



# **Douglas Partners**

*Geotechnics | Environment | Groundwater*

Report on  
Geotechnical Investigation

Narrabeen Education Precinct  
Namona Street, North Narrabeen

Prepared for  
NSW Department of Education  
c/- Johnstaff Pty Ltd

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**Integrated Practical Solutions**





# Douglas Partners

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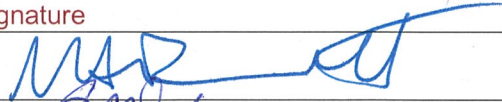
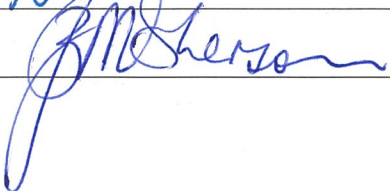
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# Report on Geotechnical Investigation

## Narrabeen Education Precinct

### Namona Street, North Narrabeen

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## 1. Introduction

This report presents the results of a geotechnical investigation undertaken for the proposed Narrabeen Education Precinct at Narrabeen North Primary School and Narrabeen Sports High School at Namona Street, North Narrabeen. The study was carried out under the Standard Form Agreement dated 16 October 2019 between NSW Department of Education and Douglas Partners Pty Ltd (DP) and undertaken in accordance with DP's proposal SYD190874 dated 3 September 2019.

It is understood that specific details of the proposed development have not been confirmed at this early stage of the project and that geotechnical assessment is required to inform the design and planning of the precinct masterplan. It is likely that the proposed development will include demolition and refurbishment of some existing buildings, and construction of new low to medium rise buildings. No basement levels are currently proposed.

The investigation included the drilling of boreholes, installation of groundwater monitoring wells, cone penetration testing (CPT) and laboratory testing of selected soil samples. Details of the field work are presented in this report, together with comments and recommendations relevant to design and construction.

A contamination assessment was undertaken in conjunction with the geotechnical investigation and is reported separately (DP Report 86973.01.R.001).

## 2. Previous Investigations

Previous geotechnical investigations and inspections undertaken by DP nearby and within the schools include:

- Northern Beaches Indoor Sports Centre, Pittwater Road, North Narrabeen (DP Project 28080.00, May 1999). Geotechnical investigation included five CPTs to depths of 12.5 - 15.0 m and collection of one sample for laboratory testing for California bearing ratio (CBR).
- Proposed Library and Homebase Building, Narrabeen North Public School (DP Project 71182.57-1, October 2009). Geotechnical investigation included four boreholes to depths of 0.9 - 7.5 m, two cone penetration tests (CPTs) to 15 m depth and dynamic cone penetrometer tests (DCPs) adjacent to the borehole locations, to depths of 2.2 - 2.7 m. Two samples underwent laboratory testing for aggressivity.
- Geotechnical inspections during construction of the Library and Homebase Building (DP Project 71693.00, March 2010) and expansion of the Northern Beaches Indoor Sports Centre (DP Project 85327.00, February 2016). The inspections comprised DCPs and geotechnical assessment for pad footings and piled foundations.

- Geotechnical investigation for a proposed development at 1416 Pittwater Road, North Narrabeen (DP Project 84593.00, January 2015). The investigation included four cone penetration tests to depths of 9.4 - 12.0 m, one borehole to 1.0 m and laboratory testing of samples for aggressivity of the sampled soil to buried steel and concrete elements.

The investigations generally encountered some granular fill near to the ground surface, overlying sand, silty sand and clayey sand to depths of about 10 m, overlying clay and silty clay. Boreholes and CPTs indicated that the sand was typically very loose to loose, becoming medium dense below 3 - 7 m. Some clay, silty clay and interbedded sand and clay were generally present below 10 m to termination depths of up to 15 m. The clays encountered were generally of a firm to very stiff consistency. Possible bedrock was encountered in one CPT at approximately 9 m depth to the east of the schools, however, no other previous tests indicated rock.

Groundwater measurements within boreholes and CPTs indicated a groundwater table at depths of between 1.8 m and 3.2 m below ground level, which was equivalent to groundwater levels at RL 0.7 m to RL 1.6 m relative to Australian Height Datum (AHD).

### **3. Site Description**

Narrabeen North Primary School (NNPS) is located on the northern side of Namona Street, North Narrabeen and is surrounded by residential dwellings to the east, grassed sporting fields to the north and Northern Beaches Sports Centre to the west. Narrabeen Sports High School (NSHS) is located on the southern side of Namona Street and is surrounded by Pittwater Road to the east, Pittwater Sports Centre to the south and Mullet Creek to the west. NNPS and NSHS are depicted as Lot 3 in Deposited Plan (DP) 1018621 and Lot 12 in DP 1119562, respectively.

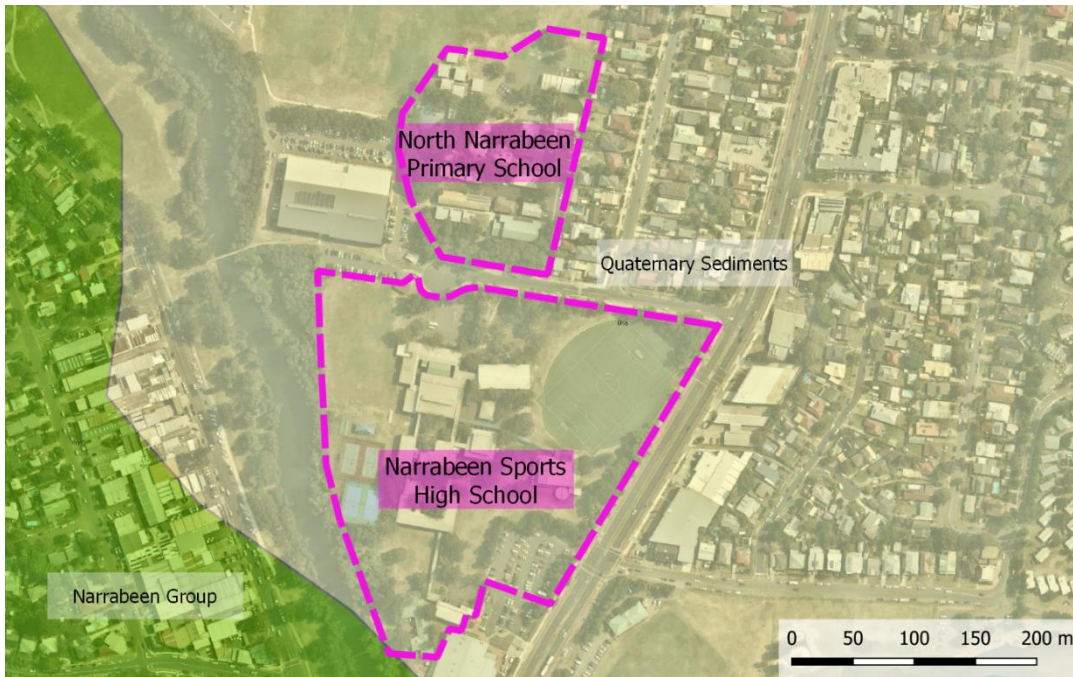
Both school sites are currently occupied by low to medium rise classrooms and hall buildings, playing fields and grassed areas, hard surface open space, landscaped areas with small retaining walls and car parking.

The ground surface across the sites are flat to gently undulating, with levels typically ranging between about RL 3 m and RL 5 m AHD.

### **4. Site Geology and Mapping**

#### **4.1 Geology and Mapping**

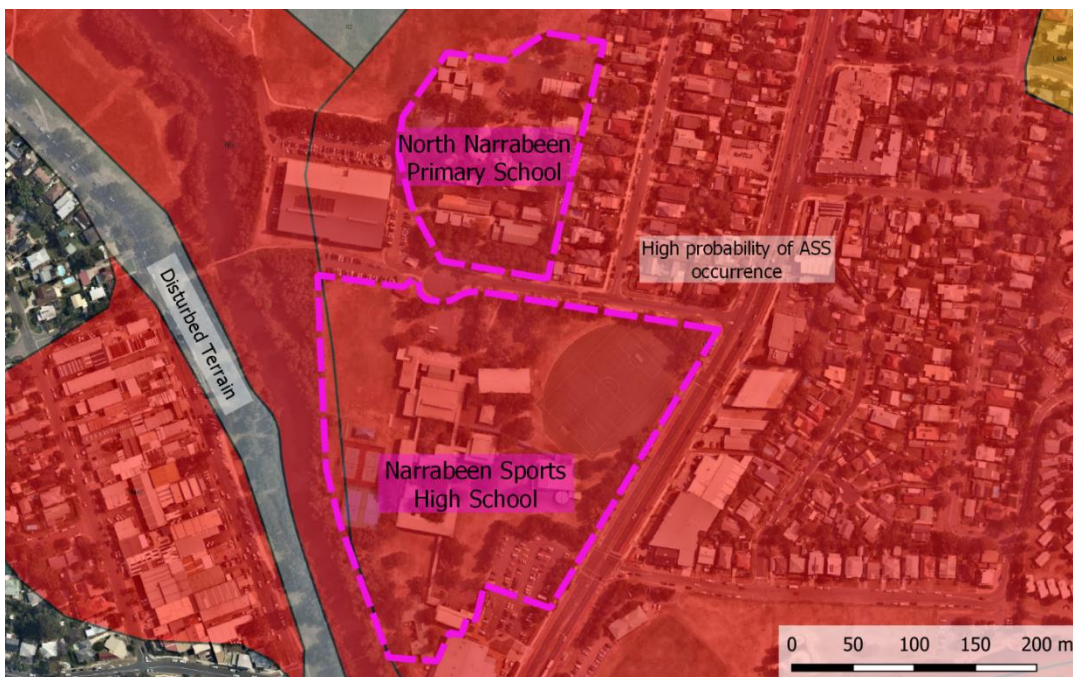
Reference to the Sydney 1:100 000 Geological Series indicates that the sites are in an area underlain by Quaternary Period stream alluvial and estuarine sediments. These sediments comprise silty to peaty quartz sand, silt and clay, ferruginous and humic cementation in places, and common shell layers. The mapping indicates that the area to south-west of the sites is underlain by the Narrabeen Group of the Triassic Period, which comprises interbedded laminite, shale and quartz, to lithic quartz sandstone. An excerpt from the Sydney 1:100 000 Geological Series Sheet 9130 is shown in Figure 1.



**Figure 1: Excerpt from Sydney 1:100 000 Geology Series Sheet 9130**

Reference to the Sydney 1:100 000 Soil Landscape Series Sheet indicates that the sites are in an area underlain by disturbed terrain (i.e. reclaimed areas and 'man-made' fill).

Reference to the 1:25 000 Acid Sulphate Soils (ASS) Risk map indicates that the sites are located within an area of high probability of occurrence of ASS below 1 - 3 m depth. An excerpt from the ASS Risk map is shown in Figure 2.



**Figure 2: Excerpt from Sydney 1:25 000 Acid Sulphate Soils (ASS) Risk Map**

## 4.2 Hydrogeology

Based on the proximity to the ocean, it is expected that the regional groundwater table would be at approximately sea level or slightly higher due to normal phreatic rise on land adjacent to the ocean or waterways.

## 5. Field Work Methods

The field work for the current investigation included the following:

- 20 cone penetration tests (CPT1 to CPT11 and CPT101 to CPT109) to depths of between 8.1 m and 30.5 m, where the CPTs were terminated due to cone refusal or reaching a target depth.
- Drilling of 27 boreholes (BH01, BH03 to BH13, BH102 to BH114, BH116 and BH117) using a small truck-mounted drilling rig and hand tools to depths of between 1.5 m and 8.0 m. Drilling was undertaken using push tube methods and 110 mm diameter solid flight augers. BH110 was drilled using hand tools due to access constraints. Due to hole collapse beneath the water table, BH104 and BH111 were extended using rotary wash boring techniques with biodegradable drilling mud to support the open borehole.
- Installation, development and measurement of groundwater monitoring wells at six borehole locations (BH04, BH06, BH10, BH104, BH106 and BH111).
- Supervision of the drilling and logging of the boreholes by an experienced engineer.

Coordinates and surface levels for all borehole and CPT locations were determined using a differential Global Positioning System (dGPS) receiver, which has a specified accuracy of 0.1 m. Coordinates are in GDA94/MGA Zone 56 format (Geocentric Datum of Australia 1994 base with Map Grid of Australia projection) and levels are relative to AHD. The test locations are shown on Drawing 1 in Appendix B.

## 6. Field Work Results

The subsurface conditions encountered at the boreholes are shown on the engineering logs in Appendix C, together with notes defining descriptive terms and classification methods used, and the CPT results (i.e. plots). The inferred soil stratification based on the measured friction ratio is shown on the respective CPT results sheets.

The general subsurface profile encountered (and inferred) at the borehole and CPT locations may be summarised as follows:

- **PAVEMENT:** asphaltic concrete, roadbase and concrete from the surface at CPT1/BH01, CPT2, CPT6/BH06 to CPT8/BH08, CPT11/BH11, BH12, CPT103/BH103 and BH113 to depths of between 0.03 m to 0.25 m; or,
- **TOPSOIL FILL:** typically comprising silty sand with minor inclusions of rootlets, gravel, clay, shells, plastic and ash was present in areas where there was no pavement. Topsoil fill was encountered from the surface at CPT3/BH03 to CPT5/BH05, CPT10/BH10, CPT104/BH104 to



CPT106/BH106, CPT108/BH108, CPT109/BH109 and BH112 to depths of between 0.1 m and 0.3 m; overlying,

- **FILL:** sand, gravelly sand, silty sand, clayey sand, silty clay, sandy clay and gravelly clay with varying proportions on igneous, sandstone and ironstone gravels, silt and rootlets, encountered in all boreholes. Ash, charcoal, plastic, concrete glass, cobbles, shells, brick, clinker, building rubble and a fibre cement sheet were also observed in some of the fill. The fill appeared typically moderately compacted, generally equivalent to loose to medium dense for the granular fill and stiff for the clayey fill, with some looser and some denser occurrences also encountered. Fill was observed to depths of between 0.2 m and 1.7 m across the school grounds, and to 2.6 m to 3.5 m at the mound at the northern end of NSHS (BH114, BH116 and BH117). BH112 and BH114 were terminated in fill as the drilling rig was unable to penetrate buried obstructions (e.g. cobbles, rubble); overlying,
- **SAND:** fine, medium and coarse grained sand encountered in all boreholes and CPTs to depths of between 4.4 m to 13.1 m. The sand was typically initially loose to medium dense, with some variability, in the upper portion of the sand layer to depths of between 1.7 m to 6.8 m. The sand then graded to medium dense or denser sand with depth in all CPTs. Thin layers of sandy clay and silty clay were intersected within the sand profiles in CPT4, CPT102 and CPT107. All boreholes (except BH112 and BH114) were terminated in sand; overlying,
- **CLAY & SAND:** clay, silty clay, silty sand and interbedded sand and clay were encountered in all CPTs. The consistency of the clay generally ranged from only firm to stiff in the upper 3 m to 5 m of the layer, with sand consistency typically loose to medium dense. It is noted that some softer and some harder/denser layers were present within the upper portion of the clay and sand layer. The lower portion of the clay and sand layer typically comprises stiff to hard clay and medium dense to very dense sand. CPT3 to CPT7, CPT9 to CPT11 and CPT103 were terminated within the clay and sand.
- **INFERRED WEATHERED ROCK:** encountered at the bases of CPT1, CPT2, CPT4, CPT8, CPT101, CPT102 and CPT104 to CPT109.

Tables 1A, 1B and 1C summarise the levels at which different materials were encountered in the CPTs and boreholes, overleaf.

**Table 1A: Summary of Inferred Material Strata Levels**

Stratum	Depth (m) [RL (m, AHD)] of Top of Stratum									
	CPT1/ BH01	CPT2	CPT3/ BH03	CPT4/ BH04	CPT5/ BH05	CPT6/ BH06	CPT7/ BH07	CPT8/ BH08	CPT9/ BH09	CPT10/ BH10
Ground Surface	[4.3]	[4.5]	[4.5]	[2.9]	[4.7]	[4.7]	[4.3]	[4.2]	[4.2]	[3.8]
Fill	0.05 [4.25]	0.06 [4.44]	0.1 [4.4]	0.1 [2.8]	0.15 [4.55]	0.03 [4.67]	0.05 [4.25]	0.05 [4.15]	0.0 [4.2]	0.2 [3.6]
Sand (variable consistency)	0.6 [3.7]	0.5 [4.0]	0.8 [3.7]	0.3 [2.6]	0.8 [3.9]	0.2 [4.5]	0.7 [3.6]	0.9 [3.3]	0.7 [3.5]	0.4 [3.5]
Sand (medium dense or denser)	5.0 [-0.7]	4.6 [-0.1]	4.9 [-0.4]	5.2 [-2.3]	2.3 [2.4]	2.2 [2.5]	1.9 [2.5]	6.6 [-2.4]	3.2 [1.1]	5.1 [-1.3]
Clay & Sand	8.9 [-4.6]	10.7 [-6.2]	10.5 [-6.0]	8.6 [-5.7]	10.6 [-5.9]	11.2 [-6.5]	11.0 [-6.7]	10.6 [-6.4]	10.9 [-6.7]	10.5 [-6.7]
Inferred Weathered Rock	24.4 [-20.1]	24.9 [-20.4]	NE	27.2 [-24.3]	NE	NE	NE	NE	NE	NE
Base of CPT/Borehole*	24.8 [-20.5]	25.5 [-21.0]	25.4 [-20.9]	28.1 [-25.2]	25.0 [-20.3]	25.0 [-20.3]	25.0 [-20.7]	17.0 [-12.8]	25.0 [-20.8]	25.0 [-21.2]

Notes: \*whichever was deeper; NE = not encountered

**Table 1B: Summary of Inferred Material Strata Levels**

Stratum	Depth (m) [RL (m, AHD)] of Top of Stratum									
	CPT11/ BH11	BH12	BH13	CPT101	CPT102/ BH102	CPT103/ BH103	CPT104/ BH104	CPT105/ BH105	CPT106/ BH106	CPT107/ BH107
Ground Surface	[4.2]	[4.4]	[4.0]	[2.1]	[2.1]	[1.9]	[2.3]	[2.1]	[2.1]	[2.0]
Fill	0.25 [3.95]	0.03 [4.37]	0.0 [4.0]	0.0 [2.1]	0.0 [2.1]	0.12 [1.78]	0.2 [2.1]	0.2 [1.9]	0.15 [1.95]	0.0 [2.0]
Sand (variable consistency)	1.3 [2.9]	0.2 [4.2]	0.8 [3.2]	0.5 [1.6]	1.0 [1.1]	0.4 [1.5]	1.4 [0.9]	1.4 [0.7]	1.5 [0.6]	NE
Sand (medium dense or denser)	6.8 [-2.6]	NE	NE	4.5 [-2.4]	2.9 [-0.8]	6.1 [-4.2]	2.7 [-0.4]	4.3 [-2.2]	2.5 [-0.4]	1.7 [0.3]
Clay & Sand	10.7 [-6.5]	NE	NE	9.8 [-7.7]	4.4 [-2.3]	14.0 [-12.1]	13.1 [-10.8]	8.3 [-6.2]	6.4 [-4.3]	9.4 [-7.4]
Inferred Weathered Rock	NE	NE	NE	24.4 [-22.3]	8.0 [-5.9]	NE	18.6 [-16.3]	19.3 [-17.2]	26.0 [-23.9]	23.7 [-21.7]
Base of CPT/Borehole*	30.5 [-26.3]	1.5 [2.9]	2.5 [1.5]	24.9 [-22.8]	8.1 [-6.0]	24.3 [-22.4]	18.7 [-16.4]	19.4 [-17.3]	27.0 [-24.9]	23.8 [-21.8]

Notes: \*whichever was deeper; NE = not encountered

**Table 1C: Summary of Inferred Material Strata Levels**

Stratum	Depth (m) [RL (m, AHD)] of Top of Stratum								
	CPT108/ BH108	CPT109/ BH109	BH110	BH111	BH112	BH113	BH114	BH116	BH117
Ground Surface	[2.1]	[2.2]	[2.2]	[2.1]	[2.1]	[2.1]	[2.3]	[5.0]	[4.5]
Fill	0.3 [1.8]	0.2 [2.0]	0.0 [2.2]	0.0 [2.1]	0.3 [1.8]	0.13 [1.97]	0.0 [2.3]	0.0 [5.0]	0.0 [4.5]
Sand (variable consistency)	1.2 [0.9]	1.6 [0.7]	0.4 [1.9]	1.7 [0.4]	NE	0.9 [1.3]	NE	3.5 [1.5]	2.7 [1.8]
Sand (medium dense or denser)	2.5 [-0.4]	3.9 [-1.7]	NE	NE	NE	NE	NE	NE	NE
Clay & Sand	12.0 [-9.9]	9.6 [-7.4]	NE	NE	NE	NE	NE	NE	NE
Inferred Weathered Rock	24.0 [-21.9]	23.1 [-20.9]	NE	NE	NE	NE	NE	NE	NE
Base of CPT/Borehole*	25.0 [-22.9]	23.5 [-21.3]	1.5 [0.7]	8.0 [-5.9]	0.6 [1.5]	2.5 [-0.4]	2.6 [-0.3]	4.5 [0.5]	4.0 [0.5]

Notes: \*whichever was deeper; NE = not encountered

Groundwater was intersected during drilling at some boreholes, measured in some of the CPT holes (after withdrawal of the rods) and measurements were made within the groundwater monitoring wells on 23 January 2020. The groundwater observations are summarised in Table 2. Free groundwater was not observed during drilling of the boreholes that are not included in Table 2, and hole collapse following CPT rod removal prevented groundwater measurements in the CPTs that are not included in Table 2, overleaf.

**Table 2: Groundwater Level Observations (Depth, m and [RL, m AHD])**

<b>Borehole/CPT</b>	<b>Observed during drilling/after CPT</b>	<b>Observed in Monitoring Well (23 January 2020)</b>
BH04	2.0 [0.9]	2.1 [0.8]
BH06	4.0 [0.7]	4.1 [0.6]
BH09	3.3 [0.9]	-
BH10	3.1 [0.7]	3.1 [0.7]
BH102	1.3 [0.8]	-
BH103	1.5 [0.4]	-
BH104	1.6 [0.7]	1.7 [0.6]
BH105	1.6 [0.6]	-
BH106	1.5 [0.6]	1.5 [0.6]
BH107	1.5 [0.5]	-
BH108	1.5 [0.6]	-
BH109	1.5 [0.8]	-
BH111	1.5 [0.6]	1.5 [0.6]
BH113	1.8 [0.5]	-
BH116	4.5 [0.5]	-
BH117	3.5 [1.0]	-
CPT1	3.8 [0.5]	-
CPT4	2.2 [0.7]	-
CPT6	4.0 [0.7]	-
CPT9	3.4 [0.8]	-
CPT108	1.7 [0.4]	-

## 7. Laboratory Testing

Ten (10) soil samples were sent to a NATA accredited analytical laboratory and were analysed to assess the exposure classification to steel and concrete below ground, and for assessment of soil salinity. The results are summarised in Table 3 and the detailed results are included in Appendix D.

Soil salinity values (EC<sub>e</sub>) have been calculated using the methods of the "Site Investigations for Urban Salinity" booklet, prepared by the Department of Land and Water Conservation (DLWC, 2002). The soil samples were all classified as "Sands" as per soil textural classification methods, with multiplication factors (M) of 17. Calculated soil salinities (EC<sub>e</sub> = M x EC<sub>1:5</sub>) are shown in Table 3, overleaf.



**Table 3: Analytical Results for Aggressivity and Salinity in Soil**

Sample/Depth (m)	Description	pH	EC (µS/cm)	Cl <sup>-</sup> (mg/kg)	SO <sub>4</sub> <sup>2-</sup> (mg/kg)	ECe (dS/m)	Aggressivity / Salinity Class
BH4/0.9-1.0	SAND	8.0	8	<10	<10	0.1	Mild to Concrete Non-aggressive to Steel Non-Saline
BH4/2.4-2.5	Silty SAND	6.8	20	<10	<10	0.3	Mild to Concrete Non-aggressive to Steel Non-Saline
BH4/4.5-5.0	Silty SAND	6.2	42	<10	25	0.7	Mild to Concrete Non-aggressive to Steel Non-Saline
BH9/0.4-0.5	FILL/Silty SAND	4.1	52	<10	<10	0.9	Severe to Concrete Mild to Steel Non-Saline
BH9/4.5-5.0	Silty SAND	5.7	17	<10	<10	0.3	Mild to Concrete Non-aggressive to Steel Non-Saline
BH104/0.4-0.5	FILL/SAND	8.7	79	<10	<10	1.3	Mild to Concrete Non-aggressive to Steel Non-Saline
BH104/2.4-2.5	SAND	8.1	26	<10	10	0.4	Mild to Concrete Non-aggressive to Steel Non-Saline
BH104/5.5-6.0	SAND	9.1	97	<10	40	1.6	Mild to Concrete Non-aggressive to Steel Non-Saline
BH111/1.4-1.5	FILL/SAND	8.7	77	<10	<10	1.3	Mild to Concrete Non-aggressive to Steel Non-Saline
BH111/4.0-4.5	SAND	9.1	130	<10	65	2.2	Mild to Concrete Non-aggressive to Steel Slightly Saline

Notes: EC = electrical conductivity; Cl<sup>-</sup> = chloride ion; SO<sub>4</sub><sup>2-</sup> = sulphate ion; samples mixed with 1:5 soil:water;

ECe = salinity value (calculated value); Aggressivity Classification per Tables 6.4.2(C) and 6.5.2(C) of AS 2159 – 2009; Salinity Class per DLWC (2002), using the criteria of Richards (1954)

Three samples were tested for California bearing ratio (CBR) and one sample for Atterberg limits and linear shrinkage. The results are summarised in Table 4 (overleaf) and the detailed laboratory test reports are included in Appendix D.

**Table 4: Results for Atterberg Limits in Soil**

Sample/Depth (m)	Description	CBR (%)	Swell (%)	MDD (t/m <sup>3</sup> )	OMC (%)	W <sub>P</sub> (%)	W <sub>L</sub> (%)	PI (%)	LS (%)
BH9/0.2-0.8	FILL/Silty SAND	17	0.0	1.59	17.0	-	-	-	-
BH11/0.6-1.0	FILL/ Silty SAND	18	-0.5	1.59	15.5	-	-	-	-
BH102/0.5-1.0	FILL/SAND	12	-0.5	1.63	10.0	-	-	-	-
BH106/0.9-1.0	FILL/Sandy CLAY	-	-	-	-	17	36	19	9.0

Notes: \*4-day soak, 4.5 kg surcharge, 100% Standard compaction; MDD = maximum dry density; OMC = optimum moisture content; W<sub>P</sub> = plastic limit; W<sub>L</sub> = liquid limit; PI = plasticity index; LS = linear shrinkage

## 8. Geotechnical Model

The site is underlain by variable depths of fill, typically granular and including some surficial topsoil fill and pavement materials. Alluvial and estuarine sands of variable consistency, grading to medium dense and denser with depth, underlie the fill across the site. Alluvial deposits of clay and sand with variable consistency are present beneath the alluvial and estuarine sediments and these underlying deposits are inferred to be of Pleistocene Epoch age. Weathered rock underlies the alluvial deposits, at variable and substantial depths.

Groundwater was measured at depths of 1.3 m to 4.5 m (RL 0.4 m to 1.0 m AHD) during the field work and within the monitoring wells. The groundwater table is expected to vary between approximately RL 0 m and 2.0 m AHD. Groundwater levels will fluctuate with weather, climactic conditions and to a lesser extent tidal influences and may temporarily rise following periods of prolonged rainfall or during spring tide highs. Groundwater levels may also be impacted by human activities such as dewatering.

The geotechnical model is illustrated in the Interpreted Geotechnical Cross-Sections A-A', B-B' and C-C' in Drawings 2 to 4, in Appendix B.

