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Report on
Preliminary Geotechnical and Hydrogeological Investigation Report

Warringah Mall Stage 2
145 Old Pittwater Road, Brookvale

Prepared for
Scentre Design & Construction Pty Ltd

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July 2018

Douglas Partners
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1. Introduction

This report presents the results of a preliminary geotechnical and hydrogeological investigation report undertaken for Stage 2 of the Warringah Mall redevelopment at 145 Old Pittwater Road, Brookvale. The report was commissioned in an Aconex correspondence (SGD-GCOR-000015) dated 17 October 2016 by Mr Wail Thomas of Scentre Design & Construction Pty Ltd and was undertaken in accordance with the Douglas Partners Pty Ltd (DP) proposal SYD161219 dated 13 October 2016.

It is understood that the Stage 2 development at the site will include extending, redeveloping and refurbishing the existing multi-storey shopping complex within the Stage 2 area, including extension of existing multi-storey car park up to Level 1M.

DP has undertaken numerous geotechnical, environmental and hydrogeological investigations at the Warringah Mall site over many years, and for various purposes. This report is intended to compile and assess the relevant information of those previous reports, for the Stage 2 development, superseding previous advice and recommendations in relation to the Stage 2 area.

The aim of this desk top study is therefore intended to:

- Consolidate the results of past geotechnical investigation in the Stage 2 area;
- Summarise groundwater level monitoring, particularly results that affect the Stage 2 area;
- Summarise the results of acid sulphate soil testing in the Stage 2 area;
- Address geotechnical stability in relation to the “Area B” part of the LEP Land Slip Risk map; and
- Identify possible further investigation for geotechnical, hydrogeological or acid sulphate soil assessment purposes in the Stage 2 area.

DP have previously prepared a Phase 2 Contamination Assessment for the Stage 2 area (DP Report 71015.18, dated December 2013), and an Acid Sulphate Soil Management Plan (DP Report 71015.37.R.002.Rev1, dated July 2018).

2. Site Description

The greater Warringah Mall site is a large shopping mall complex with significant frontages to Old Pittwater Road, Cross Street and Condamine Street/Pittwater Road, to the south, north and east of the site, respectively. Commercial and industrial properties adjoin the western site boundary. The general layout of the site is shown in Drawing 1, in Appendix B.

The greater site is largely occupied by the existing multi-storey shopping mall buildings and associated multi-level parking structures, with some on-grade, asphaltic concrete parking. The proposed Stage 2 works are located towards the eastern side of the site, with its approximate extent shown in Drawing 1. The Stage 2 development area includes the eastern on-grade car parking areas, access roads towards the north, and parts of the existing multi-storey shopping centre. For the purpose of this report, the Stage 2 development or 'works' area is referred to as "the site", while the greater Warringah Mall site is referred to as the "greater site" or the "Warringah Mall site".

2.1 Water Bodies and Topography

The natural or pre-development alignment of Brookvale Creek crosses through the Warringah Mall site, as shown in Drawing 1, based on historic aerial imagery. Subsequent development has resulted in the creek being culverted below the site.

Ground levels within the Stage 2 area are generally near-level to gently sloping, with typical levels between approximately RL 8.5 and RL 10.5, with the lowest ground levels in the car park areas over the former Brookvale Creek alignment. Ground levels rise locally along the Pittwater Road frontage (to approximately RL 11, but up to RL 12 at the Pittwater Road/Condamine Street intersection), and towards the south-western corner of the site (to approximately RL 12 to RL 18 along Old Pittwater Road).

2.2 Geology and Regional Mapping

Reference to the Sydney 1:100 000 Geological Series Sheet indicates that Stage 2 area is mainly underlain by stream alluvium and estuarine deposits comprising silty to peaty quartz sands, silt and clay with ferruginous and humic cementation in places and common sea shells. Hawkesbury Sandstone is also present in the mapping, at the south-western part of the greater site, and east of the site beyond Pittwater Road. Hawkesbury Sandstone typically comprises medium to coarse grained quartz sandstone, shale, carbonaceous claystone, laminite (thinly interbedded siltstone and fine grained sandstone) and fine to medium grained lithic sandstone. Escarpments and outcrops of Hawkesbury Sandstone are also present west and south of the site.

The regional geological mapping at the Warringah Mall site is shown in Figure 1, which indicates mapping of stream alluvial and estuarine deposits in yellow, and Hawkesbury Sandstone in green. A west-north-west to east-south-east dyke is also mapped south of the site, shown as a dotted black line.

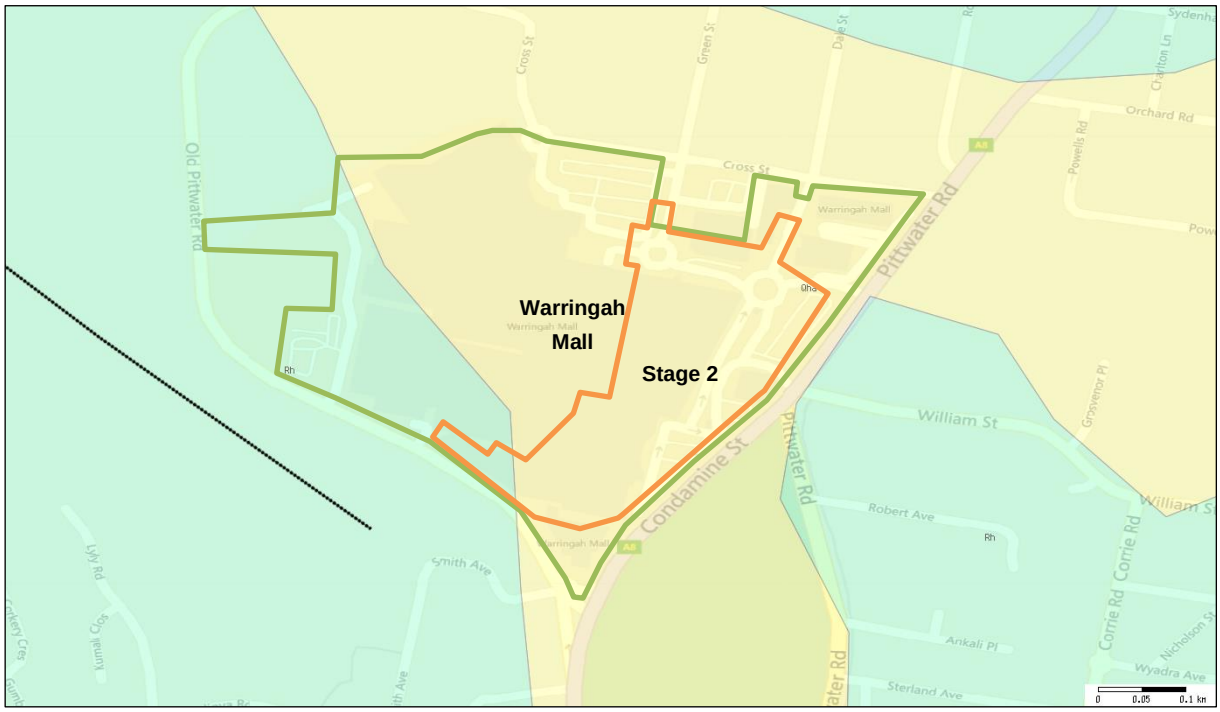


Figure 1: Extract of regional geology mapping at Warringah Mall

The results of previous geotechnical investigation at the site are generally consistent with the above mapping, although sandstone is expected to be present at relatively shallow depth over a greater part of the south-western Stage 2 area, and for a local area near the Pittwater Road/Condamine Street intersection.

Information from previous investigation reports indicates that an igneous dyke has been identified in the escarpment to the northwest of the site. The dyke has a strike of about 130°, which, if extrapolated, suggests that the dyke probably passes under the Warringah Mall site. Earlier examination of an exposure of the dyke indicated that it comprised soft white clay, with an average width of 1.5 m between Hawkesbury Sandstone outcrops. Many igneous dykes within the Sydney region are extremely weathered, forming soft to stiff clays to depths of up to 30 m. Earlier examination of aerial photographs of the area where the dyke is exposed indicated that the dyke is likely to have affected a zone about 50 m width along its length.

Reference to the 1:100 000 Soil Landscape Series Sheet indicates that the site is mainly underlain by disturbed soils, as shown in Figure 2. At its southern end, the Stage 2 area is mapped as partly underlain by the erosional Lambert soil landscape (shown in pink, derived from Hawkesbury Sandstone), and the Warriewood swamp landscape (shown in green).

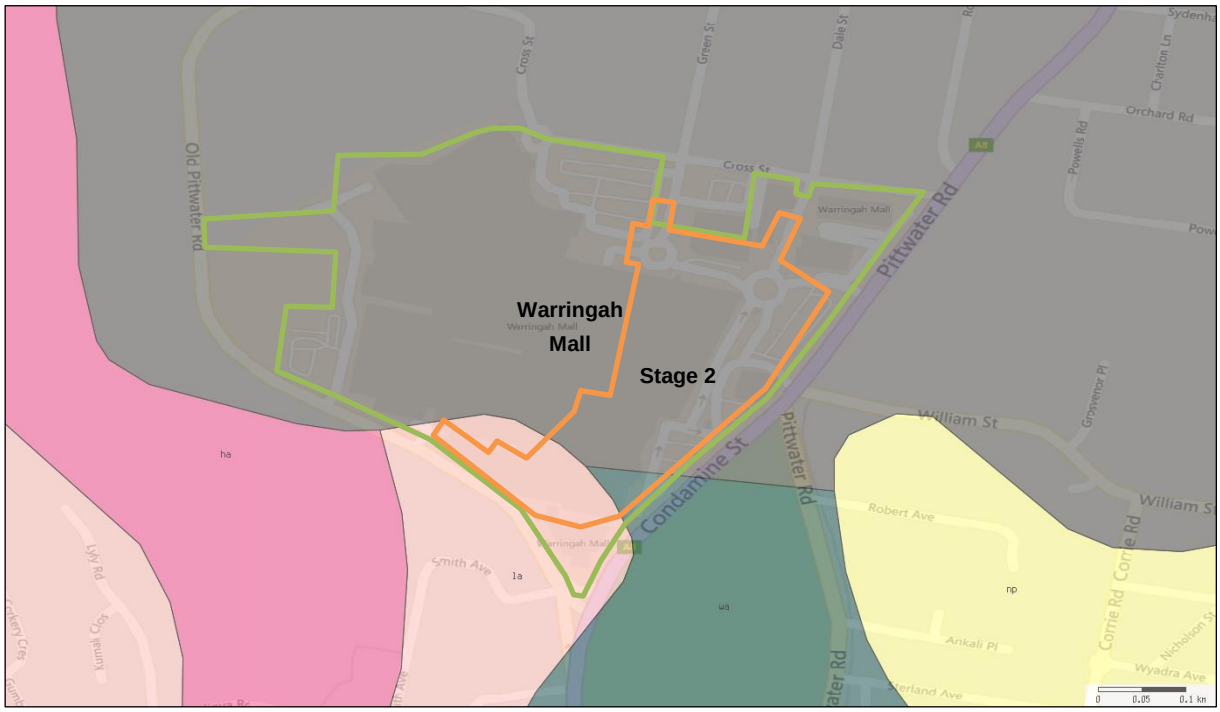


Figure 2: Extract of soil landscape mapping at Warringah Mall

The results of past investigation are generally consistent with the above soil landscape mapping, although disturbed ground is generally present in all areas and the swamp landscape is slightly more extensive than shown.

Reference to the Acid Sulphate Soil Risk mapping (digital data supplied by the NSW Department of Environment and Climate Change, based on published 1:25 000 Acid Sulphate Soil Risk Mapping, 1994-1998) indicates that the site is partly underlain by areas at “no known risk”, while other areas, including much of the northern half of the Stage 2 area, are underlain by soil with “low probability of occurrence” of acid sulphate soil (ASS). This soil mapping is generally not expected to contain ASS materials, although localised occurrence may occur. An extract of the mapping is shown in Figure 3, with areas of “low probability of occurrence” shown in orange.

Figure 3: Extract of acid sulphate soil risk mapping at Warringah Mall

The results of past investigation suggest that some acid sulphate soil is present, as is discussed in greater detail in Section 6.1.2 of this report.

3. Background

DP has undertaken several environmental and geotechnical investigations at Warringah Mall over the years for various stages of development, including assessments aided by investigations by others. These past investigations range from early works undertaken in the 1960s, to more recent investigations in 2014 and 2015.

These previous investigations of the Stage 2 area have found sands, clays and peats overlying sandstone, with sandstone found at shallow depth in some local areas. A deeply incised in-filled valley (palaeochannel) occurs within the sandstone below the site, passing below the Stage 2 area, with soil depths of over 20 m.

A broad outline of the field work methods, results and associated (geotechnical) laboratory testing previously undertaken is included below.

3.1 Field Work Methods

The methods used for past field work, and quality of that information can be broadly placed in the following categories:

- **Cored boreholes** – boreholes where drilling has been undertaken to bedrock then extended into the underlying rock using core drilling techniques. This method allows improved assessment of the rock strength and of defects within the rock;
- **Cone penetration tests (CPTs)** – involving an instrumented, cone-tipped rod being pushed into the ground, with regular readings take of cone resistance and shaft friction, and interpreted to provide information on soil properties. Generally CPTs provide a higher degree of detail on subsurface soil strength and variability when compared to boreholes. CPTs do not provide direct information on the rock, however the top of bedrock may be inferred from CPT refusal. Where the rock is deeply weathered, CPTs may advance through extremely weathered material, but would generally refuse on low and medium strength bands. CPTs that were discontinued at shallow depth due to refusal (e.g. on cobbles within filling) have not been considered;
- **Drilled-to-rock boreholes –** where boreholes have been taken down to bedrock using auger or rotary drilling methods, and where the rock strength is generally assessed based on resistance to drilling and/or cuttings on the auger. Also in this category are locations where the boreholes have been extended into the underlying rock using core drilling techniques, but where only limited information is available on the retrieved rock core (e.g. brief text description only);
- **Shallow boreholes** – where boreholes have been taken to relatively shallow depth (i.e. above the depth of refusal). These boreholes have often been undertaken for environmental or groundwater monitoring purposes, and therefore typically do not include testing for soil strength;
- **Limited information** – Where the drilling details are unknown and only 'point information' is available (e.g. bedrock levels from external reports, or from foundation inspections); and
- **Groundwater wells** – Where standpipes have been installed to allow medium or long-term measurement of groundwater levels at the site.

The approximate locations of tests for cored boreholes, CPTs, drilled-to-rock boreholes and limited information (from external reports) are shown in Drawing 2 (in Appendix B), for the greater Warringah Mall area. Approximate locations of shallow boreholes and of limited information (from inspections) in the Stage 2 area only, have been superimposed on the above test results in Drawing 2.

Standpipes were installed at some test locations during the various phases of field work, and are shown circled in blue in Drawing 2. Some of these standpipes are no longer accessible for groundwater level readings.

The past test locations falling in and around the Stage 2 area are summarised in Table C1, in Appendix C.

DP note that ground conditions may change from those encountered at the time of the original investigation due to natural processes, but also due to human influences (e.g. subsequent development of the site).

3.2 Field Work Results

Selected results of field work testing within the Stage 2 area are included in Appendix C, together with notes on classification terms and CPT interpretation. Generally, older test results have been excluded from the Appendix due to potential misinterpretation or misapplication of results (e.g. due to

subsequent changes in logging terminology, and/or site development). The selected test results are noted in Table C1, in Appendix C.

A summary of groundwater measurements from standpipes within the Stage 2 area is included in Table C2 in Appendix C, together with the results of field measurements obtained at the time of the field work. Groundwater depths of 2.7 m to 4.6 m below surface levels are indicated at the standpipe locations.

An interpreted summary of the field work results is provided in the geotechnical model in Section 6.1 of this report.

4. Past Laboratory Testing

From a geotechnical perspective, recent laboratory testing undertaken within the Stage 2 area has included:

- Acid Sulfate Soil (ASS) screening and assessment for selected bores (original report 71015.18); and
- Selected chemical testing of soil samples for assessment of soil aggressivity.

The ASS field screening was undertaken on samples from three boreholes within the Stage 2 area, as part of the investigation for the new culvert alignment. The three boreholes are marked in red in Drawing 2, in Appendix B. Selected samples were issued for sPOCAS laboratory testing. The detailed results are provided in our Report 71015.18, and a summary of the results of the screening and laboratory testing is included in Appendix D.

A summary of the results of chemical testing for subsurface aggressivity from test locations in the Stage 2 area is included in Appendix D, together with the detailed lab results.

Discussion of the results of the laboratory testing is included in Section 6.1.2 and Section 6.5.3 for the ASS results and aggressivity testing, respectively.

5. Proposed Development

The proposed development for the Stage 2 works of the Warringah Mall Redevelopment will generally include:

- Demolition of part of the retail centre, car park and associated structures located in the eastern parts of the centre;
- Construction of new multi-storey retail and the extension of existing multi-storey car park up to Level 1M, with associated access roads and ramps;
- Refurbishment and redevelopment of existing buildings, including modification and conversion of existing retail areas, and the construction of additional levels on some existing buildings;

- Minor earthworks across the general Stage 2 area for levelling and site preparation, pavement and slab construction and services, with such excavations generally expected to be less than 1 m depth; and
- Local, deeper excavation for a new loading bay access road between two existing buildings in the south-western corner of the Stage 2 area.

Excavation for the new loading bay access road will involve lowering the existing ground level between the southern shopping centre and cinema buildings, to be approximately level with the ground floor of these adjacent buildings. Based on the preliminary drawings provided to date, this will involve excavation to a depth of approximately RL 8.5 in this area. This corresponds to excavation depths of approximately 1 m towards the eastern side of the existing buildings, increasing to depths of up to approximately 8 m to 9 m below the higher ground levels towards the Old Pittwater Road frontage.

6. Comments

6.1 Geotechnical and Hydrogeological Model

Based on the available information, the subsurface profile at the site may be broadly characterised by Table 1, below.

Table 1: Summary of Typical Geotechnical Conditions

Typical Conditions	Description	Depth and Extent
Pavement materials and filling	Filling materials of variable depth, composition and compaction	To typical depths of 0.7 m to 2.5 m below ground level, extensive across the site
Variable, and often soft and loose sediments	Including very soft to firm clay, organic of peaty clay and silt, and very loose to medium dense sand and silty sand. Some medium dense to dense and stiff layers	To variable depths of up to approximately 20 m below ground level at test locations, but potentially deeper in some areas. Present across most of the Stage 2 site, but locally absent in the south-western area and towards the Condamine Street/Pittwater Road intersection
Stiff and medium dense soils or stronger	Including medium dense and dense sand and very stiff and hard clay and sandy clay. Some layers within these soils include gravel and ironstone and/or comprise residual soils	Absent in some areas, but generally overlying areas of shallow rock, and present in the lower parts of the paleochannel below approximately RL -10

Typical Conditions	Description	Depth and Extent
Hawkesbury Sandstone	Extremely low strength to high strength sandstone. May include very high strength bands and clay seams.	Typically relatively shallow (<3 m) at the south-western part of the site and near the intersection of Condamine and Pittwater Road. Rock levels fall gradually from the high point in the northern part of the site, with rock levels typically above RL 0, while in the southern part of the site rock levels fall rapidly from areas of shallow rock, to RL-20 centrally in the southern part of the site. Deeper rock may be present in some areas.

6.1.1 Groundwater

Past groundwater assessments and modelling has indicated that groundwater flow is generally toward the former alignment of Brookvale Creek (shown in the attached Drawing 1) and the nearby culvert alignment. Groundwater is inferred to flow:

- To the west or south-west at the northern part of the site; and
- To the north or north-east at the southern end of the site.

Groundwater levels were generally measured at 2 m to 4 m below ground level in the Stage 2 area. Ephemeral, perched water seepage or 'ponding' may occur within soil and rock above the permanent groundwater level, particularly following rainfall events. It is noted that some areas are susceptible to flooding, and that higher groundwater levels may potentially occur.

6.1.2 Acid Sulphate Soils

Based on the ASS field screening results and laboratory test results in the Stage 2 area, it has been assessed that:

- Potential acid sulphate soils (PASS) is present in alluvial soils below the water table within the site;
- Some natural alluvial soils above the water table could be PASS, although not to the same degree as that identified below the water table; and
- Near surface filling such as ripped/crushed sandstone is not considered to be PASS, although it may have acidic properties. It is noted, however, that Warringah Mall is within an area of highly disturbed terrain and that pockets of filling may have been sourced locally from areas of acid sulphate soils. Therefore filling, other than near-surface filling materials such as crushed sandstone and roadbase, are considered to be possible PASS, particularly filling close to the groundwater table.

The laboratory results indicate that the soils exceed the action criteria for disturbance of more than 1000 tonnes of soil, and therefore an acid sulphate soil management plan (ASSMP) has been prepared for the site (refer to DPs ASSMP dated December 2016).

6.2 Site Preparation and Earthworks

Site preparation and earthworks are expected to be required for any new on-grade pavements and slabs, particularly where re-grading of the existing ground levels is proposed.

Changes from existing site levels are a significant issue on this site due to the presence of weak alluvial soils underlying an upper, variable, but often well-compacted filling layer. In areas underlain by alluvial soils, proposed cuts will reduce the thickness of the overlying, more competent filling layer, while proposed fill may increase loads on the underlying soft soils, resulting in settlement. Settlement of soft soils may potentially increase structural and/or geotechnical loading on existing piles founded within or through the softer strata.

6.2.1 General Recommendations on Site Preparation

In areas where pavements or slab-on-ground construction is proposed, appropriate preparation of the underlying subgrade will be critical to the performance of the structure. Where slabs are to be suspended (as may be adopted for the new mall areas) some site preparation is still likely to be required to suit construction traffic. Where loading from construction traffic is high (e.g. piling rigs), this may require the design of specific working platforms (see Section 6.8).

Given the potential for flooding at the site, it is recommended that only coarse granular materials (e.g. gravel, crushed sandstone, crushed concrete) be used for the replacement filling.

