



Douglas Partners
Geotechnics | Environment | Groundwater

Report on
Preliminary Geotechnical Investigation

Proposed Melonba Primary School
Kaluta Avenue, Melonba

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

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Report on Preliminary Geotechnical Investigation

Proposed Melonba Primary School

Kaluta Avenue, Melonba

1. Introduction

This report presents the results of a preliminary geotechnical investigation undertaken by Douglas Partners Pty Ltd (DP) for the proposed Melonba Primary School at Kaluta Avenue, Melonba. The investigation was commissioned in an email dated 13 August 2021 by Ms Julie Vigar of NSW Department of Education and was undertaken in accordance with DPs' proposal 207416.00 dated 4 August 2021.

It is understood that details of the development are unknown at this stage but is likely to comprise a typical school involving the construction of several one to two storey buildings with associated pavements, recreational facilities, landscaping and associated earthworks to form proposed site levels. It is further understood that earthworks operations have taken place on the site over the past few years to form the current site levels.

The aim of the investigation was to assess the subsurface soil and groundwater conditions across the site in order to provide information for initial planning and design purposes.

The investigation included the drilling of boreholes, excavation of test pits, dynamic cone penetrometer (DCP) tests, cone penetration tests (CPT) and laboratory testing of selected samples. The details of the field work and laboratory testing are presented in this report, together with comments and recommendations for design and construction.

DP carried out a preliminary in-situ waste classification in conjunction with this preliminary geotechnical investigation, the results of which are presented in a separate report (DP Report Reference 207416.00.R.002.Rev0).

2. Background

A review of historical photographs has indicated that the site was used for agricultural purposes and comprised a largely cleared paddock until sometime between October 2016 and April 2018 when earthworks on the site commenced. Earthworks on site are understood to have been carried out by Daracon Contractors Pty Ltd with the excavation occurring across the full extent of the site (Note: all fill is understood to have been placed across the northern part of the site, where the Secondary High School is located, under Level 1 testing conditions by Geotech Testing Pty Ltd).

The following reports have been reviewed for this report;

- "Land Capability, Salinity and Contamination Assessments Report: Proposed Residential Subdivision Development Marsden Park Precinct – North West Growth Centre: Richmond Road, Marsden Park" by Geotechnique Pty Ltd dated 27 February 2012 (Ref 12576/1-AA).

- “Letter to Daracon Contractors Pty Ltd on Bulk Earthworks Practical Completion Compliance Certificate, Newpark Precincts 3, 4, & 6 (Area B) – Marsden Park” by Geotech Testing Pty Ltd dated 24 July 2018 (Ref: 8599/1-P3, 4 & 6 (R1).

The land capability assessment indicated that the site was largely vacant/grazing land in 2012 and was underlain by a deep soil profile comprising fluvial soils overlying residual clay soils. The clay site classification was assessed to be consistent with either a Class “M” or Class “H1” when assessed in accordance with AS 2870:2011 “Residential Slabs and Footings”. The salinity assessment indicated soils ranging from slightly to highly saline.

A “Bulk Earthworks” cut/fill plan by J. Wyndham Prince Consulting Civil Infrastructure Engineers and Project Managers dated 5 December 2016 (Plan No. 998510/CC03Rev B) indicated the site was in cut of up to 3 m over the site (refer Figure 1).

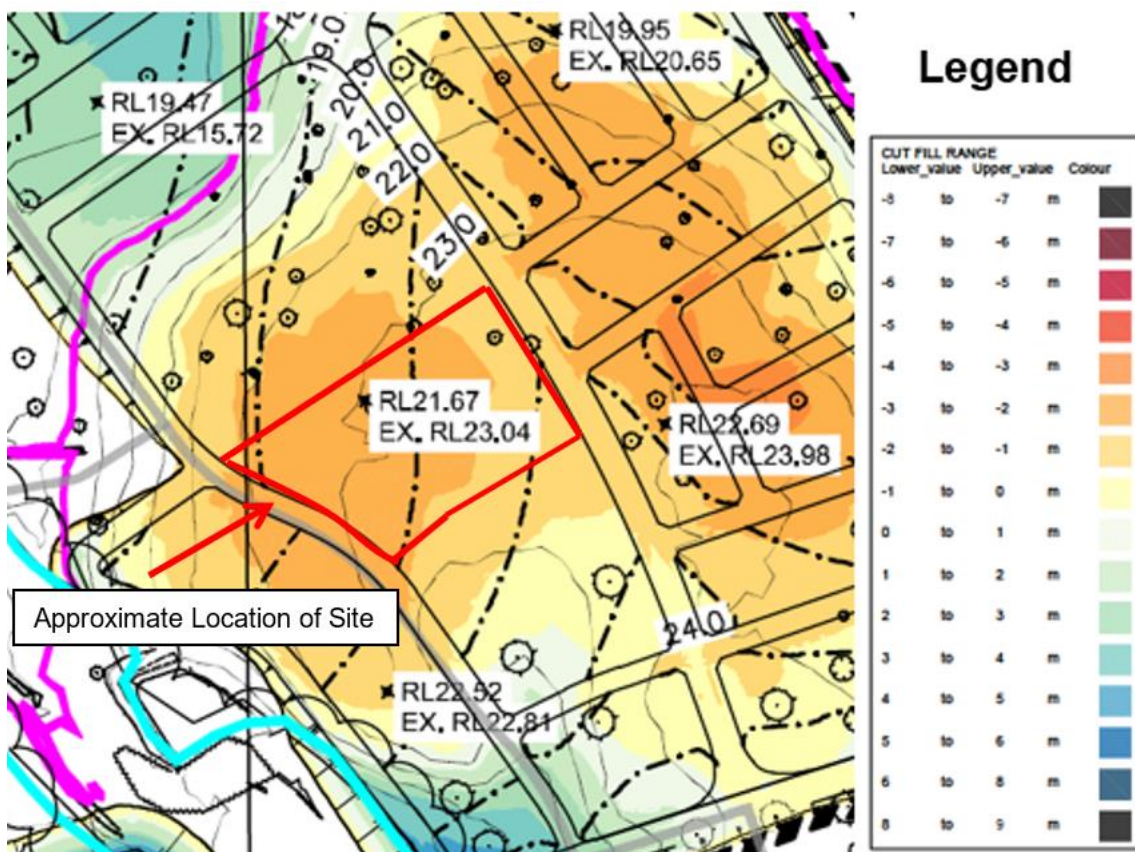


Figure 1: Excerpt of the Cut/Fill Plan showing fill depths on-site.

3. Site Description

The site which is known as part of Lot 30 in DP 1237735 is located on Kaluta Avenue, Melonba. It is an irregular shaped area of approximately 2 hectares with maximum north-south and east-west dimensions of approximately 110 m and 210 m, respectively.

At the time of the field work the site comprised undeveloped rural land which was predominantly grass covered. Wire mesh fencing was erected along all site boundaries.

The site topography generally slopes down to the north-west at gradients estimated to be less than 1° with the maximum elevation at about RL 23 (m AHD) in the south-east corner and the minimum elevation at about RL 21 (m AHD) in the north-west corner. A tributary of South Creek is located about 190 m to the west of the site.

The site is bounded by the following:

- North – undeveloped land (proposed Marsden Park Secondary School), with Elara Boulevard beyond.
- East – Kaluta Avenue with residential properties and undeveloped land beyond.
- South – Swallowtail Street with undeveloped land beyond.
- West – Galah Street with residential properties and undeveloped land beyond.

Table 1 presents site identification details and a location plan showing the site area is presented in Figure 2 (following page).

Table 1: Site Identification

Item	Details
Allotment Identification	Lot 30 DP 1237735
Street Address	Kaluta Avenue
Locality	Melonba, NSW
Site Area	2 hectares (approximately)
Local Government Area	Blacktown City Council (BCC)
Zoning	R2 – Low Density Residential
Planning Instrument(s)	BCC DCP (2015); LEP (2015)
Current Landuse	Undeveloped

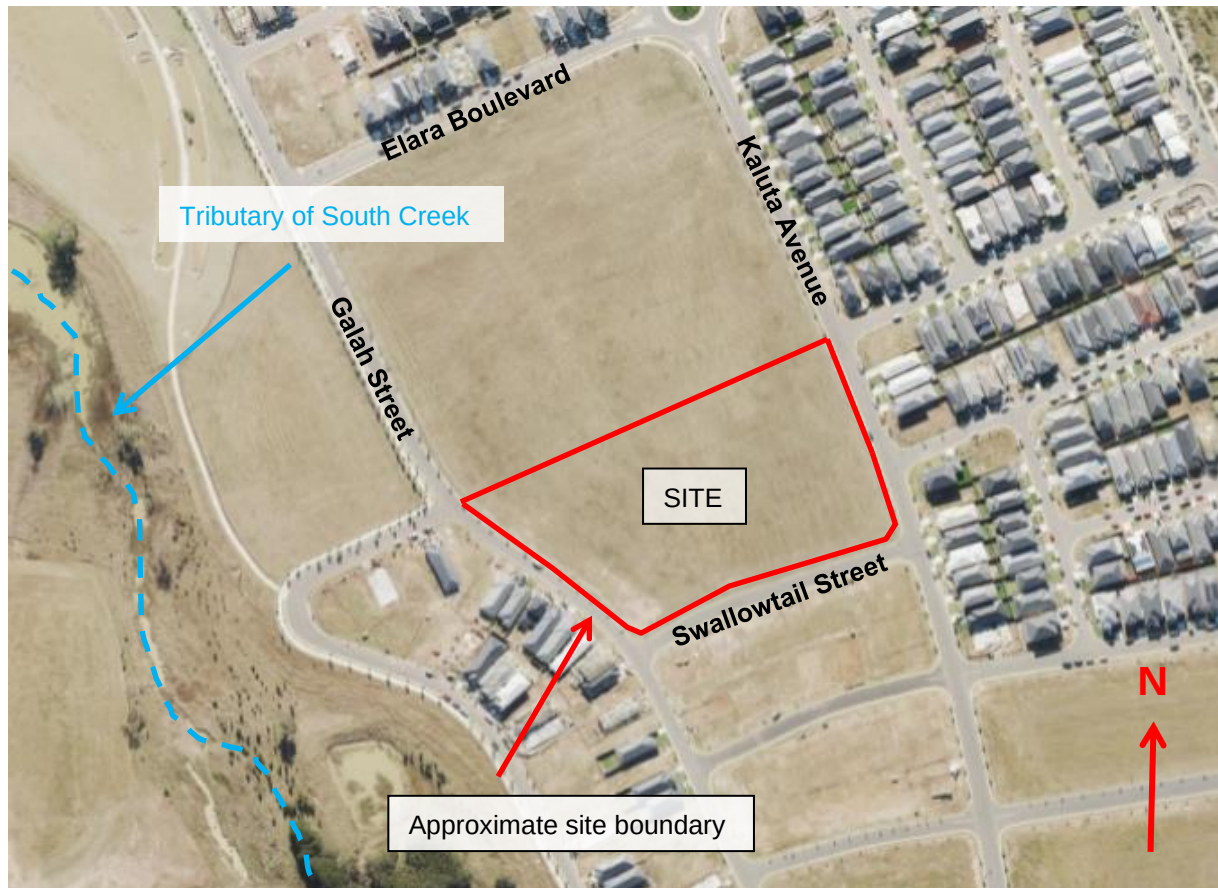


Figure 2: Site Location Plan (Source: Metro Map)

4. Published Data

4.1 Geology

Reference to the Penrith 1:100 000 scale Geological Series Sheet indicates that the site lies close to the geological boundary between Londonderry Clay of Tertiary age and Fluvial sediments of Quaternary age. The underlying bedrock at the site is expected to be Bringelly Shale of the Wianamatta Group of Triassic Age.

Descriptions of the various units are provided below:

- Londonderry Clay – typically mottled red-grey moderately to highly plastic clays with sand pockets and iron cemented sand-clay aggregates occurring throughout with abundant ironstone pisolites.
- Fluvial sediments – typically comprises fine-grained sands, silts and clays.
- Bringelly Shale – typically comprises interlayered units of dark and light grey claystone/siltstone with occasional fine-grained sandstone bands.

4.2 Hydrogeology

The closest surface water receptors to the site are two dams located about 200 m north-west and 130 m south-west of the site and a tributary of South Creek located about 190 m west of the site.

Based on the local topography, groundwater is anticipated to flow to the north-west towards South Creek. Groundwater levels however are expected to be transient due to the area being located within close proximity to an existing floodplain.

A search of the NSW Department of Primary Industries Water (DPI Water) online map of registered groundwater works was undertaken as part of the investigation. The search carried out on 25 August 2021 identified no registered groundwater boreholes within 500 m of the site.

4.3 Soil Landscape

Reference to the Penrith 1: 100 000 scale Soil Landscape Series Sheet indicates that the site is located within the Berkshire Park soil landscape group. The Berkshire Park Group typically consists of weakly pedal heavy clays and clayey sands, commonly with ironstone nodules and silcrete boulders in a sand/clay matrix. This group is characterised by erosion, frequent flooding and impermeable subsoils.

4.4 Acid Sulfate Soils

Review of published mapping indicates that the site is in an area of 'no known occurrence of acid sulfate soils'. The NSW Acid Sulfate Soils Manual 1998 published by the Acid Sulfate Soils Management Advisory Committee (ASSMAC) indicates that ASS (and Potential Acid Sulfate Soils – PASS) normally occur in alluvial or estuarine soils below RL 5 m AHD although occasionally are encountered up to RL 12 m AHD. Considering the ASS mapping and given that the site soils are at site elevations above RL 20 m AHD, it is considered unlikely that ASS is present on-site.

4.5 Salinity

The Department of Infrastructure, Planning and Natural Resources (DIPNR) "Map of Salinity Potential in Western Sydney 2002" suggests that the site is in an area of "moderate salinity potential" with a higher potential in the lower elevation areas in close proximity to the South Creek system.

5. Field Work

5.1 Methods

The field work was undertaken between 18 August 2021 and 13 September 2021 and included the following:

- Site inspection by a senior geotechnical engineer.
- Drilling of four boreholes (Bores 1 to 3 and Bore 3A) using a truck or track-mounted rig with 110 mm diameter spiral flight augers. The boreholes were drilled to depths ranging between 5.0 m and 7.4 m. Standard penetration tests (SPTs) were completed at regular depths within the overburden.
- Extension of all boreholes into the underlying bedrock using NMLC-coring techniques to obtain continuous 50 mm diameter core samples of the rock for identification and strength testing purposes. The boreholes were drilled to depths of between 9.64 m and 16.83 m.
- Excavation of 14 test pits (Pit 16 to Pit 29) using a 3.5 tonne excavator fitted with a 300 mm wide bucket attachment. The test pits were excavated to depths of between 1.2 m and 2.3 m.
- Cone Penetration Testing (CPT) at 12 locations (CPT4 to CPT115) using a ballasted truck-mounted test rig to push a 35 mm diameter cone tipped probe into the soil with a hydraulic ram system. Continuous measurements were made of the end-bearing pressure on the cone tip and the friction of the sleeve located directly behind the cone. The cone tip resistance and friction readings were displayed during the test and were stored on a computer for subsequent plotting of results and interpretation. The CPTs were undertaken to depths ranging between 0.8 m and 7.8 m.
- Dynamic Cone Penetrometer (DCP) tests adjacent to the test pits. DCPs were carried out to 1.2 m depth or prior refusal in accordance with AS1289.6.3.2.

Undisturbed and disturbed samples were collected from the boreholes and test pits to assist with logging and for laboratory testing. Bulk samples were taken in some of the test pits to enable testing to be undertaken for compaction properties and California bearing ratio (CBR).

At four CPT locations (CPT5, CPT6, CPT8 and CPT11) additional tests were carried out due to the excessive bending of the probes on inferred gravel within the soil profile.

The ground surface levels (measured in 'metres above Australian Height Datum AHD') together with the Eastings and Northings at the borehole, test pit and CPT locations were determined by using a High Precision Differential GPS which is accurate to approximately 0.1 m. The locations of the boreholes, test pits and CPT tests are shown on Drawing 1 in Appendix B.

5.2 Results

The detailed borehole logs, test pit logs and interpreted CPT logs are provided in Appendix C. Notes defining classification methods and terms used to describe the soils and rocks along with notes on the methods used for interpretation of the CPT results are provided in Appendix A. It is noted that it is sometimes difficult to distinguish between fill and natural soils and between hard clays and weathered rock from the CPT results. Therefore, the material types and boundaries shown on the CPT plots are interpretations only.

The subsurface conditions encountered underlying the site can be summarised as follows:

- **Topsoil** - silty clay topsoil to depths ranging between 0.1 m and 0.3 m in all boreholes and test pits. Inclusions of rootlets, gravel and river pebbles were encountered within the topsoil;
- **Natural Soil** - typically stiff to hard silty clay to depths of between 0.5 m and 7.4 m in all test pits and boreholes. Inclusions of river gravels, cobbles and boulders to 280 mm diameter were observed within the silty clay profile. Some layers of clayey and sandy soils were inferred to depths of 0.8 m to 6.9 m in the CPTs;
- **Weathered Siltstone** - very low, very low to low and low strength, extremely and highly weathered, grey and brown siltstone in Bores 1, 3 and 3A below depths of between 5.0 m and 7.4 m.
- **Low and Medium Strength Siltstone** - low and medium strength, moderately weathered, grey siltstone in Bores 1, 2 and 3A below depths of 6.5 m and 9.65 m respectively.

A summary of the subsurface profile is presented in Table 2. The weathered rock depths have been inferred with CPT refusal considered to represent the top of low strength (LS) or stronger rock.

Table 2: Summary of Subsurface Profile

Test Location	Surface RL (m)	Top of Weathered Siltstone		Top of Low and Medium Strength Siltstone	
		Depth (m)	RL (m AHD)	Depth (m)	RL (m AHD)
Bore 1	22.7	5.6	17.1	9.4	-
Bore 2	23.1	6.5	16.6	6.5	16.6
Bore 3	22.6	5.0	17.6	-	-
Bore 3A	22.6	7.4	15.2	9.7	14.3
CPT4	22.6	5.7	16.9	-	-
CPT5	22.8	-	-	-	-
CPT5A	22.8	5.9	16.9	-	-
CPT6	22.8	-	-	-	-
CPT6A	22.8	-	-	-	-
CPT7	23.0	5.8	17.2	-	-
CPT8	22.9	-	-	-	-
CPT8A	22.9	-	-	-	-
CPT9	23.2	6.6	16.6	-	-

Test Location	Surface RL (m)	Top of Weathered Siltstone		Top of Low and Medium Strength Siltstone	
		Depth (m)	RL (m AHD)	Depth (m)	RL (m AHD)
CPT10	23.0	6.0	17.0	-	-
CPT11	22.9	-	-	-	-
CPT11A	22.9	-	-	-	-
CPT12	22.6	5.6	17.0	-	-
CPT13	22.6	6.4	16.2	-	-
CPT14	22.3	6.9	15.4	-	-
CPT15	22.3	7.5	14.8	-	-
Pit 16	21.5	-	-	-	-
Pit 17	21.3	-	-	-	-
Pit 18	22.1	-	-	-	-
Pit 19	22.0	-	-	-	-
Pit 20	22.4	-	-	-	-
Pit 21	22.7	-	-	-	-
Pit 22	22.8	-	-	-	-
Pit 23	22.6	-	-	-	-
Pit 24	22.8	-	-	-	-
Pit 25	23.0	-	-	-	-
Pit 26	23.1	-	-	-	-
Pit 27	22.0	-	-	-	-
Pit 28	22.4	-	-	-	-
Pit 29	22.3	-	-	-	-

Free groundwater was observed at a depth of 7.2 m on completion of CPT15. No free groundwater was observed during the excavation of the test pits, drilling of the boreholes or on completion of the remaining CPT tests. Backfilling of the boreholes and test pits at the completion of drilling precluded long-term monitoring of the groundwater levels. It is noted, however, that groundwater levels are affected by preceding climatic conditions and soil/rock permeability and can therefore fluctuate with time.

6. Laboratory Testing

6.1 Mechanical Testing

Selected samples from the test pits and boreholes were tested in the laboratory for measurement of plasticity, dispersion potential, shrink-swell, moisture content, compaction properties and CBR. The detailed results are given in Appendix D and summarised in Table 3.

Table 3: Results of Laboratory Testing - Mechanical

Test Location	Material	Depth (m)	FMC (%)	OMC (%)	MDD (t/m ³)	CBR (%)	W _L (%)	W _P (%)	PI (%)	LS (%)	I _{ss} (%) / Δpf)	ECN
3	Silty Clay	0.5	-	-	-	-	-	-	-	-	3.6	-
16	Silty Clay	0.5 - 0.7	12.4	17.0	1.75	5	-	-	-	-	-	2
18	Silty Clay	0.5 – 0.7	12.7	16.5	1.69	25	36	18	18	7.0	-	2
24	Silty Clay	0.5 – 0.6	23.0	-	-	-	65	16	49	15.0	-	-

Notes:

FMC	=	Field Moisture Content	OMC	=	Standard Optimum Moisture Content
MDD	=	Maximum Dry Density	CBR	=	California bearing ratio
W _L	=	Liquid Limit	W _P	=	Plastic Limit
PI	=	Plasticity Index	I _{ss}	=	Shrink Swell Index
ECN	=	Emerson Crumb number			

The results of the laboratory testing indicate the following:

- The Atterberg Limit results indicate that the silty clay samples were generally of medium to high plasticity.
- The shrink-swell result indicates that the silty clay sample tested is highly reactive and therefore susceptible to shrink and swell movements due to changes in soil moisture content.
- The CBR values were of variable remoulded strength with values of 5 % and 25 % for the silty clay samples tested.
- The field moisture contents ranged from 12.4 % to 23.0 % for the silty clay samples tested. The field moisture contents of the samples were between 5.3 % dry and 7.0 % wet of the plastic limit.
- The Emerson Crumb Numbers were 2 indicating the silty clays have a very high dispersion potential.

6.2 Chemical Testing

Selected samples collected from the test pits were also tested in the laboratory for determination of aggressivity to concrete and steel, sodicity, textural classification and salinity.

A result summary table (Appendix D) presents the results of laboratory tests, assessments of aggressivity to concrete and steel, sodicity class, textural classification, calculated salinity electrical conductivity (ECe) and salinity class inferred from ECe values using the method of Richards (1954). The detailed laboratory test reports and chain of custody information are also provided in Appendix E.

The total test sample numbers and the range of test results obtained are summarised in Table 4.

Table 4: Results of Laboratory Testing - Chemical

Parameter		Units	Number of Tests	Range of Results
pH		pH units	13	5.3 – 6.5
Chlorides		(mg/kg)	-	-
Sulphates		(mg/kg)	-	-
Aggressivity [AS 2159]	to Concrete	-	13	non-aggressive – mildly aggressive
	to Steel	-	13	non-aggressive
Exchangeable Sodium (Na)		(meq/100g)	2	0.58 – 4.3
CEC (cation exchange capacity)		(meq/100g)	2	2.8 - 15
Sodicity [Na/CEC]		(ESP%)	2	21 - 29
Sodicity Class		[after DLWC]	2	Highly Sodic
EC1:5 [Lab.]		(mS/cm)	13	16 – 930
ECe [M x EC1:5] ¹		(dS/m)	13	<2 – 7.5
Salinity Class [after Richards]		-	13	Non-Saline to Moderately Saline

Notes: 1 M is soil textural factor

6.2.1 Aggressivity

Test results showing the aggressivity assessed by pH, sulphate concentrations and chloride concentration criteria (of AS 2159) at the test pit locations, together with the aggressivity class ranges indicated in Australian Standard AS 2159 are given in Appendix D. The absence of free groundwater in the test pits and the inferred very low permeability of the sampled clay-rich soils indicate that soils at all test pits are in Condition “B” as defined by AS 2159.