## 9. Comments

### 9.1 Proposed Development

It is understood that specific details of the proposed development have not been confirmed at this early stage of the project. It is likely that the proposed development will include demolition and refurbishment of some existing buildings, and construction of new low to medium rise buildings. Basement (i.e. below ground level) levels are not currently proposed.

## 9.2 Site Preparation

Any existing fill that is required to support structures and pavements will need to be reworked to reduce the potential for unacceptable settlements associated with poorly or variably compacted fill. New fill will also need to be placed in accordance with an engineering specification.

The following procedure is suggested during earthworks activities (subject to any requirements for remediation of contamination at the site):

- Strip organic-rich (e.g. root-affected) topsoil from areas in which new engineered fill, structures and/or pavements are proposed. A nominal depth of 200 mm would be appropriate but confirmation of this will need to be made on site at the commencement of construction;
- Excavate existing fill in areas in which new engineered fill, structures and/or pavements are proposed;
- Compact the exposed surface and proof-roll using a roller of 10 t deadweight (or equivalent) in the presence of a geotechnical engineer. Any areas exhibiting unacceptable movements during the proof-roll may require further rectification;
- Place fill in maximum 250 mm thick layers and compact to achieve a dry density ratio of between 98% and 102% relative to Standard compaction. The upper 0.5 m of pavement subgrade areas should be compacted to achieve a dry density ratio of between 100% and 102% relative to Standard compaction, with moisture contents maintained within 2% of Standard optimum moisture content. If the replacement fill is sand, compact to a density index of 75% to 80%;
- Moisture conditioning (i.e. drying or wetting) may be required for compaction of filling;
- Poor trafficability should be expected across unpaved areas of the sites. A layer of granular product (e.g. roadbase, recycled crushed concrete, etc.) should be considered as the top layer of fill to improve trafficability on site;
- Density testing should be undertaken in accordance with the requirements of AS 3798 – 2007 “Guidelines on earthworks for commercial and residential developments”.

Due the shallow groundwater table and depth of fill, the above approach of complete removal and replacement of fill would probably require dewatering in some areas and the placement of geo-fabric filter cloth and rock-fill material directly above the water table and softer soils. Complete removal and replacement of fill might not be a viable option for the project, although this approach would provide the least risk of unacceptable settlements in the fill.

An alternative to complete removal and replacement of the existing fill would be to compact the material in-situ using a combination of conventional plant and impact compaction techniques. In-situ compaction techniques are only considered appropriate for the situation where the main superstructure and walls are supported by piles with only pavements and floor slabs supported on-grade. Due to the uneven compaction levels expected for existing fill containing oversize rubble, impact compaction should not be used where raft slabs or other on-grade structures sensitive to subgrade stiffness are employed.

It is considered that where the existing depth of fill is less than 0.5 m thickness, conventional rolling plant of at least 10 tonne could be used to proof roll the fill surface (i.e. beneath topsoil) to detect any

soft or spongy areas that require replacement. Proof rolling should be observed by an experienced geotechnical professional.

Where existing fill depths exceed 0.5m, in-situ compaction will generally require impact compaction methods. Impact compaction is carried out with an irregular sided roller of at least 8 tonnes, propelled at relatively high speed to impart energy to greater depths than conventional rolling plant. Impact compaction is performed using a square or five-sided roller. Impact compaction is traditionally most effective in granular soils. DP experience is that granular material (e.g. sand) can be improved to depths of 3 m to 4 m, where above the water table. Where fill contains clayey and oversized material and, depths exceed 1.5m it may be necessary to reduce the remaining thickness of filling by carrying out some excavation.

The use of impact compaction techniques at this site would generally require a coordinated approach from the Contractor, the Geotechnical Engineer, the Structural Engineer and the Principal. A detailed proof testing programme of the finished ground surface, involving CPTs, plate load testing for the near surface modulus and proof rolling would be required, together with a detailed review of surface settlements induced by the impact compaction. The settlement criteria for the floor slab and pavement areas should be confirmed by the Structural Engineer. As a general guide, the impact compaction technique would need to achieve a uniform compaction of the in-situ fill to a density index of 75% to 80%.

Due to the rough surface left by impact compaction plant the upper 0.3 m should be scraped off and recompacted using conventional roller plant following the previously suggested procedure for earthworks activities.

Where impact compaction is employed, due consideration should be given to the effects of vibration on adjacent structures. To reduce the risk of damaging adjacent buildings, it would be normal practice to conduct vibration monitoring trials (refer to Section 9.4).

With regard to the areas of filled ground, it must be noted that there will always be a higher level of risk of unacceptable differential settlement occurring for structures supported by existing filling, compared with founding within competent natural stratum or engineered fill platforms. This relates to the inherent variability of the filling and associated variable stiffness of these materials. The CPTs indicated that the fill at the site is generally in a moderately compacted condition, although this could vary substantially across the site.

Due to the nature of the sand, it is suggested that a minimum 100 mm thick layer of DGB20 (FCR) be placed beneath all slabs and pavements to aid compaction (via confinement) of the underlying subgrade material and to provide a uniform surface for concrete placement.

From a geotechnical perspective, the existing predominantly sand fill is considered to be suitable for re-use as engineered fill, provided that it is free of oversize particles (>100 mm) and deleterious material. The suitability of re-using site-won fill and natural soil should also be considered from a contamination perspective.

### 9.3 Excavation Conditions

Excavations may be required for services trenches or other localised excavations relating to the development, which would be carried out through mostly fill and natural sands. These excavations should be readily achieved using conventional earthmoving equipment such as tracked excavators. If any excavations extend to near the groundwater levels, then it will be necessary to undertake local dewatering during excavation with appropriate trench shoring and/or battering of the sidewalls. Also, it is expected that soils below the groundwater table are acid sulphate soils (ASS) such that an appropriate management plan and controls will be required. Further comments on ASS are provided in the contamination assessment report, undertaken in conjunction with the geotechnical investigation.

Careful excavation near any existing buildings will be necessary to minimise ground movements and prevent damage to the buildings.

All excavated materials will need to be disposed of in accordance with the provisions of the current legislation and guidelines including the Waste Classification Guidelines (NSW EPA, 2014).

### 9.4 Ground Vibration

During construction, it will be necessary to use appropriate methods and equipment to keep ground vibrations at adjacent buildings and structures within acceptable limits. Based on previous experience and with reference to Australian Standard AS 2670.2-1990 "Evaluation of human exposure to whole-body vibrations – continuous and shock induced vibrations in buildings (1-80 Hz)", an initial or provisional vibration limit of 8 mm/sec vector sum peak particle velocity (VSPPV) at the foundation level of adjacent buildings for human comfort consideration is suggested. This vibration limit may need to be reduced if there are vibration-sensitive buildings (or equipment) in the area.

As the magnitude of vibration transmission is site specific, it is recommended that a vibration trial be undertaken at the commencement of piling/shoring construction and prior to earthworks (e.g. excavation and compaction/rolling). The trial may indicate that smaller or different types of piling and earthworks plant should be used.

### 9.5 Excavation Support

Vertical excavations within the fill and sand are not expected to be stable. Temporary batters of 1.5H:1V (Horizontal : Vertical) could be used to support the side of the excavations above the water table, for slopes up to 3 m high. Permanent batters for excavations and embankments should be no steeper than 2(H):1(V) and generally flatter where vegetation maintenance is required or in situations where structures or loading will be applied at the top/crest of the batter. Erosion protection should be provided for all permanent batters. Further advice should be sought if planning deep excavations.

Surcharge loads should be placed no closer to the crest of the batter than a distance equal to the vertical height of the batter, unless specific geotechnical stability analysis shows that the loads can be placed closer.

Retaining/shoring structures (if required) could be designed as anchored or propped walls subject to lateral earth pressures using the parameters in Table 5. It is suggested that preliminary design for

cantilevered or walls anchored or propped with a single row of anchors (or props) be based on a triangular distribution with the lateral earth pressure being determined as a proportion of the vertical stress as given in the following formula:

$$\sigma_z = K z \gamma, \quad \text{where } \sigma_z = \text{Horizontal pressure at depth } z \text{ (kPa)}$$

$$K = \text{Earth pressure coefficient}$$

$$z = \text{Depth (m)}$$

$$\gamma = \text{Unit weight of soil or rock (kN/m}^3\text{)}$$

**Table 5: Retaining Wall Design Parameters**

Material	Unit Weight (kN/m <sup>3</sup> )	Earth Pressure Coefficient		Coefficient of Passive Earth Pressure (K <sub>p</sub> )
		Active (K <sub>a</sub> )	At Rest (K <sub>0</sub> )	
Granular Fill / Sand	20	0.35	0.5	3.0

The 'At Rest' coefficient should be used where shoring walls are near to existing structures, to limit or reduce ground (and wall) movements. Sections of the wall where some small movement is allowable can be designed for the 'active' condition. Cantilever walls are not appropriate near to existing structures.

In addition to the loads resulting from soil pressures it will be necessary to incorporate hydrostatic loads due to the water table (potentially rising to the ground surface) and allow for any superimposed loads from adjoining structure and/or traffic.

Embedment of the wall can be used to achieve passive support. A triangular passive earth pressure distribution (increasing linearly with depth) could be assumed, starting from 0.5 m below excavation toe/base level. A suitable factor of safety should be incorporated when using the K<sub>p</sub> value shown above as this represents an ultimate, high strain/movement condition.

## 9.6 Foundations

### 9.6.1 Shallow Footings

The soils at the sites are predominantly granular (sand), which are not highly susceptible to shrink-swell movements in response to soil moisture variations. Due to the presence of fill across the site to depths greater than 0.8 m, a site classification of Class P in accordance with AS2870 – 2011 is appropriate. Footings should, therefore, be designed based on engineering principles.

For lightly loaded structures such as garden bed retaining walls up to 1 m high, light poles and security bollards, shallow strip or pad footings bearing in (natural) loose or medium dense sand, below the uncontrolled filling, may be feasible.

The allowable base bearing pressure for shallow footings on sand is dependent on the size and embedment depth of the footing, the density of the foundation material and the depth to groundwater. For example, a 0.5 m by 0.5 m pad footing or a 0.5 m wide strip footing, embedded 0.5 m deep in loose or medium dense sand, with a water table at least twice the footing width below the base of the

footing, may be designed for a maximum allowable bearing pressure of 100 kPa (loose sand) or 150 kPa (medium dense sand). Bearing pressures will reduce where the base of the footings approach the water table depth.

The amount of settlement for shallow footings founded in sand depends upon the load conditions, footing size and foundation material. The expected settlements for pad footings 0.5 m by 0.5 m and 0.5 m deep founded in loose or medium dense sand with bearing pressures of 100 kPa and 150 kPa, respectively, would be in the order of 5 mm to 10 mm.

Shallow footing excavations should be inspected by an experienced geotechnical professional prior to pouring concrete to confirm that the material is adequate for the required bearing capacity.

### 9.6.2 Piles

It is 'good engineering practice' to support all structures, particularly large, heavily loaded structures, on material with uniform properties to reduce the potential for differential settlement. Depending on the proposed structures and column loads, piles founded in medium dense sand could be required.

Given the presence of sandy soils and groundwater, 'replacement' cast-in-situ pile types such as CFA or cased bored piles should be appropriate. Driven piles might also be appropriate but potential vibrations and noise impacts to the nearby residents/structures would need careful consideration. Steel screw piles may also be appropriate to support lighter loads. Conventional bored piles will be unsuitable as the uncased excavation will be prone to collapse, particularly near or below the groundwater level.

Recommended maximum pressures and elastic modulus value for the design of piles in medium dense sand are presented in Table 6. For piles, shaft adhesion values for uplift (tension) may be taken as being equal to 70% of the values for compression.

**Table 6: Recommended Design Parameters for Cast-in-Situ Replacement Piles (e.g. CFA)**

Foundation Stratum	Maximum Allowable Pressure		Maximum Ultimate Pressure		Elastic Modulus (MPa)
	End Bearing <sup>1</sup> (kPa)	Shaft Adhesion (Compression) (kPa)	End Bearing <sup>1</sup> (kPa)	Shaft Adhesion (Compression) (kPa)	
Medium Dense Sand	800	Ref Note 2	2500	Ref Note 2	20-40

Note: 1. End bearing pressure for sand applies to pile foundations that are founded 4 diameters below the ground surface.

2. Dependent on the length and depth of the pile, depth of the water table, and the piling methodology used. Shaft adhesion should be calculated using industry standard methods with a friction angle ( $\phi'$ ) of 33 degrees for the medium dense natural sand.

To reduce the potential risk of total and differential settlement of piles, all piles should be founded at least five pile diameters above the underlying clay and sand material (i.e. purple unit shown on cross-sections in Drawings 2-4).

The total settlement of piles proportioned based on the maximum allowable pressure values in Table 6 are expected to be less than 10 mm or 1% of the pile diameter, whichever is greater. For limit state design (using ultimate pressure values), selection of the geotechnical strength reduction factor ( $\phi_g$ ) in



accordance with Australian piling code AS 2159 – 2009 is based on a series of individual risk ratings (IRR), which are weighted on numerous factors and lead to an average risk rating (ARR). Therefore, it is recommended that an appropriate geotechnical strength reduction factor be calculated by the pile designer. Preliminary design could be based on a  $\phi_g$  of 0.4 and refined as the design progresses. Footing settlements may be calculated for assessment of the serviceability limiting state using the elastic modulus values given in Table 6.

The above parameters are likely to be sufficient for loads associated with 1-3 storey buildings. Higher loads would generally need rock-socketed piles. A nominal allowable end bearing pressure of 1500 kPa and nominal allowable shaft adhesion of 150 kPa for weathered rock would be appropriate for planning purposes, however further geotechnical investigation would be required, including rock-cored boreholes, to confirm rock strength prior to detailed design.

Piling should be inspected by a geotechnical engineer to confirm that foundation conditions are suitable for the design parameters. It is noted that installation of CFA, driven and steel screw piles preclude geotechnical inspection and should be certified by the piling contractor. For CFA, driven and steel screw piles, the drilling/driving resistance and pile depths can be observed during construction and checked to see if the information correlates with adjacent borehole/CPT data. Inspection of the founding of cased bored piles below the water table is not usually possible.

### 9.6.3 Floor Slabs

A raft slab foundation may be feasible, however, this will be subject to detailed review and analysis of bearing pressures and settlements once specific details of the column layout and slab loadings are known.

Although relatively uniform conditions were encountered across the site, differential settlement across the raft slab footprint may occur depending on the layout and loading. A piled raft foundation could also be considered to reduce differential settlements, if required.

Detailed geotechnical analysis and possibly additional investigations will be required for the design and construction of both raft slabs and piled raft slabs, if these are to be considered.

Raft and piled raft foundations should be supported on strata of uniform strength/stiffness to reduce differential settlements, however this will also depend on the loads and the settlement tolerances.

Preliminary slab design may be based on modulus of subgrade reaction, which is dependent on the size of the slab area subject to loading and the foundation material. Design parameters can be provided once the column details, loads and slab areas are known. Detailed design may require analysis using finite element computer programs to model the soil/structure interaction.

## 9.7 Aggressivity

Results of aggressivity testing generally indicate mildly aggressive conditions for subsurface concrete elements and non-aggressive conditions for subsurface steel elements (referring to Tables 6.4.2(C) and 6.5.2(C) of AS 2159 – 2009). One sample collected within silty sand fill (BH9 at 0.4 - 0.5 m depth) indicated severe conditions for subsurface concrete elements and mildly aggressive conditions for subsurface steel elements. The geological and hydrogeological setting of the site are such that it



would be prudent to assume at least moderately aggressive conditions for both steel and concrete in-ground elements.

## 9.8 Salinity

The results of the laboratory testing and soil textural classification generally indicate non-saline conditions (referring to DLWC (2002) methods using the criteria outlined by Richards (1954)). One sample collected within sand (BH111 at 4.0 - 4.5 m depth) indicated slightly saline conditions. Provided that any imported fill is non-saline, standard construction practices will apply with respect to soil salinity.

## 9.9 Acid Sulphate Soils

The mapping indicates the sites are in an area with high probability of ASS below 1 - 3 m depth and the testing undertaken during the contamination assessment for the site indicate the presence of ASS. It is recommended that all material that is disturbed or brought to the surface from below the groundwater table should be treated as acid sulphate soil until proven otherwise. The effect of ASS on the durability of structural elements or services will need to be taken into account by the designers. Further comments on ASS are provided in the contamination assessment report, undertaken in conjunction with the geotechnical investigation.

## 9.10 Working Platform Assessment

Given that a piling rig is likely to be required to construct foundation piles, a working platform assessment will be required for support of the piling rig and/or mobile crane loads. The platform thickness will need to be assessed once details of piling rig or other plant loads are known.

## 9.11 Pavements

Based on the laboratory test results and previous experience in the area, a design CBR of 6% is suggested for the preliminary design of pavements, assuming subgrade preparation is carried out in accordance with Section 9.2 of this report and assuming a granular subgrade (e.g. sand or gravel).

## 9.12 Seismic Loading

In accordance with AS 1170 – 2007 “Structural Design Actions, Part 4: Earthquake Actions in Australia” a hazard factor (Z) of 0.08 and a site subsoil Class D<sub>e</sub> are appropriate for the site.

## 9.13 Dilapidation Surveys

Dilapidation surveys should be carried out on adjacent buildings and pavements that may be affected by excavations, earthworks and piling. The dilapidation surveys should be undertaken before

construction commences in order to document any existing defects, so that any claims for damage due to construction related activities can be accurately assessed.

#### **9.14 Further Investigation**

As the design progresses, additional information on the subsurface conditions and groundwater may be required, particularly if raft slabs or rock-socketed piles are considered as an option, or if excavation below the groundwater level is required. The additional investigation could include ongoing monitoring of existing groundwater wells, new groundwater wells, CPTs and boreholes. If basements are added to the proposed development, then additional analysis of shoring and retaining structures will also be required.

### **10. Limitations**

Douglas Partners Pty Ltd (DP) has prepared this report for this project at NNPS and NSHS, Namona Street, North Narrabeen in accordance with DP's proposal SYD190874 dated 3 September 2019 and acceptance received from Claudia Nolte of School's Infrastructure NSW dated 17 October 2019. The work was carried out under the Standard Form Agreement dated 16 October 2019 between NSW Department of Education and DP. This report is provided for the exclusive use of 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 sites 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 their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and 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 testing locations.

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

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

The scope of work for this report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the sites. Refer to the contamination assessment

report undertaken in conjunction with this geotechnical investigation (DP Report 86973.01.R.001) for further comments on contamination at the site.

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

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**Douglas Partners Pty Ltd**

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## **Appendix A**

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About This Report

# About this Report

# Douglas Partners



## Introduction

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

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

## Copyright

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.

# *About this Report*

## **Site Anomalies**

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

## **Information for Contractual Purposes**

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

## **Site Inspection**

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

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## Appendix B

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Drawings



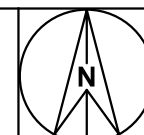
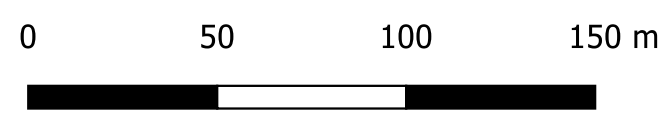


LOCALITY MAP

Notes:  
 1. Basemap from nearmap.com (dated 18/02/2020)  
 2. Test locations shown are approximate only

**Legend**

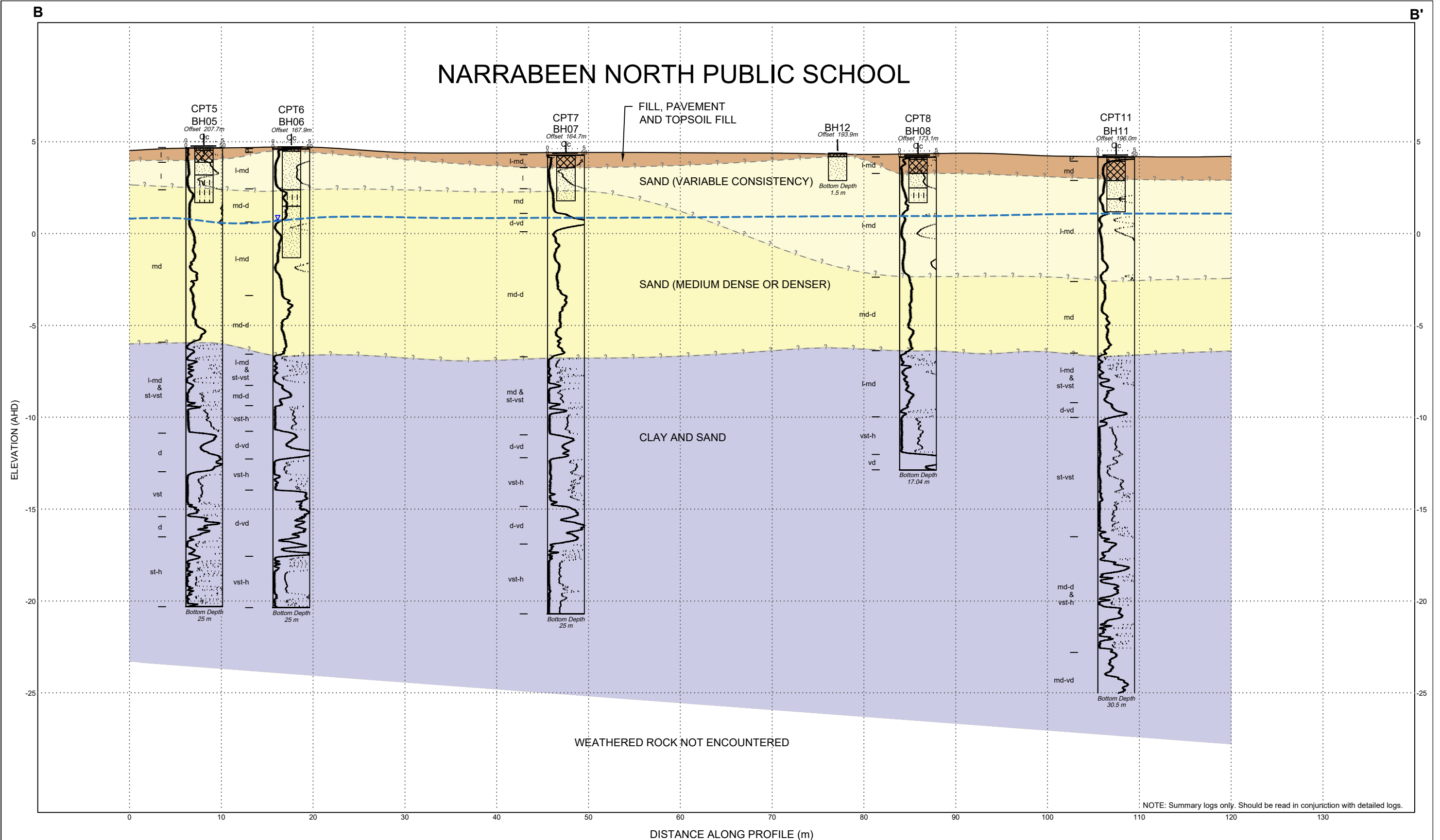
- Approximate Investigation Area
  - Approximate Narrabeen Education Precinct Boundary
  - Interpreted Geotechnical Cross-Section
- Approximate Test Locations
- ◆ Borehole and CPT
  - ◆ Borehole Only
  - ◆ CPT Only
  - W Monitoring Well Location







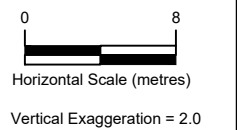
# NARRABEEN NORTH PUBLIC SCHOOL



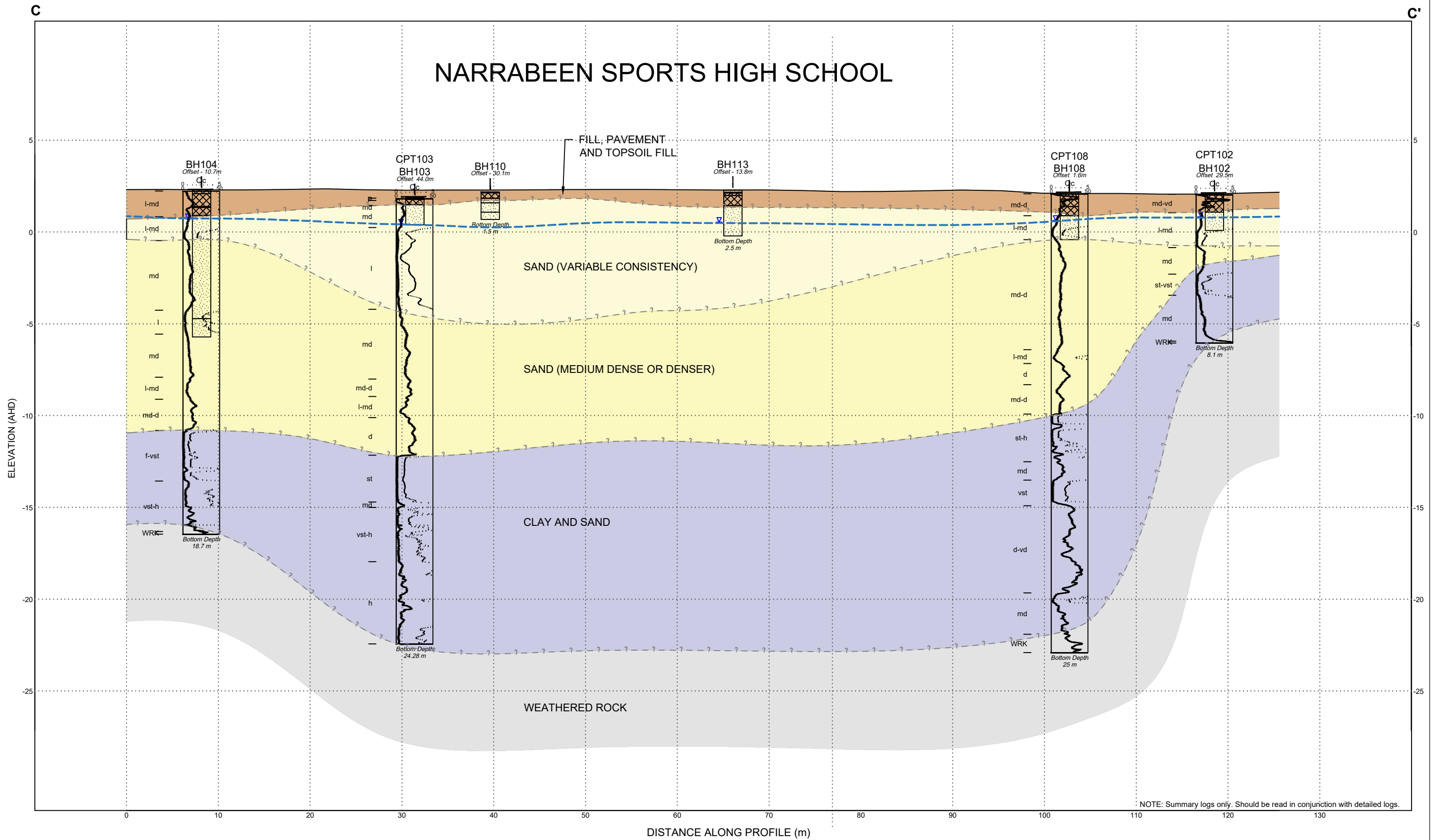
- NOTES:**
- Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
  - Summary logs included only and should be read in conjunction with detailed logs.

LEGEND	
	Filling
	Sand
	Silty Sand
	Roadbase
	Asphaltic Concrete

TESTS / OTHER	
	- Water level
	- Interpreted geotechnical boundary
N	- Standard Penetration Test Value
PP	- Pocket Penetrometer Test Value
	- Measured Groundwater Level



# NARRABEEN SPORTS HIGH SCHOOL



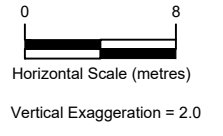
**NOTES:**  
 1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.  
 2. Summary logs included only and should be read in conjunction with detailed logs.