The test results indicate that the existing filling at the site is variable in compaction and consistency. From a geotechnical perspective, the re-use of existing granular filling is considered appropriate at the site, however reference should also be made to the results of the contamination assessment at the site (refer DP Report 71015.18). As variable filling is present, considerable care is likely to be required to keep granular and clay filling layers separate, and allowance should be made for rejection of a significant portion of these materials. Given the variability of existing filling encountered at test locations, the following minimum site preparation is recommended where long-term pavement or slab-on-ground is proposed:

- Remove existing pavement layers and filling to 0.6 m below proposed pavement or slab levels. Where over 0.6 m of filling will be required over existing levels, no preliminary excavation is required;
- Proof-roll the exposed surface using a minimum 10 tonne deadweight smooth drum roller in non-vibration mode. The subgrade should be rolled a minimum of six times, with the last two passes observed by an experienced geotechnical engineer to detect any soft spots;
- Any soft areas identified during proof rolling should be removed as directed by the geotechnical engineer. This is likely to include excavation to a depth not exceeding 0.6 m (and not below the groundwater table), followed by the placement of a geotextile separator material and then compacted crushed concrete or gravel back to the desired level;
- Replacement (granular) filling should then be placed in loose layer thickness not greater than 300 mm and compacted to 75% density ratio. Thinner layers may be required if only light plant is available. The select filling should be free of oversize particles (>100 mm) and other deleterious material. Depending on the condition of the excavated subgrade, and the proposed filling material, geofabric may be required below the replacement filling layers; and

- Density testing of the filling should be carried out in accordance with AS3798 “Guidelines for earthworks for commercial and residential developments”

It is noted that the removal of all existing filling from the site, as would generally be appropriate for the construction of controlled filling platforms, is generally not recommended at this site due to the expected weak subgrade soils and relatively high groundwater table.

It is further noted that due to the potential for differential settlement, a more detailed bridging earthworks design may be appropriate near the boundary between on-grade pavements and those supported or underlain by piled structures (e.g. over culverts or piled building slabs), depending on the accepted performance and maintenance requirements of the pavements.

The above comments are provided for typical site preparation. Further advice and specific pavement design would be appropriate, however, particularly where high loadings are proposed in the short or long term (refer also discussion in Section 6.8).

6.3 Excavation Conditions

Minor excavations of the order of 0.5 m to 1 m below existing ground levels into filling and natural soils, or extremely to low strength rock should be readily performed using conventional earthmoving equipment such as excavators or small bulldozers. Some local hammering or ripping may be required in low strength rock, or if the filling includes cement-stabilised layers or boulders.

Where bulk excavation removes a significant depth of filling, the trafficability of the site may be influenced by the weaker underlying soils. In this case, a working platform should be considered, or it may be necessary to allow for tracked equipment. If soft and loose material is exposed then swamp dozers may be required.

Deeper excavation is anticipated for the access road at the southern end of the Stage 2 works. In this area, past investigation suggests that excavation into low and medium, and possibly high strength rock may be required. Excavation of such materials may require hydraulic rock breakers in conjunction with rock saws, milling heads and heavy ripping. Rock saws or milling heads will likely be required to reduce vibrations near existing structures for human comfort and to reduce the potential for causing damage to adjacent structures.

Further investigation may be appropriate once further details of the excavation extent and depth are available.

Based on the available information and current site conditions, excavation below the permanent groundwater table is not anticipated, except for deep foundation works. No impact is expected on the permanent water table or groundwater flows. Seepage into shallow excavations may nonetheless occur (e.g. due to infiltration of rainfall) and/or subsurface ‘ponding’ or preferential seepage of water above low permeability zones (e.g. towards the base of granular filling, or above bedrock).

6.3.1 Acid Sulphate Soils

While excavation is not generally expected below the groundwater table, acid sulphate soils may be present in alluvial soils above the groundwater table, and in filling materials derived from the alluvial soils. Reference should be made to the ASSMP for excavation of these materials.

6.3.2 Vibrations

Vibrations may be induced by a large number of site activities, including excavation and piling works, and may be a concern at this site due to potential disruption of customers and tenants of Warringah Mall.

The Australian Standard AS2670.2-1990 “Evaluation of human exposure to whole-body vibrations – continuous and shock induced vibrations in buildings (1-80 Hz)” indicates an acceptable day time limit of 8 mm/s vertical peak particle velocity (PPVz) for human comfort. Ground vibration, however, can be strongly perceptible to humans at levels above 2.5 mm/s vector sum peak particle velocity (VSPPV) and can be disturbing at levels above 5 mm/s VSPPV. Complaints from residents and building occupants are sometimes received when levels are as low as 1 mm/s VSPPV.

By comparison, the German Standard DIN4150-3-1999 “Structural vibration – effects of vibration on structures” recommends that ground vibration at the foundation level of sensitive buildings be limited to 8 mm/s for mid-range frequencies. It should also be noted that even low vibration levels (of approximate 5 mm/s) are known to potentially cause compaction of very loose and loose sand layers, as are present at the site.

Where vibrations are a concern for the operation of plant at the site, consideration should be given to vibration trials at the commencement of work, which may indicate minimum set-backs from existing buildings or sensitive areas, and vibration monitoring.

Care should be taken in adopting a vibration limit as low limits may have a significant impact on the duration of works. In practice, some balance must usually be met between acceptable vibration levels and the duration of works.

6.3.3 Batter Slopes

Batter slopes may be appropriate for the sides of shallow excavations above the groundwater table. Such batters are likely to be within filling materials or the alluvial soils. Within moderately to well-compacted filling materials, or stiff to very stiff residual soils, temporary batter slopes of 1.5H:1V are recommended for slopes of a maximum height of 3 m. Where batters extend into the underlying soft and loose natural soils, flatter temporary batter slopes of 2H:1V are likely to be required, for slopes of a maximum height of 1.0 m. Higher slopes will require specific assessment.

It is suggested that the maximum permanent batter slope in the soils should be 2H:1V. Permanent batters would generally require protection against surface erosion and it is recommended that the batters be covered by topsoil and that vegetation be established as soon as possible after construction of the batters. It is noted that for ready, long-term maintenance, even flatter slopes (e.g. 3H:1V) may be appropriate.

The above batter slopes assume a level ground surface above and below the batter slope, no seepage through the batter, with no surcharges beyond the crest. More detailed assessment of batter slopes would be appropriate where shallow foundations or surcharges (e.g. traffic loadings) exist in close proximity to the crest of the batter slope.

6.3.4 Retaining Structures

Retaining structures are anticipated at the end of the access road at the southern end of Stage 2, towards Old Pittwater Road, and potentially around the eastern sides of the car park areas, depending on final levels, possible batter slopes and landscaping.

Where the retaining walls are designed as cantilevered, gravity or single (row) propped/anchored retaining walls, with a level retained surface, then preliminary design of the walls may be based on the parameters give in Table 2, and adopting a unit weight of 20 kN/m^3 in the soils.

Table 2: Preliminary Parameters for Cantilevered or Gravity Retaining Walls

Soil Type		Active Earth Pressure Coefficient (Ka)	
		Short Term	Long Term
Filling	Poorly compacted or variable	0.3	0.4
	Moderately or well compacted	0.25	0.3
Sand	Very loose and loose	0.4	0.4
	Medium dense	0.3	0.3
Clay	Soft to firm	0.4	0.4
	Stiff	0.25	0.3

The above values assume that some deformation of the retaining wall may occur. Where deformation must be limited, the use of 'at rest' earth pressures 50% higher than the active earth pressure coefficients are recommended. Higher values would be appropriate where batters are present behind the wall, and allowance should be made for surcharges behind the wall (e.g. due to traffic, stockpiles or compaction).

Retaining structures should be designed to be free-draining (e.g. with free draining backfill and suitable subsoil drainage installed to discharge the water collected in the backfill), or be designed for full hydrostatic pressures.

The deep excavation for the proposed access road at the southern end of the Stage 2 area will entail deepening the ground level between the buildings to the approximate ground floor level of the buildings. Batters or retaining structures for this excavation are likely to be limited to the western end of the access road. Based on the expected local ground conditions of residual soil underlain by Hawkesbury Sandstone, soldier piles are likely to be an appropriate retaining wall type. The wall may need to be anchored depending on permissible deflections, and the proximity of the wall to nearby roads, foundations or other surcharges.

Supplementary investigation in this area may be appropriate to provide parameters for detailed design of retaining walls in this area, or for assessment of appropriate batters. Should the excavation be close to the adjacent road reserve, then deflection monitoring may be required during excavation, depending on the requirements of the relevant authority.

6.4 Land Slip Risk Assessment

Reference to the Warringah Council Landslip Risk Map, indicates that the Stage 2 area is generally classified as "Area A – Slope less than 5 degrees", with a local zone at the southern end of "Area C – Slope more than 25 degrees". An extract of the mapping is included in Figure 4, below.

Figure 4: Extract of Landslip Risk Map (Warringah Council, accessed 7/11/16) with Area A in yellow, and Area C in pink.

Within Area C of the Stage 2 development, the proposed development includes:

- Local excavation for a new loading bay access road between the cinemas and shopping centre buildings (at the southern tip of the Stage 2 works); and
- Extensions, additions and refurbishment of the existing car park and shopping centre buildings;

Slope instability during the works within this 'Area C' part of the Stage 2 works has been assessed for risk to property and life using the general methodology outlined by the Australian Geomechanics Society (Landslide Risk Management (AGS) Subcommittee, 2007).

Identified hazards within this area are summarised in Table 3, together with qualitative assessment of likelihood, consequence and slope instability risk to property after completion of construction including appropriate engineering design and construction works. In the absence of detailed information on the proposed works, both batter slopes and retaining walls options have been considered.

Table 3: Quantitative Property Risk Assessment for Proposed Development

Hazard		Likelihood	Consequence	Risk
1	Very slow settlement of existing foundations under increased loads	Unlikely – following geotechnical and structural assessment of existing footings, and changed loadings, but depending on variability between locations	Insignificant – some very minor rectification works may be required	Very low
2a	Moderate erosion/slumping of short-term batters due to surface water flows	Unlikely – provided appropriate slope protection and upslope drainage and maintenance	Insignificant – some minor, short-term rectification	Very low
2b	Moderate erosion/slumping of long-term batters	Unlikely – provided appropriate slope protection and upslope drainage is provided, and maintenance undertaken	Minor – some limited stabilisation works may be required	Low
3a	Moderate global instability of batter slope during excavation	Rare – provided appropriate geotechnical investigation and assessment, and regular geotechnical inspections during excavation to confirm conditions	Medium to Major – depending on proximity of batters to property boundary. Stabilisation and rectification works required	Low
3b	Moderate global instability of long-term batter slope	Rare – subject to excavation in accordance with Hazard 3a, and appropriate slope maintenance	Medium to Major – depending on proximity of batters to property boundary. Stabilisation and rectification required.	Low
4a	Rapid failure of retaining wall	Rare – for retaining wall designed and constructed in accordance with engineering principles, with appropriate geotechnical and structural inspections	Medium to Major – depending on proximity of wall to property boundary. Rectification and stabilisation works required	Low

Hazard		Likelihood	Consequence	Risk
4b	Slow failure of retaining wall due to excessive deformation	Unlikely – for retaining walls designed and constructed in accordance with engineering principles with appropriate geotechnical and structural inspections	Insignificant to Minor – possible stabilisation required	Very low to low
5	Rapid failure of footings adjacent to excavation due to undermining	Rare – for limited, short-term excavation undertaken in accordance with geotechnical recommendations (including underpinning recommendations, if required)	Minor – some rectification works may be required.	Very low

The qualitative risk to property assessment indicates that the risk level to property is very low to low, subject to appropriate geotechnical investigation, assessment, and inputs during construction, and appropriate design methods and long term maintenance being adopted.

The AGS Practice note guidelines indicate that a “low” risk level is usually acceptable to regulators.

For loss of life, the individual risk can be calculated from:

$$R_{(LoL)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(D:T)}$$

where:

- $R_{(LoL)}$ is the risk (annual probability of loss of life (death) of an individual)
- $P_{(H)}$ is the annual probability of the hazardous event (erosion/ wall failure)
- $P_{(S:H)}$ is the probability of spatial impact by the hazard (e.g. of the failure reaching the individual, taking into account the distance for a given event)
- $P_{(T:S)}$ is the temporal probability (e.g. of the adjacent area being occupied by the individual) given the spatial impact
- $V_{(D:T)}$ is the vulnerability of the individual (probability of loss of life of the individual given the impact).

The assessed individual risk to life (person most at risk) resulting from slope instability is summarised in Table 4.

Table 4: Quantitative Life Risk Assessment for Proposed Development

Hazard		$P_{(H)}$	$P_{(S:H)}$	$P_{(T:S)}$	$V_{(D:T)}$	Risk $R_{(LoL)}$
1	Very slow settlement of existing foundations	1×10^{-4}	1	0.5	0.001	5×10^{-8}
2a	Moderate erosion/slumping of short-term batters	1×10^{-4}	0.1	0.1	0.5	5×10^{-7}
2b	Moderate erosion/slumping of long-term batters	1×10^{-4}	0.1	0.0005	0.1	5×10^{-10}
3a	Moderate global instability of batter slope during excavation	1×10^{-5}	0.5	0.1	1	5×10^{-7}

Hazard		$P_{(H)}$	$P_{(S:H)}$	$P_{(T:S)}$	$V_{(D:T)}$	Risk $R_{(LoL)}$
3b	Moderate global instability of long-term batter slope	1×10^{-5}	0.1	0.01	1	1×10^{-8}
4a	Rapid failure of retaining wall	1×10^{-5}	0.1	0.01	1	1×10^{-8}
4b	Slow failure of retaining wall due to excessive deformation	1×10^{-4}	0.001	5×10^{-4}	0.0001	5×10^{-16}
5	Rapid failure of footings adjacent to excavation due to undermining	1×10^{-5}	0.01	0.01	0.5	5×10^{-10}

Note: The assessment is based on the proposed use of the area for vehicle access to the loading bay, only.

The above annual risk of loss of life are below the acceptable risk to life level of 10^{-6} per annum suggested for new developments by the AGS.

More detailed geotechnical assessment and investigation will be appropriate prior to the works in this area, once further information is available.

The probability assessment of the hazards has assumed appropriate inspection and maintenance of any structures, slopes, drainage and stabilisation measures by the relevant parties. This would generally include regular visual inspections (e.g. annual and/or following heavy rainfall events) of the slopes and site developments, with regular maintenance and prompt rectification of any deterioration, including drainage and stabilisation measures. The appropriate methodology and monitoring during construction will depend on the specific batter or retaining options selected for the works, and requirements of the regulators. In addition, the assessments presume that design and construction is undertaken in accordance with the recommendations contained in this report.

The above risk assessment indicates that the proposed development can be undertaken while meeting the usually accepted criteria of risk to life and risk to property.

6.5 Foundations

The results of the investigation indicated that the alluvial soils at the site are variable in type and consistency. It is therefore recommended that all heavily loaded (two or more storeys) or settlement-sensitive structures should be founded on footings taken to bedrock, or on piles.

For more lightly loaded structures, shallow foundations may be feasible, but will be dependent on the local ground conditions and the relevant settlement criteria.

The site classification at the site will vary depending on location. Generally speaking, however, the site is underlain by loose and soft soil layers, overlain by thick and variable filling materials. Such a profile is consistent with a 'P' classification in accordance with AS2870. It is noted that AS2870 is intended for foundations of residential buildings, and therefore is not directly applicable to the current development. The classification does, however, provide a general indication of foundation requirements for single storey structures.

It is noted that the assessment of allowable bearing capacities within the sandstone material has generally been based on the classification methods of Pells et al (1998), by which the rock is classified based on particular strength, allowable defect and investigation criteria. Due to the additional criteria, the rock classification for foundation assessment (and the associated strength description) does not always match the strengths indicated by the rock logs. Similarly, the classification is intended for foundation design only, and other construction considerations (such as 'drillability' or 'excavatability') should not be based on the classification, but on the more detailed information available within the rock logs.

6.5.1 Shallow Foundations

Near-surface footings founded on at least stiff natural clay or at least loose to medium dense natural sand (at least 0.6 m deep) may generally be designed using a maximum allowable bearing pressure of 100 kPa. If pad or strip footings are to be used, however, total and differential settlement of the footings will be a critical factor, and specific calculations and acceptance of likely settlements should form part of the design process. It is noted that due to the variability of the sediments on the site, it is expected that shallow foundations on soil will be unsuitable for any large or long structures that are sensitive to differential settlement.

In part of the eastern side of the site, near the Condamine Street and Pittwater Street intersection, and at the south-western part of the site, the sandstone bedrock is at shallow depth, and it should be possible to found strip or pad footings directly into the rock at some locations. Recommended maximum allowable bearing pressures for the footing design of shallow foundations are provided in Table 5.

Table 5: Allowable Bearing Capacities for Shallow Foundations on Sandstone

Classification	Description	Allowable Bearing Capacity (kPa)
Class V	Very low strength sandstone	1000 kPa
Class IV	Low strength sandstone	1500 kPa

6.5.2 Pile Foundations

6.5.2.1 Pile Options

For the majority of the site, piles are likely to provide the most appropriate foundation solution. The type of pile which may be used will depend on various factors, including cost, ease of construction, noise, vibration, pile depth and applied load.

The results of the investigation indicate that ground conditions vary significantly across the site, with the depth to bedrock ranging from near surface to 30 m below ground level at test locations. In some areas, the depth to competent strata may preclude the use of some piles types. In other areas, the use of a combination of pile types may be appropriate.

In areas of high ground (e.g. piling for retaining walls in Area C) where rock levels are above groundwater levels bored piled may be appropriate. Pile casing may be required, however, if the bored piles are to be drilled through sand or soft clay layers before reaching bedrock.

Across most of the site, piling will be required for new building foundations in areas of deep alluvial soils. Based on the Stage 1 works, it is considered likely that continuous flight auger (CFA) grout-injected piles would be adopted for this purpose. This is a non-displacement pile that has relatively low noise and vibration levels. CFA piles are predominantly end-bearing piles and therefore require suitable bedrock or competent soils for the bearing stratum. A powerful rig would generally be required to obtain a reasonable socket into the sandstone.

6.5.2.2 Pile Foundation Design

Based on the results of field work, foundation design may generally be based on the bearing pressures given in Table 6.

Table 6: Maximum Bearing Pressures for CFA or Bored Pile Foundations on Sandstone

Classification	Description	End Bearing Pressure (MPa)		Socket Adhesion in Compression* (kPa)	
		Allowable	Ultimate**	Allowable	Ultimate**
Class V	Very low strength sandstone	1	3	75	150
Class IV	Low strength sandstone	1.5	4	100	250
Class III	Medium strength sandstone	3.5	20	350	800

Note: Higher strength classifications are associated with lower allowable defects. If such parameters are used, it will generally be appropriate to undertake further geotechnical drilling to obtain rock core to verify the rock classification. The appropriate proportion of cored bores will vary depending on the ground conditions encountered. It is further noted that the sandstone is affected by deep weathering in many locations on the site. It may not be practical to reach medium strength sandstone in all areas.

* For design for tension, it is recommended that a socket adhesion of 70% of the compressive value is adopted. Socket adhesion values assume at least 'R2' socket roughness

** Ultimate values occur at large settlements (>5% of the pile diameter). Pile performance at allowable bearing pressures should also be assessed, with due consideration of pile group effects.

6.5.2.3 Pile Foundation Construction and Inspection

Geotechnical inspection is recommended during bored piling to assess whether the materials returned on the auger are consistent with those required by the design.

CFA piles are a 'blind' piling method that provides limited feedback on the ground conditions encountered. It is noted, however, that some more modern drilling rigs are well-instrumented, allowing torque and depth measurements to be recorded with depth. The potential for geotechnical assessment during piling would generally be limited to assessment of the cuttings returned on the auger at the completion of the pile, and potentially review of recorded piling data, where available. Therefore, the piling company would need to be responsible for assessment during construction of whether suitable materials were encountered and whether bearing capacities meet requirements.

Given the presence of weak and variable soils and the relatively rapid transition to medium and high strength sandstone (or presence of medium and high strength bands) in some areas, particular care

will be required by the (CFA) piling contractor to avoid 'decompression' of the sediments on the site. Decompression involves the drilling auger drawing in the surrounding soils, usually due to a sudden decrease in the rate of penetration. Decompression can lead to settlement of the ground surface and damage to existing structures. For this and other reasons, only experienced piling contractors with suitable high-powered (high torque and crowding mechanism) piling rigs should be considered for this project.

Care would need to be taken during the installation of reinforcement to ensure that the reinforcement is located centrally within the pile. The soil removed from the pile hole will need to be subjected to appropriate handling and/or disposal.

In the areas of deep alluvial soils there is very limited scope for assessment of ground conditions during pile installation. The ground conditions indicated by the previous test/bore data also indicates variable ground conditions, in which reasonable quality bearing strata (e.g. medium dense sand layers) are underlain by weaker soils. Pile design should therefore include an integrated regime of ground testing, installation monitoring and pile testing.

6.5.3 Aggressivity

Chemical testing has been undertaken on selected soil samples in the Stage 2 area to assess the pH, electrical conductivity and sulphate ion and chloride ion concentrations within the soil. Readings of pH and electrical conductivity have also been obtained during groundwater monitoring works.

In summary, the results indicated:

- pH ranging from 4.4 to 11.3; with pH ranging from 4.8 to 8 within the natural soil, and from 6.8 to 11.3 within filling samples (3 samples only) and from 4.4 to 7.6 in groundwater;
- Sulphate (SO4) ion concentrations ranging from 7 to 1000 mg/kg;
- Chloride (Cl) ion concentrations ranging from 7 to 110 mg/kg; and
- Electrical conductivity ranging from 6 to 1100 µS/cm, corresponding to resistivity values of 909 to over 10 000 Ω.cm

Comparison of these results to Tables 6.4.2(C) and 6.5.2(C) of AS2159-2009 indicates a 'severe' exposure classification for both steel and concrete piles. Further specific testing of each development area may allow a reduced classification.

6.6 Settlement

Some differential movement should be anticipated between structures founded on rock, and structures or services founded within the soil. Allowance should be made for suitable structural and architectural articulation between structures, or parts of a structure, where footings found on different strata.

Settlement of foundations on rock are expected to be limited to less than 1% of the minimum footing dimension, for foundations designed on the basis of "allowable" bearing pressures provided in Table 6.

Settlement of foundations on soil may be highly variable at this site, and would require more detailed assessment.

Given the presence of loose and very loose sands and silty sands on the site, which may be susceptible to liquefaction under seismic loading, foundations on shallow soils may be susceptible to movement under earthquake loads.

6.7 Earthquake Provisions

Assessment of the site sub-soil class under AS1170.4-2007 (Structural Design – Earthquake Loads), based on the investigation to date, indicates the following Site sub-Soil Classes:

- Sub-Soil Class De – in areas with rock at depths greater than 3 m, and/or with less than 10 m of very soft clay and very loose sand present; and
- Sub-soil Class Be – locally towards the south-western part of the site and very locally towards the Condamine Street/Pittwater Road intersection, where very low strength rock is no deeper than 3 m below ground level and where no very loose sand or very soft clay is present.

