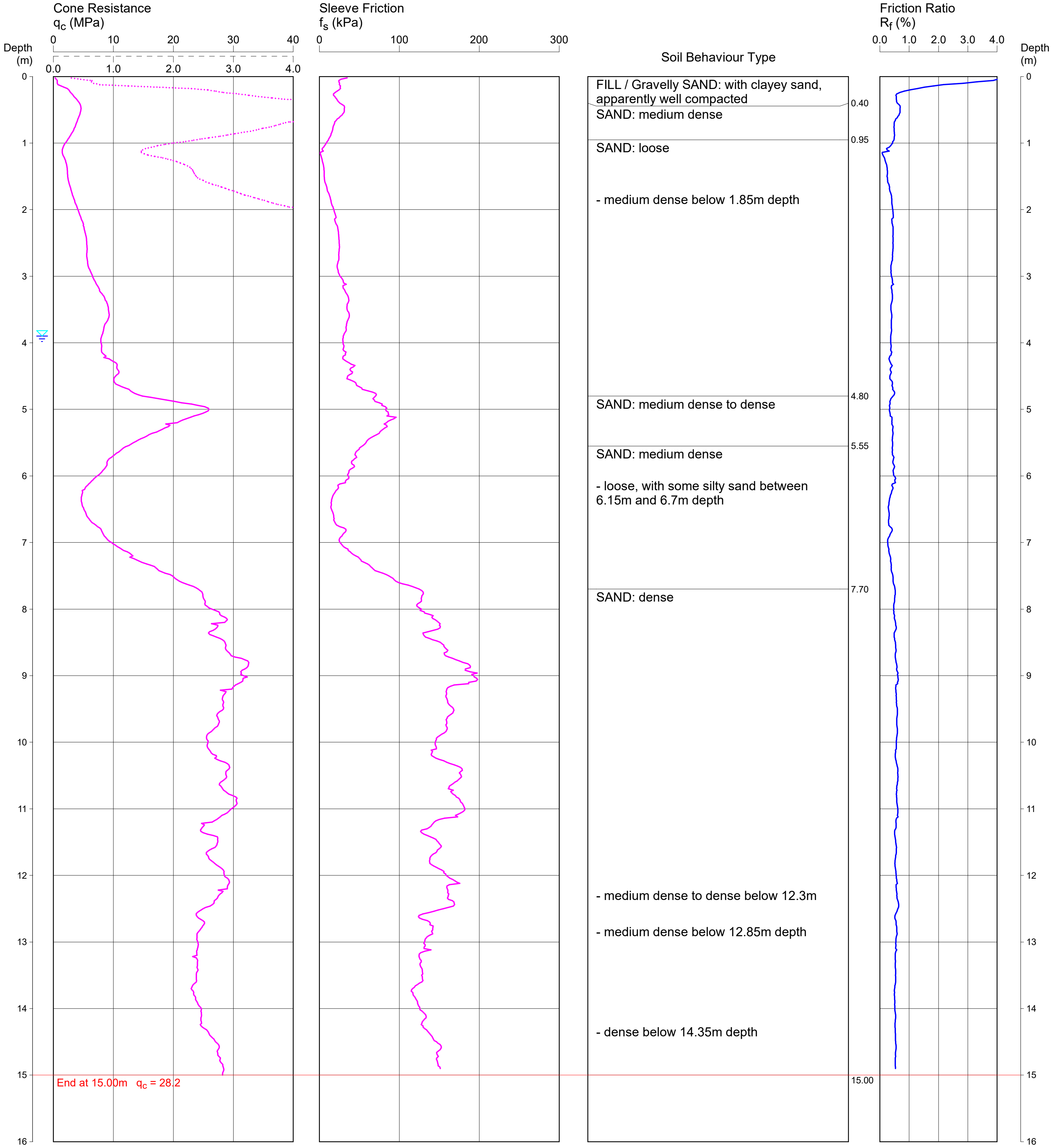
REDUCED LEVEL: 6.9 AHD

COORDINATES: 381464E 6372133N MGA94 Zone 56

CPT109

DATE 12/07/2022

PROJECT No: 216008



REMARKS: TEST DISCONTINUED DUE TO TARGET DEPTH REACHED.
GROUNDWATER LEVEL OBSERVED AT 3.9M AFTER WITHDRAWAL OF RODS.

