REPORT TO

URBIS PTY LTD

ON

GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION

FOR

PROPOSED BROOKVALE OVAL REDEVELOPMENT

AT

BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Date: 25 September 2019

Ref: 32596YJrpt

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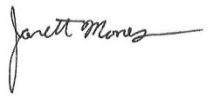

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ATTACHMENTS

1 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed Brookvale Oval Redevelopment at Brookvale Oval, Pittwater Road, Brookvale, NSW. The location of the site is shown in Figure 1. The investigation was commissioned by Urbis Pty Ltd (Urbis) by signed sub-consultancy agreement dated 19 August 2019, and was carried out in accordance with our fee proposal (Ref: P49724YJRev1, dated 13 August 2019). We previously carried out geotechnical investigations at the site in 2011 (Ref: 24983Zrpt, dated 29 June 2011 and 24983Zrpt2, dated 5 July 2011) and have included the relevant information from this investigation in this report.

Based on the architectural drawings prepared by Hassell (Ref: Project No. 014340, Drawing Nos. A_0400, A_1000 to A_1003, A_3000, A_3010 and A_6000, Revision D, dated 13 September 2019) we understand the proposed works comprise:

- a Centre of Excellence and Grandstand building which will run along the northern side of the oval and,
- the extension of the existing carpark that is located between the South-Western Stand and Alfred Road. This will be extended further to the north such that it extends behind the existing West Stand.

The Centre of Excellence and Grandstand consists of a two storey structure that incorporates grandstand seating over the field side of the structure and two levels of coaching, training and administration facilities over the rear or northern portion. Running below the centre of the structure and extending over its full width is a tunnel that provides access to the field for the players and is accessed via a lift or stairs from the ground floor level. In addition, below the eastern end of the structure provision has been made for balance and rainwater tanks and plant. We anticipate that excavation for the tunnel, tanks and plant will require cuts to maximum depths of about 4.5m (which considers a nominal concrete slab thickness of 0.2m). A locally deeper excavation may be required for the lift over run, which may extend a further 1.5m below the level of the tunnel. Some minor cut (to about 0.5m in the north-eastern hillside) and moderate filling (to about 2m in the north-eastern portion) may be required to achieve the design ground floor level. We understand that the carpark will be constructed at or close to existing levels.

Based on preliminary information provided by Taylor Thomson Whitting (TTW), we understand that working column loads range from 900kN to 1800kN. We also understand that the proposed carpark extension will not be sealed and will comprise an unsurfaced unbound pavement (i.e. a gravel pavement).

The purpose of the investigation was to obtain geotechnical information on the subsurface conditions at the investigation locations. Based on this we have provided comments and recommendations on excavation, hydrogeology, retention, earthworks, site classification, footings, pavement design and soil and rock aggressivity.

JK Environments (JKE) completed an environmental investigation of the site in conjunction with the geotechnical investigation. The results of this investigation will be separately reported in JKE's report (Ref: E32596BDrpt).

2 INVESTIGATION PROCEDURE

Prior to the commencement of the fieldwork we carried out the following:

- Review of the previous geotechnical reports by JK Geotechnics (JKG);
- Site walkover by our Senior Geotechnical Engineer, Mr Jarett Mones, on 19 June 2019 to review access and investigation locations;
- Meeting with JKE to discuss drilling programme;
- Preparation of a SWMS and,
- Carry out a dial before you dig buried services search.

Our geotechnical investigation was carried out over 2 days on 19 and 21 August 2019 and comprised the following:

- Electromagnetic scanning for buried services by a specialist sub-contractor on 19 August 2019,
- Completion of four (4) Piezocone Penetration Tests (CPT), CPT301, CPT302, CPT303 and CPT304, to refusal depths of 17.3m, 15.53m, 13.79m and 12.9m, respectively on 19 August 2019. We note that we carried out an additional two (2) tests which was beyond the scope of our works.
- Following review of the CPT data we drilled two (2) rig augered boreholes (BH), BH305 and BH306, to refusal depths of 18.6m and 23.5m, respectively on 21 August 2019.

CPT involves continuously pushing a 35mm diameter rod with a conical tip into the subsurface materials using hydraulic rams fitted to our truck mounted rig. Measurement of the resistance on the cone and the frictional resistance on a separate sleeve, positioned immediately behind the cone, are taken and the nature of the soils and their strength/relative density interpreted from of the test results using empirical correlations and geotechnical information obtained from nearby geotechnical boreholes including laboratory testing. To aid in the interpretation of the CPT's, CPT304 was carried out within about 9m of BH305. We note that the CPT's do not recover samples of the subsurface soils. A 'dummy cone' was generally initially used in the upper portion of the fill to protect the test cone from damage should obstructions in the fill be present.

The boreholes were primarily drilled to prove the depth to and strength of the bedrock, make groundwater observations and to collect soil and rock chip samples for laboratory testing. The boreholes were drilled by our track mounted JK305 rig using spiral auger techniques with an attached twin pronged Tungsten Carbide ('TC') drill bit. The apparent compaction of the fill and relative density/strength of the subsurface soils encountered in the boreholes were assessed from the results of Standard Penetration Tests (SPTs) 'N' values, augmented by the results of hand penetrometer tests on recovered cohesive soil samples from the SPT split spoon sampler. The strength of the bedrock was assessed from observation of the drilling resistance, tactile examination of recovered rock chips and correlation with the results of subsequent laboratory moisture content testing.

Groundwater levels were measured during, on completion and a short period after completion of both the CPT and boreholes. While the CPT cone measures pore pressures within the soils to provide an indication of the likely groundwater level, meaningful pore pressure readings were not recorded which is probably due to the clay content of the soils. Consequently, to determine the groundwater levels at the CPT locations the holes were dipped with a water whistle on or a short time following retraction of the cone. CPT304 was

unable to be measured due to the collapse of the hole at a depth of about 0.5m on retraction of the cone. In the boreholes groundwater levels could not be measured on completion of drilling due to the water whistle 'sticking' to the side walls of the boreholes. Consequently, we have referenced the groundwater levels measured in the standpipes installed in the JKE boreholes, BH206, BH210 and BH228. Groundwater level measurements are shown on the CPT and borehole logs.

The investigation location plan is included as Figure 2, which used the Murray Hastings survey drawing (Ref: Drawing No. MDH1245-D-07, Sheet 1 of 1, dated 3 April 2008) as a base plan for the borehole and CPT locations. The CPT's and boreholes were spread out across the site to provide good site coverage. Due to access constraints, CPT were limited to the crest of the hill. The locations were set out by taped measurements from apparent surface features. The approximate surface levels, as shown on the borehole logs and CPT results sheets, were estimated by interpolation between spot levels shown on the survey drawings and are, therefore, only approximate. The datum for the levels is Australian Height Datum (AHD), as noted on the survey drawing. We have also shown on Figure 2 the test locations carried out by JKG during the previous 2011 investigations.

Selected samples were returned to Soil Test Services Pty Ltd (STS) and Envirolab Services Pty Ltd (Envirolab), both NATA accredited laboratories, for moisture content, four day soaked CBR, percent fines, pH, sulphate content, chloride content and resistivity tests. These results are presented in the attached STS Tables A, B and C and Envirolab Certificate of Analysis No. 224835.

The investigation was carried out in the full-time presence of our Geotechnical Engineer, Mr Kartik Singh. Our Senior Geotechnical Engineer, Mr Jarett Mones, set out the investigation locations and provided supervision of the geotechnical investigation. Mr Singh was on site full time during the CPT and borehole drilling, nominated the sampling and testing locations and prepared logs of the strata encountered. The borehole logs and CPT results, which include field test results and groundwater measurements, are attached to the report together with our Report Explanation Notes, which further describe the investigation techniques, and their limitations, and define the logging terms and symbols used.

The previous investigations completed by JKG were undertaken on 16 and 24 June 2011. The investigation completed on 16 June 2011 included 5 CPT's (CPT1 to CPT5) to depths between 5.13m and 19.08m while the investigation completed on 24 June 2011 included 8 CPT's (CPT101 to CPT108) to depths between 8.1m and 20.11m. For specific details on the investigation and test results, reference should be made to the specific reports previously referenced. We have attached the previous geotechnical investigation CPT results as Appendix A.

The environmental investigation by JKE was carried out between 21 and 26 August 2019 and included 40 rig and hand augered boreholes, BH201 to BH240, to depths between 0.95m and 12m. The hand augered boreholes were carried to avoid damaging buried services. Standpipes were installed in three of the boreholes (BH206, BH210 and BH228) on completion of drilling. JKE developed and measured the groundwater in the standpipes on 29 August 2019 and then again on 4 September 2019 (about 1 week after the development of the standpipes). For further details on the JKE investigation techniques and results reference should be made to their report referenced above. We have attached the JKE borehole logs.

3 RESULTS OF INVESTIGATION

3.1 Site Description

The site is located at the toe of a generally south facing hill. The proposed Centre of Excellence and Grandstand is located at the northern end of the oval. It spans the grassed hill and paved access path and seating area located immediately adjacent to the field. Conversely, the carpark extension is removed from the proposed Centre of Excellence and Grandstand and is located on the western side of Brookvale Oval between Alfred Road and the existing West Stand.

The hill at the northern end of the field is predominantly grassed and free from structures. The northern portion of the hill is generally level while the southern portion closest to the field slopes down at about 10° to 20° towards the concrete path and seating that runs around the field. At the base of the grassed area is a masonry wall that is about 0.7m high and retains the grassed slope. The concrete path then extends out a distance of about 2.5m to 3m from the toe of the wall. At this point there is a small asphaltic concrete paved area that is occupied by bench seating and slopes down to the edge of the field at an angle of about 10^{o}.

Scattered along the northern extremity of the proposed Centre for Excellence and Grandstand footprint are a number of small brick and timber buildings, above ground rainwater tanks, concrete and asphaltic concrete pavements and medium to high sized trees. The pavements appeared to be in good condition. There is a height difference of about 3m to 3.5m from the top of the hill to the concrete path and bench seating present around the edge of the field. There are number of buried services which include but are not limited to fibre optic, power, irrigation and stormwater. A 3.5m wide stormwater easement is shown to run in a north-west to south-east direction below the north-eastern corner of the proposed Centre for Excellence and Grandstand footprint.

The proposed parking area is west of the existing West Stand and predominantly encompasses a grassed area. However, over its western side is a concrete footpath, a mulch covered area and a 0.6m high timber retaining wall. There are a number of medium sized trees further to the west, some electrical boxes at the southern end and a large light tower at the eastern side of the lawn.

The site is bound by a public park and then Federal Parade to the north, Alfred Road to the west, Pine Avenue to the east and Pittwater Road to the south. The existing grandstands, smaller kiosk buildings and retaining walls all appeared in good condition when viewed externally.

3.2 Subsurface Conditions

The 1:100,000 geological map of Sydney indicates that the site is underlain by Hawkesbury Sandstone but is close to the geological boundary with deep alluvial deposits located further to the south. These alluvial deposits are described as silty to peaty quartz sand, silt and clay and have infilled a deep paleochannel that runs between Brookvale and Curl Curl Beach.

The BH's and CPT's disclosed subsurface conditions generally comprising fill overlying deep alluvial soils that consisted of silty sand, clayey sand and sandy clay, that in turn overlie sandstone bedrock at depth. The bedrock steps down from the north to the south, possibly through buried cliff-lines. The bedrock is initially distinctly weathered and of low to medium strength, but improves shortly after initial contact to slightly weathered and is of medium to high strength. Some of the more pertinent details of the strata encountered are described below. For further details of the conditions encountered at each location, reference should be made to the attached borehole logs and CPT results sheets.

The previous subsurface investigations (carried out in 2011) and the environmental boreholes have been included in our summary below. We note that the most relevant CPT's for this project from previous investigations were CPT1 to CPT4 and CPT103 to CPT106.

Pavements

Concrete pavement thicknesses varied from 90mm (BH306, BH206 and BH208) to 120mm (BH201, BH202, BH203, BH204, BH205 and BH207) while the asphaltic concrete (AC) thickness was 30mm (BH225, CPT301 and CPT302).

Fill

From our investigation and review of JKE borehole logs, fill was encountered from the surface or from beneath the pavement in all the boreholes and extended to depths varying from 0.3m to 2.7m. BH209, BH217, BH224, BH225, BH230, BH231 to BH235 were terminated in the fill at a maximum depth of approximately 1.5m. The fill typically comprised silty clay, sandy clay, gravelly sand, clayey sand and silty sand with inclusions of ironstone, igneous and sandstone gravels, ash, slag and building rubble (bricks, concrete and glass fragments). The fill generally appeared to be poorly compacted, however there are some areas that were assessed to be moderately compacted.

Alluvial Soils

The previous and current investigations have revealed a subsurface profile comprising deep alluvial soils underlying the fill. These generally comprised loose to medium dense clayey sands and very stiff to hard sandy clays. Some denser ironstone gravel bands were also encountered at depth. While it is unclear whether the CPT's completed as part of this investigation have refused on sandstone bedrock or harder layers within the soils, it appears likely that if they have refused on harder layers within the soils that sandstone bedrock will be present at relatively shallow depth below the depth of refusal. The CPT's from previous investigations completed in the vicinity of the proposed development appear to generally have refused prematurely. However, it is possible that the refusal depths of 17.4m (CPT104) and 19.1m (CPT4) represent the depth to bedrock at these locations.

Sandstone Bedrock

Sandstone bedrock was encountered at depths of 16.8m (RL12.4m, BH305) and 21.4m (RL7.9m, BH306). When first encountered the sandstone bedrock was assessed to be distinctly weathered and of low to medium strength but improved to distinctly weathered and of medium strength at a depth of 17.1m (RL12.1m, BH305) and slightly weathered and medium to high strength at depths of 18m (RL11.2m, BH305)

and 22.5m (RL3.5m, BH306). The boreholes encountered 'TC' bit refusal in the sandstone bedrock at depths of 18.6m (RL10.6m) and 23.5m (RL2.5m).

Groundwater

Groundwater levels were measured during, on completion and a short period after the completion of the CPT's and boreholes. In BH206 and BH210 standpipes had been installed and groundwater readings taken on completion and about one week after development (4 September 2019) of the wells. Below is a summary of the groundwater measurements made in the standpipes, boreholes and CPT's.

Groundwater Depths and Reduced Levels at Test Locations			
Test Location and Surface Reduced Level (AHD)	**Date of Measurement**	**Measurement Description**	**Groundwater Depth and Reduced Level (AHD)**
BH305 (RL29.2m)	21 August 2019	Groundwater seepage during drilling	11.5m (RL17.7m)
BH306 (RL26.0m)	21 August 2019	Groundwater seepage during drilling	7.5m (RL18.5m)
CPT301 (RL29.4m)	19 August 2019	On completion	7.4m (RL22.0m)
CPT302 (RL27.75m)	19 August 2019	On completion 3hrs after completion	7.8m (RL19.95m 7.2m (RL20.55m)
CPT303 (RL29.4m)	19 August 2019	On completion 1hr after completion	8.15m (RL21.25m) 8.2m (RL21.2m)
BH206 (RL26.09m)	23 August 2019 23 August 2019 29 August 2019 4 September 2019	Groundwater seepage during drilling On completion 6 days after completion 6 days after development of wells	7.45m (RL18.64m) 7.3m (RL18.79m) 6.54m (RL19.55m) 5.37m (RL20.72m)
BH210 (RL28.67m)	21 August 2019 21 August 2019 29 August 2019 4 September 2019	Groundwater seepage during drilling On completion 8 days after completion 6 days after development of wells	8.5m (RL20.17m) 10.2m (RL18.47m) 8.81m (19.86m) 7.68m (RL20.99m)
BH228 (RL28.01m)	22 August 2019 22 August 2019 29 August 2019 4 September 2019	Groundwater seepage during drilling On completion 7 days after completion 6 days after development of wells	11.2m (RL16.81m) 11.8m (RL16.21m) 9.22m (RL18.79m) 8.6m (RL19.41m)
104 (RL Not Recorded)	24 June 2019	Inferred from CPT pore pressure measurements	5.15m
105 (RL Not Recorded)	16 June 2019	Inferred from CPT results pore pressure measurements	5.7m

3.3 Laboratory Test Results

The 4-day soaked CBR tests returned values of 5% for the clayey sand fill sampled from the north-eastern corner of the site (BH219, proposed entry area) and 6% for the silty sand sampled from the south-western corner of the site (BH236, proposed car park area).

The results of the Atterberg Limits tests on the silty clay to clayey sand sample (BH305) returned a liquid limit value of 43% and a linear shrinkage value of 9.0% indicating that the sample is moderately reactive to changes in moisture content.

The results of the percentage fines tests indicated that the fines content of the samples tested varied from 20% to 34%. In according with AS1726: 2017, the samples tested are granular (i.e. Clayey SAND). However, since the clay content in BH305 between 5.4m to 6m is near the boundary between clays and sands (i.e. 35%), a sandy CLAY to Clayey SAND soil description was adopted for this soil horizon.

Generally the moisture content test results correlated well with our field assessment of the in-situ bedrock strength. However, the sample tested from BH306 returned an unusually high result which we do not believe to be representative of the rock strength at this depth.

The above results are presented in the attached STS Tables A, B and C.

The results of the pH, sulphate, chloride and resistivity tests are summarised in the table below and are also presented in the attached Envirolab Certificate of Analysis No. 224835.

Borehole	Depth (m)	Sample Type	pH	Sulphates SO_4 (ppm)	Chlorides Cl (ppm)	Resistivity ohm.cm
BH305	6-6.45	Sandy CLAY to Clayey SAND (Alluvial)	5.1	32	<10	27,000
BH305	12-12.45	Clayey Sand (Alluvial)	4.9	37	<10	26,000
BH306	21.4-23.5	Sandstone Bedrock	5.7	<10	<10	62,000

4 COMMENTS AND RECOMMENDATIONS

4.1 Excavations

Excavation recommendations provided below should be complemented by reference to the Code of Practice 'Excavation Work', Code of Practice prepared by Safe Work Australia July 2015 (or latest version at the time of works).

Excavation for the proposed tunnel, tanks and plant room will require excavation to maximum depth of about 4.5m, although excavation for lift pit 'over runs', services, etc. may result in locally deeper areas of excavation. We have outlined the approximate tunnel, tank and plant room areas on Figure 2.

Excavation to these depths will encounter clayey and sandy fill and natural alluvial soils comprising silty sand, clayey sand and sandy clay. Excavation of these soils should be achievable using conventional excavation equipment, such as the buckets of hydraulic excavators. Where the excavated material is disposed of offsite

a waste classification will be required. Reference should be made to the JKE report for further advice on offsite disposal of spoil.

4.2 Hydrogeology

Following stabilisation of water levels in the installed wells (BH206, BH210 and BH226), the groundwater level was found to be relatively consistent across the site and varied between RL19.4m and RL21m. The wells are considered to provide a more reliable indication of groundwater levels than measurements made during, on completion or shortly after the completion of CPT's or drilling.

It is our experience that groundwater levels can fluctuate by up to about 1m, possibly more, during climatic changes or following extended periods of wet weather. The finished floor level of the proposed tunnel is shown at RL25.36m and the tanks/plant room are shown at RL26.36m. Therefore, based on the monitoring of groundwater we consider it is unlikely that the proposed excavation will encounter the groundwater table. However, groundwater seepage may occur, particularly after periods of rainfall.

Further monitoring of the wells is recommended during any future geotechnical investigations and during the detailed design stage of the project to confirm the above assessment of groundwater levels.

4.3 Retention

Due to the sandy soils and proposed geometry of the site, retaining walls may need to be installed prior to the commencement of excavation should sufficient space not allow for the formation of temporary batters or they not be considered desirable. There have been a number of revisions to the proposed development drawings, which included various setback distances for the proposed tunnel, tanks, plant room, etc. from the northern boundary. Following finalisation of the drawings, we recommend that we be provided with a copy so that we can provide feedback on the suitability of temporary batters.

Where space exists and the formation of temporary batters will not extend beyond the site boundaries or potentially undermine structures (i.e. where structures are located a minimum distance of 3H from the toe of the batter where H is the vertical height of the batter), temporary batters may be formed through the fill and alluvial soils. Temporary batters should be formed at no steeper than 1 Vertical (V):1.75 Horizontal (H). Where structures may be potentially undermined by the formation of temporary batters, further investigation will be required to determine the footing details of the structure and the materials on which they are founded. In the long term it is anticipated that retaining walls will provide permanent support to the excavations. All surcharge loads should be kept well clear of the crest of the temporary batters. As a guide, surcharge loads should be positioned no closer than 2H from the top of any batter, where H is the vertical height of the batter.

Where temporary batters are not adopted and a retention system is installed prior to the commencement of excavation we consider that the most suitable system be a cantilevered or anchored contiguous pile wall. Where retained heights are less than about 3m, cantilevered retaining walls will be suitable while for retained

heights in excess of about 3m anchored or propped retaining walls will be required. Due to the presence of sandy fill and natural soils in the upper couple of meters of the soil profile, we do not recommend the use of soldier pile walls. Similarly, we recommend that where contiguous piles are used that the gaps between the piles be progressively dry packed as excavation deepens to reduce the risk of sand runs from between the piles and the loss of sand from behind the wall. Bored piles will not be suitable due to the presence of sandy soils and a ground water table at around RL21m. In this regard we recommend that Continuous Flight Auger (CFA) or grout piles be adopted. A working platform will need to be installed to allow to safe operation of piling rigs and in this regard it is anticipated that the platform will have a minimum thickness of 0.3m, possibly much greater depending on the exposed subgrade conditions and piling rig loading.

Where temporary batters are adopted, cantilevered (gravity) retaining walls may be constructed and the void between the face of the temporary batter and back of the retaining wall backfilled with engineered fill, as detailed below in Section 4.4.2

Where cantilevered or gravity walls are adopted, they should be designed to resist a triangular earth pressure distribution. Where movement sensitive structures are not present within the zone of influence of the excavation (which is defined by a distance 2H that extends back from the top of the wall where H is the retained height) a coefficient of active lateral earth pressure, K_a, of 0.35 may be adopted. Where movement sensitive structures are located within the zone of influence of excavation, a coefficient of lateral earth pressure, K, of at least 0.55 should be adopted. A bulk unit weight of 20kN/m^3 should be used. Hydrostatic pressures and surcharge loads (such as from construction equipment, stockpiles, structures, etc.) are additional to and should be added to the above earth pressure recommendations. The above design parameters assume a horizontal retained surface. Lateral toe restraint may be achieved by adequately embedding the wall below the ground in front of the wall. A triangular lateral earth pressure distribution and a 'passive' earth pressure coefficient, K_p, of 3 should be adopted for embedment design, assuming horizontal ground in front of the wall. We note that significant deflection is required in order to mobilise the full passive pressure and, therefore we recommend that a factor of safety of at least 2 be adopted in order to reduce such deflections. Any localised excavations in front of the wall should be taken into account in the design.

Propped or anchored walls should be designed to resist a rectangular earth pressure distribution. Where movement sensitive structures are not present within the zone of influence of the excavation a lateral pressure of 6H kPa may be adopted while where movement sensitive structures are present within the zone of influence of the excavation, a lateral earth pressure distribution of 8H kPa should be adopted. All surcharge loads (such as from construction equipment, stockpiles, structures, etc.) and appropriate hydrostatic pressures should be added to the above pressures.

Where propped or anchored walls are adopted it is anticipated that long term support will be provided by the structure once completed. Until this support is provided short term support in the form of temporary anchors or internal props will be required to support the walls. Considering the geometry of the development and proposed depth of excavation, temporary props are likely to be better suited to this site than temporary anchors. However, should anchors be adopted all anchors should have minimum free and bond lengths of 3m with the bond length starting below a line drawn upwards from the base of the excavation at no steeper

than 1V:1H. Anchors formed within the sandy soils may be designed on the basis of an internal friction angle (ϕ) of 30°. All anchors should be proof loaded to a minimum 1.3 times the design load. Where anchors extend beyond the site boundaries permission must be sought from the respective property owners prior to the installation of temporary anchors. The contract for the installation of the anchors should be on a design and construct basis so that should anchors fail on proof loading there is no dispute over whether the design parameters or the installation methods are the cause of the failure.

4.4 Earthworks

4.4.1 Site and Subgrade Preparation

At this time only preliminary details have been provided on the proposed development. We anticipate that with the exception of raising site levels by up to 2m in the north-eastern portion of the site and excavated to depths of about 0.5m in the north-eastern hillside that only minor cut or fill will be required over the remainder of the site. The existing fill is considered to be uncontrolled.

Prior to placement of engineered fill or pavements we recommend the following site and subgrade preparation:

- All grass, topsoil/mulch and any other root affected soils should be stripped from the site. This soil may then be stockpiled and used for landscaping purposes if desired.
- Following site stripping the exposed subgrade should be proof rolled with at least six (6) passes of a twelve (12) tonne minimum deadweight smooth drum roller. The final pass of proof rolling should be carried out in the presence of an experienced geotechnical engineer or geotechnician. The purpose of proof rolling is to increase the near surface density of the subgrade and to identify any soft or unstable areas. Where proof rolling of sloping ground is proposed, the site may need to be benched should the slope be excessively steep to be considered unworkable.
- Where soft or heaving spots are identified they should be excavated down to a sound base and replaced with engineered fill. Where unstable or heaving areas are detected then further advice should be obtained from the geotechnical engineers.

4.4.2 Engineered Fill

Any fill used to backfill unstable subgrade areas, raise surface levels, construct pavement layers or backfill service trenches should be placed as engineered fill. Materials preferred for use as engineered fill are well-graded granular materials, such as ripped or crushed sandstone or DGB20/DGS40, which are free from organic or otherwise deleterious substances and have a maximum particle size not exceeding 75mm. Where these materials are used they should be compacted in layers of approximately 200mm loose thickness to a minimum density of 98% of Standard Maximum Dry Density (SMDD). It should be recognised that maximum layer thickness is only nominated to ensure that compaction to the required specification over the full depth of the layer is achieved. In this regard, the layer thickness may be varied depending on the size of compaction equipment used. We note that the pavement designer may specify their own compaction criteria.

The existing soils on site have a significant clay content and, although these soils may be reused it is not desirable to do so. However, where re-used a more stringent earthworks criteria must be adhered to. Where these soils are used as engineered fill they must similarly be free from organic or otherwise deleterious materials and particles with sizes in excess of 75mm. These materials should be compacted to between 98% and 102% of SMDD at a moisture content within 2% of Standard Optimum Moisture Content (SOMC) in maximum 200mm thick loose layers, although this loose thickness may be varied as discussed above.

4.4.3 Edge Compaction

In order to achieve adequate edge compaction around the building area and sloping ground, we recommend that the outer edge of each fill layer extend a horizontal distance of at least 2m beyond the design fill platform geometry. The roller must extend over the edge of each placed layer in order to seal the batter surface. On completion of filling, the excess under-compacted edge fill should be trimmed back to the design lines. The fill platform should extend at least 1.5m beyond the footprint of the structure.

4.4.4 Earthworks Inspection and Testing

Density tests should be regularly carried out on the engineered fill to confirm the above specifications are achieved, as outlined below:

- The frequency of density testing should be at least one test per layer per 1,000m^2 or three tests per visit, whichever requires the most tests (on the basis that each of the areas of filling, pavements and building, will be greater than 500m^2 but less than 1,500m^2).
- The frequency of testing for service trench backfill should be at least one test per two layers per 40 linear metres of trench.

We recommend that at least Level 2 control of fill compaction, as defined in AS3798-2007 (or latest standard at the time of testing), be adhered to on this site. We can complete the abovementioned testing and supervision if required. Preferably, the geotechnical testing authority (GTA) should be engaged directly on behalf of the client and not by the earthworks subcontractor.

4.4.5 Fill Batter Slopes

Permanent batter slopes in engineered fill should be formed at no steeper than 1V: 2H with measures taken to protect such slopes against ongoing erosion by means of fast growing vegetation (or equivalent erosion protection).

4.5 Site Classification

The site classifies as a Class 'P' site in accordance with AS2870-2011 due to the presence of the deep uncontrolled fill (up to 2.7m) encountered below the site. Shrink-swell surface movements are likely to fall within those expected for a 'Class M' (moderately reactive) site. However, based on the size of the proposed

development, we advise that the site classification does not apply to this size development but it is a useful guide in highlighting the potential foundation problems by this site and potential impact on slabs on grade.

4.6 Footings

Following excavation and filling to achieve design levels, we expect that fill will be exposed at subgrade level. Considering the size of the column loads and materials exposed at design level, high level footings are not considered suitable for this site. Consequently, we recommend that all loads be supported on piles either founded in the alluvial soils or the underlying sandstone bedrock.

Where piles are founded in the alluvial soils the allowable bearing pressure (ABP) that may be adopted will depend on a number of factors including pile diameter, founding depth, number of piles and spacing of piles in pile groups, etc. Consequently, to provide guidance on potential ABP's that may be achieved, a 0.5m diameter pile founded at a depth of 6m in sand or clay with an effective cone resistance (q_E) of at least 2MPa may be designed for an ABP of 600kPa. An allowable shaft adhesion of 15kPa (compression) and 7.5kPa (tension) may be adopted in the alluvial soils below the fill for CFA piles. Where screw piles are adopted no shaft adhesion may be adopted. Should driven piles be considered pile capacities will need to be calculated using pile driving formulae. Care must also be taken that transmitted vibrations from pile driving does not damage movement sensitive structures. In this regard further advice should be sought from piling contractors on the suitability of driven piles for this site. Should further consideration be given to founding piles within the alluvial soils further advice should be sought from this office.

Based on the provided working column loads, we consider it likely that the most economical means of supporting the structure is to uniformly support it on the underlying sandstone bedrock. Where piles are founded in sandstone bedrock of low or medium strength, ABP's of 1,000kPa or 1,500kPa respectively may be adopted. Where piles extend below a nominal 0.3m socket into rock of either low or medium strength, allowable shaft adhesions of 10% and 5% of the ABP may be adopted for compressive and tensile (uplift) loads, respectively. This assumes that the rock socket is suitably roughened. Higher ABP's in the order of at least 3.5MPa are likely to be achievable where piles are founded on sandstone bedrock of at least medium strength, although further investigation will be required to confirm this. It is anticipated that significant savings in foundation costs may be achieved where an ABP of 3.5MPa is adopted. Additional investigation to confirm the adoption of this higher ABP will require the drilling of a number of cored boreholes across the site.