It is noted that loose and very loose sands are present on the site, which may be susceptible to liquefaction under seismic loading. This could influence footings in or above such layers.

Further testing is recommended to provide greater confidence in the boundary between Class Be and Class De soils, where the difference in 'Class' is considered significant for design and construction. Alternatively, design can be broadly based on the more severe Sub-Soil Class De.

Sub-soil Class Ce is an intermediate class, and applies where more than 3 m of soil is present, but where no very loose sand or very soft clay is present. Testing to date suggests that such areas are very limited at the site, but may be present in local areas. Additional testing would be required to usefully delineate Class Ce zones, if it is useful for structural design purposes.

6.8 Pavements and Working Platforms

Specific pavement or platform design is appropriate where proposed loadings are high – such as where due to temporary high loadings (e.g. piling rigs) or long term high loadings (e.g. forklifts or regular truck traffic). These designs will depend on the specific subgrade conditions in their local areas.

Further geotechnical investigation is appropriate for pavement design. For pavement design, subgrade investigation and assessment would generally take the form of large diameter, shallow boreholes, to allow a more detailed assessment of existing pavement layers and materials, and for collection of sufficient sample for California Bearing Ratio (CBR) and density testing. For preliminary design purposes, a design CBR value of 5% would generally be suitable where there is at least 1 m of at least moderately compacted granular filling (e.g. sand or gravel) present below the subgrade level.

Working platform assessment would generally require more closely spaced tests to provide information on the variability and consistency of ground conditions. It is noted that failures of working platforms occur most frequently in the vicinity of backfilled trenches and small excavations, where backfill control may be inconsistent. As these weaker ground conditions are localised they may not be identified by testing. The contractor on site will need to pay particular attention to the location of

existing and proposed services, and to the backfilling of any excavations on site, to reduce the risk of failure.

6.9 Further Assessment and Investigation

Further geotechnical investigation is appropriate at this site. Based on the expected ground conditions, and depending on the design and construction approach adopted for the Stage 2 works, further investigation may include:

- Boreholes drilled to rock, then cored into the underlying rock, to obtain information on the rock levels and rock strength with depth across the site, for the purpose of foundation design and construction;
- Additional CPTs to delineate the boundaries between subsoil class areas, and allow further assessment of liquefaction;
- Additional CPTs/boreholes to probe the depth to rock in areas of rapidly changing sandstone levels (i.e. generally in the southern half of the Stage 2 area), with associated assessment of bedrock contours across the Stage 2 area;
- Investigation of existing foundation conditions;
- Investigation and assessment for pavement design and working platforms including laboratory CBR testing;
- Investigation for assessment of Acid Sulphate Soils. The scope for investigation is outlined in further detail in the Acid Sulphate Soil Management Plan (ASSMP, Report 71015.37.R.002), with seven boreholes proposed. Revision of the ASSMP may be appropriate depending on the results of the investigation and the detail of works in the Stage 2 area; and
- Assessment of detailed works information and the provision of geotechnical advice as appropriate.

7. Limitations

Douglas Partners (DP) has prepared this report for this project at Warringah Mall in accordance with DP's proposal dated 13 October 2016 and acceptance received from Scentre Design and Constructions dated 17 October 2017. This report is provided for the exclusive use of Scentre Design and Construction Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

The contents of this report do not constitute formal design components such as are required, by Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction of all works (not just geotechnical components) and the controls required to mitigate risk. This report does, however, identify hazards associated with the geotechnical aspects of development and presents the results of risk assessment associated with the management of these hazards. It is suggested that the developer's principal design company may wish to include the geotechnical hazards and risk assessment information contained in this report, in their own Safety Report. If the principal design company, in the preparation of its project Design Report, wishes to undertake such inclusion by use of specific extracts from this subject DP report, rather than by appending the complete report, then such inclusion of extracts should only be undertaken with DP's express agreement, following DP's review of how any such extracts are to be utilised in the context of the project Safety Report. Any such review shall be undertaken either as an extension to contract for the works associated with this subject DP report or under additional conditions of engagement, with either option subject to agreement between DP and the payee.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

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

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

Copyright

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

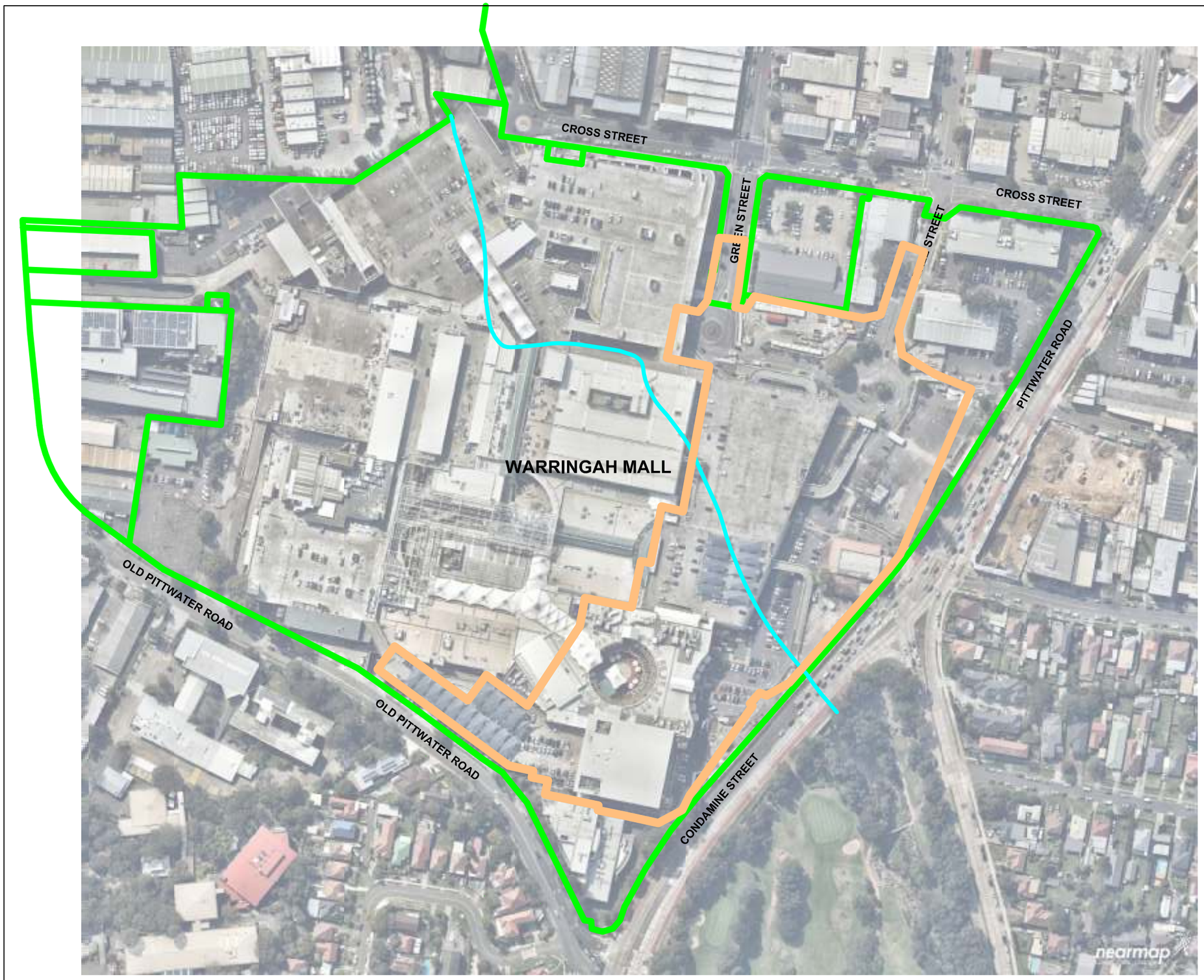
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate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

Site Inspection

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

Appendix B

Drawings



LEGEND

- Approximate Extent of Stage 2 Works
- Approximate Property Boundaries
- Approximate Pre-Development Brookvale Creek Alignment

Note: Base aerial Photograph from www.nearmap.com (dated 9/9/16, accessed 3/1/16)

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Scentre Design and Construction Pty Ltd		TITLE: **General Site Features**	PROJECT No: 71015.37
OFFICE: Sydney	DRAWN BY: SCP	**Proposed Stage 2**	DRAWING No: 1
SCALE: 1:2500	DATE: 03.11.2016	**Warringah Mall, Brookvale**	REVISION: A

N
MGA

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Scentre Design and Construction Pty Ltd		TITLE: **Test Location Plan**	PROJECT No: 71015.37
OFFICE: Sydney	DRAWN BY: SCP	**Proposed Stage 2**	DRAWING No: 2
SCALE: 1:2000	DATE: 03.11.2016	**Warringah Mall, Brookvale**	REVISION: A

MGA

Appendix C

Selected Past Field Work Results

Table C1: Summary of Past Test Locations in and around Stage 2 Area

Project	Company	Test Number	Date	Type	Plan Reference (MGA)		Results Attached
71015.01	Douglas Partners	**005**	Jul-09	shallow	**339646**	**6262324**	N
71015.01	Douglas Partners	**007**	Jul-09	drill-to-rock	**339562**	**6262190**	N
71015.06	Douglas Partners	**511**	Aug-10	drill-to-rock	**339502**	**6262163**	Y
71015.06	Douglas Partners	**512**	Aug-10	shallow	**339448**	**6262232**	Y
71015.06	Douglas Partners	**513**	Aug-10	shallow	**339491**	**6262116**	Y
71015.06	Douglas Partners	**509**	Aug-10	CPT	**339429**	**6262395**	Y
71015.06	Douglas Partners	**510**	Aug-10	CPT	**339538**	**6262213**	Y
71015.06	Douglas Partners	**511**	Aug-10	CPT	**339502**	**6262163**	Y
71015.17	Douglas Partners	**605**	Apr-13	CPT	**339479**	**6262393**	Y
71015.17	Douglas Partners	**606**	Apr-13	CPT	**339517**	**6262347**	Y
71015.17	Douglas Partners	**607**	Apr-13	CPT	**339543**	**6262341**	Y
71015.17	Douglas Partners	**608**	Apr-13	CPT	**339562**	**6262307**	Y
71015.17	Douglas Partners	**609**	Apr-13	CPT	**339621**	**6262317**	Y
71015.17	Douglas Partners	**610**	Apr-13	CPT	**339636**	**6262287**	Y
71015.17	Douglas Partners	**611**	Apr-13	CPT	**339613**	**6262252**	Y
71015.17	Douglas Partners	**612**	Apr-13	CPT	**339546**	**6262238**	Y
71015.17	Douglas Partners	**613**	Apr-13	CPT	**339555**	**6262167**	Y
71015.17	Douglas Partners	**614**	Apr-13	CPT	**339510**	**6262173**	Y
71015.17	Douglas Partners	**615**	Apr-13	CPT	**339497**	**6262125**	Y
71015.17	Douglas Partners	**616**	Apr-13	CPT	**339472**	**6262092**	Y
71015.17	Douglas Partners	**622**	Apr-13	cored	**339481**	**6262418**	Y
71015.17	Douglas Partners	**623**	Apr-13	cored	**339458**	**6262391**	Y
71015.17	Douglas Partners	**624**	Apr-13	cored	**339534**	**6262343**	Y
71015.17	Douglas Partners	**625**	Apr-13	cored	**339651**	**6262340**	Y
71015.17	Douglas Partners	**626**	Apr-13	cored	**339630**	**6262300**	Y
71015.17	Douglas Partners	**627**	Apr-13	cored	**339603**	**6262270**	Y
71015.17	Douglas Partners	**628**	Apr-13	cored	**339555**	**6262169**	Y
71015.18	Douglas Partners	**738**	Apr-13	shallow	**339512**	**6262386**	see 71015.18
71015.18	Douglas Partners	**739**	Apr-13	shallow	**339516**	**6262347**	see 71015.18
71015.18	Douglas Partners	**740**	Apr-13	shallow	**339535**	**6262343**	see 71015.18
71015.18	Douglas Partners	**741**	Apr-13	shallow	**339568**	**6262360**	see 71015.18
71015.18	Douglas Partners	**742**	Apr-13	shallow	**339615**	**6262336**	see 71015.18
71015.18	Douglas Partners	**743**	Apr-13	shallow	**339641**	**6262344**	see 71015.18
71015.18	Douglas Partners	**744**	Apr-13	shallow	**339667**	**6262342**	see 71015.18
71015.18	Douglas Partners	**745**	Apr-13	shallow	**339597**	**6262326**	see 71015.18
71015.18	Douglas Partners	**746**	Apr-13	shallow	**339621**	**6262317**	see 71015.18
71015.18	Douglas Partners	**747**	Apr-13	shallow	**339647**	**6262310**	see 71015.18
71015.18	Douglas Partners	**748**	Apr-13	shallow	**339562**	**6262307**	see 71015.18
71015.18	Douglas Partners	**749**	Apr-13	shallow	**339553**	**6262287**	see 71015.18
71015.18	Douglas Partners	**750**	Apr-13	shallow	**339607**	**6262292**	see 71015.18
71015.18	Douglas Partners	**751**	Apr-13	drill-to-rock	**339595**	**6262275**	see 71015.18
71015.18	Douglas Partners	**752**	Apr-13	drill-to-rock	**339613**	**6262267**	see 71015.18
71015.18	Douglas Partners	**753**	Apr-13	shallow	**339582**	**6262266**	see 71015.18
71015.18	Douglas Partners	**754**	Apr-13	shallow	**339605**	**6262246**	see 71015.18
71015.18	Douglas Partners	**755**	Apr-13	shallow	**339548**	**6262249**	see 71015.18
71015.18	Douglas Partners	**756**	Apr-13	drill-to-rock	**339566**	**6262238**	see 71015.18
71015.18	Douglas Partners	**757**	Apr-13	shallow	**339543**	**6262225**	see 71015.18
71015.18	Douglas Partners	**758**	Apr-13	drill-to-rock	**339549**	**6262213**	see 71015.18
71015.18	Douglas Partners	**759**	Apr-13	shallow	**339522**	**6262197**	see 71015.18
71015.18	Douglas Partners	**760**	Apr-13	shallow	**339560**	**6262201**	see 71015.18
71015.18	Douglas Partners	**761**	Apr-13	shallow	**339511**	**6262173**	see 71015.18
71015.18	Douglas Partners	**762**	Apr-13	shallow	**339524**	**6262161**	see 71015.18
71015.18	Douglas Partners	**763**	Apr-13	shallow	**339555**	**6262168**	see 71015.18
71015.18	Douglas Partners	**764**	Apr-13	shallow	**339490**	**6262149**	see 71015.18
71015.18	Douglas Partners	**765**	Apr-13	shallow	**339522**	**6262149**	see 71015.18
71015.18	Douglas Partners	**766**	Apr-13	shallow	**339510**	**6262132**	see 71015.18
71015.18	Douglas Partners	**767**	Apr-13	shallow	**339489**	**6262117**	see 71015.18
71015.18	Douglas Partners	**768**	Apr-13	shallow	**339472**	**6262093**	see 71015.18
71015.32	Douglas Partners	**CPT1**	Aug-14	CPT	**339532**	**6262134**	Y
71015.30	Douglas Partners	**VP4**	Sep-15	cored	**339473**	**6262414**	Y
71015.31	Douglas Partners	**Z7-2**	Dec-15	CPT	**339659**	**6262316**	Y
71015.31	Douglas Partners	**Z7-1**	Dec-15	CPT	**339647**	**6262302**	Y
71015.31	Douglas Partners	**Z11-4**	Dec-15	CPT	**339575**	**6262195**	Y
71015.31	Douglas Partners	**Z11-3**	Dec-15	CPT	**339564**	**6262180**	Y
71015.31	Douglas Partners	**Z11-2**	Dec-15	CPT	**339510**	**6262133**	Y

Table C1: Summary of Past Test Locations in and around Stage 2 Area

Project	Company	Test Number	Date	Type	Plan Reference (MGA)		Results Attached
71015.31	Douglas Partners	**Z11-1**	Dec-15	CPT	**339499**	**6262115**	Y
183.00	Frankipile	**B1**	Nov-60	cored/limited	**339438**	**6262105**	N
183.00	Frankipile	**B2**	Nov-60	cored/limited	**339440**	**6262115**	N
183.00	Frankipile	**B3**	Nov-60	cored/limited	**339419**	**6262124**	N
4025.00	Brickell Moss	**F8**	Nov-68	unclear/limited	**339521**	**6262174**	N
4025.00	Brickell Moss	**F9**	Nov-68	unclear/limited	**339471**	**6262196**	N
4025.00	Brickell Moss	**F10**	Nov-68	unclear/limited	**339486**	**6262263**	N
4025.00	Brickell Moss	**F11**	Nov-68	unclear/limited	**339508**	**6262256**	N
4025.00	Brickell Moss	**F12**	Nov-68	unclear/limited	**339540**	**6262246**	N
4025.00	Brickell Moss	**F13**	Nov-68	unclear/limited	**339252**	**6262174**	N
	Edwards Building Services	**G1A**	Jan-84	cored/limited	**339464**	**6262242**	N
	Edwards Building Services	**G2A**	Jan-84	cored/limited	**339482**	**6262266**	N
	Edwards Building Services	**G3A**	Jan-84	cored/limited	**339479**	**6262222**	N
	Edwards Building Services	**G4A**	Jan-84	cored/limited	**339504**	**6262211**	N
	Edwards Building Services	**G5A**	Jan-84	cored/limited	**339466**	**6262194**	N
	Edwards Building Services	**G6A**	Jan-84	cored/limited	**339504**	**6262188**	N
7196.00	Coffey	**H1**	Oct-83	drill-to-rock	**339541**	**6262295**	N
7196.00	Coffey	**H2**	Oct-83	drill-to-rock	**339496**	**6262275**	N
7196.00	Coffey	**H3**	Oct-83	drill-to-rock	**339498**	**6262212**	N
7196.00	Coffey	**H4**	Nov-83	cored	**339470**	**6262216**	N
7196.00	Coffey	**H5**	Nov-83	drill-to-rock	**339527**	**6262267**	N
7196.00	Coffey	**H6**	Nov-83	drill-to-rock	**339551**	**6262331**	N
7196.00	Coffey	**H7**	Nov-83	drill-to-rock	**339510**	**6262340**	N
7196.00	Coffey	**H8**	Nov-83	cored	**339498**	**6262306**	N
XGT0238	Longworth McKenzie	**L5**	Jul-86	unknown/limited	**339565**	**6262248**	N
XGT0238	Longworth McKenzie	**L7**	Jul-86	unknown/limited	**339577**	**6262271**	N
XGT0238	Longworth McKenzie	**L8**	Jul-86	unknown/limited	**339558**	**6262236**	N
9030-4	Douglas Partners	**O1**	Feb-90	drill-to-rock	**339457**	**6262266**	N
9030-4	Douglas Partners	**O2**	Feb-90	drill-to-rock	**339448**	**6262233**	N
9030A	Douglas Partners	**Q1**	Sep-90	cored	**339477**	**6262402**	N
9030A	Douglas Partners	**Q2**	Sep-90	CPT	**339484**	**6262419**	N
9030B	Douglas Partners	**R22**	Oct-90	cored	**339440**	**6262215**	N
9030B	Douglas Partners	**R23**	Oct-90	cored	**339439**	**6262191**	N
19950	Douglas Partners	**S128**	Jun-94	Bore	**339332**	**6262121**	N
19950	Douglas Partners	**S129**	Jun-94	CPT	**339392**	**6262161**	N
19950	Douglas Partners	**S130**	Jun-94	CPT	**339479**	**6262153**	N
19950A	Douglas Partners	**T203**	Jan-95	auger-to-rock	**339453**	**6262078**	N
23609I	Douglas Partners	**U301**	Oct-97	cored	**339285**	**6262162**	N
23609I	Douglas Partners	**U302**	Oct-97	cored	**339311**	**6262135**	N
23609I	Douglas Partners	**U303**	Oct-97	cored	**339322**	**6262152**	N
23609I	Douglas Partners	**U304**	Oct-97	cored	**339338**	**6262112**	N
23609I	Douglas Partners	**U305**	Oct-97	cored	**339358**	**6262148**	N
23609I	Douglas Partners	**U306**	Nov-97	cored	**339322**	**6262127**	N
23609I	Douglas Partners	**U307**	Oct-97	cored	**339355**	**6262103**	N
23609I	Douglas Partners	**U308**	Oct-97	cored	**339372**	**6262081**	N
23609I	Douglas Partners	**U309**	Nov-97	cored	**339390**	**6262109**	N
23609I	Douglas Partners	**U310**	Oct-97	cored	**339374**	**6262157**	N
23609I	Douglas Partners	**U311**	Oct-97	cored	**339396**	**6262142**	N
23609I	Douglas Partners	**U312**	Oct-97	cored	**339410**	**6262155**	N
23609I	Douglas Partners	**U313**	Nov-97	CPT	**339472**	**6262164**	N
23609I	Douglas Partners	**U315**	Nov-97	CPT	**339463**	**6262139**	N
23609I	Douglas Partners	**U316**	Nov-97	CPT	**339457**	**6262119**	N
23609I	Douglas Partners	**U317**	Nov-97	CPT	**339452**	**6262097**	N
23609I	Douglas Partners	**U318**	Nov-97	CPT	**339446**	**6262075**	N
23609K	Douglas Partners	**V327**	Nov-98	cored	**339354**	**6262133**	N
23609K	Douglas Partners	**V328**	Nov-98	cored	**339380**	**6262128**	N
23609K	Douglas Partners	**V329**	Nov-98	cored	**339414**	**6262104**	N
1072.00	Ground Test	**W1**	Jun-66	drill-to-rock	**339517**	**6262361**	N
1072.00	Ground Test	**W2**	Jun-66	cored/limited	**339562**	**6262374**	N
1072.00	Ground Test	**W3**	Jun-66	cored/limited	**339558**	**6262349**	N
1072.00	Ground Test	**W4**	Jun-66	cored/limited	**339520**	**6262380**	N
NOTE	Letter suffixes are shown in the drawing at some locations, where multiple attempts at testing have been adopte						

Table C2: Summary of Historical and Current Groundwater Gauging and Field Results

Bore	Date Measured	TD (m)	Top of Well Casing Elevation	Depth to Screened interval	Depth to Water*	Corrected Water Elevation	Dissolved Oxygen	Electrical Conductivity	Redox Potential	pH	Temperature
			(mAHD)	(m)	(m)	(mAHD)	(mg/L)	(uS/cm)	(mV)		(°C)
509	15-Sep-10	5.5	10.17	4.0-5.5	2.76	7.41	7.91	247	-22	5.99	21.6
510	15-Sep-10	6	8.62	4.5-6.0	2.80	5.82	6.30	363	-139	5.60	19.5
	22-Aug-11	6	8.62	4.5-6.0	2.80	5.82	3.56	353	-136	5.67	17.6
	2-Mar-12	6	8.62	4.5-6	2.69	5.93	0.35	555	-55	5.82	19.8
	7-Sep-12	6	8.62	4.5-6	3.16	5.46	0.60	600	-161	5.94	18.9
	29-May-13	6	8.62	4.5-6	3.10	5.52	0.06	189	-96	5.98	20.2
	28-May-13	6	8.62	4.5-6	2.93	5.69	2.01	715	97	5.75	21.7
	10-Jul-14	6	8.62	4.5-6	3.24	5.38	0.03	571	54	5.85	19.2
511	15-Sep-10	8	9.45	6.5-8.0	3.50	5.95	9.31	6	81	5.02	20.8
	22-Aug-11	8	9.45	6.5-8.0	3.41	6.04	2.90	303	-181	6.50	17.8
	2-Mar-12	8	9.45	6.5-8	3.39	6.06	0.27	305	38	5.42	21.5
	7-Sep-12	8	9.45	6.5-8	3.62	5.83	1.20	294	-105	5.54	19.5
	29-May-13	8	9.45	6.5-8	3.79	5.66	0.02	290	2	4.44	20.2
	28-May-13	8	9.45	6.5-8	3.90	5.55	1.42	391	83	5.85	24.6
	10-Jul-14	8	9.45	6.5-8	3.90	5.55	0.43	267	36	5.42	20.5
512	15-Sep-10	7.4	9.99	4.0-5.5	2.61	7.38	0.79	436	-234	6.04	19.0
	22-Aug-11	7.4	9.99	4.0-5.5	2.89	7.10	0.85	185	-68	6.11	17.7
	21-Nov-11	7.4	9.99	4.0-5.5	2.93	7.06	1.05	206	-87	5.68	20.5
	2-Feb-12	7.4	9.99	4-5.5	2.92	7.07	1.69	276	-21	5.94	20.6
	10-Sep-12	7.4	9.99	4-5.5	2.99	7.00	0.37	281	11	6.03	18.0
	29-May-13	7.4	9.99	4-5.5	2.90	7.09	0.00	262	21	4.36	20.2
	28-May-13	7.4	9.99	4-5.5	2.88	7.11	0.24	260	7	7.59	20.0
	10-Jul-14	7.4	9.99	4-5.5	2.91	7.08	0.27	265	26	5.47	18.8
513	2-Mar-12	10	9.90	7-10	3.14	6.76	0.38	255	-29	5.70	20.5
	7-Sep-12	10	9.90	7-10	3.37	6.53	0.45	284	-12	5.77	19.0
	29-May-13	10	9.90	7-10	3.61	6.29	0.17	260	-74	4.91	19.9
	28-Nov-13	10	9.90	7-10	4.61	5.29	2.50	398	88	5.96	22.4
	10-Jul-14	10	9.90	7-10	3.78	6.12	0.04	289	22	5.70	18.8

Notes:

* below top of well casing

ID = identification

mAHD = metres above Australia Height Datum

m = metres

Redox Potential Measured using a YSI Ag/AgCl 3.5M KCl sensor in February 2012 Round. A 90 FMLV Ag/AgCl saturated KCl sensor was used in all other rounds.