Water depth after test: 3.90m depth (measured)

File: P:\216008.00 - HUNTER RIVER and IRRAWANG, High Schools\4.0 Field Work\4.2 Testing\CPT109.CP5

Cone ID: 170705 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: SCHOOL UPGRADES

LOCATION: HUNTER RIVER HIGH SCHOOL, 36 ELKIN AVENUE, HEATHERBRAE

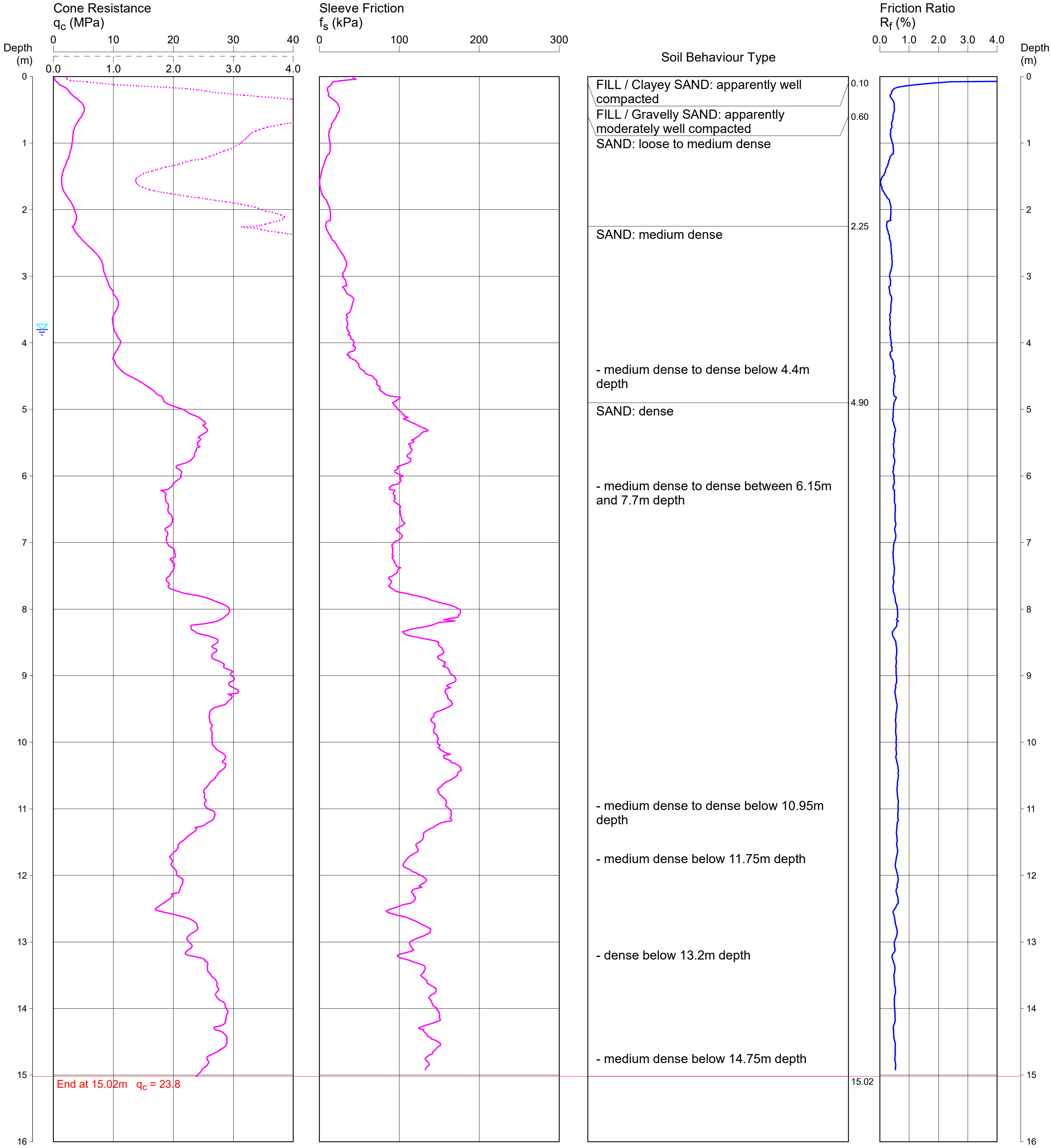
REDUCED LEVEL: 6.9 AHD

COORDINATES: 381444E 6372106N MGA94 Zone 56

CPT110

DATE 12/07/2022

PROJECT No: 216008



REMARKS: TEST DISCONTINUED DUE TO TARGET DEPTH REACHED.
GROUNDWATER LEVEL OBSERVED AT 3.8M AFTER WITHDRAWAL OF RODS.