The results show that the samples tested indicate the ground conditions are non-aggressive to mildly aggressive to concrete and non-aggressive to steel with reference to AS2159. The pH profiles with depth are shown in Figure 3.

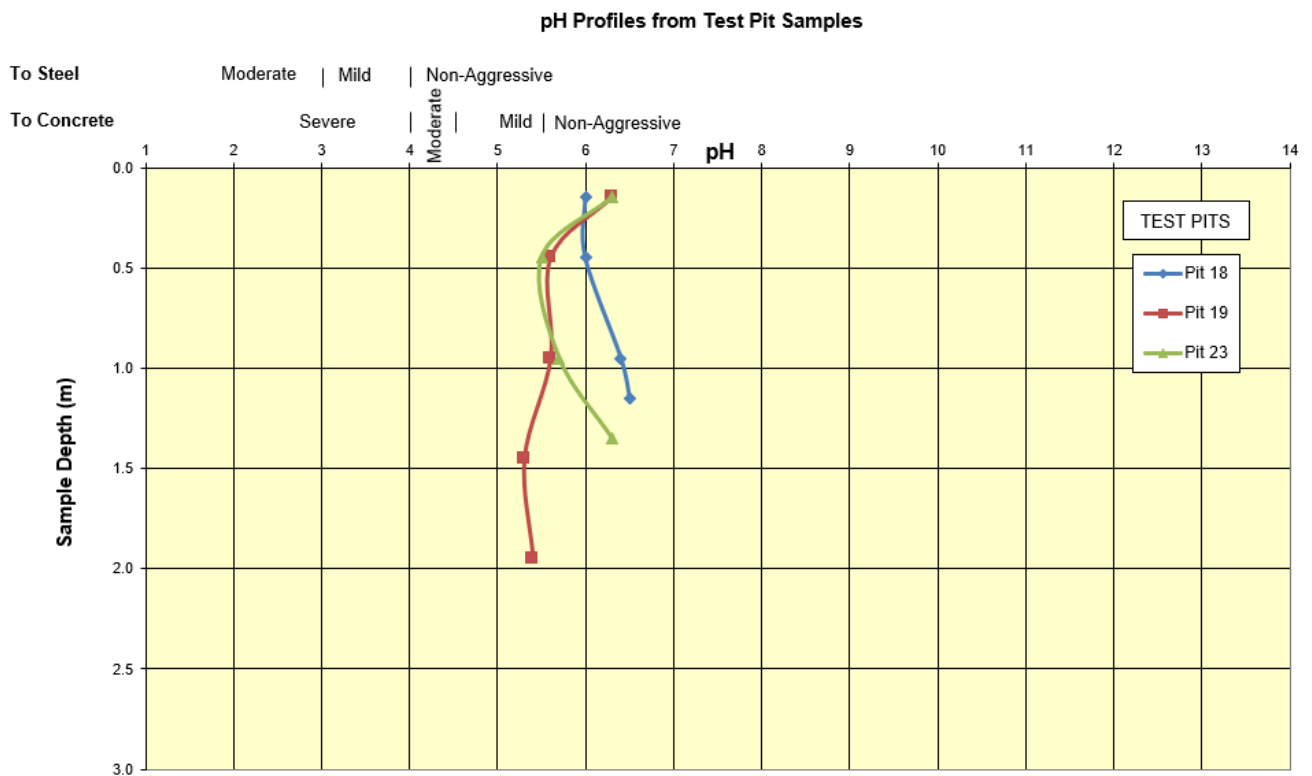


Figure 3: pH Profiles from Test Pits

6.2.2 Salinity

Figure 4 (following page) shows the salinity classifications based on the electrical conductivity (ECe) at the test pit locations, together with the salinity classifications of Richards (1954). Test results are provided in Appendix D.

The results indicate that the samples tested were varied ranging from non-saline to moderately saline.

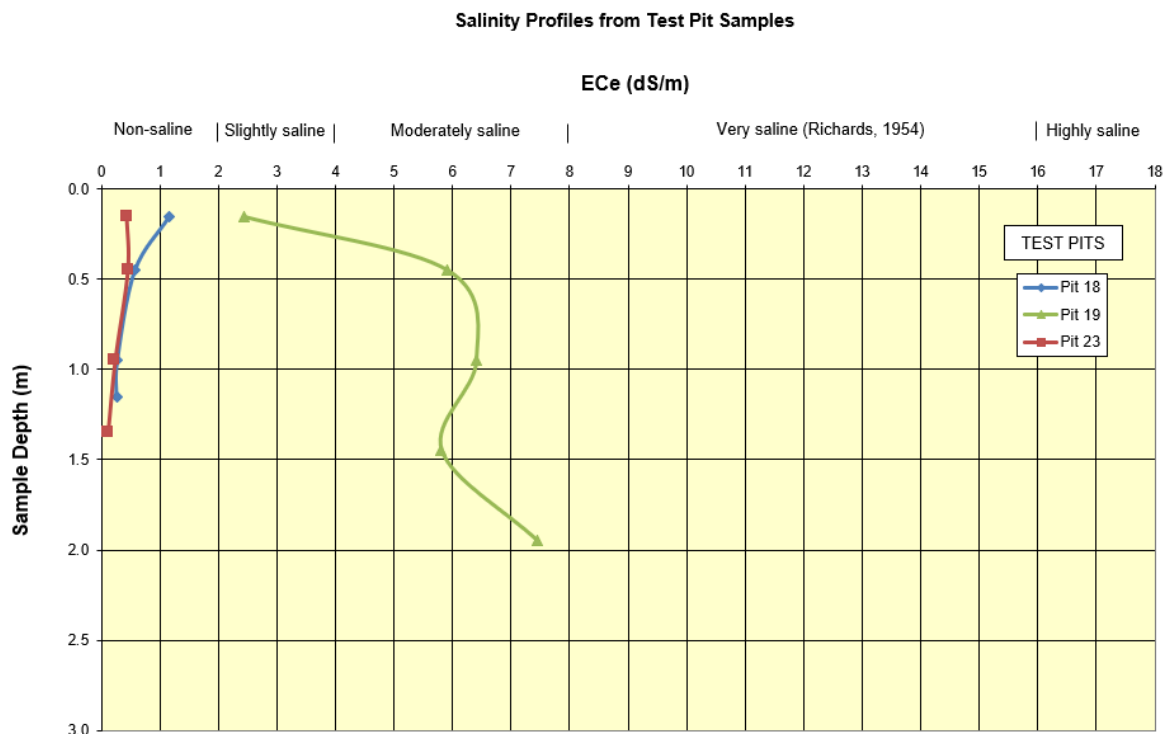


Figure 4: Salinity Profiles from Test Pits

6.2.3 Sodicty

The sodicty test results (refer Appendix D) indicates highly sodic soils, indicating a high potential for erosion of soils left exposed.

6.3 Point Load Testing

Point Load Strength Index (Is_{50}) testing was carried out on selected rock core specimens. The results of the tests are shown on the borehole logs at the appropriate depths. Figure 5 (following page) shows the range of Is_{50} results at the various depths (shown as Reduced Levels relative to AHD).

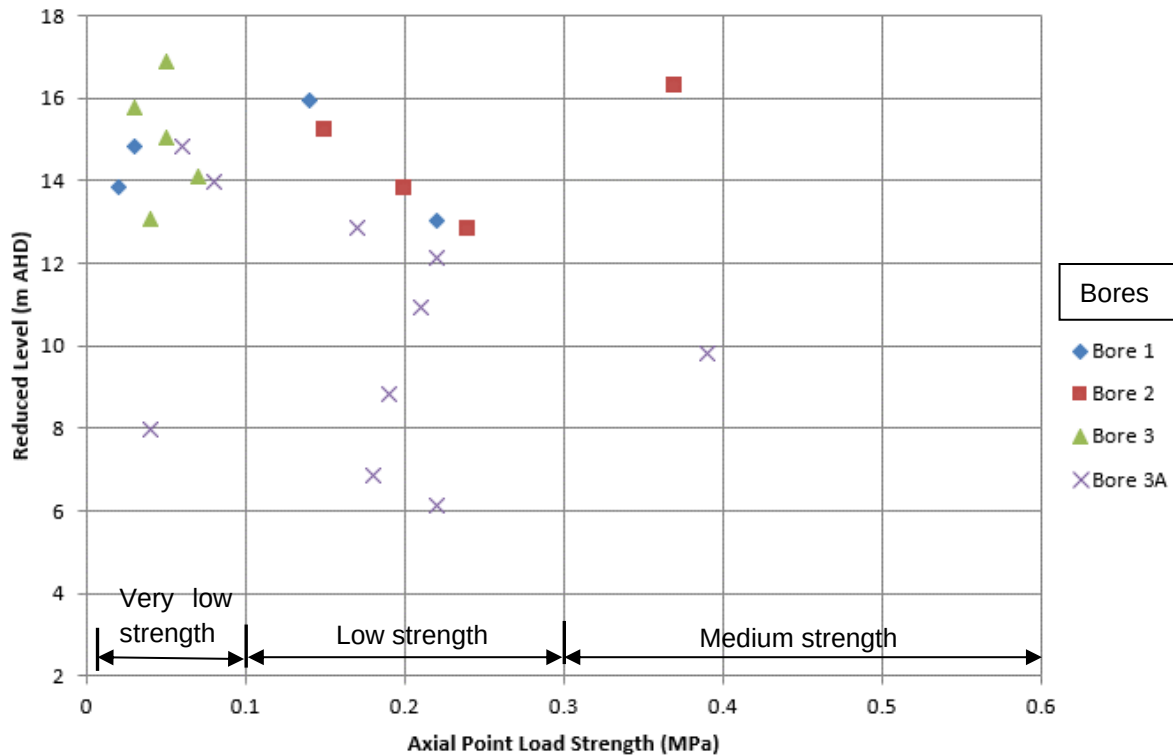


Figure 5: Results of Axial Point Load Tests

7. Proposed Development

It is understood that the proposed development will involve the construction of a primary school. At the time of this report, details of the proposed layout of the school were not available however it is expected to include one to two-storey buildings, pavements and associated outdoor and landscaped areas.

It is also expected that a maximum of 1 m of cut and fill will be required based on the existing site topography. Only minor amounts of fill are expected to be imported to the site.

8. Comments

8.1 Geological Model

The site is underlain generally by up to about 0.3 m of topsoil, overlying stiff to hard natural clays with occasional clayey sand layers. Siltstone bedrock was encountered or inferred at depths of between 5.0 m and 7.5 m in the boreholes and CPTs. The clays on site are typically reactive and of medium to high plasticity.

Groundwater was encountered at a depth of 7.2 m depth at CPT15. Groundwater was not encountered at any other location during this investigation. Notwithstanding this, water seepage is expected to flow

over the soil/rock interface and along bedding planes and joints within the rock. Groundwater levels are expected to fluctuate with variations in climatic conditions.

8.2 Preliminary Site Classification

The results of field work indicate that the site is underlain by topsoil (typically up to about 0.3 m depth) overlying residual clay soils then weathered rock.

The laboratory testing indicates that the clays at the site are of medium to high plasticity and therefore likely to be susceptible to shrink-swell movements in response to seasonal variations in soil moisture content. Based on the soil depth, and the results of laboratory testing, it is considered that the natural soil profile would be expected to be consistent with a “H2” classification as per AS 2870. AS2870 indicates that characteristic surface movements (y_s) of 60 mm to 75 mm are expected for a Class “H” site.

8.3 Site Preparation and Earthworks

8.3.1 Excavation Conditions

Excavation to depths of up to 1 m is generally expected to encounter topsoil and natural soils which should be achievable using conventional earthmoving equipment such as hydraulic excavators.

Vibration generated during earthworks operations would generally be at a level that would not adversely affect the neighbouring structures.

All excavated materials disposed of off-site will need to be classified in accordance with the provisions of the current legislation and guidelines including the *Waste Classification Guidelines* (EPA, 2014). This includes topsoil, fill and natural materials that may be removed from the site. Reference should be made to DP’s preliminary waste classification assessment report for further comments.

8.3.2 Subgrade Preparation

For planning purposes, the following site preparation measures are recommended for subgrade preparation and any site platform filling placement for the development:

- remove any deleterious, soft, wet or highly compressible material or material rich in organics or root matter (such as topsoils). Based on DP’s investigation this will typically range from 0.1m to 0.3 m depth. Topsoil materials should be separately stockpiled for use in landscaping or removed off site;
- roll the exposed surface with at least six passes of a minimum 12 tonne deadweight smooth drum roller, with a final test roll pass accompanied by careful visual inspection to ensure that any deleterious materials such as soft, wet or highly compressible soil and any organics are identified and removed;
- place approved filling, where required, in layers not exceeding 250 mm loose thickness, with each layer compacted to a minimum dry density ratio of 98% Standard within 2% of optimum moisture

content (OMC) and to a minimum dry density ratio of 100% Standard within 0.5 m of subgrade or floor slab levels. New filling should be free of oversize particles (>75mm) and deleterious material;

- moisture conditioning of clay soils may be required if soils are saturated or dry. Moisture conditioning of saturated soils would involve drying in 'sunny and windy' weather, blending with other drier materials or lime stabilisation. Where the soil is dry, it is expected that this will involve either tyning or excavation with the addition of water to increase the moisture content;
- promptly cover any exposed clay at subgrade level with a minimum 150 mm of select granular fill (minimum CBR 15%) to reduce potential wetting and drying and trafficability problems; and
- new filling required to achieve design levels for support of any on-ground slabs and/or structural loads will need to be carried out under Level 1 testing conditions as defined in AS 3798–2007 "Guidelines on Earthworks for Commercial and Residential Developments". Level 2 testing is recommended for filling materials beneath pavements, recreational and landscaping areas.

The above procedures will require geotechnical inspection and testing services during construction.

8.4 Excavation Support

8.4.1 Batter Slopes

Excavation of a maximum of 1 m for the proposed buildings and pavement areas are assumed to be within residual clays.

The soils exposed in cuts (e.g. service trenches) will not be able to stand vertically without support in the longer term. Where space permits, it will be possible to batter the sides of the excavation and in these conditions, it is suggested to allow for temporary side slopes of 1H:1V in the clay soils.

A maximum batter slope of 2H:1V is recommended for permanent slopes in the clays to allow for maintenance, provided that the slopes are protected against surface erosion and local slumping. Where the slopes are to be vegetated to prevent erosion, a maximum batter slope of 3H:1V is recommended. The batter slopes recommended above are appropriate provided there are no surcharge loads from buildings or structures near the top of the batters.

All battered slopes will need to have appropriate drainage measures installed to limit the potential for slopes to be adversely affected by water runoff.

8.4.2 Retaining Structures

Where there is insufficient room to batter the sides of the excavations, the construction of retaining walls will be required for long term support. Cantilevered retaining walls will generally be suitable where some lateral movement can be tolerated at the crest of the wall.

Cantilevered retaining walls up to 1.5 m high, for which some deflection is acceptable, may be designed on the basis of a triangular earth pressure distribution using a bulk unit weight of 20 kN/m³ for the retained material, and an active earth pressure coefficient (K_a) of 0.35 (level backfill conditions). In situations where the wall movements must be minimised or reduced, an 'at rest' earth pressure

coefficient (K_0) of 0.6 should be used. Allowance should be made for surcharge pressures acting on the walls (e.g. sloping backfill, vehicle loads etc.).

Drainage should be included behind the retaining walls to prevent the build-up of hydrostatic pressure.

8.5 Foundations

8.5.1 General

All structural loads will need to be supported on a uniform founding layer being either natural clays/controlled engineering fill, or siltstone bedrock.

The foundation systems adopted will be dependent on the loads applied by the structure and the depth required to be installed. A shallow foundation system for relatively lightly loaded structures. Piled foundation systems would be required to support more significant loads.

8.5.2 Shallow Foundations

Shallow footings (e.g., pad or strip footings) founded on controlled fill or stiff natural clays prepared in accordance with Section 8.3.2 could be designed for an allowable bearing pressure of 150 kPa. The design of shallow footings should also take account of shrink-swell movements associated with the site classification outlined in Section 8.2.

8.5.3 Piled Foundations

Where higher column loads are proposed, it is recommended that all footing loads for each building be transferred to a uniform founding stratum to avoid potential excessive differential settlement across the building. Careful construction controls, however, will need to be implemented to manage issues associated with possible water seepage and sand layers if bored piles are adopted. Temporary or permanent liners (i.e. casing) may be required for bored piles, as well as provision for pumping out water prior to concrete placement. Alternatively, piles may be constructed using continuous flight auger (CFA) piles.

A high torque drilling rig that can penetrate boulders in the natural soils is recommended. Localised excavation of pile locations, where boulders are present near the surface, maybe required. This method, however, is only considered effective to depths of 3 m to 5 m, depending on the size of the machine.

Recommended design parameters for shallow footings and bored piles are presented in Table 5.

Table 5: Maximum Foundation Design Parameters

Unit	Serviceability Design Values		Limit State Design Values		Elastic Modulus (MPa)
	Allowable End Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)	Ultimate End Bearing Pressure (kPa)	Shaft Adhesion (kPa)	
Stiff (or stronger) Natural Clay (>3 m depth)	300	40	-	-	-
Very Low to Low Strength Bedrock	1000	100	3000	300	100
Low and Medium Strength Bedrock	1500	150	6000	350	500

The total (long-term) settlement of a piled footing designed using the allowable parameters provided in this report should be less than about 1% of the pile diameter upon application of the design dead load. Serviceability analysis should be undertaken if the ultimate bearing pressures (incorporating a suitable reduction factor) are used to proportion the piles.

For design using the ultimate values provided in Table 4, a geotechnical strength reduction factor (ϕ_g) should be determined by the designer in accordance with Australian Standard AS 2159:2009 "Piling – Design and Installation" (2009). The serviceability assessment should be based on using geotechnical parameters that are appropriately selected and to which no reduction factor is applied.

For uplift or tension loading, 60% of the above shaft adhesion parameters may be adopted for design purposes. In addition to traditional 'piston pull-out' or sidewall slip failure mechanisms, the uplift capacity should be checked for 'cone pull-out' failure modes. This should be based on AS4678-2002 "Earth-retaining Structures". Uplift capacity for groups of piles will need to consider interaction between piles, which will generally lead to a lesser capacity than the sum of the capacity of individual piles in the group.

Over the designated 'socket length' the sidewalls of bored piles should be clean and free of clay 'smear'. Also, the sidewalls should meet the minimum roughness category of "R2" (defined as grooves of 1 to 4 mm depth and width greater than 2 mm, at a spacing of 50 mm to 200 mm) in Pells et.al (1998). A 'grooving' or 'roughening' tool may be required to achieve this criterion.

The foundation design parameters assume that the foundation excavations (e.g. for pad footings or bored piers) are clean and free of loose debris and water immediately prior to the placement of concrete. All foundations should be constructed below the zone of influence of any existing or proposed service trenches. The zone of influence can be conservatively defined by a plane extending upwards at 45° from the base of the service trench.

All footings in one structure should be founded on the same strata to achieve uniform founding conditions and limit the potential for differential movement between different parts of the structure.

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

8.6 Floor Slabs

Where the building is to be designed with a suspended floor slab, site preparation measures will be minimal. If slabs are to be cast on ground (but designed as suspended slabs), then checks should be made to ensure that concrete is not poured onto softened or wet ground that could lead to deformation of the slab. Furthermore, in areas where clay is present, to reduce the potential for swelling of soils beneath the slab the top 100 mm of the ground surface should be scarified and loosed prior to forming up for the slab. Alternatively, void formers could be used.

Where site preparation is undertaken in accordance with Section 8.3.2, on-grade slabs could be constructed in place of suspended slabs. Based on the results of the subsurface investigations, subgrade conditions are expected to be formed over natural clay material.

Floor slabs should be cast independently of pads or pile and beam footings and incorporate control joints to allow for differential movements. Edge protection, such as deepened stiffening edge beams in conjunction with surface paving should also be included to minimise the effects of reactivity movements due to the high reactivity of the site clays.

8.7 Seismic Classification

In accordance with Part 4 of the Structural design actions Standard, AS1170.4 – 2007, the site is assessed to have a Site Sub-Soil Class of “C_e”. This is in accordance with the definitions presented in Section 4.2 – Class Definitions.

8.8 Pavements

Based on the highly reactive clays on-site, concrete pavements and ground slabs should be articulated to allow for differential movement together with a drainage system to limit the potential for shrink-swell movements that could potentially damage pavements.

Laboratory testing for CBR and compaction was carried out on two bulk samples recovered from the subgrade soils over the site. CBR values of 5 % and 25 % were obtained for the clay samples tested however, experience in the area suggest CBR values in the range of 2 – 4%. Allowing for variability of results, it is suggested that the design of pavements be based on a design CBR value for the subgrade of 3 %. If imported material is used to level the site and form subgrade levels, the design CBR value will depend on the type and depth of imported material. Pavements should be placed on a subgrade prepared in accordance with the recommendations provided in Section 8.3.2.

8.9 Site Maintenance and Drainage

Surface and subsurface drainage for the building and pavements should be incorporated into the design. Subsoil drainage should be installed to not less than 500 mm depth below subgrade level adjacent to pavement areas and to any lawn or garden areas, where the ingress of water beneath the pavement subgrade may be possible. Preparation of subgrade surfaces should be such that adequate cross-falls for the surface drainage purposes are achievable across the final pavement.

Site trafficability during dry weather should pose no problems, however inclement weather may cause clayey soils to soften and become unsuitable for construction traffic until the site conditions dry. In areas where high levels of construction traffic are expected, a temporary hardstand comprising crushed rock could be constructed to aid in trafficability during wet weather.

Care should be taken to avoid external influences on the soil moisture-regime. Detailing of surface and subsurface drainage should be aimed at avoiding substantial wetting of the soils beneath building areas. Surface water should be directed away from building areas and the upper section of service trenches should be backfilled with compacted clay soil to avoid the trench acting as an inlet drain.

A copy of the CSIRO Building Technology File BTF 18 entitled, 'Foundation Maintenance and Footing Performance, A Homeowners Guide', which further describes appropriate site maintenance requirements set out within Appendix B of AS2870 is included in Appendix E.

8.10 Salinity

8.10.1 Impact of the Saline Soils on the Proposed Development

The mild aggressivity to concrete, the presence of non-saline to moderately saline soils and the highly sodic soils are naturally occurring features of the local landscape and are not considered significant impediments for future redevelopment of the site, provided appropriate remediation or management techniques are employed.

Salinity and aggressivity affects the durability of concrete and steel by causing premature breakdown of concrete and corrosion of steel. This has impacts on the longevity of structures in contact with these materials. As a result, management will be required.