BOREHOLE LOG

CLIENT: AMP Capital Investors Pty Ltd
PROJECT: Supplementary Contamination Assessment
LOCATION: Warringah Mall

SURFACE LEVEL: 9.45 AHD
EASTING: 339501.81
NORTHING: 6262162.61
DIP/AZIMUTH: 90°/--

BORE No: 511B
PROJECT No: 71015.06
DATE: 17/8/2010
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.15	BITUMEN/ASPHALT							Gatic cover
		ROADBASE							
	0.5	FILLING - black clayey sand filling with quartz, sandstone fragments and metal pieces							Bentonite
	1.5	SAND - yellow red, medium grained sand with some sandstone and ironstone gravel							Backfilled with gravel
	2.2	ORGANIC CLAY - black organic clay with trace sand and decomposed roots and wood with a sulphurous odour							03/02/12 3.39m
	4.0	CLAYEY SAND - yellow grey, medium grained clayey sand, wet							Bentonite
	5.25	SAND - grey, medium grained sand with some clay							Backfilled with gravel
	5.5	SAND - yellow brown, medium grained sand with some clay							
	8.0	SAND - very loose							Machine slotted PVC screen
									End cap

RIG: **DRILLER:** **LOGGED:** ZM **CASING:** Uncased

TYPE OF BORING: Solid flight auger to 8.0m

WATER OBSERVATIONS: Free groundwater observed at 3.8m

REMARKS: Adjacent to location 511A (approximately 1.0m to the north)

SURVEY DATUM:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: AMP Capital Investors Pty Ltd
PROJECT: Supplementary Contamination Assessment
LOCATION: Warringah Mall

SURFACE LEVEL: 9.45 AHD
EASTING: 339501.81
NORTHING: 6262162.61
DIP/AZIMUTH: 90°/--

BORE No: 511B
PROJECT No: 71015.06
DATE: 17/8/2010
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
-1	11	SAND - very loose *(continued)*							
-2	12	12.0 SAND - loose to mediumd ense							
-3	13								
-4	14								
-5	15								
-6	16								
-7	17								
-8	18								
-9	18.8								
-10	19	CLAYEY SAND - dense							

RIG: **DRILLER:** **LOGGED:** ZM **CASING:** Uncased

TYPE OF BORING: Solid flight auger to 8.0m

WATER OBSERVATIONS: Free groundwater observed at 3.8m

REMARKS: Adjacent to location 511A (approximately 1.0m to the north)

SURVEY DATUM:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: AMP Capital Investors Pty Ltd
PROJECT: Supplementary Contamination Assessment
LOCATION: Warringah Mall

SURFACE LEVEL: 9.45 AHD
EASTING: 339501.81
NORTHING: 6262162.61
DIP/AZIMUTH: 90°/--

BORE No: 511B
PROJECT No: 71015.06
DATE: 17/8/2010
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
-11	20.5	CLAYEY SAND - dense *(continued)*							
		WEATHERED ROCK							
	20.9	Bore discontinued at 20.9m - target depth reached							
-12	21								
	22								
-13	23								
-14	24								
-15	25								
-16	26								
-17	27								
-18	28								
-19	29								
-20									

RIG: **DRILLER:** **LOGGED:** ZM **CASING:** Uncased

TYPE OF BORING: Solid flight auger to 8.0m

WATER OBSERVATIONS: Free groundwater observed at 3.8m

REMARKS: Adjacent to location 511A (approximately 1.0m to the north)

SURVEY DATUM:

SAMPLING & IN SITU TESTING LEGEND

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

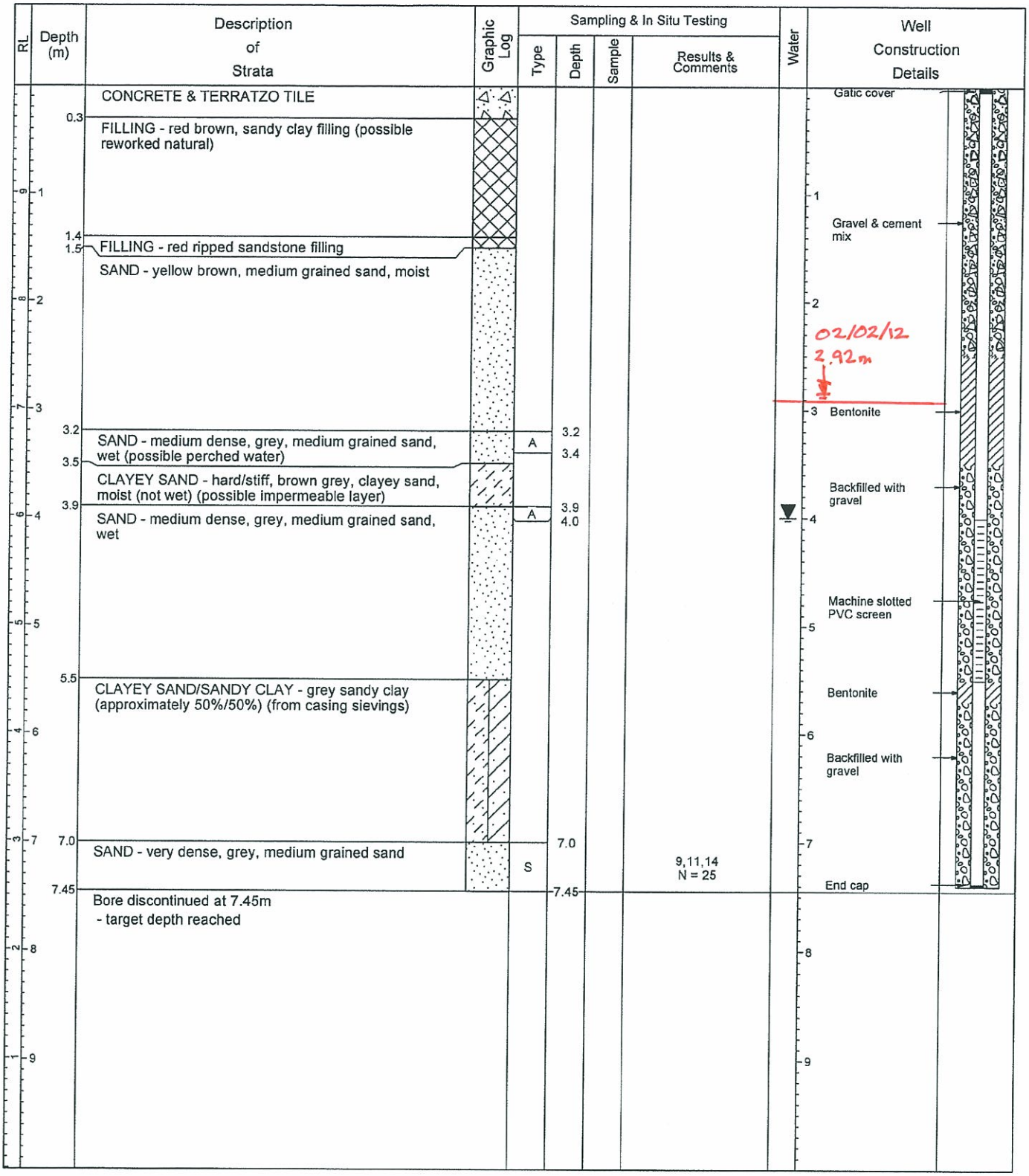
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: AMP Capital Investors Pty Ltd
PROJECT: Supplementary Contamination Assessment
LOCATION: Warringah Mall

SURFACE LEVEL: 9.99 AHD
EASTING: 339447.34
NORTHING: 6262230.02
DIP/AZIMUTH: 90°/--

BORE No: 512
PROJECT No: 71015.06
DATE: 6/9/2010
SHEET 1 OF 1



RIG: Bobcat (9T) **DRILLER:** SY **LOGGED:** ZM **CASING:** HW to 7.4m **SURVEY DATUM:**

TYPE OF BORING: Solid flight auger to 5.5m; Rotary with mud (liquid polymer) to 7.4m

WATER OBSERVATIONS: Free groundwater observed at 4.0m

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: AMP Capital Investors Ltd
PROJECT: Groundwater Monitoring
LOCATION: Crab Car Park, Warringah Mall, Brookvale

SURFACE LEVEL:--
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH513
PROJECT No: 71015.09
DATE: 2/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.15	ASPHALTIC CONCRETE							Gatic cover
		FILLING - black clayey sand filling with quartz sandstone fragments							
	1	- timber and metal sheet at 1.0m							
	1.8	SAND - light grey, medium grained sand							
	2.0	ORGANIC CLAY - black, organic clay with trace sand and decomposed roots and timber with a sulphurous odour							02/02/12 3.14m
	3.0	SAND - dark grey, medium grained sand							Cement/bentonite grout
		- wet at 3.5m							
	5								Blank casing
	8								Gravel Machine slotted PVC screen
	10.0								End cap

Bore discontinued at 10.0m - target depth reached

RIG: Bobcat **DRILLER:** S Younan **LOGGED:** RA **CASING:** HW

TYPE OF BORING: Solid flight auger to 5.0m; Rotary to 10.0m

WATER OBSERVATIONS: Free groundwater observed at 3.5m

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics | Environment | Groundwater

CONE PENETRATION TEST

CLIENT: AMP CAPITAL INVESTORS LTD

PROJECT: SUPPLEMENTARY G-W ASSESSMENT

LOCATION: OLD PITTWATER ROAD, BROOKVALE

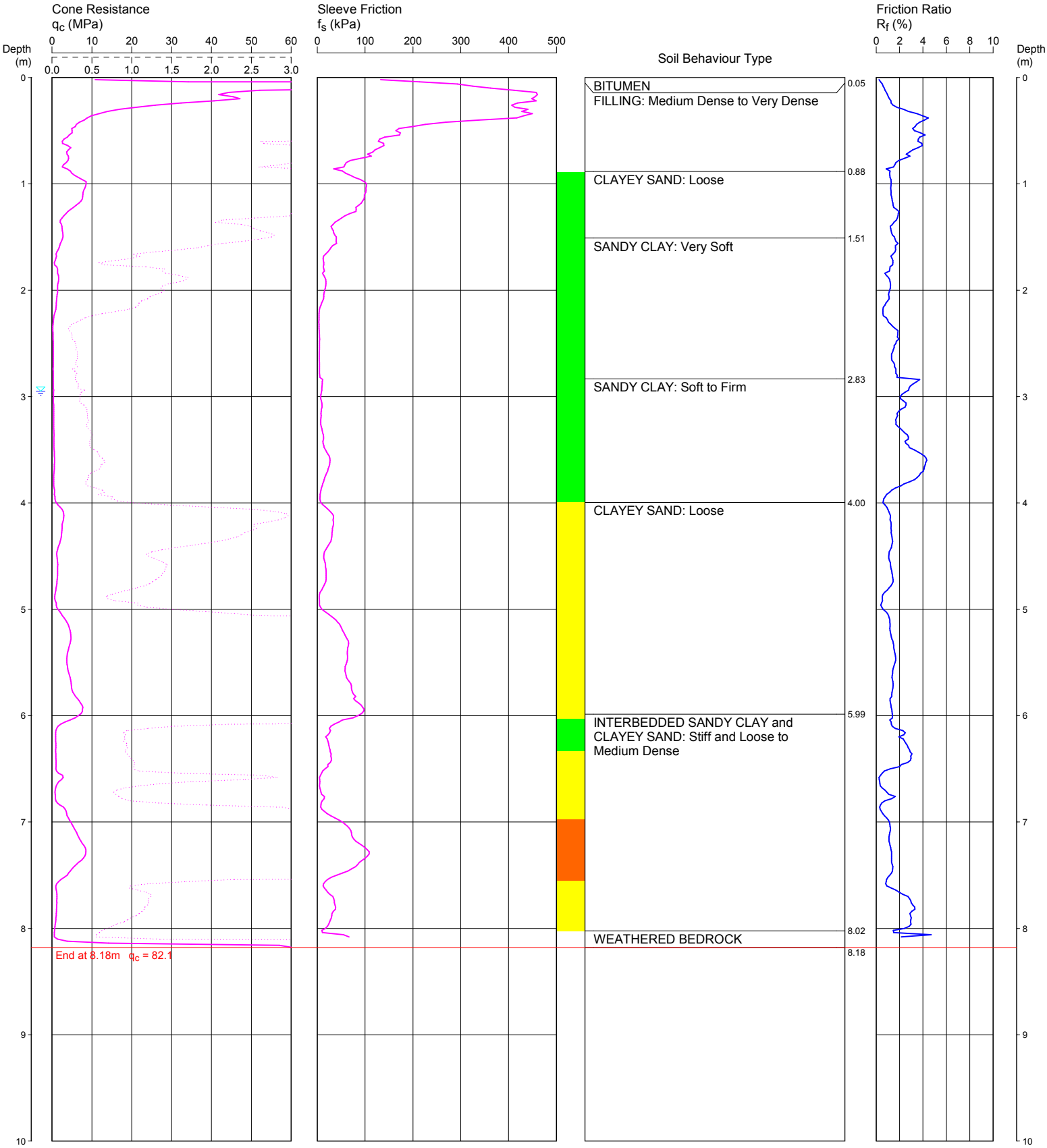
PROJECT No: 71015.06

CPT 509E

Page 1 of 1

DATE 5/08/2010

SURFACE RL:



= Clay

= Medium dense sand

= Loose sand

REMARKS:

Date
Plotted
Checked

File: P:\71015.06 BROOKVALE, Additional Groundwater and Littles Dry Cleaning LR\Field\7101550[illegible]5
Cone ID: CONE-416 Type: 2 Standard

ConePlot Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

CONE PENETRATION TEST

CLIENT: AMP CAPITAL INVESTORS LTD

PROJECT: SUPPLEMENTARY G-W ASSESSMENT

LOCATION: OLD PITTWATER ROAD, BROOKVALE

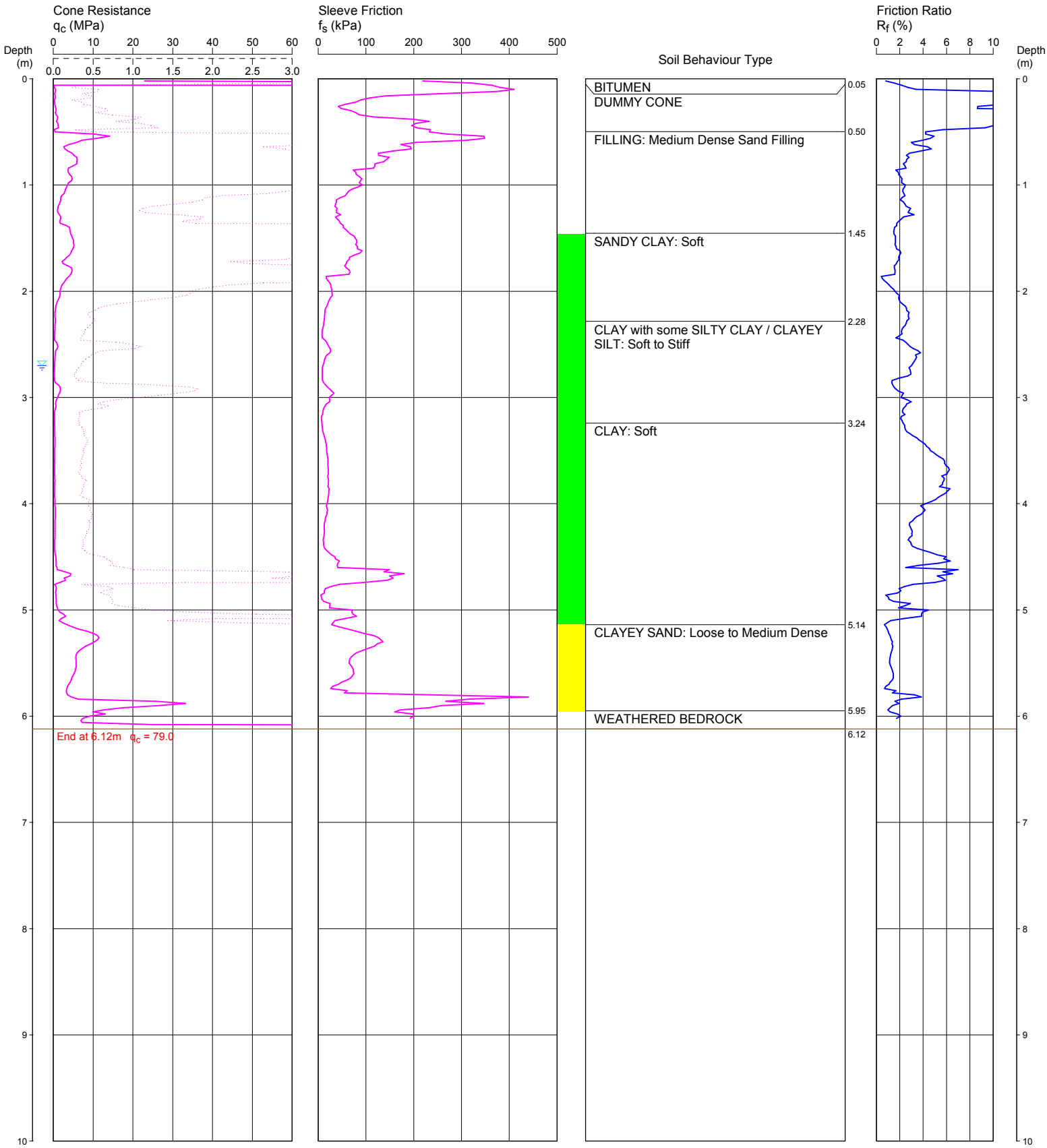
PROJECT No: 71015.06

CPT 510D

Page 1 of 1

DATE 5/08/2010

SURFACE RL:



= Clay

= Medium dense sand

= Loose sand

REMARKS:

Date
Plotted
Checked

File: P:\71015.06 BROOKVALE, Additional Groundwater and Littles Dry Cleaning LR\Field\7101551[illegible]5