Water depth after test: 3.80m depth (measured)

File: P:\216008.00 - HUNTER RIVER and IRRAWANG, High Schools\4.0 Field Work\4.2 Testing\CPT110.CP5
Cone ID: 170705 **Type:** I-CFXY-10

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: SCHOOL UPGRADES

LOCATION: HUNTER RIVER HIGH SCHOOL, 36 ELKIN AVENUE, HEATHERBRAE

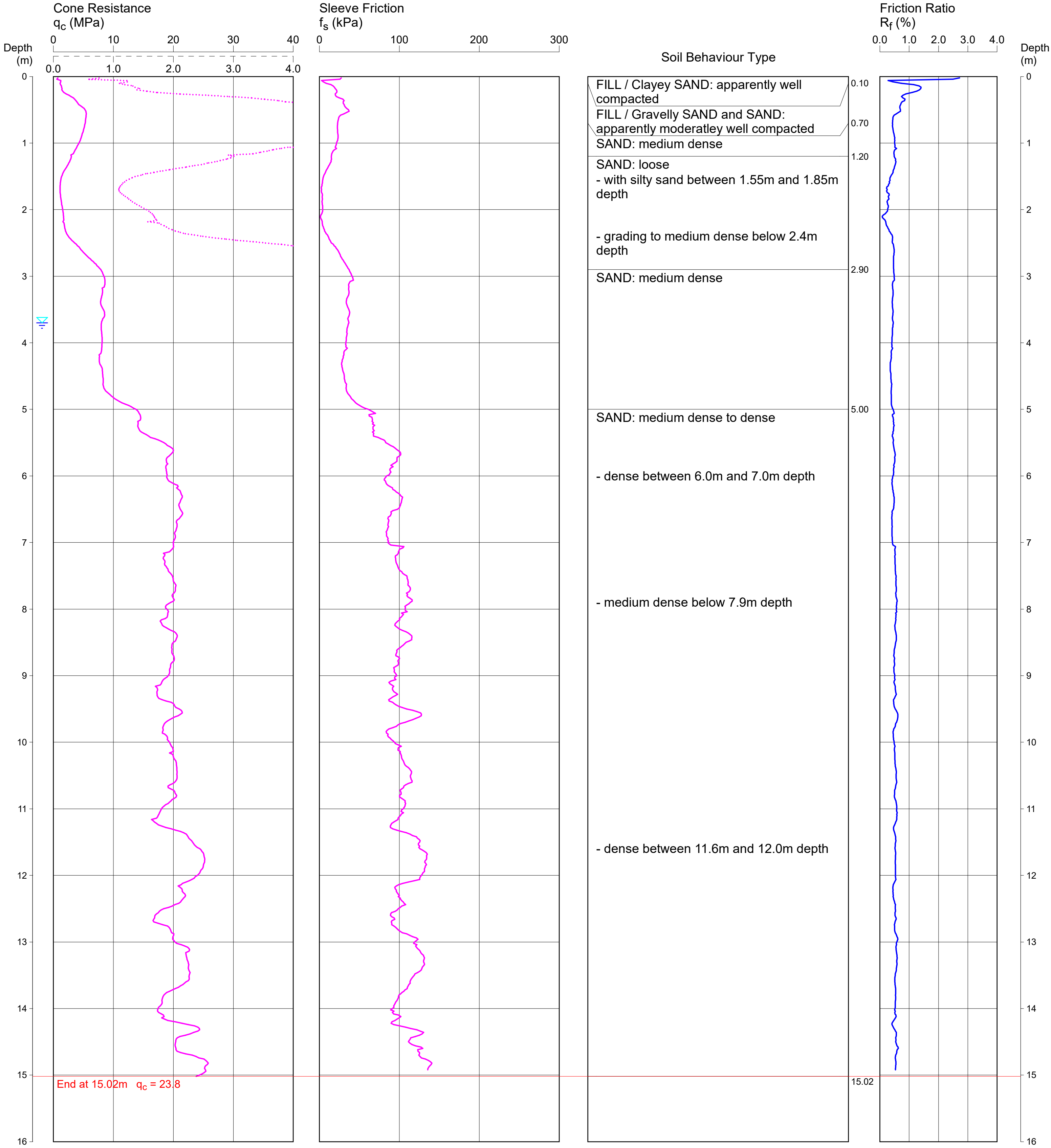
REDUCED LEVEL: 6.9 AHD

COORDINATES: 381416E 6372072N MGA94 Zone 56

CPT111

DATE 12/07/2022

PROJECT No: 216008



REMARKS: TEST DISCONTINUED DUE TO TARGET DEPTH REACHED.
GROUNDWATER LEVEL OBSERVED AT 3.7M AFTER WITHDRAWAL OF RODS.

Water depth after test: 3.70m depth (measured)

File: P:\216008.00 - HUNTER RIVER and IRRAWANG, High Schools\4.0 Field Work\4.2 Testing\CPT111.CP5
Cone ID: 170705 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
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Appendix C

Laboratory Test Results

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
Newcastle Laboratory
15 Callistemon Close Warabrook Newcastle NSW 2310
Phone: (02) 4960 9600
Email: dan.byrnes@douglaspartners.com.au

ilac-MRA NATA

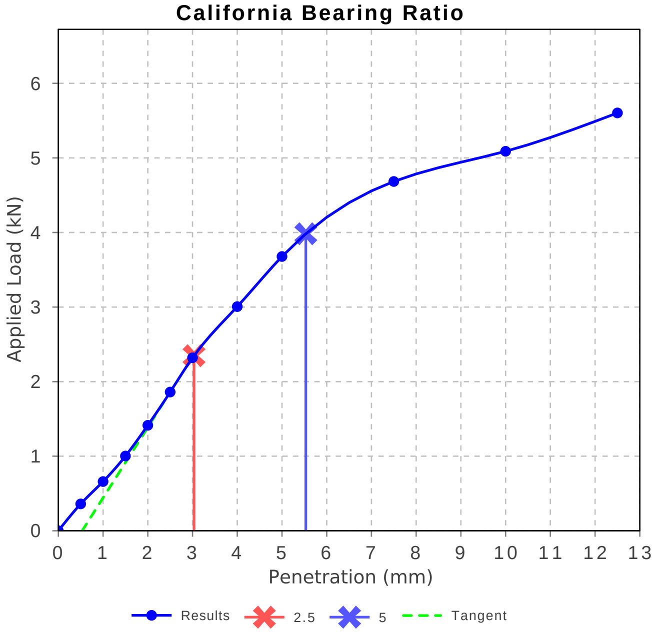
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Dan Byrnes
Technical Supervisor / Associate
Laboratory Accreditation Number: 828

Report Number:	**216008.00-1**
Issue Number:	1
Date Issued:	12/08/2022
Client:	NSW Department of Education Level 5 NSW, 2000, Sydney NSW 2000
Project Number:	216008.00
Project Name:	School Upgrades
Project Location:	36 Elkin Avenue and 80 Mount Hall Rd, Heatherbrae & Raymond Terrace NSW
Work Request:	8690
Sample Number:	NC-8690A
Date Sampled:	12/07/2022
Dates Tested:	26/07/2022 - 02/08/2022
Sampling Method:	Sampled by Douglas Partners *The results apply to the sample as received*
Sample Location:	**102, Depth: 0.5 - 0.7m**
Material:	Sand

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**20**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.67		
Optimum Moisture Content (%)	16.5		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	99.0		
Dry Density after Soaking (t/m^3)	1.67		
Field Moisture Content (%)	5.2		
Moisture Content at Placement (%)	16.5		
Moisture Content Top 30mm (%)	16.4		
Moisture Content Rest of Sample (%)	16.2		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	27.0		
Swell (%)	-0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		