Sodic soils have low permeability due to infilling of interstices with fine clay particles during the weathering process, restricting infiltration of surface water and potentially creating perched water tables, seepage in cut faces or ponding of water in flat open areas. In addition, sodic soils tend to erode when exposed. Management of sodic soils would therefore be required to prevent these adverse effects.

8.10.2 Salinity Management Plan

The current salinity investigation indicates that materials within the site range from non-saline to moderately saline with near-surface soils (within 0.5 m of the existing ground surface) generally non-saline. Testing of other parameters associated with salinity indicates that the materials are non – aggressive to mildly aggressive to concrete and non - aggressive to steel. In addition, shallow soils were highly sodic.

The amount of information regarding the distribution of salinity across the site is limited. Therefore, the management strategies assume the most conservative approach of moderately saline soils being present across the site. Further investigation may be able to delineate areas of lower salinity, however, given the high potential in the nearby South Creek it is likely that saline soils will probably be encountered elsewhere on-site.

The following management strategies are confined to the management of those factors with a potential to impact on the development:

- A. Management should focus on capping of the upper surface of the sodic soils, both exposed by excavation and placed as fill, with a more permeable material to prevent ponding, to reduce capillary rise, to act as a drainage layer and to reduce the potential for erosion;
- B. With respect to any required imported fill which is expected to be only in small quantities, testing should be undertaken prior to importation to determine the salinity characteristics of the material, which should not be greater than mildly - aggressive and, where possible, should not be greater than "moderately saline" in classification;
- C. Sodic soils can also be managed by maintaining vegetation where possible and planting new salt tolerant species. The addition of organic matter, gypsum and lime can also be considered where appropriate. After gypsum addition, reduction of sodicity levels may require some time for sufficient infiltration and leaching of sodium into the subsoils, however capping of exposed sodic material should remain the primary management method. Topsoil added at the completion of construction is, in effect, also adding organic matter which may help infiltration and leaching of sodium;
- D. Avoiding water collecting in low lying areas, in depressions, or behind fill. This can lead to water logging of the soils, evaporative concentration of salts, and eventual breakdown in soil structure resulting in accelerated erosion;
- E. Any pavements should be designed to be well drained of surface water. There should not be excessive concentrations of run-off or ponding that would lead to waterlogging of the pavement or additional recharge to the groundwater through any more permeable zones in the underlying fill material;
- F. Surface drains should generally be provided along the top of batter slopes to reduce the potential for concentrated flows of water down slopes possibly causing scour; and
- G. Salt tolerant grasses and trees should be considered for landscaping to reduce soil erosion and to maintain the existing evapo – transpiration and groundwater levels. Reference should be made to an experienced landscape planner or agronomist.

The following additional strategies are recommended for completion of service installation and for building construction. These strategies should be complementary to standard good building practices recommended within the Building Code of Australia, including cover to reinforcement within concrete and correct installation of a brick damp course, so that it cannot be bridged to allow moisture to move into brick work and up the wall.

- H. Soils are classified as non - aggressive to mildly aggressive to concrete. Concrete piles, cast-in place, exposed to mildly aggressive soils should have a minimum strength of 32 MPa and a minimum cover to reinforcement of 60 mm (as per AS2159) to limit the corrosive effects of the surrounding soils (in accordance with AS2159);

- I. With regard to concrete structures exposed to moderately saline soils with salinities of greater than 4 dS/m to 8 dS/m that are classified as mildly aggressive to concrete (AS3600 – A2), slabs and foundations should have a minimum strength of 25 MPa, a minimum cover to reinforcement of 45 mm from unprotected ground and should be allowed to cure for a minimum of three days (as per AS3600) to limit the corrosive effects of the surrounding soils. If the proposed ground surface levels are greater than 0.5 m below current site levels, then the classification and comments for very saline soils in point J below are applicable; and
- J. Wet cast concrete pipes and currently manufactured spun concrete pipes are understood to have estimated compressive strengths of 50 MPa and 60 to 70 MPa, respectively, in excess of the requirements for mass concrete in H and I above. Reference to the maximum and minimum test results of Table 4 (Section 6.2 of this report) and to Tables E1 and 3.1 of AS 4058 – 2007 “Precast concrete pipes” indicates that the site falls within the AS 4058 Clay/Stagnant (low sulphate) soil type (chlorides $\leq 20,000$ ppm, $\text{pH} \geq 4.5$ and sulphates $\leq 1,000$ ppm) and (in the absence of tidal water flow) falls within the AS 4058 Normal durability environment. Under these conditions, AS 4058-compliant reinforced concrete pipes of general purpose Portland cement, with a minimum cover to reinforcement of 10 mm, are expected to have a design life in excess of 100 years. Any concrete pipes installed within the site should employ AS 4058-compliant steel reinforced pipes of general purpose Portland cement, with minimum cover to reinforcement of 10 mm, or should be fibre reinforced.

9. Further Investigation

It is anticipated that once development details have been finalised and the site layout has been determined, further geotechnical investigation will be required to provide detailed information to optimise design. It is expected that additional geotechnical investigation beneath building footprints will be required particularly to clarify soil reactivity, and if piles socketed into rock are proposed, rock strength and consistency. The extent of the investigation will be dependent on the proposed loads of the building structure.

10. References

- AS 1170 (2007) *Structural Design Actions, Part 4: Earthquake Actions in Australia*, Standards Australia
- AS 1726 (2017) *Geotechnical Site Investigations*, Standards Australia
- AS 2159 (2009) *Piling Design and Installation*, Standards Australia
- AS 2870 (2011) *Residential Slabs and Footings*, Standards Australia
- AS 3798 (2007) *Guidelines on Earthworks for Commercial and Residential Developments*, Standards Australia
- AS 4678 (2002) *Earth-retaining Structures*, Standards Australia
- Blacktown City Council (2005) *Engineering Guide to Development*
- Blacktown City Council (2005) *Civil Works Specification*

- Clark and Jones (1991) *Penrith 1: 100 000 Geological Sheet 9030* 1st edition, Geological Survey of New South Wales, Sydney
- Department of Infrastructure, Planning and Natural Resources, *Salinity Potential in Western Sydney* (2002), NSW Government.
- NSW Department of Minerals and Energy, *Penrith Geological Series Sheet No 9030* (1991), NSW Government.
- Pells, Mostyn and Walker (1998) *Foundations on Sandstone and Shale in the Sydney Region*, Australian Geomechanics Society
- Richards, L. A. (ed.) (1954), *Diagnosis and Improvement of Saline and Alkaline Soils*, USDA Handbook No. 60, Washington D.C.
- Walker and Pells (1998) *The Construction of Bored Piles Socketed into Shale and Sandstone*, Australian Geomechanics Society

11. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Kaluta Avenue, Melonba in accordance with DP's proposal dated 4 August 2021 and acceptance received from Ms Julie Vigar dated 13 August 2021. The work was carried out under contract ID SINSW02173/21, dated 13 August 2021). This report is provided for the exclusive use of NSW Department of Education for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

This report must be read in conjunction with all of the attached notes 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 for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

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.

Douglas Partners Pty Ltd

Appendix A

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.

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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.

DATA FOR DESCRIPTION AND CLASSIFICATION OF SOILS – Page 1

Major Divisions				Description		Field Identification				
				Group Symbol*	Typical Name	Grading		Nature of Fines	Dry Strength	
COARSE-GRAINED SOILS	More than 65% by dry mass, (excluding that larger than 63 mm) is greater than 0.075 mm	GRAVEL	More than 50% of coarse grains are greater than 2.36 mm	GW	Well graded gravels and gravel-sand mixtures, little or no fines.	Good	Wide range in grain size	'Clean' materials (not enough fines to bind grains)	None	
				GP	Poorly graded gravels and gravel-sand mixtures, little or no fines.	Poor	Predominantly one size or gap graded			
		GRAVELLY SOILS		GM	Silty gravels, gravel-sand-silt mixtures.	Good to Fair	'Dirty' materials with excess of fines	Fines are non-plastic	None to medium	
				GC	Clay gravels, gravel-sand-clay mixtures.			Fines are plastic	Medium to high	
	More than 50% of coarse grains are less than 2.36 mm	SAND	SW	Well graded sands and gravelly sands, little or no fines.	Good	Wide range in grain size	'Clean' materials (not enough fines to bind grains)	None		
			SP	Poorly graded sands and gravelly sands, little or no fines.	Poor	Predominantly one size or gap graded				
		SANDY SOILS	SM	Silty sand, sand-silt mixtures.	Good to Fair	'Dirty' materials with excess of fines	Fines are non-plastic	None to medium		
			SC	Clayey sands, sand-clay mixtures.			Fines are plastic	Medium to high		
	* For coarse grained soils where the fines content is between 5% and 12%, the soil shall be given a dual classification eg GP-GM.						Dry Strength		Dilatancy	Toughness
	FINE-GRAINED SOILS	More than 35% by dry mass, (excluding that larger than 63 mm) is less than 0.075 mm	Liquid Limit less than 35%	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.	None to low		Slow to rapid	Low	
CL				Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high		None to slow	Medium		
OL				Organic silts and organic silty clays of low plasticity	Low to medium		Slow	Low		
35% <LL< 50%			CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high		None to slow	Medium		
Liquid Limit greater than 50%			MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.	Low to medium		None to slow	Low to medium		
			CH	Inorganic clays of high plasticity, fat clays.	High to very high		None	High		
			OH	Organic clays of medium to high plasticity.	Medium to high		None to very slow	Low to medium		
			Pt	Peat muck and other highly organic soils.	Readily identified by colour, odour, spongy feel and generally fibrous texture					

ORDER OF DESCRIPTION

In the soil description the terms should be given in the following order:

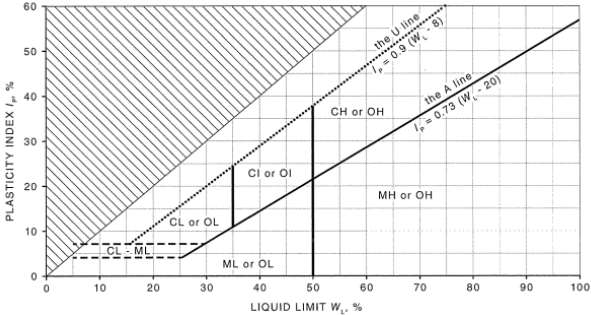
- SOIL NAME & UNIFIED CLASSIFICATION SYMBOL.
- Plasticity, behavioural or particle characteristics of the primary soil component
- Colour
- Secondary soil components' name(s), estimated proportion(s), plasticity, behavioural or particle characteristics, colour and where practical, its plasticity
- Moisture Condition (disturbed or undisturbed state)
- Consistency of fine-grained soils (undisturbed state only)
- Relative density of coarse-grained soils (determined by in situ tests)
- Structure of soil (in undisturbed state)
- Zoning
- Defects
- Cementing
- Origin of soil
- Additional observations

EXAMPLES:

Silty SAND SM: fine to coarse grained, light brown, 15% non-plastic fines, with gravel, 20% angular particles, moist, apparently dense in place, alluvial.

SILT ML: low plasticity, brown, trace fine sand, w > PL, firm, estuarine.

PLASTICITY CHART (after AS 1726:2017)



The classification system excludes the boulder and cobble fractions of the soil and classifies only the materials less than 63 mm in size.

PARTICLE SIZES

Boulders	> 200 mm
Cobbles	63 mm to 200 mm
Gravel	2.36 mm to 63 mm
Sand	0.075 mm to 2.36 mm
Silt and Clay	< 0.075 mm

SAND

COARSE	MEDIUM	FINE	SILT
2.36-0.6 mm	0.6-0.2 mm	0.2-0.075 mm	0.075-0.002 mm

SILT

DATA FOR DESCRIPTION AND CLASSIFICATION OF SOILS – Page 2

GRAVEL	
Density	Field Test
LOOSE	By inspection of voids and particle packing.
DENSE	

SAND							
Density	Field Test	DPT Blows per 300 mm ⁽¹⁾		SPT N Blows	CPT q _c MPa	Relative Density %	Estimated Friction Angle
		Dry ⁽²⁾	Wet ⁽³⁾				
VERY LOOSE	Easily penetrated with 13 mm reinforcing rod pushed by hand.	< 1	0	0 – 4	0 – 2	0 – 15	25 - 30
LOOSE	Easily penetrated with 13 mm reinforcing rod pushed by hand. Can be excavated with a spade; 50 mm wooden peg can be easily driven.	1 - 3	< 1	4 – 10	2 – 5	15 – 35	27 - 32
MEDIUM DENSE	Penetrated 300 mm with 13 mm reinforcing rod driven by 2 kg hammer – hard shovelling.	3 - 8	1 - 6	10 – 30	5 – 15	35 – 65	30 - 35
DENSE	Penetrated 300 mm with 13 mm reinforcing rod driven with 2 kg hammer, requires pick for excavation; 50 mm wooden peg hard to drive	8 – 15	6 - 10	30 – 50	15 – 25	65 – 85	35 - 40
VERY DENSE	Penetrated only 25 – 50 mm with 13 mm reinforcing rod driven by 2 kg hammer.	> 15	> 10	> 50	> 25	85 – 100	38 - 43

⁽¹⁾Valid for depths up to approx 1m bgl; ⁽²⁾At a mc of approx. 3%-5%; ⁽³⁾At a mc of approx. 15%.

SILT & CLAY							
Consistency	Field Test	DCP Blows per 150 mm	SPT N Blows	Undrained Shear Strength C _u	Unconfined Compressive Strength q _u	CPT q _c kPa	Shear Vane Preferred
				Shear Vane (kPa)	PP* (kPa)		
VERY SOFT	Easily penetrated > 40 mm by thumb. Exudes between thumb and fingers when squeezed in hand	< 1	< 2	< 12	< 25	0 - 180	
SOFT	Easily penetrated 10 mm by thumb. Moulded by light finger pressure.	1 – 1.5	2 – 4	12 – 25	25 – 50	180 - 375	
FIRM	Impression by thumb with moderate effort. Moulded by strong finger pressure	1.5 – 3	4 – 8	25 – 50	50 – 100	375 - 750	
STIFF	Slight impression by thumb cannot be moulded with finger	3 – 6	8 – 16	50 – 100	100 – 200	750 - 1500	
VERY STIFF	Very tough. Readily indented by thumbnail.	6 – 12	16 – 32	100 – 200	200 – 400	1500 - 3000	
HARD	Brittle. Indented with difficulty by thumbnail.	> 12	> 32	> 200	> 400	> 3000	
FRIABLE	Easily crumbled or broken into small pieces by hand.						

* Pocket Penetrometer (PP) may overestimate q_u by a factor of 1.5 to 2.0.
Note: Visual-tactile assessment is indicative only. Use in-situ testing for logging

MOISTURE OF FINE GRAINED SOILS

Moist, dry of plastic limit	w < PL	Wet, near liquid limit	w ≈ LL
Moist, near plastic limit	w ≈ PL	Wet, wet of liquid limit	w > LL
Moist, wet of plastic limit	w > PL		

DEGREE OF SATURATION OF SANDS

Condition of Sand	Criteria	Degree of Saturation (%)
Dry	Non-cohesive and free-running	0 – 25%
Moist	Feels cool, darker colour, grains tend to adhere to one another	25 – 75%
Wet	Feels cold, makes hands wet, should be close to water table	75 – 99%

FIELD IDENTIFICATION PROCEDURE FOR FINE GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus 0.4 mm sieve size particles. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking):

After removing particles larger than 0.4 mm sieve size, prepare a pat of moist soil with a volume of about 8000 mm³. Add enough water if necessary to make the soil soft but not sticky. Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil. Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics):

After removing particles larger than 0.4 mm sieve size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same dry strength but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit):

After removing particles larger than the 0.4 mm sieve size, a specimen of soil about 12 mm cube in size, is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about 3 mm in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced, and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached. After the thread crumbles, the pieces should be lumped together, and a slight kneading action continued until the lump crumbles.

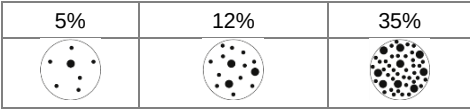
The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay or low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

PROPORTION OF MINOR AND SECONDARY COMPONENTS

Term	Meaning	Approximate Proportion	
		Coarse Soils	Fine Soils
Trace	Just detectable by feel or eye. Soil properties of main component virtually unaffected.	< 5% fines	< 15% sand / gravel
		< 15 % coarse fraction	
With	Easily detectable by feel or eye. Soil properties only slightly affected by minor components.	5% – 12% fines	15% – 30% sand / gravel
		15% – 30% coarse fraction	
Prefix	Easily detected by feel or eye. Soil properties significantly affected by secondary components.	> 12% fines	> 30% sand / gravel
		> 30% coarse fraction	

PROPORTIONS OF SECONDARY COMPONENTS



DATA FOR DESCRIPTION AND CLASSIFICATION OF ROCK

SEDIMENTARY ROCK TYPE DEFINITIONS

Rock Type	Definition
Conglomerate	More than 50% of the rock consists of gravel sized (greater than 2 mm) fragments.
Sandstone	More than 50% of the rock consists of sand sized (0.06 mm to 2 mm) grains.
Siltstone	More than 50% of the rock consists of silt-sized (less than 0.06 mm) granular particles and the rock is not laminated.
Claystone	More than 50% of the rock consists of clay or sericitic material and the rock is not laminated.
Shale	More than 50% of the rock consists of silt or clay sized particles and the rock is laminated.

Rocks possessing characteristics of two groups are described by their predominant particle size with reference also to the minor constituents, e.g. Clayey SANDSTONE, Sandy SHALE.

DEGREE OF WEATHERING

Term	Abbreviation	Definition
Residual soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure, 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 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. DW*
Moderately Weathered	MW	
Slightly Weathered	SW	
Fresh	FR	Rock shows no sign of decomposition of individual minerals or colour changes.

*If highly and moderately weathered rock cannot be differentiated use the term, 'Distinctly Weathered (DW)'.

ORDER OF DESCRIPTION

In the rock description the terms should be given in the following order:
ROCK NAME
Grain size and type
Colour
Fabric and texture
Inclusions and minor components
Moisture content
Durability
Strength
Weathering and/or alteration
Defects – type, orientation, spacing, roughness
Stratigraphic unit
Geological structure

STRATIFICATION

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

DEGREE OF FRACTURING

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core discontinuous. These include bedding plane partings, joints and other rock defects, **but exclude artificial fractures such as drilling breaks.**

Term	Description
Fragmented	The core is comprised primarily of fragments of length less than 20 mm, and mostly of width less than the core diameter
Highly Fractured	Core lengths are generally less than 20 mm to 40 mm with occasional fragments
Fractured	Core lengths are mainly 30 mm to 100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths are generally 300 mm or longer with occasional sections of 100 mm to 300 mm
Unbroken	The core contains very few fractures

ROCK STRENGTH

Rock strength is classified using the unconfined compressive strength (UCS). Where adequate UCS data are not available then the classification may be based on the Point Load Strength ($I_{s(50)}$) and refers to the strength of the rock substance in the direction normal to the bedding.

Strength Term	UCS MPa	Field Guide	Approx $I_{s(50)}$ MPa
Material less than very low strength is to be described using soil properties			
Very Low	2	Material crumbles under firm blows with sharp end of pick; can be peeled with knife. Pieces up to 30 mm thick can be broken by finger pressure.	0.1
Low		Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.	0.3
Medium	20	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.	1.0
High	60	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.	3.0
Very High	200	Hand specimen breaks with pick after more than one blow; rock rings under hammer.	10.0
Extremely High		Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.	

The approximate point load strength ($I_{s(50)}$) is based on an assumed ratio to UCS of 1:20. This ratio may vary widely and should be determined for each site and rock type.

DISCONTINUITIES / DEFECTS

The actual defect is described not the process which formed or may have formed it, e.g. 'sheared zone', not 'zone of shearing'; the latter suggests a currently active process. Spacing*: A measure of the spacing of discontinuities. Measure mean and range of spacings for each set where possible (do not use descriptive terms). Thickness, openness: Measured in millimetres normal to plane of the discontinuity. Persistence*: The areal extent of a discontinuity. Give trace lengths in metres. Roughness and Shape*: A measure of the inherent surface unevenness and waviness of the defect relative to its mean plane.	Coating or Infilling: Clean: no visible coating or infilling. Stained: no visible coating or infilling but surfaces are discoloured by mineral staining. Veneer: a visible coating or infilling of soil or mineral substance but usually unable to be measured (less than 1 mm). Patchy Veneer: if discontinuous over the plane. Coating: a visible coating or infilling of soil or mineral substance, greater than 1 mm thick. Describe composition and thickness. * Usually determined in field exposures	Roughness: Very Rough Rough Smooth Polished Slickensided Shape*: Planar Curved Undulating Stepped Irregular
--	--	---

Discontinuity Spacing in Three Dimensions:

The spacing of discontinuities in exposures may be described with reference to the size and shape of rock bounded by the discontinuities.

Equidimensional	Same size in all directions
Tabular	Thickness much less than length or width
Columnar	Height much greater than cross section
Polyhedral	Irregular defects without obvious pattern

Field Procedure Logging	Figure 5.1
Ed 9 / Rev 1	May 2019



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.