Cone ID: CONE-416 Type: 2 Standard

ConePlot Version 5.8.1

Douglas Partners

Geotechnics · Environment · Groundwater

CONE PENETRATION TEST

CLIENT: AMP CAPITAL INVESTORS LTD

PROJECT: SUPPLEMENTARY G-W ASSESSMENT

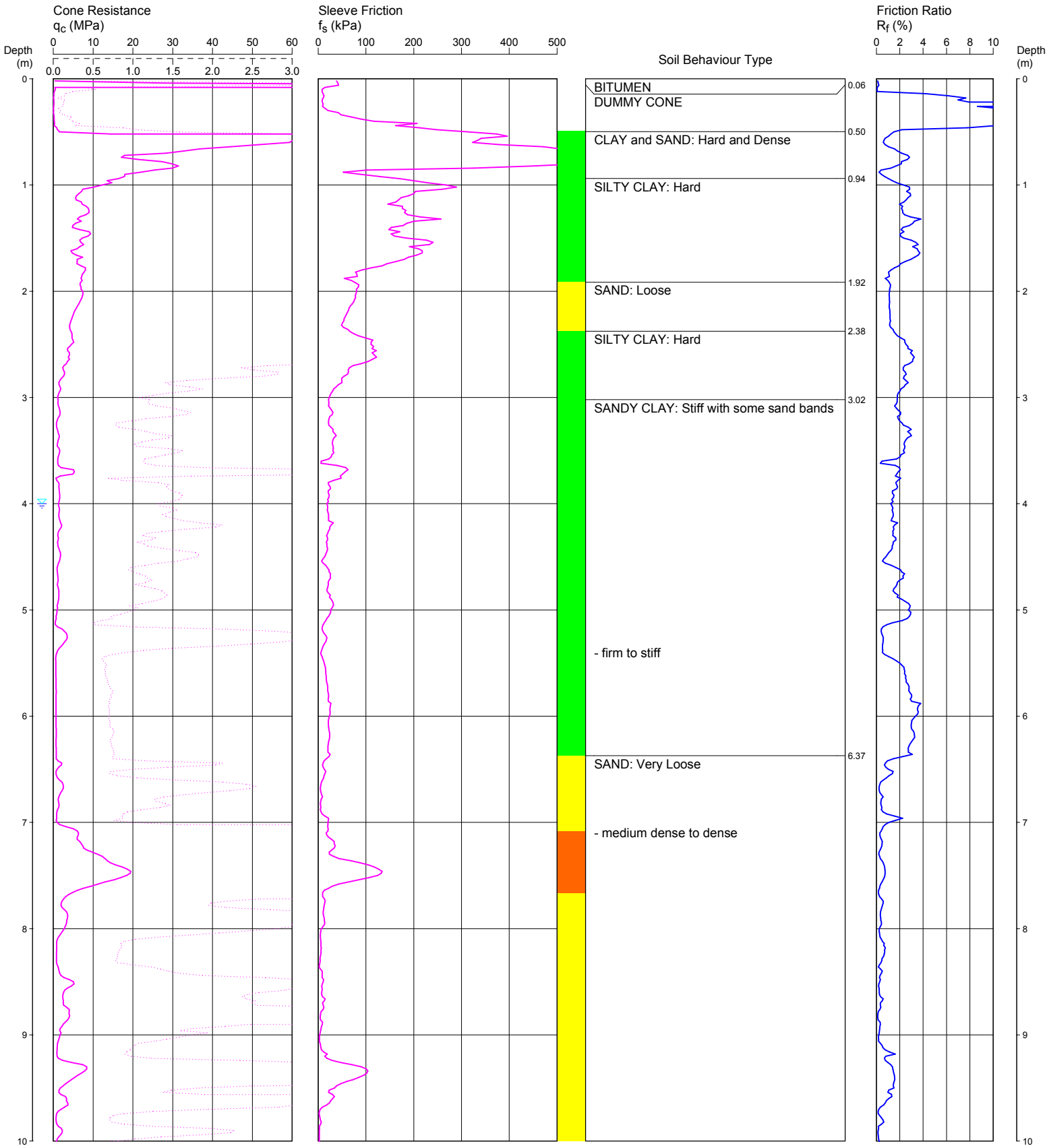
LOCATION: OLD PITTWATER ROAD, BROOKVALE

PROJECT No: 71015.06

CPT 511

DATE 4/08/2010

SURFACE RL:



= Clay

= Medium dense sand

= Loose sand

REMARKS: DUMMY CONE to 0.50m

Date
Plotted
Checked

File: P:\71015.06 BROOKVALE, Additional Groundwater and Littles Dry Cleaning LR\Field\71015511
Cone ID: CONE-HH5 Type: 2 Standard

ConePlot Version 5.8.1

Douglas Partners
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CONE PENETRATION TEST

CLIENT: AMP CAPITAL INVESTORS LTD

PROJECT: SUPPLEMENTARY G-W ASSESSMENT

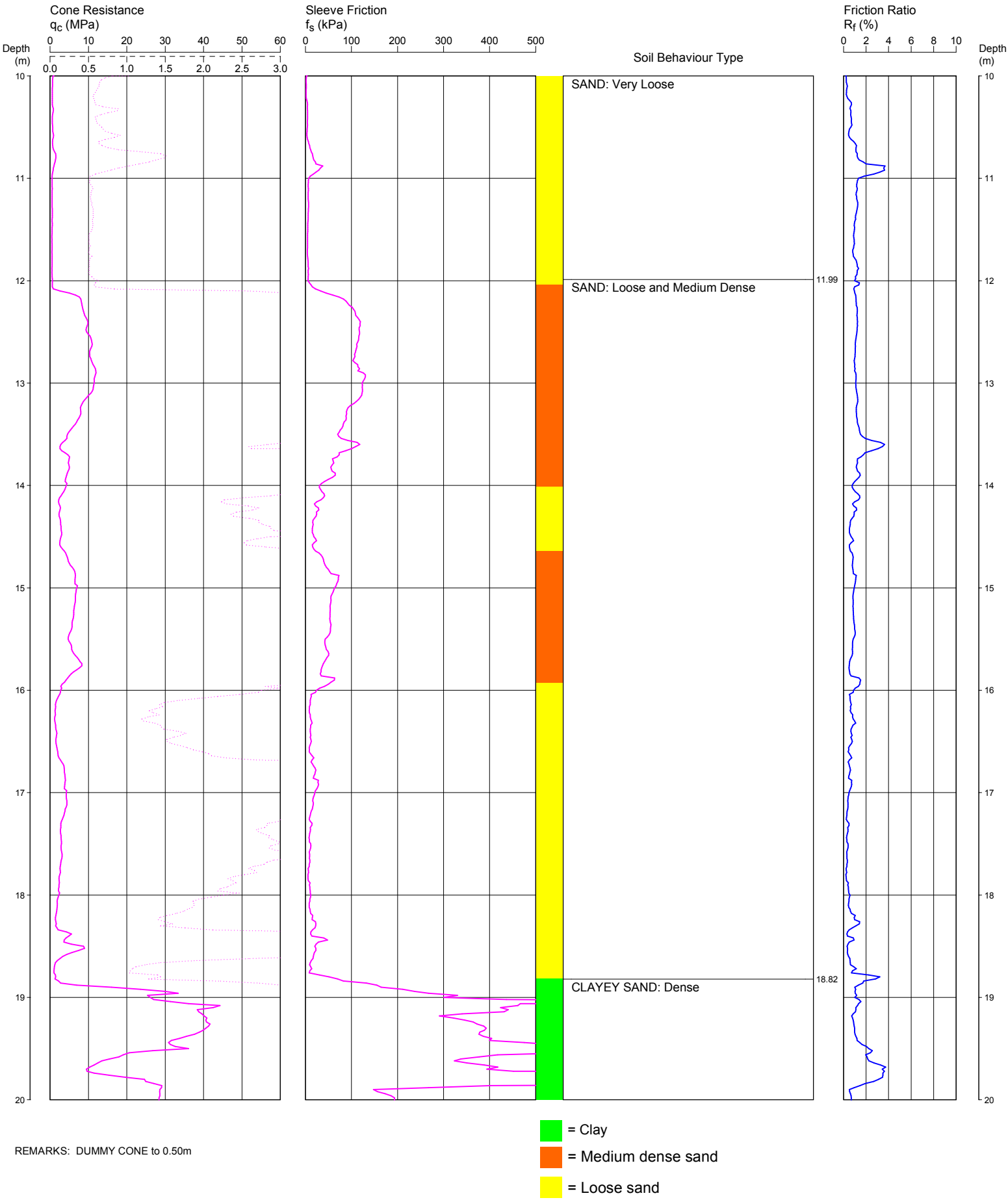
LOCATION: OLD PITTWATER ROAD, BROOKVALE

PROJECT No: 71015.06

CPT 511

DATE 4/08/2010

SURFACE RL:



REMARKS: DUMMY CONE to 0.50m

= Clay

= Medium dense sand

= Loose sand

Date
Plotted
Checked

File: P:\71015.06 BROOKVALE, Additional Groundwater and Littles Dry Cleaning LR\Field\71015511
Cone ID: CONE-HH5 Type: 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: AMP CAPITAL INVESTORS LTD

PROJECT: SUPPLEMENTARY G-W ASSESSMENT

LOCATION: OLD PITTWATER ROAD, BROOKVALE

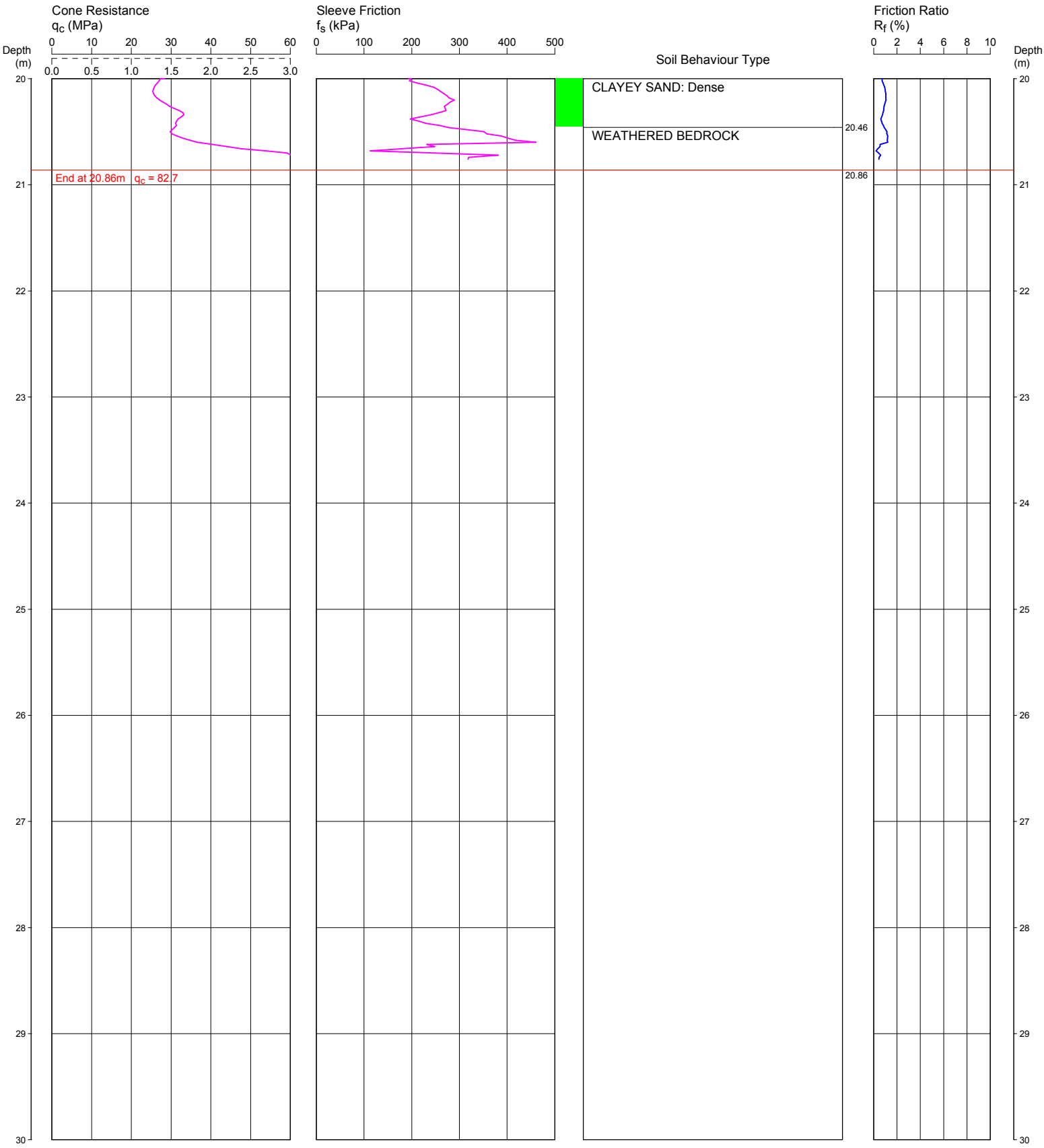
PROJECT No: 71015.06

CPT 511

Page 3 of 3

DATE 4/08/2010

SURFACE RL:



REMARKS: DUMMY CONE to 0.50m

= Clay

= Medium dense sand

= Loose sand

Date
Plotted
Checked

File: P:\71015.06 BROOKVALE, Additional Groundwater and Littles Dry Cleaning LR\Field\71015511
Cone ID: CONE-HH5 Type: 2 Standard

ConePlot Version 5.8.1

Douglas Partners
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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL REDEVELOPMENT

LOCATION: CONDAMINE ROAD, BROOKVALE

REDUCED LEVEL: RL 9.5m AHD

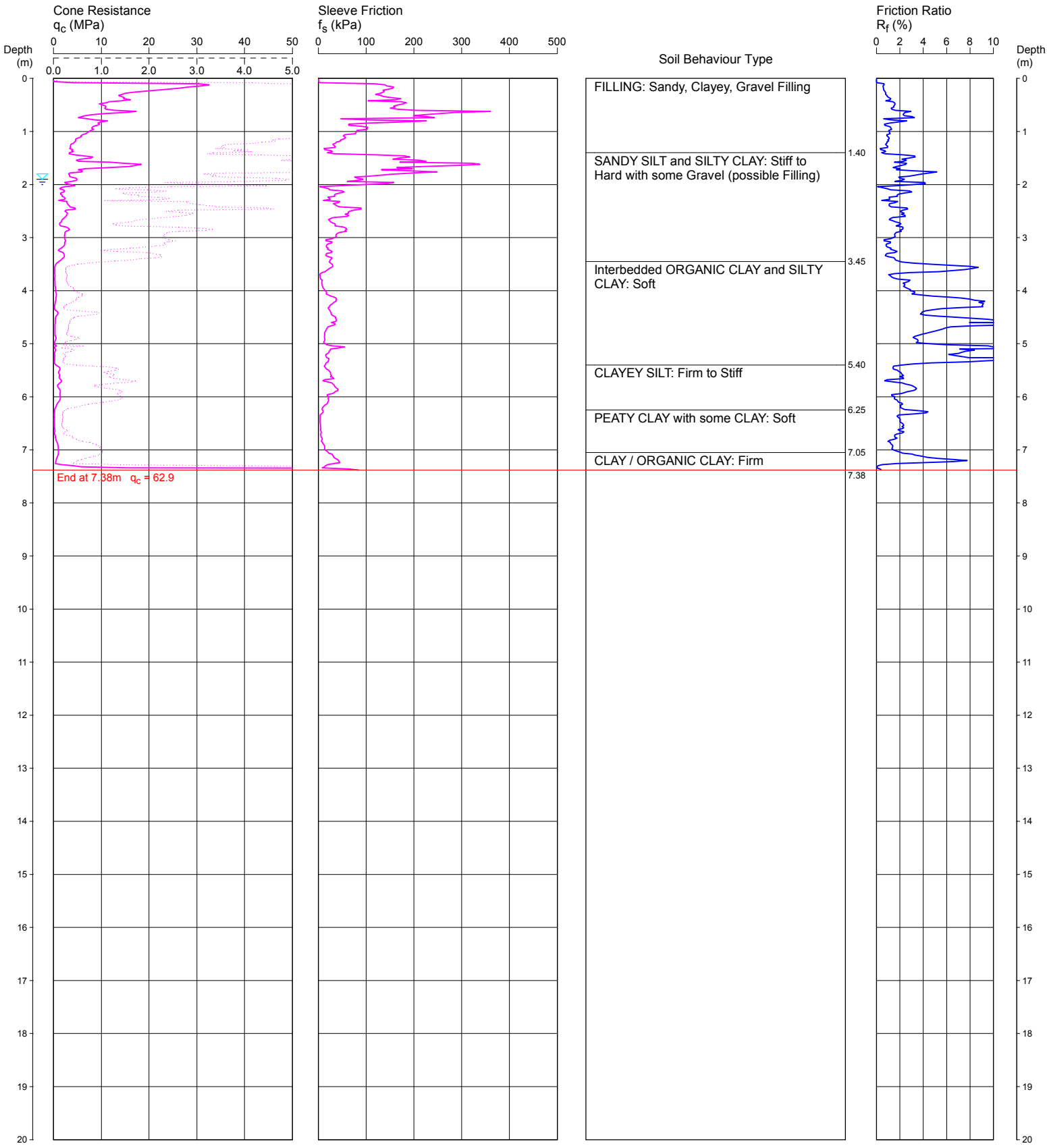
COORDINATES:

605

Page 1 of 1

DATE 11/04/2013

PROJECT No: 71015.17



REMARKS: GROUNDWATER OBSERVED AT 1.9m DEPTH AFTER REMOVAL OF RODS.

Water depth after test: 1.90m depth (assumed)

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\605.CP5

Cone ID: 120631 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL REDEVELOPMENT

LOCATION: CONDAMINE ROAD, BROOKVALE

REDUCED LEVEL: RL 9.3m AHD

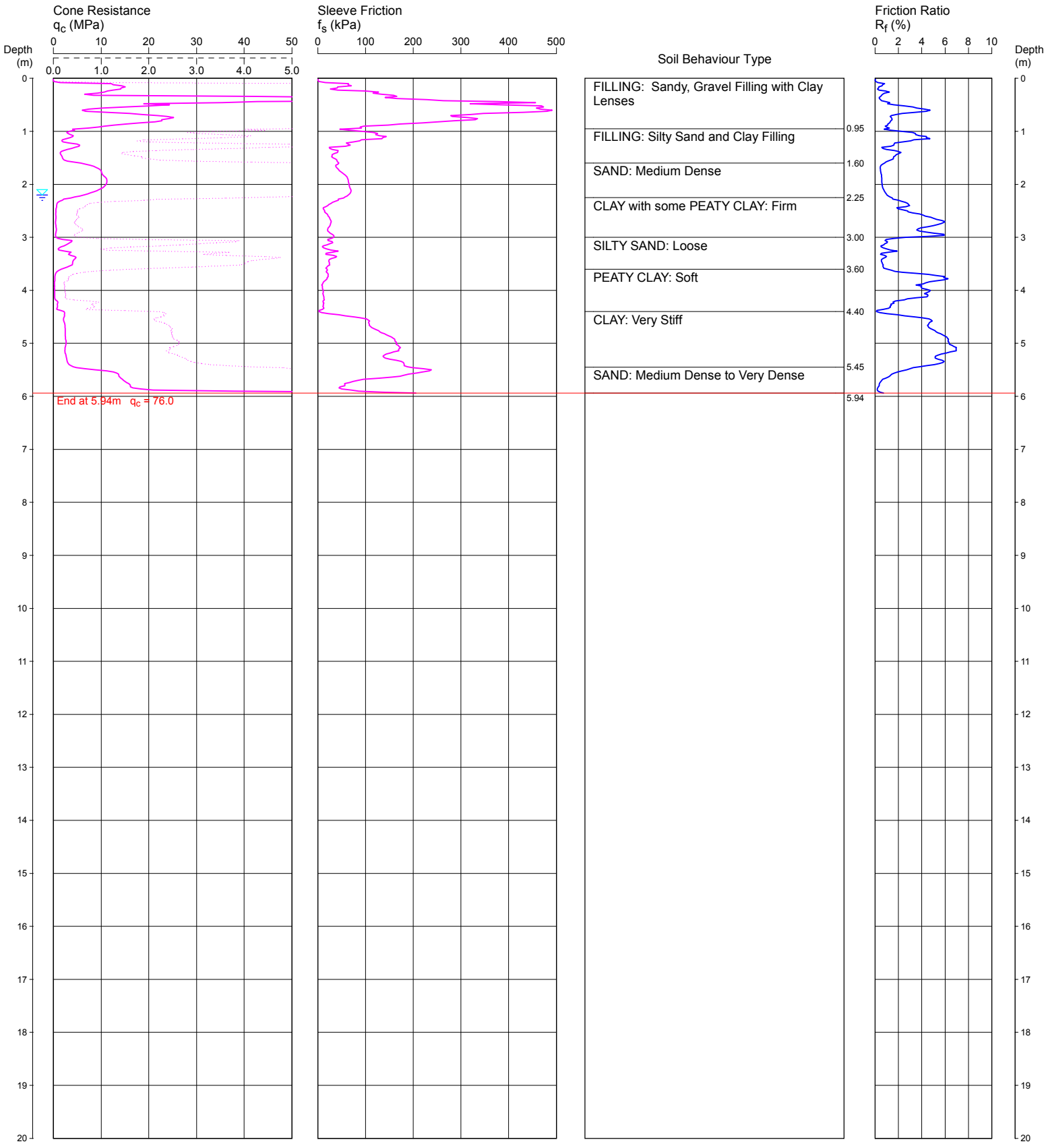
COORDINATES:

606A

Page 1 of 1

DATE 11/4/2013

PROJECT No: 71015.17



REMARKS: GROUNDWATER OBSERVED AT 2.2m DEPTH AFTER REMOVAL OF RODS.

Water depth after test: 2.20m depth (assumed)

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\606A.CP5

Cone ID: 120631 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL REDEVELOPMENT

LOCATION: CONDAMINE ROAD, BROOKVALE

REDUCED LEVEL: RL 9.0m AHD

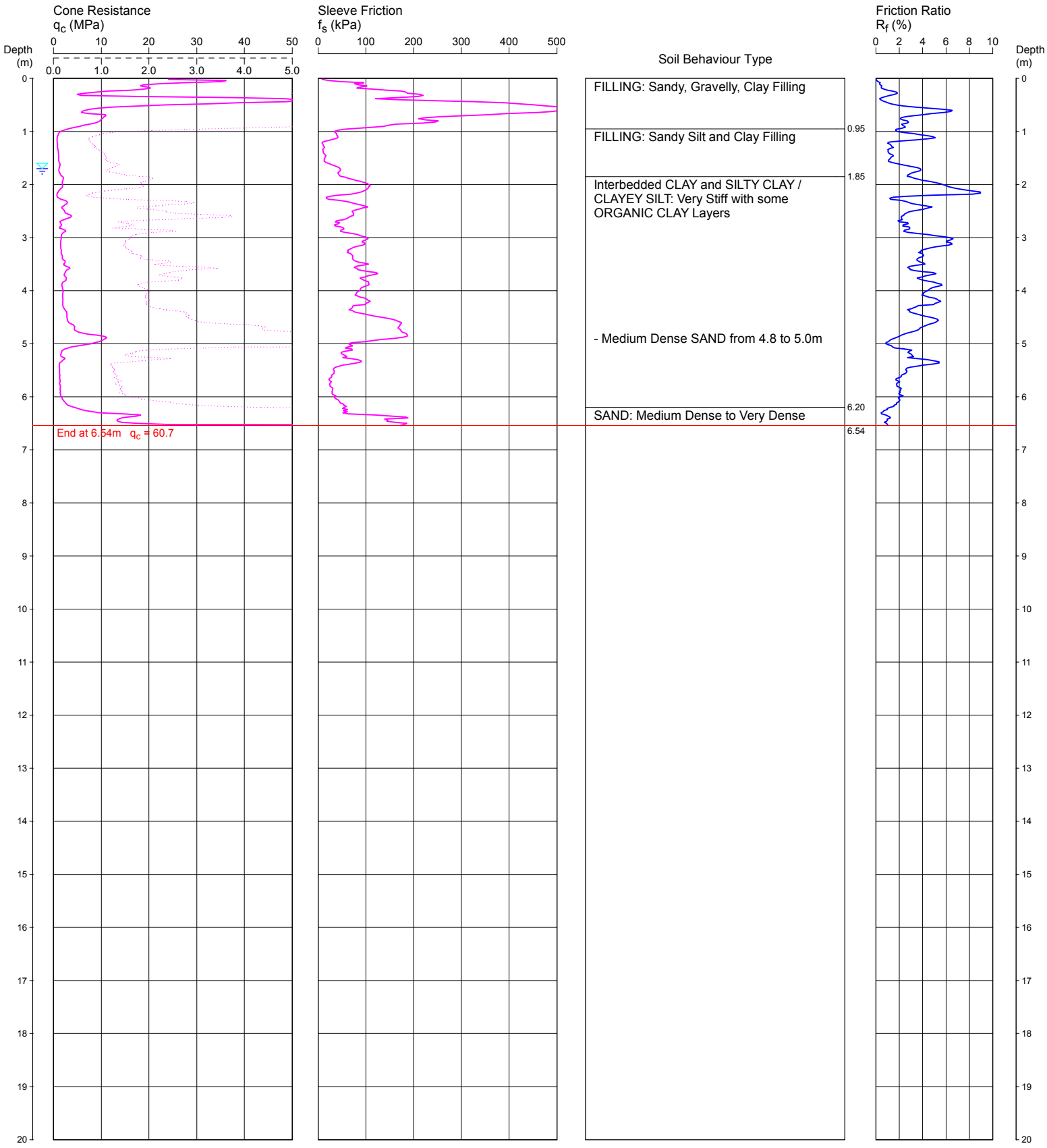
COORDINATES:

607

Page 1 of 1

DATE 11/04/2013

PROJECT No: 71015.17



REMARKS: GROUNDWATER OBSERVED AT 1.7m DEPTH AFTER REMOVAL OF RODS.