**LEGEND**

Filling	Roadbase
Sand	Asphaltic Concrete
Silty Sand	

**TESTS / OTHER**

- Water level
- ? - - - - Interpreted geotechnical boundary
- N - Standard Penetration Test Value
- PP - Pocket Penetrometer Test Value
- Measured Groundwater Level



CLIENT: NSW Department of Education  
 OFFICE: Sydney      DRAWN BY: MB  
 SCALE: 1:400 (H)      DATE: 02.03.2020  
 1:200 (V) @ A3

TITLE: **Interpreted Geotechnical Cross-Section C**  
**Narrabeen Education Precinct**  
**Namona St, North Narrabeen**

PROJECT No: 86973.00  
 DRAWING No: 4  
 REVISION: 0

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## **Appendix C**

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Results of Field Work



## Sampling

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

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

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

## Test Pits

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

## Large Diameter Augers

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

## Continuous Spiral Flight Augers

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

reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

## Non-core Rotary Drilling

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

## Continuous Core Drilling

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

## Standard Penetration Tests

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

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

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:  
4,6,7  
N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:  
15, 30/40 mm

# Sampling Methods

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

## **Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests**

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

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





## Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

## Soil Types

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

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

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

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

Definitions of grading terms used are:

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

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)

- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)

- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with 'Mix of Soil and Cobbles/Boulders' with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

# Soil Descriptions

## Cohesive Soils

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

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

## Cohesionless Soils

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

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

## Soil Origin

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

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;

- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

## Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.  
Soil tends to stick together.  
Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.  
Soil tends to stick together, free water forms when handling.

## Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w < PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL' (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w > PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈ LL' (i.e. near the liquid limit).
- 'Wet' or 'w > LL' (i.e. wet of the liquid limit).





## Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index  $I_{s(50)}$  is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

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

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

## Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
<i>Note: If HW and MW cannot be differentiated use DW (see below)</i>		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

# Rock Descriptions

## Degree of Fracturing

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

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

## Rock Quality Designation

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

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

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

## Stratification Spacing

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

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

# Symbols & Abbreviations

# Douglas Partners



## Introduction

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

## Drilling or Excavation Methods

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

## Water

▷	Water seep
▽	Water level

## Sampling and Testing

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

## Description of Defects in Rock

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

## Defect Type

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

## Orientation

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

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

## Coating or Infilling Term

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

## Coating Descriptor

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

## Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

## Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough



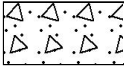

## Other

fg	fragmented
bnd	band
qtz	quartz




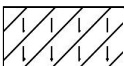



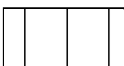
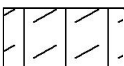
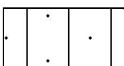

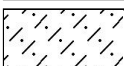
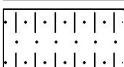




# Symbols & Abbreviations

## Graphic Symbols for Soil and Rock

### General

	Asphalt
	Road base
	Concrete
	Filling

### Soils

	Topsoil
	Peat
	Clay
	Silty clay
	Sandy clay
	Gravelly clay
	Shaly clay
	Silt
	Clayey silt
	Sandy silt
	Sand
	Clayey sand
	Silty sand
	Gravel
	Sandy gravel
	Cobbles, boulders
	Talus

### Sedimentary Rocks

	Boulder conglomerate
	Conglomerate
	Conglomeratic sandstone
	Sandstone
	Siltstone
	Laminite
	Mudstone, claystone, shale
	Coal
	Limestone

### Metamorphic Rocks

	Slate, phyllite, schist
	Gneiss
	Quartzite

### Igneous Rocks

	Granite
	Dolerite, basalt, andesite
	Dacite, epidote
	Tuff, breccia
	Porphyry



# Cone Penetration Tests

# Douglas Partners



## Introduction

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

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

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

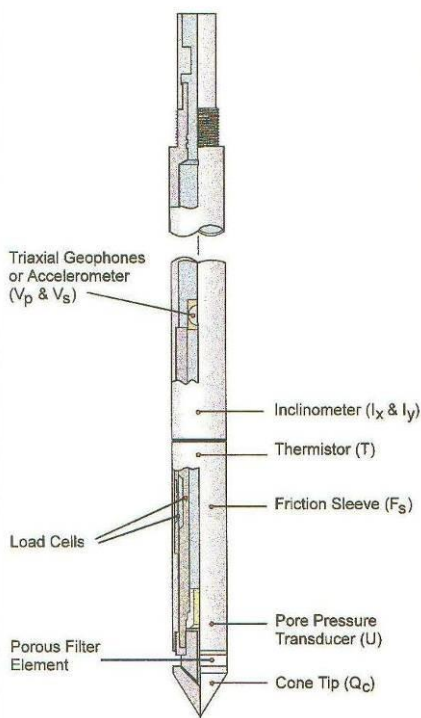


Figure 1: Cone Diagram

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

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



Figure 2: Purpose built CPT rig

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

## Types of CPTs

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

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

## Strata Interpretation

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

# Cone Penetration Tests

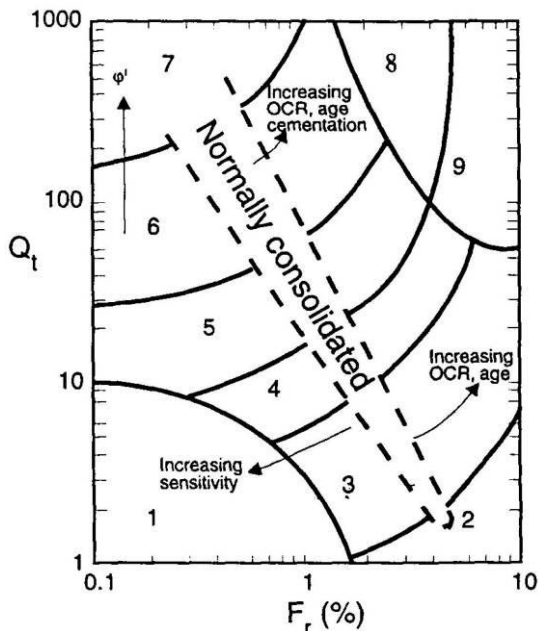


Figure 3: Soil Classification Chart

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

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

## Engineering Applications

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

### Settlement

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

## Pile Capacity

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

## Dynamic or Earthquake Analysis

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

## Other Applications

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

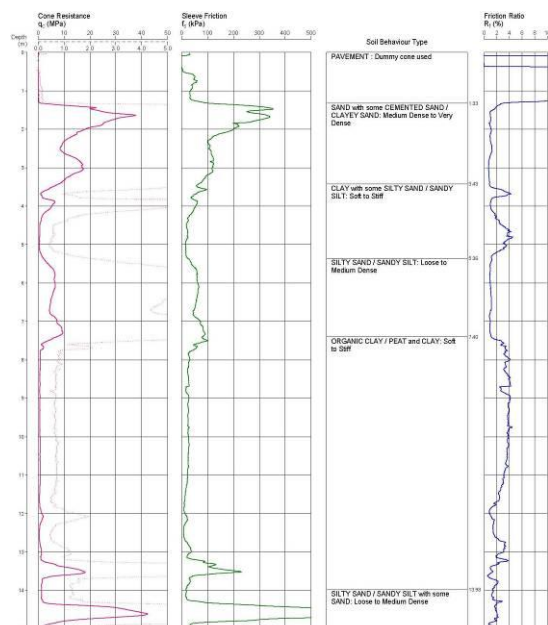


Figure 4: Sample Cone Plot

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 4.3 AHD

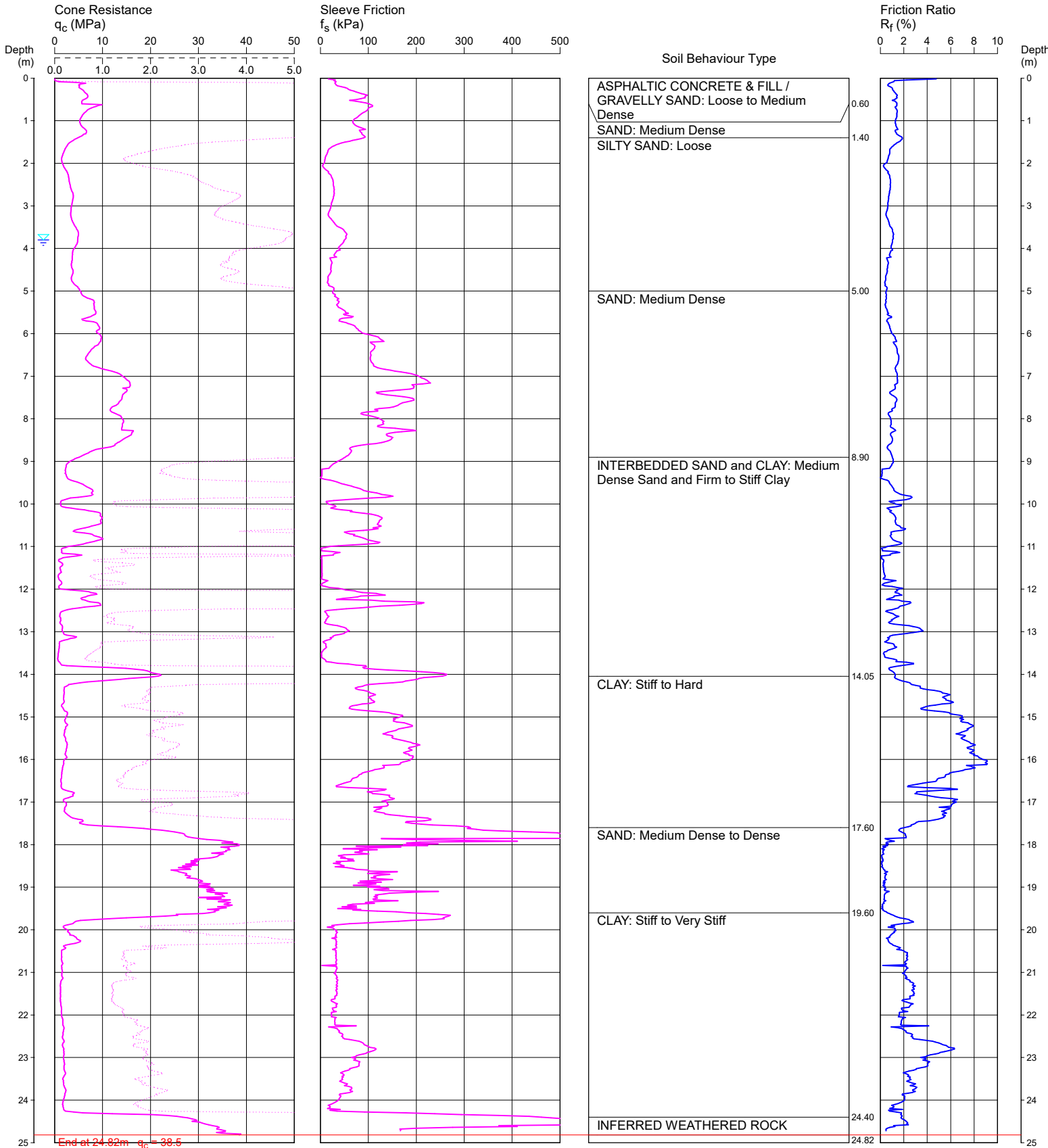
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# CPT1

Page 1 of 1

DATE 15/01/2020

PROJECT No: 86973



REMARKS: DIACORE TO 0.06m; TEST DISCONTINUED DUE TO CONE TIP REFUSAL  
GROUNDWATER MEASURED AT 3.8m AFTER REMOVAL OF RODS

Water depth after test: 3.80m depth (measured)

File: P:\86973.00 - NARRABEEN, Public and High School, Geo\4.0 Field Work\4.2 Testing\CPT1.CP5  
Cone ID: 161225 Type: I-CFYX-10

ConePlot Version 5.9.2  
© 2003 Douglas Partners Pty Ltd

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 4.5 AHD

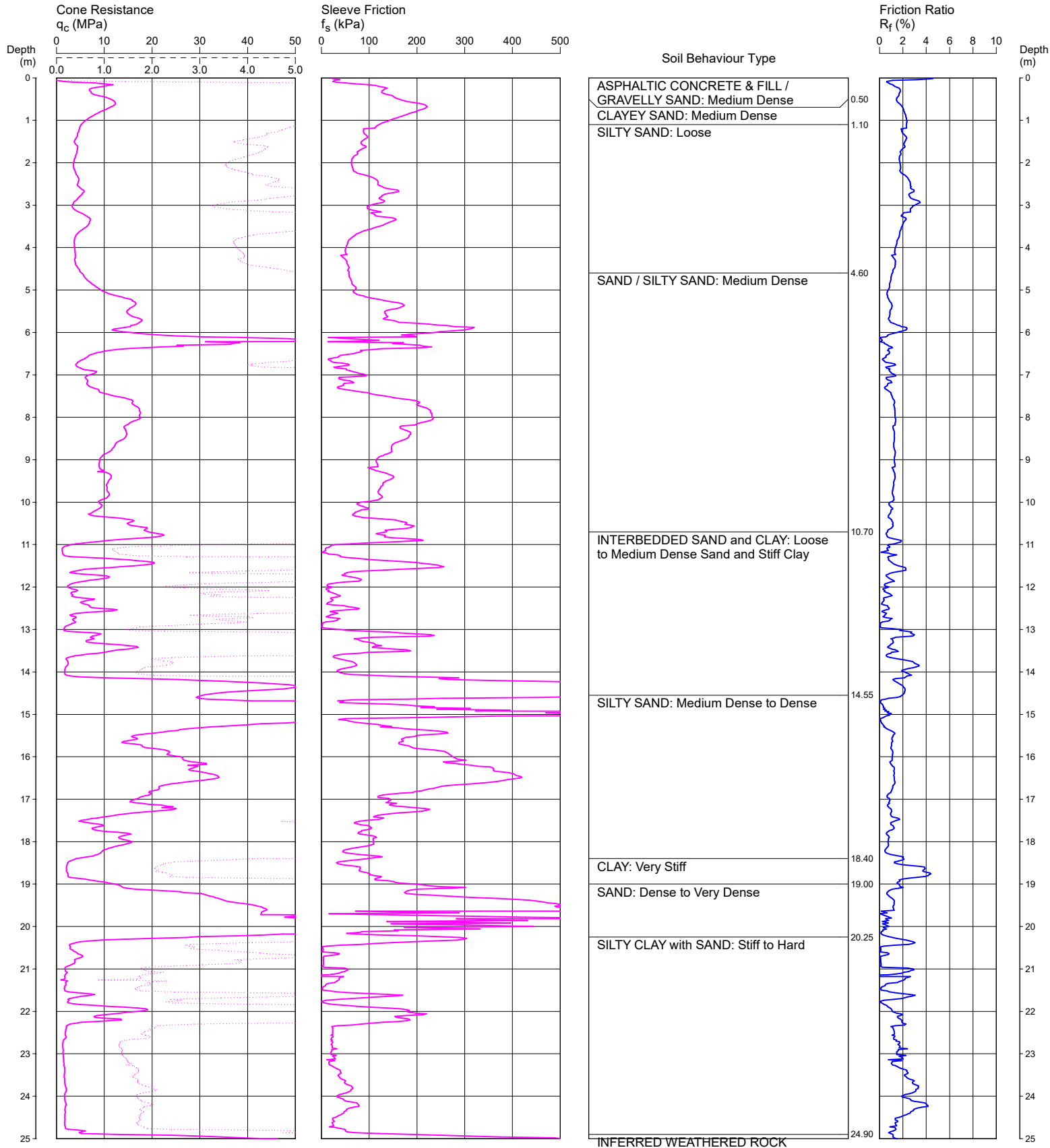
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# CPT2

Page 1 of 2

DATE 15/01/2020

PROJECT No: 86973



REMARKS: DIACORE TO 0.06m; TEST DISCONTINUED DUE TO CONE TIP REFUSAL  
HOLE COLLAPSE MEASURED AT 0.5m AFTER REMOVAL OF RODS



# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 4.5 AHD

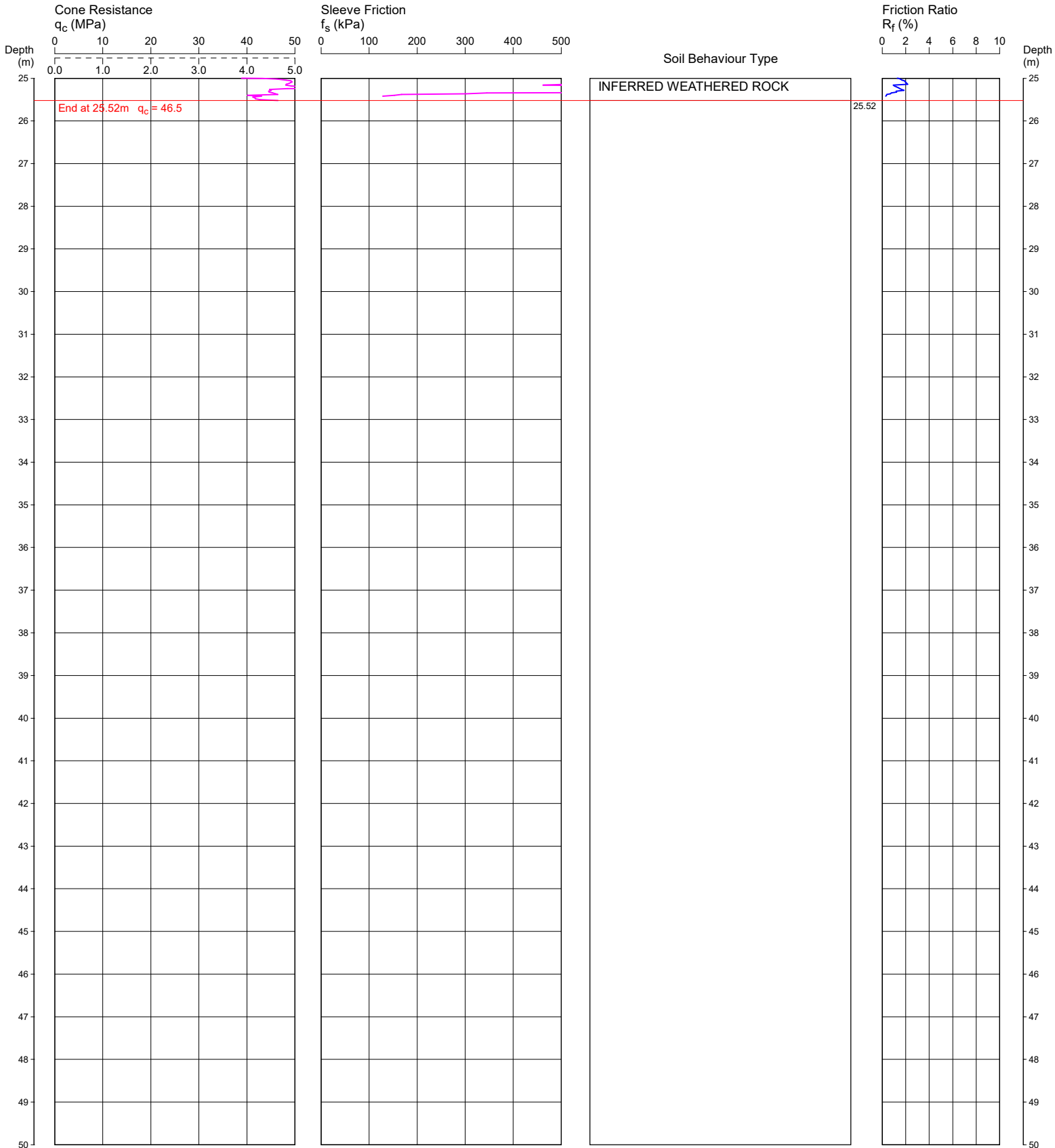
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## CPT2

Page 2 of 2

DATE 15/01/2020

PROJECT No: 86973



REMARKS: DIACORE TO 0.06m; TEST DISCONTINUED DUE TO CONE TIP REFUSAL  
HOLE COLLAPSE MEASURED AT 0.5m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 4.5 AHD

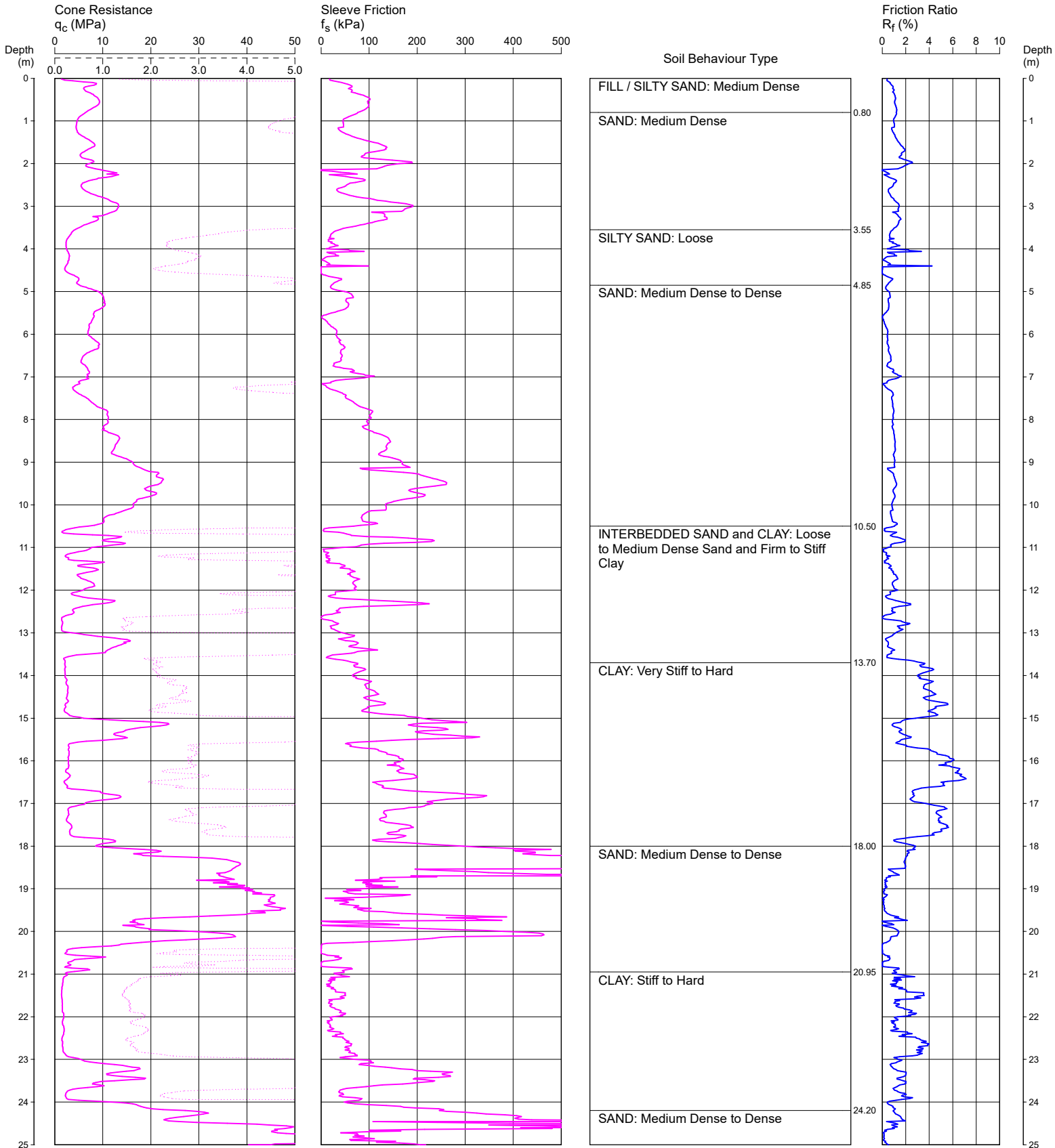
COORDINATES: 342229.9E 6269957.3N

# CPT3

Page 1 of 2

DATE 16/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED AT TARGET DEPTH  
 HOLE COLLAPSE MEASURED AT 3.7m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 4.5 AHD

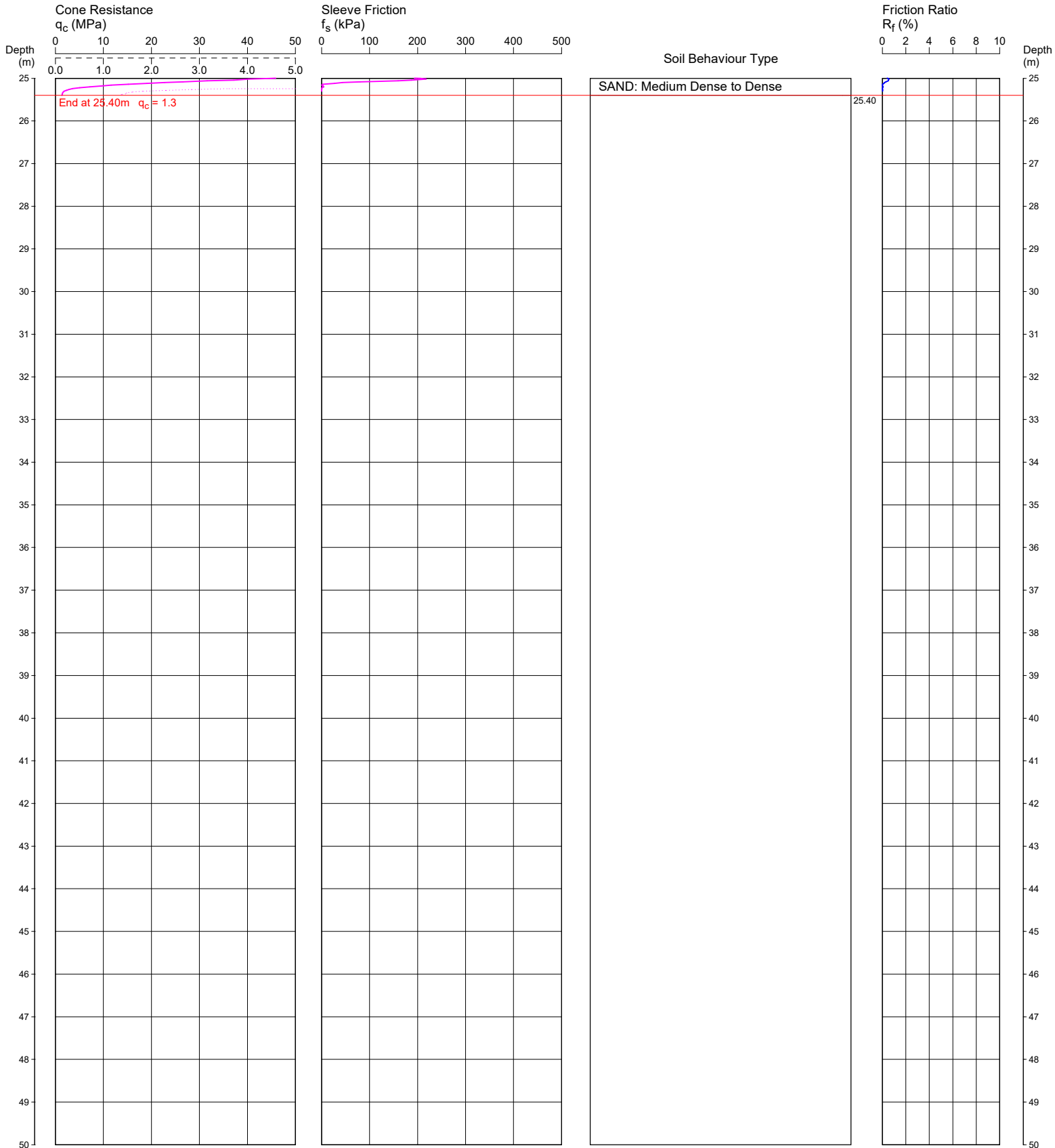
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# CPT3