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 ₅₀	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

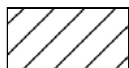
Soils



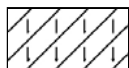
Topsoil



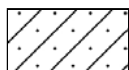
Peat



Clay



Silty clay



Sandy clay



Gravelly clay



Shaly clay



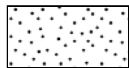
Silt



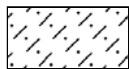
Clayey silt



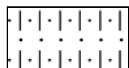
Sandy silt



Sand



Clayey sand



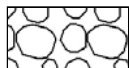
Silty sand



Gravel



Sandy gravel

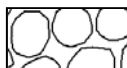


Cobbles, boulders



Talus

Sedimentary Rocks



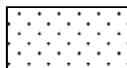
Boulder conglomerate



Conglomerate



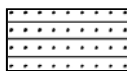
Conglomeratic sandstone



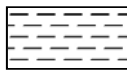
Sandstone



Siltstone



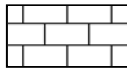
Laminite



Mudstone, claystone, shale

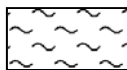


Coal

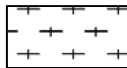


Limestone

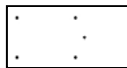
Metamorphic Rocks



Slate, phyllite, schist

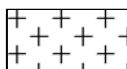


Gneiss

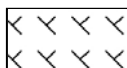


Quartzite

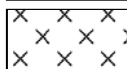
Igneous Rocks



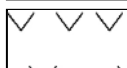
Granite



Dolerite, basalt, andesite



Dacite, epidote



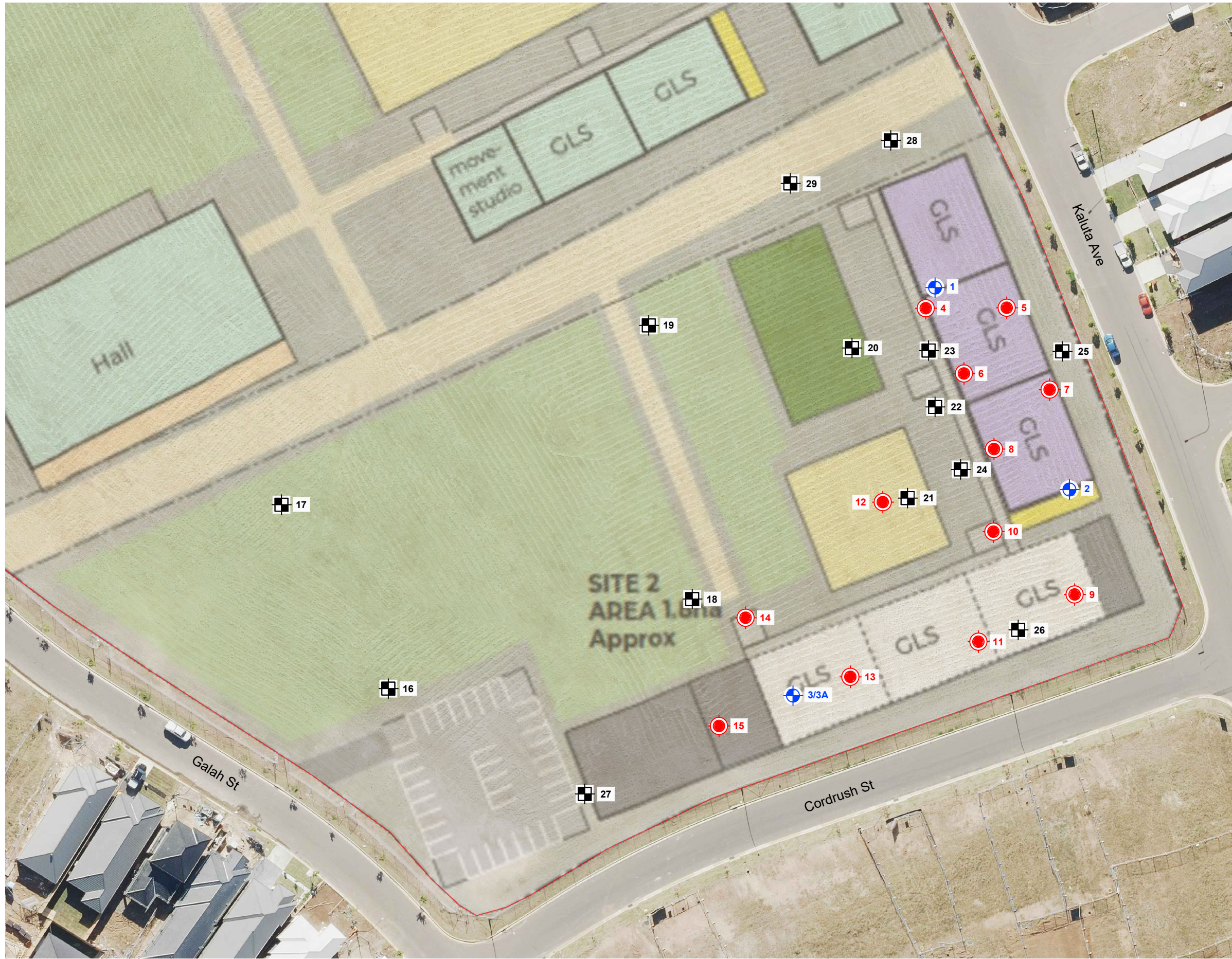
Tuff, breccia



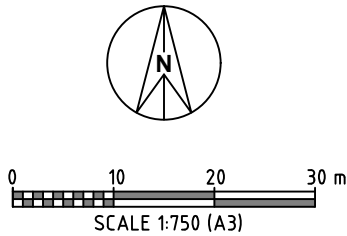
Porphyry

Appendix B

Drawing No 1



Location Plan



LEGEND:-

- Borehole Location and Number
- Test Pit Location and Number
- CPT Location and Number

NOTE:-

- Test locations are approximate only and are shown with reference to existing site features.
- Image obtained from Metromap. Date of imagery 05-06-2021.

Appendix C

Results of Field Work

BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22.7
COORDINATE E:296456 N: 6269063.7
DATUM/GRID: GDA2020 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 1
PROJECT No: 207416.00
DATE: 18/08/21
SHEET: 1 of 2

CONDITIONS ENCOUNTERED							SAMPLE			TESTING AND REMARKS					
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. (°)	DENSITY. (°)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	
No free groundwater observed	0.0	0.1	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (Topsoil)		FILL	NA		<PL			A	0.1			
			(CI-CH) Silty CLAY; red brown; medium to high plasticity		RES	ST		<PL			A	0.5			
	22	0.7	(CI-CH) Silty CLAY; pale brown; medium to high plasticity; with ironstone gravel								A	1.0			
		1									SPT		SPT	5,8,11 N=19	
												1.45			
	21				RES	VST		<PL							
		2											2		
													2.5		
	20	2.7	(CI-CH) Silty CLAY; grey and red; medium to high plasticity								SPT		SPT	5,11,16 N=27	
		3											2.95		
													3		
													3.5		
	19				RES	VST		<PL			SPT		SPT	5,12,16 N=28	
	4											3.95			
												4			
															
	18														

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

PLANT: Explora
METHOD: 100mm SFA to 2.5m, rotary to 5.5m, NMLC coring to 9.7m

OPERATOR: Ground Test
CASING: HW to 2.5m, HQ to 5.5m

LOGGED: PF

REMARKS:

BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22.7
COORDINATE E:296456 **N:** 6269063.7
DATUM/GRID: GDA2020 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 1
PROJECT No: 207416.00
DATE: 18/08/21
SHEET: 2 of 2

CONDITIONS ENCOUNTERED							SAMPLE			TESTING AND REMARKS			
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. ^(*) DENSITY. ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
No free groundwater observed	5.0		SILTSTONE; brown; very low strength, highly weathered		XWM		NA		SPT		5.0	SPT	16,23,25/110
	5.5		CORE LOSS;								5.41		
	5.62		SILTSTONE; brown; fine; extremely low strength, extremely weathered, Bringelly Shale										
	6										6		
	16				XWM		NA						
	7										7		
	7.35		SILTSTONE; grey brown; fine; very low to low strength, highly weathered, Bringelly Shale										
	15												
	8										8	PLT	0.03
	14				XWM		NA						
	9										9	PLT	0.02
	13	9.7	Borehole discontinued at 9.70m depth									PLT	0.22

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

PLANT: Explora

OPERATOR: Ground Test

LOGGED: PF

METHOD: 100mm SFA to 2.5m, rotary to 5.5m, NMLC coring to 9.7m

CASING: HW to 2.5m, HQ to 5.5m

REMARKS:

BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 23.1
COORDINATE E:296482 N: 6269024.7
DATUM/GRID: GDA2020 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 2
PROJECT No: 207416.00
DATE: 19/08/21
SHEET: 1 of 3

CONDITIONS ENCOUNTERED							SAMPLE			TESTING AND REMARKS				
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. (°)	DENSITY (°)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
No free groundwater observed	23	0.0	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout, trace gravel (Topsoil)		FILL	NA	<PL							
		0.1	(CI-CH) Silty CLAY; red and grey; medium to high plasticity; trace sand		RES	ST	<PL			A		0.1		
		0.5	(CI-CH) Silty CLAY; yellow brown; medium to high plasticity; trace sand							A		0.5		
		1.0								A		1.0		
	22				RES	VST	<PL			SPT			SPT	11,15,18 N=33
		1.45										1.45		
													SPT	5,9,12 N=21
		2.0	(CI-CH) Silty CLAY; pale grey; medium to high plasticity; trace ironstone gravel									2.0		
		2.5								SPT		2.5		
		2.95										2.95		
	20	3.0	3.0m: below 3.0m red and grey											SPT
			RES	VST	<PL					3.5				
									SPT					
											3.95			
	19	4.0												

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

PLANT: Explora
METHOD: 100mm SFA to 2.5m, rotary to 6.5m, NMLC coring to 10.5m
REMARKS:

OPERATOR: Ground Test
CASING: HW to 2.5m, HQ to 6.5m

LOGGED: PF

BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 23.1
COORDINATE E:296482 N: 6269024.7
DATUM/GRID: GDA2020 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 2
PROJECT No: 207416.00
DATE: 19/08/21
SHEET: 2 of 3

CONDITIONS ENCOUNTERED						SAMPLE			TESTING AND REMARKS	
GROUNDWATER	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. (°)	DENSITY (°)	MOISTURE	REMARKS	TYPE	INTERVAL
No free groundwater observed	18	(CI-CH) Silty CLAY; pale grey; medium to high plasticity; trace ironstone gravel (<i>continued</i>)		RES	VST		<PL		SPT	5.07
	5.5	(CH) Silty CLAY; pale grey; high plasticity; (possibly extremely weathered siltstone)		RES	XWR		<PL			5.45
	6									6
	6.5	SILTSTONE; grey; low to medium strength, moderately weathered, Bringelly Shale		NA	XWR		NA			PLT-0.37
	7									7
	7.25	SILTSTONE; grey; low strength, moderately weathered, with clay seams, Bringelly Shale		NA	XWR		NA			PLT-0.15
	8									8
	8									
	9									PLT-0.20
	9									
	14									

PLANT: Explora
METHOD: 100mm SFA to 2.5m, rotary to 6.5m, NMLC coring to 10.5m
REMARKS:

OPERATOR: Ground Test
CASING: HW to 2.5m, HQ to 6.5m

LOGGED: PF

BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 23.1
COORDINATE E:296482 N: 6269024.7
DATUM/GRID: GDA2020 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 2
PROJECT No: 207416.00
DATE: 19/08/21
SHEET: 3 of 3

CONDITIONS ENCOUNTERED														SAMPLE			TESTING AND REMARKS		
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. ^(*)	DENSITY ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS					
No free groundwater observed	13		SILTSTONE; grey; low strength, moderately weathered, with clay seams, Bringelly Shale <i>(continued)</i>		NA			NA					PLT	0.24					
	10.5		Borehole discontinued at 10.50m depth																
	11											11							
	12																		
	11											12							
	13																		
	10											13							
	14																		
	9											14							

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

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

PLANT: Explora
METHOD: 100mm SFA to 2.5m, rotary to 6.5m, NMLC coring to 10.5m
REMARKS:

OPERATOR: Ground Test
CASING: HW to 2.5m, HQ to 6.5m

LOGGED: PF

EXPORTED 26/11/21 11:59. TEMPLATE ID: DP_101_02_00_S01LOG

BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22.6
COORDINATE E:296446.1 N: 6269009.2
DATUM/GRID: GDA2020 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 3
PROJECT No: 207416.00
DATE: 19/08/21
SHEET: 1 of 2

CONDITIONS ENCOUNTERED							SAMPLE			TESTING AND REMARKS					
GROUNDWATER	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. (°)	DENSITY. (°)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS		
RL (m)															
No free groundwater observed	0.0	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (Topsoil)		FILL	NA	<PL			A		0.1				
	0.1														
	0.5	(CI-CH) Silty CLAY; red and grey; medium to high plasticity		RES	ST	<PL			A		0.5				
									U						
	1.0	(CI-CH) Silty CLAY; red grey and orange; medium to high plasticity; with ironstone gravel		RES	ST	<PL			A		1.0				
	1.2	(CI-CH) Silty CLAY; pale brown; medium to high plasticity		RES	VST	<PL			SPT		SPT			4,7,16 N=23	
										1.45					
	2.0	(CI-CH) Silty CLAY; grey brown; medium to high plasticity; with ironstone gravel									2				
2.5								2.5							
3.0								2.95							
3.5			RES	VST	<PL			3.5							
4.0								3.95							

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

PLANT: Explora
METHOD: 100mm SFA to 2.5m, rotary to 5.0m, NMLC coring to 9.64m
REMARKS:

OPERATOR: Ground Test
CASING: HW to 2.5m, HQ to 5.0m

LOGGED: PF

BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22.6
COORDINATE E:296446.1 N: 6269009.2
DATUM/GRID: GDA2020 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 3
PROJECT No: 207416.00
DATE: 19/08/21
SHEET: 2 of 2

CONDITIONS ENCOUNTERED						SAMPLE			TESTING AND REMARKS	
GROUNDWATER	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. (°)	DENSITY. (°)	MOISTURE	REMARKS	TYPE	INTERVAL
RL (m)										
No free groundwater observed	5.0	SILTSTONE; pale brown; fine; very low strength, extremely weathered, with occasional clay seams, Bringelly Shale								
	17									
	6									
	16									
	7									
	7.5	SILTSTONE; grey; fine; highly weathered, Bringelly Shale								
	15									
	8									
	14									
	9									
	13									
	9.64	Borehole discontinued at 9.64m depth								

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

PLANT: Explora

METHOD: 100mm SFA to 2.5m, rotary to 5.0m, NMLC coring to 9.64m

REMARKS:

OPERATOR: Ground Test

CASING: HW to 2.5m, HQ to 5.0m

LOGGED: PF

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 22.6

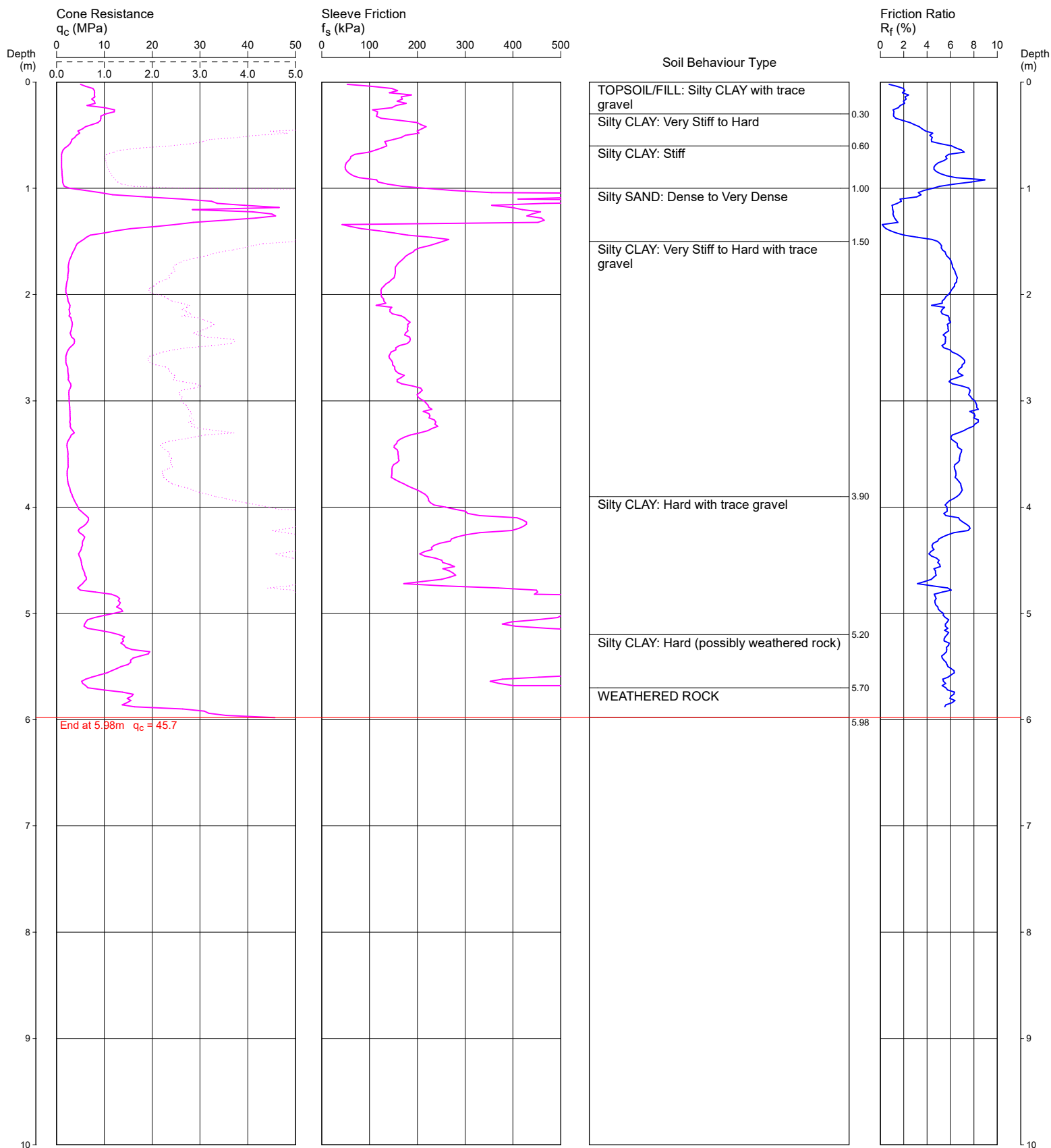
COORDINATES: 296454.2E 6269059.7N

CPT4

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 22.8

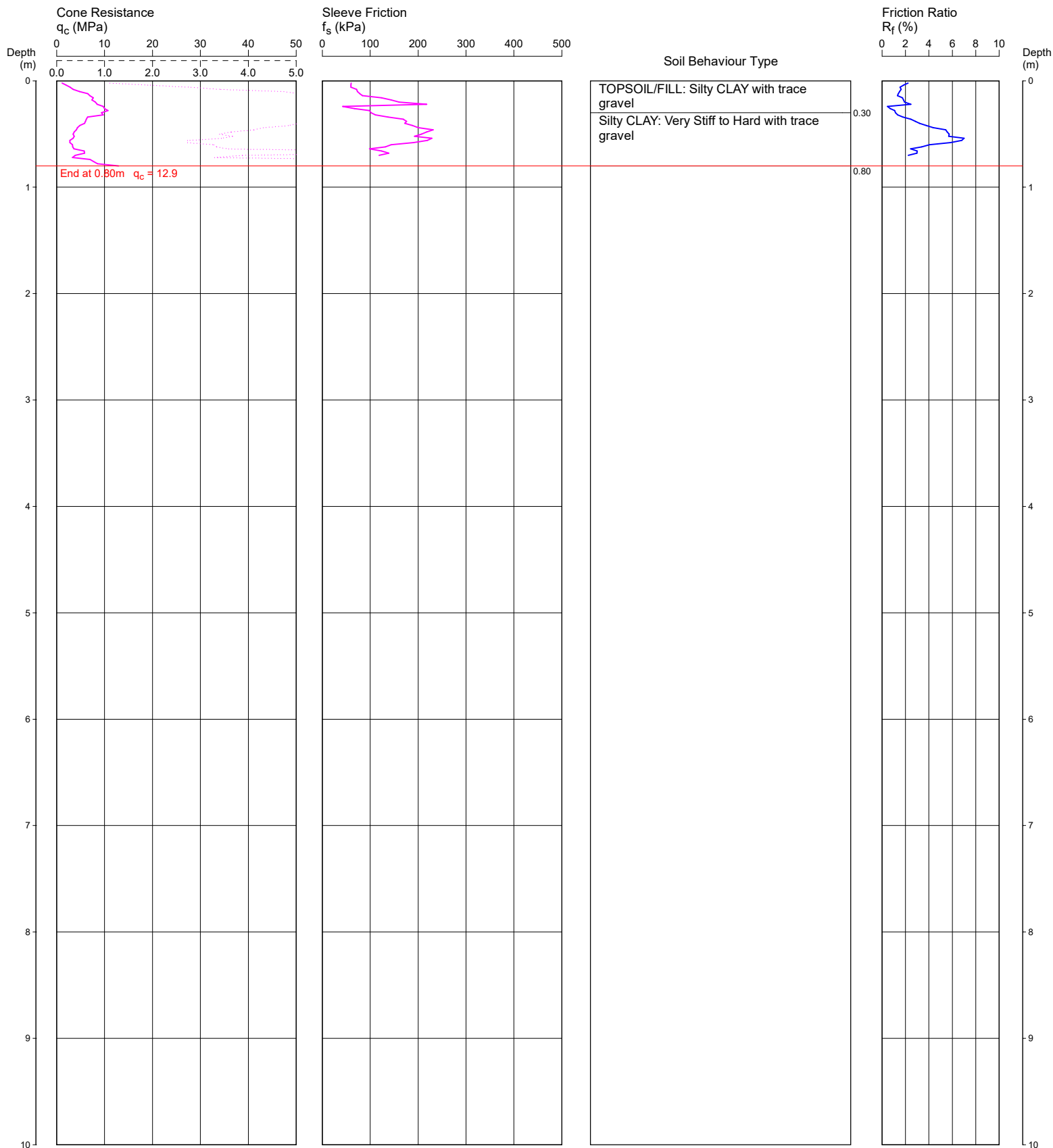
COORDINATES: 296469.9E 6269059.8N

CPT5

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO CONE BENDING ON GRAVEL
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 22.8