Based on the groundwater level and collapsible nature of the sandy soils, bored piers are not considered suitable for this site. Screw piles, driven piles and CFA or grout injected piles are all considered suitable for this site. We note that given the relatively high strength of the sandstone bedrock, where piles are required to be socketed into the underlying bedrock high capacity piling rigs and augers fitted with rock teeth will be required. Where CFA piles are adopted and piles are required to be socketed into the underlying sandstone bedrock decompression of the soils may occur. Where this occurs slumping of surface soils around the head of the pile may occur and the successful piling contractor should be asked how they will mitigate against this risk.

During footing construction we recommend that where piles are founded on the underlying sandstone bedrock that all piles be inspected by a geotechnical engineer to confirm that the design ABP's have been achieved. Where piles are designed to be founded within the alluvial soils we recommend that periodic pile inspections be carried out during their construction to confirm the design founding stratum. We note however that inspection of CFA piles founded within the alluvial soils will essentially only confirm the depth at which the piles are founded. Should CFA piles be adopted, piles should initially be installed adjacent to the CPT/borehole locations to assist the geotechnical engineer in confirming the materials in which the piles are founded. Due to the expected stepped nature of the sandstone bedrock, further boreholes are strongly recommended to more accurately profile the bedrock levels across the site.

The design should also consider potential for contamination in the drill spoil. Some ways to reduce the spoil waste include the following:

- On site supervision by an environmental scientist to assess the extents of contamination/filling during piling.
- Prior to piling, test pit excavations could be carried out at pile locations to remove the contaminated fill materials. The test pits could then be backfilled with cement stabilised sand and the pile then drilled which will help reduce the amount of material other than VENM disposed of offsite.

4.7 Pavement Design

We understand at this stage that the proposed pavements will not be surfaced with asphaltic concrete or concrete and will comprise an unbound gravel. Prior to the placement of pavements we recommend that the recommendations provided in *Section 4.4 Earthworks* be closely followed.

Based on the results of the four day soaked CBR tests, flexible pavements formed over the clayey sand fill may be preliminarily designed for a CBR value of 5%. Further CBR tests should be completed to confirm or refine this value. Subsoil drains should be installed on the high side of the pavements with inverts not less than 0.3m below subgrade level and should discharge to Council's stormwater system. The pavement subgrade should be graded to promote water to flow towards the subsoil drains.

4.8 Aggressivity

The laboratory test results indicate that for buried concrete structures the soils have a 'Moderate' exposure classification in accordance with Table 6.4.2 (C) of AS2159-2009 "Piling Design and Installation''. For buried steel structures the soils have a 'Mild' exposure classification in accordance with Table 6.5.2 (C) AS2159-2009.

4.9 Further Geotechnical Input

The following is a summary of the further geotechnical input which is required and which has been detailed in the preceding sections of this report:

- The recommendations provided in this report should be reviewed once details of the proposed development, such as development locations, floor levels and bulk excavation levels and finalised

structural loads, are confirmed and following any additional geotechnical investigation. It is likely that further advice/input will be required during the structural and civil engineering design to address issues that may not have been addressed in this report. To some degree, this is an "iterative" process between evaluation of the geotechnical site conditions and the development of the structural and civil designs.

- Further monitoring of the groundwater wells to confirm the design groundwater levels.
- Following stripping of the subgrade and prior to the placement of engineered fill or pavements proof rolling of the subgrade in the presence of an experienced geotechnician or geotechnical engineer.
- Where engineered fill is placed the completion of insitu density tests to confirm that the fill has been placed in accordance with the earthworks specification.
- Design of a working platform to support the piling rigs.
- Geotechnical inspection of footings and or piles to ensure they are founded on materials suitable for the design ABP. This includes both foundation piles and temporary works, such as scaffolding, etc.
- Where piles are designed to be founded on the underlying sandstone bedrock, further investigation should be undertaken to more accurately determine the bedrock profile and the location of the buried sandstone clifflines.
- Where an ABP of 3.5MPa is required further investigation in the form of cored boreholes will be necessary to confirm that this is a suitable bearing pressure.
- Geotechnical inspection of subgrade to confirm that materials are consistent with the materials on which the pavement was designed. Further CBR tests should be carried out to confirm the design CBR value.

5 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. As an example, special treatment of soft spots may be required as a result of their discovery during proof-rolling, etc. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and JK Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

The long term successful performance of floor slabs and pavements is dependent on the satisfactory completion of the earthworks. In order to achieve this, the quality assurance program should not be limited to routine compaction density testing only. Other critical factors associated with the earthworks may include subgrade preparation, selection of fill materials, control of moisture content and drainage, etc. The satisfactory control and assessment of these items may require judgment from an experienced engineer. Such judgment often cannot be made by a technician who may not have formal engineering qualifications and experience. In order to identify potential problems, we recommend that a pre-construction meeting be held so that all parties involved understand the earthworks requirements and potential difficulties. This meeting should clearly define the lines of communication and responsibility.

The subsurface conditions between the completed investigation locations may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

A waste classification will need to be assigned to any soil excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), General Solid, Restricted Solid or Hazardous Waste. Analysis takes seven to 10 working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing (and associated delays) should be expected. We strongly recommend that this issue is addressed prior to the commencement of excavation on site.

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE A
MOISTURE CONTENT, ATTERBERG LIMIT AND LINEAR SHRINKAGE TEST REPORT

Client:	JK Geotechnics	**Ref No:**	32596YJ
Project:	Proposed Brookvale Redvelopment	**Report:**	A
Location:	Brookvale Oval, Brookvale, NSW	**Report Date:**	3/09/2019
		Page 1 of 1	

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	LINEAR SHRINKAGE %
305	5.40 - 6.00	17.8	43	20	23	9.0 *
305	17.00 - 18.00	4.6	-	-	-	-
305	18.00 - 18.60	7.1	-	-	-	-
306	21.40 - 23.50	12.6	-	-	-	-

Notes:

- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 27/08/2019.
- Sampled and supplied by client. Samples tested as received.
- * Denotes Linear Shrinkage cracked.

03/09/2019

NATA Accredited Laboratory Number:1327

Authorised Signature / Date
(D. Treweek)

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE B
FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client:	JK Geotechnics	**Ref No:**	32596YJ
Project:	Proposed Brookvale Redevelopment	**Report:**	B
Location:	Brookvale Oval, Brookvale, NSW	**Report Date:**	3/09/2019
		Page 1 of 1	

BOREHOLE NUMBER	BH 219	BH 236
DEPTH (m)	0.50 - 1.00	0.50 - 1.10
Surcharge (kg)	4.5	4.5
Maximum Dry Density (t/m^3)	1.73 STD	1.78 STD
Optimum Moisture Content (%)	15.4	12.9
Moulded Dry Density (t/m^3)	1.68	1.73
Sample Density Ratio (%)	98	98
Sample Moisture Ratio (%)	98	100
Moisture Contents		
Insitu (%)	12.9	7.5
Moulded (%)	15.0	12.9
After soaking and		
After Test, Top 30mm(%)	23.0	21.1
Remaining Depth (%)	20.2	17.4
Material Retained on 19mm Sieve (%)	2*	0
Swell (%)	0.0	0.0
C.B.R. value: @2.5mm penetration	5	6

NOTES: Sampled and supplied by client. Samples tested as received.

- Refer to appropriate Borehole logs for soil descriptions
- Test Methods: AS 1289 6.1.1, 5.1.1 & 2.1.1.
- Date of receipt of sample: 27/08/2019.
- * Denotes not used in test sample.

03/09/2019

NATA Accredited Laboratory Number:1327

Authorised Signature / Date
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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE C
PERCENTAGE FINES TEST REPORT

Client:	JK Geotechnics	**Ref No:**	32596YJ
Project:	Proposed Brookvale Redevelopment	**Report:**	C
Location:	Brookvale Oval, Brookvale, NSW	**Report Date:**	30/08/2019
		Page 1 of 1	

AS 1289	TEST METHOD	3.6.1
BOREHOLE NUMBER	**DEPTH**	**PERCENTAGE FINER THAN 0.075mm**
	m	**%**
305	3.00 - 3.45	20
305	5.40 - 6.00	34
305	9.00 - 9.45	31
305	10.50 - 10.95	28
306	6.00 - 6.45	31
306	9.00 - 9.45	24
306	16.50 - 16.95	24

Notes:

- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 27/08/2019.
- Sampled and supplied by client. Samples tested as received.

30/08/2019

NATA Accredited Laboratory Number:1327

Authorised Signature / Date
(D. Treweek)

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www.envirolab.com.au

CERTIFICATE OF ANALYSIS 224835

Client Details

Client	JK Geotechnics
Attention	Kartik Singh
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**32596YJ, Brookvale**
Number of Samples	3 Soil
Date samples received	27/08/2019
Date completed instructions received	27/08/2019

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	03/09/2019
Date of Issue	29/08/2019

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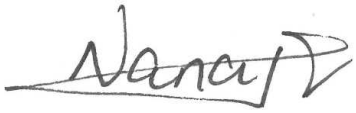
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil				
Our Reference		224835-1	224835-2	224835-3
Your Reference	UNITS	305	305	306
Depth		6-6.45	12-12.45	21.4-23.5
Date Sampled		21.08.19	21.08.19	21.08.19
Type of sample		Soil	Soil	Soil
Date prepared	-	28/08/2019	28/08/2019	28/08/2019
Date analysed	-	28/08/2019	28/08/2019	28/08/2019
pH 1:5 soil:water	pH Units	5.1	4.9	5.7
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	32	37	<10
Resistivity in soil*	ohm m	270	260	620

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 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
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	-			28/08/2019	[NT]	[NT]	[NT]	[NT]	28/08/2019	[NT]
Date analysed	-			28/08/2019	[NT]	[NT]	[NT]	[NT]	28/08/2019	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	91	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	100	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[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.

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; 60-140% for organics (+/-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.

JKGeotechnics

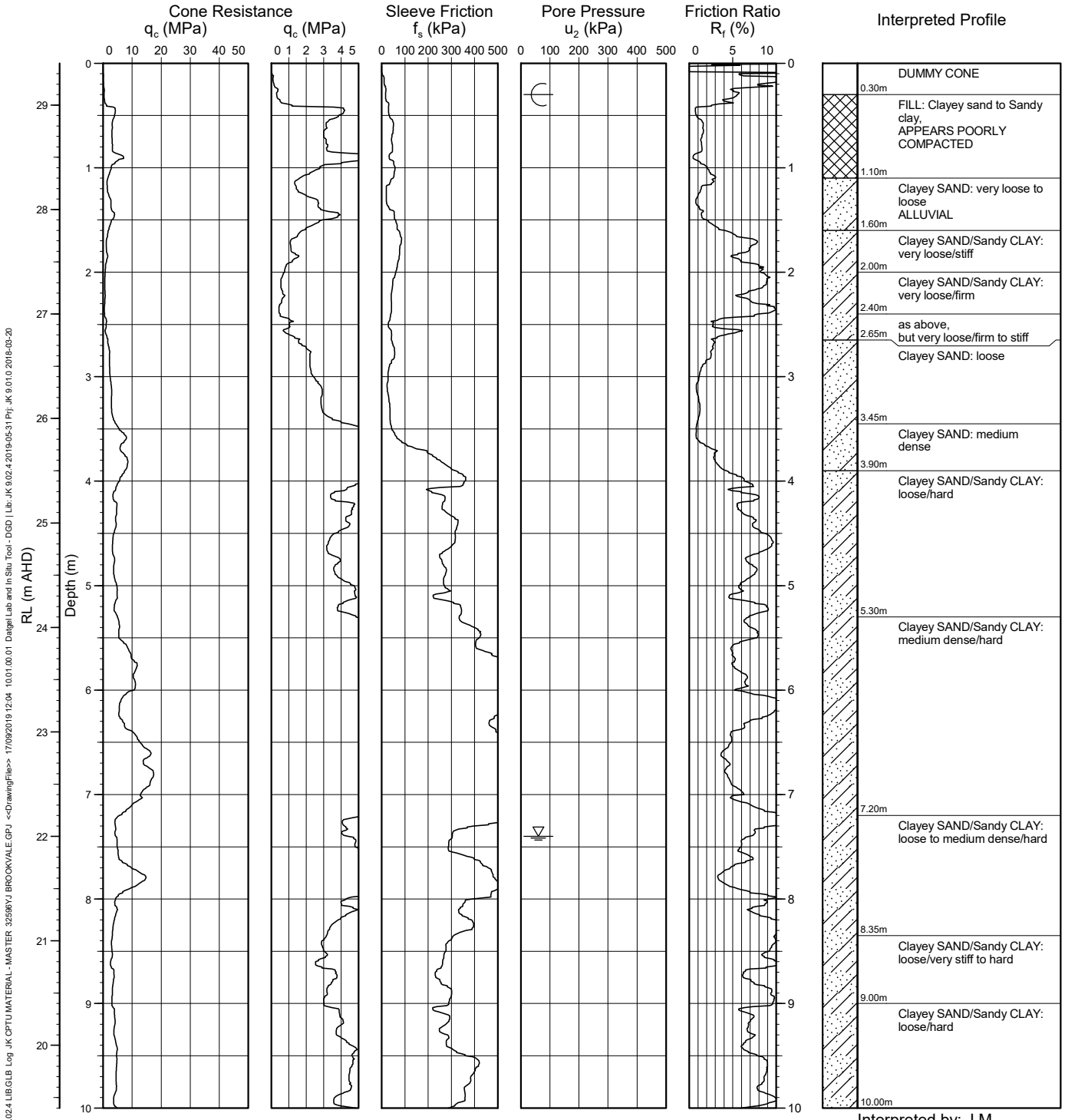
CONE PENETROMETER TEST RESULTS

CPT No. 301 **1 / 2**

EASTING: N/A
NORTHING: N/A

Client:	URBIS PTY LTD
Project:	PROPOSED BROOKVALE OVAL REDEVELOPMENT
Location:	BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ	**R.L. Surface:** ~29.4 m	**Data File:** 32596YJ Brookvale
Date: 19/8/19	**Datum:** AHD	**Operator:** B.J./K.K.S.



Interpreted by: J.M.
Checked by: W.T.

JKGeotechnics

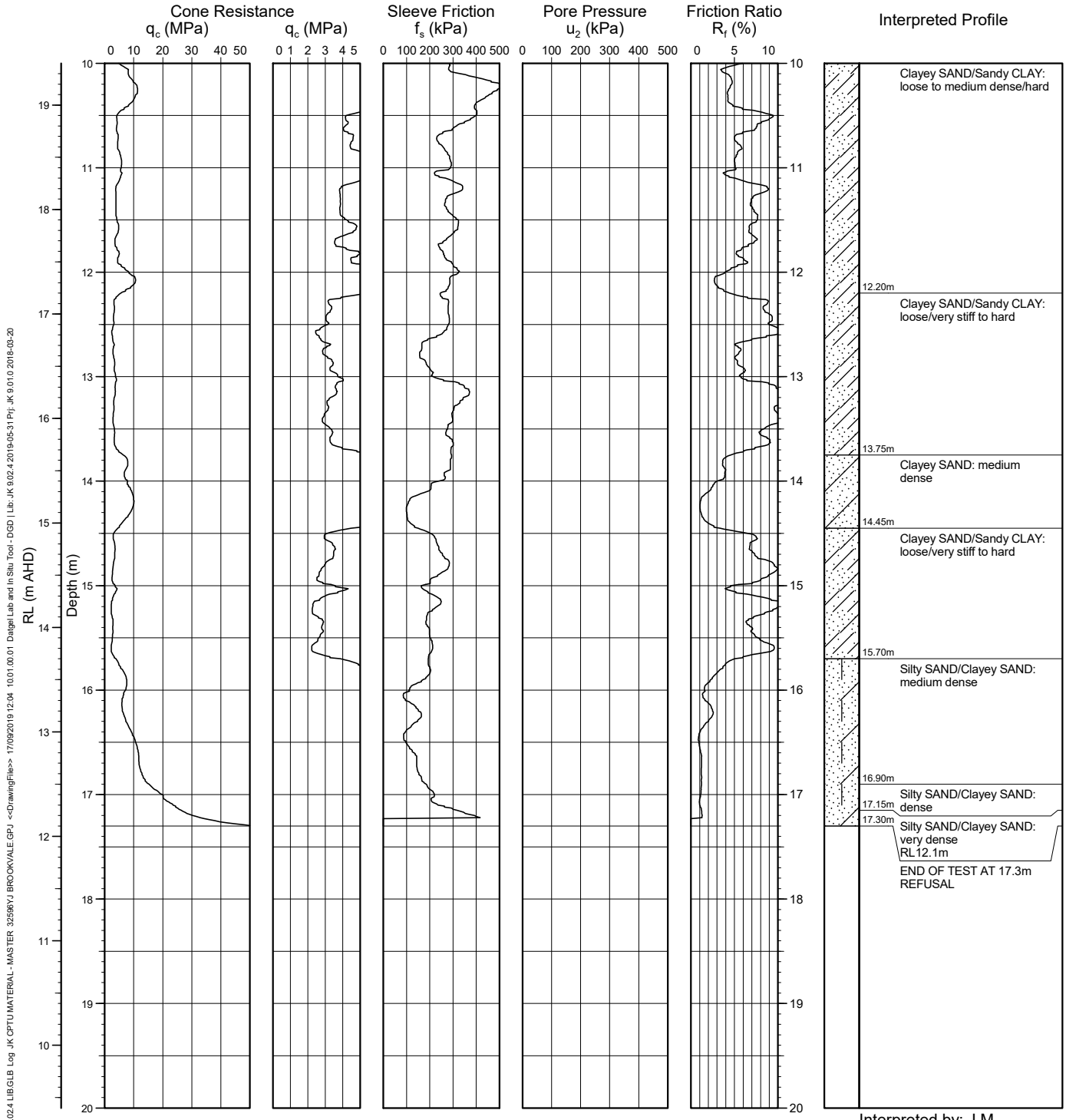
CONE PENETROMETER TEST RESULTS

CPT No. 301 **2 / 2**

EASTING: N/A
NORTHING: N/A

Client:	URBIS PTY LTD
Project:	PROPOSED BROOKVALE OVAL REDEVELOPMENT
Location:	BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ	**R.L. Surface:** ~29.4 m	**Data File:** 32596YJ Brookvale
Date: 19/8/19	**Datum:** AHD	**Operator:** B.J./K.K.S.



Interpreted by: J.M.
Checked by: W.T.

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CONE PENETROMETER TEST RESULTS

CPT No. 302 **1 / 2**

EASTING: N/A
NORTHING: N/A

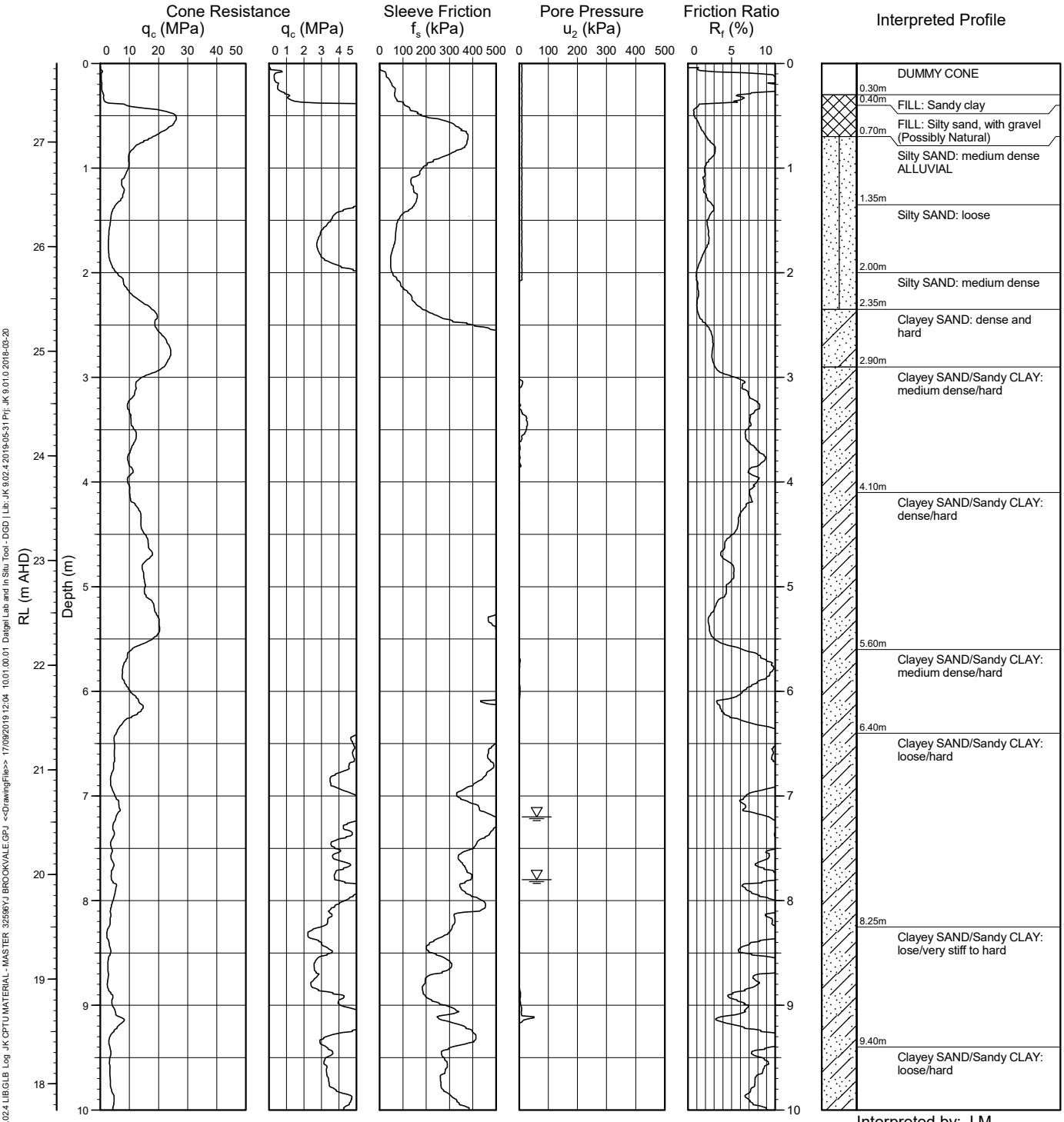
Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL REDEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ **R.L. Surface:** ~27.75 m **Data File:** 32596YJ Brookvale

Date: 19/8/19 **Datum:** AHD **Operator:** B.J./K.K.S.



Interpreted by: J.M.
Checked by: W.T.

JKGeotechnics

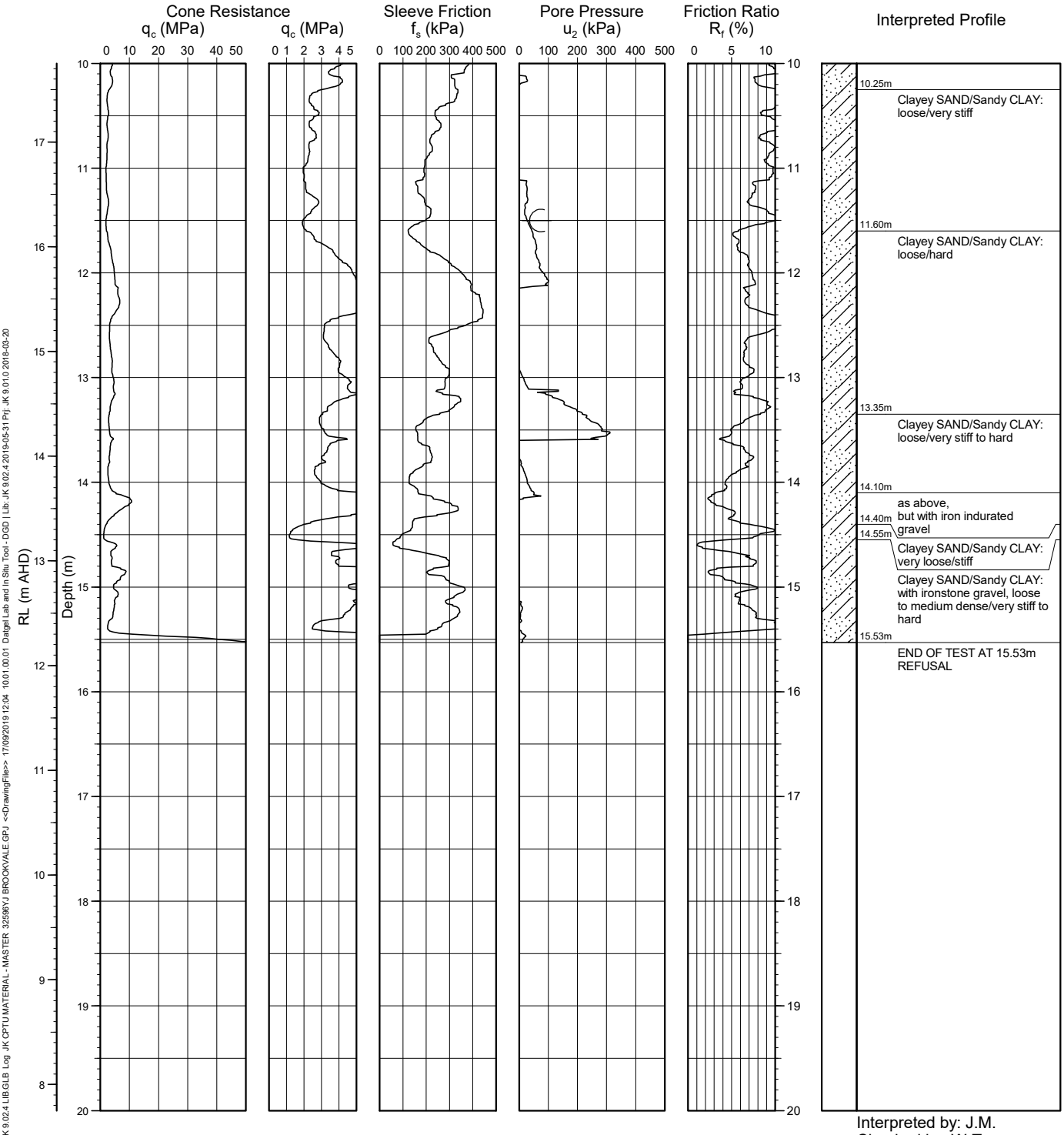
CONE PENETROMETER TEST RESULTS

CPT No. 302 **2 / 2**

EASTING: N/A
NORTHING: N/A

Client:	URBIS PTY LTD
Project:	PROPOSED BROOKVALE OVAL REDEVELOPMENT
Location:	BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ	**R.L. Surface:** ~27.75 m	**Data File:** 32596YJ Brookvale
Date: 19/8/19	**Datum:** AHD	**Operator:** B.J./K.K.S.



Interpreted by: J.M.
Checked by: W.T.

JKGeotechnics

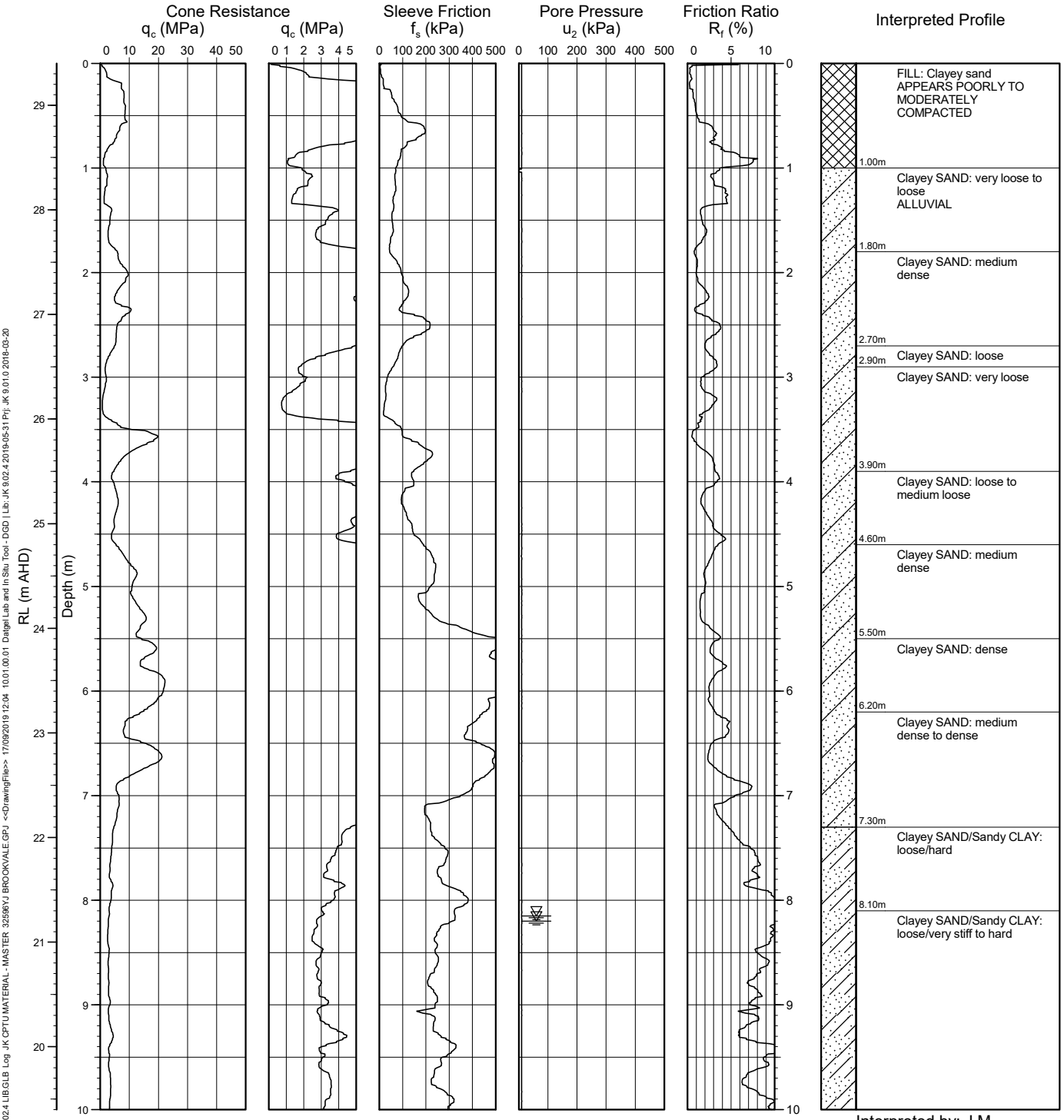
CONE PENETROMETER TEST RESULTS

CPT No. 303 **1 / 2**

EASTING: N/A
NORTHING: N/A

Client:	URBIS PTY LTD
Project:	PROPOSED BROOKVALE OVAL REDEVELOPMENT
Location:	BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ	**R.L. Surface:** ~29.4 m	**Data File:** 32596YJ Brookvale
Date: 19/8/19	**Datum:** AHD	**Operator:** B.J./K.K.S.