Page 2 of 2

DATE 16/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED AT TARGET DEPTH  
HOLE COLLAPSE MEASURED AT 3.7m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 2.9 AHD

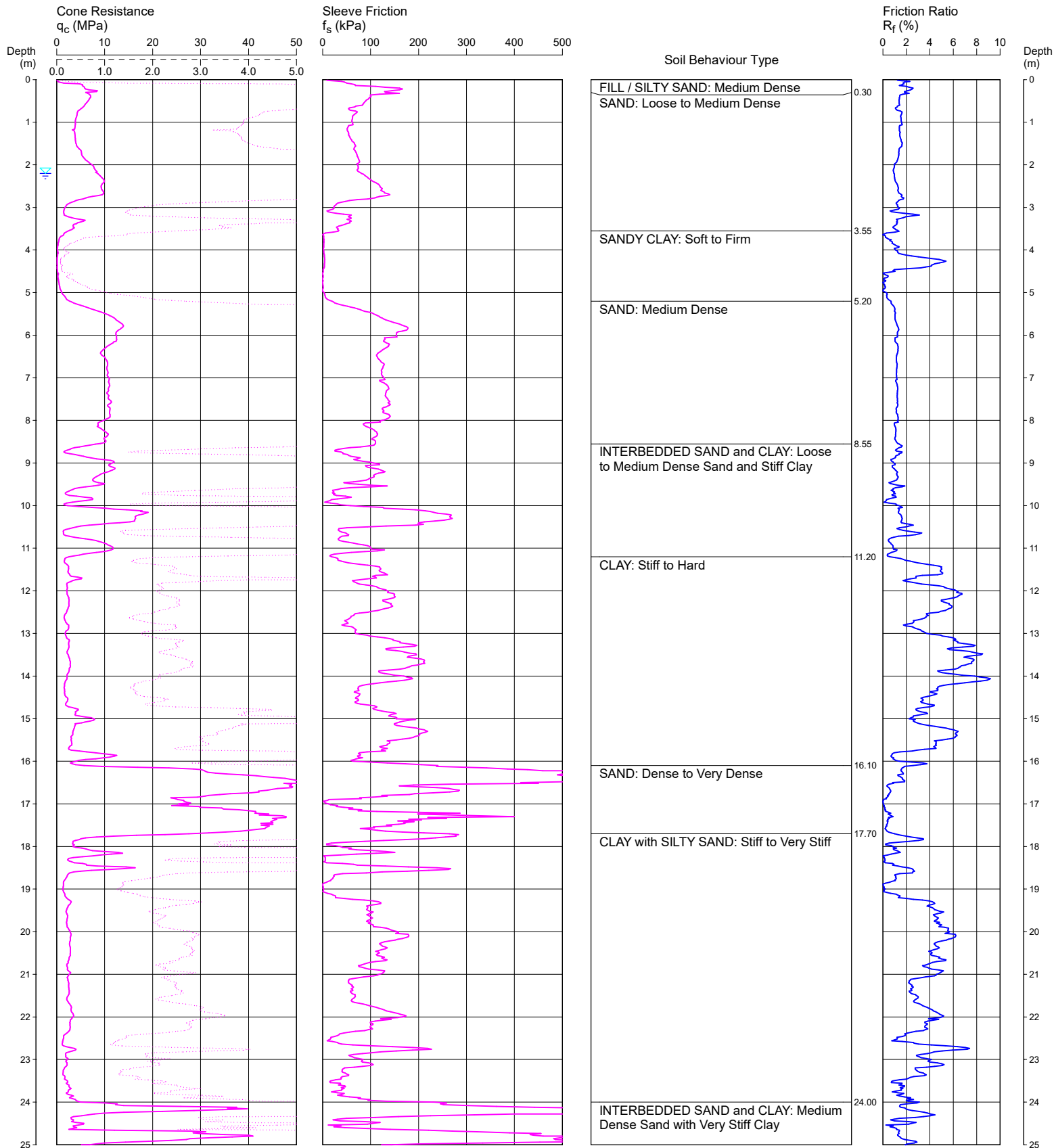
COORDINATES: 342213.9E 6270007.2N

# CPT4

Page 1 of 2

DATE 15/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE BENDING NEAR REFUSAL  
GROUNDWATER MEASURED AT 2.2m AFTER REMOVAL OF RODS

Water depth after test: 2.20m depth (measured)

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Cone ID: 170707

Type: I-CFXY-10

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 2.9 AHD

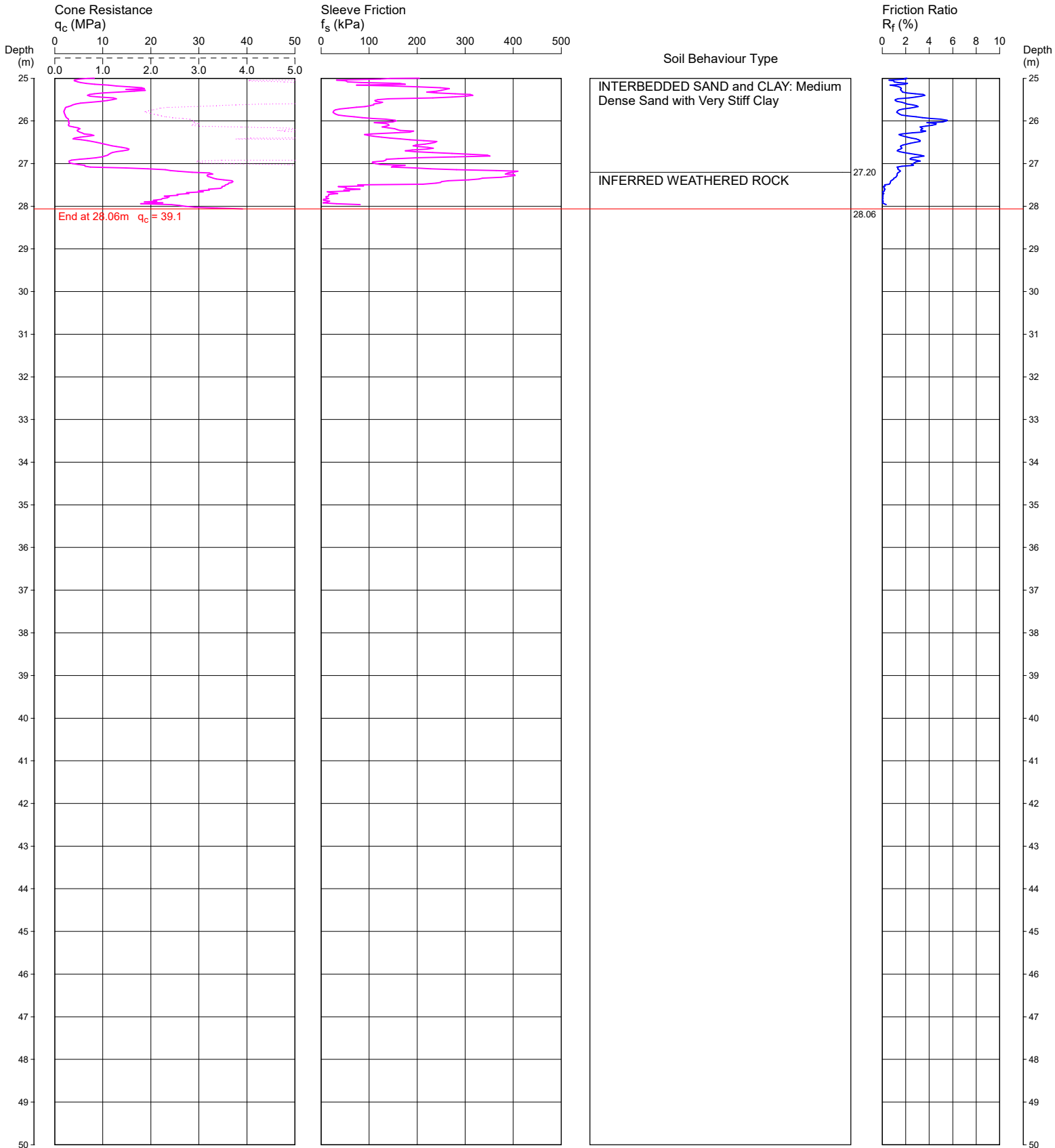
COORDINATES: 342213.9E 6270007.2N

**CPT4**

Page 2 of 2

DATE 15/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE BENDING NEAR REFUSAL  
GROUNDWATER MEASURED AT 2.2m AFTER REMOVAL OF RODS

Water depth after test: 2.20m depth (measured)

File: P:\86973.00 - NARRABEEN, Public and High School, Geo\4.0 Field Work\4.2 Testing\CPT4.CP5

Cone ID: 170707

Type: I-CFY-10

ConePlot Version 5.9.2  
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# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 4.7 AHD

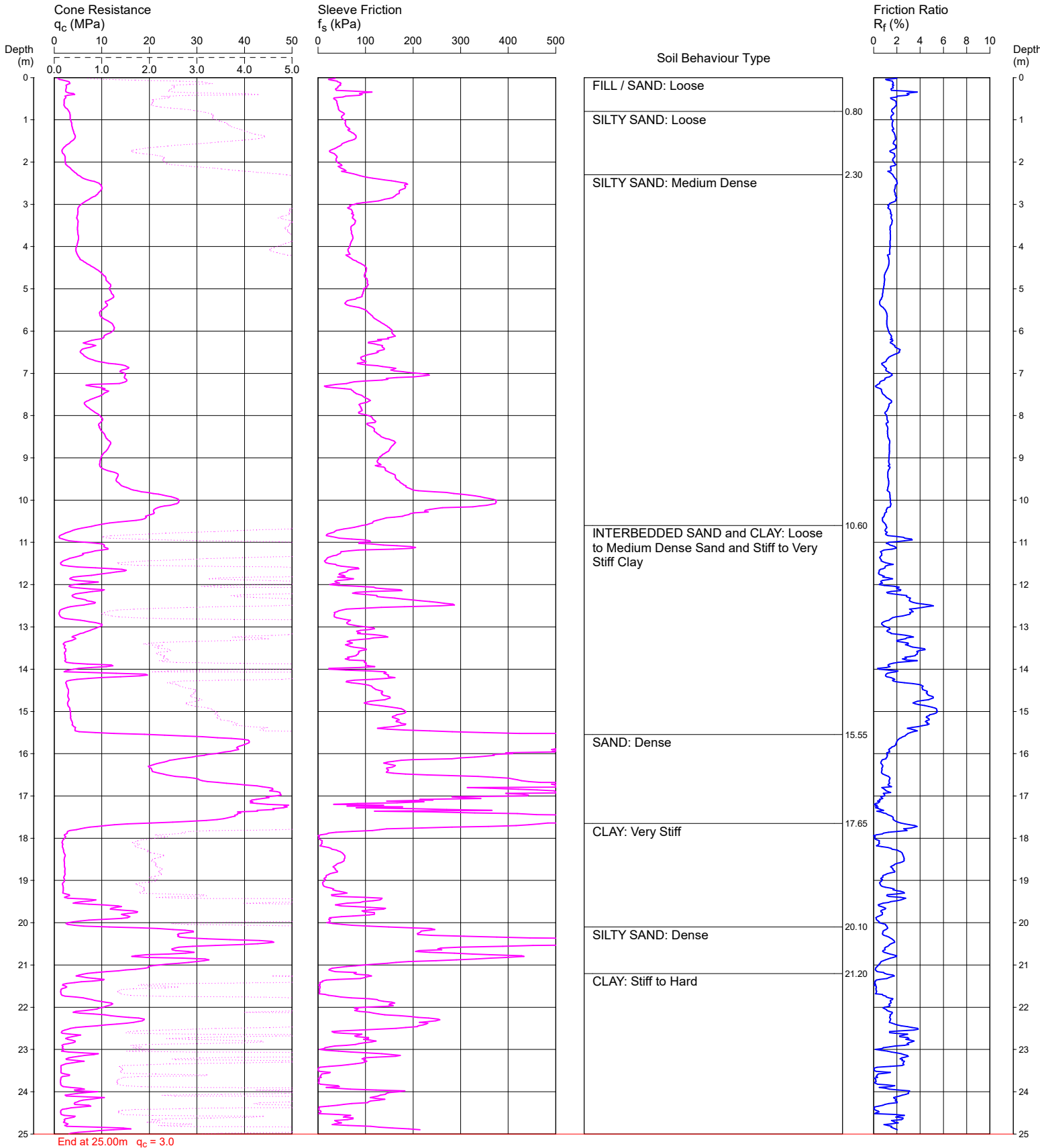
COORDINATES: 342193.8E 6269948.2N

# CPT5

Page 1 of 1

DATE 16/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED AT TARGET DEPTH  
HOLE COLLAPSE MEASURED AT 2.0m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 4.7 AHD

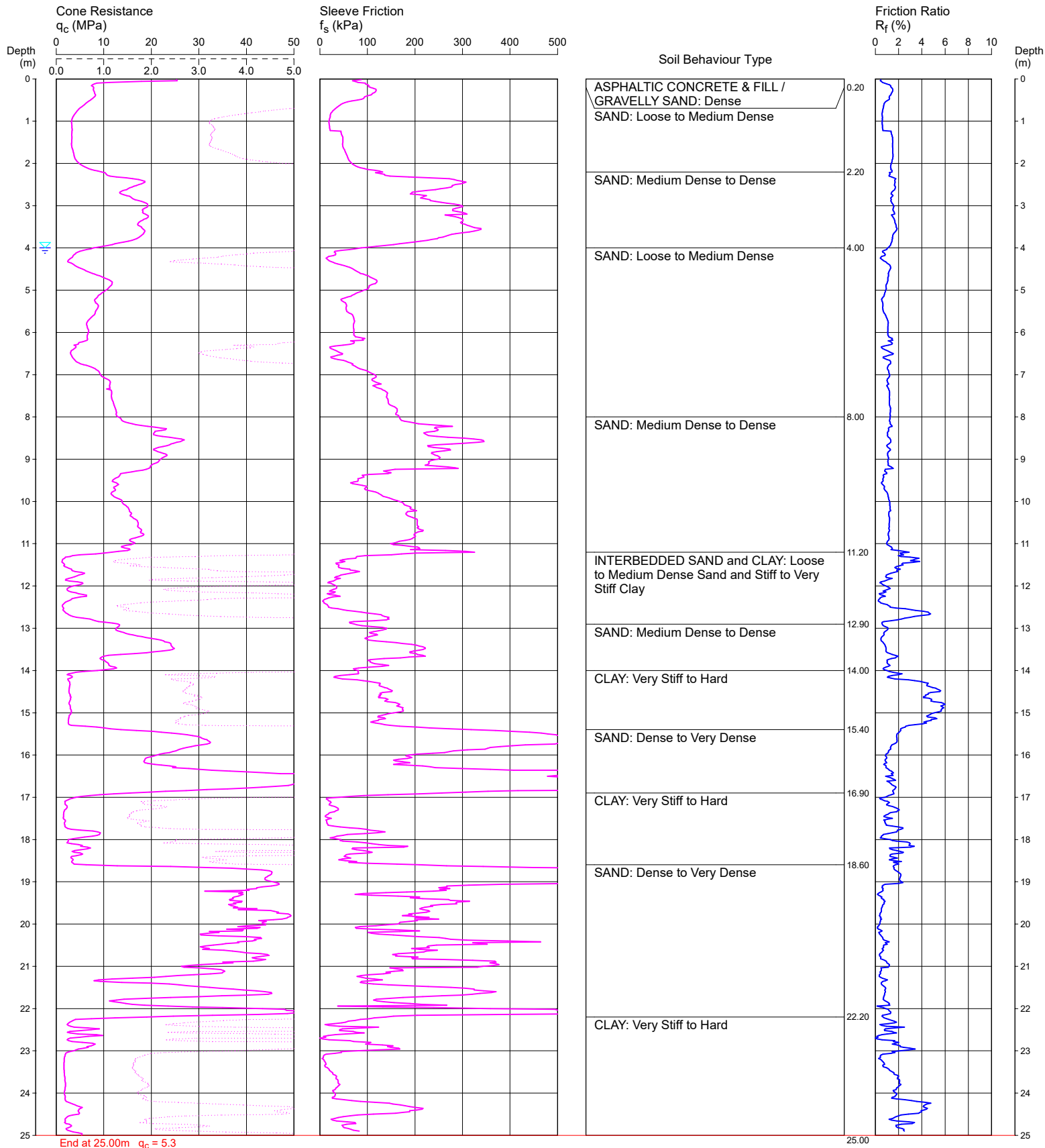
COORDINATES: 342195.8E 6269907.2N

## CPT6

Page 1 of 1

DATE 16/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED AT TARGET DEPTH  
 GROUNDWATER MEASURED AT 4.0m AFTER REMOVAL OF RODS

Water depth after test: 4.00m depth (measured)

File: P:\86973.00 - NARRABEEN, Public and High School, Geo\4.0 Field Work\4.2 Testing\CPT6.CP5  
 Cone ID: 170707 Type: I-CFY-10

ConePlot Version 5.9.2  
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# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 4.3 AHD

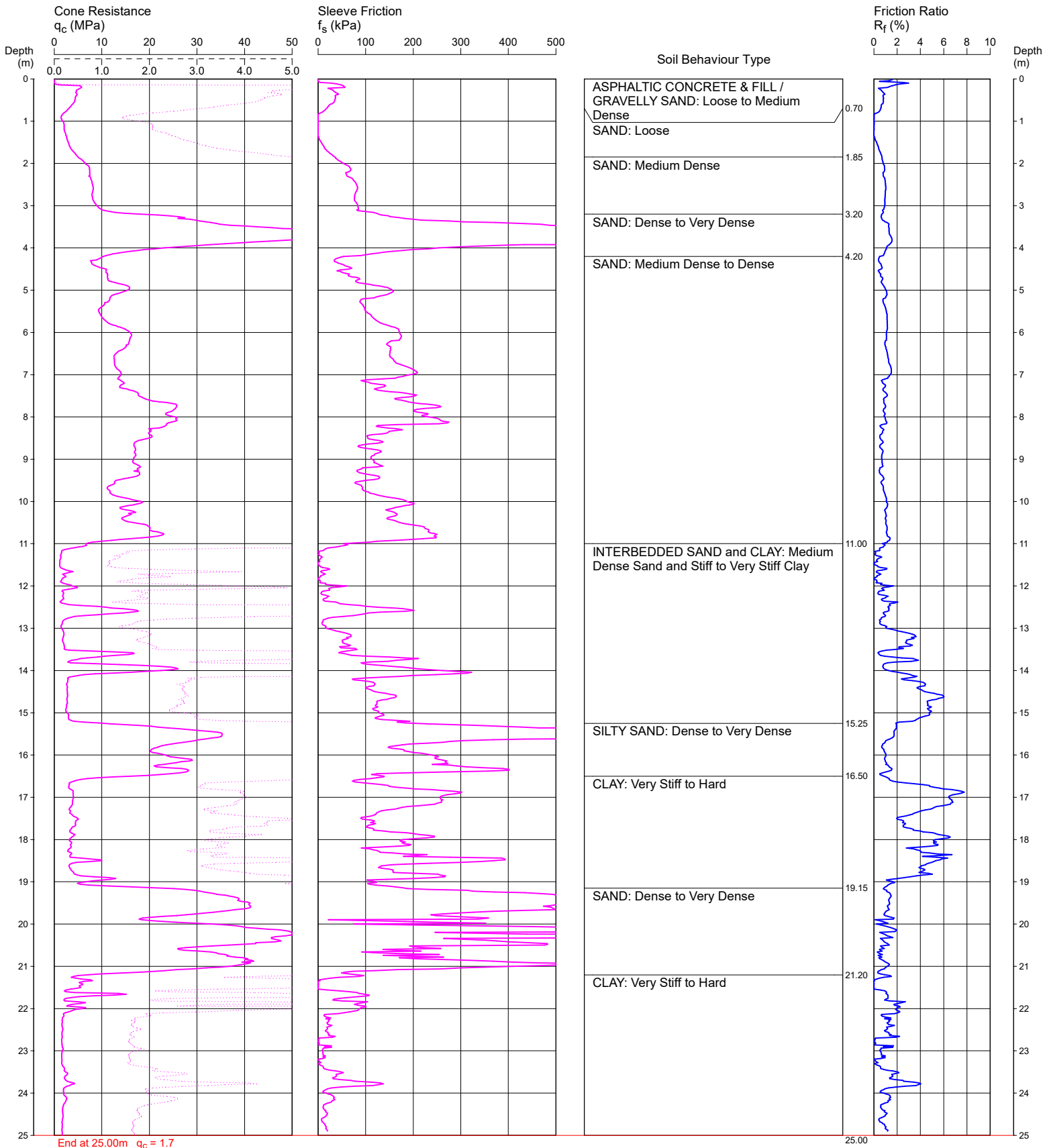
COORDINATES: 342224.6E 6269898.6N

## CPT7

Page 1 of 1

DATE 15/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED AT TARGET DEPTH  
HOLE COLLAPSE MEASURED AT 1.8m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 4.2 AHD

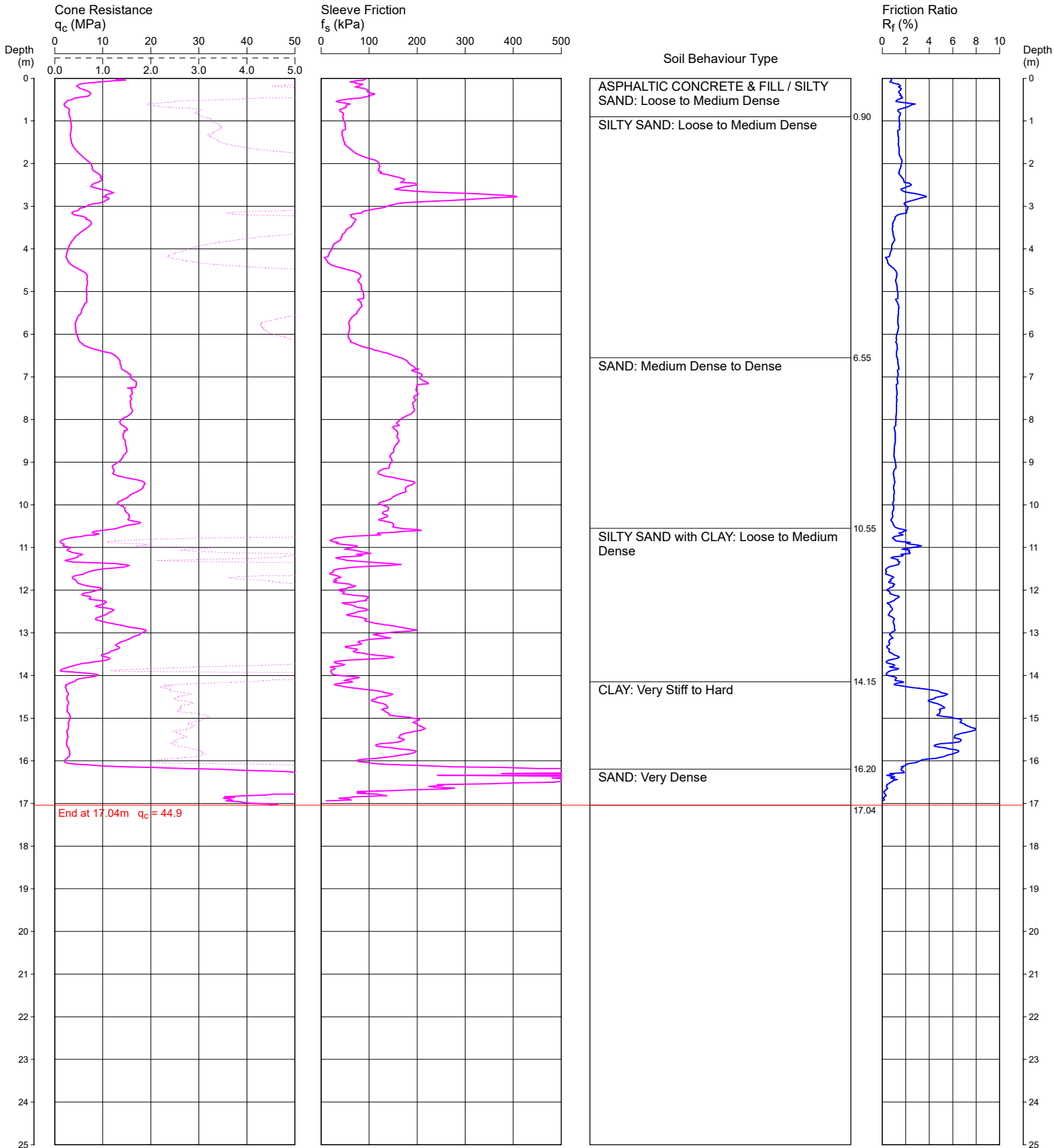
COORDINATES: 342263.8E 6269899.7N

# CPT8

Page 1 of 1

DATE 15/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL  
HOLE COLLAPSE MEASURED AT 3.4m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 4.2 AHD

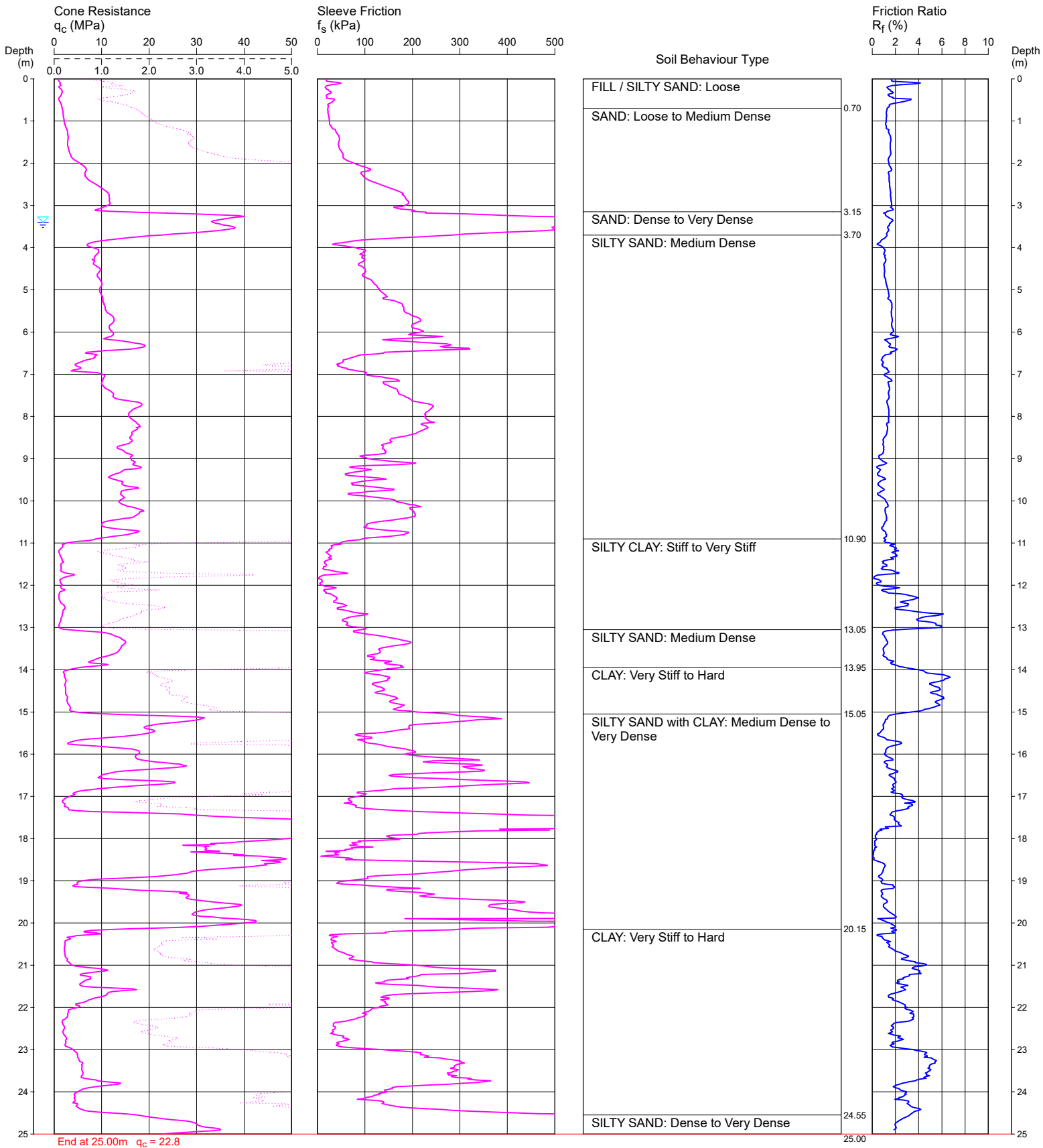
COORDINATES: 342223.1E 6269873.0N

# CPT9

Page 1 of 1

DATE 16/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED AT TARGET DEPTH  
GROUNDWATER MEASURED AT 3.4m AFTER REMOVAL OF RODS