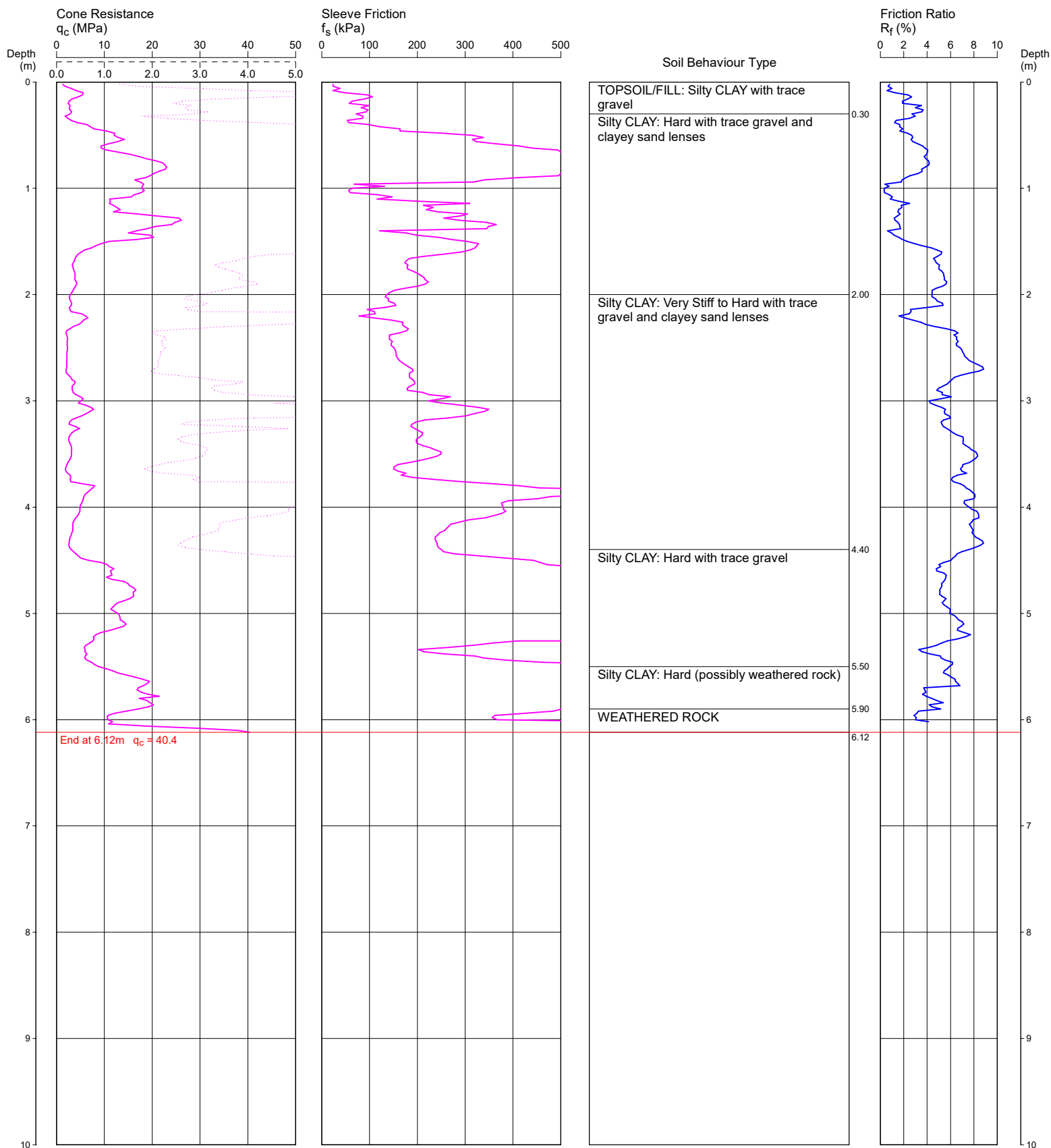
COORDINATES: 296469.9E 6269059.8N

CPT5A

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 22.8

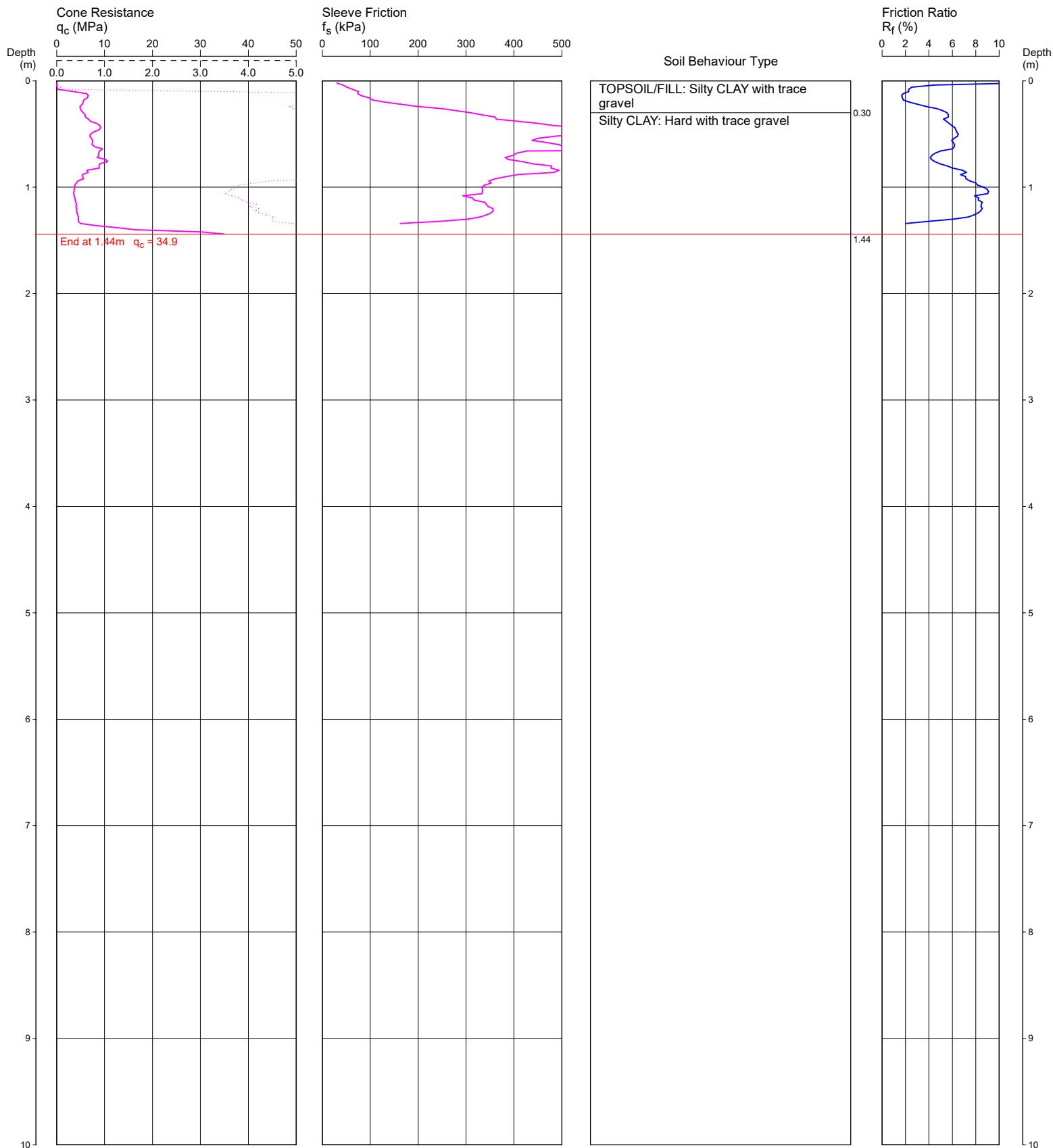
COORDINATES: 296461.6E 6269047.1N

CPT6

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO CONE BENDING IN GRAVELS
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 22.8

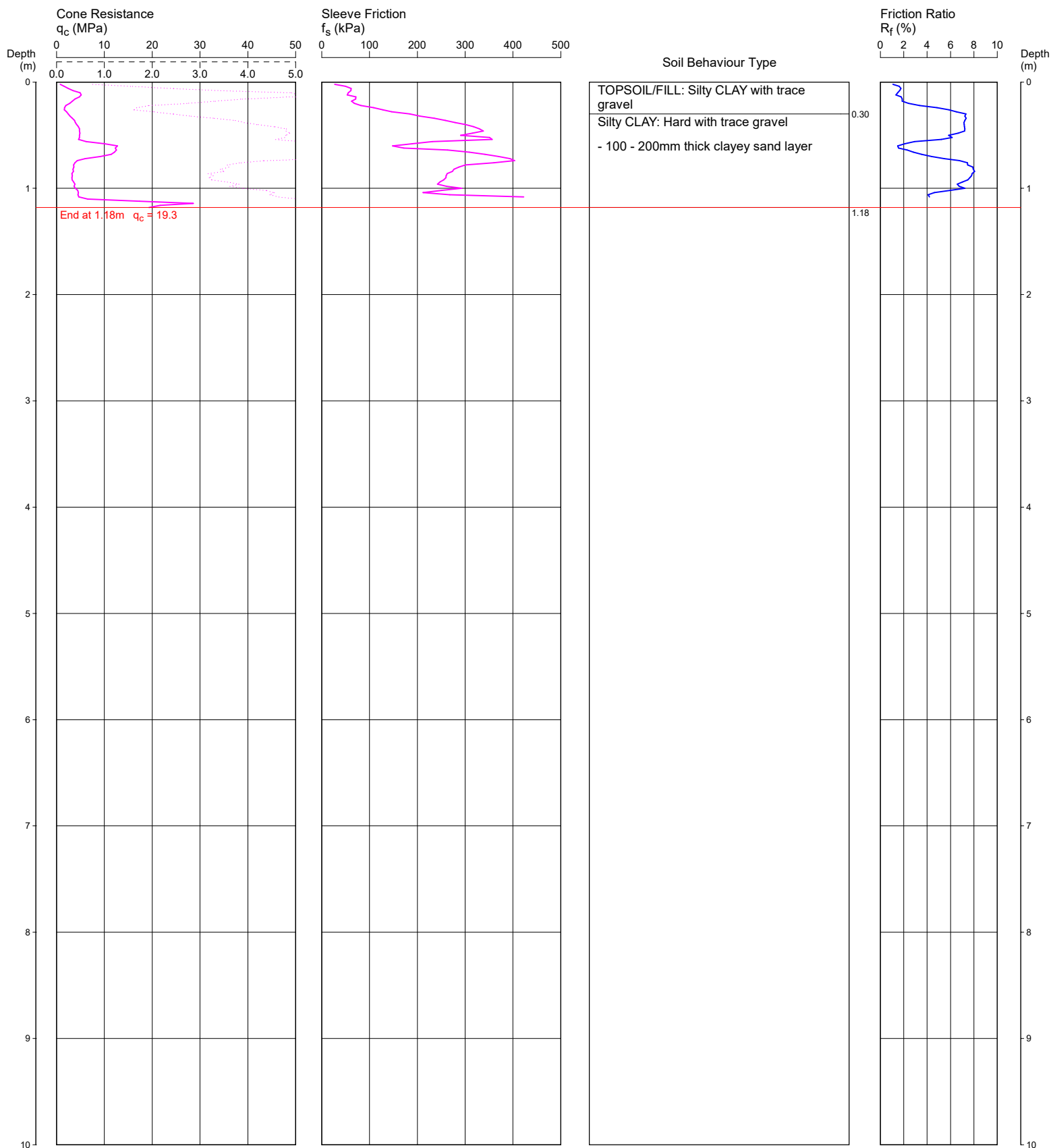
COORDINATES: 296461.6E 6269047.1N

CPT6A

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO CONE BENDING IN GRAVELS
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 23.0

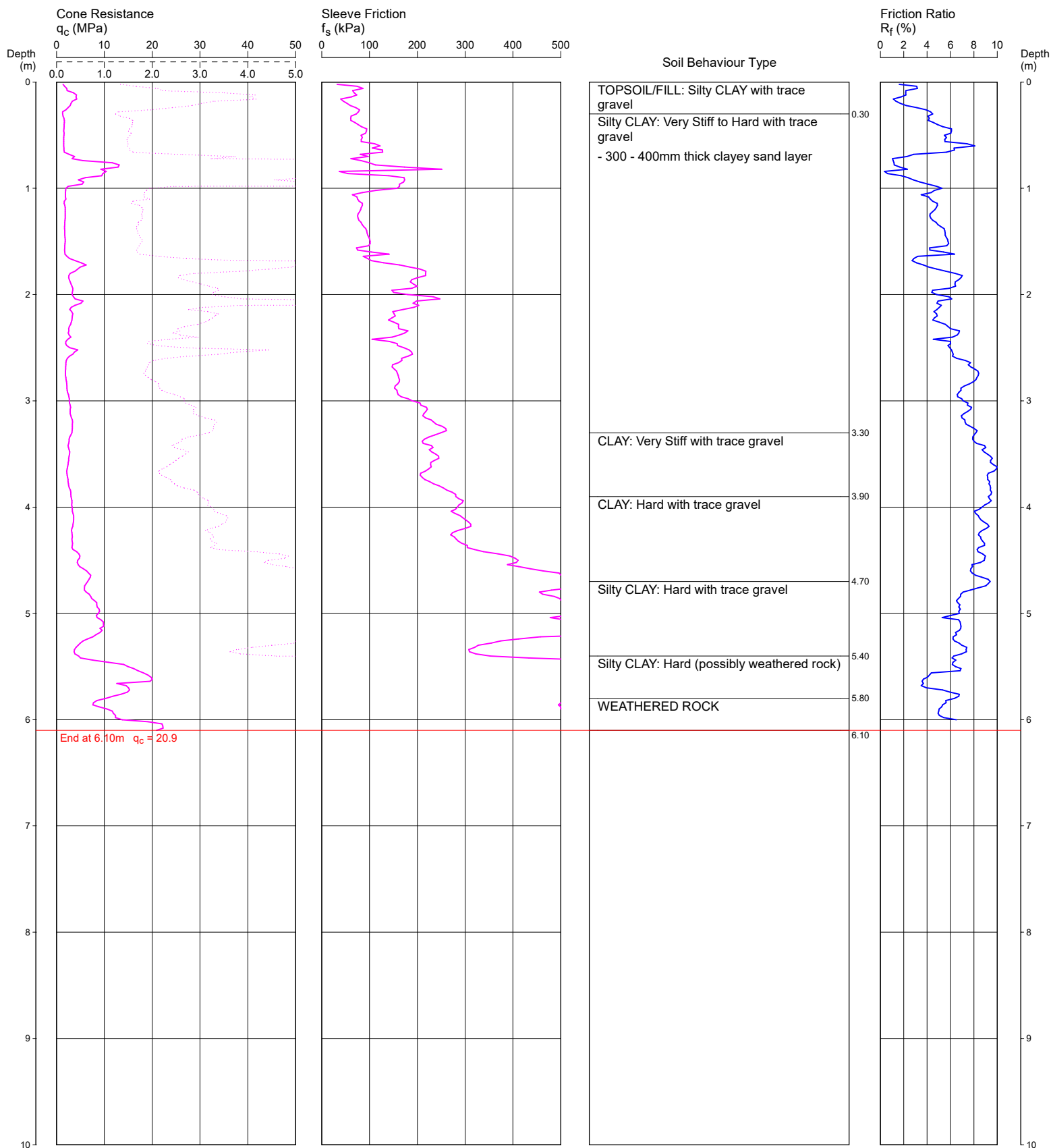
COORDINATES: 296478.1E 6269044.0N

CPT7

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 22.9

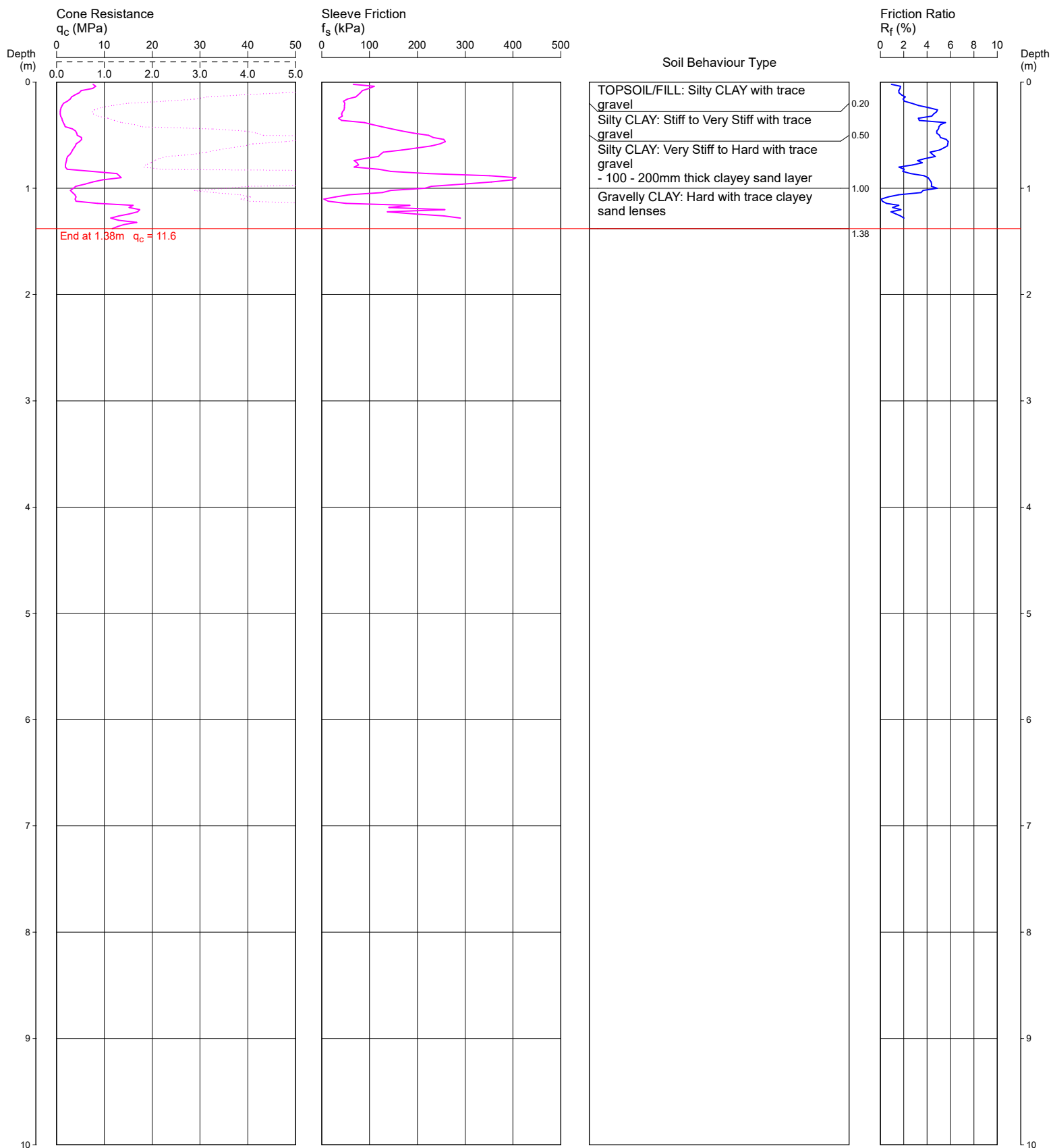
COORDINATES: 296467.4E 6269032.5N

CPT8

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO CONE BENDING IN GRAVELS
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 22.9

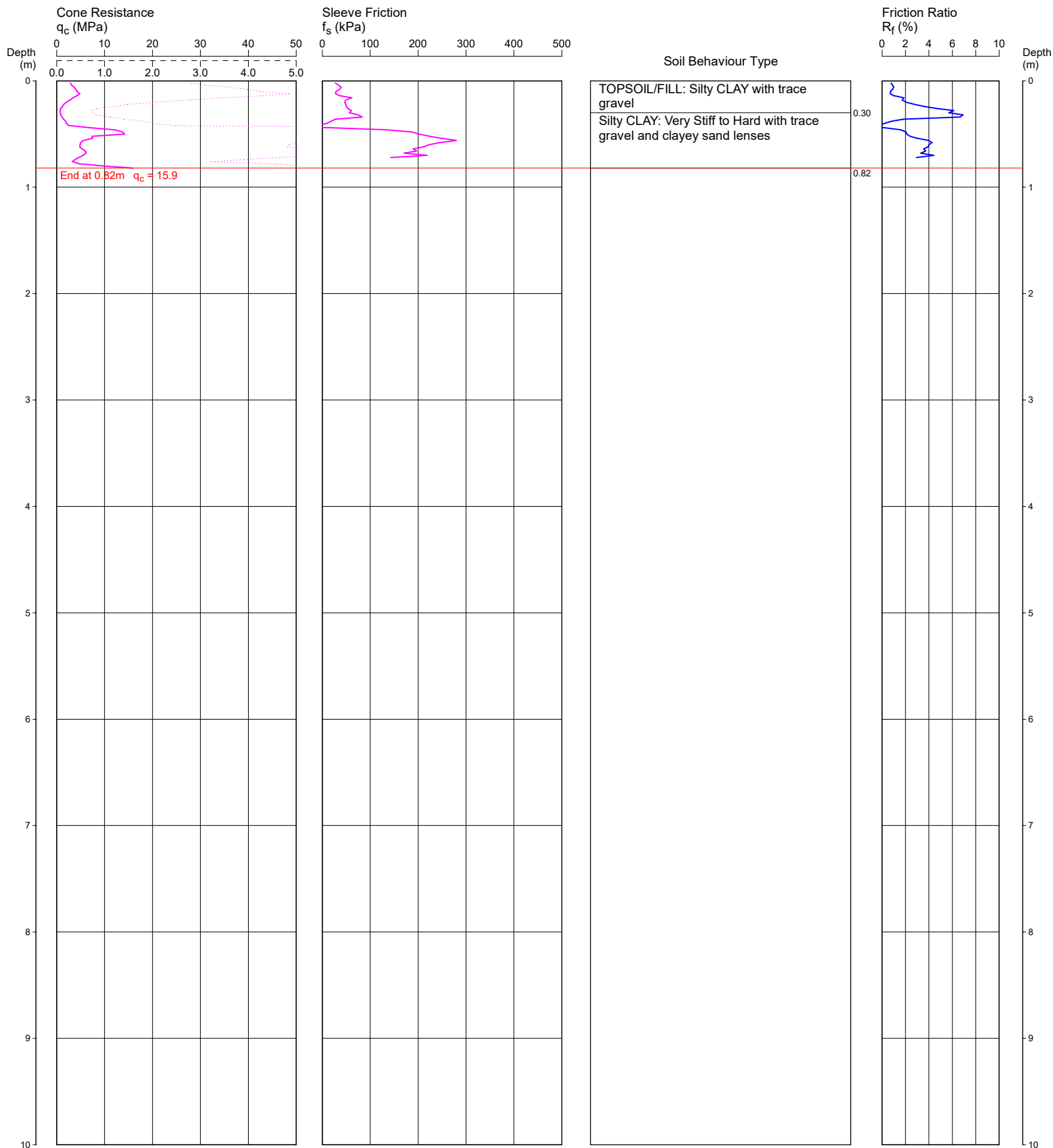
COORDINATES: 296467.4E 6269032.5N

CPT8A

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO CONE BENDING IN GRAVELS
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 23.2