Water depth after test: 1.70m depth (assumed)

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\607.CP5

Cone ID: 120631 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL DEVELOPMENT

LOCATION: CONDAMINE STREET, BROOKVALE

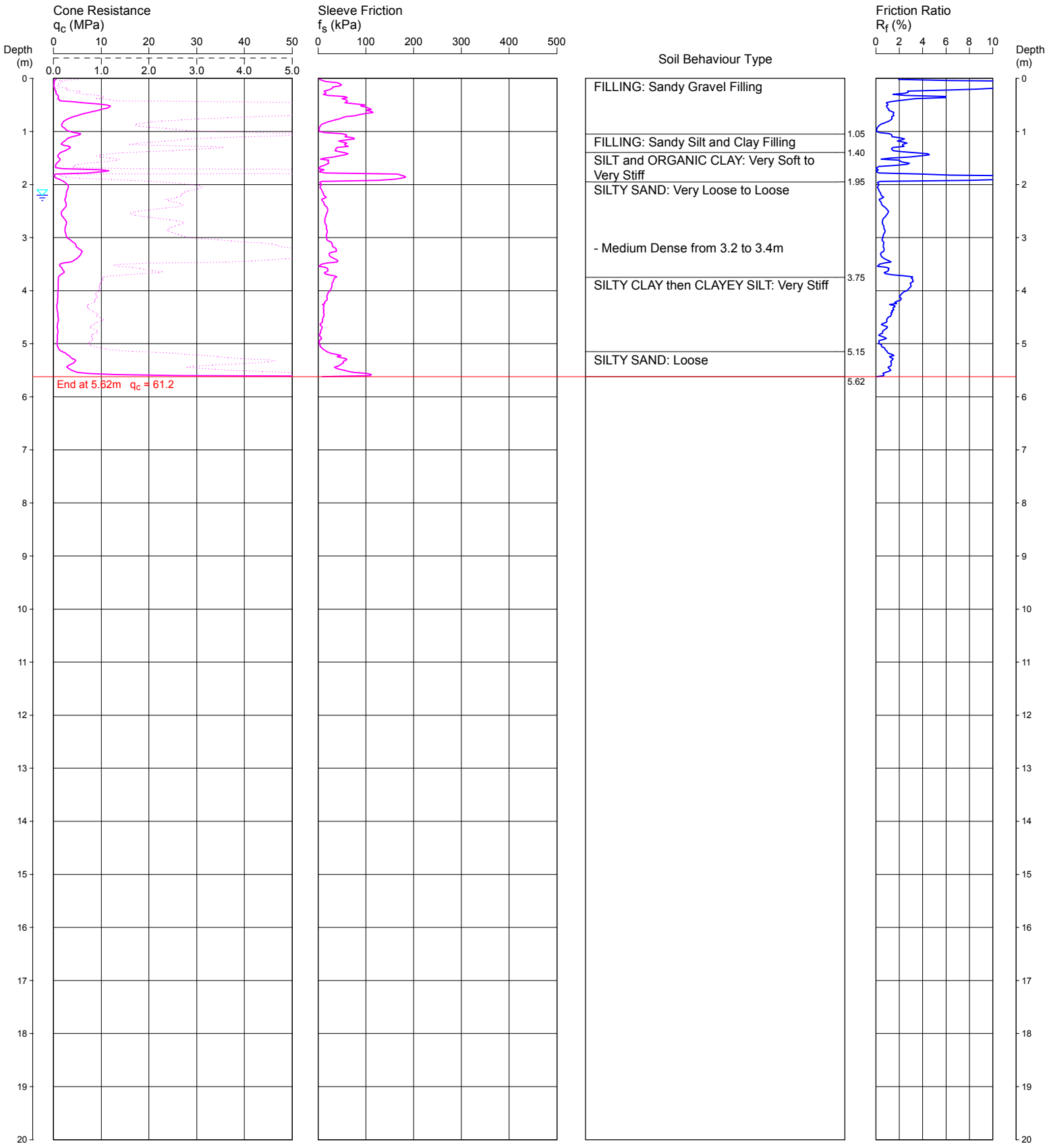
REDUCED LEVEL: RL 9.0m AHD

COORDINATES:

608

DATE 15/4/2013

PROJECT No: 71015.17



REMARKS: GROUNDWATER OBSERVED AT 2.2m DEPTH AFTER REMOVAL OF RODS.
DUMMY CONE TO 0.5m DEPTH.

Water depth after test: 2.20m depth (assumed)

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\608.CP5

Cone ID: 120624 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL REDEVELOPMENT

LOCATION: CONDAMINE STREET, BROOKVALE

REDUCED LEVEL: RL 9.0m AHD

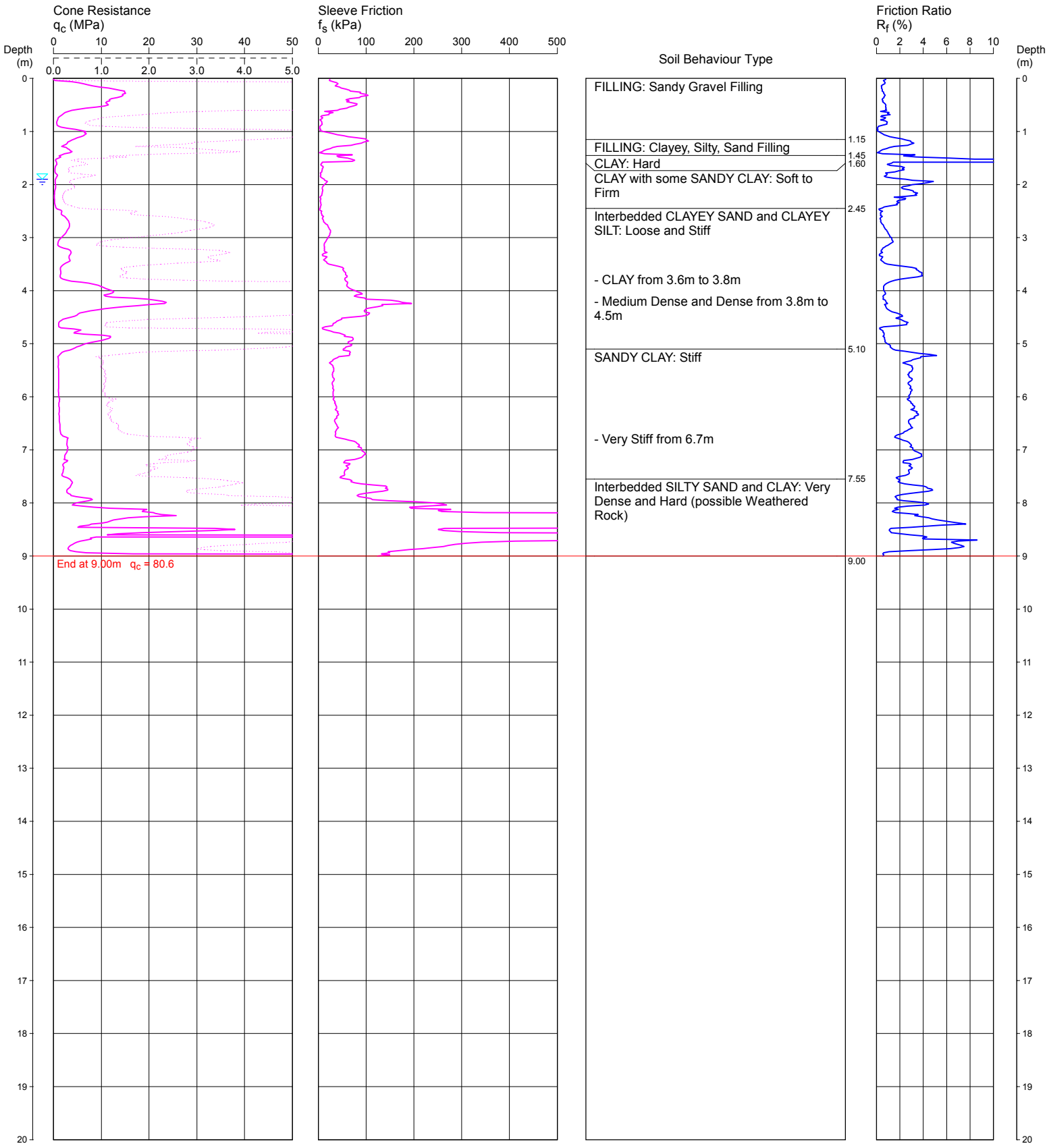
COORDINATES:

609

Page 1 of 1

DATE 16/4/2013

PROJECT No: 71015.17



REMARKS: PREDRILLED HOLE TO APPROXIMATELY 1m DEPTH.
GROUNDWATER OBSERVED AT 1.9m DEPTH AFTER REMOVAL OF RODS.

Water depth after test: 1.90m depth (assumed)

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\609.CP5

Cone ID: 120624 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL REDEVELOPMENT

LOCATION: CONDAMINE STREET, BROOKVALE

REDUCED LEVEL: RL 10.0m AHD

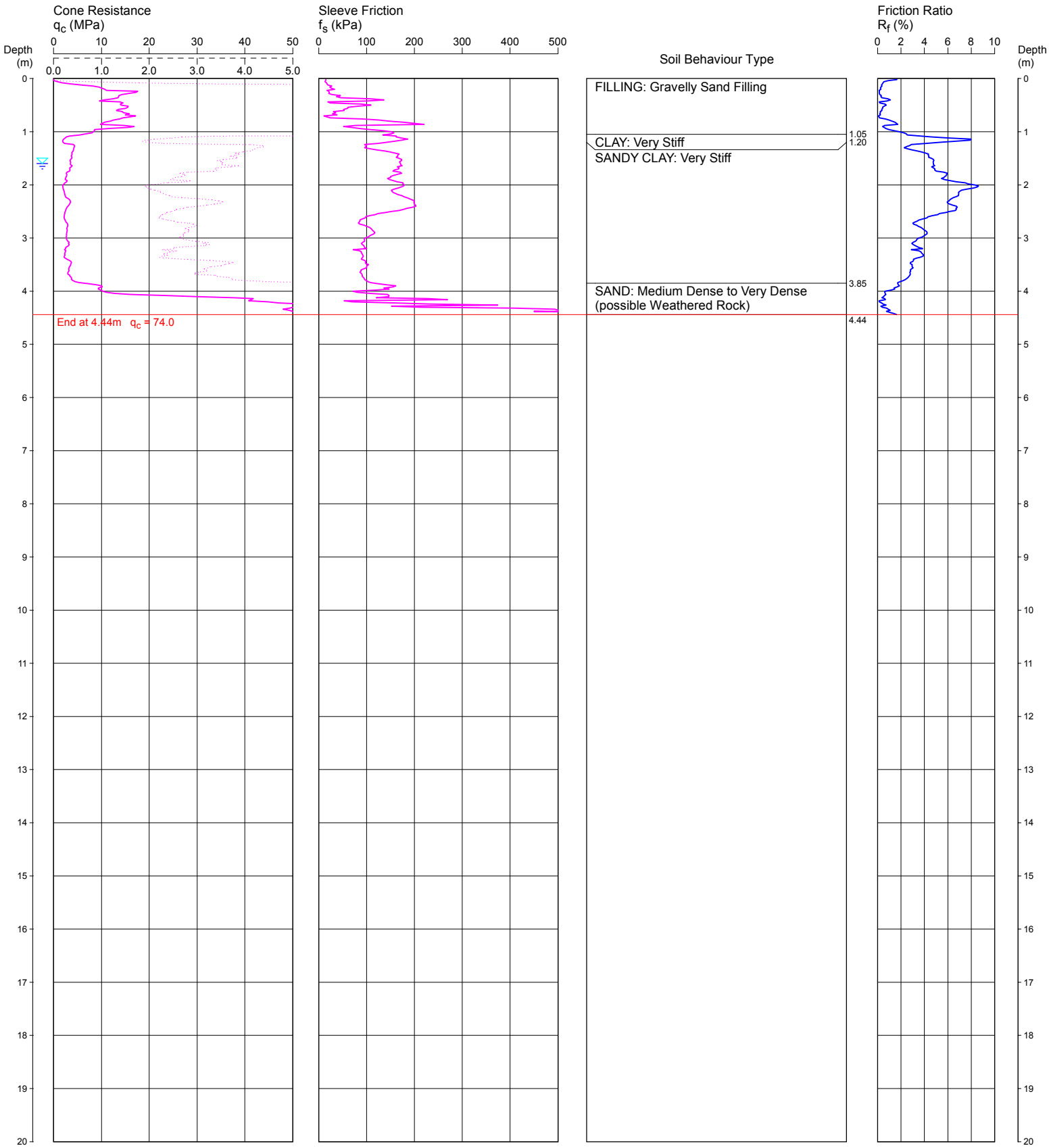
COORDINATES:

610

Page 1 of 1

DATE 16/4/2013

PROJECT No: 71015.17



REMARKS: PREDRILLED HOLE TO APPROXIMATELY 0.7m DEPTH.
GROUNDWATER OBSERVED AT 1.6m DEPTH AFTER REMOVAL OF RODS.

Water depth after test: 1.60m depth (assumed)

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\610.CP5

Cone ID: 120624 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL REDEVELOPMENT

LOCATION: CONDAMINE STREET, BROOKVALE

REDUCED LEVEL: RL 10.1m AHD

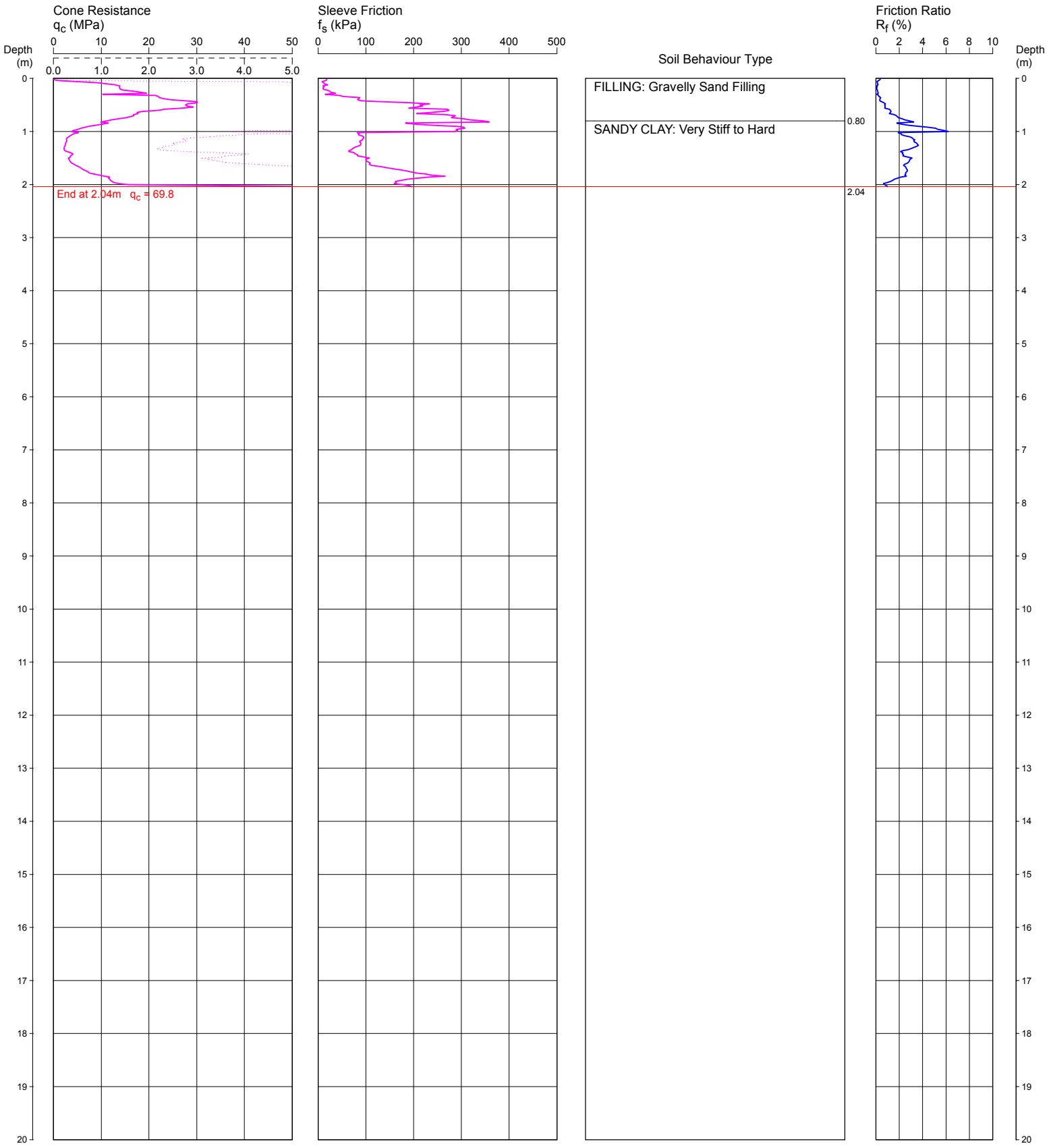
COORDINATES:

611

Page 1 of 1

DATE 16/4/2013

PROJECT No: 71015.17



REMARKS: PREDRILLED HOLE TO APPROXIMATELY 1m DEPTH.
HOLE COLLAPSE AT 1.95m DEPTH AFTER REMOVAL OF RODS.

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\611.CP5
Cone ID: 120624 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL DEVELOPMENT

LOCATION: CONDAMINE STREET, BROOKVALE

REDUCED LEVEL: RL 8.6m AHD

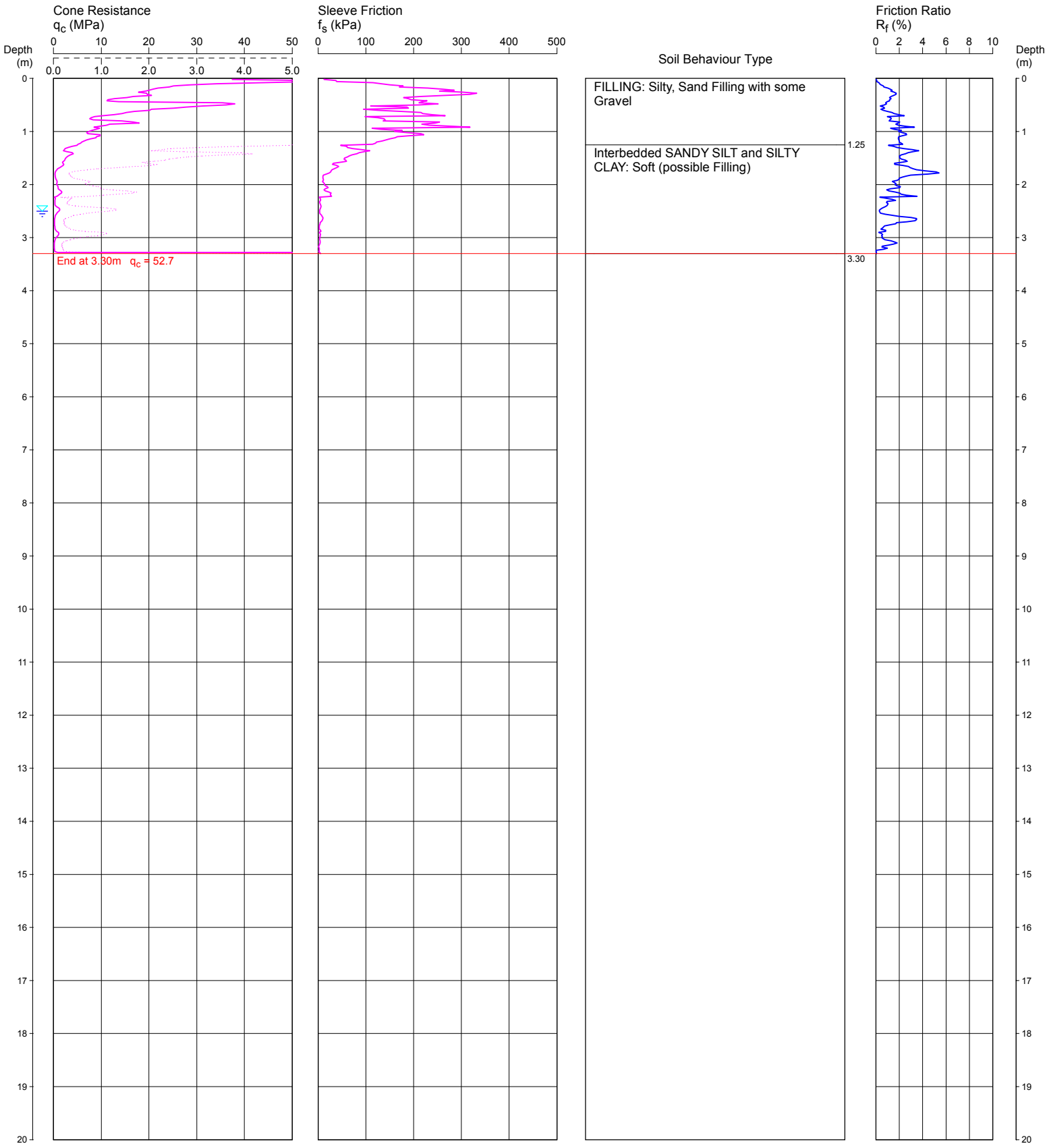
COORDINATES:

612B

Page 1 of 1

DATE 15/4/2013

PROJECT No: 71015.17



REMARKS: GROUNDWATER OBSERVED AT 2.5m DEPTH AFTER REMOVAL OF RODS.