Water depth after test: 3.40m depth (measured)

File: P:\86973.00 - NARRABEEN, Public and High School, Geo\4.0 Field Work\4.2 Testing\CPT9.CP5  
Cone ID: 170707 Type: I-CFXY-10



# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 3.8 AHD

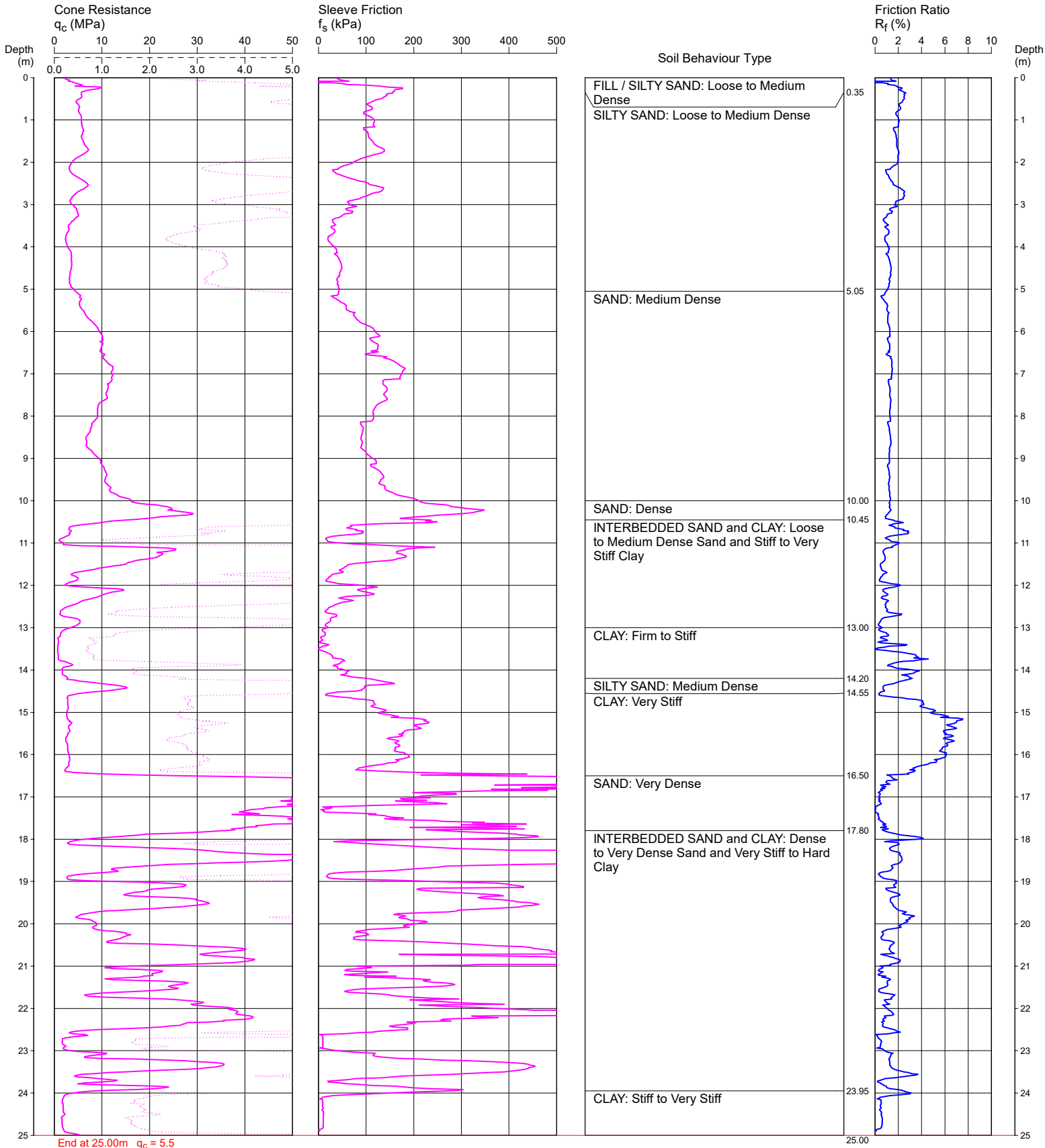
COORDINATES: 342270.9E 6269850.6N

# CPT10

Page 1 of 1

DATE 16/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED AT TARGET DEPTH  
HOLE COLLAPSE MEASURED AT 2.4m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 4.2 AHD

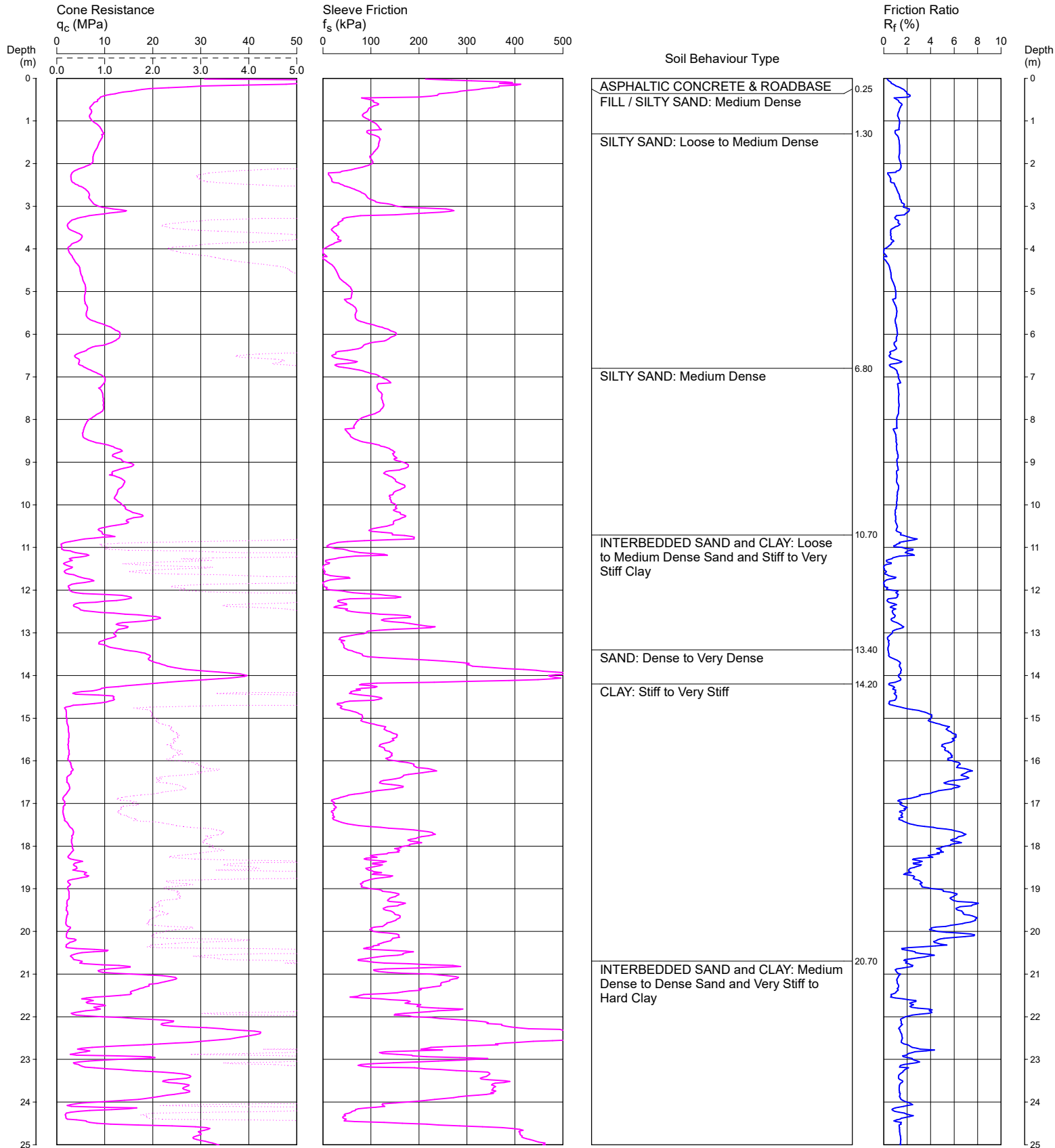
COORDINATES: 342289.3E 6269918.2N

# CPT11

Page 1 of 2

DATE 15/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED AT TARGET DEPTH  
HOLE COLLAPSE MEASURED AT 1.1m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 4.2 AHD

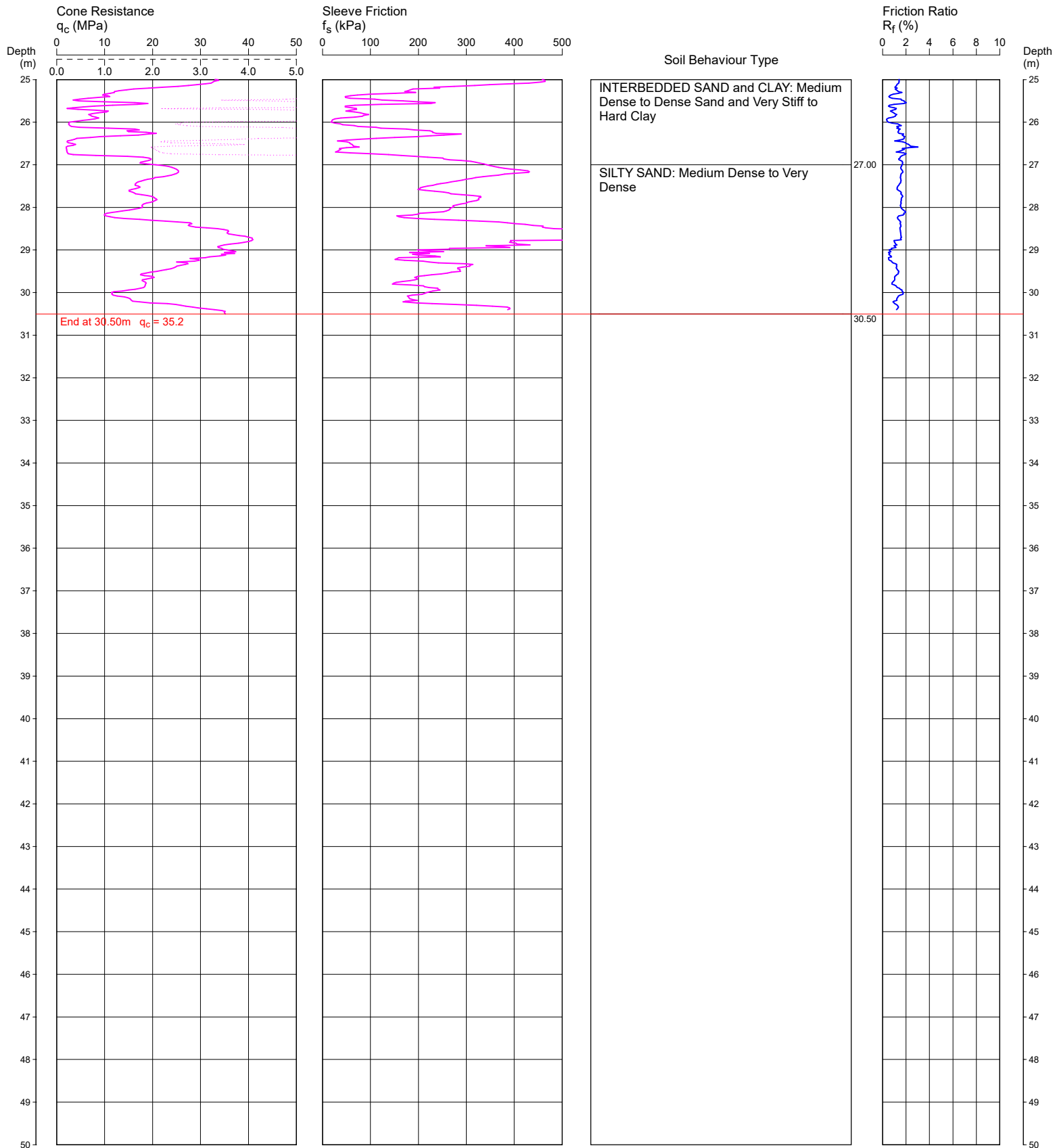
COORDINATES: 342289.3E 6269918.2N

# CPT11

Page 2 of 2

DATE 15/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED AT TARGET DEPTH  
HOLE COLLAPSE MEASURED AT 1.1m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 2.1 AHD

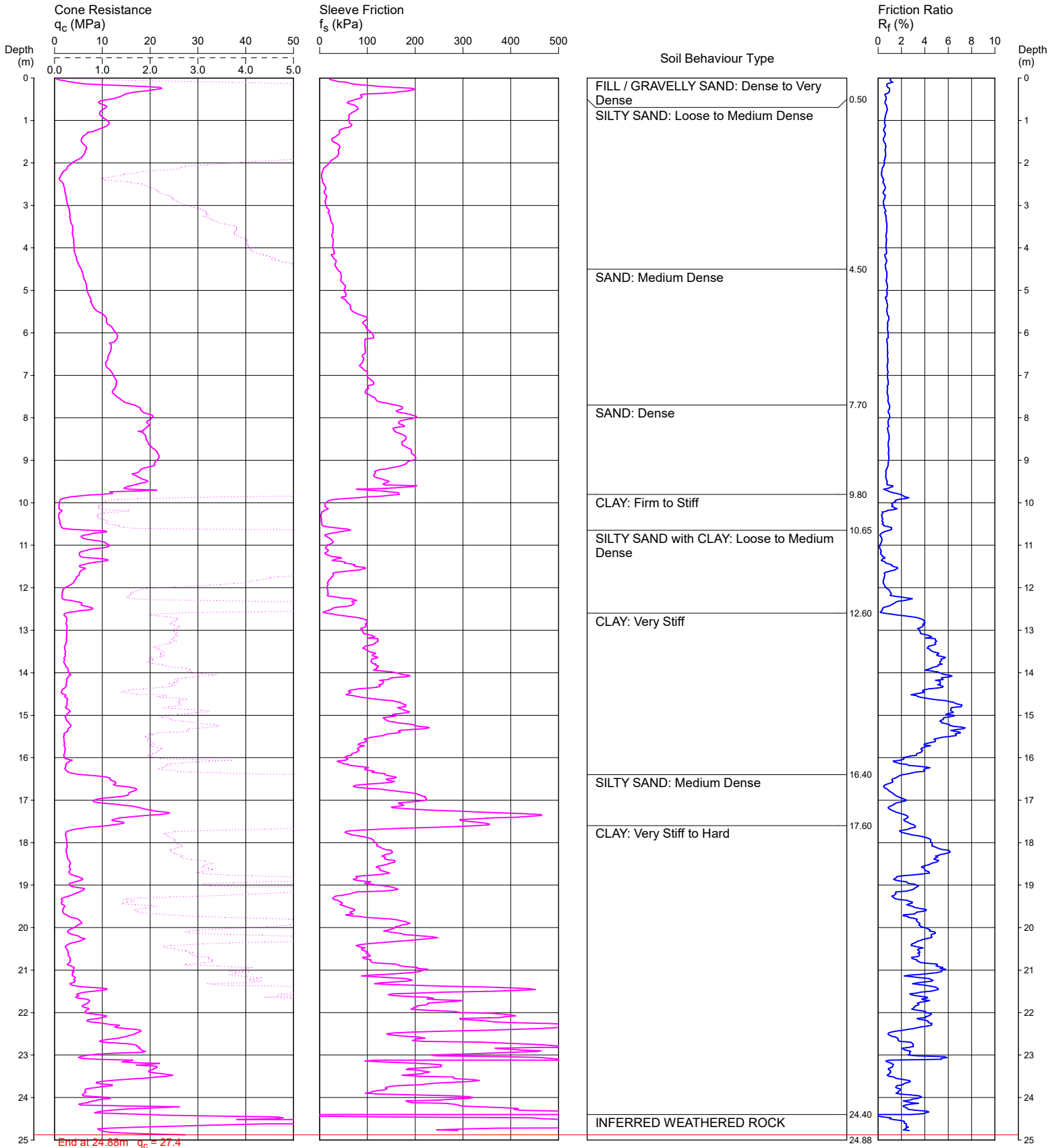
COORDINATES: 342233.8E 6269795.5N

# CPT101

Page 1 of 1

DATE 14/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE ROD BOWING  
HOLE COLLAPSE MEASURED AT 1.1m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 2.1 AHD

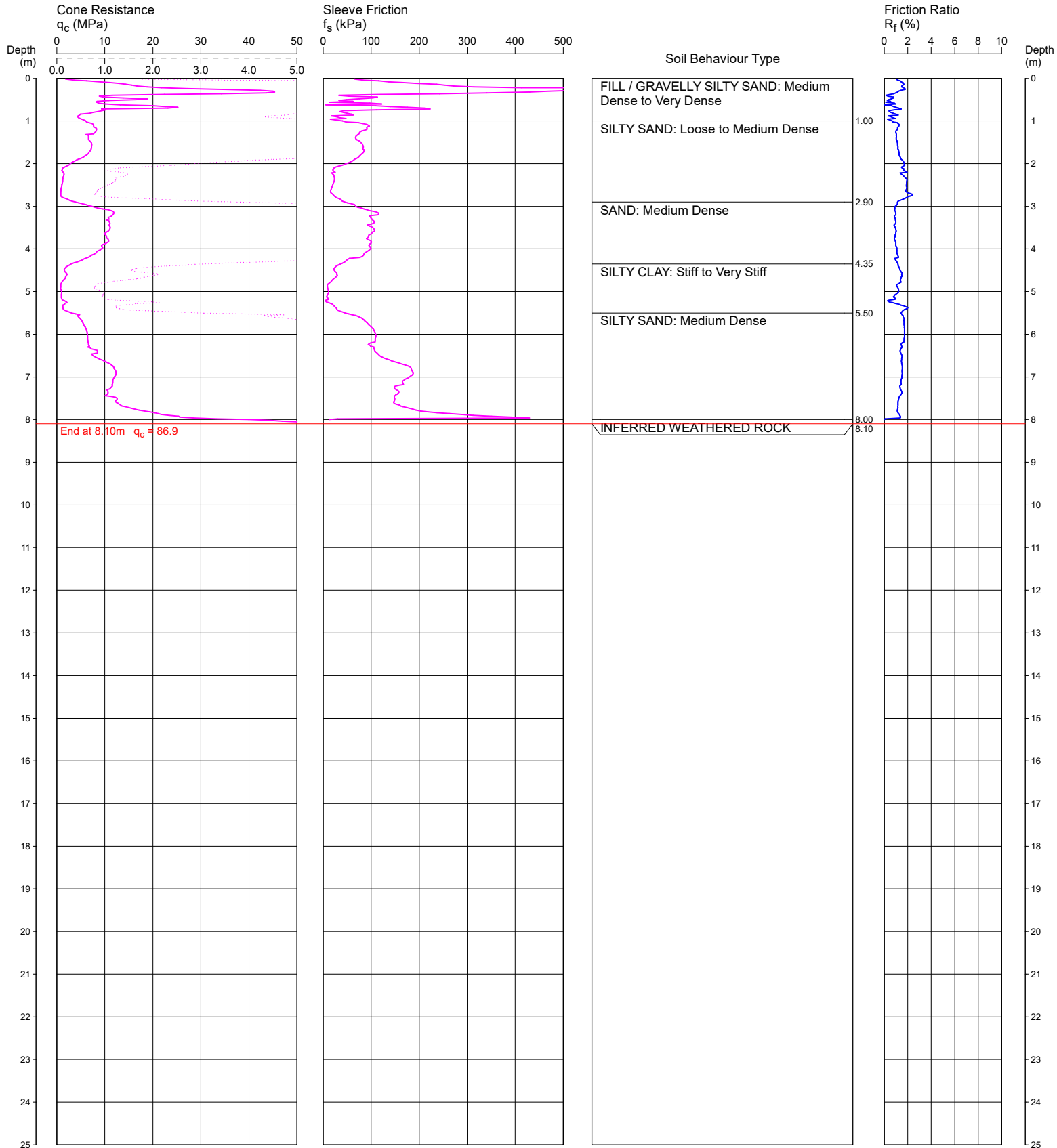
COORDINATES: 342269.2E 6269752.5N

# CPT102

Page 1 of 1

DATE 14/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL  
HOLE COLLAPSE MEASURED AT 1.9m AFTER REMOVAL OF RODS



# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 1.9 AHD

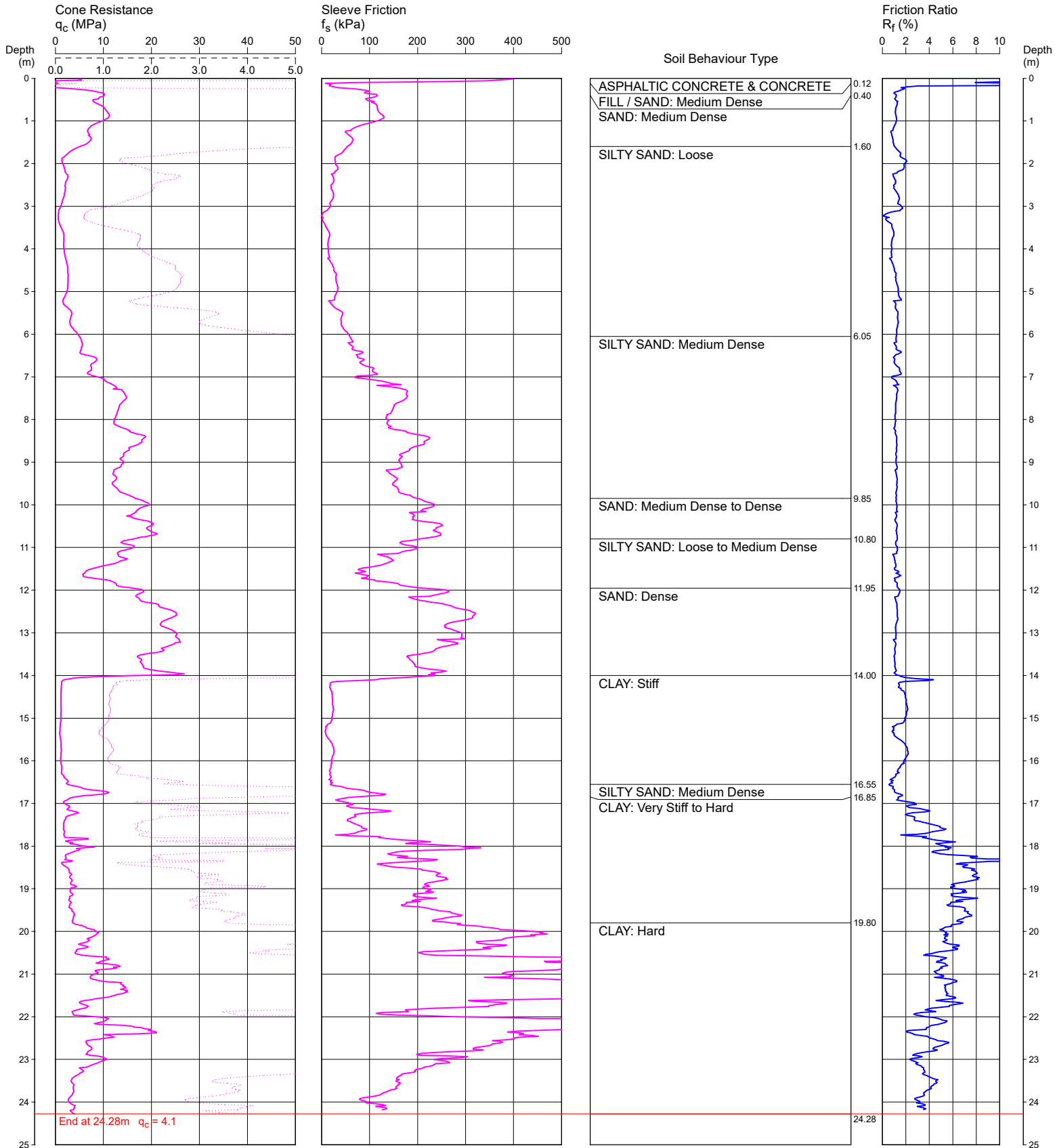
COORDINATES: 342186.3E 6269783.0N

# CPT103

Page 1 of 1

DATE 14/01/2020

PROJECT No: 86973



REMARKS: DUMMY CONE TO 0.3m TO PENETRATE PAVEMENT; TEST DISCONTINUED DUE TO EXCESSIVE ROD BOWING  
HOLE COLLAPSE MEASURED AT 1.3m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 2.3 AHD

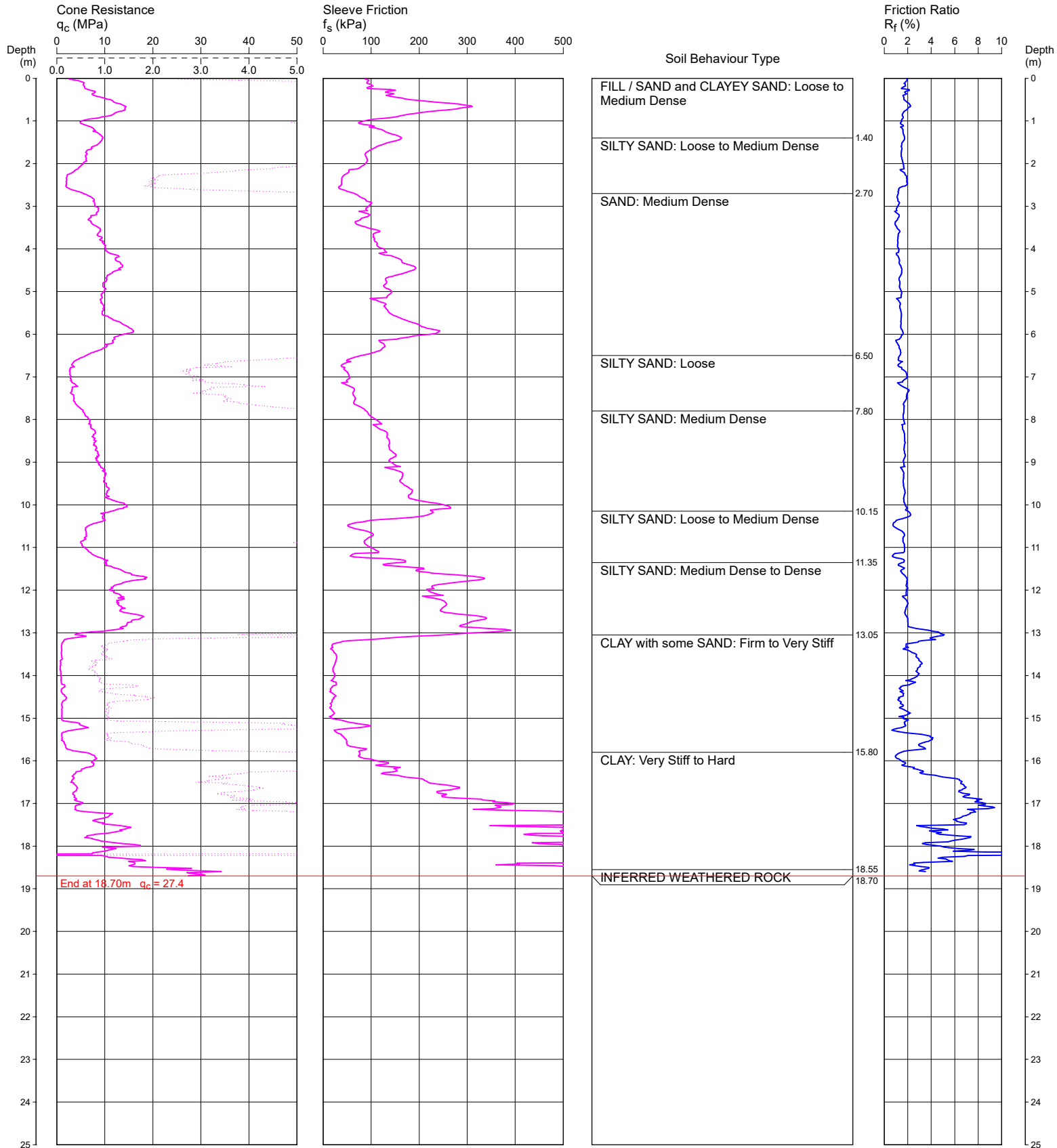
COORDINATES: 342153.3E 6269733.5N

# CPT104

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DATE 14/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE ROD BOWING NEAR REFUSAL  
HOLE COLLAPSE MEASURED AT 0.5m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 2.2 AHD