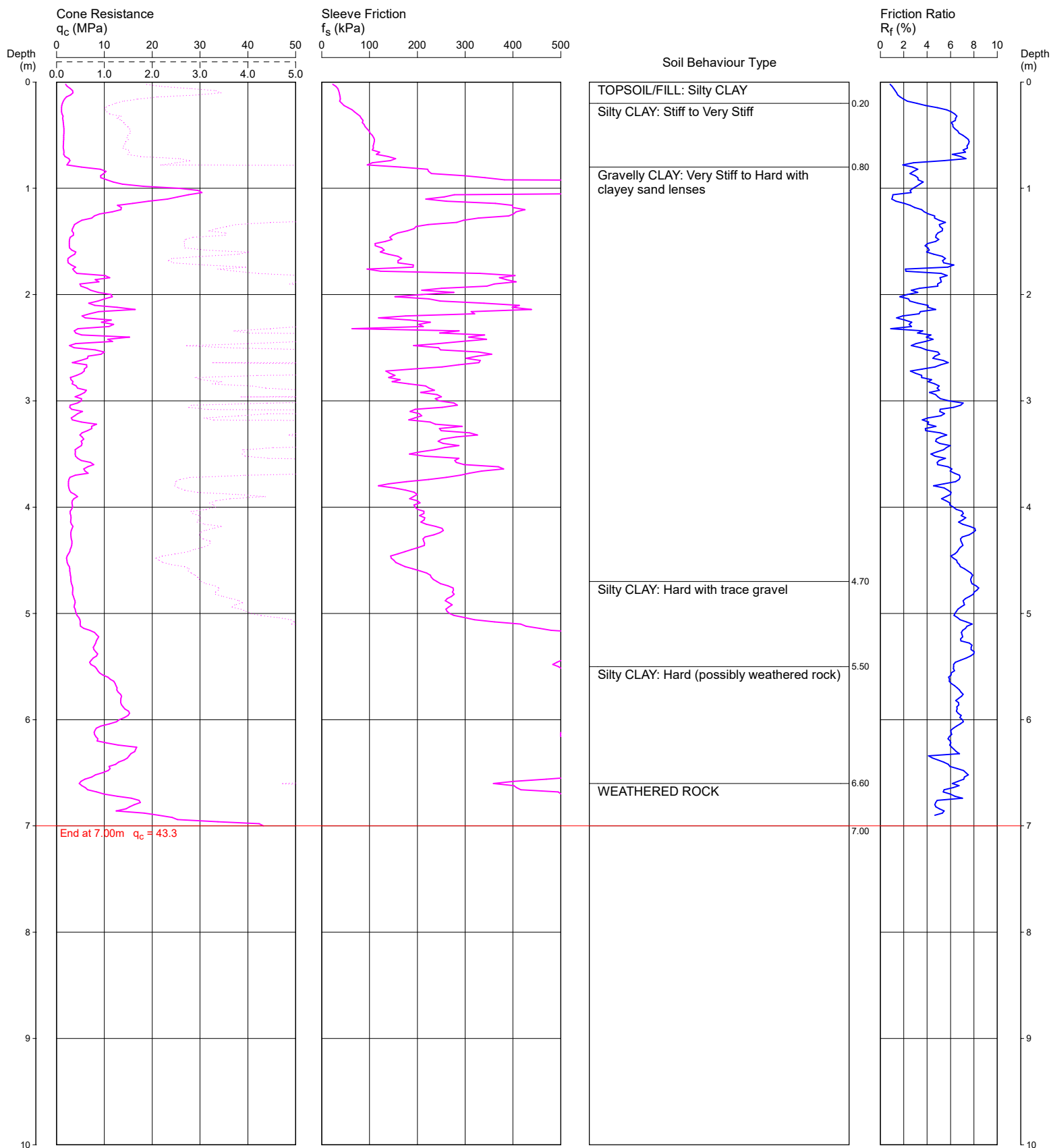
COORDINATES: 296483.0E 6269004.4N

CPT9

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 23.0

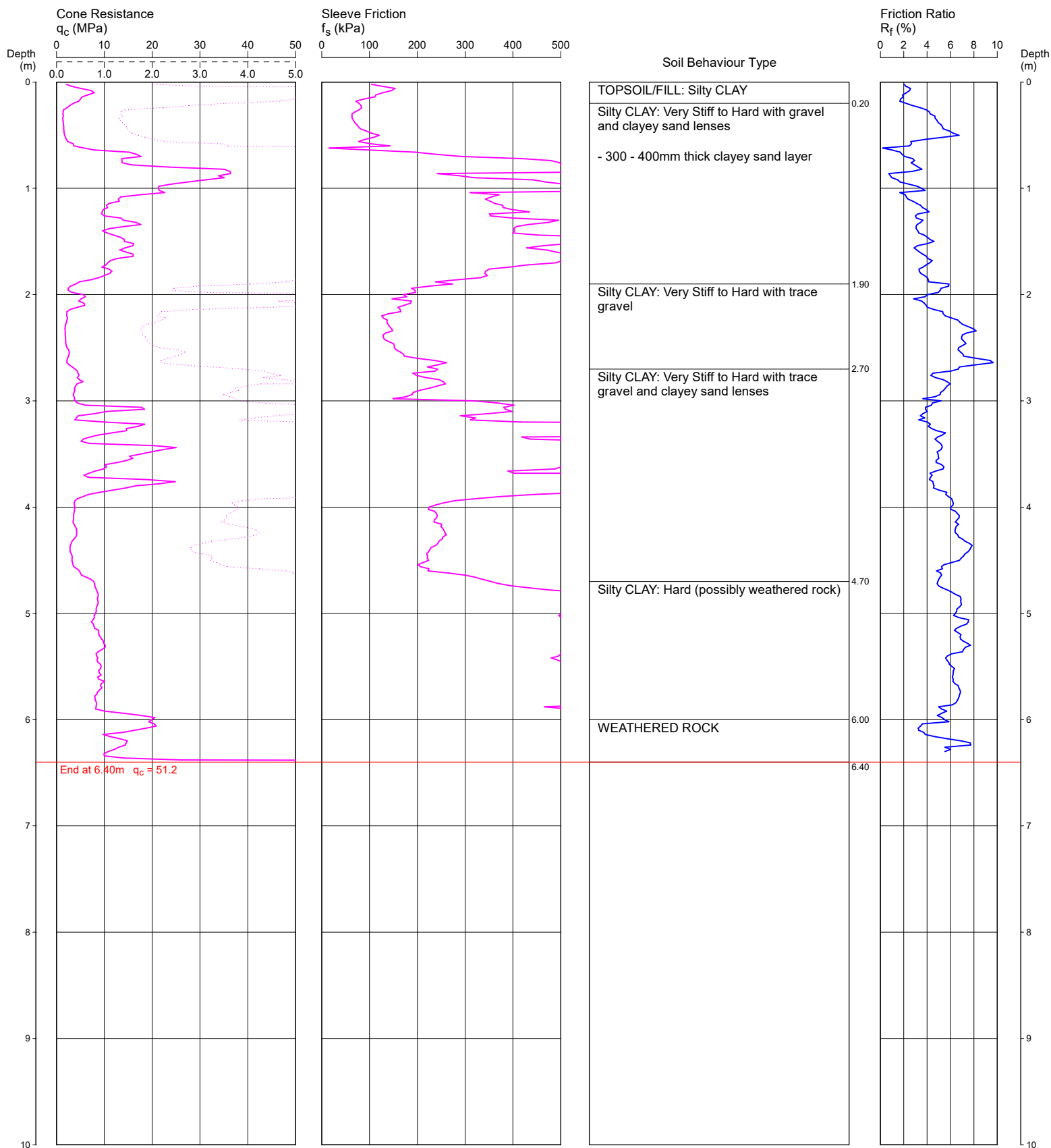
COORDINATES: 296467.3E 6269016.5N

CPT10

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 22.9

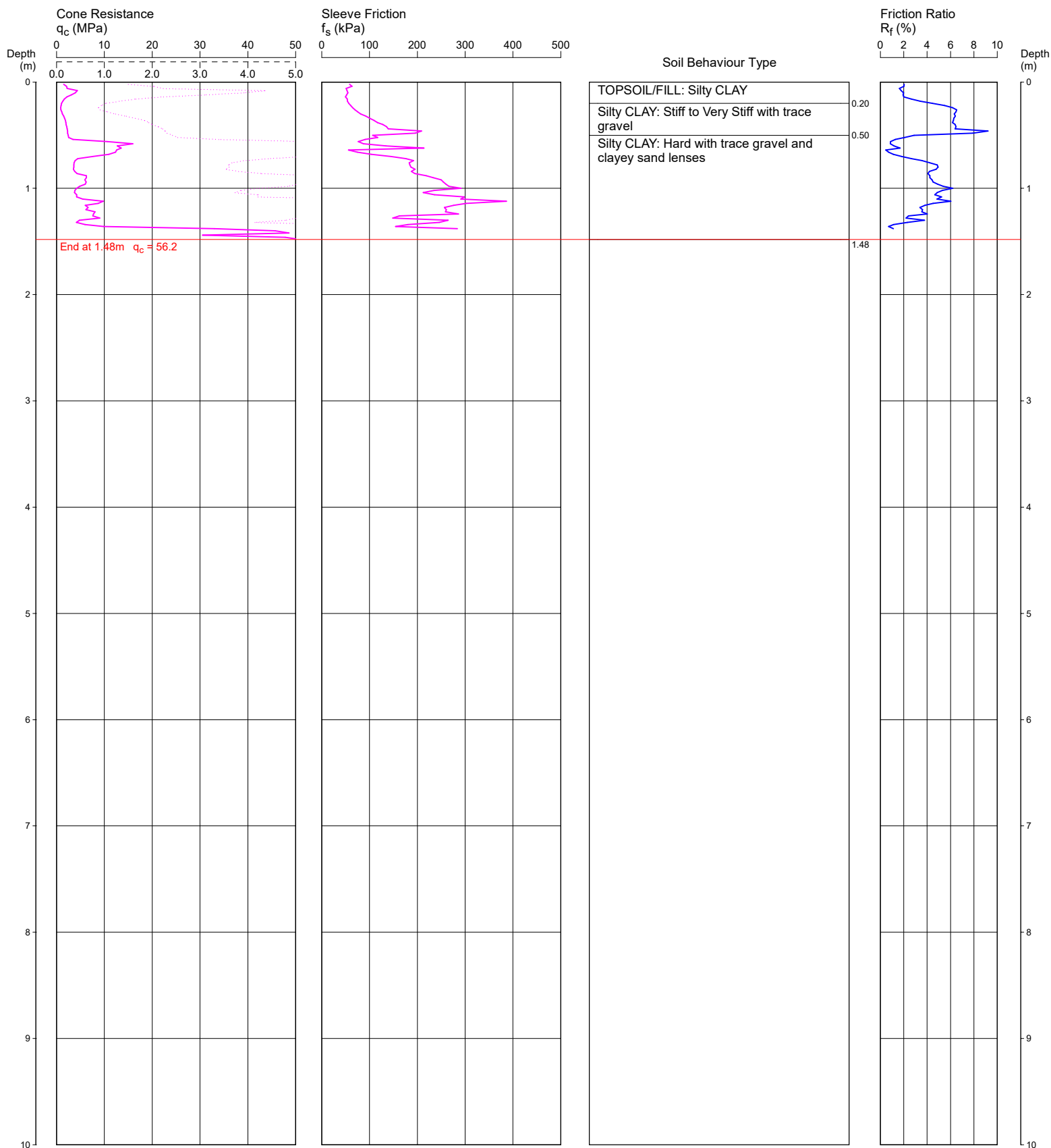
COORDINATES: 296464.4E 6268995.3N

CPT11

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO CONE BENDING IN GRAVELS
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 22.9

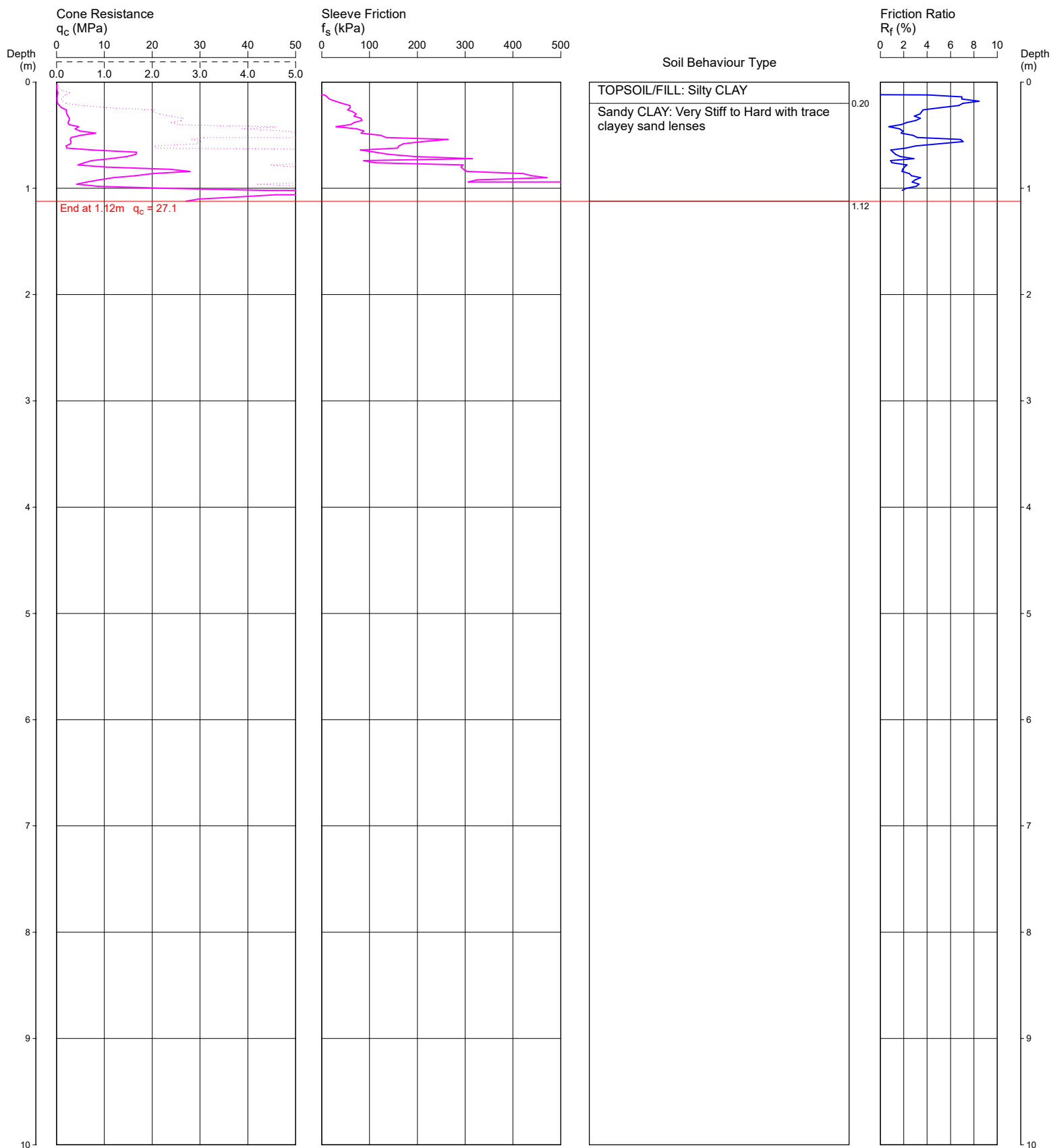
COORDINATES: 296464.4E 6268995.3N

CPT11A

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO CONE BENDING IN GRAVELS
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 22.6