California Bearing Ratio



Material Test Report

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Approved Signatory: Dan Byrnes
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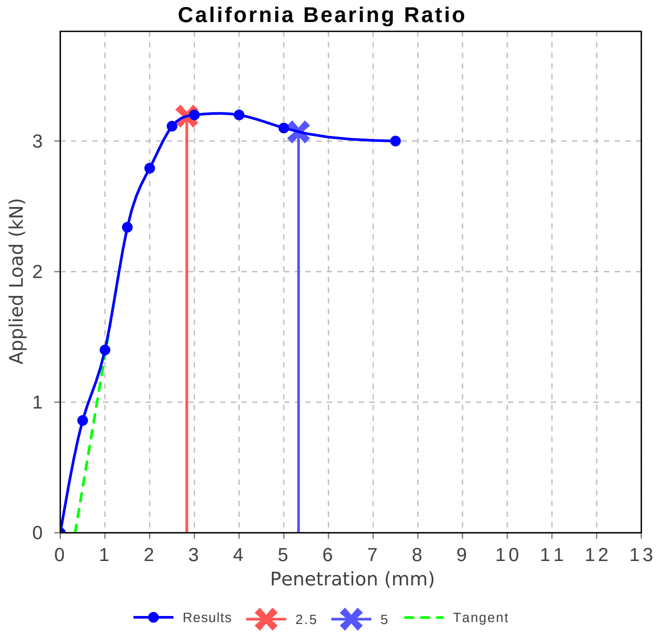
Report Number:	**216008.00-1**
Issue Number:	1
Date Issued:	12/08/2022
Client:	NSW Department of Education Level 5 NSW, 2000, Sydney NSW 2000
Project Number:	216008.00
Project Name:	School Upgrades
Project Location:	36 Elkin Avenue and 80 Mount Hall Rd, Heatherbrae & Raymond Terrace NSW
Work Request:	8690
Sample Number:	NC-8690B
Date Sampled:	12/07/2022
Dates Tested:	26/07/2022 - 02/08/2022
Sampling Method:	Sampled by Douglas Partners *The results apply to the sample as received*
Sample Location:	**104, Depth: 0.6 - 0.8m**
Material:	Sand

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**25**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.67		
Optimum Moisture Content (%)	15.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.67		
Field Moisture Content (%)	4.4		
Moisture Content at Placement (%)	15.1		
Moisture Content Top 30mm (%)	17.8		
Moisture Content Rest of Sample (%)	18.2		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	53.0		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		



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CERTIFICATE OF ANALYSIS 301292

Client Details

Client	Douglas Partners Newcastle
Attention	Kate Fulham
Address	Box 324 Hunter Region Mail Centre, Newcastle, NSW, 2310

Sample Details

Your Reference	**216008.00, Heatherbrae**
Number of Samples	21 Soil
Date samples received	25/07/2022
Date completed instructions received	25/07/2022

Analysis Details

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

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

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

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	27/07/2022
Date of Issue	27/07/2022

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Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Soil Aggressivity				
Our Reference		301292-1	301292-2	301292-3
Your Reference	UNITS	105	106	107
Depth		2.0	3.0	1.5
Date Sampled		12/07/2022	12/07/2022	12/07/2022
Type of sample		Soil	Soil	Soil
pH 1:5 soil:water	pH Units	6.5	5.9	5.8
Electrical Conductivity 1:5 soil:water	µS/cm	6	5	13
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	<10	20

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

QUALITY CONTROL: Soil Aggressivity					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	99	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	97	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	98	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	93	[NT]

Result Definitions

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

Quality Control Definitions

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

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

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

pH/EC
Samples were out of the recommended holding time for this analysis.

Appendix D

Drawing R.001.D.001 – Site and Test Location Plan

LOCALITY

Legend

Approximate Test Location and Number

- Borehole
- Cone Penetration Test
- Combined (Borehole & CPT)
- 2m Contour
- Approximate Lot Boundary

0 15 30 45 60 75 90 105 m

Notes:
1. Base image from Metromaps (dated 19 September 2021).
2. Locality image from WhereIS Maps.
3. Test locations are approximate only and are shown with reference to existing site features.

Douglas Partners
Geotechnics · Environment · Groundwater

CLIENT: NSW Department of Education		TITLE: Site and Test Location Plan School Upgrades Hunter River High School 36 Elkin Avenue, Heatherbrae	PROJECT No: 216008.00
OFFICE: Newcastle	DRAWN BY: KMF		DRAWING No: R.001.D.001
SCALE: 1:1500 @ A3	DATE: August 2022		REVISION: 0

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