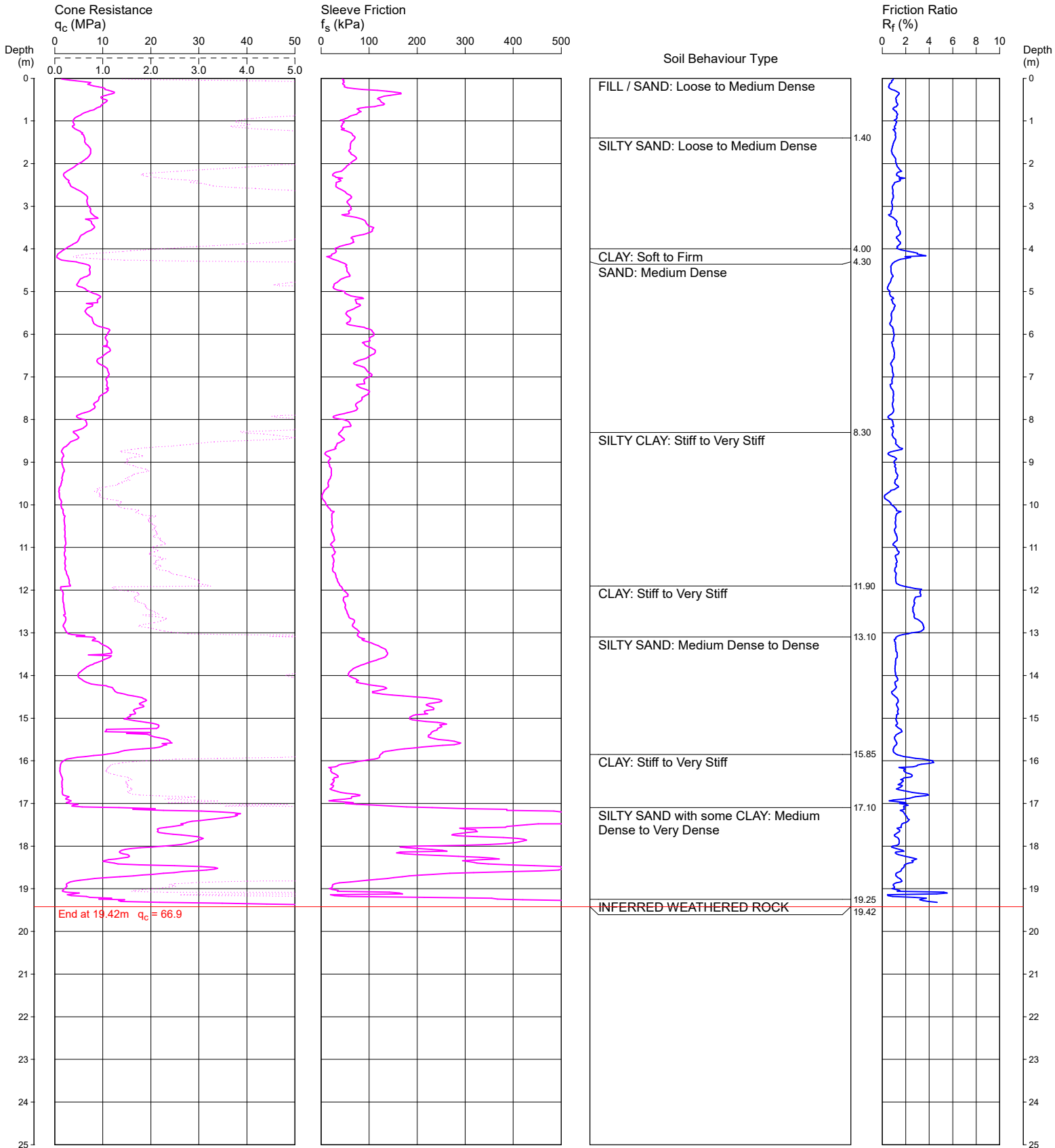
COORDINATES: 342146.9E 6269682.5N

# CPT105

Page 1 of 1

DATE 14/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL  
HOLE COLLAPSE MEASURED AT 1.7m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 2.1 AHD

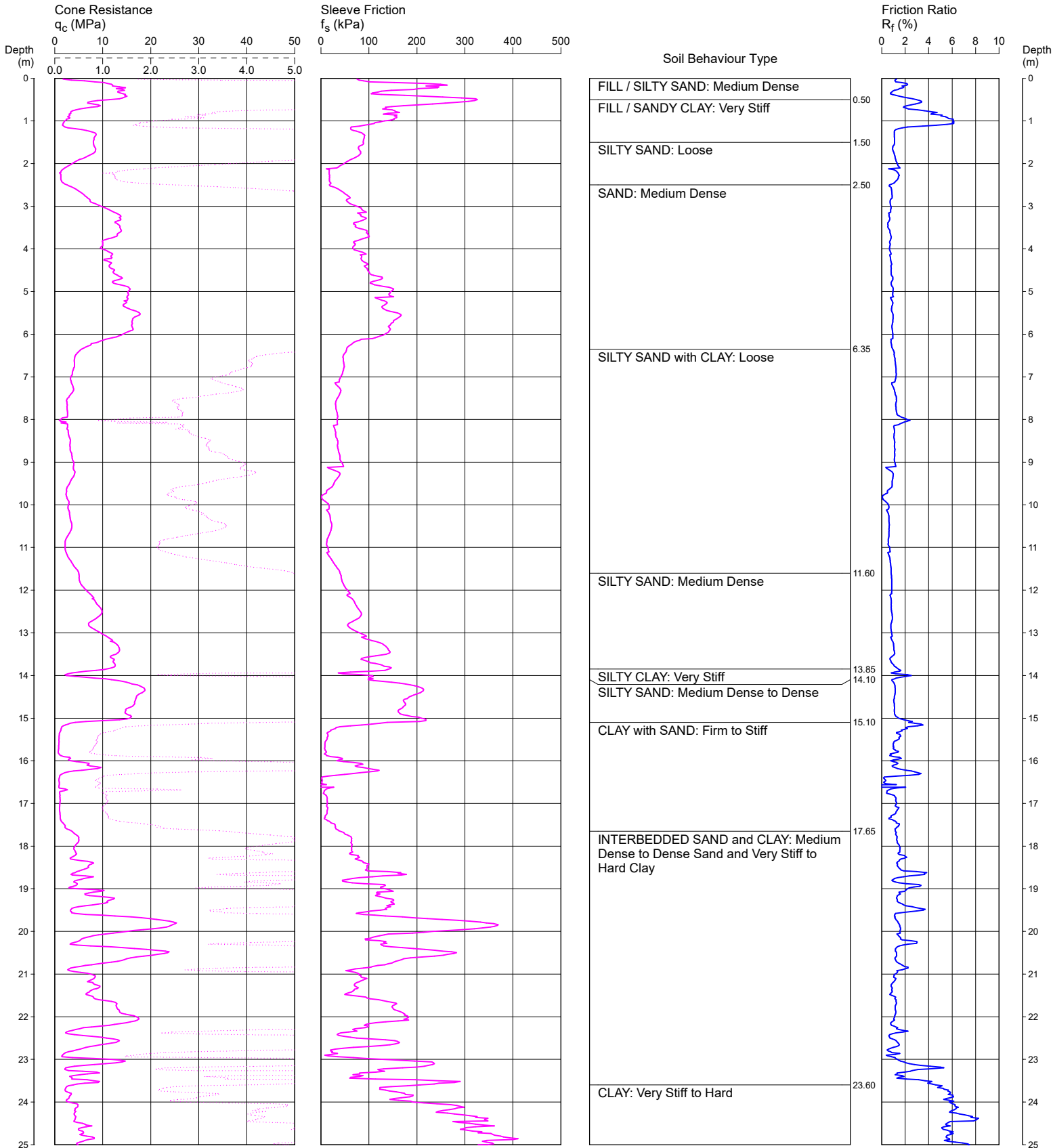
COORDINATES: 342210.2E 6269674.3N

# CPT106

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DATE 15/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL  
HOLE COLLAPSE MEASURED AT 0.7m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 2.1 AHD

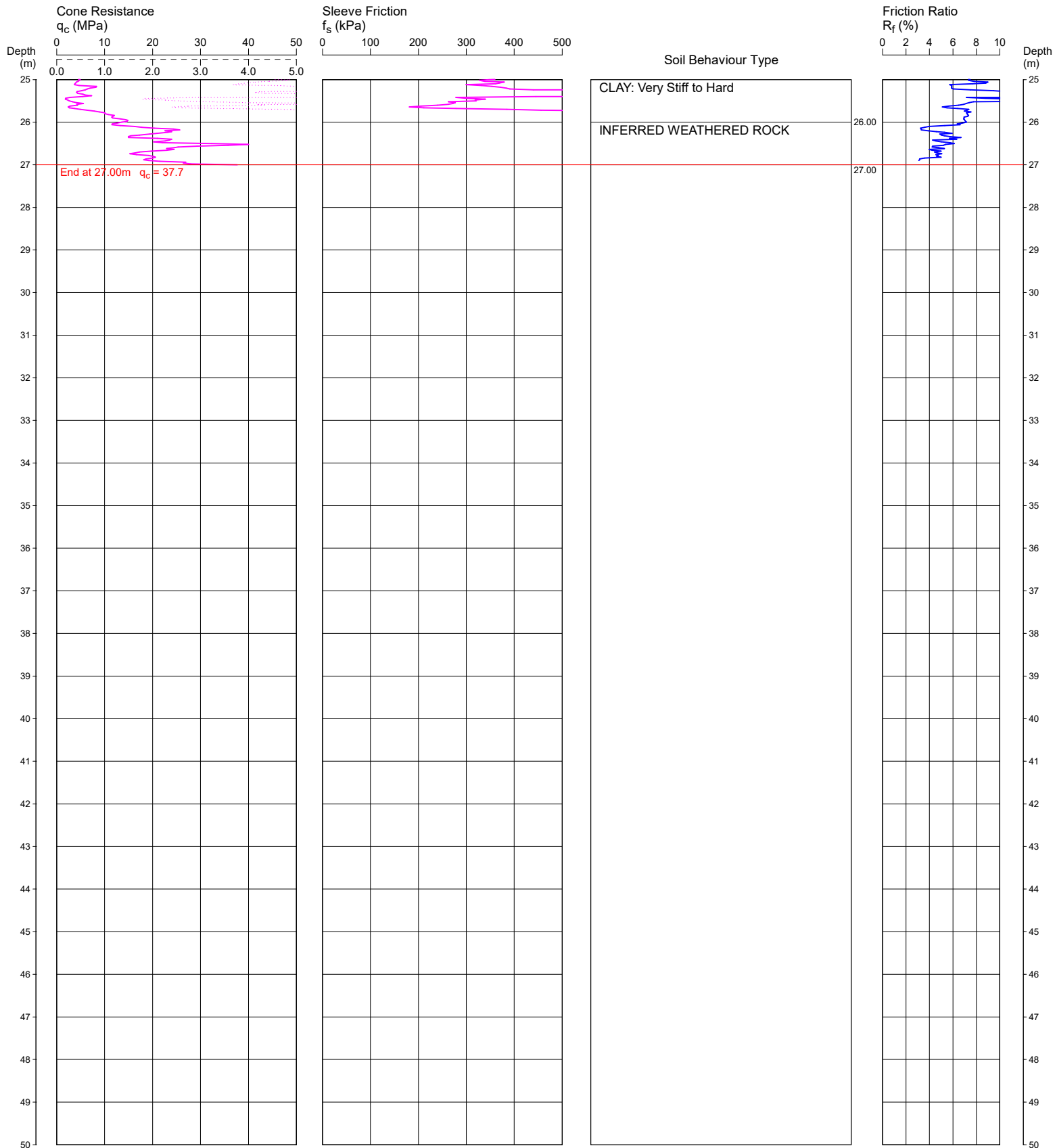
COORDINATES: 342210.2E 6269674.3N

# CPT106

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DATE: 15/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL  
HOLE COLLAPSE MEASURED AT 0.7m AFTER REMOVAL OF RODS

# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 2.0 AHD

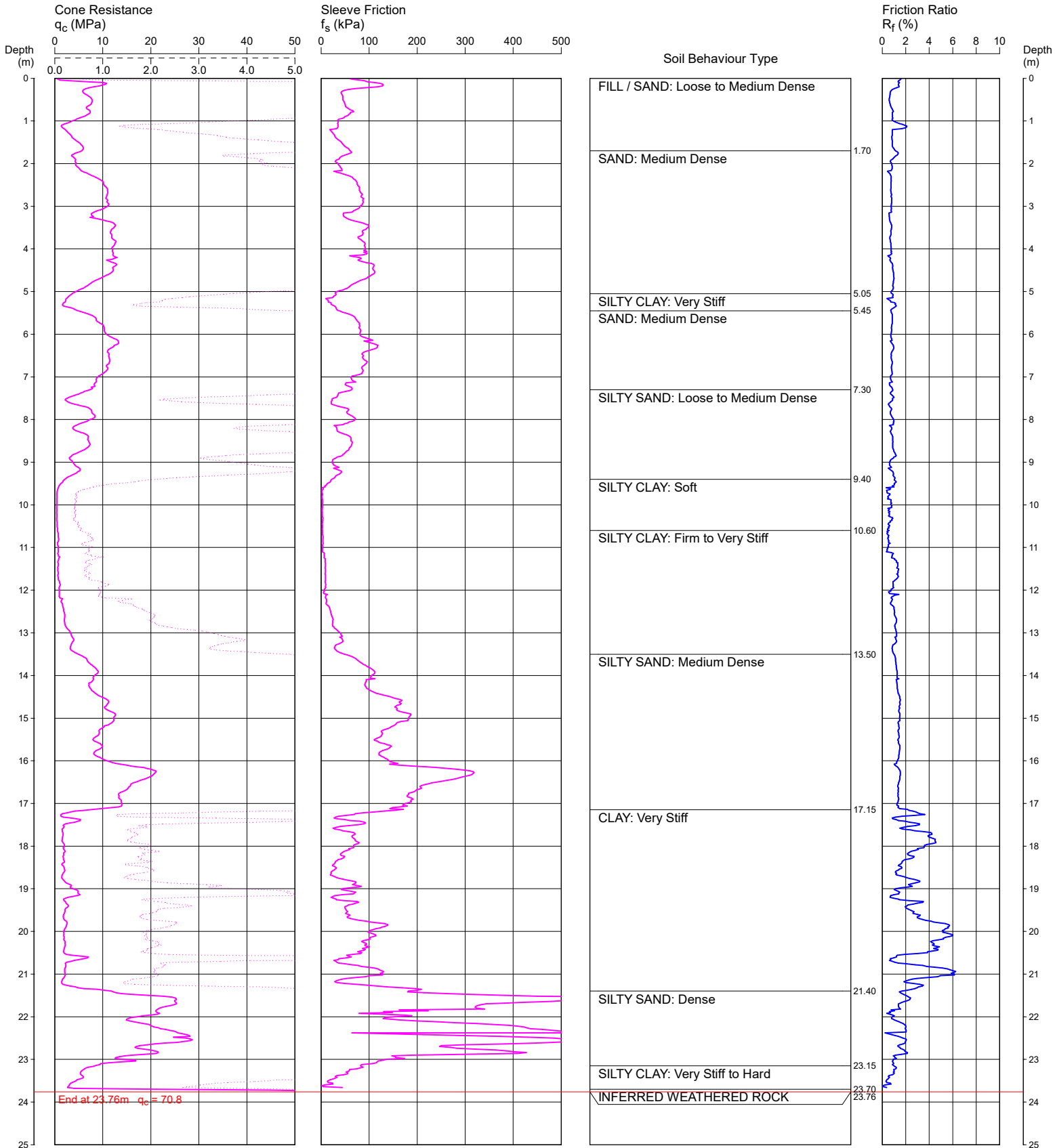
COORDINATES: 342209.0E 6269638.7N

**CPT107**

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DATE 14/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE BENDING NEAR REFUSAL  
HOLE COLLAPSE MEASURED AT 1.0m AFTER REMOVAL OF RODS



# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 2.1 AHD

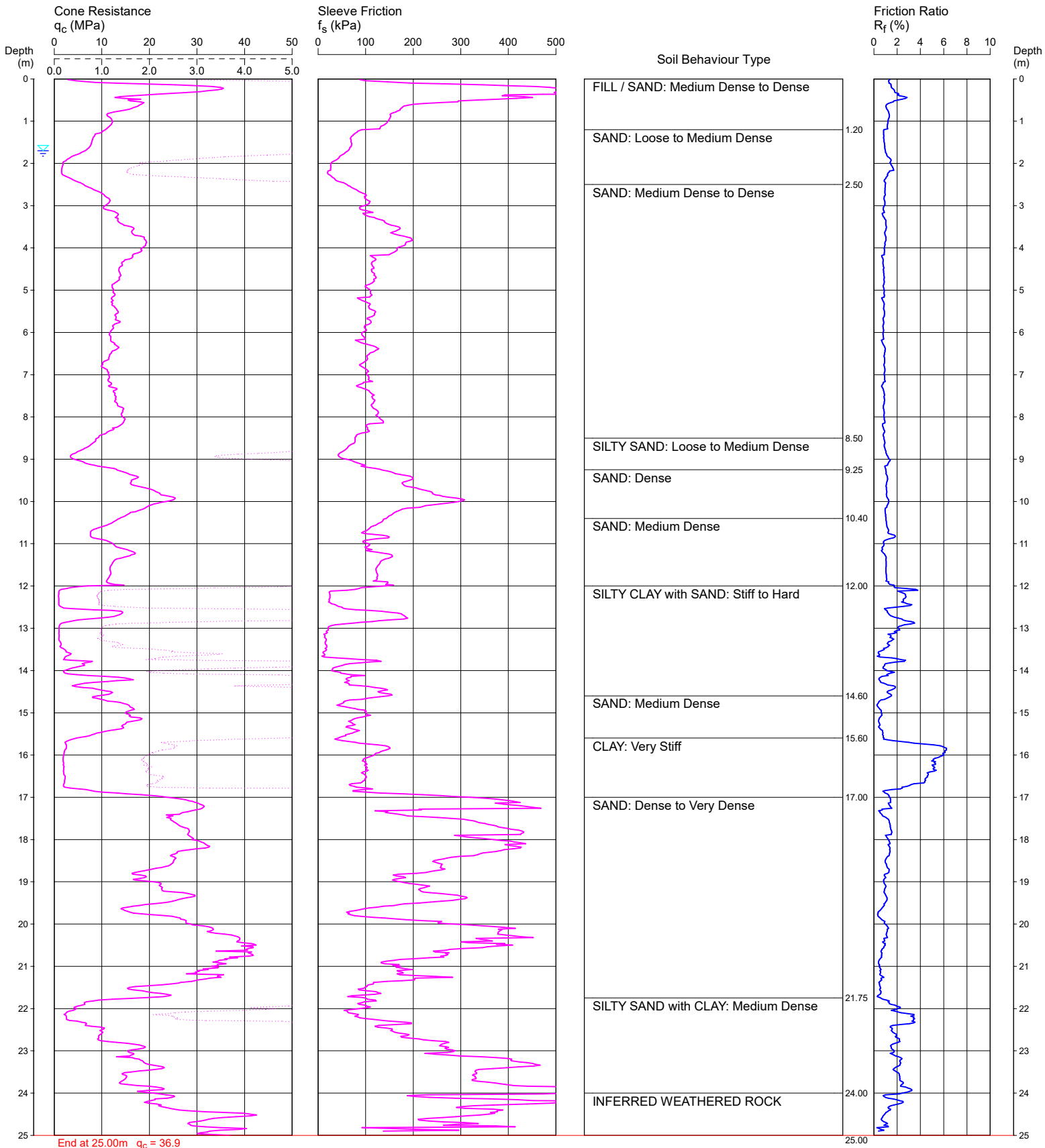
COORDINATES: 342248.5E 6269728.1N

## CPT108

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DATE 14/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED AT TARGET DEPTH  
GROUNDWATER MEASURED AT 1.7m AFTER REMOVAL OF RODS

Water depth after test: 1.70m depth (measured)

File: P:\86973.00 - NARRABEEN, Public and High School, Geo\4.0 Field Work\4.2 Testing\CPT108.CP5

Cone ID: 161225

Type: I-CFYX-10

ConePlot Version 5.9.2  
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# CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION  
PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

REDUCED LEVEL: 2.2 AHD

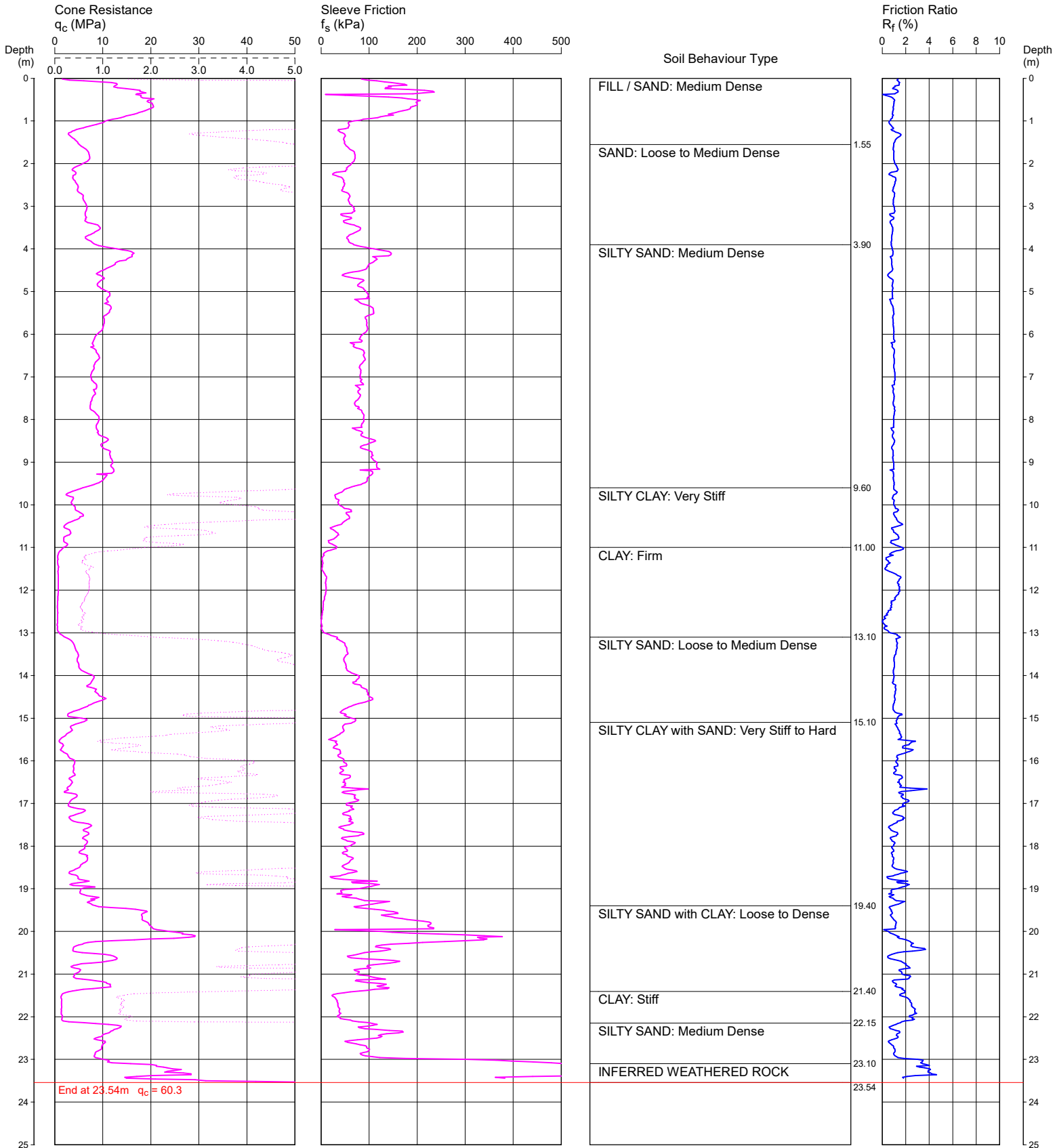
COORDINATES: 342192.0E 6269605.7N

**CPT109**

Page 1 of 1

DATE 14/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL  
HOLE COLLAPSE MEASURED AT 1.7m AFTER REMOVAL OF RODS

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 4.3 AHD  
**EASTING:** 342285.8  
**NORTHING:** 6269998.5  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH01  
**PROJECT No:** 86973.01  
**DATE:** 23/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
	0.05	ASPHALTIC CONCRETE	■	E	0.05		PID<1ppm		
	0.15	FILL/Gravelly SAND SP: fine to coarse, brown, igneous, trace silt, moist	▨	E*	0.4		PID<1ppm		
	0.6	FILL/Silty SAND SM: fine to medium, dark grey, trace ash, moist	▩	E	0.9		PID<1ppm		
	1.0	SAND SP: fine to medium, pale grey, moist, alluvial and estuarine	●	E	1.4		PID<1ppm		
	1.5	Silty SAND SM: fine to coarse, dark brown, indurated, moist, alluvial and estuarine	·	E	1.9		PID<1ppm		
	2.0	Bore discontinued at 2.0m - Target Depth Reached		E	2.0		PID<1ppm		

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Push tube to 2.0m

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD1/20200123 taken at 0.4-0.5m