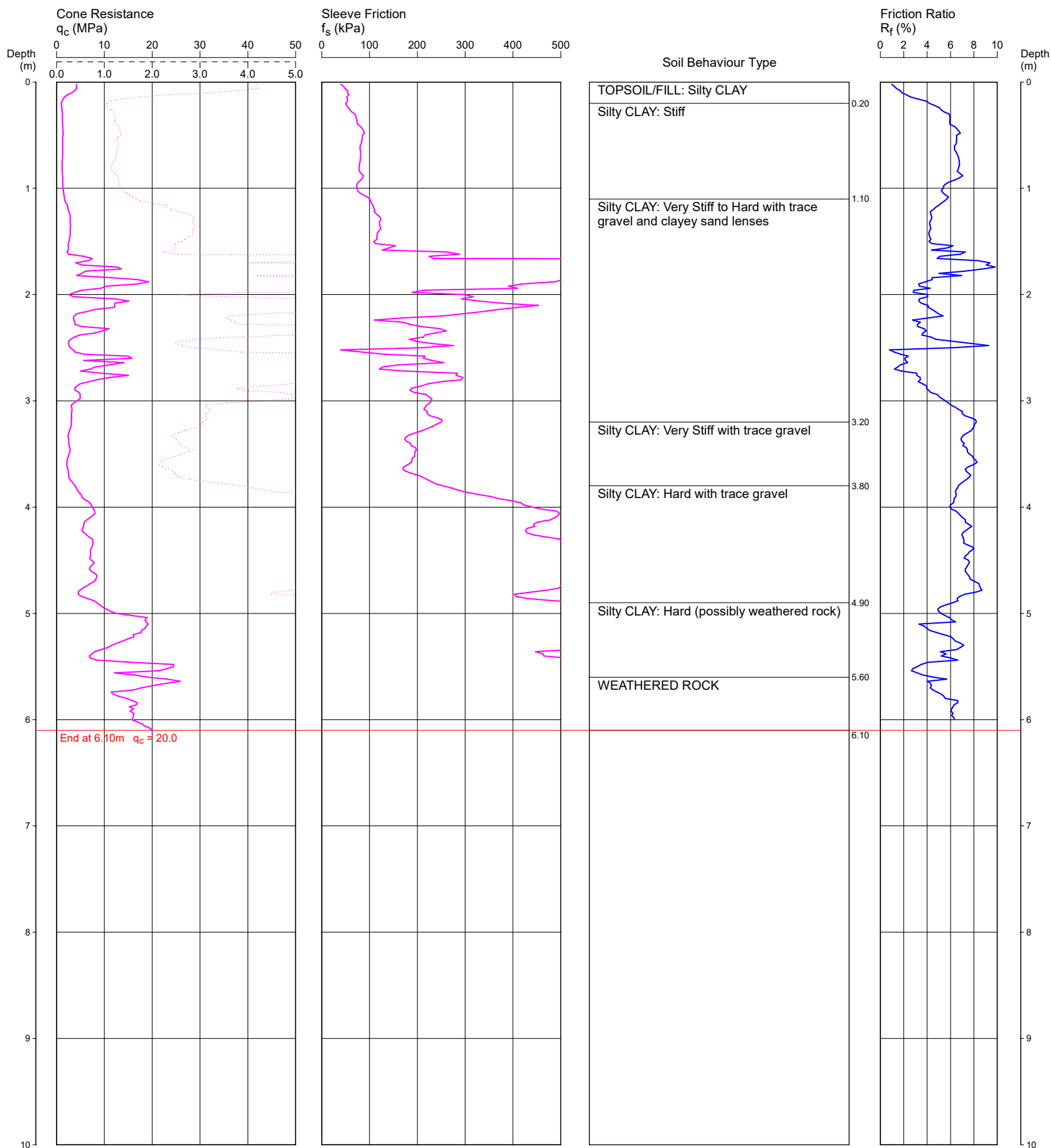
COORDINATES: 296445.9E 6269022.2N

CPT12

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 22.6

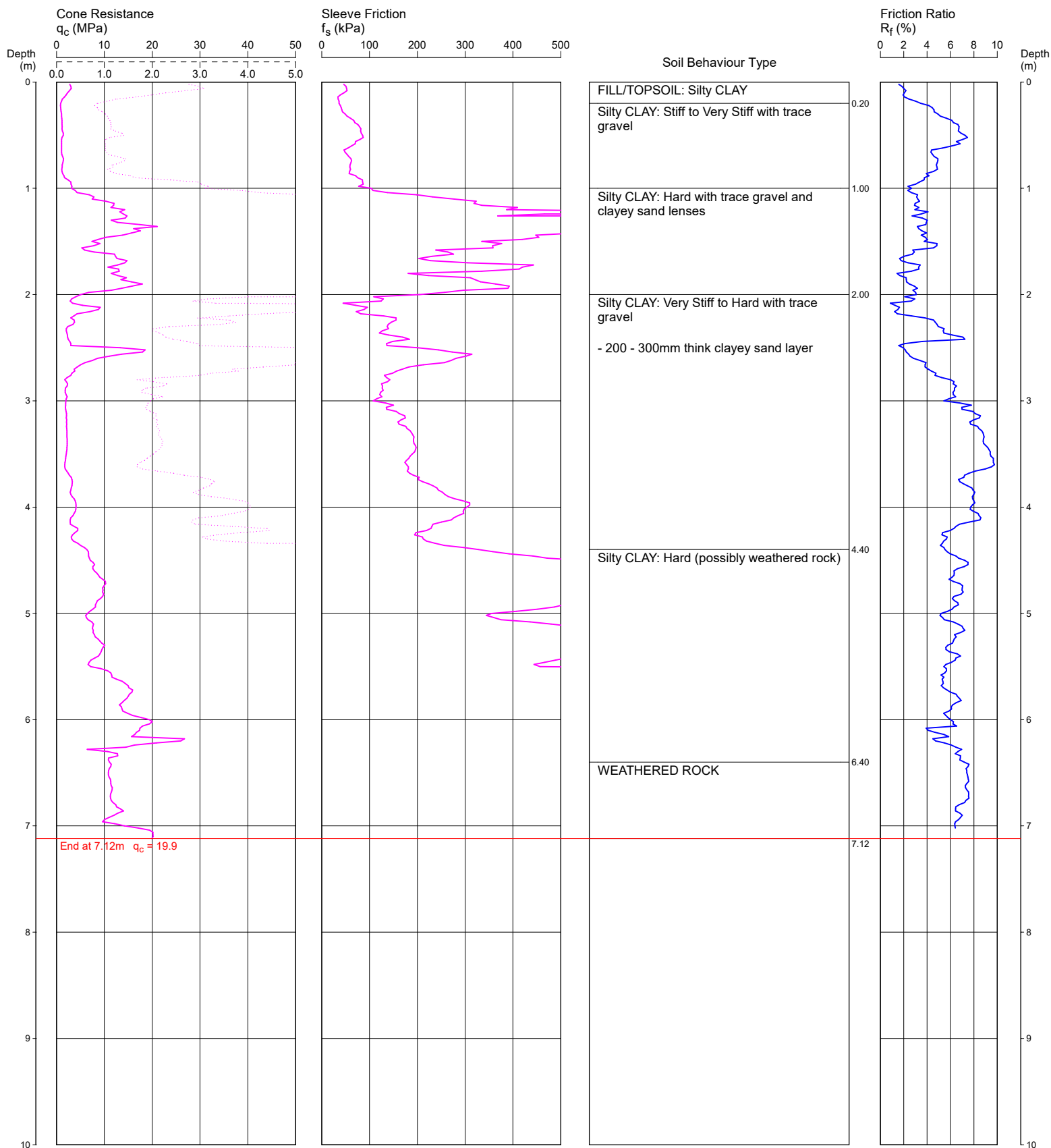
COORDINATES: 296439.7E 6268988.5N

CPT13

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 22.3

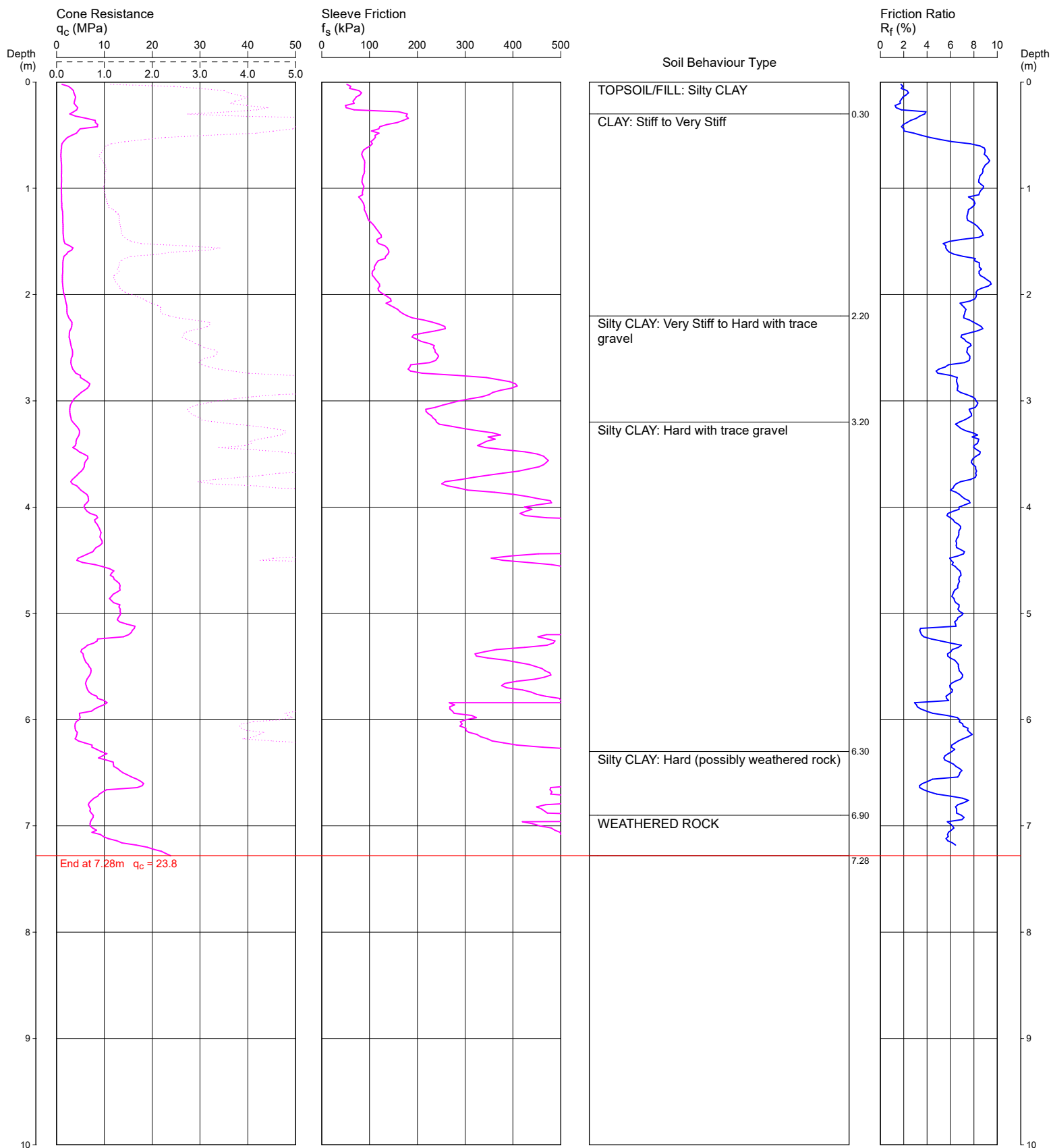
COORDINATES: 296419.5E 6268999.9N

CPT14

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: MELONBA PRIMARY SCHOOL

LOCATION: KALUTA AVENUE, MELONBA

REDUCED LEVEL: 22.3

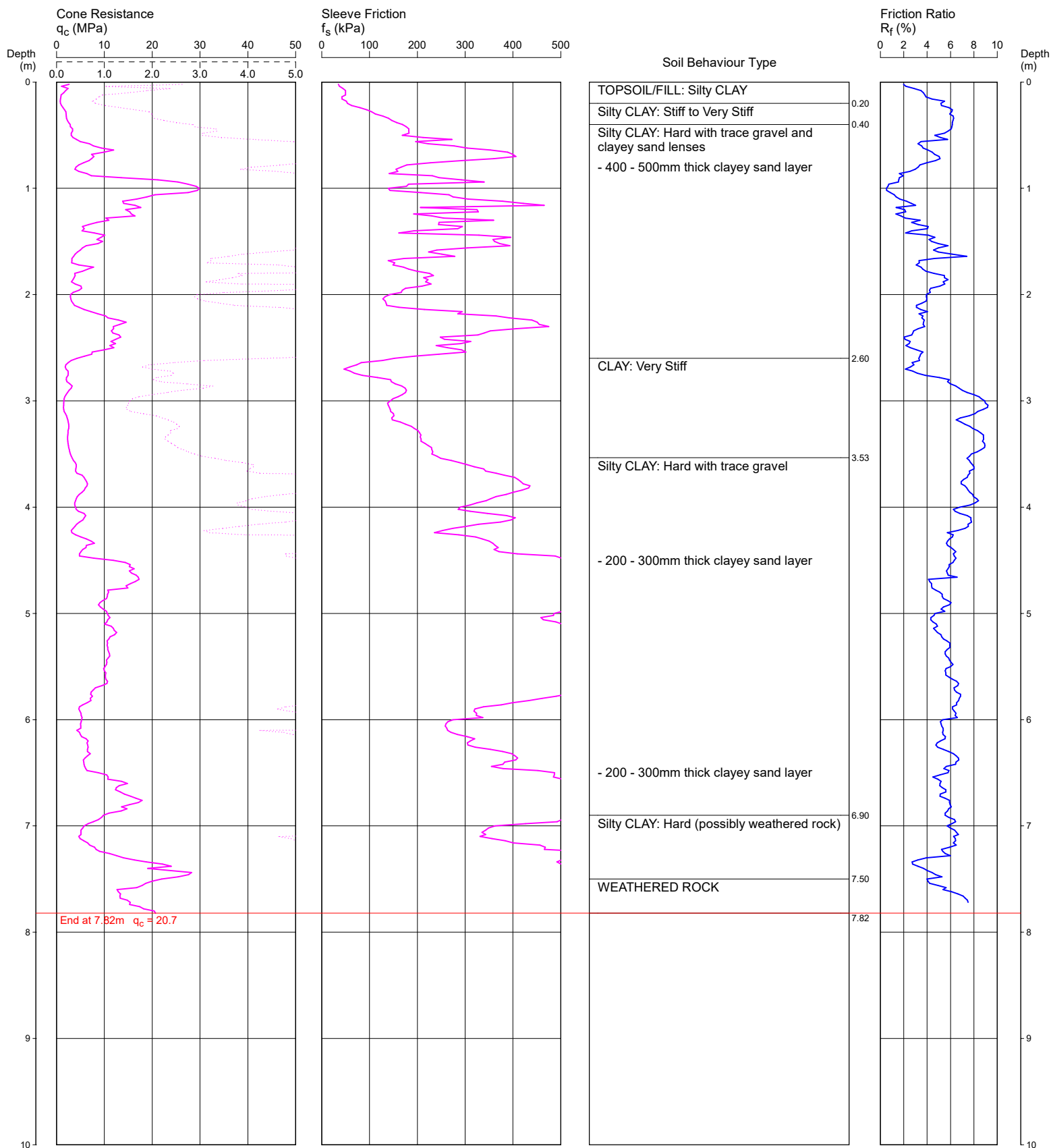
COORDINATES: 296414.3E 6268979.1N

CPT15

Page 1 of 1

DATE 20/08/2021

PROJECT No: 207416.00



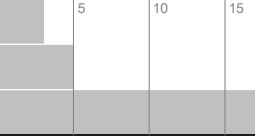
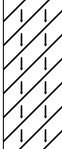
REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
GROUNDWATER OBSERVED AT 7.2M AFTER WITHDRAWAL OF RODS

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 21.5
COORDINATE E:296350.5 N: 6268986.3
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 16
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED											SAMPLE			TESTING AND REMARKS	
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. ^(*)	DENSITY ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	
20/08/21, No free groundwater observed		0.0	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil)		FILL	NA		<PL					DCP/150		
		0.19	(CI-CH) Silty CLAY; grey yellow; medium to high plasticity		RES	ST		<PL							
	21					H				B		0.5			
		0.7	Test pit discontinued at 0.70m depth Refusal									0.7			
		1										1			
		20													
		2										2			
		19													
		3										3			
		18													
		4										4			
		17													

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

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

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 0.7m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

LOGGED: KA

EXPORTED 01/09/21 16:18. TEMPLATE ID: DP_101.02.00_SOILLOG

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 21.3
COORDINATE E:296330 N: 6269021.8
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 17
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED						SAMPLE			TESTING AND REMARKS			
GROUNDWATER	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. (%) DENSITY (%)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
20/08/21, No free groundwater observed	0.0	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil)		FILL	NA	<PL		J		0.0		
	0.19	(CI-CH) Silty CLAY; grey yellow; medium to high plasticity; with river pebbles, with ironstone gravel			F			J		0.3		
	1			RES	H	<PL				1		
	1.4	Test pit discontinued at 1.40m depth Refusal										
	2									2		
	3									3		
	4									4		

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

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 1.4m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

LOGGED: KA

EXPORTED 01/09/21 16:18. TEMPLATE ID: DP_101.02.00_SOILLOG

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22.1
COORDINATE E:296409.2 **N:** 6269003.6
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 18
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED										SAMPLE			TESTING AND REMARKS	
GROUNDWATER	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. ^(*)	DENSITY ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	
20/08/21, No free groundwater observed	0.0	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil)		FILL	NA		<PL		D		0.0	DCP/150		
	0.22	(CI-CH) Silty CLAY; grey yellow; medium to high plasticity; with river pebbles, with ironstone gravel		RES	ST		<PL		D		0.22			
					H		<PL		D		0.4			
									D		0.5			
									B		0.6			
											0.7			
											0.9			
									D		1.0			
											1.1			
									D		1.2			
	1.2	Test pit discontinued at 1.20m depth Refusal												

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 1.2m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

LOGGED: KA

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22
COORDINATE E:296400.8 N: 6269056.6
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 19
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED						SAMPLE			TESTING AND REMARKS		
GROUNDWATER	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. ^(%) DENSITY ^(%)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE
20/08/21, No free groundwater observed	0.0	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil)		FILL	NA	<PL		D	0.1	0.1	DCP/150
	0.26	(CI-CH) Silty CLAY; grey yellow; medium to high plasticity; with river pebbles, with ironstone gravel							0.2	0.2	
									0.4	0.4	
									0.5	0.5	
									0.9	0.9	
									1.0	1.0	
									1.4	1.4	
									1.5	1.5	
									1.9	1.9	
									2.0	2.0	
20	2.0	Test pit discontinued at 2.00m depth Limit of investigation		RES	ST TO VST	<PL		D			
19	3.0			RES	ST TO VST	<PL		D			
18	4.0			RES	ST TO VST	<PL		D			

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

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 2.0m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

LOGGED: KA

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22.4
COORDINATE E:296440 N: 6269052
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 20
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED						SAMPLE			TESTING AND REMARKS		
GROUNDWATER	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. ^(%) DENSITY ^(%)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE
20/08/21, No free groundwater observed	0.0	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil)		FILL	NA	<PL					
	0.15	(CI-CH) Silty CLAY; grey yellow mottled orange; medium to high plasticity; with ironstone gravel, with river pebbles throughout			ST TO VST						
	22										
	1			RES	H	<PL					
	21										
	1.8	Test pit discontinued at 1.80m depth Limit of investigation									
	2										
	20										
	3										
	19										
	4										
	18										

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

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 1.8m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

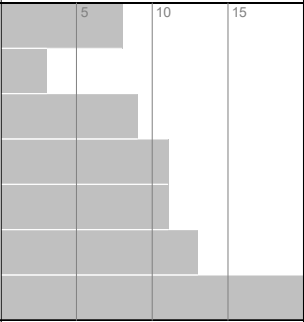
LOGGED: KA

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22.7
COORDINATE E:296450.7 N: 6269023
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 21
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED							SAMPLE			TESTING AND REMARKS			
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. ⁽¹⁾ DENSITY ⁽¹⁾	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
20/08/21, No free groundwater observed	0.0		FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil), with river pebbles		FILL	NA	<PL	pp = 200-230 kPa	D	D	0.4	DCP/150	
	0.19		(CI-CH) Silty CLAY; grey yellow; medium to high plasticity; with river pebbles, with ironstone gravel, trace rootlets to 1.0m			ST TO VST							
	22				RES		<PL				1		
	21												
	2										2		
	2.1	Test pit discontinued at 2.10m depth Refusal											
	20												
	3										3		
	19												
	4										4		
	18												

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ⁽¹⁾Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

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

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 2.10m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

LOGGED: KA

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22.8
COORDINATE E:296456 N: 6269040.6
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 22
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED											SAMPLE			TESTING AND REMARKS		
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. ⁽¹⁾	DENSITY ⁽¹⁾	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS		
20/08/21, No free groundwater observed		0.0	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil), with river pebbles		FILL	NA		<PL					PP	 5 10 15 150-210 210-220		
		0.28	(CI-CH) Silty CLAY; orange; medium to high plasticity; trace rootlets, with river pebbles		RES	ST TO VST	<PL									
		0.5	(CI-CH) Silty CLAY, trace; grey yellow; medium to high plasticity; with river pebbles, with ironstone gravel													
	22	1			RES	H		<PL				1				
	1.5	Test pit discontinued at 1.50m depth Refusal														
	21	2										2				
	20	3										3				
	19	4										4				
	18															

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ⁽¹⁾Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

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

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 1.5m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

LOGGED: KA

EXPORTED 01/09/21 16:18. TEMPLATE ID: DP_101.02.00_SOILLOG

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22.6
COORDINATE E:296454.8 N: 6269051.5
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 23
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED											SAMPLE			TESTING AND REMARKS											
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. ⁽¹⁾	DENSITY ⁽¹⁾	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS											
20/08/21, No free groundwater observed		0.0	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil), with river pebbles (CI-CH) Silty CLAY; grey yellow; medium to high plasticity; with red ironstone bands from 0.3-0.9m, trace rootlets from 0.3-1.0m, with river pebbles		FILL	NA		<PL	pp = 190-230 kPa	D		0.1	DCP/150												
		0.2									D				0.2										
											D				0.4										
											D				0.5										
		22									D				0.7										
											D				0.8										
		1									D				0.9										
											D				1.0										
		1.3									D				1.2										
					1.3											1.3									
		21	Test pit discontinued at 1.30m depth Refusal		RES	ST TO VST		<PL																	
		2																							
		20																							
		3																							
		19																							
															4										
		18																							

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ⁽¹⁾Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

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

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 1.3m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

LOGGED: KA

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22.8
COORDINATE E:296461 N: 6269028.5
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 24
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED						SAMPLE			TESTING AND REMARKS				
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. ^(%) DENSITY ^(%)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
20/08/21, No free groundwater observed	0.0		FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil), with ironstone gravel		FILL	NA	<PL	pp = 180-190 kPa	D			DCP/150	
	0.18		(CI-CH) Silty CLAY; grey yellow; medium to high plasticity; with river pebbles, with ironstone gravel, trace rootlets between 0.18-0.7m		RES	F TO ST	<PL						
	22	1											
		1.2	Test pit discontinued at 1.20m depth Refusal										
	21	2											
	20	3											
	19	4											
	18												

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

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

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 1.2m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

LOGGED: KA

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 23
COORDINATE E:296480.6 N: 6269051.3
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 25
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED						SAMPLE			TESTING AND REMARKS	
GROUNDWATER	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. (%) DENSITY ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)
20/08/21, No free groundwater observed	0.0	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil), with river pebbles		FILL	NA	<PL	pp = 100-120 kPa	J		0.0
	0.1	(CH) Silty CLAY; orange; high plasticity; (possibly fill), with river pebbles, trace rootlets		RES	ST	<PL		J		0.1
21	0.6	(CH) Silty CLAY; grey yellow; high plasticity; with river pebbles, with ironstone gravel throughout		RES	VST TO H	<PL				0.4
	1.0									0.5
21	2.0	Test pit discontinued at 2.10m depth Refusal		RES	VST TO H	<PL				1.0
	2.1									2.0
20	3.0			RES	VST TO H	<PL				2.1
	4.0									3.0
19	4.0			RES	VST TO H	<PL				4.0
	4.0									4.0

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

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 2.10m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

LOGGED: KA

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 23.1
COORDINATE E:296472.1 N: 6268997.6
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 26
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED						SAMPLE			TESTING AND REMARKS		
GROUNDWATER	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. ^(%) DENSITY ^(%)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE
20/08/21, No free groundwater observed	23	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil), with river pebbles		FILL	NA	<PL		J		0.0	DCP/150
	0.2	(CI-CH) Silty CLAY; grey yellow; medium to high plasticity; with river pebbles, with ironstone gravel, trace rootlets from 0.2-0.9m						J		0.1	
	1			RES	ST TO VST	<PL				0.4	
	2						pp = 280-320 kPa	D		0.5	
	2.3	Test pit discontinued at 2.30m depth Refusal									
	3									1.9	
	4									2.0	
	19										
	20										
	21										
	22										
	23										

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

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 2.30m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

LOGGED: KA

EXPORTED 01/09/21 16:19. TEMPLATE ID: DP_101.02.00_SOILLOG

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22
COORDINATE E:296388.4 N: 6268966
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 27
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED						SAMPLE			TESTING AND REMARKS		
GROUNDWATER	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. (%) DENSITY (%)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE
20/08/21, No free groundwater observed	0.0	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil)		FILL	NA	<PL		J		0.0	DCP/150
	0.24	(CI-CH) Silty CLAY; grey yellow; medium plasticity; with river pebbles, with ironstone gravel		RES	VST TO H	<PL		B J		0.4	
20/08/21, No free groundwater observed	0.5	Test pit discontinued at 0.50m depth Refusal								0.5	
	1									1	
	2									2	
	3									3	
20/08/21, No free groundwater observed	4									4	

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

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 0.5m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

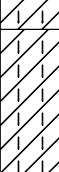
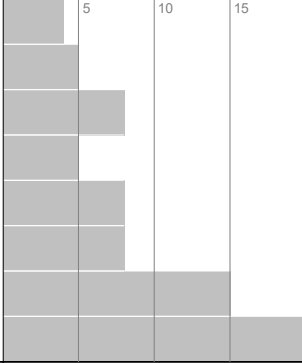
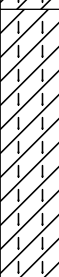
LOGGED: KA

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22.4
COORDINATE E:296447.5 N: 6269092
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 28
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED										SAMPLE			TESTING AND REMARKS	
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. ⁽¹⁾ DENSITY ⁽²⁾	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	
20/08/21, No free groundwater observed	0.0	0.1	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil)		FILL	NA	<PL	pp = 240-250 kPa	D	0.3	0.3	DCP/150		
		0.6	(CI-CH) Silty CLAY; orange grey; medium to high plasticity; trace rootlets throughout		RES	ST TO VST	<PL							B
	1.0		(CI-CH) Silty CLAY; grey yellow; medium to high plasticity; with river pebbles throughout		RES	VST TO H	<PL	pp = 200-240 kPa	D	1.4	1.5			
	21	1.5	Test pit discontinued at 1.50m depth Refusal											
		2.0									2			
		20												
		3.0									3			
		19												
		4.0									4			
		18												

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ⁽¹⁾Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

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

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 1.5m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

LOGGED: KA

TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Melonba Primary School
LOCATION: Kaluta Avenue, Melonba

SURFACE LEVEL: 22.3
COORDINATE E:296428.1 **N:** 6269083.7
DATUM/GRID: GDA2020 Zone 56

LOCATION ID: 29
PROJECT No: 207416.00
DATE: 20/08/21
SHEET: 1 of 1

CONDITIONS ENCOUNTERED										SAMPLE			TESTING AND REMARKS	
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	CONSIS. ^(*)	DENSITY. ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
20/08/21, No free groundwater observed		0.0	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout (topsoil)		FILL	NA		<PL	pp = 170-190 kPa	J		0.1	DCP/150	
		0.22	(CH) Silty CLAY, with gravel; grey yellow; high plasticity			F TO ST		<PL		J		0.5		
	22				RES	VST TO H				D		0.6		
												0.7		
		1										0.8		
			1.4m: at 1.4-1.8m river pebbles with ironstone gravel									1		
		21												
		1.8	Test pit discontinued at 1.80m depth											
		2	Limit of investigation									2		
		20												
		3										3		
		19												
		4										4		
		18												

PLANT: 3.5 Tonne IHI Excavator
METHOD: 300mm toothed bucket to 1.8m depth
REMARKS:

OPERATOR: A&A Hire
CASING: Not used

LOGGED: KA

Appendix D

Laboratory Test Results

Material Test Report



Accredited for compliance with ISO/IEC 17025 - Testing

(Signature)

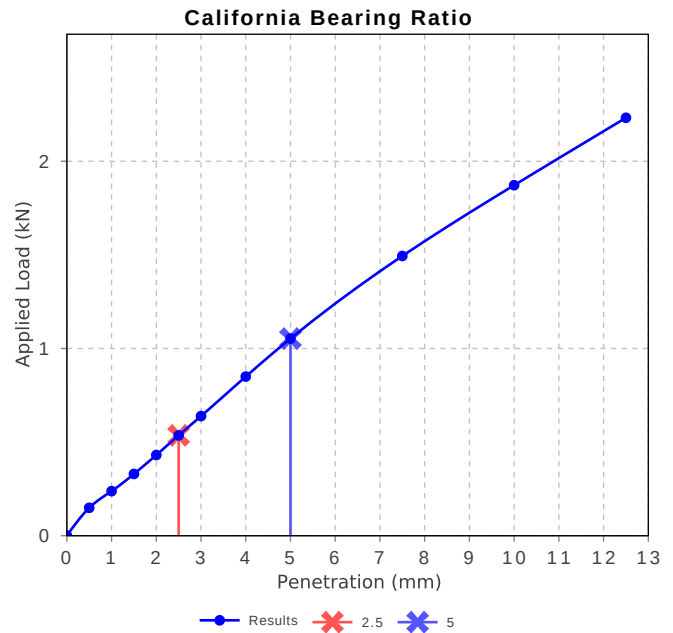
Approved Signatory: Ramon Arancia

Assistant Laboratory Manager

Laboratory Accreditation Number: 828

Report Number: 207416.00-1
Issue Number: 1
Date Issued: 18/10/2021
Client: NSW Department of Education
Levels 7 & 8, 259 George Street, Sydney NSW 2000
Contact: Gina Gou
Project Number: 207416.00
Project Name: Melonba Primary School
Project Location: Kaluta Avenue, Melonba NSW
Work Request: 6678
Sample Number: MA-6678A
Date Sampled: 20/08/2021
Dates Tested: 24/09/2021 - 12/10/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: 16 , Depth: 0.5 - 0.7m

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	5		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m ³)	1.75		
Optimum Moisture Content (%)	17.0		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m ³)	1.75		
Field Moisture Content (%)	12.4		
Moisture Content at Placement (%)	16.9		
Moisture Content Top 30mm (%)	17.4		
Moisture Content Rest of Sample (%)	17.3		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	71.4		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		



Material Test Report



Accredited for compliance with ISO/IEC 17025 - Testing

(Signature)

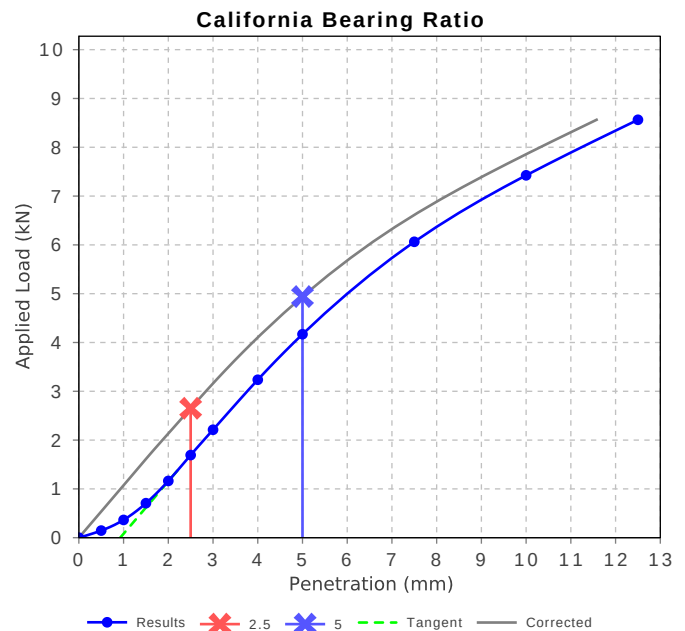
Approved Signatory: Ramon Arancibia

Assistant Laboratory Manager

Laboratory Accreditation Number: 828

Report Number: 207416.00-1
Issue Number: 1
Date Issued: 18/10/2021
Client: NSW Department of Education
Levels 7 & 8, 259 George Street, Sydney NSW 2000
Contact: Gina Gou
Project Number: 207416.00
Project Name: Melonba Primary School
Project Location: Kaluta Avenue, Melonba NSW
Work Request: 6678
Sample Number: MA-6678B
Date Sampled: 20/08/2021
Dates Tested: 24/09/2021 - 12/10/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: 18 , Depth: 0.5 - 0.7m
Material: Light brown sandy clay