Interpreted by: J.M.
Checked by: W.T.

JKGeotechnics

CONE PENETROMETER TEST RESULTS

CPT No. 303 **2 / 2**

EASTING: N/A
NORTHING: N/A

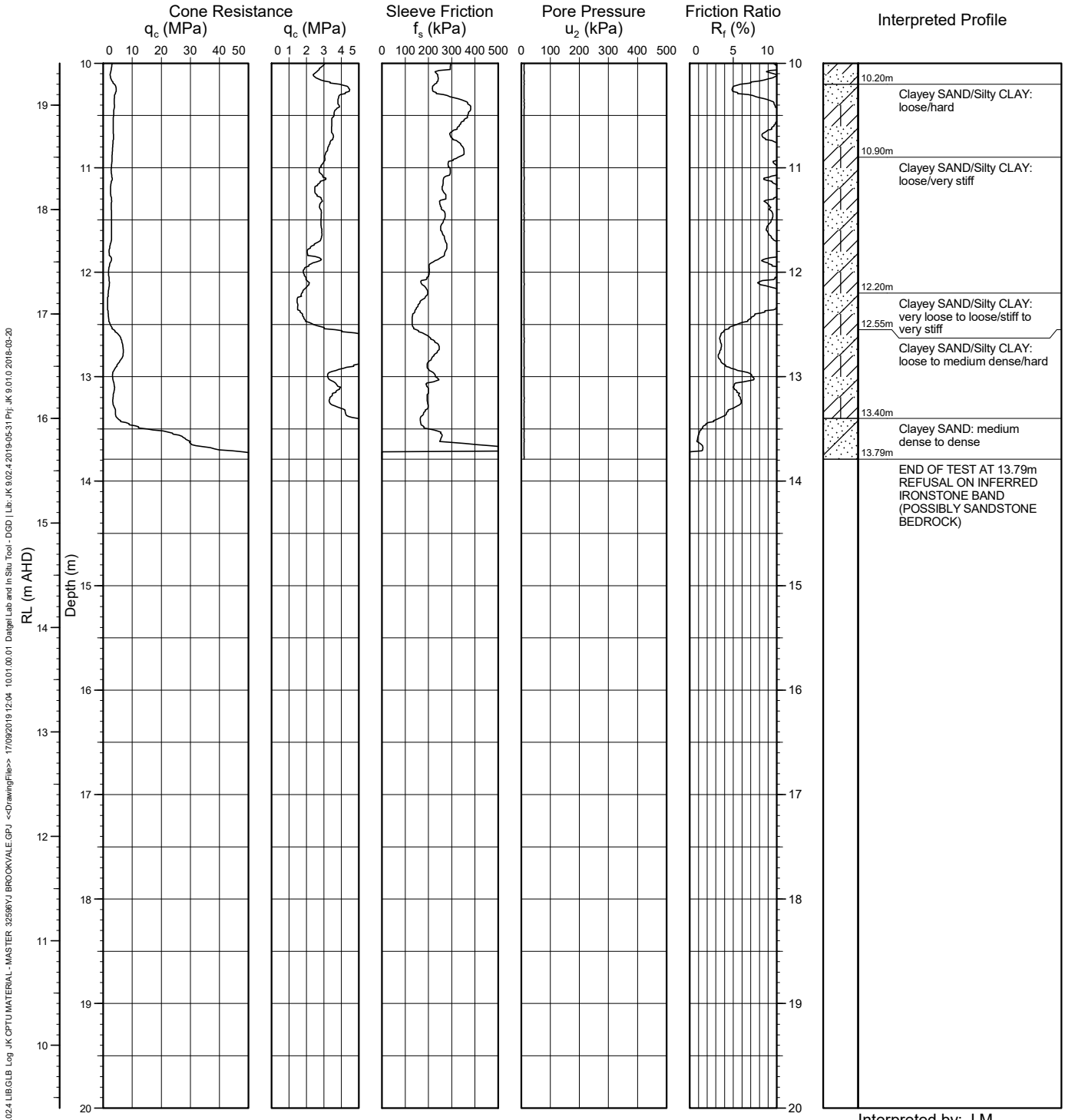
Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL REDEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ **R.L. Surface:** ~29.4 m **Data File:** 32596YJ Brookvale

Date: 19/8/19 **Datum:** AHD **Operator:** B.J./K.K.S.



Interpreted by: J.M.
Checked by: W.T.

JKGeotechnics

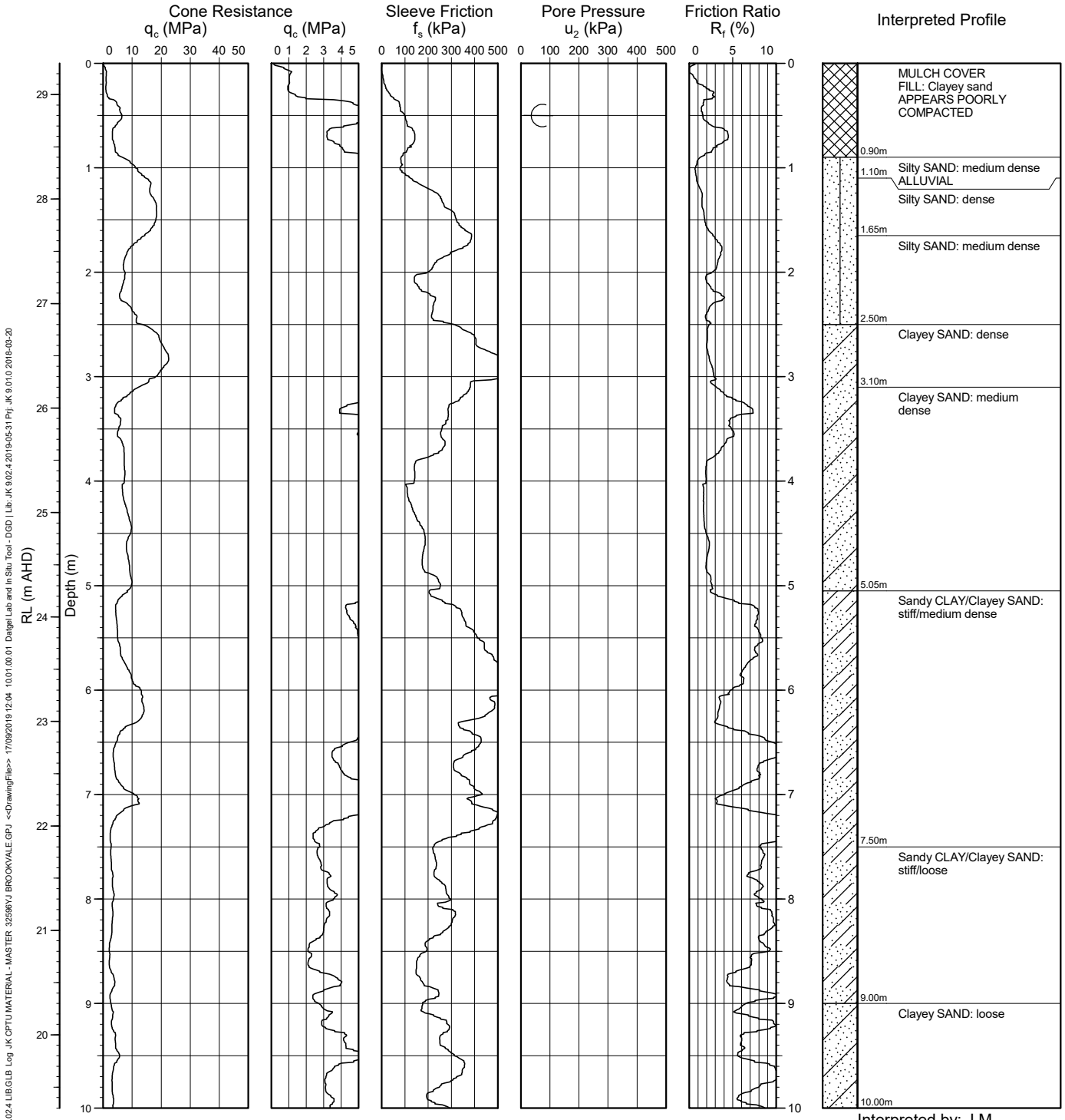
CONE PENETROMETER TEST RESULTS

CPT No. 304 **1 / 2**

EASTING: N/A
NORTHING: N/A

Client:	URBIS PTY LTD
Project:	PROPOSED BROOKVALE OVAL REDEVELOPMENT
Location:	BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ	**R.L. Surface:** ~29.3 m	**Data File:** 32596YJ Brookvale
Date: 19/8/19	**Datum:** AHD	**Operator:** B.J./K.K.S.



Interpreted by: J.M.
Checked by: W.T.

JKGeotechnics

CONE PENETROMETER TEST RESULTS

CPT No. 304 **2 / 2**

EASTING: N/A
NORTHING: N/A

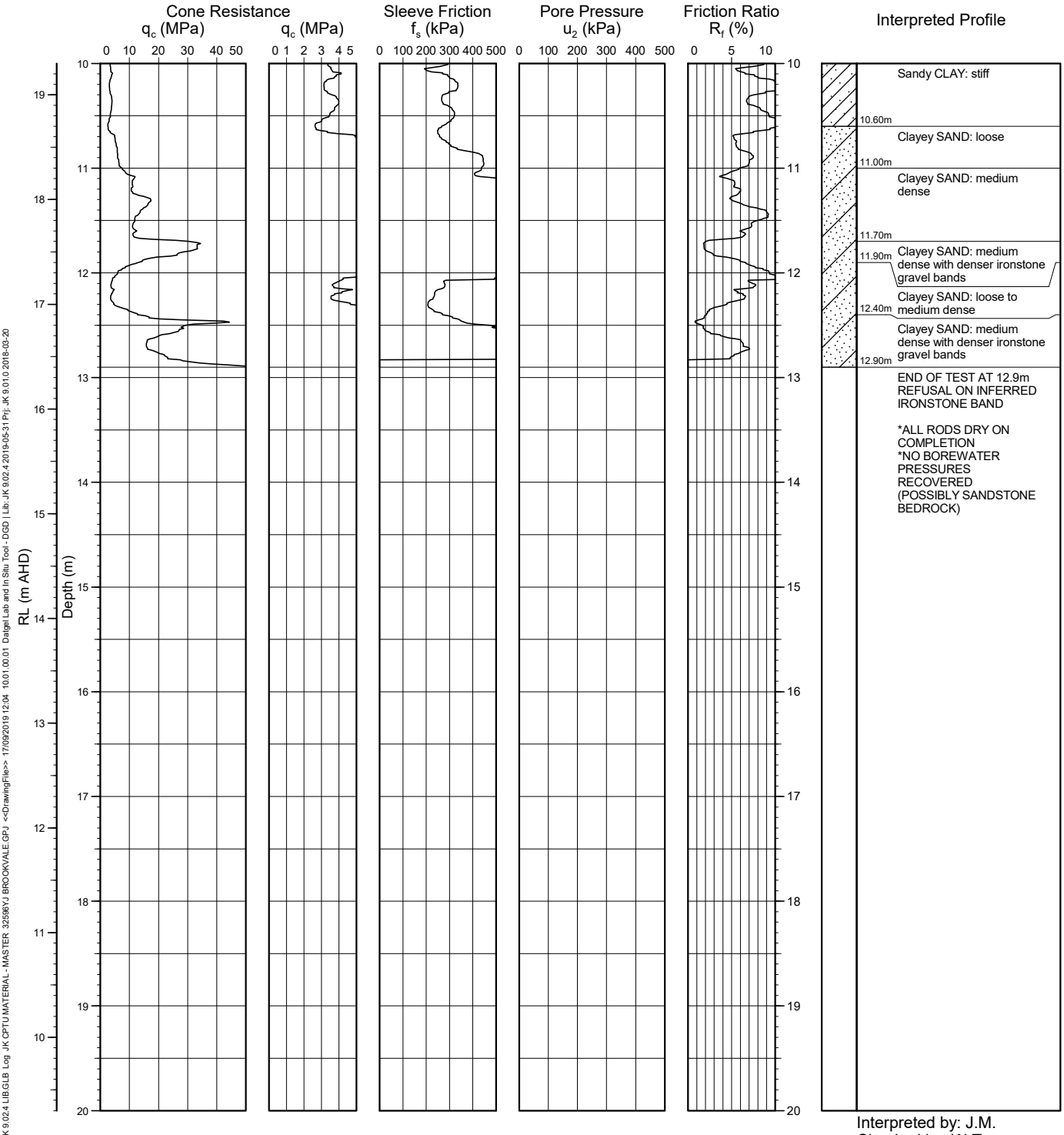
Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL REDEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ **R.L. Surface:** ~29.3 m **Data File:** 32596YJ Brookvale

Date: 19/8/19 **Datum:** AHD **Operator:** B.J./K.K.S.



Interpreted Profile

- Sandy CLAY: stiff
- 10.60m
- Clayey SAND: loose
- 11.00m
- Clayey SAND: medium dense
- 11.70m
- 11.90m Clayey SAND: medium dense with denser ironstone gravel bands
- Clayey SAND: loose to medium dense
- 12.40m
- Clayey SAND: medium dense with denser ironstone gravel bands
- 12.90m
- END OF TEST AT 12.9m REFUSAL ON INFERRED IRONSTONE BAND

*ALL RODS DRY ON COMPLETION
*NO BOREWATER PRESSURES RECOVERED (POSSIBLY SANDSTONE BEDROCK)

Interpreted by: J.M.
Checked by: W.T.

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BOREHOLE LOG

Borehole No. 305 1/3

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL REDEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 29.2m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** K.K.S./J.M.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
GROUND-WATER LEVEL ON COMPLET-ION COULD NOT BE MEASURED					N = 7 3,3,4	0			FILL: Clayey sand, fine to medium grained, brown and dark brown, trace of fine to medium grained sub-angular igneous and sandstone gravel and root fibres.	M			GRASS COVER APPEARS POORLY COMPACTED
					N = 11 5,5,6	1		SM	Silty SAND: fine to coarse grained, grey.		MD		ALLUVIAL
					N = 12 2,5,7	2		SC	Silty clayey SAND: medium fine to coarse grained, orange brown, medium plasticity fines.				
					N = 13 5,6,7	3			as above, but, trace of fine to medium grained ironstone gravel.			210 240 190	
					N = 12 4,5,7	4		CI/SC	Sandy CLAY to Clayey SAND: medium plasticity/fine to coarse grained, red brown.	w≈PL/M	St/MD	140 150 170	
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No. 305 2/3

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL REDEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 29.2m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** K.K.S./J.M.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
								CI/SC	Sandy CLAY to Clayey SAND: medium plasticity/fine to coarse grained, red brown.	w≈PL/M	St/MD		
											St/L		
				■	N = 10 5,5,5			SC	Clayey SAND: fine to coarse grained, orange brown and grey, medium plasticity fines.	M	L		
						8							
						9			as above, but red brown and grey.			200	
				■	N = 9 4,4,5								
						10		CI	Sandy CLAY: medium plasticity, red brown, fine to coarse grained sand.	w≈PL	St		
				■	N = 9 3,4,5			SC	Clayey SAND: fine to coarse grained, grey mottled red brown and yellow brown, medium plasticity clay fines.	M	L	250 250 260	
						11					MD		
▶									Clayey SAND: fine to medium grained, red brown, trace of fine to medium grained ironstone gravel, medium plasticity fines.	W			
				■	N = 34 5,13,21	12							
						13							
				■	N = 16 5,8,8				as above, but red mottled yellow brown and grey.			380	
						14							

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BOREHOLE LOG

Borehole No. 305 3/3

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL REDEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 29.2m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** K.K.S./J.M.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
									Clayey SAND: fine to coarse grained, yellow brown mottled red brown, trace of fine to medium grained ironstone gravel, medium plasticity fines.	W	MD		
					N > 15 23,15/ 50mm REFUSAL	15			as above, but red brown mottled yellow brown.				
								CI	Sandy CLAY: medium plasticity, yellow brown, trace of fine to medium grained ironstone gravel, fine to medium grained sand.	w>PL	VSt-Hd		POSSIBLY EXTREMELY WEATHERED SANDSTONE
					N = SPT 10/50mm REFUSAL	16							
						17		-	SANDSTONE: grey and red brown.	DW	L		HAWKESBURY SANDSTONE
											M		LOW TO MODERATE 'TC' BIT RESISTANCE
						18				SW	M-H		HIGH RESISTANCE
									END OF BOREHOLE AT 18.6m				'TC' BIT REFUSAL
						19							
						20							

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BOREHOLE LOG

Borehole No. **306** 1/4

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL REDEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 26.0m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** K.K.S./J.M.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
GROUND-WATER LEVEL ON COMPLET-ION COULD NOT BE MEASURED						0			CONCRETE: 90mm.t				8mm DIA. REINFORCEMENT 25mm TOP COVER
					N = 10 3,5,6			-	FILL: Silty clay, medium plasticity, light grey mottled red brown, trace of fine to coarse grained ironstone sub-angular to angular gravel.	w≈PL			APPEARS MODERATELY COMPACTED
						1			FILL: Clayey sand, fine to coarse grained, dark grey, trace of fine to medium grained sub angular igneous gravel.	M			
								SM		M	MD		ALLUVIAL
					N = 22 8,10,12			SC	Silty SAND: fine to coarse grained, yellow brown, with medium plasticity fines.				
						2			Clayey SAND: fine to coarse grained, yellow brown mottled red brown.				
										W			
									as above, but grey mottled red brown and brown.				
					N = 18 6,8,10	3		SC/CI	Clayey SAND to Sandy CLAY: fine to coarse grained/medium plasticity, grey mottled red brown	W/w>PL	MD/VSt	300 320 330	
										M/w>PL			
						4							
					N = 14 5,6,8			SC	Clayey SAND: fine to coarse grained, grey mottled red brown and brown, medium plasticity fines.	M	MD	380 330 490	
						5							
									as above, but grey mottled red brown and yellow brown.				
					N = 11 5,5,6	6						380 450 420	
						7							

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BOREHOLE LOG

Borehole No. **306** 2/4

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL REDEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 26.0m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** K.K.S./J.M.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
▶						8		SC	Clayey SAND: fine to coarse grained, grey mottled red brown and yellow brown.	M	MD		
								SM	Clayey SAND: fine to coarse grained, yellow brown mottled red brown, with medium plasticity fines.	W			
					N = 14 5,6,8	9		SC	Clayey SAND: fine to coarse grained, grey mottled yellow brown, with medium plasticity fines.			280 330 440	
						10		SC/Cl	Clayey SAND: fine to coarse grained/ medium plasticity, yellow brown mottled red brown.	W/w>PL	MD/ St-VSt		
					N = 15 4,6,9	11		SC	Clayey SAND: fine to coarse grained, grey mottled yellow brown, with medium plasticity fines.	W		300 310	
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No. 306 3/4

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL REDEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 26.0m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** K.K.S./J.M.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
								SC	Clayey SAND: fine to coarse grained, grey mottled yellow brown and red brown, with medium plasticity fines.	W	MD		
					N = 4 2,2,2	15			as above, but yellow brown mottled red brown and grey.		VL		
					N = 15 4,6,11	16					MD	350	
					N = 17 4,7,10	17							
						18		SM	Silty SAND: fine to coarse grained, red brown.				
					N = 12 5,6,6	19							
						20		SC	Clayey SAND: fine to medium grained, red brown and yellow brown, with medium plasticity fines.				

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BOREHOLE LOG

Borehole No. **306** 4/4

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL REDEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: 32596YJ **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 26.0m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** K.K.S./J.M.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
								SC	Clayey SAND: fine to medium grained, red brown and yellow brown, with medium plasticity fines.	M	MD		
						22		-	SANDSTONE: grey and red brown.	DW	L-M		HAWKESBURY SANDSTONE MODERATE 'TC' BIT RESISTANCE WITH LOW BANDS
						23				SW	M-H		HIGH RESISTANCE
									END OF BOREHOLE AT 23.5m				'TC' BIT REFUSAL
						24							
						25							
						26							
						27							

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ENVIRONMENTAL LOG

Log No. 201 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 28.68m

Date: 22/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION							0			CONCRETE: 120mm.t				
									-	FILL: Gravelly sand, fine to coarse grained, grey, fine to medium grained igneous sub angular, trace of ironstone gravel.	M			2.2kg BUCKET NO FCF 4.6kg BUCKET NO FCF
						N = 19 6,10,9			SP	FILL: Clayey sand, fine to medium grained, light brown, trace of ironstone gravel.	D			ALLUVIAL
							1			Silty SAND: fine to coarse grained, light grey.				
										END OF BOREHOLE AT 1.5m				
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 202 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 26.36m

Date: 23/8/19 **Datum:** AHD

Plant Type: JK205 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION			■		■	N = 8 3,4,4	0		-	CONCRETE: 120mm.t				
										FILL: Silty sand, fine to coarse grained, brown, trace of clay fines.	M			2.0kg BUCKET NO FCF
									SC	Clayey SAND: fine to coarse grained, orange brown.	M			ALLUVIAL
							1			END OF BOREHOLE AT 0.95m				
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 203 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 26.46m

Date: 23/8/19 **Datum:** AHD

Plant Type: JK205 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION	■		■		■		0			CONCRETE: 120mm.t				
									-	FILL: Silty sand, fine to coarse grained, brown, trace of igneous gravel.	M			3.4kg BUCKET NO FCF
	■		■								w>PL			1.5kg BUCKET NO FCF
	■		■			N = 5 3,2,3			CL-CI	FILL: Silty clay, low to medium plasticity, red brown, trace of ironstone gravel.	w<PL			ALLUVIAL
							1			Sandy CLAY: low to medium plasticity, brown, fine to coarse grained sand.				
										END OF BOREHOLE AT 1.0m				
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 204 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 26.34m

Date: 23/8/19 **Datum:** AHD

Plant Type: JK205 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION						N = 11 0,1,10	0		-	CONCRETE: 120mm.t FILL: Silty sand, fine to medium grained, light brown.	M w>PL			NOT ENOUGH SAMPLE FOR BUCKET 5.3kg BUCKET NO FCF
										FILL: Silty clay, low to medium plasticity, red brown, trace of ironstone and sandstone gravel and ash.				
							1		CL-CI	FILL: Sandy clay. low to medium plasticity, dark grey, fine to medium grained sand.	w<PL			NOT ENOUGH SAMPLE FOR BUCKET
										Sandy CLAY: low to medium plasticity, orange brown.				ALLUVIAL
										END OF BOREHOLE AT 1.5m				
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 205 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 26.23m

Date: 23/8/19 **Datum:** AHD

Plant Type: JK205 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION							0			CONCRETE: 120mm.t				
									-	FILL: Silty sand, fine to medium grained, light brown.	M w>PL			NOT ENOUGH SAMPLE FOR BUCKET 9.9kg BUCKET NO FCF
						N = 4 2,2,2				FILL: Silty clay, low to medium plasticity, red brown, trace of ironstone, sandstone and igneous gravel and ash.				3.2kg BUCKET NO FCF
							1			FILL: Sandy clay, low to medium plasticity, dark grey, fine to medium grained sand, trace of ironstone gravel.				
									CL-CI		w<PL			ALLUVIAL
						N = 6 3,3,3				Sandy CLAY: low to medium plasticity, brown, fine to coarse grained sand.				
							2			as above, but orange brown.				
										END OF BOREHOLE AT 1.95m				
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No. 206 **1/2**

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 26.09m

Date: 23/8/19 **Datum:** AHD

Plant Type: JK205 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
							0			CONCRETE: 90mm.t				
									-	FILL: Silty sand, fine to medium grained, light brown.	M w≈PL			NOT ENOUGH SAMPLE FOR BUCKET 9.4kg BUCKET NO FCF
						N = 3 2,1,2				FILL: Silty clay, medium plasticity, red brown and grey, trace of ironstone, sandstone and igneous gravel, slag and ash.				3.5kg BUCKET NO FCF
							1		SC	Clayey SAND: fine to coarse grained, orange brown.	D			ALLUVIAL
						N = 14 5,5,9	2							
						N = 15 7,7,8	3		SC/CI	Clayey SAND to Sandy CLAY: fine to coarse grained/medium plasticity, grey mottled red brown.	M/w>PL			
						N = 14 6,7,7	4		SC	Clayey SAND: fine to coarse grained, grey mottled orange brown and brown, medium plasticity fines.	M			
▼ ON 4/9/19							5				W			
						N = 13 4,6,7	6							
							7							

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ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No. 206 **2/2**

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 26.09m

Date: 23/8/19 **Datum:** AHD

Plant Type: JK205 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
ON COMPLE-TION ▽						N = 8 6,4,4	8		SC	Clayey SAND: fine to coarse grained, grey mottled orange brown and brown, medium plasticity fines.	W			
										Clayey SAND: fine to coarse grained, orange brown.				
							9			END OF BOREHOLE AT 9.0m				Groundwater monitoring well installed to 9.0m. Class 18 machine slotted 50mm dia. PVC standpipe 9.0m to 3.0m. Casing 3.0m to 0.0m. 2mm sand filter pack 9.0m to 2. 0m. Bentonite seal 2.0m to 1. 0m. Backfilled with sand (and/or cuttings) to the surface. Completed with concreted gatic cover.
							10							
							11							
							12							
							13							
							14							

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ENVIRONMENTAL LOG

Log No. 207 **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 25.99m

Date: 23/8/19 **Datum:** AHD

Plant Type: JK205 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION							0			CONCRETE: 120mm.t				
									-	FILL: Silty sand, fine to medium grained, light brown, trace of igneous gravel.	M w>PL			3.0kg BUCKET NO FCF 10.2kg BUCKET NO FCF
						N = 6 2,2,8	1			FILL: Silty clay, low to medium plasticity, red brown and grey, trace of ironstone, sandstone and igneous gravel and ash.				
						N = 12 3,5,7			CL-CI	Sandy CLAY: low to medium plasticity, brown.	M			ALLUVIAL
							2			END OF BOREHOLE AT 1.95m				
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 208 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 25.79m

Date: 23/8/19 **Datum:** AHD

Plant Type: JK205 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION							0			CONCRETE: 90mm.t				
						N = 5 4,2,3			-	FILL: Silty sand, fine to coarse grained, light brown, trace of igneous gravel.	M			3.0kg BUCKET NO FCF 11.2kg BUCKET NO FCF
							1			FILL: Silty clayey sand, fine to coarse sand, grey, trace of sandstone and ironstone gravel and brick fragments.				
						N = 5 2,3,2			CI-CH	Sandy CLAY: medium to high plasticity, orange brown, trace of ironstone gravel.	w>PL			ALLUVIAL
							2							
										END OF BOREHOLE AT 2.5m				
							3							
							4							
							5							
							6							
							7							

JKEnvironments

ENVIRONMENTAL LOG

Log No. 209 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** HAND TOOLS **R.L. Surface:** ≈ 27.53m

Date: 23/8/19 **Datum:** AHD

Plant Type: N/A **Logged/Checked by:** S.W./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■		■		■		0			FILL: Silty clay, low to medium plasticity, dark brown, trace of igneous gravel, glass and root fibres.	w<PL			GRASS COVER
	■		■							FILL: Silty clay, low to medium plasticity, red brown, with ironstone gravel, trace of ash.	M			10.4kg BUCKET NO FCF NOT ENOUGH SAMPLE FOR BUCKET
							1			FILL: Clayey sand, fine to coarse grained, brown, trace of igneous gravel and ash.				NOT ENOUGH SAMPLE FOR BUCKET
										FILL: Silty clayey sand, fine to coarse grained, dark brown, trace of ironstone gravel and ash.				NOT ENOUGH SAMPLE FOR BUCKET
										END OF BOREHOLE AT 0.8m				HAND TOOL REFUSAL
							2							
							3							
							4							
							5							
							6							
							7							

JKEnvironments

ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No. 210 **1/2**

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 28.67m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK308 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			■		■		0			FILL: Sandy silt, low to medium plasticity, brown, with organic material.	w>PL			MULCH COVER
						N = 11 4,5,6				FILL: Silty sandy clay, low to medium plasticity, light brown, trace of ironstone gravel.				5.9kg BUCKET NO FCF 1.8kg BUCKET NO FCF
							1		SM	Silty SAND: fine to coarse grained, light grey.	D			ALLUVIAL
			■			N = 8 3,4,4			SC	Silty clayey SAND: fine to coarse grained, brown.	D			
							2			as above, but light brown.	M			
						N = 5 3,3,2	3							
							4							
						N = 9 5,5,4								
							5							
									CI/SC	Sandy CLAY TO Clayey SAND: medium plasticity, fine to coarse grained, light brown.	w≈PL/M			
						N = 12 5,7,5	6							
							7							

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ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No. 210 **2/2**

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 28.67m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK308 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
									CI/SC	Sandy CLAY TO Clayey SAND: medium plasticity, fine to coarse grained, light brown.	w≈PL/M			
						N = 8 6,4,4			SC	Clayey SAND: fine to coarse grained, orange brown and grey, trace of ironstone gravel.	M			
▼ ON 4/9/19							8							
▶										as above, but red brown and grey.	W			
							9							
▼ ON COMPLE-TION							10							
							11							
							12			END OF BOREHOLE AT 12.0m				Groundwater monitoring well installed to 10.9m. Class 18 machine slotted 50mm dia. PVC standpipe 10.9m to 4.9m. Casing 4.9m to 0.0m. 2mm sand filter pack 10.9m to 4.5m. Bentonite seal 4.5m to 4.0m. Backfilled with sand to the surface. Completed with concreted gatic cover.
							13							
							14							

JKEnvironments

ENVIRONMENTAL LOG

Log No. 211 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 28.56m

Date: 22/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION							0			FILL: Silty sand, fine to medium grained, brown, trace of ironstone gravel and root fibres.	M			GRASS COVER 11.3kg BUCKET NO FCF
						N = 9 6,4,5				FILL: Clayey sand, fine to coarse grained, light brown, trace of ironstone gravel and ash.				5.9kg BUCKET AMF4
							1		SM	Silty SAND: fine to coarse grained, light grey.	D			ALLUVIAL
						N = 13 6,6,7								
							2			END OF BORHEOLE AT 1.95m				
							3							
							4							
							5							
							6							
							7							

JKEnvironments

ENVIRONMENTAL LOG

Log No. 212 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 28.69m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK308 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION			■		■		0			FILL: Silty sand, fine to coarse grained, brown, trace igneous gravel.	M			GRASS COVER NO FCF 0.1m 11.9kg BUCKET
			■		■	N = 7 4,3,4				FILL: Silty clay, low to medium plasticity, brown, with ironstone gravel, trace of slag and ash.	w>PL			NO FCF 9.8kg BUCKET NO FCF
			■		■		1			FILL: Silty sand, fine to medium grained, brown, trace of ironstone gravel, slag and ash.	M			1.8kg BUCKET NO FCF
			■			N = 9 6,5,4			SM	as above, but , dark grey.	M			NOT ENOUGH SAMPLE FOR BUCKET
							2			Silty SAND: fine to coarse grained, light grey. END OF BOREHOLE AT 2.0m				ALLUVIAL
							3							
							4							
							5							
							6							
							7							