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

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 4.5 AHD  
**EASTING:** 342229.9  
**NORTHING:** 6269957.2  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH03  
**PROJECT No:** 86973.01  
**DATE:** 22/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
	0.1	FILL/TOPSOIL (Silty SAND) SM: fine to medium, dark brown, trace rootlets, moist		F	0.0		PID<1ppm		
	0.1			F	0.1		PID<1ppm		
	0.35	FILL/Silty SAND SM: fine to coarse, brown and orange-brown, moist		F	0.2		PID<1ppm		
	0.5			F	0.3		PID<1ppm		
	0.8	FILL/Silty SAND SM: fine to medium, dark grey, trace ash and charcoal, moist			0.35				
	1.0				0.45				
	1.0	FILL/SAND SP: fine to medium, grey, trace ash, moist (possible natural)		E	0.9		PID<1ppm		1
	1.0			E	1.0				
	1.4	SAND SP: fine to medium, grey, moist, alluvial and estuarine		E	1.4		PID<1ppm		
	1.5			E	1.5				
	1.9	- From 1.0m: pale grey	E	1.9		PID<1ppm		2	
	2.0		E	2.0					
	2.65	SAND SP: fine to medium, dark brown, trace rootlets, indurated, moist, alluvial and estuarine							
	3.0	Bore discontinued at 3.0m - Target Depth Reached, refusal on coffee rock						3	
	4.0							4	
	5.0							5	
	6.0							6	
	7.0							7	
	8.0							8	
	9.0							9	

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Push tube to 3.0m

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 2.9 AHD  
**EASTING:** 342213.9  
**NORTHING:** 6270007.2  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH04  
**PROJECT No:** 86973.01  
**DATE:** 21/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			Results & Comments
	0.1	FILL/TOPSOIL (Silty SAND) SM: fine to coarse, dark brown, trace rootlets, moist  FILL/Gravelly CLAY CH: medium to high plasticity, orange-brown, ironstone, sandstone, igneous, trace silt, w~PL  SAND SP: fine to medium, grey, moist, alluvial and estuarine - From 0.4m: fine, pale grey		E	0.0		PID<1ppm	Well Plug and Flush Gatic Cover Concrete 0-0.15m  Bentonite 0.15-0.9m Plain PVC 0-1.5m  1  2  3 Machine Slotted PVC Screen 1.5-4.5m  4  5 End Cap	
	0.3			E	0.1		PID<1ppm		
				E	0.3				
				E	0.4				PID<1ppm
				E	0.5				
	0.9			E	0.9		PID<1ppm		
	1.0			E	1.0				
	1.5			E	1.5		PID<1ppm		
	1.6			E	1.6				
	2.1	- From 2.0m: wet		E**	2.4		PID<1ppm		
		SAND SP: fine to medium, brown and dark brown, indurated, wet, alluvial and estuarine		E**	2.5				
	3.5			E	3.5			Gravel 0.9-4.5m	
	3.6	Sandy CLAY CL: low plasticity, brown and dark brown, fine to medium sand, trace sub-rounded gravel, wet, alluvial and estuarine		E	3.5		PID<1ppm		
	4.0			E	4.0				
	4.5			E	4.5			PID<1ppm	
	5.0			E	5.0				
	5.2	SAND SP: fine to medium, yellow-brown, trace sub-rounded gravel, saturated, alluvial and estuarine		E	5.5		PID<1ppm		
	6.0			E	6.0				
	6.5			E	6.5			PID<1ppm	
	7.0			E	7.0				
	7.5			E	7.5			PID<1ppm	
	8.0	Bore discontinued at 8.0m - Target Depth Reached		E	8.0				

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Push tube to 2.0m, Solid flight augers (TC-bit) to 8.0m

**WATER OBSERVATIONS:** Free groundwater observed whilst push tubing at 2.0m

**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD4/20200121 taken from 0.1-0.3m, \*\*Blind replicate sample BD5/20200121 taken from 2.4-2.5m

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

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 4.7 AHD  
**EASTING:** 342193.8  
**NORTHING:** 6269948.2  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH05  
**PROJECT No:** 86973.01  
**DATE:** 22/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
0.15 0.4 0.8 1 1.5 2 3 4 5 6 7 8 9	0.15	FILL/TOPSOIL (Silty SAND) SM: fine to coarse, brown, trace rootlets, gravel, moist		E	0.0 0.1		PID<1ppm		
		FILL/Silty SAND SM: fine to coarse, grey, trace ash and charcoal, moist		E	0.4 0.5		PID<1ppm		
		Silty SAND SM: fine to medium, grey and pale grey, moist, alluvial and estuarine		E	0.9 1.0		PID<1ppm	1	
				E	1.4 1.5		PID<1ppm		
				E	1.9 2.0		PID<1ppm	2	
				E*	2.9 3.0		PID<1ppm	3	
		3.0	Bore discontinued at 3.0m - Target Depth Reached						

**RIG:** MD-200                      **DRILLER:** Tightsite                      **LOGGED:** LT                      **CASING:** Uncased  
**TYPE OF BORING:** Push tube to 3.0m  
**WATER OBSERVATIONS:** No free groundwater observed  
**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD8/20200122 taken from 2.9-3.0m

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





# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 4.7 AHD  
**EASTING:** 342195.8  
**NORTHING:** 6269907.2  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH06  
**PROJECT No:** 86973.01  
**DATE:** 22/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details
				Type	Depth	Sample		
	0.03	ASPHALTIC CONCRETE	[X]	E	0.05			Well Plug and Flush Gatic Cover Concrete 0-0.15m  Backfill 0.15-1.3m  Plain PVC 0-2.8m  Bentonite 1.3-2.3m  Gravel 2.3-5.8m  Machine slotted PVC Screen 2.8-5.8m  End Cap
	0.2	FILL/Silty SAND SM: fine to medium, dark grey, trace ash, moist	[X]	E	0.15		PID<1ppm	
			[X]	E	0.4		PID<1ppm	
		SAND SP: fine to medium, grey, moist	[D]	E	0.5			
		From 0.7m: pale grey	[D]	E	0.9		PID<1ppm	
			[D]	E	1.0			
			[D]	E*	1.4		PID<1ppm	
			[D]	E*	1.5			
			[D]	E	1.9		PID<1ppm	
			[D]	E	2.0			
	2.3	SAND SP: fine to medium, brown and red-brown, indurated, moist, alluvial and estuarine	[D]	A	2.4		PID<1ppm	
			[D]	A	2.5			
	3.2	SAND SP: fine to medium, pale grey, moist, alluvial and estuarine	[D]					
	6.0	Bore discontinued at 6.0m - Target Depth Reached						

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Push tube to 3.0m, Solid flight augers (TC-bit) to 6.0m

**WATER OBSERVATIONS:** Free groundwater observed whilst augering at 4.0m

**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD4/20200122 taken from 1.4-1.5m

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

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 4.3 AHD  
**EASTING:** 342224.6  
**NORTHING:** 6269898.6  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH07  
**PROJECT No:** 86973.01  
**DATE:** 22/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
	0.03	ASPHALTIC CONCRETE	█	E	0.05				
	0.05	ROADBASE: gravel, igneous <20mm	▨	E	0.15				
		FILL/Silty SAND SM: fine to medium, dark grey, trace ash, moist	▩	E	0.4				
	0.7	SAND SP: fine to medium, pale grey, moist, alluvial and estuarine	▩	E	0.9				
			▩	E*	1.0				
			▩	E	1.4				
			▩	E	1.5				
			▩	E	1.9				
			▩	E	2.0				
			▩	E	2.4				
	2.5	Bore discontinued at 2.5m - Target Depth Reached	▩	E	2.5				

**RIG:** MD-200                      **DRILLER:** Tightsite                      **LOGGED:** LT                      **CASING:** Uncased  
**TYPE OF BORING:** Push tube to 2.5m  
**WATER OBSERVATIONS:** No free groundwater observed  
**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD5/20200122 taken from 1.4-1.5m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 4.2 AHD  
**EASTING:** 342263.8  
**NORTHING:** 6269899.7  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH08  
**PROJECT No:** 86973.01  
**DATE:** 22/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
	0.03	ASPHALTIC CONCRETE	▬	E	0.05		PID<1ppm		
	0.05	ROADBASE: gravel, igneous <20mm	▨	E	0.15		PID<1ppm		
	0.15			E	0.4		PID<1ppm		
		FILL/Silty SAND SM: fine to coarse, dark grey, trace ash and chemical, moist	▩	E	0.5		PID<1ppm		
	0.9	FILL/Silty SAND SM: fine to medium, grey, trace ash, moist	▩	E	0.9		PID<1ppm	1	
	1.0	Silty SAND SM: fine to medium, grey, moist, alluvial and estuarine	▩	E	1.0		PID<1ppm		
	1.4			E	1.4		PID<1ppm		
	1.5			E	1.5		PID<1ppm		
	1.7	Silty SAND SM: fine to medium, brown and red-brown, indurated, moist, alluvial and estuarine	▩	E*	1.9		PID<1ppm	2	
	2.0			E	2.0		PID<1ppm		
	2.5			E	2.5		PID<1ppm		
	2.5	Bore discontinued at 2.5m - Target Depth Reached							

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Push tube to 2.5m

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD6/20200122 taken from 1.9-2.0m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	▷	Water seep
E	Environmental sample	≡	Water level
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 4.2 AHD  
**EASTING:** 342223.1  
**NORTHING:** 6269873  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH09  
**PROJECT No:** 86973.01  
**DATE:** 22/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details			
				Type	Depth	Sample					
4 3 2 1 0 1 2 3 4 5 6 7 8 9	0.7	FILL/Silty SAND SM: fine to coarse, dark grey, trace plastic, ash, moist	[Cross-hatched pattern]	E	0.0	Sample	Results & Comments	Water			
					0.1						PID<1ppm
					0.2						PID<1ppm
					0.4						PID<1ppm
					0.5						PID<1ppm
		1.0	SAND SP: fine, pale grey, moist, alluvial and estuarine	[Dotted pattern]	E**	0.9	PID<1ppm	1			
					1.0	PID<1ppm					
					1.4	PID<1ppm					
					1.5	PID<1ppm					
					1.9	PID<1ppm					
		2.0	SAND SP: fine to coarse, dark brown, wet, alluvial and estuarine	[Dotted pattern]	E	2.4	PID<1ppm	2			
					2.5	PID<1ppm					
					2.9	PID<1ppm					
					3.0	PID<1ppm					
					3.1	PID<1ppm					
	3.0	SAND SP: fine to coarse, dark brown, wet, alluvial and estuarine - From 3.3m: saturated	[Dotted pattern]	E	3.2	PID<1ppm	3	▼			
				3.4	PID<1ppm						
				3.5	PID<1ppm						
				4.0	PID<1ppm						
				4.5	PID<1ppm Slight Sulfidic Odour						
	3.5	Silty SAND SM: fine to coarse, brown and yellow-brown, trace shells, saturated, alluvial and estuarine	[Vertical dashed pattern]	E	5.0	PID<1ppm Slight Sulfidic Odour and Stain	4				
				5.5	PID<1ppm						
				6.0	PID<1ppm						
				6.5	PID<1ppm						
				7.0	PID<1ppm						
	4.0	Bore discontinued at 8.0m - Target Depth Reached	[Vertical dashed pattern]	E	7.5	PID<1ppm	5				
				8.0	PID<1ppm						
				8.0	PID<1ppm						
				8.0	PID<1ppm						
				8.0	PID<1ppm						

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Push tube to 3.0m, Solid flight augers (TC-bit) to 8.0m

**WATER OBSERVATIONS:** Free groundwater observed whilst augering at 3.3m

**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD2/20200121 taken from 0.4-0.5m, \*\*Blind replicate sample BD3/20200121 taken from 0.9-1.0, Bulk sample for CBR taken from 0.2-0.8m

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

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 3.8 AHD  
**EASTING:** 342270.9  
**NORTHING:** 6269850.6  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH10  
**PROJECT No:** 86973.01  
**DATE:** 22/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details
				Type	Depth	Sample		
	0.2	FILL/TOPSOIL (Silty SAND) SM: fine to medium, dark brown, with clay, trace rootlets, moist		E	0.0		PID<1ppm	Well Plug and Flush Gatic Cover Concrete 0-0.15m Backfill 0.15-0.5m
	0.35			E	0.1		PID<1ppm	
		FILL/Silty CLAY CL-CH: low to medium plasticity, orange and brown, with sand and ironstone gravel, trace rootlets, moist		E	0.2		PID<1ppm	Plain PVC 0-2.0m Bentonite 0.5-1.5m
				E	0.3		PID<1ppm	
		Silty SAND SM: fine to medium, grey, dry, alluvial and estuarine - From 0.8m: pale grey		E*	0.4			
				E	0.5			
		Silty SAND SM: fine to medium, dark brown, indurated, moist, alluvial and estuarine		E	0.9		PID<1ppm	
				E	1.0		PID<1ppm	
		Silty SAND SM: fine to medium, dark brown, indurated, moist, alluvial and estuarine		E	1.4		PID<1ppm	
				E	1.5		PID<1ppm	
		Silty SAND SM: fine to medium, dark brown, indurated, moist, alluvial and estuarine		E	1.9		PID<1ppm	
				E	2.0		PID<1ppm	
		Silty SAND SM: fine to medium, dark brown, indurated, moist, alluvial and estuarine		E	2.4		PID<1ppm	
				E	2.5		PID<1ppm	
		Silty SAND SM: fine to medium, dark brown, indurated, moist, alluvial and estuarine		E	2.9		PID<1ppm	
				E	3.0		PID<1ppm	
		- From 3.1m: wet						
	3.3	SAND SM-SC: fine to medium, brown and yellow-brown, trace silt and clay, wet, alluvial and estuarine		A	4.0		PID<1ppm	Gravel 1.5-6.0m Machine Slotted PVC Screen 2.0-6.0m
				A	4.5		PID<1ppm	
		- From 5.1m: silty						
	6.0	Bore discontinued at 6.0m - Target Depth Reached						End cap

**RIG:** MD-200      **DRILLER:** Tightsite      **LOGGED:** LT      **CASING:** Uncased  
**TYPE OF BORING:** Push tube to 3.0m, Solid flight augers (TC-bit) to 6.0m  
**WATER OBSERVATIONS:** Free groundwater observed whilst augering at 3.1m  
**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD1/20200121 taken from 0.9-1.0m,

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

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 4.2 AHD  
**EASTING:** 342289.3  
**NORTHING:** 6269918.2  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH11  
**PROJECT No:** 86973.01  
**DATE:** 22/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.05	ASPHALTIC CONCRETE	[Symbol]							
	0.25	ROADBASE: gravel, igneous <20mm	[Symbol]	E	0.3		PID<1ppm			
		FILL/Silty SAND SM: fine to medium, grey, trace roots, moist	[Symbol]	E*	0.4					
			[Symbol]	E*	0.9		PID<1ppm			
	1.0		[Symbol]		1.0					
	1.3	Silty SAND SM: fine to medium, pale brown and pale grey, trace roots, moist, alluvial and estuarine	[Symbol]	E	1.5		PID<1ppm			
		- From 1.5m: pale brown	[Symbol]	E	1.7					
			[Symbol]	E	1.9		PID<1ppm			
			[Symbol]	E	2.0					
	2.3	Silty SAND SM: fine to medium, dark grey, moist, alluvial and estuarine	[Symbol]	E	2.4		PID<1ppm			
			[Symbol]	E	2.5					
	3.0	Bore discontinued at 3.0m - Target Depth Reached	[Symbol]	E	2.9		PID<1ppm			
			[Symbol]	E	3.0					

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Push tube to 3.0m

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD7/20200122 taken from 0.9-1.0m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 4.4 AHD  
**EASTING:** 342259.1  
**NORTHING:** 6269921.8  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH12  
**PROJECT No:** 86973.01  
**DATE:** 22/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.03	ASPHALTIC CONCRETE	[Cross-hatched pattern]	E	0.05		PID<1ppm			
	0.2	FILL/Silty SAND SM: fine to medium, dark grey, trace ash and charcoal, moist	[Dotted pattern]	E	0.15		PID<1ppm			
		SAND SP: fine to medium, pale grey, trace ash, dry, alluvial and estuarine	[Dotted pattern]	E	0.4		PID<1ppm			
			[Dotted pattern]	E	0.5		PID<1ppm			
			[Dotted pattern]	E	0.9		PID<1ppm	1		
			[Dotted pattern]	E	1.0		PID<1ppm			
			[Dotted pattern]	E	1.4		PID<1ppm			
			[Dotted pattern]	E	1.5		PID<1ppm			
	1.5	Bore discontinued at 1.5m - Target Depth Reached								
	2							2		
	3							3		
	4							4		
	5							5		
	6							6		
	7							7		
	8							8		
	9							9		

**RIG:** MD-200                      **DRILLER:** Tightsite                      **LOGGED:** LT                      **CASING:** Uncased  
**TYPE OF BORING:** Push tube to 1.5m  
**WATER OBSERVATIONS:** No free groundwater observed  
**REMARKS:** Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 4.0 AHD  
**EASTING:** 342230.9  
**NORTHING:** 6269984.8  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH13  
**PROJECT No:** 86973.01  
**DATE:** 22/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample		Results & Comments	
	0.1	FILL/Silty SAND SM: fine to coarse, brown and dark brown, trace rootlets, moist	[Cross-hatch pattern]	E	0.0 0.1		PID<1ppm		
		FILL/Silty SAND SM: fine to medium, dark grey, trace ash, moist	[Cross-hatch pattern]	E	0.4 0.5		PID<1ppm		
	0.8	SAND SP: fine to medium, pale grey, moist	[Dotted pattern]	E	0.9 1.0		PID<1ppm	1	
			[Dotted pattern]	E	1.4 1.5		PID<1ppm		
			[Dotted pattern]	E	1.9 2.0		PID<1ppm	2	
	2.5	Bore discontinued at 2.5m - Target Depth Reached							
	3							3	
	4							4	
	5							5	
	6							6	
	7							7	
	8							8	
	9							9	

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Push tube to 2.5m

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 2.1 AHD  
**EASTING:** 342269.2  
**NORTHING:** 6269752.5  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH102  
**PROJECT No:** 86973.01  
**DATE:** 23/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.3	FILL/Silty SAND SM: fine to coarse, dark brown, trace clay and rootlets, moist		E	0.0		PID<1ppm			
				B	0.03					
	1.0	FILL/SAND SW: fine to coarse, pale brown, trace gravel, concrete and glass, moist		E	0.1		PID<1ppm			
				E	0.4					
				B	0.5					
				E*	1.0					
	1.0	Silty SAND SM: fine to medium, dark grey, moist, alluvial and estuarine		E*	1.1		PID<1ppm			
				E	1.4					
	2.0	Bore discontinued at 2.0m - Target Depth Reached		E	1.5		PID<1ppm			
2										
3										
4										
5										
6										
7										
8										
9										

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Solid flight augers (TC-bit) to 0.5m, Push tube to 2.0m

**WATER OBSERVATIONS:** Free groundwater observed whilst push tubing at 1.3m

**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD4/20200123 taken at 1.0-1.1m, Bulk sample for CBR taken from 0.5-1.0m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 1.9 AHD  
**EASTING:** 342186.3  
**NORTHING:** 6269783  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH103  
**PROJECT No:** 86973.01  
**DATE:** 20/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
	0.03	ASHPALTIC CONCRETE	[Cross-hatched pattern]	A	0.15		PID=5ppm		
	0.12	CONCRETE: grey with aggregate <20mm	[Cross-hatched pattern]	A	0.25		PID<1ppm		
	0.4	FILL/SAND SW: fine to coarse, brown, with sandstone gravels and cobbles, trace shells, moist	[Dotted pattern]	A	0.4				
		SAND SP: fine to medium, pale grey, moist, alluvial and estuarine	[Dotted pattern]	E	0.5				
	1.0				1.0			1	
	1.4			E*	1.4		PID<1ppm	▼	
	1.5	Bore discontinued at 1.5m - Target Depth Reached			1.5				
	2.0							2	
	3.0							3	
	4.0							4	
	5.0							5	
	6.0							6	
	7.0							7	
	8.0							8	
	9.0							9	

**RIG:** MD-200      **DRILLER:** Tightsite      **LOGGED:** LT      **CASING:** Uncased  
**TYPE OF BORING:** Solid flight augers (TC-bit) to 0.5m, Push Tube to 1.5m  
**WATER OBSERVATIONS:** Free groundwater observed whilst push tubing at 1.5m  
**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD1/20200120 taken at 1.4-1.5m

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



# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 2.3 AHD  
**EASTING:** 342153.3  
**NORTHING:** 6269733.5  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH104  
**PROJECT No:** 86973.01  
**DATE:** 21/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details			
				Type	Depth	Sample			Results & Comments		
	0.2	FILL/TOPSOIL (Silty SAND) SM: fine to medium, dark brown, trace rootlets, moist		A*	0.0		PID<1ppm				
		FILL/SAND SW: fine to coarse, pale brown, with shell fragments, moist		A	0.1						
					0.4		PID<1ppm				
					0.5						
	0.9	FILL/Silty CLAY CL-CH: low to medium plasticity, dark brown, trace rootlets and organic matter, moist (possible original topsoil)		A	0.9		PID<1ppm				
	0.95			E	0.95		PID<1ppm				
					1.0						
					1.4		PID<1ppm				
					1.5						
	1.38	FILL/SAND SW: fine to coarse, pale yellow-brown, with shell fragments, moist		E	1.4		PID<1ppm				
		Silty SAND SM: fine to medium, grey, trace shells, moist, alluvial and estuarine		E	1.9		PID<1ppm				
		- From 1.6m: dark grey, wet			2.0						
		- From 2.3m: with organic matter			2.4		PID<1ppm				
					2.5						
	2.7	SAND SP: fine to medium, dark grey, trace shells, wet, alluvial and estuarine			3.5		PID<1ppm				
	- From 3.5m: saturated	E		4.0							
					4.5		PID<1ppm				
					5.0						
					5.5		PID<1ppm				
					6.0						
					6.5		PID<1ppm				
					7.0						
					7.5		PID<1ppm				
					8.0						
	8.0	Bore discontinued at 8.0m - Target Depth Reached									

**RIG:** MD-200      **DRILLER:** Tightsite      **LOGGED:** LT      **CASING:** HW Cased to 6.0m  
**TYPE OF BORING:** Solid flight augers (TC-bit) to 0.5m, Push tube to 6.0m, Wash bore to 8.0m  
**WATER OBSERVATIONS:** Free groundwater observed whilst push tubing at 1.6m  
**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD3/20200120 taken from 0-0.1m

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



# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 2.2 AHD  
**EASTING:** 342146.9  
**NORTHING:** 6269682.5  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH105  
**PROJECT No:** 86973.01  
**DATE:** 20/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details			
				Type	Depth	Sample					
2 1 0 -1 -2 -3 -4 -5 -6 -7 -8 -9	0.2	FILL/TOPSOIL (Silty SAND) SM: fine to medium, dark brown, trace rootlets, moist	[Cross-hatched pattern]	A	0.0 0.1		PID<1ppm	1 2			
		FILL/SAND SW: fine to coarse, brown, trace shells and gravel, moist		A	0.4 0.5		PID<1ppm				
				E	0.9 1.0		PID=1ppm				
	1.4	- From 1.3m : dark brown		E	1.3		PID<1ppm				
		Silty SAND SM: fine to medium, grey, moist, alluvial and estuarine		E	1.4 1.5		PID<1ppm PID<1ppm				
		- From 1.62m: wet		E	1.9 2.0		PID<1ppm				
	2.5	Bore discontinued at 2.5m - Target Depth Reached		E	2.4 2.5		PID<1ppm				

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Solid flight augers (TC-bit) to 0.5m, Push tube to 2.5m

**WATER OBSERVATIONS:** Free groundwater observed whilst push tubing at 1.62m

**REMARKS:** Location coordinates are in MGA94 Zone 56.

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



# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 2.1 AHD  
**EASTING:** 342210.2  
**NORTHING:** 6269674.3  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH106  
**PROJECT No:** 86973.01  
**DATE:** 22/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details
				Type	Depth	Sample		
	0.15	FILL/TOPSOIL (Silty SAND) SM: fine to medium, dark brown, trace rootlets, moist		E	0.0		PID<1ppm	
				E	0.1		PID<1ppm	
	0.5	FILL/SAND SP: fine to medium, brown, trace glass, moist		E	0.3		PID<1ppm	
				E	0.4		PID<1ppm	
				E	0.5		PID<1ppm	
	1	FILL/Sandy CLAY CH: medium to high plasticity, mottled red, yellow-brown, pale-brown and pale grey, with igneous, sandstone and ironstone gravel, trace clinker, moist		E	0.9		PID<1ppm	
				E	1.0		PID<1ppm	
	1.48	Silty SAND SM: fine to medium, grey, wet, alluvial and estuarine		E	1.4		PID<1ppm	
	2			E	1.5		PID<1ppm	
				E	1.9		PID<1ppm	
		E		2.0		PID<1ppm		
2.5	SAND SP: fine to medium, grey, saturated, alluvial and estuarine		E	2.9		PID<1ppm		
			E	3.0		PID<1ppm		
4.0	Bore discontinued at 4.0m - Target Depth Reached						End Cap	

**RIG:** MD-200      **DRILLER:** Tightsite      **LOGGED:** LT      **CASING:** Uncased  
**TYPE OF BORING:** Push tube to 3.0m, Solid flight augers (TC-bit) 4.0m  
**WATER OBSERVATIONS:** Free groundwater observed whilst push tubing at 1.5m  
**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD2/20200122 taken from 0.4-0.5m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 2.0 AHD  
**EASTING:** 342209  
**NORTHING:** 6269638.7  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH107  
**PROJECT No:** 86973.01  
**DATE:** 22/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
	0.28	FILL/Silty SAND SM: fine to coarse, dark brown, trace rootlets, moist	[Cross-hatch pattern]	E	0.0 0.1		PID<1ppm		
	0.72	FILL/SAND SW: fine to coarse, pale yellow-brown, trace shells, dry to moist	[Cross-hatch pattern]	E*	0.4 0.5		PID<1ppm		
	1.0	FILL/SAND SW: fine to coarse, pale brown, with shell fragments, moist to wet	[Cross-hatch pattern]	E	0.9 1.0		PID<1ppm	1	
	1.5	FILL/Silty SAND SM: fine to medium, dark grey, trace ash, wet	[Cross-hatch pattern]	E	1.4 1.5		PID<1ppm	▼	
	1.7	SAND SP: fine to medium, grey, wet, alluvial and estuarine	[Dotted pattern]	E	1.9 2.0		PID<1ppm	2	
	2.5	- From 2.5m: dark grey	[Dotted pattern]	E	2.4 2.5		PID<1ppm		
	3.0	Bore discontinued at 3.0m - Target Depth Reached	[Dotted pattern]	E	2.9 3.0		PID<1ppm	3	
	4.0							4	
	5.0							5	
	6.0							6	
	7.0							7	
	8.0							8	
	9.0							9	

**RIG:** MD-200      **DRILLER:** Tightsite      **LOGGED:** LT      **CASING:** Uncased  
**TYPE OF BORING:** Push tube to 3.0m  
**WATER OBSERVATIONS:** Free groundwater observed whilst push tubing at 1.5m  
**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD1/20200122 taken at 0.4-0.5m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 2.1 AHD  
**EASTING:** 342248.5  
**NORTHING:** 6269728.1  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH108  
**PROJECT No:** 86973.01  
**DATE:** 23/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details		
				Type	Depth	Sample	Results & Comments				
0.3 0.7 1 1.2 2 2.5	0.0 - 0.1	FILL/TOPSOIL (Silty SAND) SM : fine to coarse, dark brown, with gravel, trace rootlets and ash, moist	[Cross-hatched pattern]	E <sup>t</sup>	0.0 0.1		PID<1ppm	1 2			
	0.4 - 0.5	FILL/Silty SAND SM: fine to medium, brown, trace gravel, rootlets and ash, moist	[Cross-hatched pattern]	E	0.4 0.5		PID<1ppm				
	0.9 - 1.0	FILL/SAND SW: fine to coarse, pale brown, trace shell, moist	[Cross-hatched pattern]	E	0.9 1.0		PID<1ppm				
	1.4 - 1.5	SAND SP: fine to medium, pale grey, moist, alluvial and estuarine - From 1.5m: wet	[Dotted pattern]	E	1.4 1.5		PID<1ppm				▼
	1.9 - 2.0	- From 2.1m: saturated	[Dotted pattern]	E	1.9 2.0		PID<1ppm				
	2.5		Bore discontinued at 2.5m - Target Depth Reached								
3 4 5 6 7 8 9								3 4 5 6 7 8 9			

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Push tube 2.5m

**WATER OBSERVATIONS:** Free groundwater observed whilst push tubing at 1.5m

**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD3/20200123 taken at 0.0-0.1m

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



# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 2.2 AHD  
**EASTING:** 342192  
**NORTHING:** 6269605.7  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH109  
**PROJECT No:** 86973.01  
**DATE:** 22/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details		
				Type	Depth	Sample				Results & Comments
2 1 0 -1 -2 -3 -4 -5 -6 -7 -8 -9	0.2	FILL/TOPSOIL (Silty SAND) SM: dark brown, trace rootlets, moist		E	0.0		PID<1ppm	1 2 3 4 5 6 7 8 9		
	0.1			E	0.1					
	0.3			E	0.3					
	0.5	FILL/SAND SW: fine to coarse, pale brown, trace brick, moist		E	0.5					PID<1ppm
	0.9	FILL/SAND SW: fine to coarse, pale brown, trace shells, moist		E*	0.9					PID<1ppm
	1.0			E	1.0					
	1.4			E	1.4					
	1.45	FILL/Silty SAND SM: dark grey, fine to coarse grained, trace rootlets, wet		E	1.45					PID<1ppm
	1.55			E	1.55					
	1.9	SAND SP: grey, fine to medium grained, wet, alluvial and estuarine		E	1.9					PID<1ppm
2.0		E	2.0			PID<1ppm				
2.4		E	2.4			PID<1ppm				
2.5	- 2.4m: dark grey, sulphidic odour, mottled brown colour	E	2.5			Slight Sulfidic Odour				
2.9	= 2.7m: wuth shells to 2.9m, slight to no odour	E	2.9			PID<1ppm				
3.0	Bore discontinued at 3.0m - Target Depth Reached	E	3.0			PID<1ppm				

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Push tube to 3.0m

**WATER OBSERVATIONS:** Free groundwater observed whilst push tubing at 1.45m

**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD3/20200122 taken from 0.9-1.0

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		gp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 2.2 AHD  
**EASTING:** 342180.6  
**NORTHING:** 6269708.6  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH110  
**PROJECT No:** 86973.01  
**DATE:** 23/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
2 1 0 -1 -2 -3 -4 -5 -6 -7 -8 -9	0.05	FILL/Silty SAND SM: fine to medium, dark brown, trace roots, moist		A	0.1		PID<1ppm	1 2 3 4 5 6 7 8 9		
	0.2			A	0.2		PID<1ppm			
	0.35			A	0.3		PID<1ppm			
	0.6	FILL/Silty SAND SM: fine to medium, dark brown, moist		A	0.4		PID<1ppm			
	0.6			A	0.5					
	1	SAND SC: fine to medium, pale brown with gravel, trace clay, moist, alluvial and estuarine		A	0.9		PID<1ppm			
	1.1	SAND SW: fine to coarse, pale brown, trace shells, moist, alluvial and estuarine		A	1.2		PID<1ppm			
	1.1			A	1.3		PID<1ppm			
	1.5			A	1.4		PID<1ppm			
	1.5	SAND SW: fine to coarse, dark grey, moist, alluvial and estuarine			1.5					
	2	- From 1.5m: fine to medium, pale grey Bore discontinued at 1.5m - Target Depth Reached								

**RIG:** Hand Tools

**DRILLER:** LT/TB

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Hand auger to 1.5m

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** Location coordinates are in MGA94 Zone 56.