Water depth after test: 2.50m depth (assumed)

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\612B.CP5

Cone ID: 120624 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL REDEVELOPMENT

LOCATION: CONDAMINE STREET, BROOKVALE

REDUCED LEVEL: RL 9.6m AHD

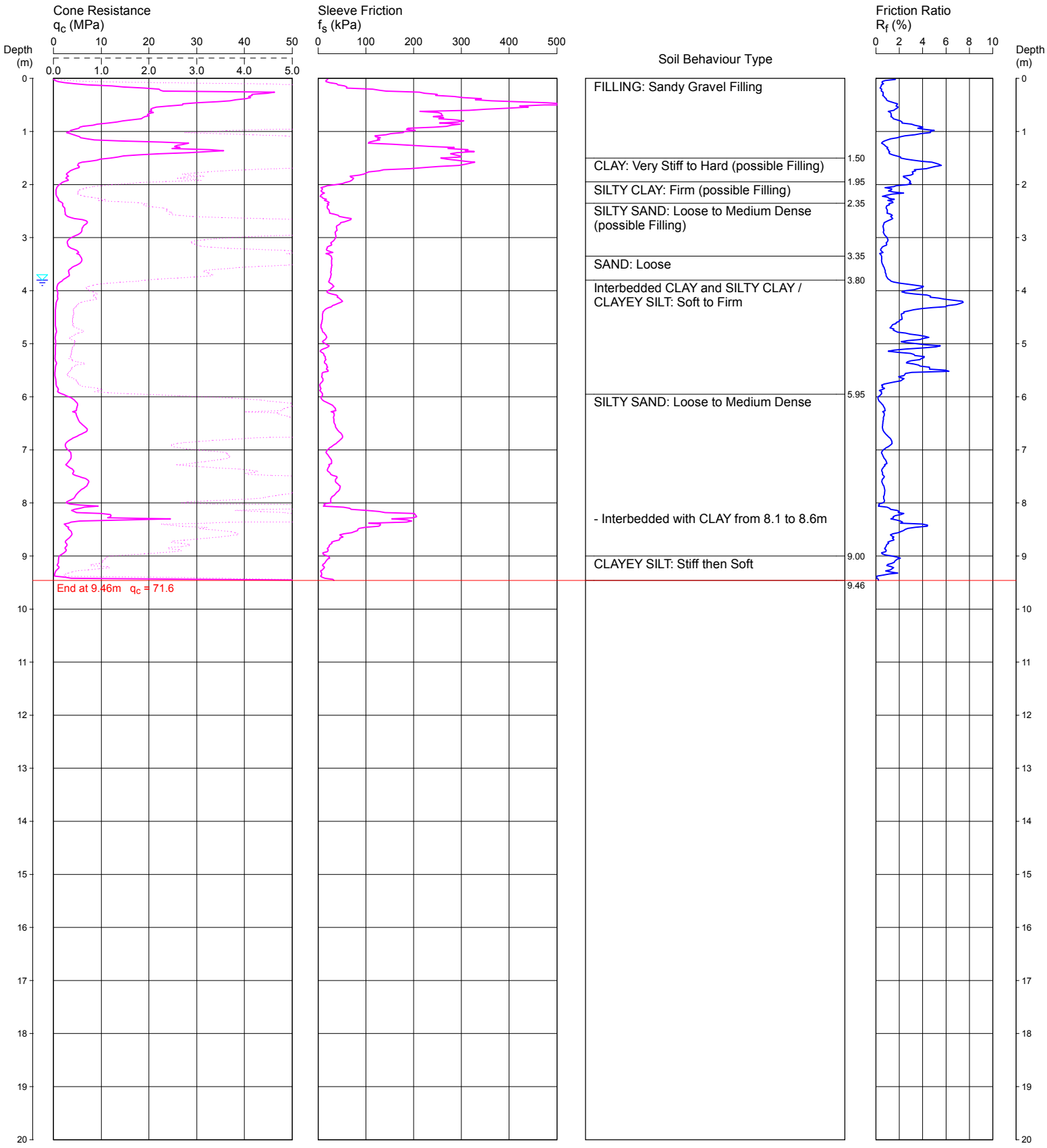
COORDINATES:

613

Page 1 of 1

DATE 16/4/2013

PROJECT No: 71015.17



REMARKS: PREDRILLED TO APPROXIMATELY 1m DEPTH.
GROUNDWATER OBSERVED AT 3.8m DEPTH AFTER REMOVAL OF RODS.

Water depth after test: 3.80m depth (assumed)

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\613.CP5

Cone ID: 120624 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL REDEVELOPMENT

LOCATION: CONDAMINE STREET, BROOKVALE

REDUCED LEVEL: RL 9.4m AHD

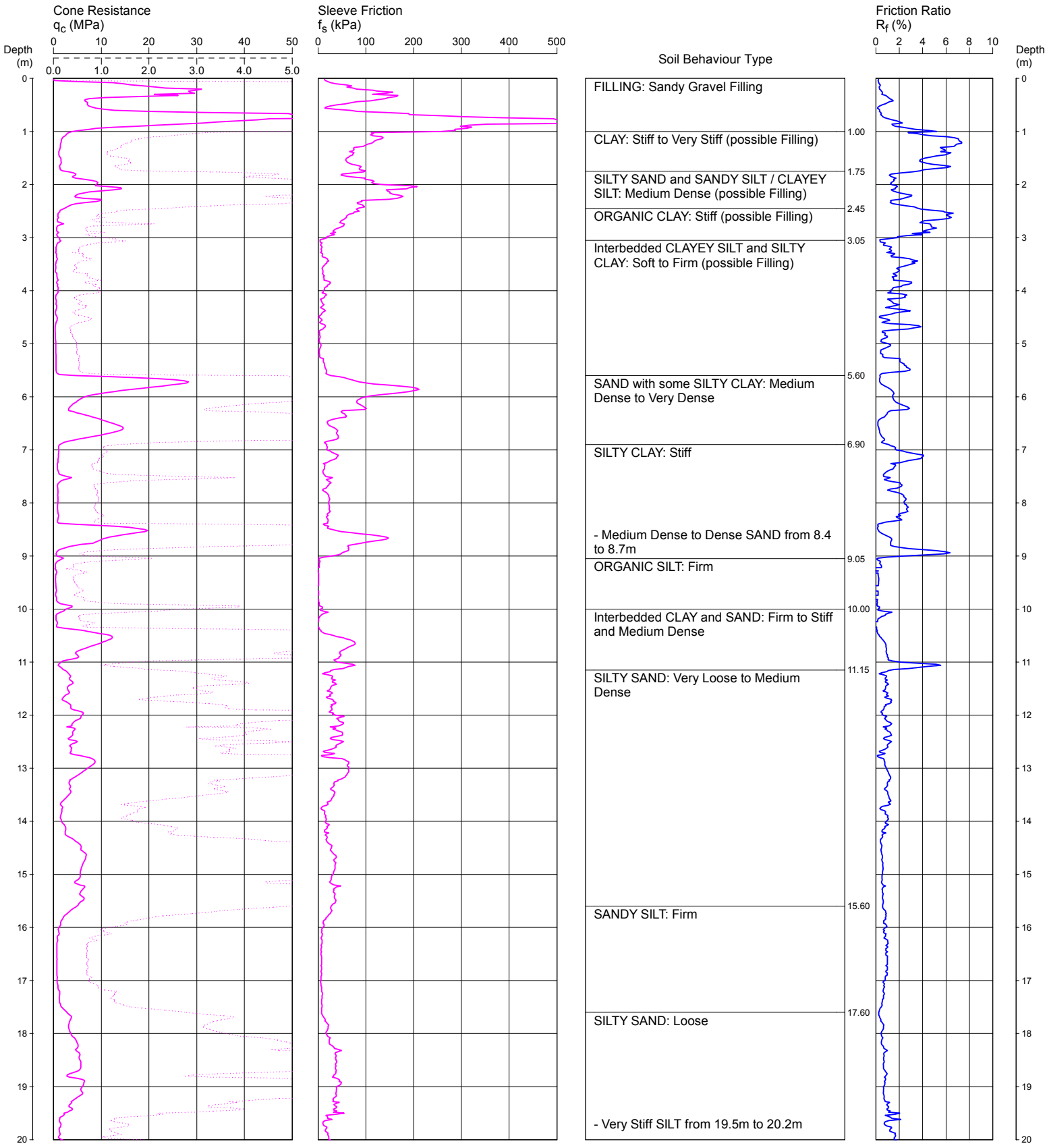
COORDINATES:

614

Page 1 of 2

DATE 16/4/2013

PROJECT No: 71015.17



REMARKS: PREDRILLED HOLE TO 0.7m DEPTH.
HOLE COLLAPSE AT 2.2m DEPTH AFTER REMOVAL OF RODS.

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\614.CP5
Cone ID: 120624 **Type:** I-CFXY-10

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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL REDEVELOPMENT

LOCATION: CONDAMINE STREET, BROOKVALE

REDUCED LEVEL: RL 9.4m AHD

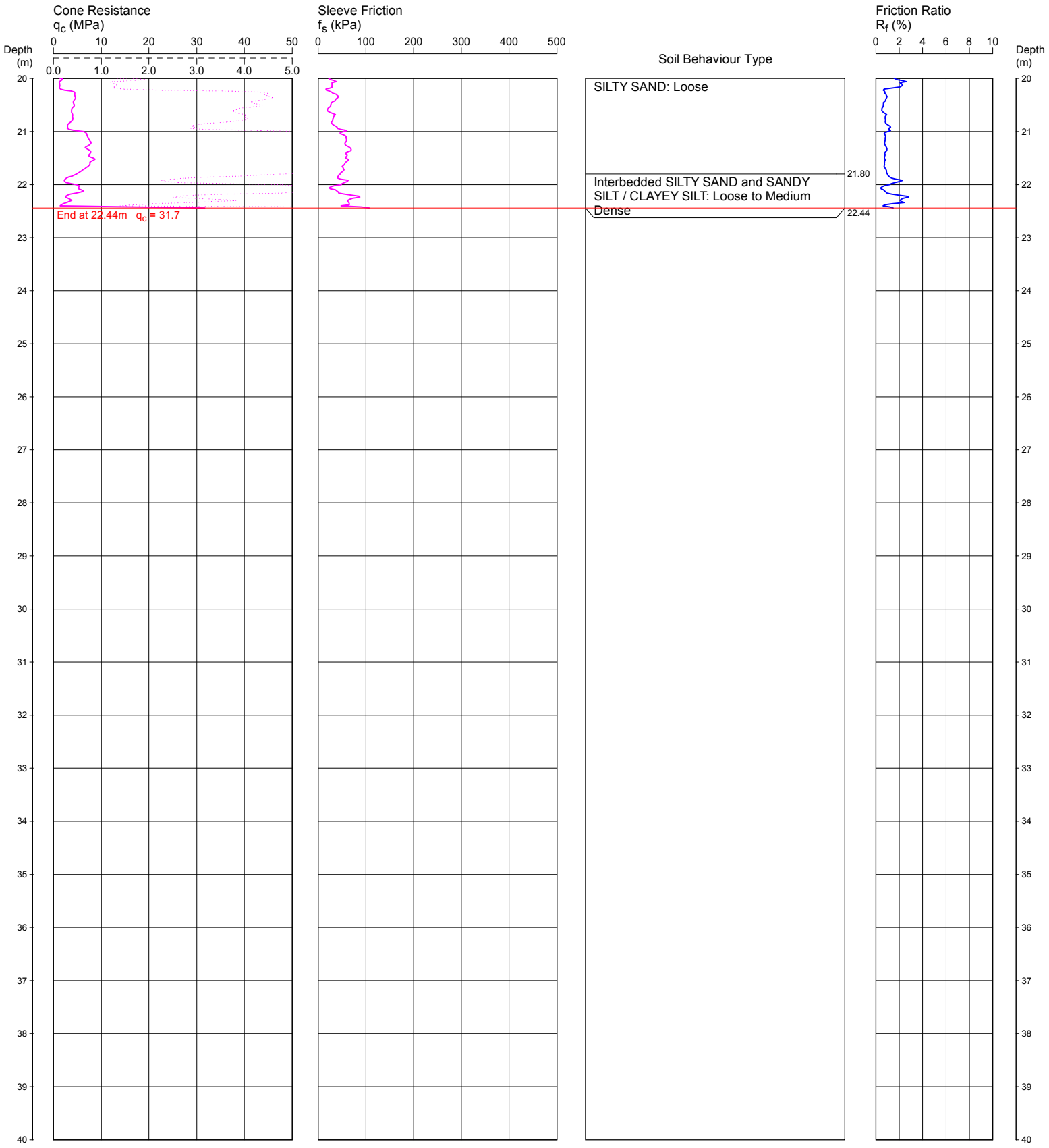
COORDINATES:

614

Page 2 of 2

DATE 16/4/2013

PROJECT No: 71015.17



REMARKS: PREDRILLED HOLE TO 0.7m DEPTH.
HOLE COLLAPSE AT 2.2m DEPTH AFTER REMOVAL OF RODS.

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\614.CP5
Cone ID: 120624 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL DEVELOPMENT

LOCATION: CONDAMINE STREET, BROOKVALE

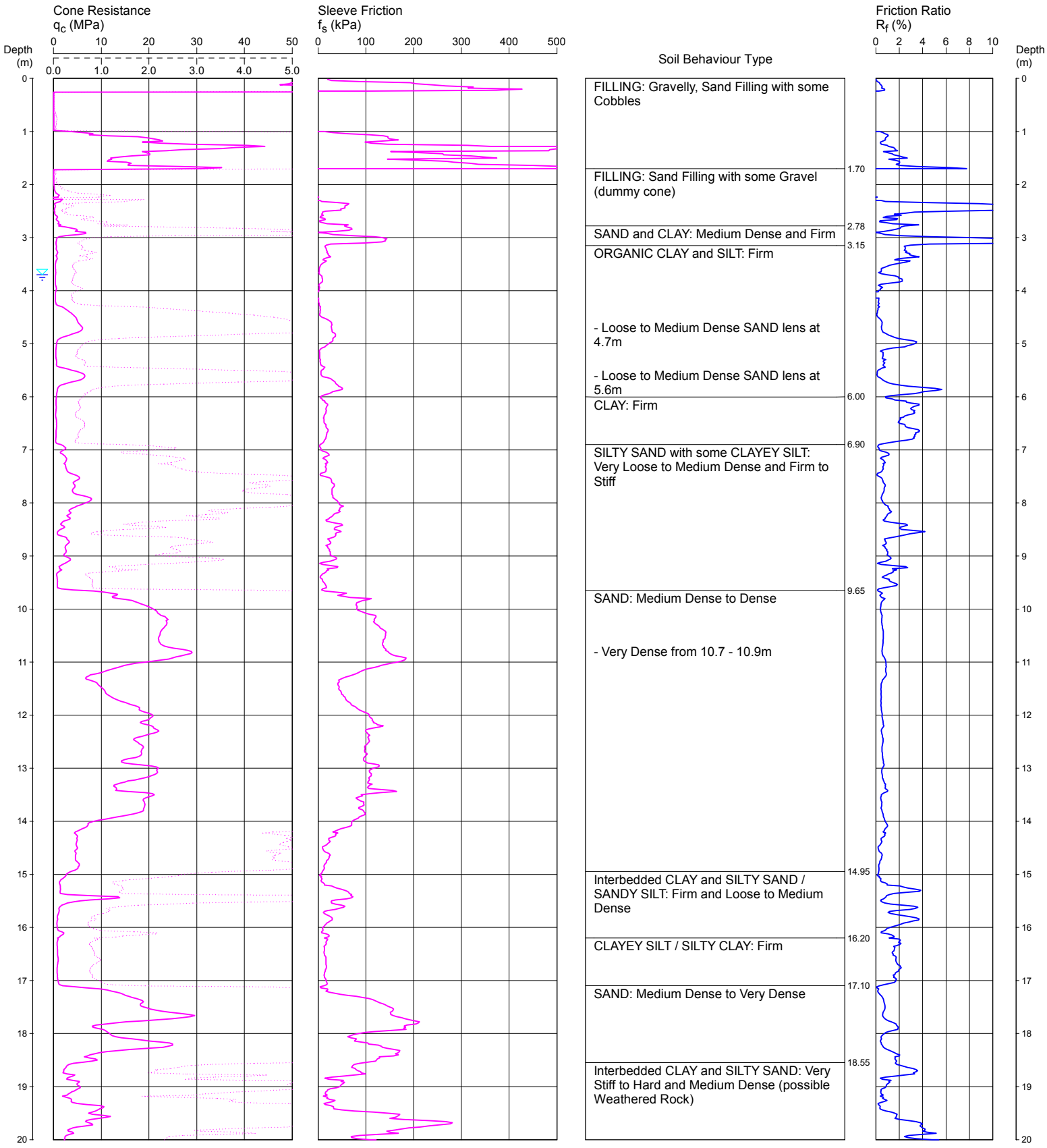
REDUCED LEVEL: RL 9.1m AHD

COORDINATES:

615C

DATE 15/4/2013

PROJECT No: 71015.17



REMARKS: DUMMY CONE FROM 0.24-1.0m AND 1.7-2.78m DEPTH.
GROUNDWATER OBSERVED AT 3.7m DEPTH AFTER REMOVAL OF RODS.

Water depth after test: 3.70m depth (assumed)

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\615.CP5

Cone ID: 120624 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL DEVELOPMENT

LOCATION: CONDAMINE STREET, BROOKVALE

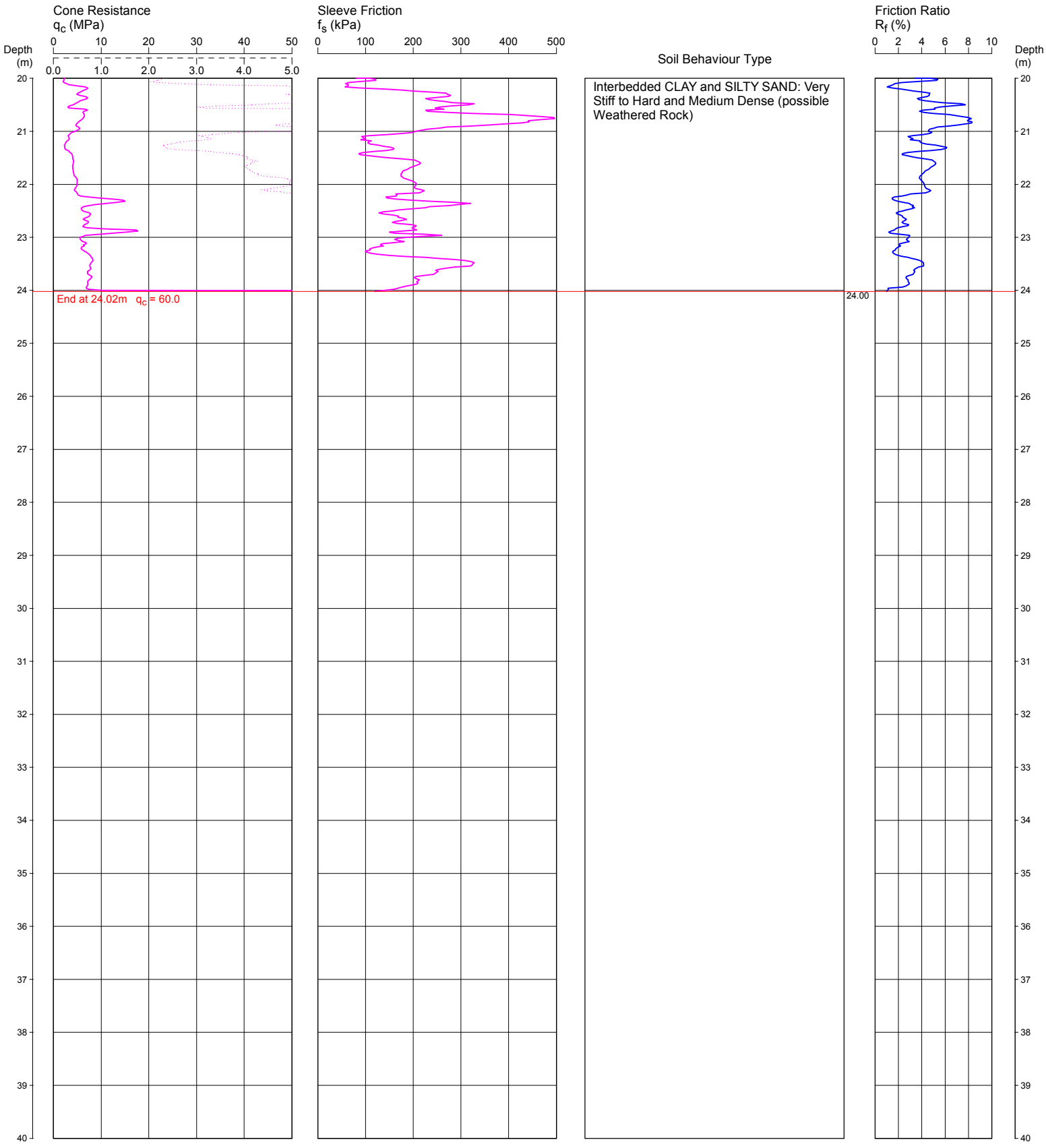
REDUCED LEVEL: RL 9.1m AHD

COORDINATES:

615C

DATE 15/4/2013

PROJECT No: 71015.17



REMARKS: DUMMY CONE FROM 0.24-1.0m AND 1.7-2.78m DEPTH.
GROUNDWATER OBSERVED AT 3.7m DEPTH AFTER REMOVAL OF RODS.