JKEnvironments

ENVIRONMENTAL LOG

Log No. 213 **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 29.42m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK308 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION							0			FILL: Silty sand, fine to medium grained, brown, trace of sandstone gravel and brick fragments.	M			GRASS COVER 8.4kg BUCKET NO FCF
						N = 4 3,2,2				FILL: Silty sand, fine to coarse grained, light brown, trace of sandstone gravel, ash and slag.				11.8kg BUCKET AMF1
						N = 2 1,1,1	1			FILL: Clayey sand, fine to coarse grained, orange brown trace of ironstone and igneous gravel.				8.4kg BUCKET NO FCF
							2		SM	Silty SAND: fine to coarse grained, light grey.	M			ALLUVIAL
									SC	Clayey SAND: fine to coarse grained, brown.	M			
										END OF BOREHOLE AT 2.5m				
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 214 **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 29.32m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK308 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION			■		■		0			FILL: Silty sand, fine to coarse grained, brown, trace of sandstone gravel.	M			GRASS COVER AMF2 0.1 9.1kg BUCKET AMF2 8.4kg BUCKET NO FCF
			■		■	N = 2 3,1,1				FILL: Silty sand, fine to coarse grained, grey, trace of igneous ironstone and sandstone gravel.				
			■		■		1			FILL: Silty clay, low to medium plasticity, red brown, trace of ironstone, sandstone and igneous gravel and slag.	w>PL			11.9KG BUCKET NO FCF
			■		■	N = 2 2,1,1								
			■		■		2							7.8kg BUCKET NO FCF
			■			N = 7 6,3,4	3		SM	Silty SAND: fine to coarse grained, brown, trace of clay fines.	M			ALLUVIAL
							4			END OF BOREHOLE AT 3.3m				
							5							
							6							
							7							

JKEnvironments

ENVIRONMENTAL LOG

Log No. 215 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 29.01m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK308 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION							0			FILL: Silty sand, fine to coarse grained, brown, trace of sandstone gravel.	M			GRASS COVER NO FCF 0.1 9.0kg BUCKET NO FCF
						N = 2 2,1,1				FILL: Silty sand, fine to coarse grained, light brown, trace of ironstone and sandstone gravel.	w<PL			2.5kg BUCKET NO FCF
							1			FILL: Silty clay, low to medium plasticity, red brown, trace of ironstone and igneous gravel and ash.				10.6kG BUCKET NO FCF
						N = 3 2,1,2	2							10.3KG BUCKET NO FCF
						N = 6 2,2,4	3		SM	Silty SAND: fine to coarse grained, grey.	D			ALLUVIAL
										END OF BOREHOLE AT 3.15m				
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 216 **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 28.31m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK308 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION			■		■		0			FILL: Silty sand, fine to medium grained, brown, trace of sandstone and igneous gravel.	M			GRASS COVER NO FCF 0.1m 9.6kg BUCKET NO FCF
					■	N = 3 2,1,2				FILL: Silty sand, fine to coarse grained, light brown, trace of sandstone gravel and asphalt.	w>PL			2.6kg BUCKET NO FCF
					■		1			FILL: Silty clay, low to medium plasticity, red brown, trace of ironstone, sandstone and igneous gravel, ash and slag.				10.1kg BUCKET NO FCF
			■		■	N = 11 6,5,6	2							
										FILL: Clayey sand, fine to coarse grained, brown, trace of ironstone gravel and ash.	M			12.1kG BUCKET NO FCF 5.2kg BUCKET NO FCF
					■	N = 8 3,4,4	3		SM	Silty SAND: fine to coarse grained, grey.	D			ALLUVIAL
										END OF BOREHOLE AT 3.2m				
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 217 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 29.0m

Date: 23/8/19 **Datum:** AHD

Plant Type: JK205 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION	■		■		■		0			FILL: Silty sand, fine to coarse grained, brown, trace of sandstone gravel.	M			GRASS COVER NO FCF 0.1m 10.4kg BUCKET NO FCF
	■		■		■	N = 4 2,2,2				FILL: Silty sand, fine to coarse grained, grey, trace of sandstone gravel, clay fines and ash.	w>PL			3.8kg BUCKET NO FCF
	■		■		■		1			FILL: Silty clay, low to medium plasticity, red brown, trace of ironstone, sandstone and igneous gravel and ash.				7.8kg BUCKET NO FCF
						N > 3 3 REFUSAL				END OF BOREHOLE AT 1.50m				REFUSAL ON INFERRED CONCRET
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 218 **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 29.32m

Date: 23/8/19 **Datum:** AHD

Plant Type: JK205 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION						N = 10 4,4,6	0			FILL: Silty sand, fine to coarse grained, brown, trace of sandstone gravel and asphalt.	D			GRASS COVER NO FCF 0.1m 10.3kG BUCKET
											w>PL			
							1			FILL: Silty clay, low to medium plasticity, red brown, trace of ironstone, sandstone and igneous gravel, slag and ash.				NO FCF 9.2kg BUCKET NO FCF
						N = 16 5,8,8				FILL: Silty clay, low to medium plasticity, brown and grey, with fine to coarse grained, sand, trace of ironstone and sandstone gravel.				3.0kg BUCKET NO FCF
							2		SM	Silty SAND: fine to coarse grained, light brown.	M			ALLUVIAL
							3			END OF B0REHOLE AT 3.0m				
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 219 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 28.76m

Date: 22/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION	■		■		■		0			FILL: Silty sand, fine to coarse grained, brown, trace of igneous gravel, asphalt and brick fragments.	M			GRASS COVER NO FCF 0.1m 10.8kg BUCKET NO FCF
	■		■		■	N = 14 7,6,8				FILL: Clayey sand, fine to coarse grained, brown, trace of ironstone and igneous gravel, concrete and brick fragments.				11.8kg BUCKET NO FCF
	■		■				1							
	■		■			N = 8 5,5,3			SM	Silty SAND: fine to coarse grained, light grey.	D			ALLUVIAL
							2			END OF BOREHOLE AT 1.95m				
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 220 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 29.41m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK308 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION			■		■		0			FILL: Sandy silt, low to medium plasticity, brown, fine to medium grained sand, with organic material.	w<PL			MULCH COVER NO FCF 0.1m 5.8kg BUCKET NO FCF 2.4kg BUCKET NO FCF
			■		■					FILL: Clayey sand, fine to coarse grained, light brown, trace of igneous and sandstone gravel.	M			
						N = 11 4,5,6			SM	Silty SAND: fine to coarse grained, light grey.	D			ALLUVIAL
						N = 19 7,8,11	1		-	Silty clayey SAND: fine to coarse grained, brown.	D			
							2			END OF BOREHOLE AT 1.95m				
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 221 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 29.49m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK308 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■		■		■		0			FILL: Sandy silt, low to medium plasticity, brown, fine to medium grained sand, with organic material.	w<PL			MULCH COVER NO FCF 0.1m 4.2kg BUCKET NO FCF 6.7kg BUCKET NO FCF
	■		■		■	N = 7 4,4,3				FILL: Silty sandy clay, low to medium plasticity, light brown, trace of ironstone and sandstone gravel.				
	■		■				1		SM	Silty SAND: fine to coarse grained, light grey.	D			ALLUVIAL
										END OF BOREHOLE AT 1.5m				
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 222 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 29.47m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK308 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION						N = 10 6,5,5	0			FILL: Silty sand, fine to coarse grained, brown, trace of ironstone and igneous gravel and root fibres.	M			GRASS COVER NO FCF 0.1m 11.3kg BUCKET NO FCF 10.9kg BUCKET NO FCF
										FILL: Clayey sand, fine to medium grained, light brown, trace of ironstone gravel and ash.				
							1		SM	Silty SAND: fine to coarse grained, light grey.	D			ALLUVIAL
										END OF BOREHOLE AT 1.5m				
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 223 **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 29.29m

Date: 21/8/19 **Datum:** AHD

Plant Type: JK308 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION	■		■		■		0			FILL: Silty sand, fine to medium grained, brown, trace of ironstone and igneous gravel.	M			GRASS COVER 8.5kg BUCKET NO FCF 11.3kg BUCKET NO FCF
	■		■		■	N = 7 3,3,4				FILL: Silty sand, fine to coarse grained, grey, trace of sandstone gravel, glass and ash.				
					■		1							
	■		■			N = 4 2,2,2			SM	Silty SAND: fine to coarse grained, light grey.	M			ALLUVIAL
							2			END OF BOREHOLE AT 1.95m				
							3							
							4							
							5							
							6							
							7							

JKEnvironments

ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No. 224 **1/1**

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 28.29m

Date: 22/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■		■		■		0			FILL: Silty sand, fine to coarse grained, grey, trace of concrete fragments and root fibres.	D			GRASS COVER NO FCF 0.1m 9.8kg BUCKET
										END OF BOREHOLE AT 0.2m				REFUSAL ON INFERRRED CONCRETE
							1							
							2							
							3							
							4							
							5							
							6							
							7							

JKEnvironments

ENVIRONMENTAL LOG

Log No. 225 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 28.12m

Date: 22/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION			■		■	N > 2 6,2,0/ 50mm REFUSAL	0		-	ASPHALTIC CONCRETE: 30mm.t FILL: Silty sand, fine to coarse grained, brown, trace of ironstone and igneous gravel and ash.	M			11.2kg BUCKET NO FCF
							1			END OF BOREHOLE AT 0.8m				REFUSAL ON INFERRED CONCRETE
							2							
							3							
							4							
							5							
							6							
							7							

JKEnvironments

ENVIRONMENTAL LOG

Log No. 226 **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 28.10m

Date: 22/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION			■		■		0			FILL: Sandy silt, low to medium plasticity, brown with organic material, trace of igneous gravel and slag.	w<PL			MULCH COVER NO FCF 0.1m 5.5kg BUCKET NO FCF
						N = 9 4,5,4			SM	Silty SAND: fine to coarse grained, light grey.	D			ALLUVIAL
							1							
										END OF BOREHOLE AT 1.5m				
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 227 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 28.44m

Date: 22/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION	■		■		■		0			FILL: Sandy clay, low to medium plasticity, brown with organic material.	w<PL			MULCH COVER 5.5kg BUCKET NO FCF
	■		■			N = 9 6,4,5			SM	Silty SAND: fine to coarse grained, light grey.	D			ALLUVIAL
							1			END OF BOREHOLE AT 1.0m				
							2							
							3							
							4							
							5							
							6							
							7							

JKEnvironments

ENVIRONMENTAL LOG

Log No. 228 **1/2**

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 28.01m

Date: 22/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
							0			FILL: Sandy silt, low to medium plasticity, brown, with organic material.	w<PL			MULCH COVER NO FCF 0.1m
						N = 10 5,4,6			SM	Silty SAND: fine to coarse grained, light grey.	D			5.7kg BUCKET NO FCF ALLUVIAL
						N = 10 7,5,5,	1			Silty SAND: fine to coarse grained, brown, trace of clay fines.				
						N = 17 10,9,8	2		SC	Clayey SAND: fine to coarse grained, orange brown.	D			
						N = 11 4,6,5	3		CL-CI	Sandy CLAY: low to medium plasticity, orange brown, fine to coarse grained sand.	w<PL			
						N = 33 8,15,18	4		CI-CH	Sandy CLAY: medium to high plasticity, red brown mottled grey, with ironstone bands.	w<PL			
							5							
							6							
							7							

JKEnvironments

ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No. 228 **2/2**

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 28.01m

Date: 22/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
									CI-CH	Sandy CLAY: medium to high plasticity, red brown mottled grey, with ironstone bands.	w<PL			
						N = 14 6,8,6	8		SC	Clayey SAND: fine to coarse grained, yellow brown mottled grey with ironstone bands.	M			
▼ ON 4/9/19							9		CI-CH	Sandy CLAY: medium to high plasticity, red brown mottled grey with ironstone bands.	w<PL			
▶							10							
							11							
▼ ON COMPLETION							12			END OF BOREHOLE AT 12.0m				Groundwater monitoring well installed to 12.0m. Class 18 machine slotted 50mm dia. PVC standpipe 12.0m to 6.0m. Casing 6.0m to 0.0m. 2mm sand filter pack 12.0m to 2.8m. Bentonite seal 2.8m to 1.3m. Backfilled with sand to the surface. Completed with concreted gatic cover.
							13							
							14							

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ENVIRONMENTAL LOG

Log No. 229 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** HAND TOOLS **R.L. Surface:** ≈ 26.07m

Date: 26/8/19 **Datum:** AHD

Plant Type: N/A **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■		■		■		0			FILL: Sandy silt, low to medium plasticity, brown, with organic material, trace of igneous gravel and root fibres.	w<PL			MULCH COVER NO FCF 0.1m 5.0kg BUCKET NO FCF 2.0kg BUCKET NO FCF 2.5kg BUCKET NO FCF
											w<PL			
	■		■		■					FILL: Sandy clay, low to medium plasticity, red brown, fine to medium grained sand, trace of ironstone and igneous gravel.				
							1			FILL: Sandy clay, low to medium plasticity, grey, fine to medium grained sand, trace of ash.	M			NOT ENOUGH SAMPLE FOR BUCKET
	■		■						SC		M			
										FILL: Clayey sand, fine to medium grained, brown, trace of ash.				ALLUVIAL
										Clayey SAND: fine to coarse grained, brown.				
							2			END OF BOREHOLE AT 1.8m				
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No. 230 **1/1**

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** HAND TOOLS **R.L. Surface:** ≈ 25.73m

Date: 23/8/19 **Datum:** AHD

Plant Type: N/A **Logged/Checked by:** S.W./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION			■		■		0			FILL: Silty sand, fine to coarse grained, brown, trace of igneous gravel, glass and root fibres.	D M			GRASS COVER NO FCF 0.1m 11.9kg BUCKET NO FCF NOT ENOUGH SAMPLE FOR BUCKET
										FILL: Silty clayey sand, fine to coarse grained, brown, trace of ironstone and igneous gravel, concrete fragments and ash.				
							1			END OF BOREHOEL AT 0.4m				HAND TOOL REFUSAL
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No. 231 **1/1**

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** HAND TOOLS **R.L. Surface:** ≈ 26.08m

Date: 26/8/19 **Datum:** AHD

Plant Type: N/A **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION			■		■		0			FILL: Sandy silt, low to medium plasticity, brown, with organic material, trace of igneous gravel and glass.	w<PL			MULCH COVER NO FCF 0.1m 4.8kg BUCKET NO FCF
										END OF BOREHOLE AT 0.3m				HAND TOOL REFUSAL
							1							
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 232 **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** HAND TOOLS **R.L. Surface:** ≈ 25.73m

Date: 23/8/19 **Datum:** AHD

Plant Type: N/A **Logged/Checked by:** S.W./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■		■		■		0			FILL: Silty sand, fine to coarse grained, dark brown, trace of brick fragments and root fibres.	D			GRASS COVER NO FCF 0.1m 10.4kg BUCKET NO FCF
											M			
										FILL: Silty clayey sand, fine to coarse grained, brown, trace of igneous and ironstone gravel.	w<PL			NOT ENOUGH SAMPLE FOR BUCKET NO FCF
											w<PL			
							1		SC	FILL: Sandy clay, low to medium plasticity, grey brown, trace of ironstone and igneous gravel and ash.	M			ALLUVIAL
										FILL: Sandy clay, low to medium plasticity, grey, trace of ironstone gravel.				
										Clayey SAND: fine to coarse grained, brown.				
							2			as above, but light brown.				
										END OF BOREHOLE AT 1.4m				
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 233 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** HAND TOOLS **R.L. Surface:** ≈ 25.66m

Date: 26/8/19 **Datum:** AHD

Plant Type: N/A **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■		■		■		0			FILL: Sandy silt, low to medium plasticity, brown, with organic material, trace of igneous gravel.	w<PL			MULCH COVER NO FCF 0.1m 5.3kg BUCKET
	■		■						SM	FILL: Clayey sand, fine to coarse grained, brown, trace of sandstone gravel and ash.	M D			NO FCF NOT ENOUGH SAMPLE FOR BUCKET
							1			Silty SAND: fine to coarse grained, light grey.				ALLUVIAL
										as above, but light brown.				
										END OF BOREHOLE AT 0.9m				
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 234 **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** HAND TOOLS **R.L. Surface:** ≈ 25.46m

Date: 23/8/19 **Datum:** AHD

Plant Type: N/A **Logged/Checked by:** S.W./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION			■		■		0			FILL: Silty sand, fine to coarse grained, brown, trace of igneous gravel, brick fragments and root fibres.	D			GRASS COVER NO FCF 0.1m
			■							FILL: Silty clayey sand, fine to coarse grained, brown, trace of igneous gravel.	M			12.4kg BUCKET NO FCF
			■							FILL: Clayey sand, fine to coarse grained, grey brown, trace of igneous and ironstone gravel and ash.				NOT ENOUGH SAMPLE FOR BUCKET
			■				1		SC		M			NO FCF ALLUVIAL
										FILL: Silty clayey sand, fine to coarse grained, grey, trace of ironstone gravel and ash.				
										Clayey SAND: fine to coarse grained, orange brown, trace of ironstone gravel.				
							2			END OF BOREHOLE AT 1.6m				
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No. 235 **1/1**

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** HAND TOOLS **R.L. Surface:** ≈ 26.52m

Date: 26/8/19 **Datum:** AHD

Plant Type: AHD **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION			■		■		0			FILL: Sandy silt, low to medium plasticity, brown, with organic material, trace of igneous gravel.	w<PL			MULCH COVER NO FCF 0.1m 6.3kg BUCKET NO FCF
										FILL: Sandy clay, low to medium plasticity, brown and red brown, with ironstone gravel.				NOT ENOUGH SAMPLE FOR BUCKET
							1			END OF BOREHOLE AT 0.3m				HAND TOOL REFUSAL
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 236 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 25.46m

Date: 22/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION	■		■		■		0			FILL: Silty sand, fine to coarse grained, brown, trace of igneous, ironstone and sandstone gravel.	D			GRASS COVER NO FCF 0.1m 11.7kg BUCKET NO FCF 10.0kg BUCKET NO FCF
						N = 13 6,8,5				FILL: Silty sand, fine to coarse grained, grey brown, trace of sandstone and ironstone gravel, brick fragments and ash.	M			
	■		■				1		SM	Silty SAND: fine to coarse grained, brown.	M			ALLUVIAL
						N = 8 3,4,4			CL-CI	Sandy CLAY: low to medium plasticity, orange brown, fine to coarse grained sand.	w>PL			
							2			END OF BOREHOLE AT 1.95m				
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 237 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 25.33m

Date: 22/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■		■		■		0			FILL: Silty sand, fine to coarse grained, brown and red brown, trace of ironstone gravel and organic material.	D			MULCH COVER NO FCF 0.1m
	■		■			N = 11 5,5,6			SM	Silty SAND: fine to coarse grained, light grey.	D			8.5kg BUCKET NO FCF ALLUVIAL
							1			as above, but brown.				
										END OF BOREHOLE AT 0.95m				
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 238 **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 25.30m

Date: 22/8/19 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION			■		■		0			FILL: Silty sand, fine to coarse grained, brown, trace of igneous gravel, concrete and root fibres.	D			MULCH COVER NO FCF 0.1m 10.1kg BUCKET NO FCF
						N = 8 4,4,4			SM	Silty SAND: fine to coarse grained, light brown.	D			ALLUVIAL
							1			END OF BOREHOLE AT 0.95m				
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 239 1/1

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** HAND TOOLS **R.L. Surface:** ≈ 25.03m

Date: 26/8/19 **Datum:** AHD

Plant Type: N/A **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION							0			FILL: Clayey sand, fine to medium grained, brown, trace of igneous and sandstone gravel, brick and ash.	D			MULCH COVER NO FCF 0.1m 6.5kg BUCKET NO FCF
							1			FILL: Silty sand, fine to coarse grained, grey.				POSSIBLY NATURAL
										FILL: Silty sand, fine to coarse grained, brown, trace of slag.				NOT ENOUGH SAMPLE FOR BUCKET NO FCF
									SM	Silty SAND: fine to coarse grained, light brown.	D			ALLUVIAL
							2			END OF BOREHOLE AT 1.8m				
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No. 240 **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: URBIS PTY LTD

Project: PROPOSED BROOKVALE OVAL DEVELOPMENT

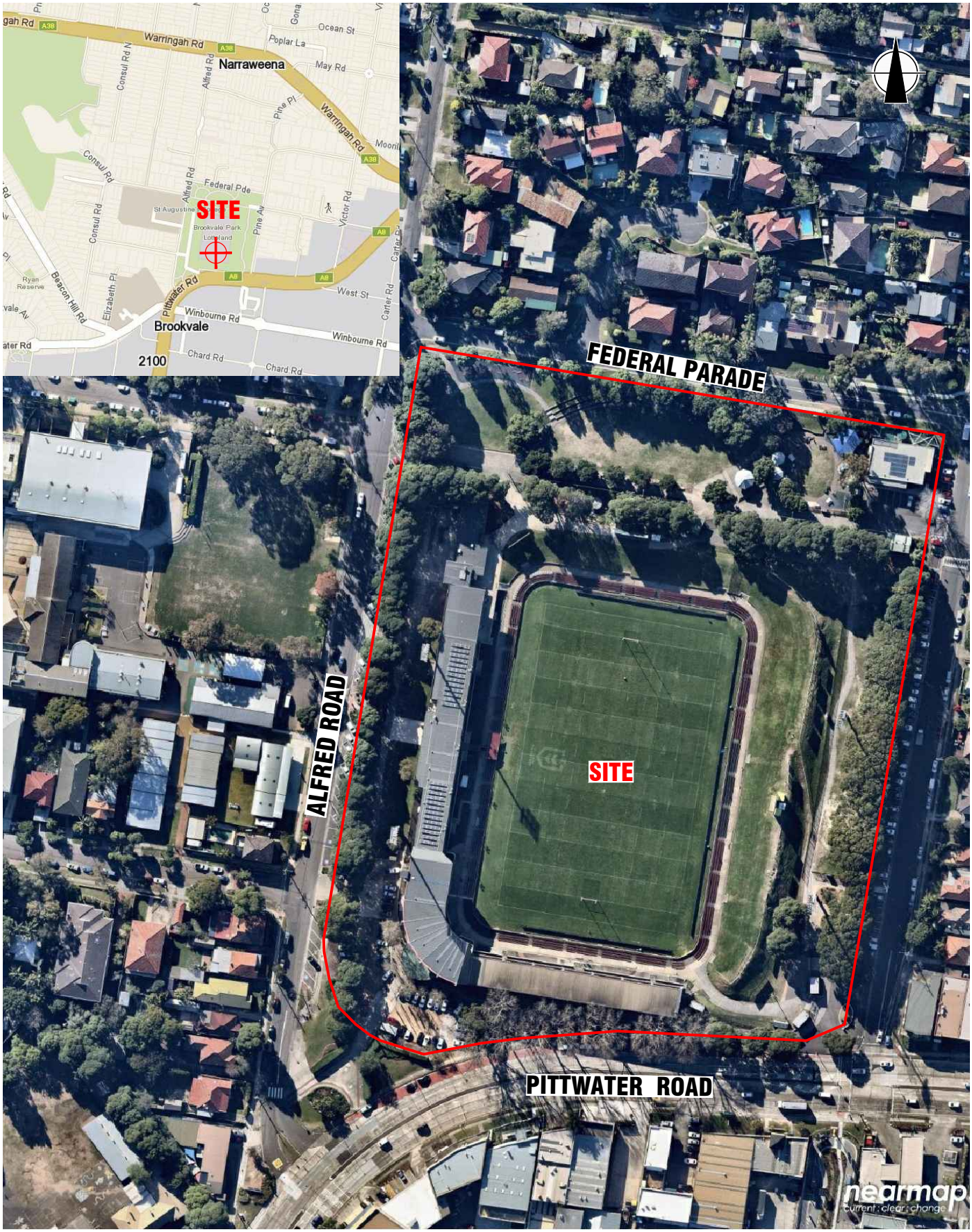
Location: BROOKVALE OVAL, PITTWATER ROAD, BROOKVALE, NSW

Job No.: E32596BD **Method:** HAND TOOLS **R.L. Surface:** ≈ 25.11m

Date: 26/8/19 **Datum:** AHD

Plant Type: N/A **Logged/Checked by:** A.M./M.D.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE-TION	■		■		■		0			FILL: Clayey sand, fine to coarse grained, brown, trace of igneous, ironstone and sandstone gravel, brick, concrete fragments and ash.	M			NO FCF 0.1m 14.3kg BUCKET NO FCF
	■		■						SM	Silty SAND: fine to coarse grained, light brown.	M			ALLUVIAL
							1			END OF BOREHOLE AT 1.0m				
							2							
							3							
							4							
							5							
							6							
							7							



0 20 40 60 80 100

SCALE 1:2000 @A4 METRES

This plan should be read in conjunction with the JK Geotechnics report.

Title: **SITE LOCATION PLAN**

Location: BROOKVALE OVAL, PITTWATER ROAD
BROOKVALE, NSW

Report No: 32596YJ

Figure: 1

JKGeotechnics

PROPOSED CENTRE OF EXCELLENCE AND GRANDSTAND

PROPOSED ENTRY

RAINWATER TANKS AND POOL PLANT

PROPOSED TUNNEL AND LIFT

PROPOSED BALANCE TANKS

PROPOSED ENTRY

PROPOSED CARPARK

BH201 BH202 BH203 BH204 BH205 BH206 BH207 BH208 BH209 BH210 BH211 BH212 BH213 BH214 BH215 BH216 BH217 BH218 BH219 BH220 BH221 BH222 BH223 BH224 BH225 BH226 BH227 BH228 BH229 BH230 BH231 BH232 BH233 BH234 BH235 BH236 BH237 BH238 BH239 BH240

1 2 3 4 5

101 102 103 104 105 106 107 108

301 302 303 304 305 306

1 T0 5 CPT LOCATION 16 JUNE 2011 GEOTECHNICAL INVESTIGATION.

101 TO 108 CPT LOCATION 24 JUNE 2011 GEOTECHNICAL INVESTIGATION.

305 AND 306 BOREHOLE LOCATION 21 AUGUST 2019 GEOTECHNICAL INVESTIGATION.

301 TO 304 CPT LOCATION 19 AUGUST GEOTECHNICAL INVESTIGATION.

201 TO 240 BOREHOLE LOCATION 19 AUGUST ENVIRONMENTAL INVESTIGATION.

REFERENCE: HASSELL DRAWING No A_1000, REV D, DATED 13/09/2019.

0 10 20 30 40 50

SCALE 1:1000 @A3 METRES

This plan should be read in conjunction with the JK Geotechnics report.

Title: **INVESTIGATION LOCATION PLAN**

Location: BROOKVALE OVAL, PITTWATER ROAD BROOKVALE, NSW

Report No: 32596YJ

Figure: 2

JKGeotechnics

REPORT EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726:2017 *'Geotechnical Site Investigations'*. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached soil classification table qualified by the grading of other particles present (eg. sandy clay) as set out below:

Soil Classification	Particle Size
Clay	< 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2.36mm
Gravel	2.36 to 63mm
Cobbles	63 to 200mm
Boulders	> 200mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose (VL)	< 4
Loose (L)	4 to 10
Medium dense (MD)	10 to 30
Dense (D)	30 to 50
Very Dense (VD)	> 50

Cohesive soils are classified on the basis of strength (consistency) either by use of a hand penetrometer, vane shear, laboratory testing and/or tactile engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength (kPa)	Indicative Undrained Shear Strength (kPa)
Very Soft (VS)	≤ 25	≤ 12
Soft (S)	> 25 and ≤ 50	> 12 and ≤ 25
Firm (F)	> 50 and ≤ 100	> 25 and ≤ 50
Stiff (St)	> 100 and ≤ 200	> 50 and ≤ 100
Very Stiff (VSt)	> 200 and ≤ 400	> 100 and ≤ 200
Hard (Hd)	> 400	> 200
Friable (Fr)	Strength not attainable – soil crumbles	

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'shale' is used to describe fissile mudstone, with a weakness parallel to bedding. Rocks with alternating inter-laminations of different grain size (eg. siltstone/claystone and siltstone/fine grained sandstone) is referred to as 'laminite'.

SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shrink-swell behaviour, strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All methods except test pits, hand auger drilling and portable Dynamic Cone Penetrometers require the use of a mechanical rig which is commonly mounted on a truck chassis or track base.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils and 'weaker' bedrock if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for a large excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Refusal of the hand auger can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of limited reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock cuttings. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be assessed from the cuttings, together with some information from "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, NMLC or HQ triple tube core barrels, which give a core of about 50mm and 61mm diameter, respectively, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as NO CORE. The location of NO CORE recovery is determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the bottom of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils, as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289.6.3.1–2004 (R2016) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – Standard Penetration Test (SPT)'*.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63.5kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm 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 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as

  N > 30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

A modification to the SPT is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as 'N_c' on the borehole logs, together with the number of blows per 150mm penetration.

Cone Penetrometer Testing (CPT) and Interpretation: The cone penetrometer is sometimes referred to as a Dutch Cone. The test is described in Australian Standard 1289.6.5.1–1999 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Static Cone Penetration Resistance of a Soil – Field Test using a Mechanical and Electrical Cone or Friction-Cone Penetrometer'*.

In the tests, a 35mm or 44mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm or 165mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck. The CPT does not provide soil sample recovery.

As penetration occurs (at a rate of approximately 20mm per second), the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa. There are two scales presented for the cone resistance. The lower scale has a range of 0 to 5MPa and the main scale has a range of 0 to 50MPa. For cone resistance values less than 5MPa, the plot will appear on both scales.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

  The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between CPT and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of CPT values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

There are limitations when using the CPT in that it may not penetrate obstructions within any fill, thick layers of hard clay and very dense sand, gravel and weathered bedrock. Normally a 'dummy' cone is pushed through fill to protect the equipment. No information is recorded by the 'dummy' probe.

Flat Dilatometer Test: The flat dilatometer (DMT), also known as the Marchetti Dilometer comprises a stainless steel blade having a flat, circular steel membrane mounted flush on one side.