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

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 2.1 AHD  
**EASTING:** 342166.6  
**NORTHING:** 6269590.6  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH111  
**PROJECT No:** 86973.01  
**DATE:** 20/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			Results & Comments
	0.0 - 0.1	FILL/Silty SAND SM: fine to medium, dark brown, trace shells, gravel, organics and plastic, moist		A	0.0				
	0.1 - 0.4			A	0.4				PID<1ppm
	0.4 - 0.5	FILL/SAND SW: fine to coarse, pale brown, trace shells, moist		E*	0.9				
	0.5 - 0.9			E*	1.0				PID<1ppm
	0.9 - 1.4	FILL/SAND SM: fine to coarse, dark grey, trace organic matter, ash and clay, moist		E	1.4				
	1.4 - 1.7			E	1.5				PID<1ppm
	1.7 - 1.9	SAND SP: fine to medium, grey and pale grey, trace roots and shell fragments, wet, alluvial and estuarine		E	1.9				
	1.9 - 2.0			E	2.0				PID<1ppm
	2.0 - 2.4			E	2.4				PID<1ppm
	2.4 - 2.5			E	2.5				PID<1ppm
	2.5 - 3.0			E	3.0				PID<1ppm
	3.0 - 3.5			E	3.5				PID<1ppm
	3.5 - 4.0			E	4.0				PID<1ppm
	4.0 - 4.5			E	4.5				PID<1ppm
	4.5 - 5.0			E	5.0				PID<1ppm
5.0 - 5.5	E			5.5	PID<1ppm				
5.5 - 6.0	E	6.0	PID<1ppm						
6.0 - 6.5	E	6.5	PID<1ppm						
6.5 - 7.0	E	7.0	PID<1ppm						
7.0 - 7.5	E	7.5	PID<1ppm						
7.5 - 8.0	E	8.0	PID<1ppm						
8.0	Bore discontinued at 8.0m - Target Depth Reached				8.0				

**RIG:** MD-200      **DRILLER:** Tightsite      **LOGGED:** LT      **CASING:** HW Cased to 6.0m

**TYPE OF BORING:** Solid flight augers (TC-bit) to 0.5m, Push tube to 5.5m, Wash bore to 8.0m

**WATER OBSERVATIONS:** Free groundwater observed whilst push tubing at 1.5m

**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD2/20200120 taken at 0.9-1.0m

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



# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 2.1 AHD  
**EASTING:** 342159.5  
**NORTHING:** 6269622.3  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH112  
**PROJECT No:** 86973.01  
**DATE:** 20/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.0	FILL/TOPSOIL (Silty SAND) SM: fine to medium, dark brown, trace rootlets and clay, moist	[Cross-hatched pattern]	A	0.0		PID<1ppm			
	0.1			A	0.1					
	0.6	FILL/Silty SAND SM: fine to coarse, brown with sandstone and igneous gravels and cobbles, trace concrete, building rubble and fibre cement sheet (asbestos containing material), moist  Bore discontinued at 0.6m - Refusal at depth 0.6m on possible gravel	[Cross-hatched pattern]	A	0.4		PID<1ppm Fibre cement sheet sample 'A1'			
	0.5			A1	0.5					
	0.6				0.6					
	1.0									
	2.0									
	3.0									
	4.0									
	5.0									
	6.0									
	7.0									
	8.0									
	9.0									

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Solid flight augers (TC-bit) to 0.6m

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 2.3 AHD  
**EASTING:** 342209.6  
**NORTHING:** 6269719.7  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH113  
**PROJECT No:** 86973.01  
**DATE:** 23/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
	0.13	CONCRETE: grey with aggregate <20mm							
	0.16	FILL/GRAVEL GP: fine to coarse, grey brown, igneous and sandstone, with sand, moist		E	0.2		PID<1ppm		
	0.3			E	0.3		PID<1ppm		
	0.3			E	0.4				
	0.85	FILL/SAND SW: fine to coarse, brown and pale brown, with shells, moist		E	0.7		PID<1ppm		
				E	0.8		PID<1ppm		
				E*	0.9		PID<1ppm		
	1	FILL/Clayey SAND SC: fine to coarse, brown, trace gravel, roots and ash, moist		E	1.0				
				E	1.4		PID<1ppm		
	2	SAND SW: fine to coarse, dark grey and grey, moist, alluvial and estuarine		E	1.5				
			E	1.9		PID=2ppm			
	2.0								
	2.5	Bore discontinued at 2.5m - Target Depth Reached							

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Push tube to 2.5m

**WATER OBSERVATIONS:** Free groundwater observed whilst push tubing at 1.8m

**REMARKS:** Location coordinates are in MGA94 Zone 56. \*Blind replicate sample BD2/20200123 taken at 0.9-1.0m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 3.4 AHD  
**EASTING:** 342245.1  
**NORTHING:** 6269787.8  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH114  
**PROJECT No:** 86973.01  
**DATE:** 23/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
3 2 1 0 -1 -2 -3 -4 -5 -6 -7 -8 -9 -10	0.2	FILL/Silty SAND: fine to medium, dark brown, trace rootlets, moist	X	E	0.0 0.1		PID<1ppm			
		FILL/SAND SM: fine to coarse, brown, with shells and organic matter, trace silt moist	X	E	0.4 0.5		PID<1ppm			
			X	E	0.9 1.0		PID<1ppm	1		
		- From 1.8m: with ironstone and concrete gravel	X					2		
	2.6	Bore discontinued at 2.6m - Refusal at 2.6m on possible gravel						3		

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Solid flight augers (TC-bit) to 2.6m

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 5.0 AHD  
**EASTING:** 342260.1  
**NORTHING:** 6269797.7  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH116  
**PROJECT No:** 86973.01  
**DATE:** 23/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
	0.15	FILL/Silty SAND SM: fine to medium, trace clay, roots							
		FILL/SAND SW: fine to coarse, pale brown, with shells, moist		E	0.4 0.5		PID<1ppm		
	1			E	0.9 1.0		PID<1ppm		
				E	1.4 1.5		PID<1ppm		
	2			E	1.9 2.0		PID<1ppm		
				E	2.4 2.5		PID<1ppm		
	3			E	2.9 3.0		PID<1ppm		
	3.1	FILL. Silty SAND SM: fine to coarse, brown, trace clay, moist		E	3.1		PID=2ppm		
	3.2			E	3.2				
	3.5	FILL/SAND SP: fine to medium, red-brown, moist		E	3.4 3.5		PID<1ppm		
	3.7	Silty SAND SM: fine to medium, dark brown, trace organic matter, moist		E	3.6 3.7		PID<1ppm		
	4	SAND SP: fine to medium, pale brown, moist, alluvial and estuarine		E	4.1 4.2		PID<1ppm		
	4.5	- From 4.4m: wet Bore discontinued at 4.5m - Target Depth Reached		E	4.4 4.5		PID<1ppm	▼	
	5								
	6								
	7								
	8								
	9								

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Push tube to 4.5m

**WATER OBSERVATIONS:** Free groundwater observed whilst push tubing at 4.5m

**REMARKS:** Location coordinates are in MGA94 Zone 56.


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

# BOREHOLE LOG

**CLIENT:** NSW Department of Education  
**PROJECT:** Narrabeen Education Project  
**LOCATION:** Namona St, North Narrabeen

**SURFACE LEVEL:** 4.5 AHD  
**EASTING:** 342258.2  
**NORTHING:** 6269781.2  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH117  
**PROJECT No:** 86973.01  
**DATE:** 23/1/2020  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
4 3 2 1 0 1 2 3 4 5 6 7 8 9	0.2	FILL/SAND SM: fine to medium, dark brown, trace silt and roots, moist		E	0.1 0.2		PID<1ppm	1 2 3 4		
	0.6	FILL/SAND SM: fine to coarse, pale brown, with shells, trace ash and asphaltic concrete, dry		E	0.4 0.5		PID<1ppm			
	1.0	FILL/ Silty SAND SM: fine to coarse, brown, with shells, trace gravel, moist		E	0.9 1.0		PID<1ppm			
	1.4			E	1.4 1.5		PID<1ppm			
	1.9			E*	1.9 2.0		PID<1ppm			
	2.4			E	2.4 2.5		PID<1ppm			
	2.7	SAND SW: fine to coarse, orange-brown, trace shell graffments, moist		E	2.9 3.0		PID=2ppm			
	3.0	SAND SP: fine to medium, pale grey, moist, alluvial and estuarine		E	3.4 3.5		PID<1ppm			
		- From 3.5m: wet								
	3.9			E	3.9 4.0		PID<1ppm			
	4.0	Bore discontinued at 4.0m - Target Depth Reached								

**RIG:** MD-200

**DRILLER:** Tightsite

**LOGGED:** LT

**CASING:** Uncased

**TYPE OF BORING:** Solid flight augers (TC-bit) to 4.0m

**WATER OBSERVATIONS:** Free groundwater observed whilst augering at 3.5m

**REMARKS:** Location coordinates are in MGA94 Zone 56. \* Blind replicate sample BD5/20200123 taken at 1.9-2.0m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

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## **Appendix D**

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### Laboratory Test Results

# Material Test Report

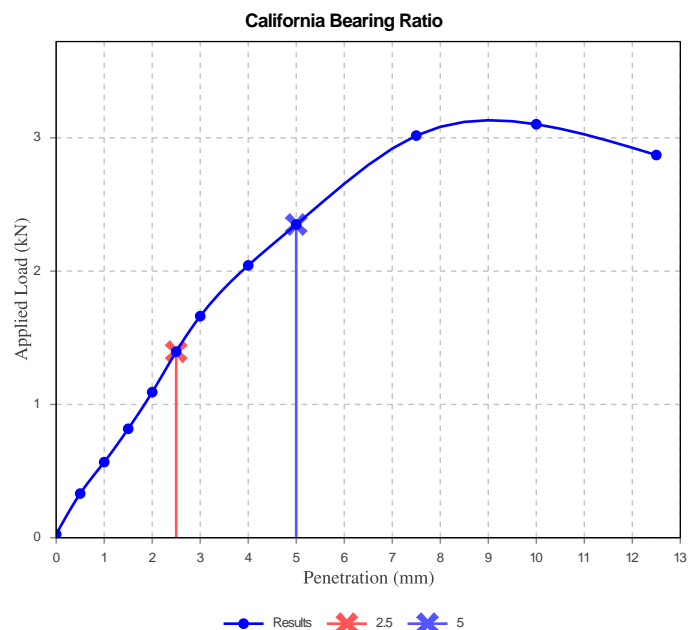


*Norman Weimann*

Approved Signatory: Norman Weimann  
dp-norman.weimann  
NATA Accredited Laboratory Number: 828

**Report Number:** 86973.00-1  
**Issue Number:** 2 - This version supersedes all previous issues  
**Reissue Reason:** Include PI report  
**Date Issued:** 19/02/2020  
**Client:** School Infrastructure NSW/ Department of Education  
10 Coral Crescent, Gateshead NSW 2325  
**Contact:** Claudia Nolte  
**Project Number:** 86973.00  
**Project Name:** Narrabeen Education Precinct  
**Project Location:** Namona St, North Narrabeen  
**Work Request:** 5522  
**Sample Number:** SY-5522A  
**Date Sampled:** 20/01/2020  
**Dates Tested:** 31/01/2020 - 11/02/2020  
**Sampling Method:** Sampled by Engineering Department  
*The results apply to the sample as received*  
**Sample Location:** BH102 (0.5-1.0)  
**Material:** FILL/SAND: pale brown

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	12		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m <sup>3</sup> )	1.63		
Optimum Moisture Content (%)	10.0		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	97.0		
Dry Density after Soaking (t/m <sup>3</sup> )	1.64		
Field Moisture Content (%)	2.4		
Moisture Content at Placement (%)	9.9		
Moisture Content Top 30mm (%)	18.8		
Moisture Content Rest of Sample (%)	19.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	2		
Swell (%)	-0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)			



# Material Test Report



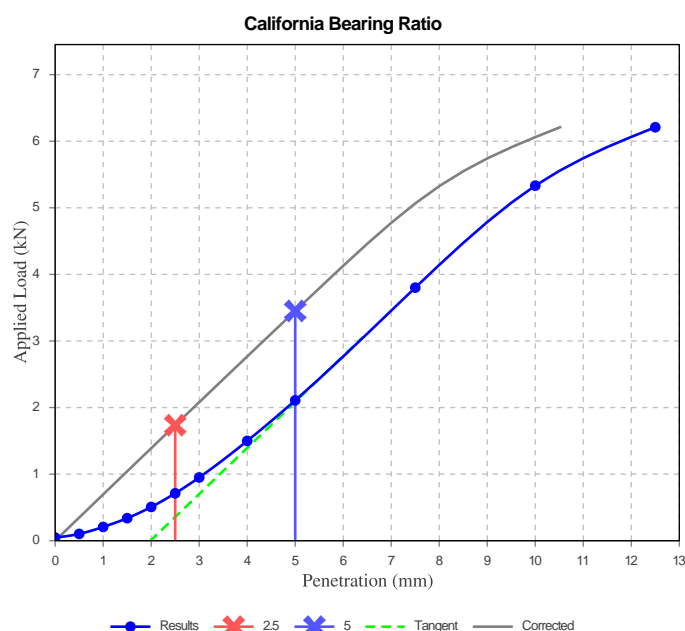

Approved Signatory: Norman Weimann

dp-norman.weimann

NATA Accredited Laboratory Number: 828

**Report Number:** 86973.00-1  
**Issue Number:** 2 - This version supersedes all previous issues  
**Reissue Reason:** Include PI report  
**Date Issued:** 19/02/2020  
**Client:** School Infrastructure NSW/ Department of Education  
 10 Coral Crescent, Gateshead NSW 2325  
**Contact:** Claudia Nolte  
**Project Number:** 86973.00  
**Project Name:** Narrabeen Education Precinct  
**Project Location:** Namona St, North Narrabeen  
**Work Request:** 5522  
**Sample Number:** SY-5522B  
**Date Sampled:** 20/01/2020  
**Dates Tested:** 31/01/2020 - 11/02/2020  
**Sampling Method:** Sampled by Engineering Department  
 The results apply to the sample as received  
**Sample Location:** BH9 (0.2-0.8m)  
**Material:** FILL/Silty SAND: dark grey

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	17		
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 <sup>3</sup> )	1.59		
Optimum Moisture Content (%)	17.0		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	101.0		
Dry Density after Soaking (t/m <sup>3</sup> )	1.59		
Field Moisture Content (%)	9.8		
Moisture Content at Placement (%)	17.4		
Moisture Content Top 30mm (%)	20.4		
Moisture Content Rest of Sample (%)	19.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	2		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)			





# Material Test Report

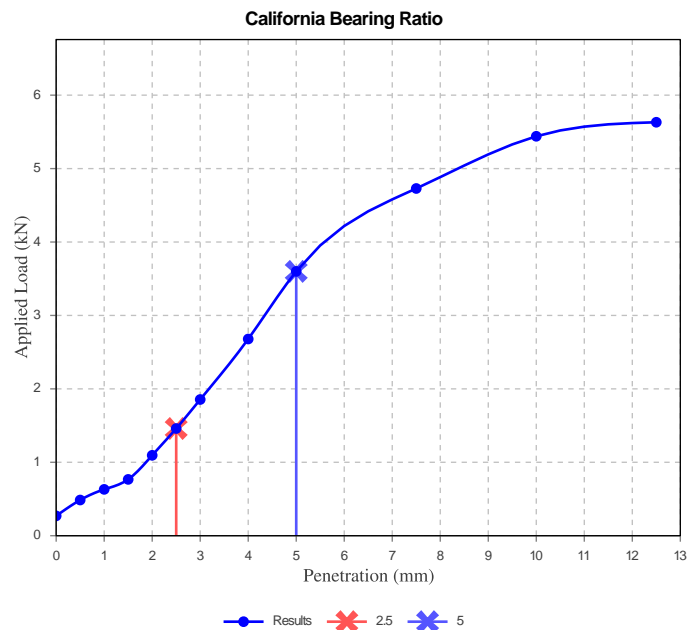


*Norman Weimann*

Approved Signatory: Norman Weimann  
dp-norman.weimann  
NATA Accredited Laboratory Number: 828

**Report Number:** 86973.00-1  
**Issue Number:** 2 - This version supersedes all previous issues  
**Reissue Reason:** Include PI report  
**Date Issued:** 19/02/2020  
**Client:** School Infrastructure NSW/ Department of Education  
10 Coral Crescent, Gateshead NSW 2325  
**Contact:** Claudia Nolte  
**Project Number:** 86973.00  
**Project Name:** Narrabeen Education Precinct  
**Project Location:** Namona St, North Narrabeen  
**Work Request:** 5522  
**Sample Number:** SY-5522C  
**Date Sampled:** 20/01/2020  
**Dates Tested:** 31/01/2020 - 11/02/2020  
**Sampling Method:** Sampled by Engineering Department  
*The results apply to the sample as received*  
**Sample Location:** BH11 (0.6-1.0m)  
**Material:** FILL/SILTY SAND: grey

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	<b>18</b>		
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 <sup>3</sup> )	1.59		
Optimum Moisture Content (%)	15.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m <sup>3</sup> )	1.59		
Field Moisture Content (%)			
Moisture Content at Placement (%)	15.6		
Moisture Content Top 30mm (%)	21.0		
Moisture Content Rest of Sample (%)	19.3		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	2		
Swell (%)	-0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)			



# Material Test Report



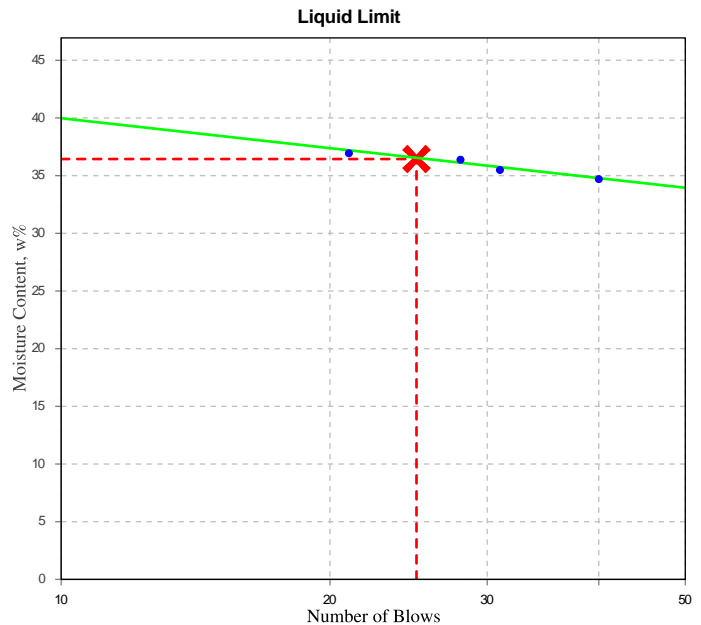
*Norman Weimann*

Approved Signatory: Norman Weimann  
dp-norman.weimann

NATA Accredited Laboratory Number: 828

**Report Number:** 86973.00-1  
**Issue Number:** 2 - This version supersedes all previous issues  
**Reissue Reason:** Include PI report  
**Date Issued:** 19/02/2020  
**Client:** School Infrastructure NSW/ Department of Education  
 10 Coral Crescent, Gateshead NSW 2325  
**Contact:** Claudia Nolte  
**Project Number:** 86973.00  
**Project Name:** Narrabeen Education Precinct  
**Project Location:** Namona St, North Narrabeen  
**Work Request:** 5522  
**Sample Number:** SY-5522D  
**Date Sampled:** 20/01/2020  
**Dates Tested:** 31/01/2020 - 10/02/2020  
**Sampling Method:** Sampled by Engineering Department  
*The results apply to the sample as received*  
**Sample Location:** BH106 (0.9-1.0m)  
**Material:** FILL/Sandy CLAY:mottled yellow-brown, red and pale brown

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	36		
Plastic Limit (%)	17		
Plasticity Index (%)	19		
Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	9.0		
Cracking Crumbling Curling	None		
Moisture Content (AS 1289 2.1.1)			
Moisture Content (%)		17.5	





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12 Ashley St Chatswood NSW 2067  
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customerservice@envirolab.com.au  
www.envirolab.com.au

## **CERTIFICATE OF ANALYSIS 235584-A**

### **Client Details**

<b>Client</b>	Douglas Partners Pty Ltd
<b>Attention</b>	Matthew Bennett
<b>Address</b>	96 Hermitage Rd, West Ryde, NSW, 2114

### **Sample Details**

<b>Your Reference</b>	<b>86973.00, Narrabeen</b>
<b>Number of Samples</b>	39 Soil
<b>Date samples received</b>	29/01/2020
<b>Date completed instructions received</b>	31/01/2020

### **Analysis Details**

Please refer to the following pages for results, methodology summary and quality control data.  
Samples were analysed as received from the client. Results relate specifically to the samples as received.  
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

### **Report Details**

<b>Date results requested by</b>	07/02/2020
<b>Date of Issue</b>	07/02/2020
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. <b>Tests not covered by NATA are denoted with *</b>	

#### **Results Approved By**

Priya Samarawickrama, Senior Chemist

#### **Authorised By**

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		235584-A-4	235584-A-6	235584-A-8	235584-A-16	235584-A-24
Your Reference	UNITS	BH4/0.9-1.0	BH4/2.4-2.5	BH4/4.5-5.0	BH9/0.4-0.5	BH9/4.5-5.0
Date Sampled		21/01/2020	21/01/2020	21/01/2020	22/01/2020	22/01/2020
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	05/02/2020	05/02/2020	05/02/2020	05/02/2020	05/02/2020
Date analysed	-	05/02/2020	05/02/2020	05/02/2020	05/02/2020	05/02/2020
pH 1:5 soil:water	pH Units	8.0	6.8	6.2	4.1	5.7
Electrical Conductivity 1:5 soil:water	µS/cm	8	20	42	52	17
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	<10	25	<10	<10

Method ID	Methodology Summary
<b>Inorg-001</b>	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.
<b>Inorg-002</b>	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
<b>Inorg-081</b>	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.

Client Reference: 86973.00, Narrabeen

QUALITY CONTROL: Misc Inorg - Soil					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			05/02/2020	[NT]	[NT]	[NT]	[NT]	05/02/2020	[NT]
Date analysed	-			05/02/2020	[NT]	[NT]	[NT]	[NT]	05/02/2020	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	104	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	87	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	99	[NT]

**Result Definitions**

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



## Quality Control Definitions

<b>Blank</b>	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.
<b>Duplicate</b>	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.
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## CERTIFICATE OF ANALYSIS 235573-A

### Client Details

Client	Douglas Partners Pty Ltd
Attention	Matthew Bennett
Address	96 Hermitage Rd, West Ryde, NSW, 2114

### Sample Details

Your Reference	<b>86973.00, Narrabeen</b>
Number of Samples	51 Soil, 1 Material
Date samples received	29/01/2020
Date completed instructions received	31/01/2020

### 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	07/02/2020
Date of Issue	06/02/2020

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

#### Results Approved By

Priya Samarawickrama, Senior Chemist

#### Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		235573-A-10	235573-A-13	235573-A-16	235573-A-31	235573-A-34
Your Reference	UNITS	BH104/0.4-0.5	BH104/2.4-2.5	BH104/5.5-6.0	BH111/1.4-1.5	BH111/4.0-4.5
Date Sampled		20/01/2020	21/01/2020	21/01/2020	20/01/2020	20/01/2020
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	05/02/2020	05/02/2020	05/02/2020	05/02/2020	05/02/2020
Date analysed	-	05/02/2020	05/02/2020	05/02/2020	05/02/2020	05/02/2020
pH 1:5 soil:water	pH Units	8.7	8.1	9.1	8.7	9.1
Electrical Conductivity 1:5 soil:water	µS/cm	79	26	97	77	130
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	10	40	<10	65

Method ID	Methodology Summary
<b>Inorg-001</b>	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.
<b>Inorg-002</b>	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
<b>Inorg-081</b>	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.

Client Reference: 86973.00, Narrabeen

QUALITY CONTROL: Misc Inorg - Soil					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			05/02/2020	31	05/02/2020	05/02/2020		05/02/2020	[NT]
Date analysed	-			05/02/2020	31	05/02/2020	05/02/2020		05/02/2020	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	31	8.7	8.7	0	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	31	77	82	6	104	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	31	<10	<10	0	87	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	31	<10	<10	0	99	[NT]

**Result Definitions**

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

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## Report Comments

pH#

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