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	25		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m ³)	1.69		
Optimum Moisture Content (%)	16.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m ³)	1.69		
Field Moisture Content (%)	12.7		
Moisture Content at Placement (%)	16.4		
Moisture Content Top 30mm (%)	17.9		
Moisture Content Rest of Sample (%)	16.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	71.8		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		



Material Test Report



Douglas Partners Pty Ltd

Macarthur Laboratory

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Fax: (02) 4646 1886

Email: meregal.henakaa@douglaspartners.com.au



Accredited for compliance with ISO/IEC 17025 - Testing

Atenabawls

Approved Signatory: Nilusha Arachchi
clean lab

Laboratory Accreditation Number: 828

Report Number: 207416.00-1
Issue Number: 2 - This version supersedes all previous issues
Reissue Reason: approving Atterberg, Emerson & Shrink/Swell results
Date Issued: 20/10/2021
Client: NSW Department of Education
Levels 7 & 8, 259 George Street, Sydney NSW 2000
Contact: Gina Gou
Project Number: 207416.00
Project Name: Melonba Primary School
Project Location: Kaluta Avenue, Melonba NSW
Work Request: 6678
Sample Number: MA-6678A
Date Sampled: 20/08/2021
Dates Tested: 24/09/2021 - 08/10/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: 16 , Depth: 0.5 - 0.7m

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	2		
Soil Description	As above		
Nature of Water	Distilled water		
Temperature of Water (°C)	22		

Material Test Report

Report Number: 207416.00-1
Issue Number: 2 - This version supersedes all previous issues
Reissue Reason: approving Atterberg, Emerson & Shrink/Swell results
Date Issued: 20/10/2021
Client: NSW Department of Education
Levels 7 & 8, 259 George Street, Sydney NSW 2000
Contact: Gina Gou
Project Number: 207416.00
Project Name: Melonba Primary School
Project Location: Kaluta Avenue, Melonba NSW
Work Request: 6678
Sample Number: MA-6678B
Date Sampled: 20/08/2021
Dates Tested: 24/09/2021 - 14/10/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: 18 , Depth: 0.5 - 0.7m
Material: Light brown sandy clay



Accredited for compliance with ISO/IEC 17025 - Testing

Atenakawls

Approved Signatory: Nilusha Arachchi
clean lab

Laboratory Accreditation Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Unknown		
Preparation Method	Dry Sieve		
Liquid Limit (%)	36		
Plastic Limit (%)	18		
Plasticity Index (%)	18		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	7.0		
Cracking Crumbling Curling	Cracking		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	2		
Soil Description	As above		
Nature of Water	Distilled water		
Temperature of Water (°C)	22		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	12.7

Material Test Report

Report Number: 207416.00-1
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Reissue Reason: approving Atterberg, Emerson & Shrink/Swell results
Date Issued: 20/10/2021
Client: NSW Department of Education
Levels 7 & 8, 259 George Street, Sydney NSW 2000
Contact: Gina Gou
Project Number: 207416.00
Project Name: Melonba Primary School
Project Location: Kaluta Avenue, Melonba NSW
Work Request: 6678
Sample Number: MA-6678D
Date Sampled: 20/08/2021
Dates Tested: 24/09/2021 - 14/10/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: 24 , Depth: 0.5 - 0.6m
Material: Red brown clay



Accredited for compliance with ISO/IEC 17025 - Testing

Atenabawel

Approved Signatory: Nilusha Arachchi
clean lab

Laboratory Accreditation Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Unknown		
Preparation Method	Dry Sieve		
Liquid Limit (%)	65		
Plastic Limit (%)	16		
Plasticity Index (%)	49		
Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	15.0		
Cracking Crumbling Curling	Cracking		
Moisture Content (AS 1289 2.1.1)			
Moisture Content (%)		23.0	

Material Test Report



Accredited for compliance with ISO/IEC 17025 - Testing

Atenakawel

Approved Signatory: Nilusha Arachchi
clean lab

Laboratory Accreditation Number: 828

Report Number: 207416.00-1
Issue Number: 2 - This version supersedes all previous issues
Reissue Reason: approving Atterberg, Emerson & Shrink/Swell results
Date Issued: 20/10/2021
Client: NSW Department of Education
Levels 7 & 8, 259 George Street, Sydney NSW 2000
Contact: Gina Gou
Project Number: 207416.00
Project Name: Melonba Primary School
Project Location: Kaluta Avenue, Melonba NSW
Work Request: 6678
Date Sampled: 20/08/2021
Dates Tested: 24/09/2021 - 12/10/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Location: Kaluta Avenue, Melonba

Shrink Swell Index AS 1289 7.1.1 & 2.1.1					
Sample Number	MA-6678C				
Date Sampled	20/08/2021				
Date Tested	12/10/2021				
Material Source	**				
Sample Location	3 (0.5m)				
Inert Material Estimate (%)	0				
Pocket Penetrometer before (kPa)	200				
Pocket Penetrometer after (kPa)	180				
Shrinkage Moisture Content (%)	20.8				
Shrinkage (%)	3.8				
Swell Moisture Content Before (%)	21.9				
Swell Moisture Content After (%)	29.2				
Swell (%)	5.4				
Shrink Swell Index Iss (%)	3.6				
Visual Description	**				
Cracking	SC				
Crumbling	No				
Remarks	**				

Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.

Cracking Terminology: UC Uncracked, SC Slightly Cracked, MC Moderately Cracked, HC Highly Cracked, FR Fragmented.

NATA Accreditation does not cover the performance of pocket penetrometer readings.

CERTIFICATE OF ANALYSIS 276369

Client Details

Client	Douglas Partners Pty Ltd (Riverstone)
Attention	Gavin Boyd
Address	43 Hobart St, Riverstone, NSW, 2765

Sample Details

Your Reference	<u>207416.00, Marsden Park</u>
Number of Samples	23 Soil
Date samples received	23/08/2021
Date completed instructions received	23/08/2021

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

Date results requested by	30/08/2021
Date of Issue	27/08/2021
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Hannah Nguyen, Metals Supervisor
Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil

Our Reference		276369-1	276369-2	276369-3	276369-4	276369-5
Your Reference	UNITS	19	19	19	19	19
Depth		0.1-0.2	0.4-0.5	0.9-1.0	1.4-1.5	1.9-2
Date Sampled		20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	25/08/2021	25/08/2021	25/08/2021	25/08/2021	25/08/2021
Date analysed	-	25/08/2021	25/08/2021	25/08/2021	25/08/2021	25/08/2021
pH 1:5 soil:water	pH Units	6.3	5.6	5.6	5.3	5.4

Misc Inorg - Soil

Our Reference		276369-6	276369-7	276369-8	276369-9	276369-10
Your Reference	UNITS	18	18	18	18	23
Depth		0.1-0.2	0.4-0.5	0.9-1	1.1-1.2	0.4-0.5
Date Sampled		20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	25/08/2021	25/08/2021	25/08/2021	25/08/2021	25/08/2021
Date analysed	-	25/08/2021	25/08/2021	25/08/2021	25/08/2021	25/08/2021
pH 1:5 soil:water	pH Units	6.0	6.0	6.4	6.5	5.5

Misc Inorg - Soil

Our Reference		276369-11	276369-12	276369-13
Your Reference	UNITS	23	23	23
Depth		1.3-1.4	0.9-1	0.1-0.2
Date Sampled		20/08/2021	20/08/2021	20/08/2021
Type of sample		Soil	Soil	Soil
Date prepared	-	25/08/2021	25/08/2021	25/08/2021
Date analysed	-	25/08/2021	25/08/2021	25/08/2021
pH 1:5 soil:water	pH Units	6.3	5.7	6.3

Texture and Salinity*						
Our Reference	UNITS	276369-1	276369-2	276369-3	276369-4	276369-5
Your Reference		19	19	19	19	19
Depth		0.1-0.2	0.4-0.5	0.9-1.0	1.4-1.5	1.9-2
Date Sampled		20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	25/08/2021	25/08/2021	25/08/2021	25/08/2021	25/08/2021
Date analysed	-	25/08/2021	25/08/2021	25/08/2021	25/08/2021	25/08/2021
Electrical Conductivity 1:5 soil:water	µS/cm	270	740	800	830	930
Texture Value	-	9.0	8.0	8.0	7.0	8.0
Texture	-	CLAY LOAM	LIGHT MEDIUM CLAY	LIGHT MEDIUM CLAY	MEDIUM CLAY	LIGHT MEDIUM CLAY
ECe	dS/m	2.4	5.9	6.4	5.8	7.5
Class	-	SLIGHTLY SALINE	MODERATELY SALINE	MODERATELY SALINE	MODERATELY SALINE	MODERATELY SALINE

Texture and Salinity*						
Our Reference	UNITS	276369-6	276369-7	276369-8	276369-9	276369-10
Your Reference		18	18	18	18	23
Depth		0.1-0.2	0.4-0.5	0.9-1	1.1-1.2	0.4-0.5
Date Sampled		20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	25/08/2021	25/08/2021	25/08/2021	25/08/2021	25/08/2021
Date analysed	-	25/08/2021	25/08/2021	25/08/2021	25/08/2021	25/08/2021
Electrical Conductivity 1:5 soil:water	µS/cm	130	83	40	38	66
Texture Value	-	9.0	7.0	7.0	7.0	7.0
Texture	-	CLAY LOAM	MEDIUM CLAY	MEDIUM CLAY	MEDIUM CLAY	MEDIUM CLAY
ECe	dS/m	<2	<2	<2	<2	<2
Class	-	NON SALINE	NON SALINE	NON SALINE	NON SALINE	NON SALINE

Texture and Salinity*				
Our Reference	UNITS	276369-11	276369-12	276369-13
Your Reference		23	23	23
Depth		1.3-1.4	0.9-1	0.1-0.2
Date Sampled		20/08/2021	20/08/2021	20/08/2021
Type of sample		Soil	Soil	Soil
Date prepared	-	25/08/2021	25/08/2021	25/08/2021
Date analysed	-	25/08/2021	25/08/2021	25/08/2021
Electrical Conductivity 1:5 soil:water	µS/cm	16	34	49
Texture Value	-	7.0	7.0	9.0
Texture	-	MEDIUM CLAY	MEDIUM CLAY	CLAY LOAM
ECe	dS/m	<2	<2	<2
Class	-	NON SALINE	NON SALINE	NON SALINE

ESP/CEC			
Our Reference		276369-1	276369-7
Your Reference	UNITS	19	18
Depth		0.1-0.2	0.4-0.5
Date Sampled		20/08/2021	20/08/2021
Type of sample		Soil	Soil
Date prepared	-	26/08/2021	26/08/2021
Date analysed	-	26/08/2021	26/08/2021
Exchangeable Ca	meq/100g	0.8	0.1
Exchangeable K	meq/100g	<0.1	0.1
Exchangeable Mg	meq/100g	1.4	10
Exchangeable Na	meq/100g	0.58	4.3
Cation Exchange Capacity	meq/100g	2.8	15
ESP	%	21	29

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
INORG-123	Determined using a "Texture by Feel" method.
Metals-020	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			25/08/2021	2	25/08/2021	25/08/2021		25/08/2021	[NT]
Date analysed	-			25/08/2021	2	25/08/2021	25/08/2021		25/08/2021	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	2	5.6	5.5	2	101	[NT]

QUALITY CONTROL: Misc Inorg - Soil					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	12	25/08/2021	25/08/2021		[NT]	[NT]
Date analysed	-			[NT]	12	25/08/2021	25/08/2021		[NT]	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	12	5.7	5.7	0	[NT]	[NT]

QUALITY CONTROL: Texture and Salinity*					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			25/08/2021	[NT]	[NT]	[NT]	[NT]	25/08/2021	[NT]
Date analysed	-			25/08/2021	[NT]	[NT]	[NT]	[NT]	25/08/2021	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	97	[NT]

QUALITY CONTROL: ESP/CEC					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			26/08/2021	[NT]	[NT]	[NT]	[NT]	26/08/2021	[NT]
Date analysed	-			26/08/2021	[NT]	[NT]	[NT]	[NT]	26/08/2021	[NT]
Exchangeable Ca	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	113	[NT]
Exchangeable K	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	110	[NT]
Exchangeable Mg	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	113	[NT]
Exchangeable Na	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	104	[NT]

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	
The recommended maximums for analytes in urine are taken from "2018 TLVs and BEIs", as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.	
Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2	

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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

Project No: 207416.00					Suburb: Marsden Park (Source Site Castle Hill)					To: Envirolab Services				
Project Manager: G Boyd					Order Number:					Sampler: KA				
Email: gavin.boyd@douglaspartners.com.au; kristine.nicodemus@douglaspartners.com.au										Attn: 99106200				
Turnaround time: ☒ Standard ☐ 72 hour ☐ 48 hour ☐ 24 hour ☐ Same day										Contact: phone Email				
Prior Storage: ☒ Fridge ☐ Freezer ☐ Shelf					Do samples contain 'potential' HBM? ☒ No ☐ Yes (If YES, then handle, transport and store in accordance with FPM HAZID)									

Lab ID	Sample ID			Date Sampled	Sample Type	Container Type	Analytes										Notes/ Preservation/ Additional Requirements
	Location / Other ID	Depth From	Depth To		S - soil W - water	G - glass P - plastic	Combo 8a	Combo 3	pH, eCE, T	Sodicity							
1	19	0.1	0.2	20/08/21	S	P			•	•							
2	19	0.4	0.5	20/08/21	S	P			•								
3	19	0.9	1.0	20/08/21	S	P			•								
4	19	1.4	1.5	20/08/21	S	P			•								
5	19	1.9	2	20/08/21	S	P			•								
6	18	0.1	0.2	20/08/21	S	P			•								
7	18	0.4	0.5	20/08/21	S	P			•	•							
8	18	0.9	1	20/08/21	S	P			•								
9	18	1.1	1.2	20/08/21	S	P			•								
10	23	0.4	0.5	20/08/21	S	P			•								
11	23	1.3	1.4	20/08/21	S	P			•								
12	23	0.9	1	20/08/21	S	P			•								
13	23	0.1	0.2	20/08/21	S	P			•								

Metals to analyse:

Number of samples in container:

Send results to: Douglas Partners Pty Ltd

Address:

Relinquished by:

Transported to laboratory by:

Phone:

Date:

Signed:

LAB RECEIPT

Lab Ref. No: 276369

Received by: Kate Lee

Date & Time: 23/8/21

Signed: KL

Project No: 207416.00	Suburb: Marsden Park (Source Site Castle Hill)	To: Envirolab Services
Project Manager: G Boyd	Order Number:	Dispatch date: 12 Ashley Street Sydney

Lab ID	Sample ID			Date Sampled	Sample Type	Container Type	Analytes											Notes/ Preservation/ Additional Requirements
	Location / Other ID	Depth From	Depth To		S - soil W - water	G - glass P - plastic	Combo8a	Combo 3	pH,eCE, T	Sodicity								
14	17	0	0.1	20/08/21	S	G												HOLD
15	17	0.3	0.4	20/08/21	S	G												HOLD
16	25	0	0.1	20/08/21	S	G												HOLD
17	25	0.4	0.5	20/08/21	S	G												HOLD
18	26	0	0.1	20/08/21	S	G												HOLD
19	26	0.4	0.5	20/08/21	S	G												HOLD
20	27	0.4	0.6	20/08/21	S	G												HOLD
21	27	0	0.1	20/08/21	S	G												HOLD
22	29	0.1	0.2	20/08/21	S	G												HOLD
23	29	0.5	0.6	20/08/21	S	G												HOLD

H 276369

SAMPLE RECEIPT ADVICE

Client Details

Client	Douglas Partners Pty Ltd (Riverstone)
Attention	Gavin Boyd

Sample Login Details

Your reference	207416.00, Marsden Park
Envirolab Reference	276369
Date Sample Received	23/08/2021
Date Instructions Received	23/08/2021
Date Results Expected to be Reported	30/08/2021

Sample Condition

Samples received in appropriate condition for analysis	Yes
No. of Samples Provided	23 Soil
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	12
Cooling Method	Ice
Sampling Date Provided	YES

Comments

Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	Phone: 02 9910 6200
Fax: 02 9910 6201	Fax: 02 9910 6201
Email: ahie@envirolab.com.au	Email: jhurst@envirolab.com.au

Analysis Underway, details on the following page:



Envirolab Services Pty Ltd

ABN 37 112 535 645

12 Ashley St Chatswood NSW 2067

ph 02 9910 6200 fax 02 9910 6201

customerservice@envirolab.com.au

www.envirolab.com.au

Sample ID	Misc Inorg - Soil	Texture and Salinity*	ESP/CEC	On Hold
19-0.1-0.2	✓	✓	✓	
19-0.4-0.5	✓	✓		
19-0.9-1.0	✓	✓		
19-1.4-1.5	✓	✓		
19-1.9-2	✓	✓		
18-0.1-0.2	✓	✓		
18-0.4-0.5	✓	✓	✓	
18-0.9-1	✓	✓		
18-1.1-1.2	✓	✓		
23-0.4-0.5	✓	✓		
23-1.3-1.4	✓	✓		
23-0.9-1	✓	✓		
23-0.1-0.2	✓	✓		
17-0-0.1				✓
17-0.3-0.4				✓
25-0-0.1				✓
25-0.4-0.5				✓
26-0-0.1				✓
26-0.4-0.5				✓
27-0.4-0.6				✓
27-0-0.1				✓
29-0.1-0.2				✓
29-0.5-0.6				✓

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.

Requests for longer term sample storage must be received in writing.

Please contact the laboratory immediately if observed settled sediment present in water samples is to be included in the extraction and/or analysis (exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS analysis where solids are included by default.

TAT for Micro is dependent on incubation. This varies from 3 to 6 days.

CERTIFICATE OF ANALYSIS 284157

Client Details

Client	Douglas Partners Pty Ltd
Attention	Gavin Boyd
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	<u>207416.00, Melonba</u>
Number of Samples	2 Soil
Date samples received	30/11/2021
Date completed instructions received	30/11/2021

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

Date results requested by	01/12/2021
Date of Issue	01/12/2021
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Diego Bigolin, Inorganics Supervisor

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil			
Our Reference		284157-1	284157-2
Your Reference	UNITS	BH3	BH3
Depth		1.5-1.95	3.0-3.45
Type of sample		Soil	Soil
Date prepared	-	01/12/2021	01/12/2021
Date analysed	-	01/12/2021	01/12/2021
pH 1:5 soil:water	pH Units	5.4	5.1
Chloride, Cl 1:5 soil:water	mg/kg	310	1,100
Sulphate, SO4 1:5 soil:water	mg/kg	43	180

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

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			01/12/2021	[NT]	[NT]	[NT]	[NT]	01/12/2021	[NT]
Date analysed	-			01/12/2021	[NT]	[NT]	[NT]	[NT]	01/12/2021	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	98	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	107	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	117	[NT]

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	
The recommended maximums for analytes in urine are taken from "2018 TLVs and BEIs", as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.	
Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2	

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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

FPM - ENVID/Form COC 02

SAMPLE RECEIPT ADVICE

Client Details

Client	Douglas Partners Pty Ltd
Attention	Gavin Boyd

Sample Login Details

Your reference	207416.00, Melonba
Envirolab Reference	284157
Date Sample Received	30/11/2021
Date Instructions Received	30/11/2021
Date Results Expected to be Reported	01/12/2021

Sample Condition

Samples received in appropriate condition for analysis	Yes
No. of Samples Provided	2 Soil
Turnaround Time Requested	Same day
Temperature on Receipt (°C)	20
Cooling Method	None
Sampling Date Provided	Not Provided on the COC

Comments

Nil

Please direct any queries to:

Aileen Hie

Phone: 02 9910 6200
Fax: 02 9910 6201
Email: ahie@envirolab.com.au

Jacinta Hurst

Phone: 02 9910 6200
Fax: 02 9910 6201
Email: jhurst@envirolab.com.au

Analysis Underway, details on the following page:

Sample ID	Misc Inorg - Soil
BH3-1.5-1.95	✓
BH3-3.0-3.45	✓

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.

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TAT for Micro is dependent on incubation. This varies from 3 to 6 days.

Appendix E

CSIRO Notes

Foundation Maintenance and Footing Performance: A Homeowner's Guide



BTF 18
replaces
Information
Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpendes).

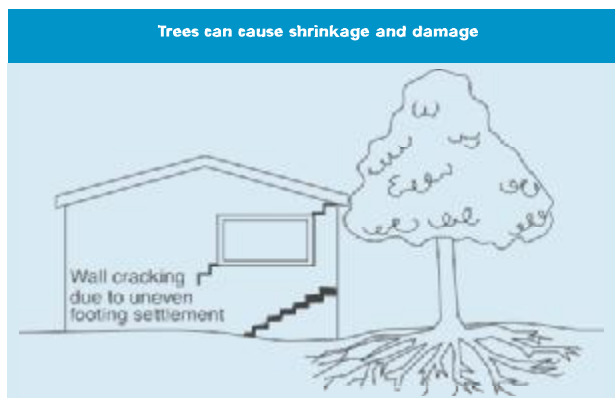
Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures

Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures

Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.

Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.

- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing

Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage

In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

Protection of the building perimeter

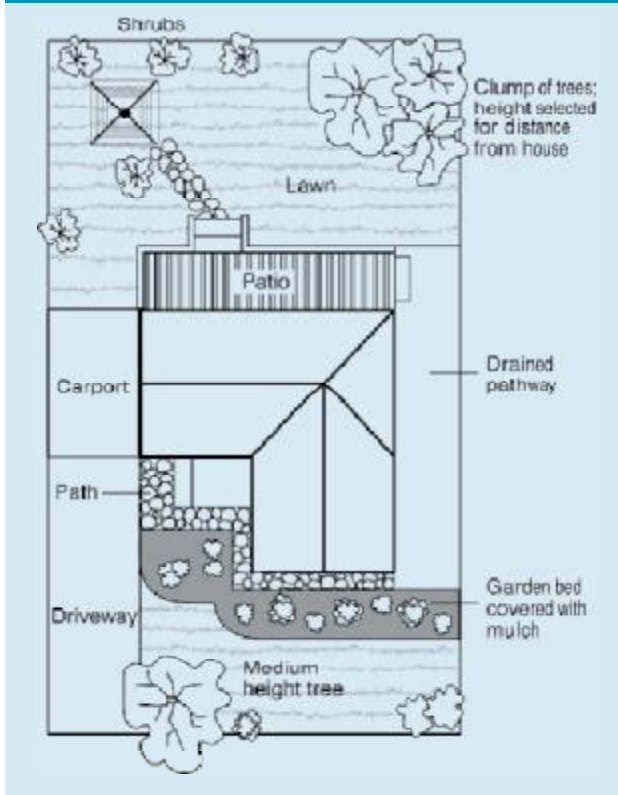
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4

Gardens for a reactive site



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

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