The blade is connected to a control unit at ground surface by a pneumatic-electrical tube running through the insertion rods. A gas tank, connected to the control unit by a pneumatic cable, supplies the gas pressure required to expand the membrane. The control unit is equipped with a pressure regulator, pressure gauges, an audio-visual signal and vent valves.

The blade is advanced into the ground using our CPT rig or one of our drilling rigs, and can be driven into the ground using an SPT hammer. As soon as the blade is in place, the membrane is inflated, and the pressure required to lift the membrane (approximately 0.1mm) is recorded. The pressure then required to lift the centre of the membrane by an additional 1mm is recorded. The membrane is then deflated before pushing to the next depth increment, usually 200mm down. The pressure readings are corrected for membrane stiffness.

The DMT is used to measure material index (I_D), horizontal stress index (K_D), and dilatometer modulus (E_D). Using established correlations, the DMT results can also be used to assess the 'at rest' earth pressure coefficient (K_o), over-consolidation ratio (OCR), undrained shear strength (C_u), friction angle (ϕ), coefficient of consolidation (C_h), coefficient of permeability (K_h), unit weight (γ), and vertical drained constrained modulus (M).

The seismic dilatometer (SDMT) is the combination of the DMT with an add-on seismic module for the measurement of shear wave velocity (V_s). Using established correlations, the SDMT results can also be used to assess the small strain modulus (G_o).

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a 16mm diameter rod with a 20mm diameter cone end with a 9kg hammer dropping 510mm. The test is described in Australian Standard 1289.6.3.2–1997 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – 9kg Dynamic Cone Penetrometer Test'*.

The results are used to assess the relative compaction of fill, the relative density of granular soils, and the strength of cohesive soils. Using established correlations, the DCP test results can also be used to assess California Bearing Ratio (CBR).

Refusal of the DCP can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Vane Shear Test: The vane shear test is used to measure the undrained shear strength (C_u) of typically very soft to firm fine grained cohesive soils. The vane shear is normally performed in the bottom of a borehole, but can be completed from surface level, the bottom and sides of test pits, and on recovered undisturbed tube samples (when using a hand vane).

The vane comprises four rectangular blades arranged in the form of a cross on the end of a thin rod, which is coupled to the bottom of a drill rod string when used in a borehole. The size of the vane is dependent on the strength of the fine grained cohesive soils; that is, larger vanes are normally used for very low strength soils. For borehole testing, the size of the vane can be limited by the size of the casing that is used.

For testing inside a borehole, a device is used at the top of the casing, which suspends the vane and rods so that they do not sink under self-weight into the 'soft' soils beyond the depth at which the test is to be carried out. A calibrated torque head is used to rotate the rods and vane and to measure the resistance of the vane to rotation.

With the vane in position, torque is applied to cause rotation of the vane at a constant rate. A rate of 6° per minute is the common rotation rate. Rotation is continued until the soil is sheared and the maximum torque has been recorded. This value is then used to calculate the undrained shear strength. The vane is then rotated rapidly a number of times and the operation repeated until a constant torque reading is obtained. This torque value is used to calculate the remoulded shear strength. Where appropriate, friction on the vane rods is measured and taken into account in the shear strength calculation.

LOGS

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

The terms and symbols used in preparation of the logs are defined in the following pages.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than 'straight line' variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

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

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it 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 and may not be the same at the time of construction.
- 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 be washed out of the hole or 'reverted' chemically if reliable water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after the groundwater level has stabilised at intervals ranging from several days to 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 perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg. bricks, steel, etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably assess the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soils for Engineering Purposes'* or appropriate NSW Government Roads & Maritime Services (RMS) test methods. Details of the test procedure used are given on the individual report forms.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

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

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.
- Details of the development that the Company could not reasonably be expected to anticipate.

If these occur, the Company will be pleased to assist with investigation or advice to resolve any problems occurring.

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, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Where information obtained from this investigation 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. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Copyright in all documents (such as drawings, borehole or test pit logs, reports and specifications) provided by the Company shall remain the property of Jeffery and Katauskas Pty Ltd. Subject to the payment of all fees due, the Client alone shall have a licence to use the documents provided for the sole purpose of completing the project to which they relate. Licence to use the documents may be revoked without notice if the Client is in breach of any obligation to make a payment to us.

REVIEW OF DESIGN

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/constraints are quite complex, it is prudent to have a joint design review which involves an experienced geotechnical engineer/engineering geologist.

SITE INSPECTION

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types and appropriate footing or pile founding depths, or

iii) full time engineering presence on site.

SYMBOL LEGENDS

SOIL


FILL


TOPSOIL


CLAY (CL, CI, CH)


SILT (ML, MH)


SAND (SP, SW)


GRAVEL (GP, GW)


SANDY CLAY (CL, CI, CH)


SILTY CLAY (CL, CI, CH)


CLAYEY SAND (SC)


SILTY SAND (SM)


GRAVELLY CLAY (CL, CI, CH)


CLAYEY GRAVEL (GC)


SANDY SILT (ML, MH)


PEAT AND HIGHLY ORGANIC SOILS (Pt)

ROCK


CONGLOMERATE


SANDSTONE


SHALE/MUDSTONE


SILTSTONE


CLAYSTONE


COAL


LAMINITE


LIMESTONE


PHYLLITE, SCHIST


TUFF


GRANITE, GABBRO


DOLERITE, DIORITE


BASALT, ANDESITE


QUARTZITE

OTHER MATERIALS


BRICKS OR PAVERS


CONCRETE


ASPHALTIC CONCRETE

CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

Major Divisions		Group Symbol	Typical Names	Field Classification of Sand and Gravel	Laboratory Classification	
Coarse grained soil (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 4$ $1 < C_c < 3$
		GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	Fines behave as silt
		GC	Gravel-clay mixtures and gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	Fines behave as clay
	SAND (more than half of coarse fraction is smaller than 2.36mm)	SW	Sand and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 6$ $1 < C_c < 3$
		SP	Sand and gravel-sand mixtures, little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		SM	Sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	N/A
		SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	

Major Divisions		Group Symbol	Typical Names	Field Classification of Silt and Clay			Laboratory Classification
				Dry Strength	Dilatancy	Toughness	% < 0.075mm
Fine grained soils (more than 35% of soil excluding oversize fraction is less than 0.075mm)	SILT and CLAY (low to medium plasticity)	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity	None to low	Slow to rapid	Low	Below A line
		CL, CI	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay	Medium to high	None to slow	Medium	Above A line
		OL	Organic silt	Low to medium	Slow	Low	Below A line
	SILT and CLAY (high plasticity)	MH	Inorganic silt	Low to medium	None to slow	Low to medium	Below A line
		CH	Inorganic clay of high plasticity	High to very high	None	High	Above A line
		OH	Organic clay of medium to high plasticity, organic silt	Medium to high	None to very slow	Low to medium	Below A line
	Highly organic soil	Pt	Peat, highly organic soil	–	–	–	–

Laboratory Classification Criteria

A well graded coarse grained soil is one for which the coefficient of uniformity $Cu > 4$ and the coefficient of curvature $1 < C_c < 3$. Otherwise, the soil is poorly graded. These coefficients are given by:

$$C_U = \frac{D_{60}}{D_{10}} \qquad and \qquad C_C = \frac{(D_{30})^2}{D_{10}\, D_{60}}$$

Where D_{10}, D_{30} and D_{60} are those grain sizes for which 10%, 30% and 60% of the soil grains, respectively, are smaller.

NOTES:

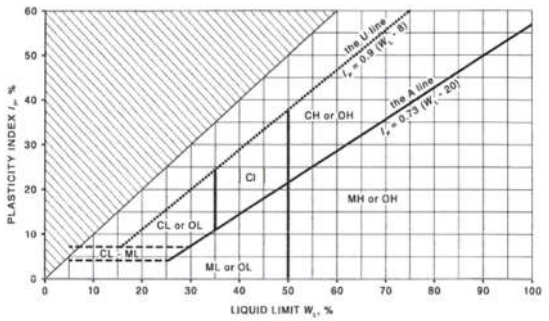
1 For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.

2 Where the grading is determined from laboratory tests, it is defined by coefficients of curvature (C_c) and uniformity (C_u) derived from the particle size distribution curve.

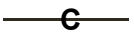
3 Clay soils with liquid limits > 35% and ≤ 50% may be classified as being of medium plasticity.

4 The U line on the Modified Casagrande Chart is an approximate upper bound for most natural soils.

Modified Casagrande Chart for Classifying Silts and Clays according to their Behaviour



LOG SYMBOLS

Log Column	Symbol	Definition
Groundwater Record		Standing water level. Time delay following completion of drilling/excavation may be shown.
		Extent of borehole/test pit collapse shortly after drilling/excavation.
		Groundwater seepage into borehole or test pit noted during drilling or excavation.
Samples	ES	Sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
	ASB	Soil sample taken over depth indicated, for asbestos analysis.
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.
	SAL	Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'Refusal' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60° solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of undrained shear strength.
	PID = 100	Photoionisation detector reading in ppm (soil sample headspace test).
Moisture Condition (Fine Grained Soils)	w > PL	Moisture content estimated to be greater than plastic limit.
	$w \approx$ PL	Moisture content estimated to be approximately equal to plastic limit.
	w < PL	Moisture content estimated to be less than plastic limit.
	$w \approx$ LL	Moisture content estimated to be near liquid limit.
	w > LL	Moisture content estimated to be wet of liquid limit.
(Coarse Grained Soils)	D	DRY – runs freely through fingers.
	M	MOIST – does not run freely but no free water visible on soil surface.
	W	WET – free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT – unconfined compressive strength ≤ 25kPa.
	S	SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa.
	F	FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa.
	St	STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa.
	VSt	VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa.
	Hd	HARD – unconfined compressive strength > 400kPa.
	Fr	FRIABLE – strength not attainable, soil crumbles.
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other assessment.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (I_D) Range (%)** / **SPT 'N' Value Range (Blows/300mm)**
	VL	VERY LOOSE – ≤ 15 – 0 – 4
	L	LOOSE – > 15 and ≤ 35 – 4 – 10
	MD	MEDIUM DENSE – > 35 and ≤ 65 – 10 – 30
	D	DENSE – > 65 and ≤ 85 – 30 – 50
	VD	VERY DENSE – > 85 – > 50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other assessment.
Hand Penetrometer Readings	300 250	Measures reading in kPa of unconfined compressive strength. Numbers indicate individual test results on representative undisturbed material unless noted otherwise.

Log Column	Symbol	Definition
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Twin pronged tungsten carbide bit.
	T_{60}	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.
	Soil Origin	The geological origin of the soil can generally be described as: RESIDUAL – soil formed directly from insitu weathering of the underlying rock. No visible structure or fabric of the parent rock. EXTREMELY WEATHERED – soil formed directly from insitu weathering of the underlying rock. Material is of soil strength but retains the structure and/or fabric of the parent rock. ALLUVIAL – soil deposited by creeks and rivers. ESTUARINE – soil deposited in coastal estuaries, including sediments caused by inflowing creeks and rivers, and tidal currents. MARINE – soil deposited in a marine environment. AEOLIAN – soil carried and deposited by wind. COLLUVIAL – soil and rock debris transported downslope by gravity, with or without the assistance of flowing water. Colluvium is usually a thick deposit formed from a landslide. The description 'slopewash' is used for thinner surficial deposits. LITTORAL – beach deposited soil.

Classification of Material Weathering

Term		Abbreviation		Definition
Residual Soil		RS		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely Weathered		XW		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.
Highly Weathered	Distinctly Weathered (Note 1)	HW	DW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately Weathered		MW		The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly Weathered		SW		Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh		FR		Rock shows no sign of decomposition of individual minerals or colour changes.

NOTE 1: The term 'Distinctly Weathered' is used where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock. 'Distinctly Weathered' is defined as follows: *'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores'*. There is some change in rock strength.

Rock Material Strength Classification

Term	Abbreviation	Uniaxial Compressive Strength (MPa)	Guide to Strength	
			Point Load Strength Index $Is_{(50)}$ (MPa)	Field Assessment
Very Low Strength	VL	0.6 to 2	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low Strength	L	2 to 6	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium Strength	M	6 to 20	0.3 to 1	Scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High Strength	H	20 to 60	1 to 3	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High Strength	VH	60 to 200	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High Strength	EH	> 200	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Abbreviations Used in Defect Description

Cored Borehole Log Column		Symbol Abbreviation	Description
Point Load Strength Index		• 0.6	Axial point load strength index test result (MPa)
		x 0.6	Diametral point load strength index test result (MPa)
Defect Details	– Type	Be	Parting – bedding or cleavage
		CS	Clay seam
		Cr	Crushed/sheared seam or zone
		J	Joint
		Jh	Healed joint
		Ji	Incipient joint
		XWS	Extremely weathered seam
	– Orientation	Degrees	Defect orientation is measured relative to normal to the core axis (ie. relative to the horizontal for a vertical borehole)
	– Shape	P	Planar
		C	Curved
		Un	Undulating
		St	Stepped
		Ir	Irregular
	– Roughness	Vr	Very rough
		R	Rough
		S	Smooth
		Po	Polished
		Sl	Slickensided
	– Infill Material	Ca	Calcite
		Cb	Carbonaceous
		Clay	Clay
		Fe	Iron
		Qz	Quartz
		Py	Pyrite
	– Coatings	Cn	Clean
		Sn	Stained – no visible coating, surface is discoloured
		Vn	Veneer – visible, too thin to measure, may be patchy
		Ct	Coating ≤ 1mm thick
		Filled	Coating > 1mm thick
	– Thickness	mm.t	Defect thickness measured in millimetres

APPENDIX A

PREVIOUS CPT LOGS BY JK GEOTECHNICS 1 TO 5 AND 101 TO 108

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

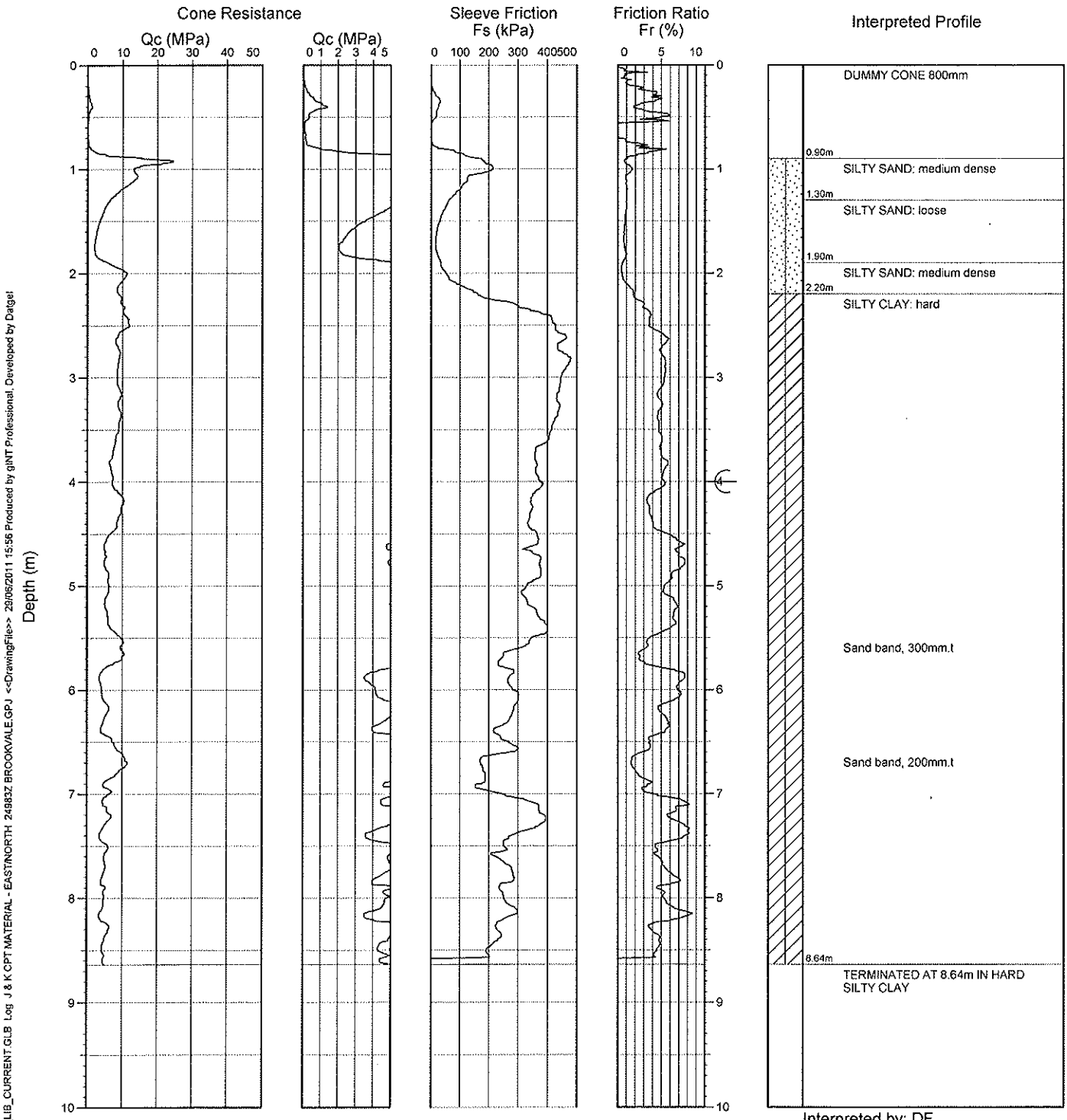
EFCP No. 1 1 / 1

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

EASTING: 0.0
SOUTHING: 0.0

Client:	WARINGAH COUNCIL
Project:	PROPOSED NEW GRANDSTAND AT BROOKVALE OVAL (STAGE 4)
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z	**R.L. Surface:** N/A	**Data File:** 24983Z_1B.GEF
Date: 16/6/11	**Datum:**	**Operator:**



Interpreted by: DF
Checked by:

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

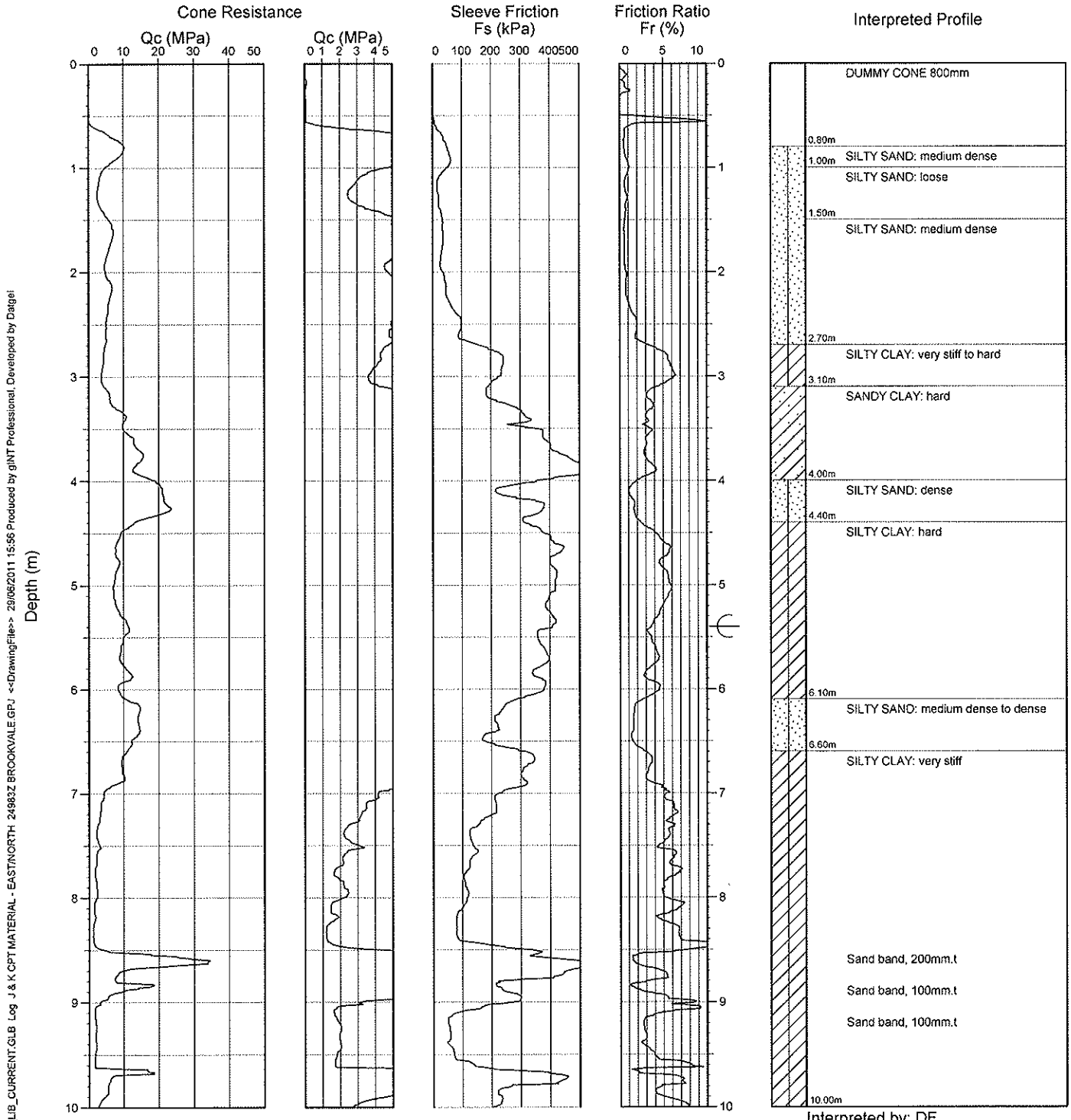
EFCP No. 2 1 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

EASTING: 0.0
SOUTHING: 0.0

Client:	WARINGAH COUNCIL
Project:	PROPOSED NEW GRANDSTAND AT BROOKVALE OVAL (STAGE 4)
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z	**R.L. Surface:** N/A	**Data File:** 24983Z_2.GEF
Date: 16/6/11	**Datum:**	**Operator:**



Interpreted by: DF
Checked by:

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

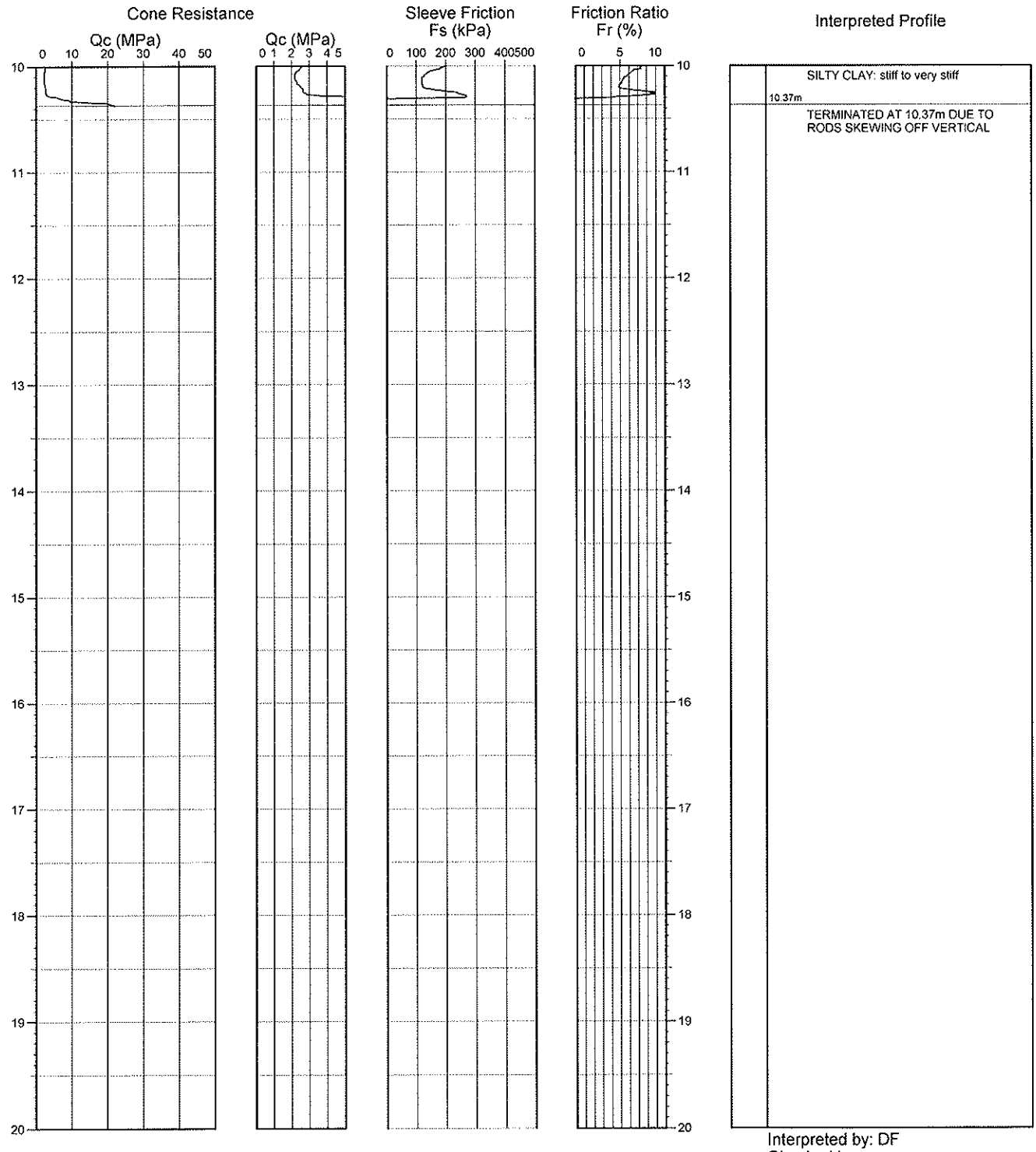
EFCP No.
2
2 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

EASTING: 0.0
SOUTHING: 0.0

Client:	WARINGAH COUNCIL
Project:	PROPOSED NEW GRANDSTAND AT BROOKVALE OVAL (STAGE 4)
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z	**R.L. Surface:** N/A	**Data File:** 24983Z_2.GEF
Date: 16/6/11	**Datum:**	**Operator:**



Interpreted by: DF
Checked by:

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

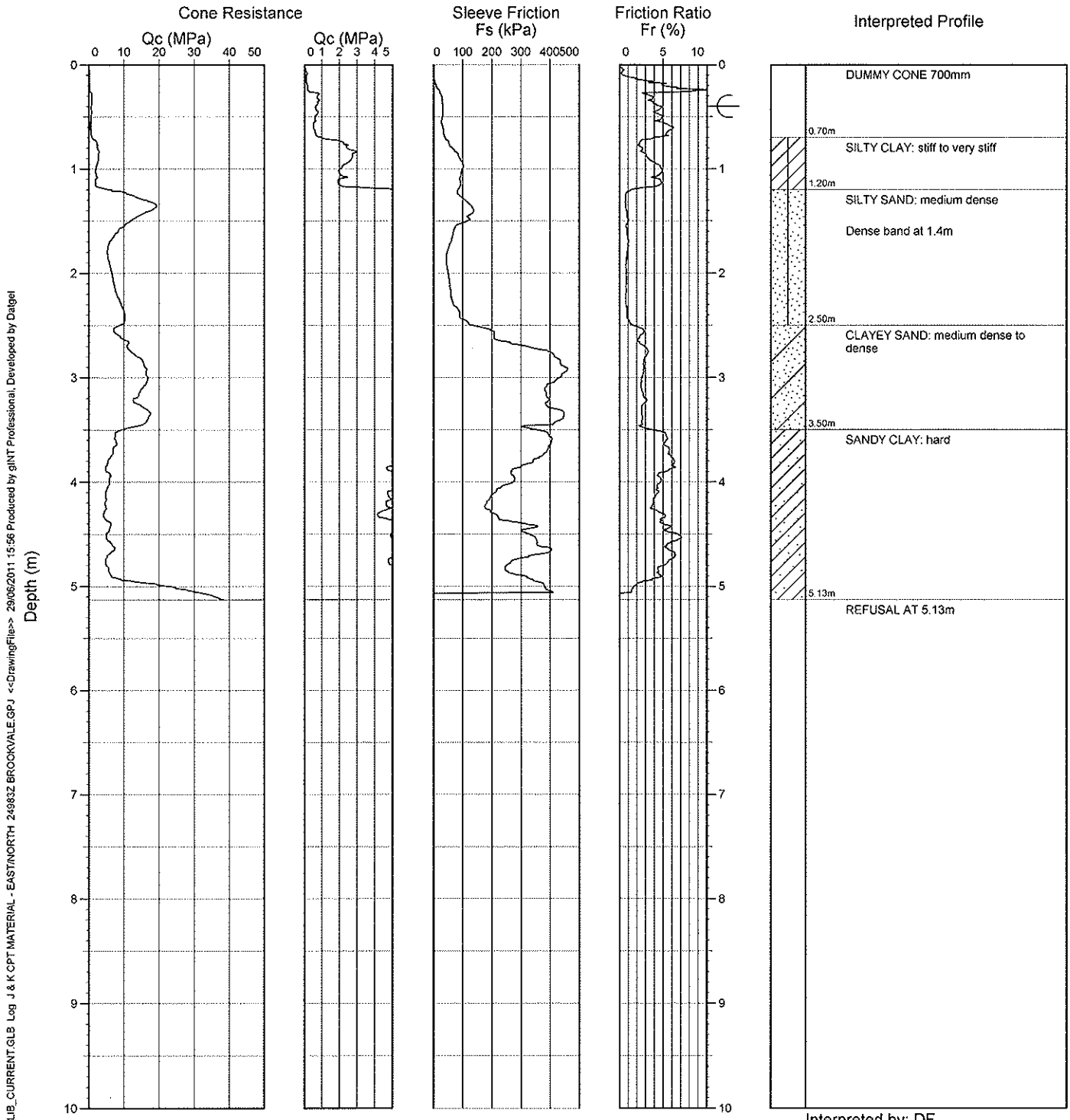
EFCP No. 3 **1 / 1**

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

EASTING: 0.0
SOUTHING: 0.0

Client:	WARINGAH COUNCIL
Project:	PROPOSED NEW GRANDSTAND AT BROOKVALE OVAL (STAGE 4)
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z	**R.L. Surface:** N/A	**Data File:** 24983Z_3.GEF
Date: 16/6/11	**Datum:**	**Operator:**



Interpreted by: DF
Checked by:

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

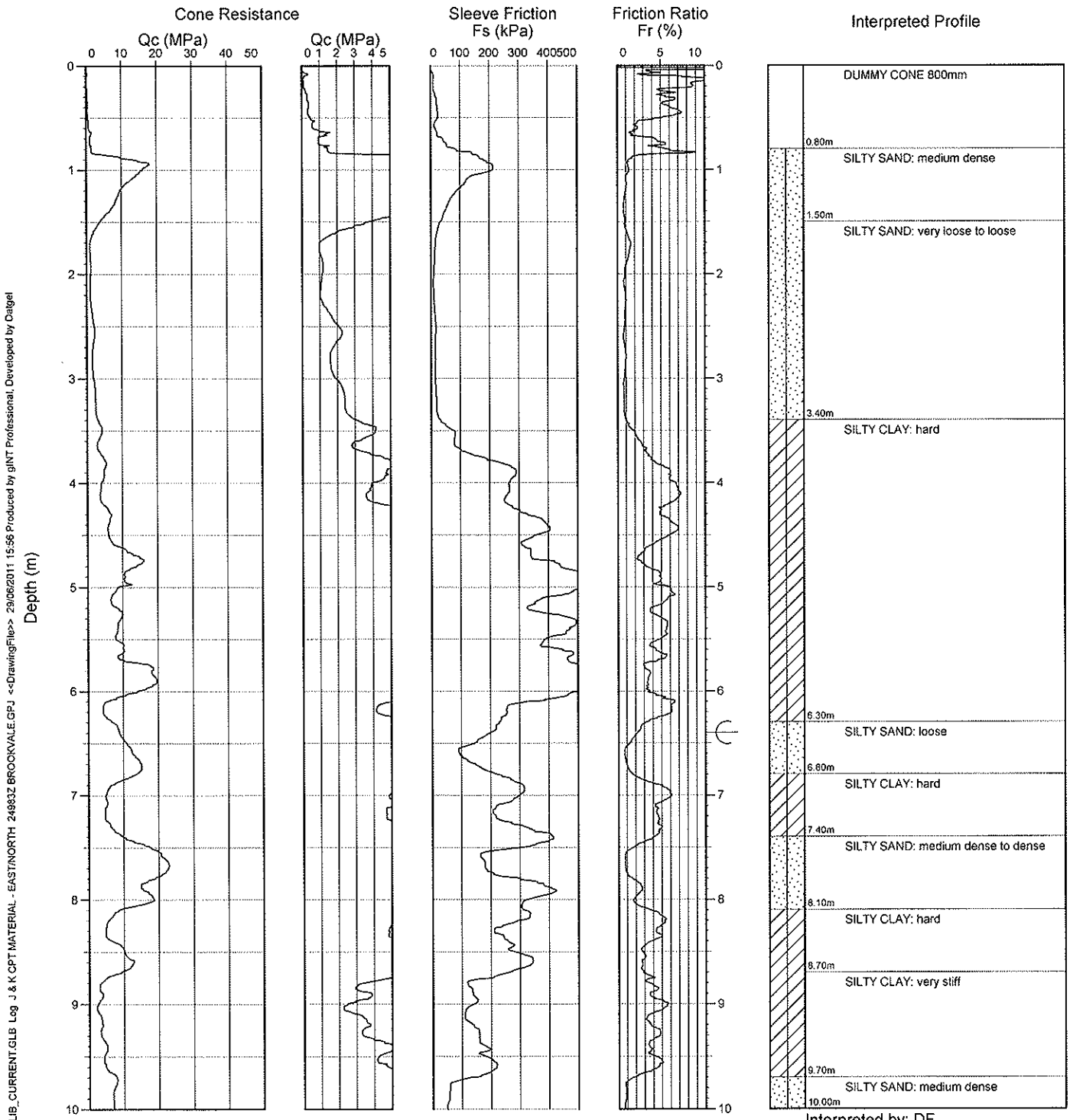
EFCP No. 4 1 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

EASTING: 0.0
SOUTHING: 0.0

Client:	WARINGAH COUNCIL
Project:	PROPOSED NEW GRANDSTAND AT BROOKVALE OVAL (STAGE 4)
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z	**R.L. Surface:** N/A	**Data File:** 24983Z_4.GEF
Date: 16/6/11	**Datum:**	**Operator:**



Interpreted by: DF
Checked by: RL

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

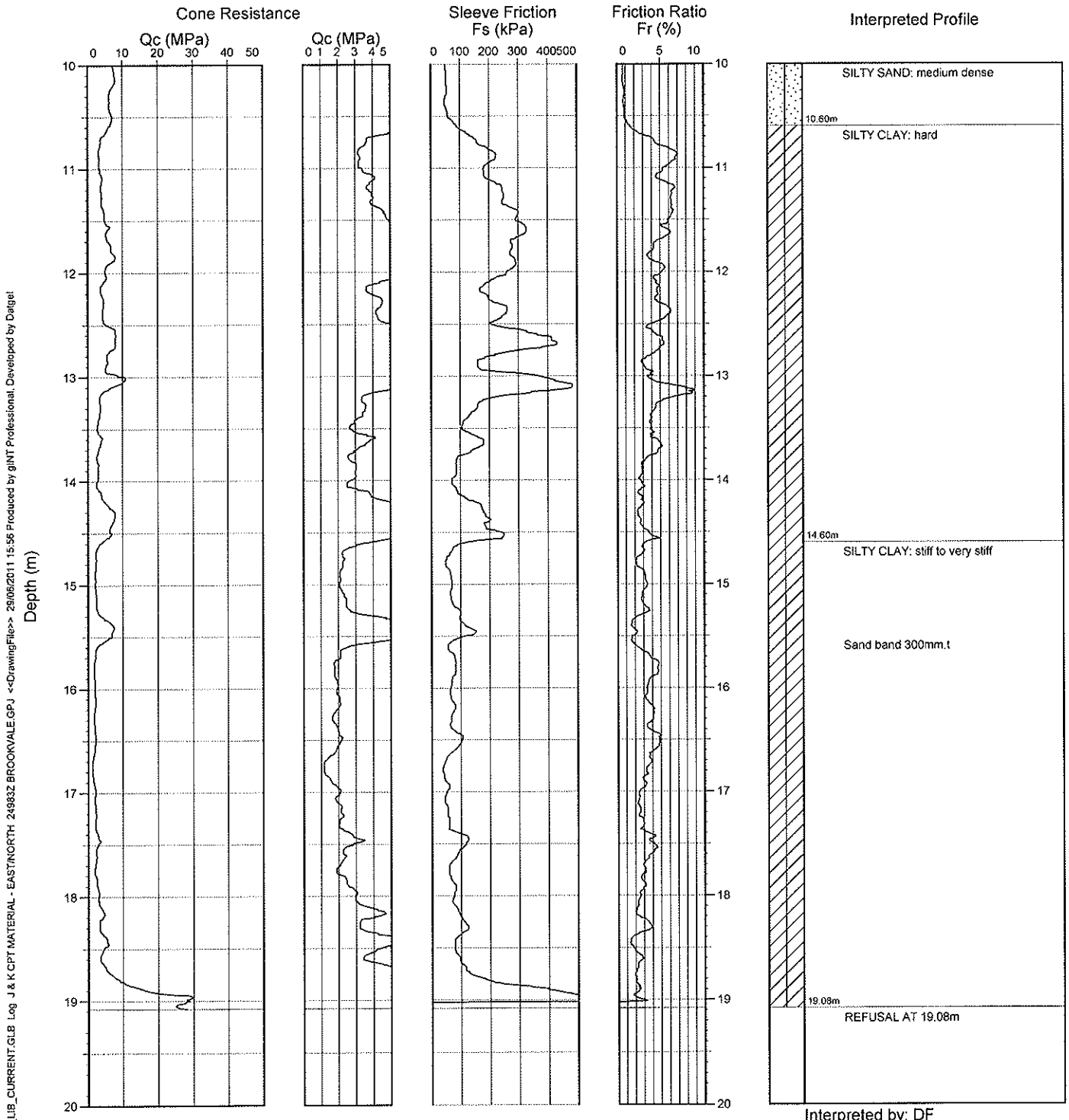
EFCP No. 4 2 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

EASTING: 0.0
SOUTHING: 0.0

Client:	WARINGAH COUNCIL
Project:	PROPOSED NEW GRANDSTAND AT BROOKVALE OVAL (STAGE 4)
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z	**R.L. Surface:** N/A	**Data File:** 24983Z_4.GEF
Date: 16/6/11	**Datum:**	**Operator:**



Interpreted by: DF
Checked by:

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

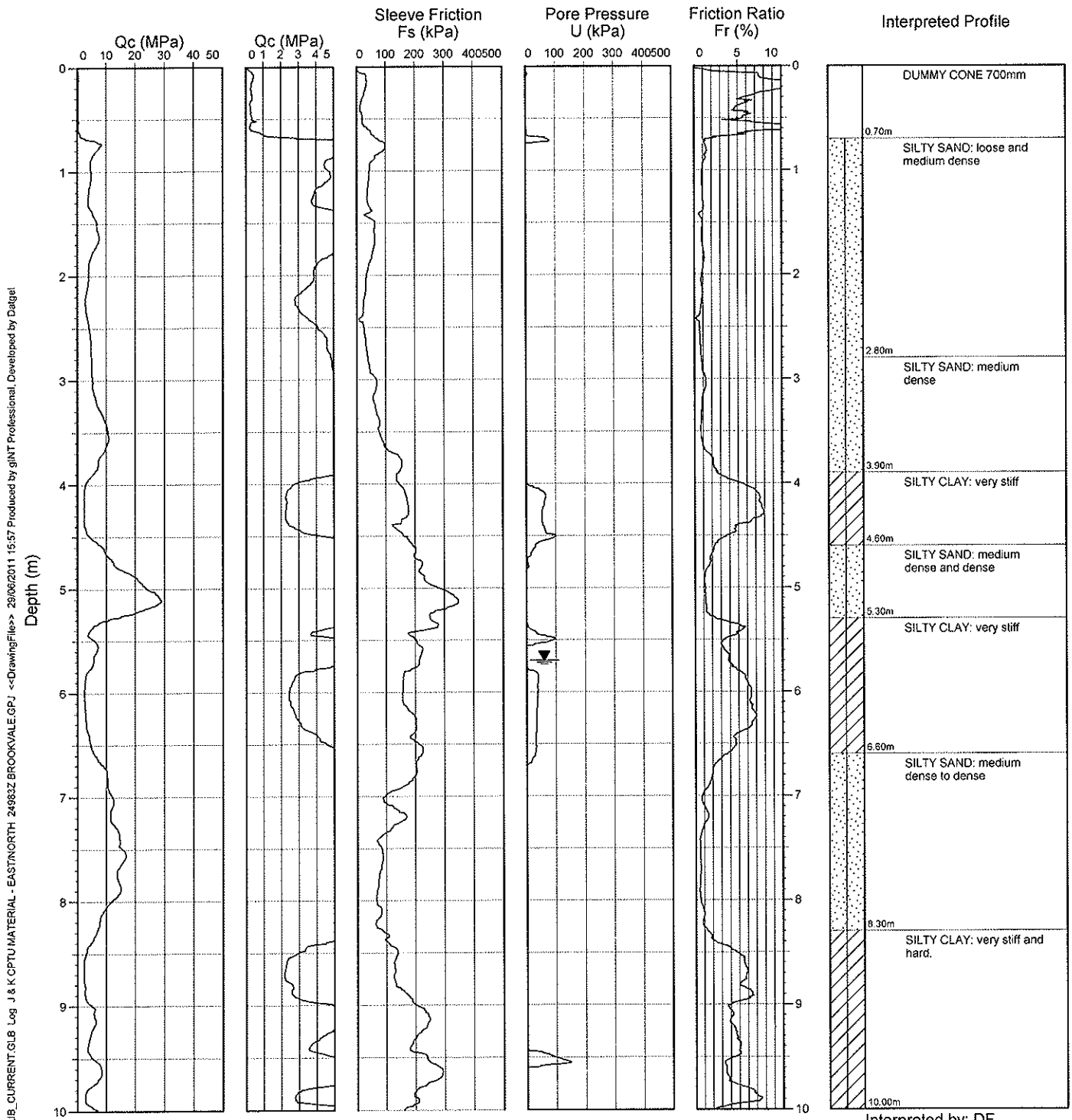
EFCP No. 5 1 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

EASTING: 0.0
SOUTHING: 0.0

Client:	WARINGAH COUNCIL
Project:	PROPOSED NEW GRANDSTAND AT BROOKVALE OVAL (STAGE 4)
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z	**R.L. Surface:** N/A	**Data File:** 24983Z_100.GEF
Date: 16/6/11	**Datum:**	**Operator:**



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Checked by:

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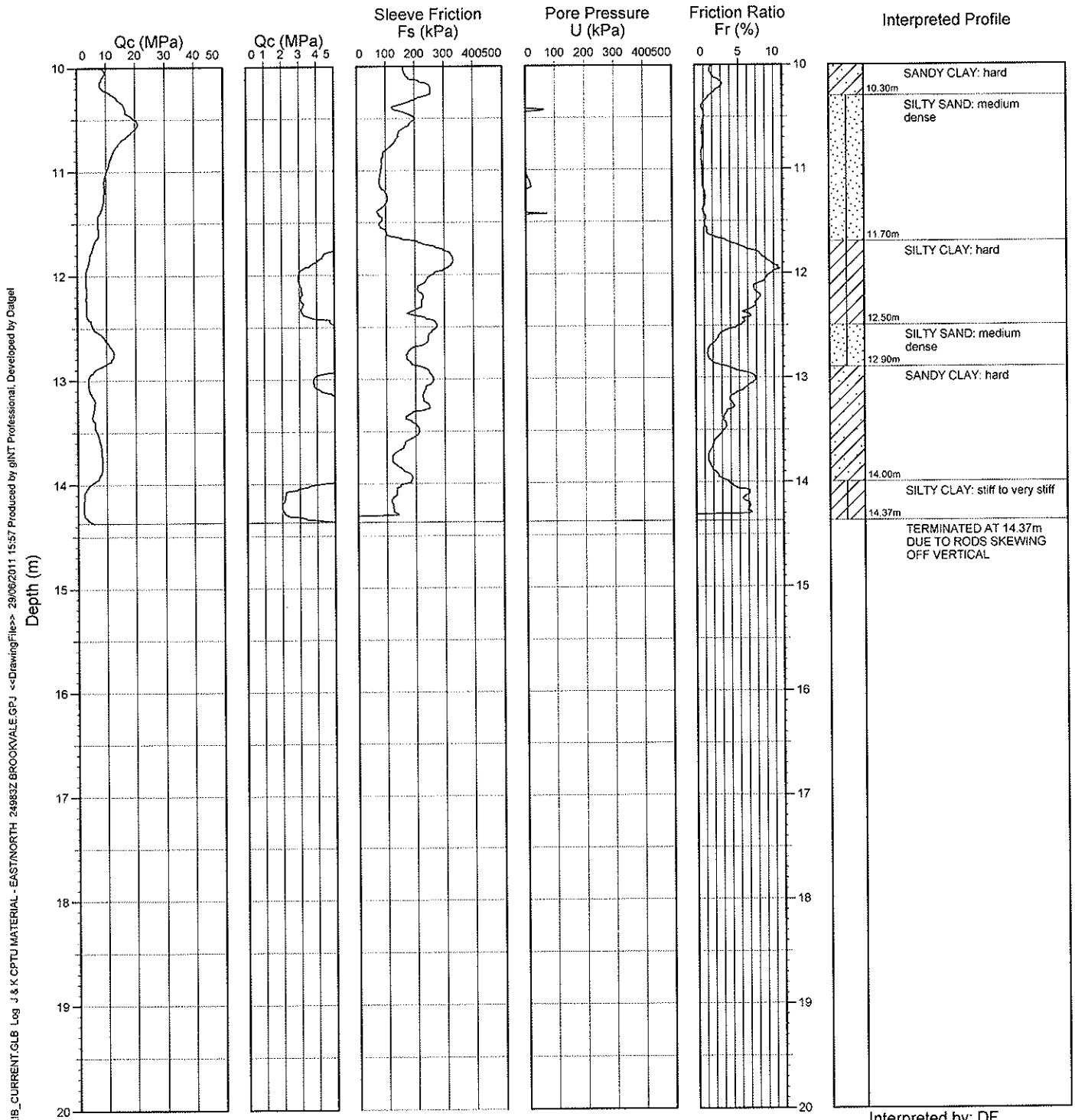
EFCP No. 5 2 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

EASTING: 0.0
SOUTHING: 0.0

Client:	WARINGAH COUNCIL
Project:	PROPOSED NEW GRANDSTAND AT BROOKVALE OVAL (STAGE 4)
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z	**R.L. Surface:** N/A	**Data File:** 24983Z_100.GEF
Date: 16/6/11	**Datum:**	**Operator:**



Interpreted by: DF
Checked by:

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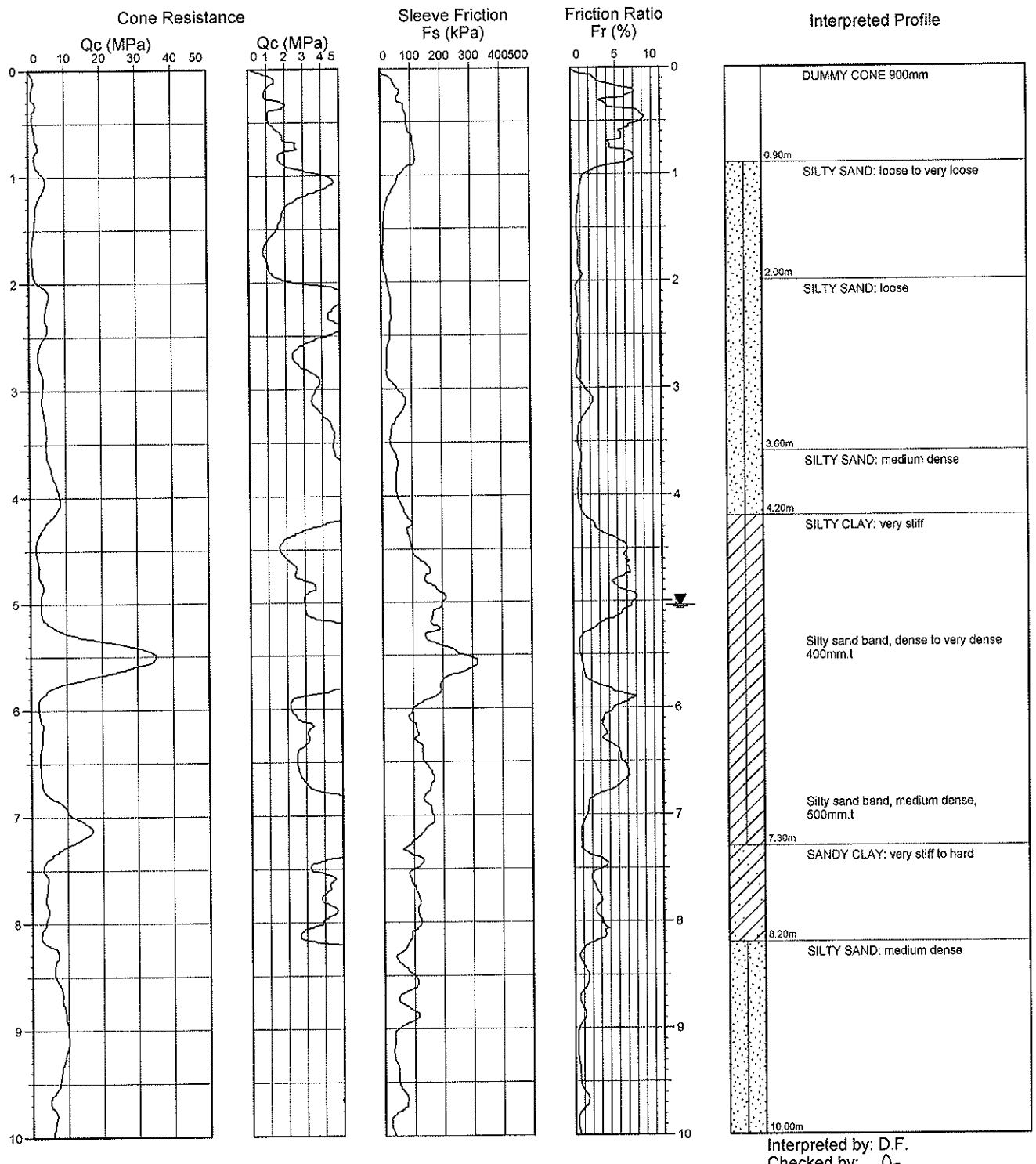
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 101 1 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_101b.GEF
Date: 24/6/11	**Datum:**	**Operator:**



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Checked by:

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Jeffery and Katauskas Pty Ltd

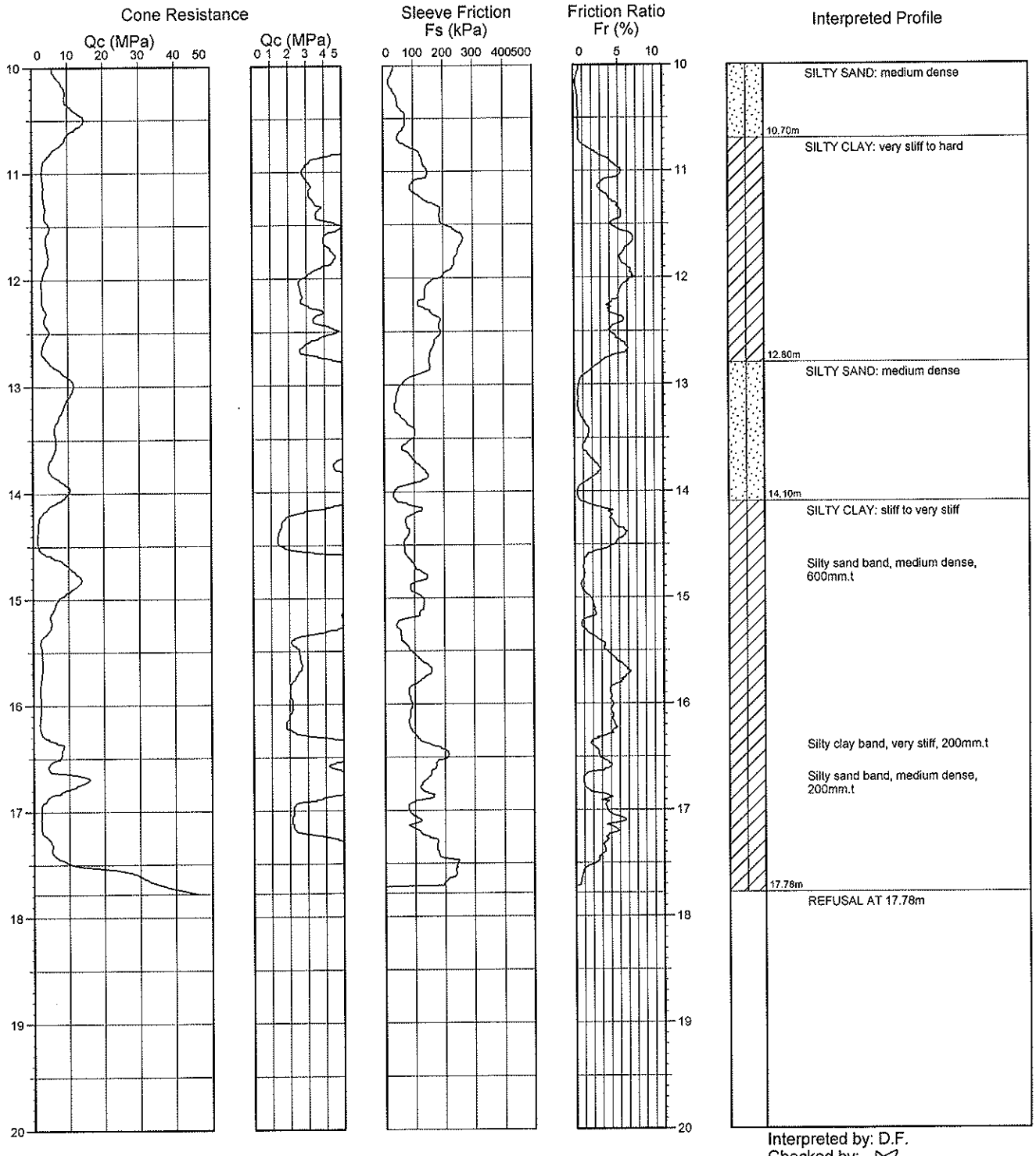
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 101 2 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_101b.GEF
Date: 24/6/11	**Datum:**	**Operator:**



Interpreted by: D.F.
Checked by:

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 102 1 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_102.GEF
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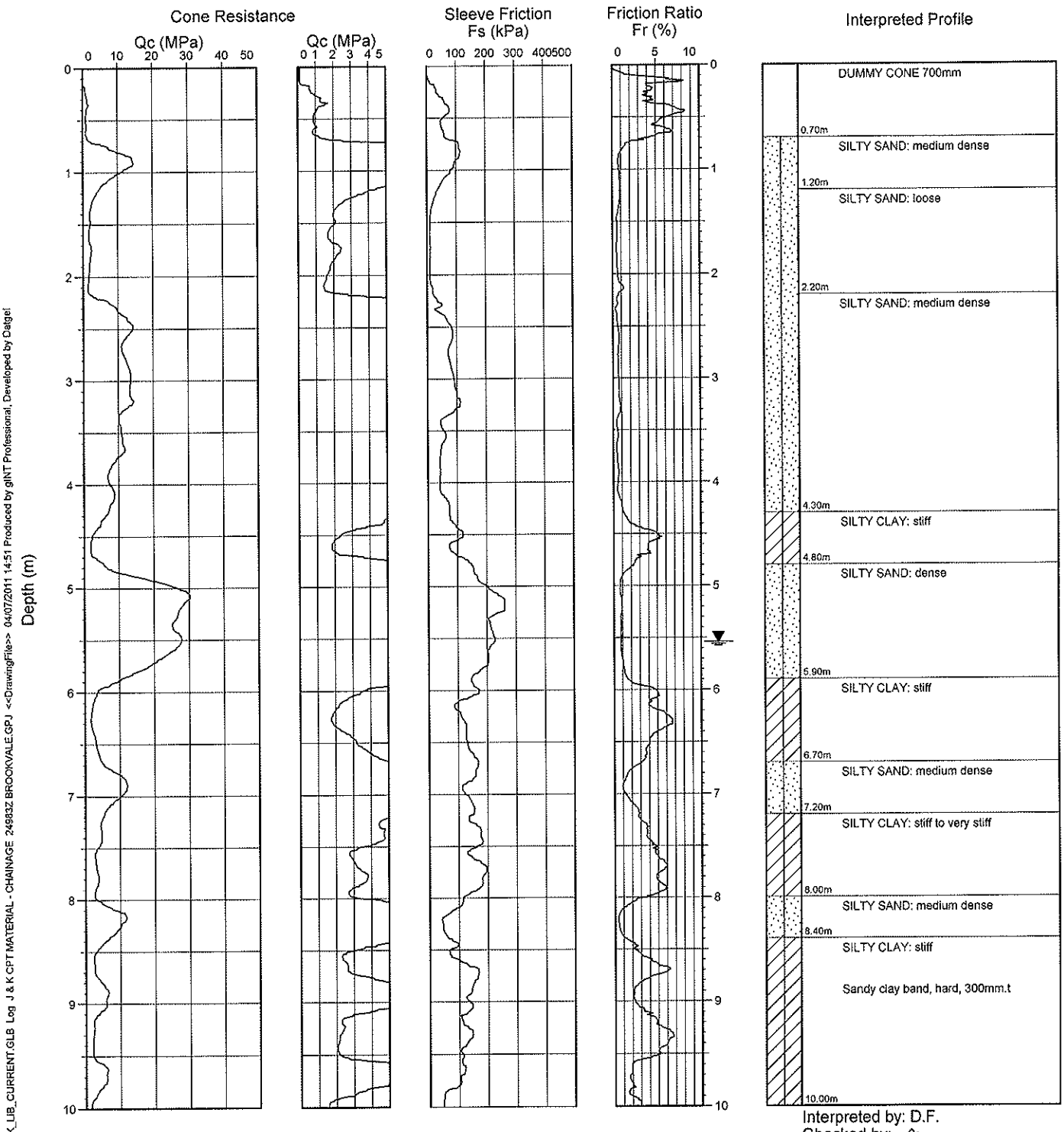

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Checked by:

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 102 2 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL		
Project:	BROOKVALE OVAL MASTERPLAN		
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW		
Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_102.GEF	
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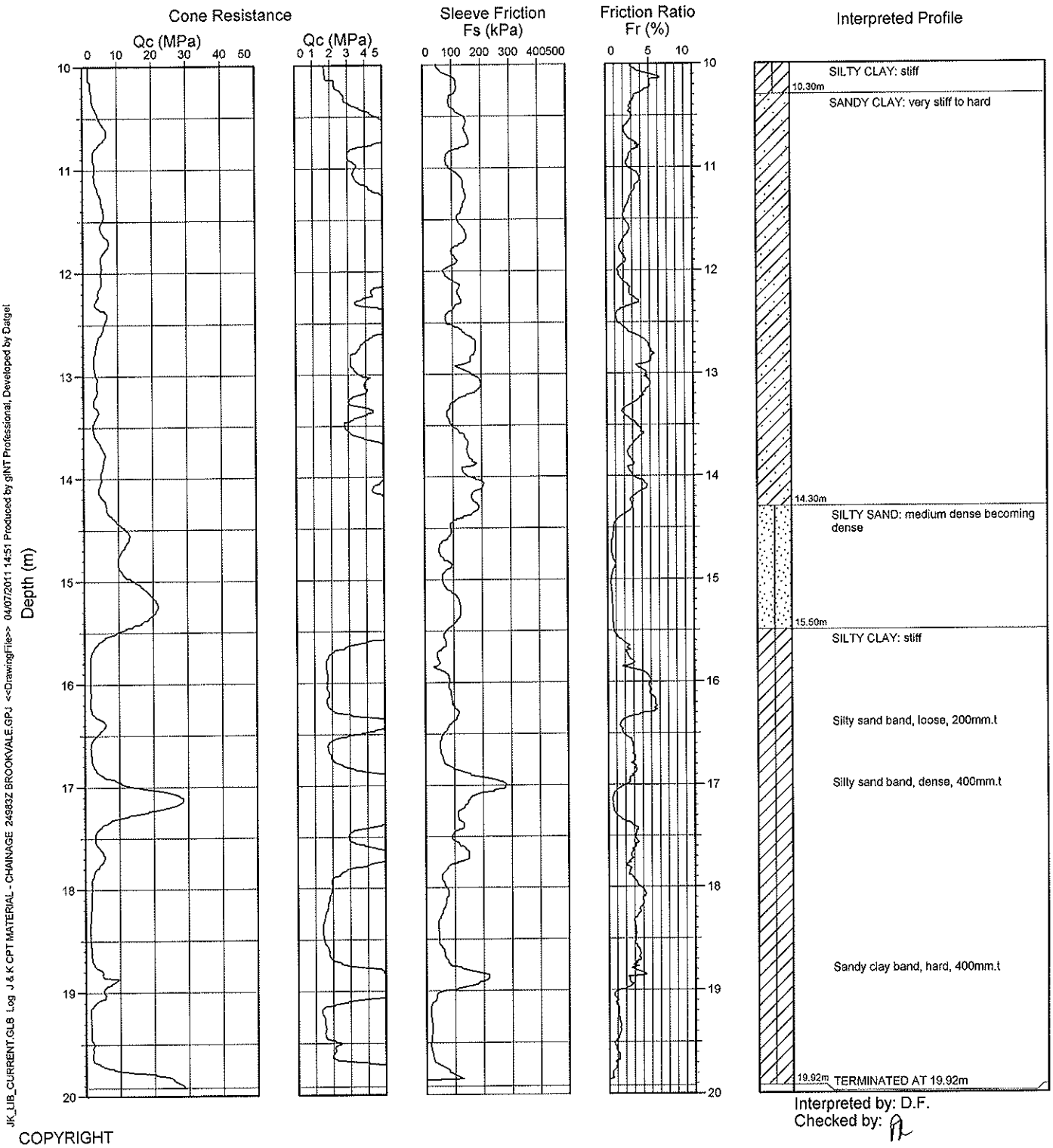


Interpreted by: D.F.

Checked by:

Jeffery and Katauskas Pty Ltd

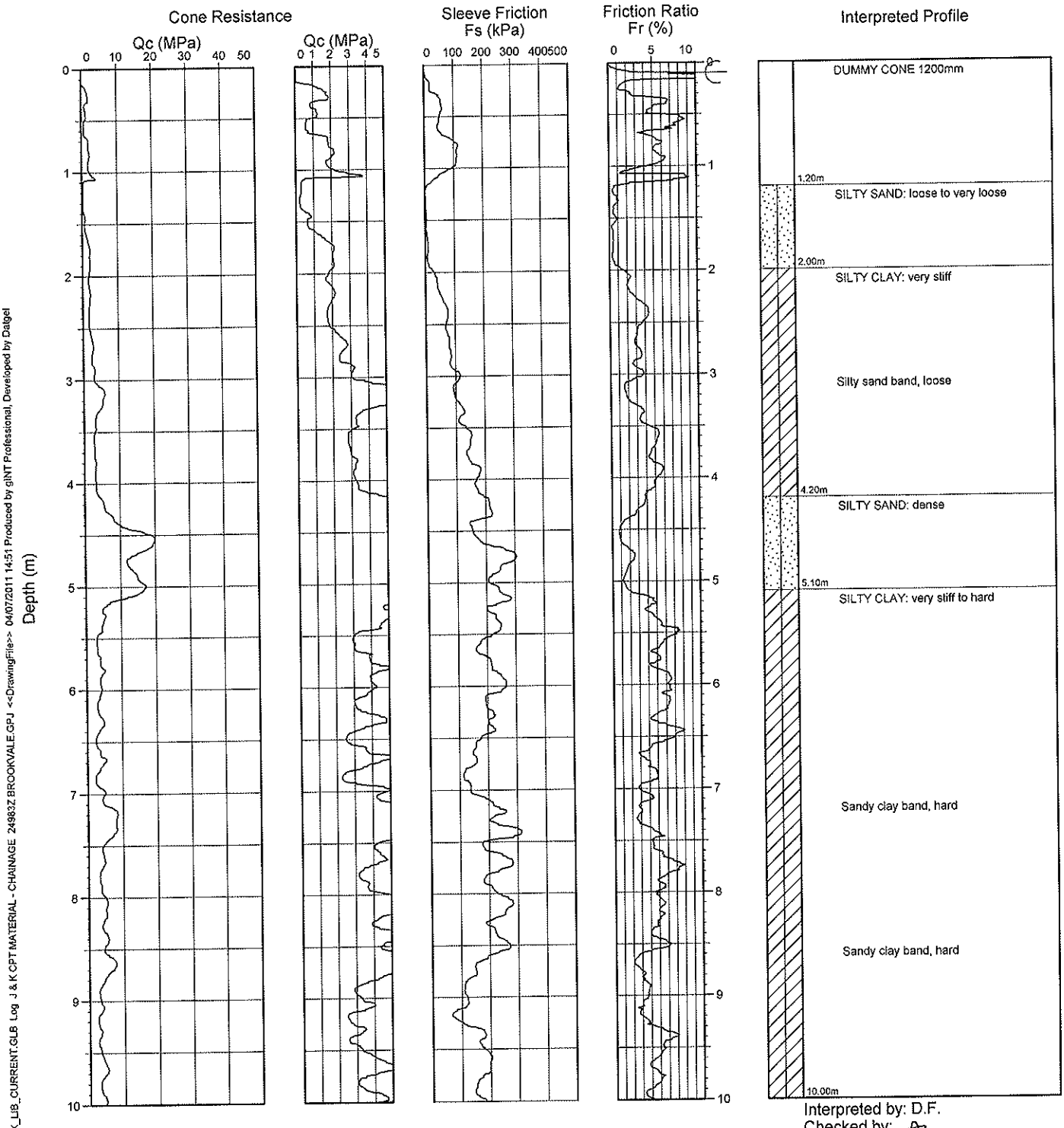
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 103 1 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_103.GEF
Date: 24/6/11	**Datum:**	**Operator:**



Interpreted by: D.F.
Checked by: AR

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 103 2 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_103.GEF
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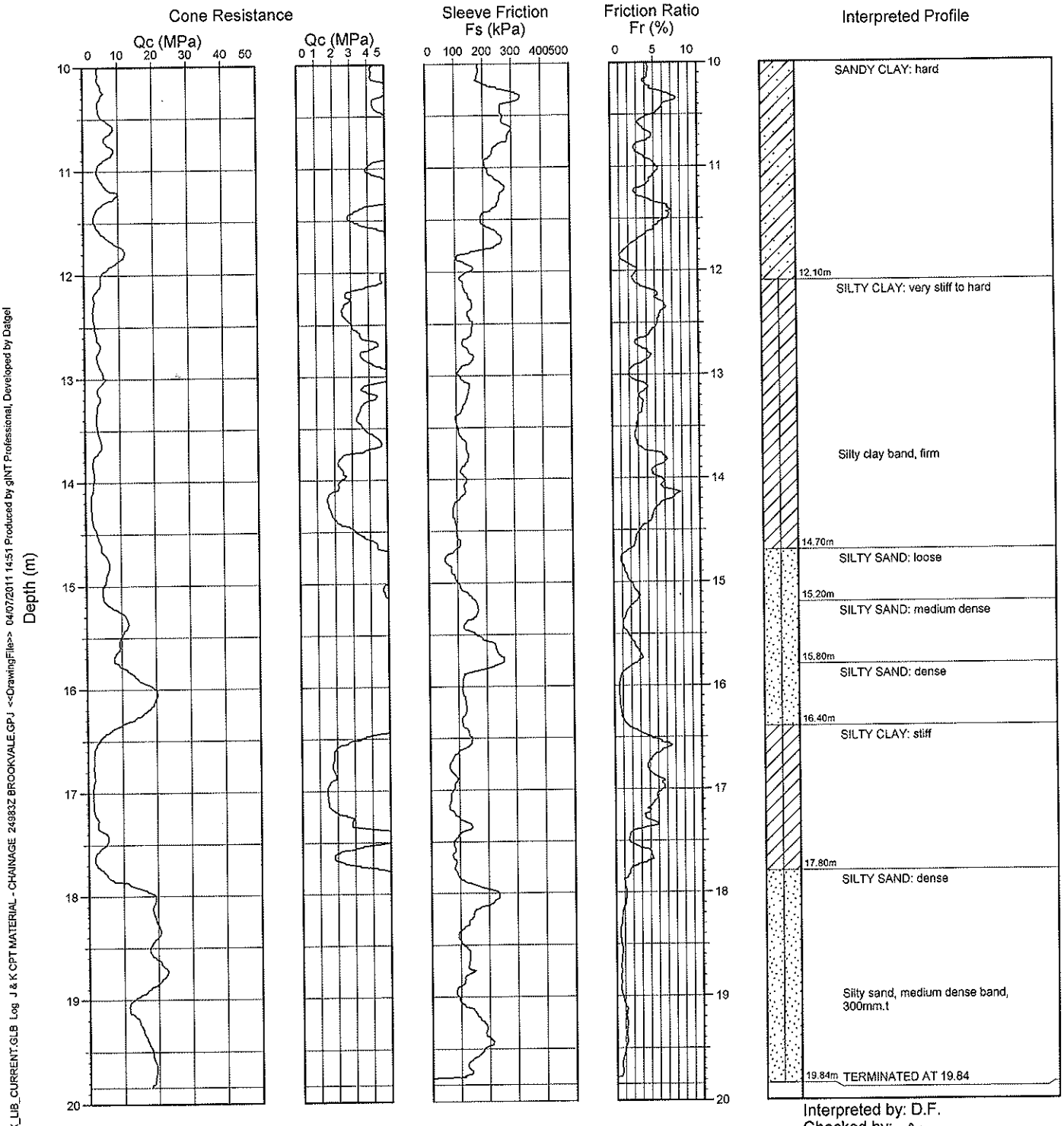

Interpreted by: D.F.
Checked by: AL

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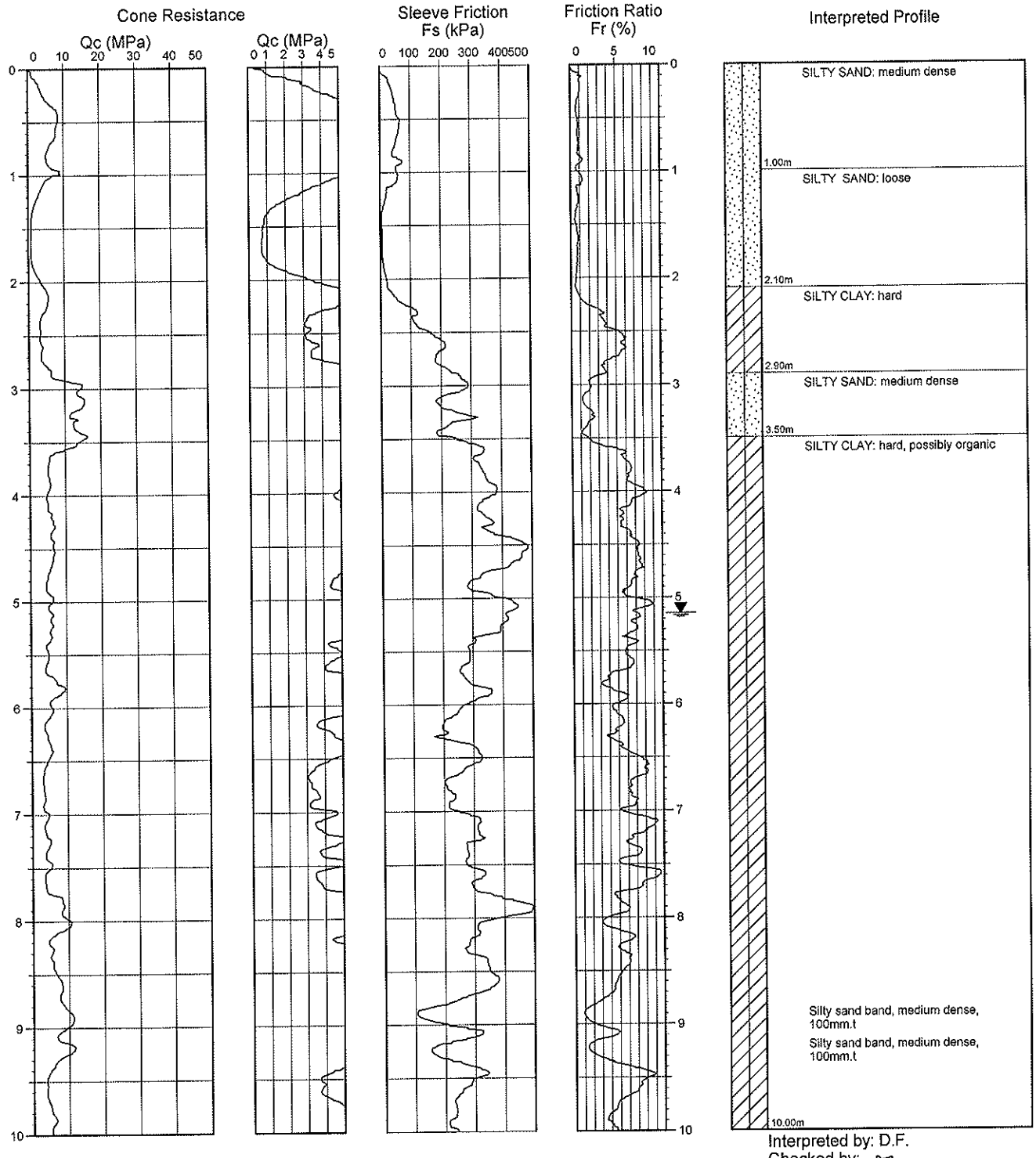
Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 104 1 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL		
Project:	BROOKVALE OVAL MASTERPLAN		
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW		
Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_109.GEF	
Date: 24/6/11	**Datum:**	**Operator:**	



Interpreted by: D.F.
Checked by: RZ

Jeffery and Katauskas Pty Ltd

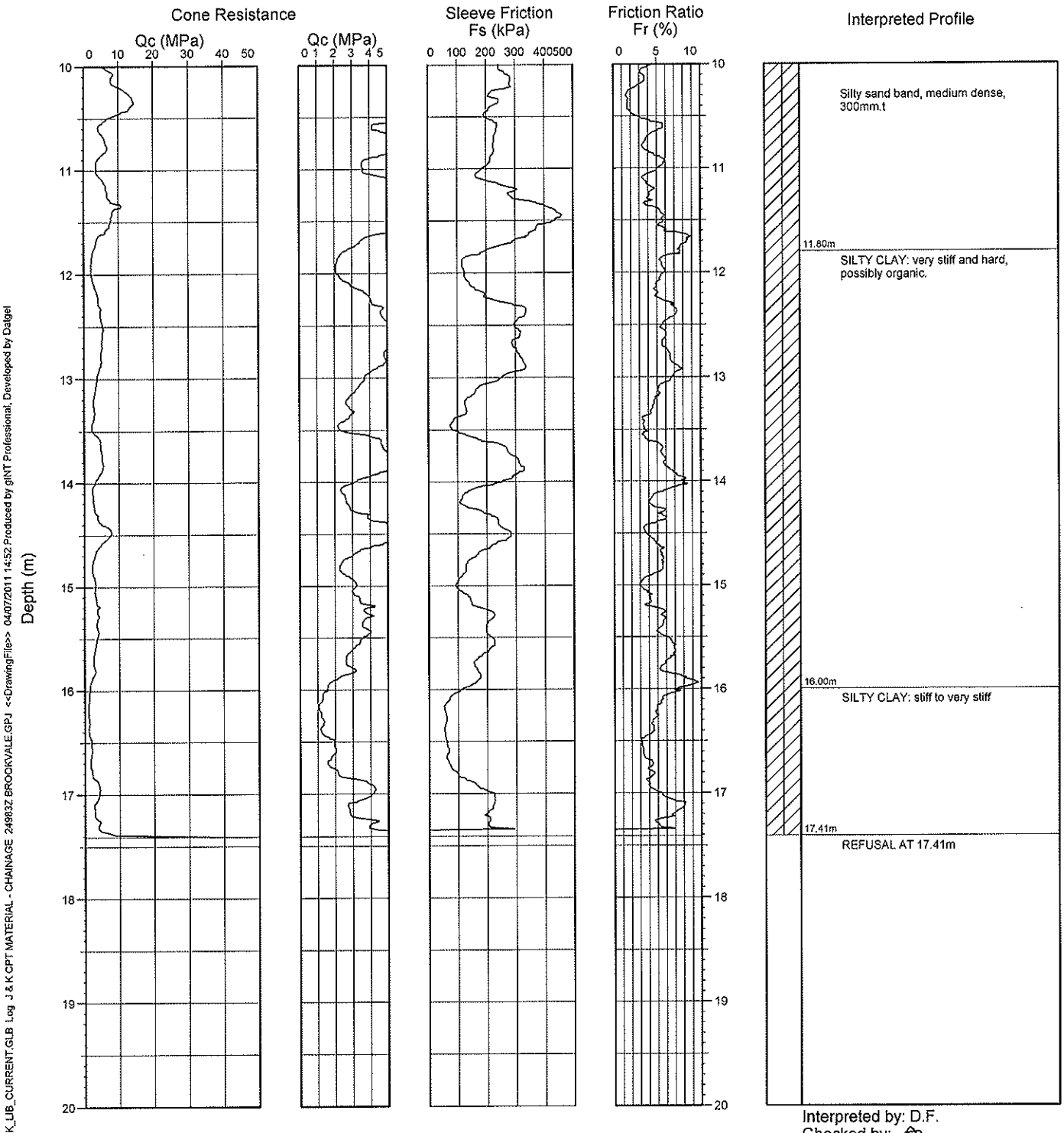
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 104 2 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_109.GEF
Date: 24/6/11	**Datum:**	**Operator:**



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JK_UB_CURRENT.GLB Log J & K CPT MATERIAL - CHAINAGE 24983Z BROOKVALE.GPJ <<DrawingFile>> 04/07/2011 14:52 Produced by gINT Professional, Developed by Datgel

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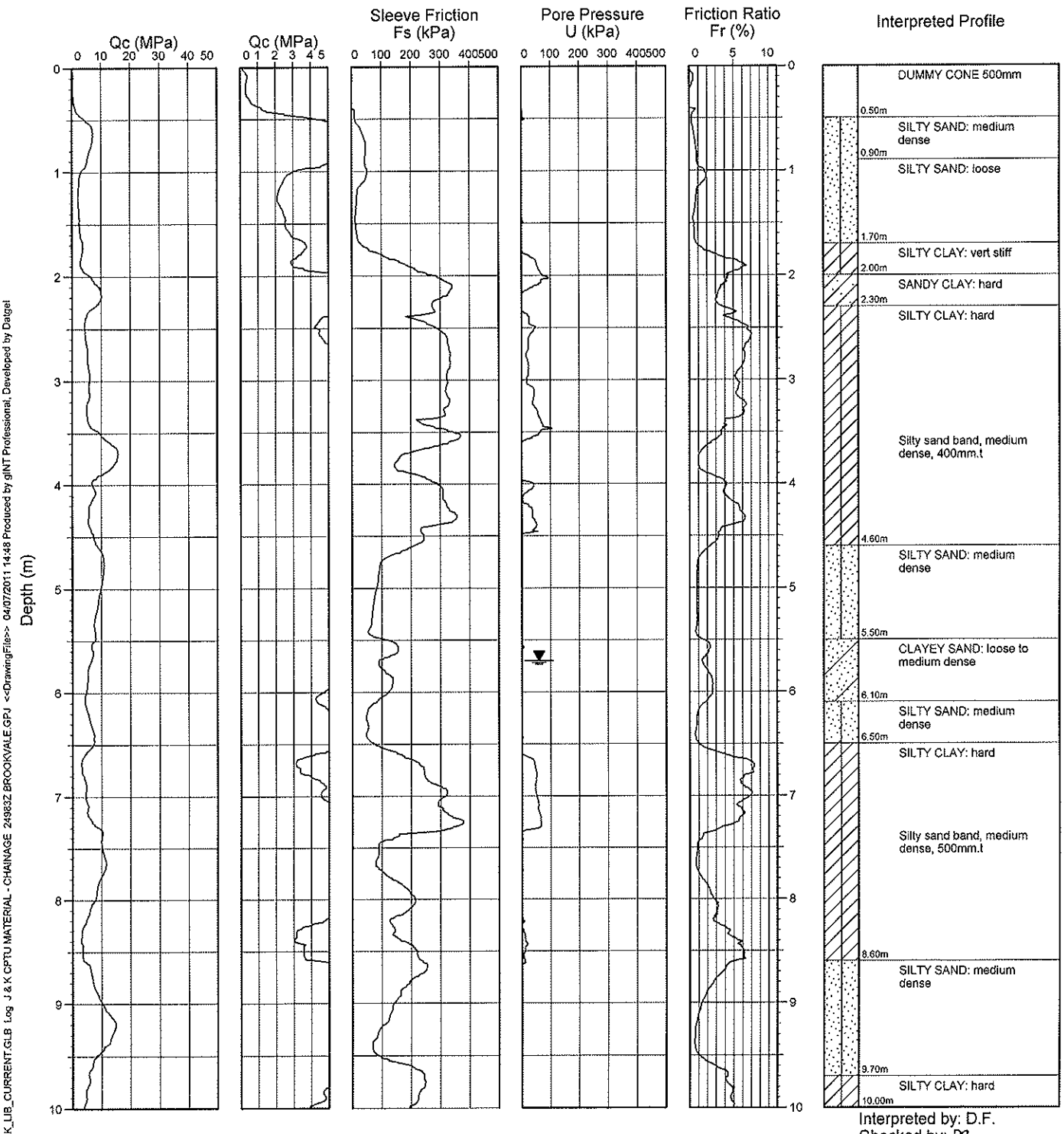
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 105 1 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL		
Project:	BROOKVALE OVAL MASTERPLAN		
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW		
Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Z_105.GEF	
Date: 16/6/11	**Datum:**	**Operator:**	



Interpreted by: D.F.

Checked by: RP

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Jeffery and Katauskas Pty Ltd

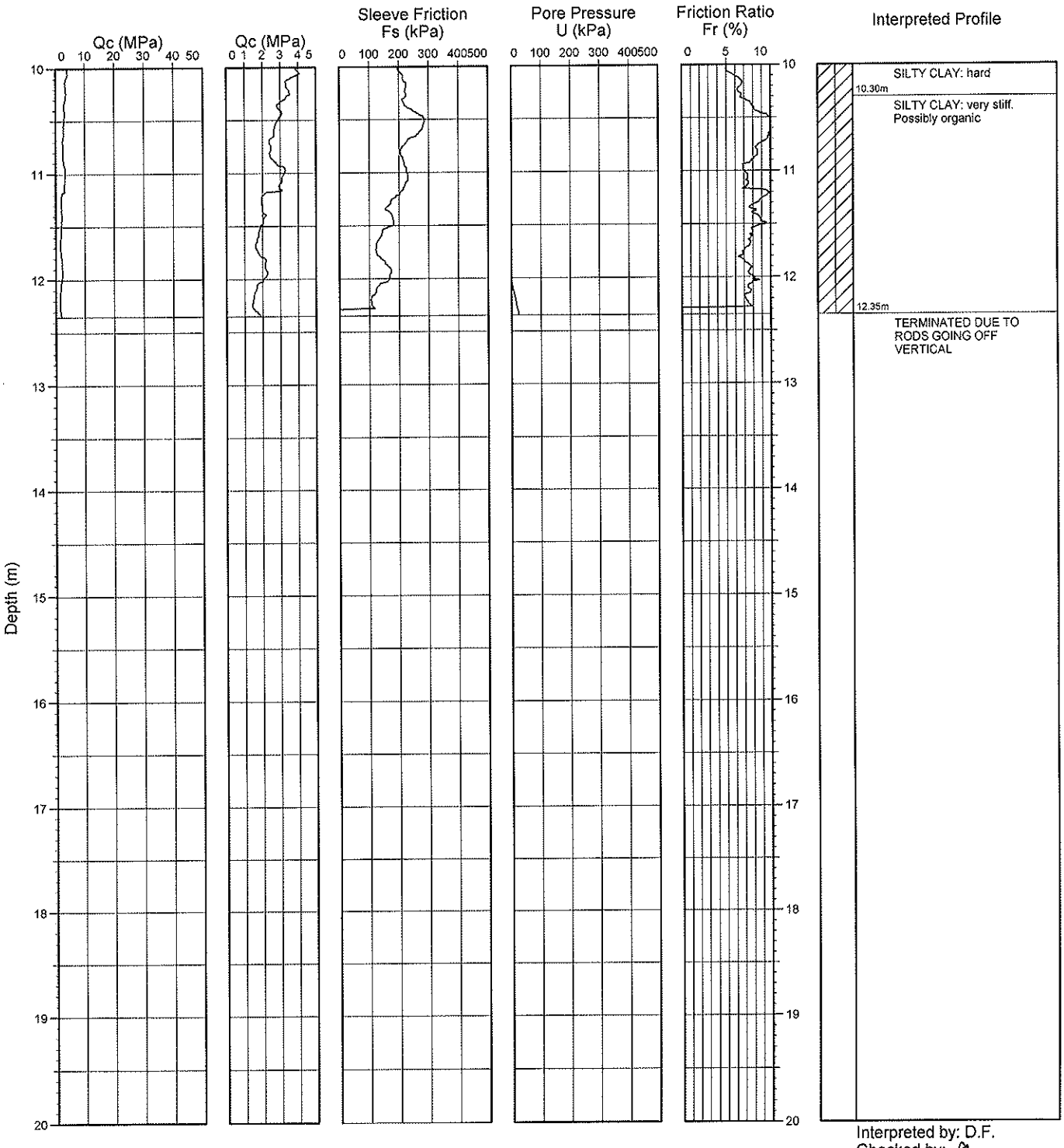
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 105 2 / 2

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Z_105.GEF
Date: 16/6/11	**Datum:**	**Operator:**



Interpreted by: D.F.

Checked by: R

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Jeffery and Katauskas Pty Ltd

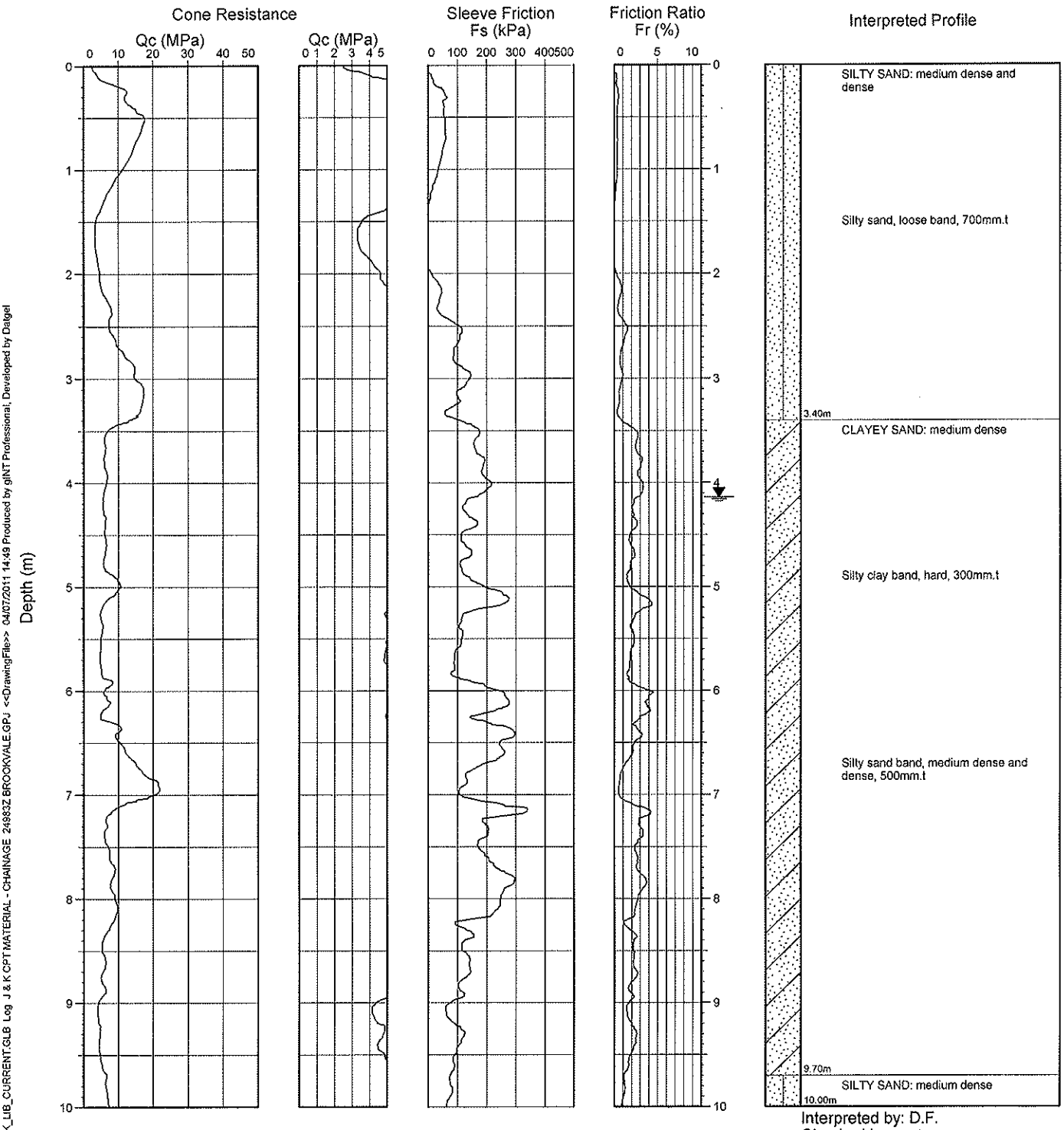
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 106 1 / 3

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_106.GEF
Date: 24/6/11	**Datum:**	**Operator:**



Interpreted by: D.F.
Checked by:

Jeffery and Katauskas Pty Ltd

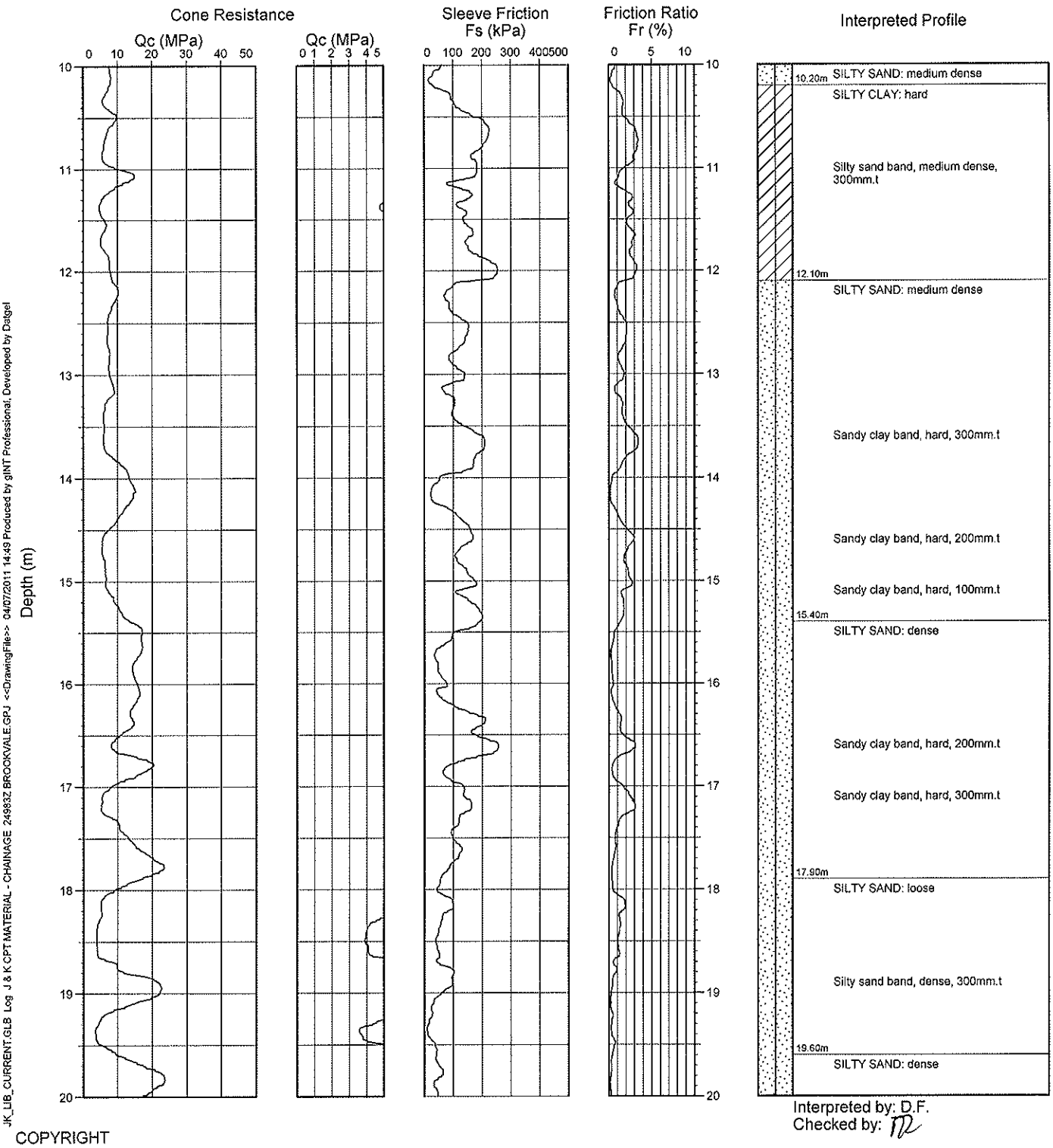
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 106 2 / 3

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_106.GEF
Date: 24/6/11	**Datum:**	**Operator:**



Interpreted by: D.F.
Checked by: MP

Jeffery and Katauskas Pty Ltd

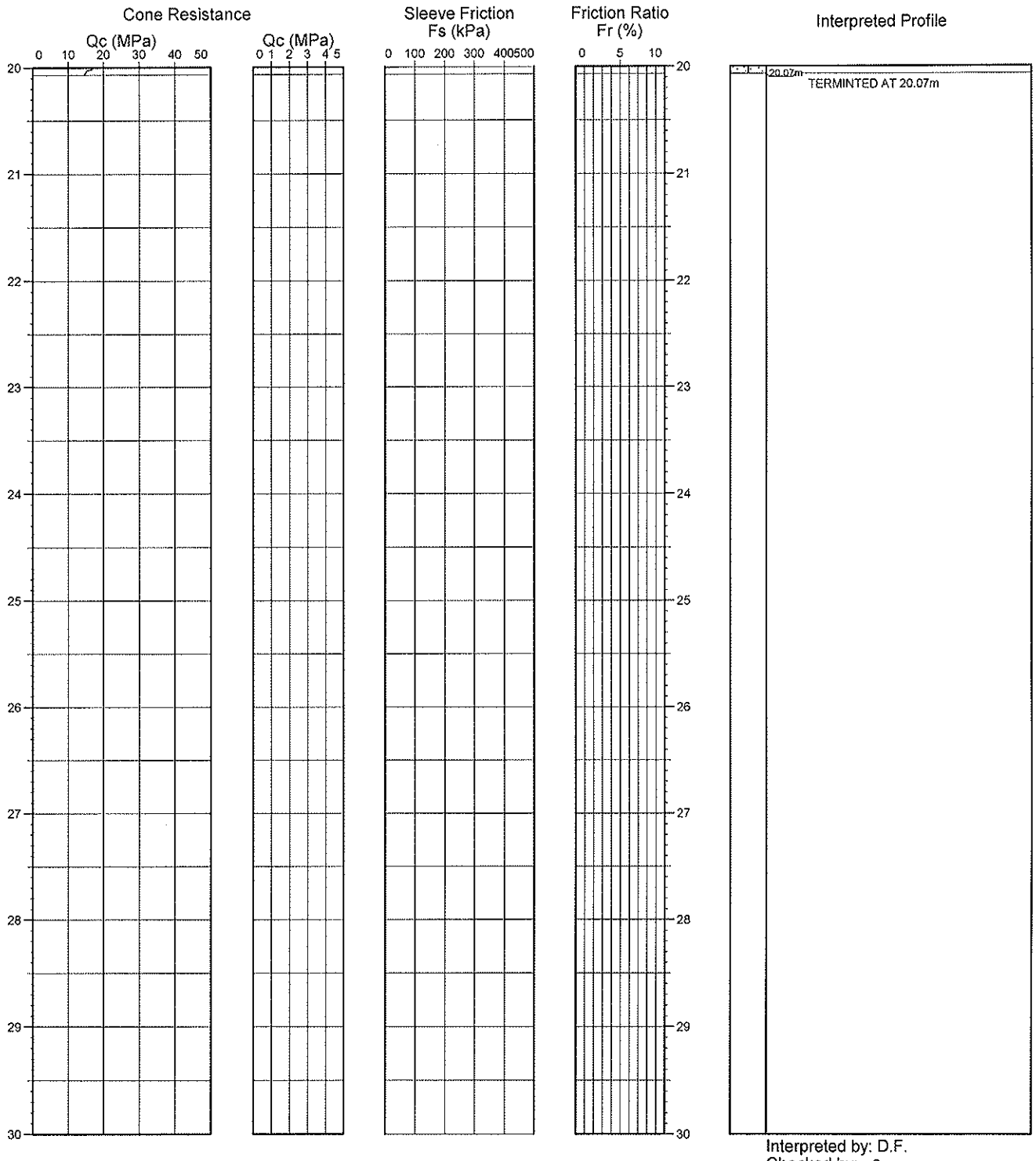
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 106 3 / 3

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_106.GEF
Date: 24/6/11	**Datum:**	**Operator:**



Interpreted by: D.F.
Checked by:

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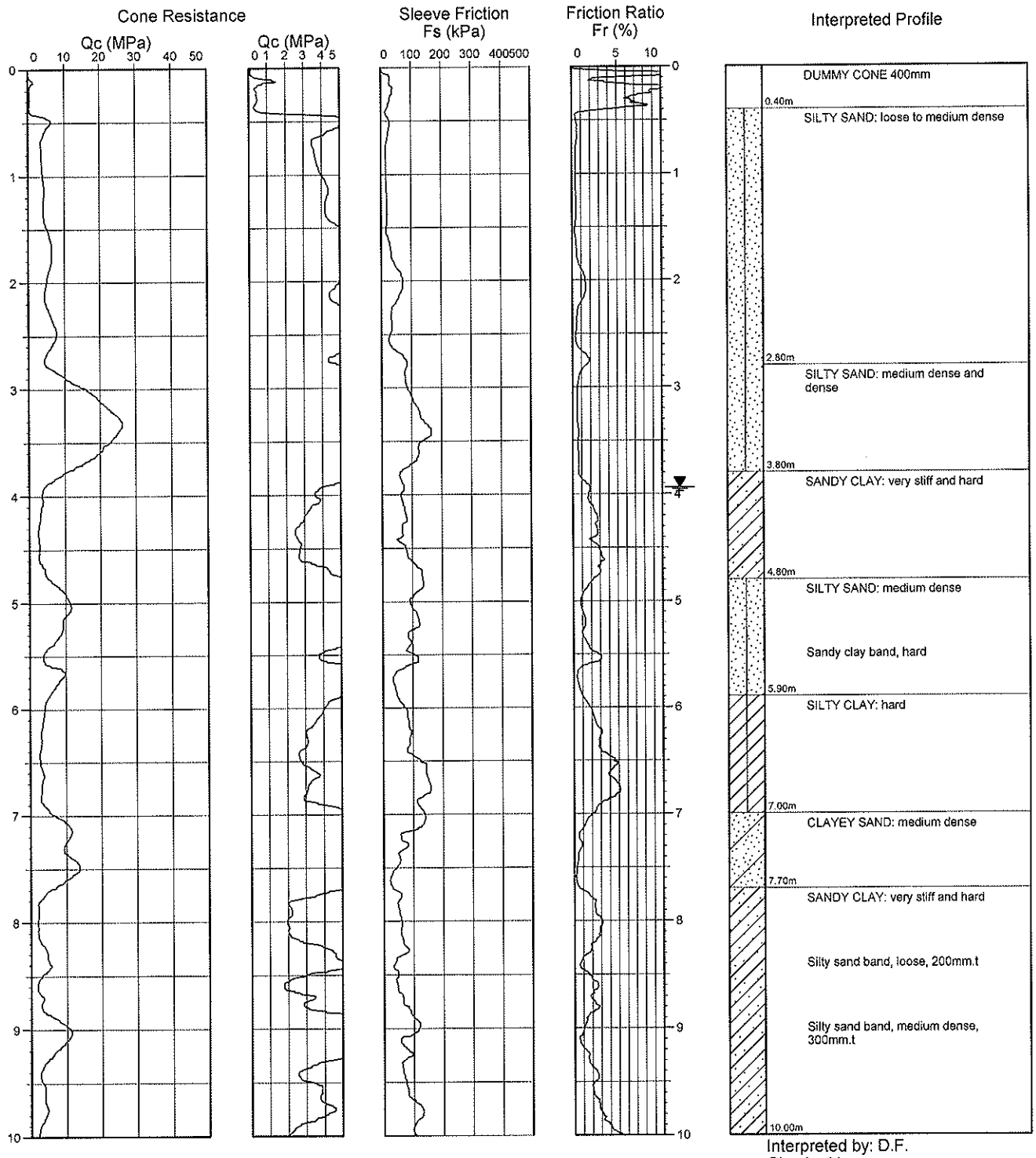
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 107 1 / 3

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_107.GEF
Date: 24/6/11	**Datum:**	**Operator:**



Interpreted by: D.F.
Checked by:

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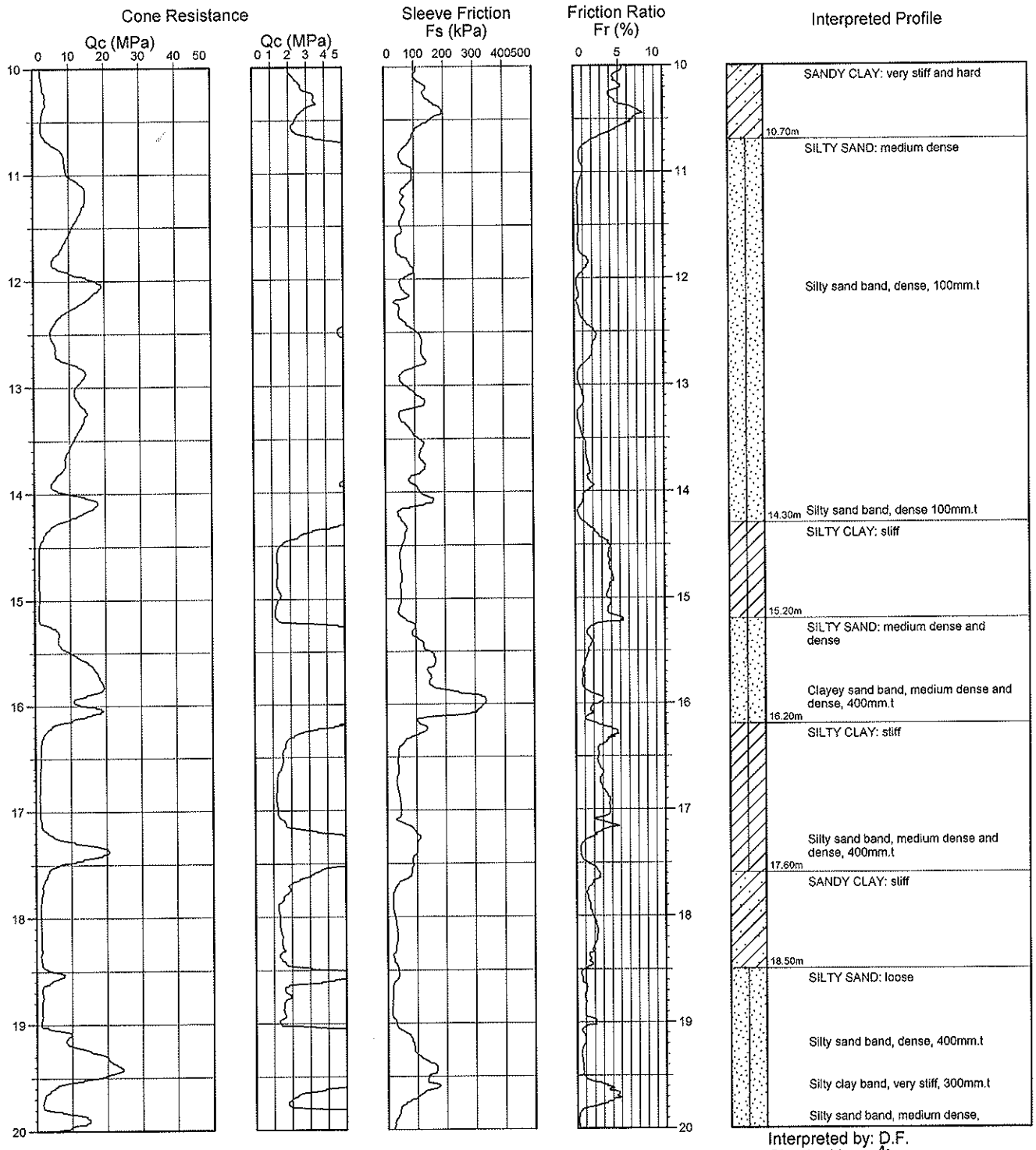
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 107 2 / 3

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_107.GEF
Date: 24/6/11	**Datum:**	**Operator:**



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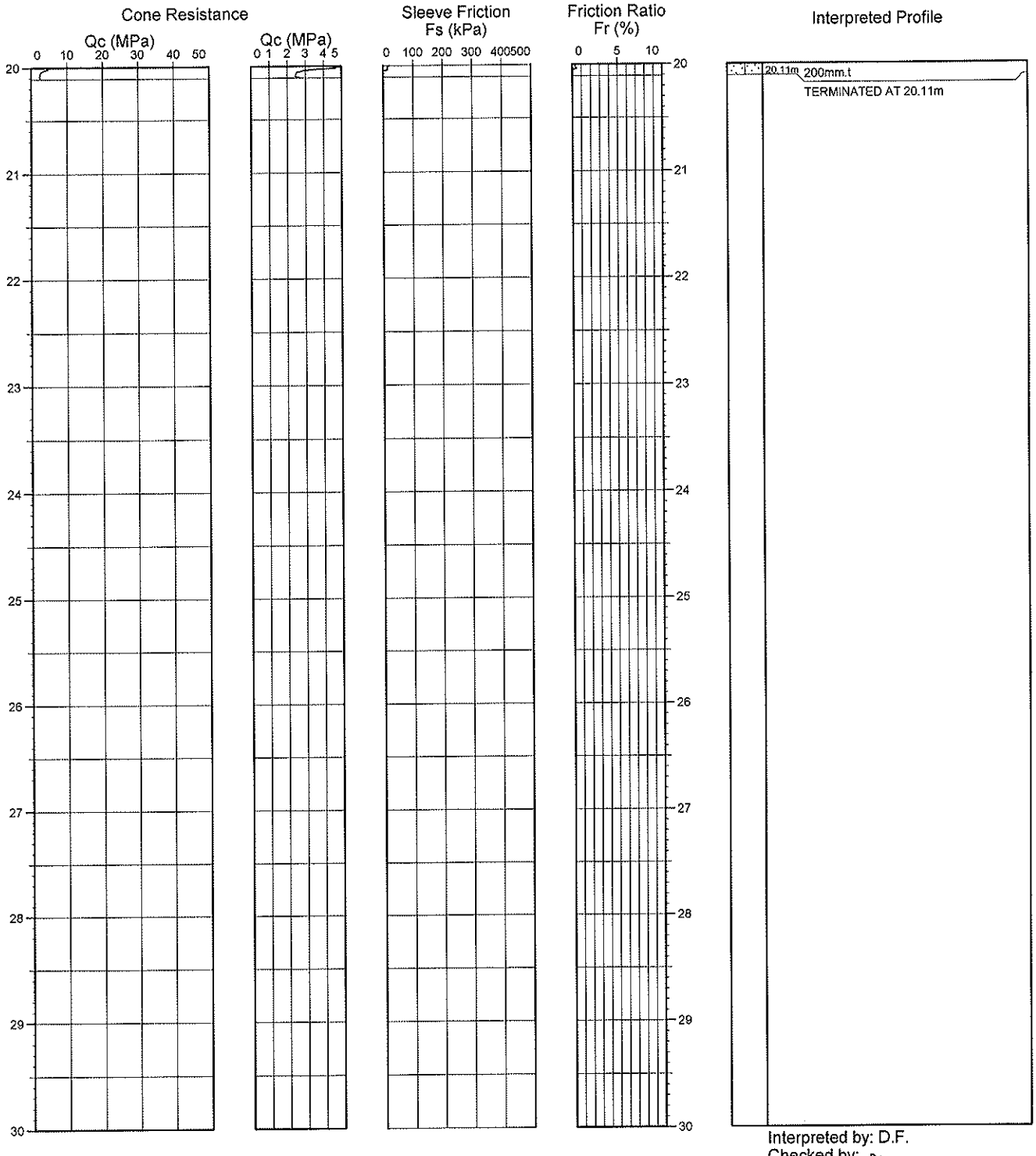
EFCP No. 107 3 / 3

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_107.GEF
Date: 24/6/11	**Datum:**	**Operator:**



Interpreted by: D.F.

Checked by: AR

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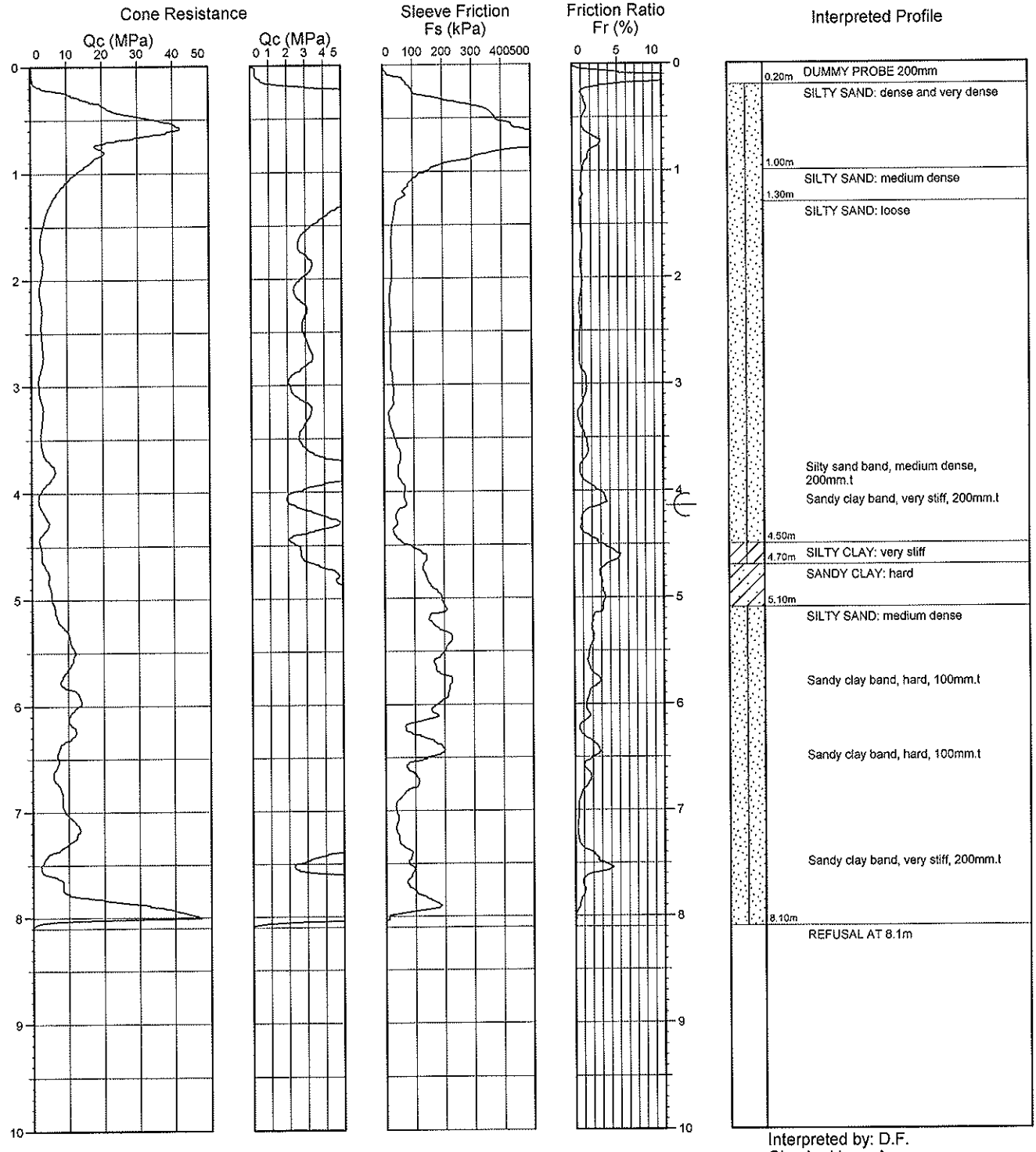
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

EFCP No. 108 1 / 1

ELECTRICAL FRICTION CONE PENETROMETER TEST RESULTS

Client:	WARINGAH COUNCIL
Project:	BROOKVALE OVAL MASTERPLAN
Location:	ALFRED STREET (CNR. PITTWATER AVENUE), BROOKVALE, NSW

Job No.: 24983Z2	**R.L. Surface:** N/A	**Data File:** 24983Zb_108b.GEF
Date: 24/6/11	**Datum:**	**Operator:**



Interpreted by: D.F.
Checked by:

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ABN 17 003 550 801

REPORT EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, the SAA Site Investigation Code. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (eg sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'Shale' is used to describe thinly bedded to laminated siltstone.

SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained 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.

Details of the type and method of sampling used are given on the attached logs.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All except test pits, hand auger drilling and portable dynamic cone penetrometers require the use of a mechanical drilling rig which is commonly mounted on a truck chassis.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as hard clay, gravel or ironstone, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water 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 "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength 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 F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm 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 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as

  N>30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as "N_c" on the borehole logs, together with the number of blows per 150mm penetration.

Static Cone Penetrometer Testing and Interpretation: Cone penetrometer testing (sometimes referred to as a Dutch Cone) described in this report has been carried out using an Electronic Friction Cone Penetrometer (EFCP). The test is described in Australian Standard 1289, Test F5.1.

In the tests, a 35mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between EFCP and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of EFCP values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a sliding hammer and counting the blows for successive 100mm increments of penetration.

Two relatively similar tests are used:

- Cone penetrometer (commonly known as the Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS1289, Test F3.2). The 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.
- Perth sand penetrometer – a 16mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test F3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

LOGS

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

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

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

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it 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 and may not be the same at the time of construction.
- 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 be washed out of the hole or 'reverted' chemically if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after stabilising at intervals ranging from several days to 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 perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg bricks, steel etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soil for Engineering Purposes'*. Details of the test procedure used are given on the individual report forms.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg to a twenty storey building). If this happens, the company 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 aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.

If these occur, the company will be pleased to assist with investigation or advice to resolve any problems occurring.

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, the company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed that at some later stage, well after the event.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Attention is drawn to the document *'Guidelines for the Provision of Geotechnical Information in Tender Documents'*, published by the Institution of Engineers, Australia. Where information obtained from this investigation 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. The company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

REVIEW OF DESIGN

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer.

SITE INSPECTION

The company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or

iii) full time engineering presence on site.

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GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS

SOIL


FILL


TOPSOIL


CLAY (CL, CH)


SILT (ML, MH)


SAND (SP, SW)


GRAVEL (GP, GW)


SANDY CLAY (CL, CH)


SILTY CLAY (CL, CH)


CLAYEY SAND (SC)


SILTY SAND (SM)


GRAVELLY CLAY (CL, CH)


CLAYEY GRAVEL (GC)


SANDY SILT (ML)


PEAT AND ORGANIC SOILS

ROCK


CONGLOMERATE


SANDSTONE


SHALE


SILTSTONE, MUDSTONE, CLAYSTONE


LIMESTONE


PHYLLITE, SCHIST


TUFF


GRANITE, GABBRO


DOLERITE, DIORITE


BASALT, ANDESITE


QUARTZITE

DEFECTS AND INCLUSIONS


CLAY SEAM


SHEARED OR CRUSHED SEAM


BRECCIATED OR SHATTERED SEAM/ZONE


IRONSTONE GRAVEL


ORGANIC MATERIAL

OTHER MATERIALS


CONCRETE


BITUMINOUS CONCRETE, COAL


COLLUVIUM

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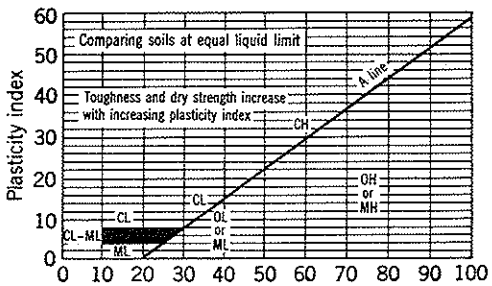
UNIFIED SOIL CLASSIFICATION TABLE

Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights)						Group Symbols [a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils: More than half of material is *larger* than 75 μm sieve size[b] (The 75 μm sieve size is about the smallest particle visible to naked eye)	Gravels: More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	Use grain size curve in identifying the fractions as given under field identification Determine percentages of gravel and sand from grain size curve Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP* More than 12% *GM, GC, SM, SC* 5% to 12% *Borderline* cases requiring use of dual symbols $C_U = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *GW* Atterberg limits below "A" line, or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols Atterberg limits above "A" line, with *PI* greater than 7
			Predominantly one size or a range of sizes with some intermediate sizes missing			*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)			*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)			*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		
	Sands: More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes			*SW*	Well graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *SW* Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols Atterberg limits below "A" line with *PI* greater than 7
			Predominantly one size or a range of sizes with some intermediate sizes missing			*SP*	Poorly graded sands, gravelly sands, little or no fines		
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)			*SM*	Silty sands, poorly graded sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)			*SC*	Clayey sands, poorly graded sand-clay mixtures		
Fine-grained soils: More than half of material is *smaller* than 75 μm sieve size	Identification Procedures on Fraction Smaller than 380 μm Sieve Size								
	Silts and clays: liquid limit less than 50		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)				
			None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)	
			Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity		
	Silts and clays: liquid limit greater than 50		Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays		
			Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity		
Highly Organic Soils			Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils		



Plasticity chart
for laboratory classification of fine grained soils

NOTE: 1) Soils possessing characteristics of two groups are designated by combinations of group symbols (e.g. GW-GC, well graded gravel-sand mixture with clay fines).

2) Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.

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LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record		Standing water level. Time delay following completion of drilling may be shown.
		Extent of borehole collapse shortly after drilling.
		Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
	ASB	Soil sample taken over depth indicated, for asbestos screening.
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.
	SAL	Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of Undrained Shear Strength.
	PID = 100	Photoionisation detector reading in ppm (Soil sample headspace test).
Moisture Condition (Cohesive Soils)	MC > PL	Moisture content estimated to be greater than plastic limit.
	MC ≈ PL	Moisture content estimated to be approximately equal to plastic limit.
	MC < PL	Moisture content estimated to be less than plastic limit.
(Cohesionless Soils)	D	DRY - runs freely through fingers.
	M	MOIST - does not run freely but no free water visible on soil surface.
	W	WET - free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT - Unconfined compressive strength less than 25kPa
	S	SOFT - Unconfined compressive strength 25-50kPa
	F	FIRM - Unconfined compressive strength 50-100kPa
	St	STIFF - Unconfined compressive strength 100-200kPa
	VSt	VERY STIFF - Unconfined compressive strength 200-400kPa
	H	HARD - Unconfined compressive strength greater than 400kPa
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other tests.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (I_D) Range (%)** / **SPT 'N' Value Range (Blows/300mm)**
	VL	Very Loose: <15 / 0-4
	L	Loose: 15-35 / 4-10
	MD	Medium Dense: 35-65 / 10-30
	D	Dense: 65-85 / 30-50
	VD	Very Dense: >85 / >50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other tests.
Hand Penetrometer Readings	300 250	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise.
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Tungsten carbide wing bit.
	T 60	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.

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LOG SYMBOLS

ROCK MATERIAL WEATHERING CLASSIFICATION

TERM	SYMBOL	DEFINITION
Residual Soil	RS	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely weathered rock	XW	Rock is weathered to such an extent that it has "soil" properties, ie it either disintegrates or can be remoulded, in water.
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh rock	FR	Rock shows no sign of decomposition or staining.

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining, Science and Geomechanics. Abstract Volume 22, No 2, 1985.

TERM	SYMBOL	Is (50) MPa	FIELD GUIDE
Extremely Low:	EL	0.03	Easily remoulded by hand to a material with soil properties.
Very Low:	VL	0.1	May be crumbled in the hand. Sandstone is "sugary" and friable.
Low:	L	0.3	A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
Medium Strength:	M	1	A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
High:	H	3	A piece of core 150mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
Very High:	VH	10	A piece of core 150mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
Extremely High:	EH		A piece of core 150mm long x 50mm dia. is very difficult to break with hand-held hammer. Rings when struck with a hammer.

ABBREVIATIONS USED IN DEFECT DESCRIPTION

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to the long core axis (ie relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Ironstained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	