Water depth after test: 3.70m depth (assumed)

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\615.CP5

Cone ID: 120624 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: WESTFIELD DESIGN AND CONSTRUCTION PTY LTD

PROJECT: WARRINGAH MALL DEVELOPMENT

LOCATION: CONDAMINE STREET, BROOKVALE

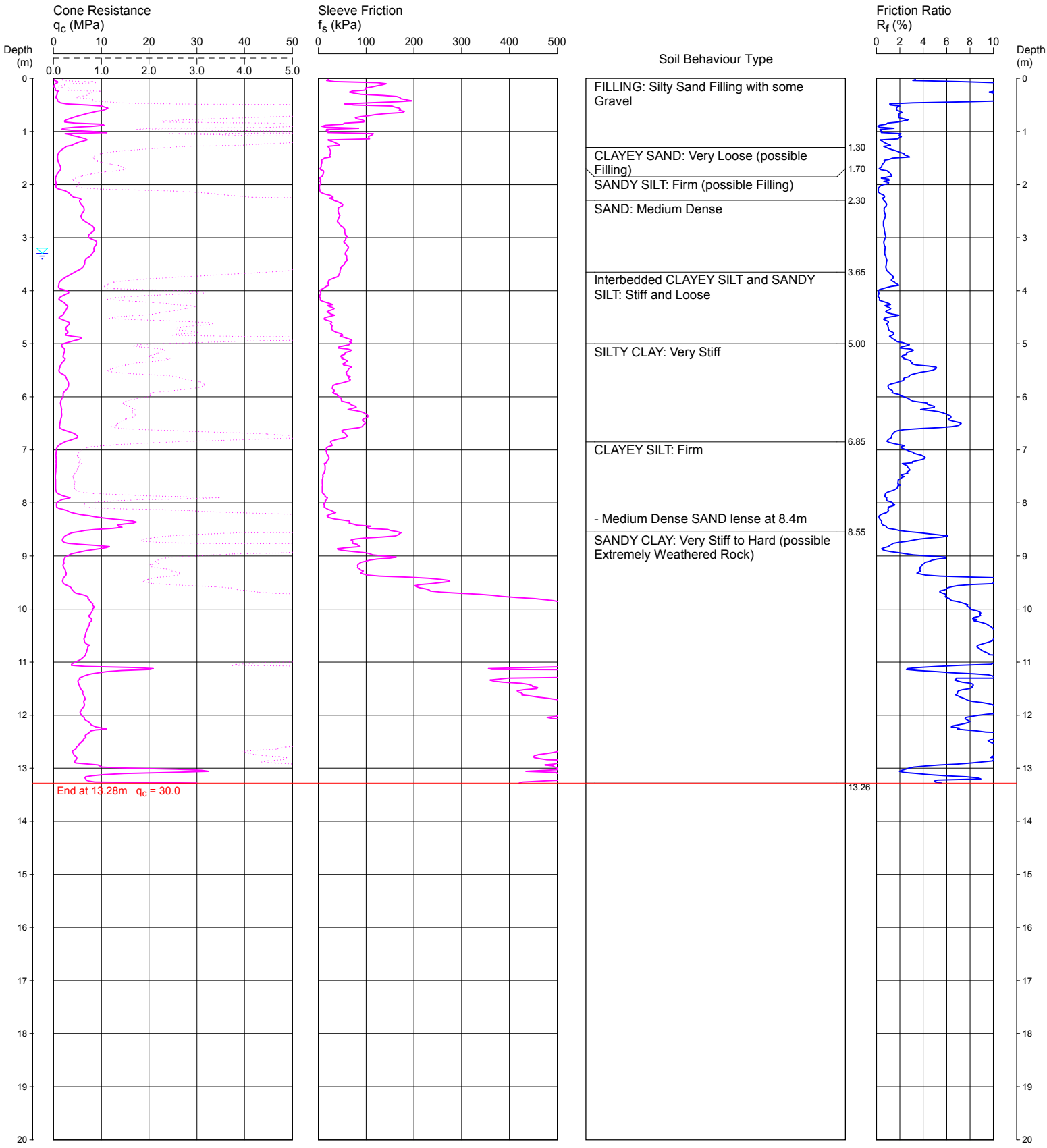
REDUCED LEVEL: RL 8.8m AHD

COORDINATES:

616A

DATE 15/4/2013

PROJECT No: 71015.17



REMARKS: DUMMY CONE TO 0.5m DEPTH.
GROUNDWATER OBSERVED AT 3.3m DEPTH AFTER REMOVAL OF RODS.

Water depth after test: 3.30m depth (assumed)

File: P:\71015.17 BROOKVALE, Warringah Mall redevelopment SCP\Field\CPTs\616.CP5

Cone ID: 120624 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

DOUGLAS PARTNERS PTY LTD

WARRINGAH MALL REDEVELOPMENT - BROOKVALE

BORE 622 PROJECT 71015.17 APR 2013

9.4 – 12.4m

BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 9.4*
EASTING: 339481
NORTHING: 6262418
DIP/AZIMUTH: 90°/--

BORE No: 622
PROJECT No: 71015.17
DATE: 18/4/2013
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.05	ASPHALTIC CONCRETE							A			
	0.35	ROADBASE GRAVEL							A			
		FILLING - poorly compacted, dark grey, sandy clay filling with some roadbase gravel, moist							A			
1	1.2	SANDY CLAY - soft then stiff, light grey, fine to medium grained sandy clay, wet				18-04-13			S			1,2,2 N = 4
2		2.0m: stiff							S			10,12,9 N = 21
3	3.5	SAND: medium dense, light brown, fine to medium grained sand with some silt and clay, wet							S			6,8,5 N = 13
4												
5	5.0	PEATY CLAY - very soft, dark grey, peaty clay with trace of fine grained sand, wet							S			0,0,0 N = 0
6	6.6	SAND - medium dense, grey, fine to medium grained sand wet							S			5,9,10 N = 19
7	7.7	SANDY CLAY - very stiff, grey brown, fine to medium grained, sandy clay with some ironstone gravel, moist										
8	8.5	SANDSTONE - very low strength, brown, fine to medium grained sandstone						Unless otherwise stated rock is fractured along rough planar bedding dipping at 0°-10°	S			25/50mm refusal
9	9.4	SANDSTONE - low strength, fresh, slightly fractured, light grey, medium grained sandstone						9.58m: B10°, cly 10mm 9.85m: B5°, cly 20mm	C	100	95	PL(A) = 0.2

RIG: DT100 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary drilling to 9.4m; NMLC-Coring to 12.4m

WATER OBSERVATIONS: Free groundwater observed at 1.2m whilst augering

REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 9.4*
EASTING: 339481
NORTHING: 6262418
DIP/AZIMUTH: 90°/--

BORE No: 622
PROJECT No: 71015.17
DATE: 18/4/2013
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	10.05	SANDSTONE - medium then high strength, fresh and moderately weathered, slightly fractured, light grey yellow brown and red brown, medium grained sandstone						10.58m to 10.66m: B(x3) 10°-15°, fe, cly 2-5mm 10.96m: J75°, pl, ro, cln 11.36m: B5°, fe, cly 11.64m & 11.7m: J20°-25°, pl, ro, fe	C	100	95	PL(A) = 0.6 PL(A) = 0.9 PL(A) = 1.2
	12.4	Bore discontinued at 12.4m										

RIG: DT100 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.5m
TYPE OF BORING: Solid flight auger to 2.5m; Rotary drilling to 9.4m; NMLC-Coring to 12.4m
WATER OBSERVATIONS: Free groundwater observed at 1.2m whilst augering
REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics | Environment | Groundwater

DOUGLAS PARTNERS PTY LTD

WARRINGAH MALL REDEVELOPMENT - BROOKVALE

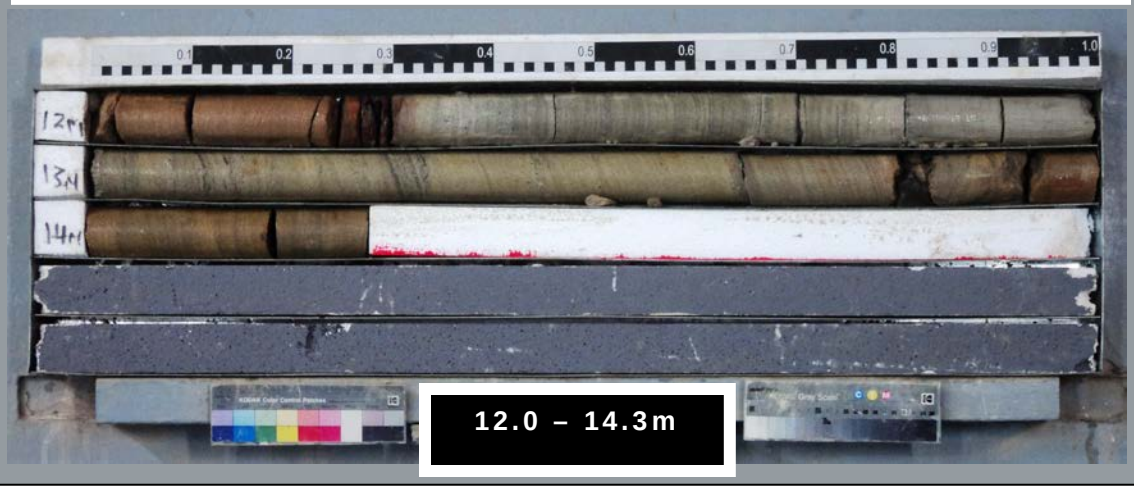
BORE 623 PROJECT 71015.17 APR 2013

8.5 – 12.0m

DOUGLAS PARTNERS PTY LTD

WARRINGAH MALL REDELOPMENT - BROOKVALE

BORE 623 PROJECT 71015.17 APR 2013



12.0 – 14.3m

BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 9.6*
EASTING: 339458
NORTHING: 6262391
DIP/AZIMUTH: 90°/--

BORE No: 623
PROJECT No: 71015.17
DATE: 17/4/2013
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
			EW HW MW SW FS FR		Ex Low / Very Low / Low / Medium / High / Very High / Ex High		0.01 / 0.05 / 0.10 / 0.50 / 1.00	B - Bedding J - Joint S - Shear F - Fault				
	0.1	ASPHALTIC CONCRETE							A			
		ROADBASE GRAVEL							A			
	0.6	FILLING - poorly compacted, dark grey, sandy clay filling with some crushed rock fragments and roadbase gravel, moist							A			
1		0.9m: hydrocarbon odour							S			5,4,5 N = 9
2	2.0	INTERBEDDED PEATY CLAYEY SAND AND SAND - very soft dark grey and black peaty clayey sand and very loose dark black sand with some clay, wet				17-04-13			S			0,0,1 N = 1
3		3.1m: light grey clay band										
4									S			0,0,0 N = 0
5												
6		5.9m: charcoal sandy clay band							S			1,0,0 N = 0
7	7.0	CLAYEY SAND - loose, light grey to grey, fine grained clayey sand, wet							S			0,2,2 N = 4
8	8.2	SANDSTONE - extremely low strength, fine to medium grained sandstone						Unless otherwise stated rock is fractured along rough planar bedding dipping at 0°-10°				
9								8.5m: CORE LOSS: 1500mm	C	33	28	

RIG: DT100 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary drilling to 8.5m; NMLC-Coring to 14.3m

WATER OBSERVATIONS: Free groundwater observed at 2.1m whilst augering

REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 9.6*
EASTING: 339458
NORTHING: 6262391
DIP/AZIMUTH: 90°/--

BORE No: 623
PROJECT No: 71015.17
DATE: 17/4/2013
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	10.13	SANDSTONE - medium strength, slightly weathered, fractured and slightly fractured, light grey and brown, medium to coarse grained sandstone						10m: CORE LOSS: 130mm 13.13m to 13.33m: B(x5) 0°-5°, cly vn 10.4m: J55°, un ro, cln 10.73m: J30°, un, ro, fe	C	33	28	PL(D) = 0.5
	11.1	SANDSTONE - medium to high and high strength, slightly weathered, slightly fractured, light grey brown, medium to coarse grained sandstone						11m: CORE LOSS: 100mm 11.21m: B0°, fe, cly 11.86m & 11.98m: B0°-10°, fe 12.22m: J25°, pl, ro, fe 12.37m: B5°, cly 5mm 12.6m to 12.3m: B(x4) 0°-5°, fe 12.7m & 12.81m: B0°-5°, cly co 1mm 13m: B0°, cly 10mm 13.64m: B10°, cly vn 13.83m: J35°, pl, ro, cln 14.18m: B5°, cbs co	C	100	99	PL(D) = 1.3
									C	100	90	PL(D) = 1 PL(D) = 1.1 PL(D) = 1.4
	14.3	Bore discontinued at 14.3m										

RIG: DT100 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary drilling to 8.5m; NMLC-Coring to 14.3m

WATER OBSERVATIONS: Free groundwater observed at 2.1m whilst augering

REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

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WARRINGAH MALL REDEVELOPMENT - BROOKVALE

BORE 624 PROJECT 71015.17 APR 2013

7.0 – 11.0m

DOUGLAS PARTNERS PTY LTD

WARRINGAH MALL REDELOPMENT - BROOKVALE

BORE 624 PROJECT 71015.17 APR 2013

11.0 – 14.5m

BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 9.1*
EASTING: 339534
NORTHING: 6262343
DIP/AZIMUTH: 90°/--

BORE No: 624
PROJECT No: 71015.17
DATE: 19/4/2013
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.05	ASPHALTIC CONCRETE							A			
	0.35	ROADBASE GRAVEL							A			
	0.7	FILLING - red brown silty clay filling with trace of fine grained sand and ironstone gravel, moist							A			
	1.0	FILLING - crushed sandstone and sandy clay filling, moist to wet							S			12,8,5 N = 13
		CLAYEY SAND - medium dense, grey, fine grained clayey sand, moist (possible filing) -from 1.4m: wet				19-04-13						
	2.1	SANDY CLAY - stiff, light grey brown, fine to medium grained sandy clay, wet							S			2,3,5 N = 8
									S			3,5,9 N = 14
	5.0	SANDY CLAY - firm, light grey, fine to medium grained sandy clay, wet							S			2,2,4 N = 6
	6.5	SANDSTONE - extremely low strength, light grey brown, fine to medium grained sandstone						Unless otherwise stated rock is fractured along rough planar bedding dipping at 0°-10°				
	7.0	SANDSTONE - low and very low strength, highly and slightly weathered, slightly fractured, light grey, medium to coarse grained sandstone						7.22m: CORE LOSS: 270mm	C	49	49	PL(A) = 0.2
	7.49							8m: CORE LOSS: 2290mm				
									C	0	0	

RIG: DT100 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary drilling to 7.0m; NMLC-Coring to 14.5m

WATER OBSERVATIONS: Free groundwater observed at 1.4m whilst augering

REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 9.1*
EASTING: 339534
NORTHING: 6262343
DIP/AZIMUTH: 90°/--

BORE No: 624
PROJECT No: 71015.17
DATE: 19/4/2013
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	10.29	SANDSTONE - low and very low strength, highly and slightly weathered, slightly fractured, light grey, medium to coarse grained sandstone(continued)							C	55	5	
	10.76							10.7m: CORE LOSS: 60mm				
11	11.1	SANDSTONE - medium then medium to high strength, slightly weathered, slightly fractured and unbroken, light grey brown, medium to coarse grained sandstone						11.04m: J30°. un, ro cz 10mm	C	99	85	
								11.53m: B0°, cly 11.64m: B0°. cly vn 11.87m: B10°, cly 12.06m: B0°, cly 10mm	C	100	77	PL(A) = 0.4 PL(A) = 0.7
13									C	100	99	PL(A) = 0.6
14								14.2m: B0°. fe				PL(A) = 1
	14.5	Bore discontinued at 14.5m										
15												
16												
17												
18												
19												

RIG: DT100 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary drilling to 7.0m; NMLC-Coring to 14.5m

WATER OBSERVATIONS: Free groundwater observed at 1.4m whilst augering

REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

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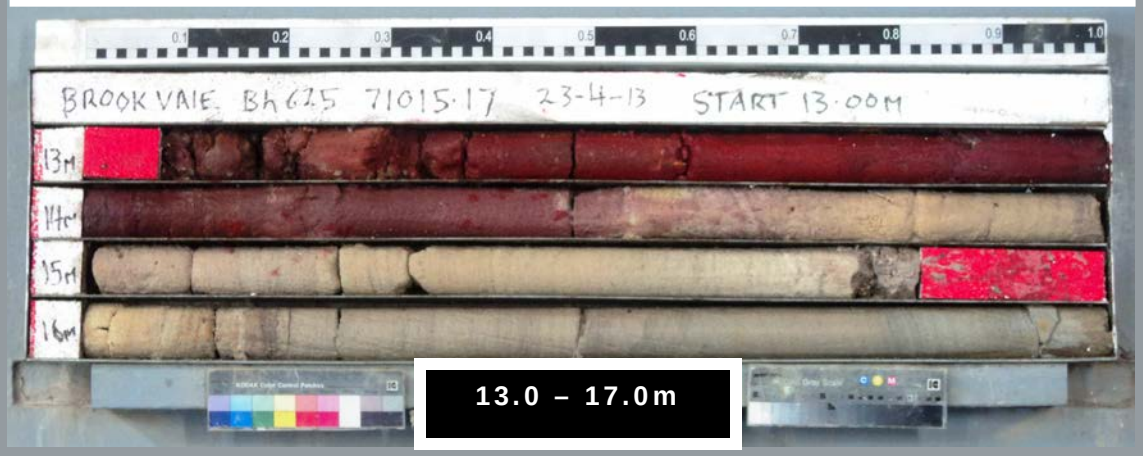
WARRINGAH MALL REDEVELOPMENT - BROOKVALE

BORE 625 PROJECT 71015.17 APR 2013



13.0 – 17.0m

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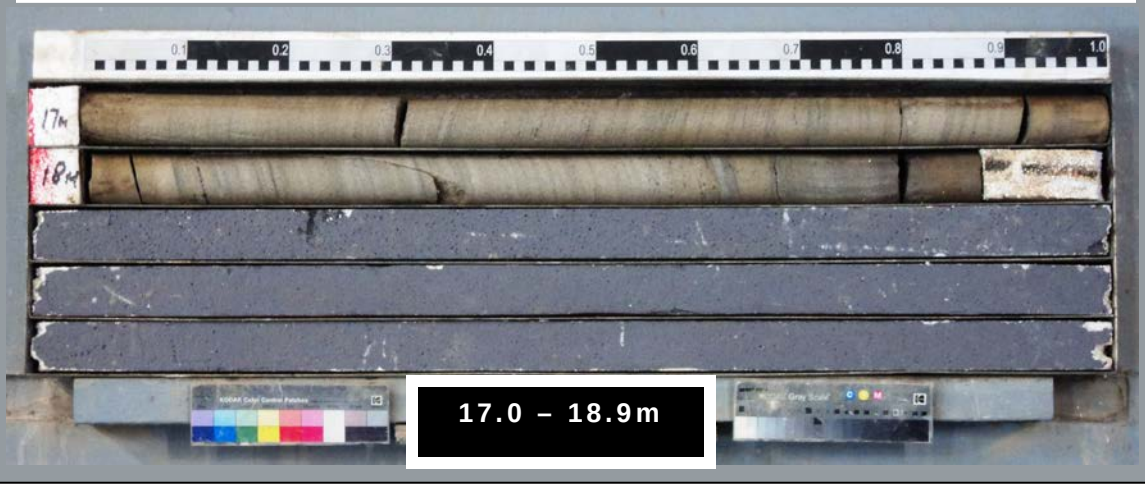
WARRINGAH MALL REDELOPMENT - BROOKVALE

BORE 625 PROJECT 71015.17 APR 2013



17.0 – 18.9m

BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 10.1*
EASTING: 339651
NORTHING: 6262340
DIP/AZIMUTH: 90°/--

BORE No: 625
PROJECT No: 71015.17
DATE: 23/4/2013
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.05	ASPHALTIC CONCRETE							A			
	0.3	ROADBASE GRAVEL							A			
		FILLING - variably compacted, red brown, crushed sandstone filling with some clay							A			
	1								S			6,5,9 N = 14
	2.1	CLAY - firm to stiff, light grey clay, moist							S			1,3,5 N = 8
	3.5	SANDY CLAY - very stiff, light grey brown, fine to medium grained sandy clay, moist							S			3,8,12 N = 20
	5.0	CLAY - stiff, light grey clay, moist							S			3,5,5 N = 10
	7.0	SAND - dense, light grey, fine to medium grained sand with some silt and clay							S			14,16,16 N = 32
	7.9	PEATY CLAY - very soft, dark grey, peaty clay with trace of fine grained sand, wet							S			0,0,0 N = 0
	10.0											

RIG: DT100 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary drilling to 13.0m; NMLC-Coring to 19.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 10.1*
EASTING: 339651
NORTHING: 6262340
DIP/AZIMUTH: 90°/--

BORE No: 625
PROJECT No: 71015.17
DATE: 23/4/2013
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.0	CLAYEY SAND - medium dense, dark grey, fine to medium grained clayey sand, wet							S			1,4,13 N = 17
	11											
	11.8	SANDY CLAY - stiff, light grey, fine grained sandy clay, moist (possibly extremely low strength sandstone)						Unless otherwise stated rock is fractured along rough planar bedding dipping at 0°-10°	S			4,5,8 N = 13
	12											
	13.0	SANDSTONE - very low strength, highly weathered, slightly fractured, red purple brown then light grey brown, medium to coarse grained sandstone						13m: CORE LOSS: 80mm 13.22m: J10°-15°, un, ro, fe, cly 13.58m: J5-10°, un, ro, fe, cly	C	80	55	PL(A) = 1.5
	13.08											
	14								C	100	18	
								14.52m: B0°, cly				
	15											
	15.1	SANDSTONE - medium strength, slightly weathered then fresh, slightly fractured, light grey brown, medium to coarse grained sandstone -15.7 to 16.15m: very low strength						15.32m: J35°, cu, ro, cln	C	88	40	PL(A) = 0.5 PL(A) = 0.6
	16							15.82m: CORE LOSS: 180mm				
	16.0							16.16m: B0°, cly 5mm 16.48m: B10°, cly 5mm				PL(A) = 1.3
	17							16.92m: J45°, pl, sm, cly co 1mm				
	17.2	SANDSTONE - high strength, fresh, slightly fractured and unbroken, light grey, medium to coarse grained sandstone							C	100	95	PL(A) = 1.9
	18							18.11 to 18.38m: B10°, cly co, J85°, un, ro, cln 18.62m: B5°,cly 2mm				PL(A) = 0.5
	18.9	Bore discontinued at 18.9m										
	19											

RIG: DT100 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary drilling to 13.0m; NMLC-Coring to 19.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

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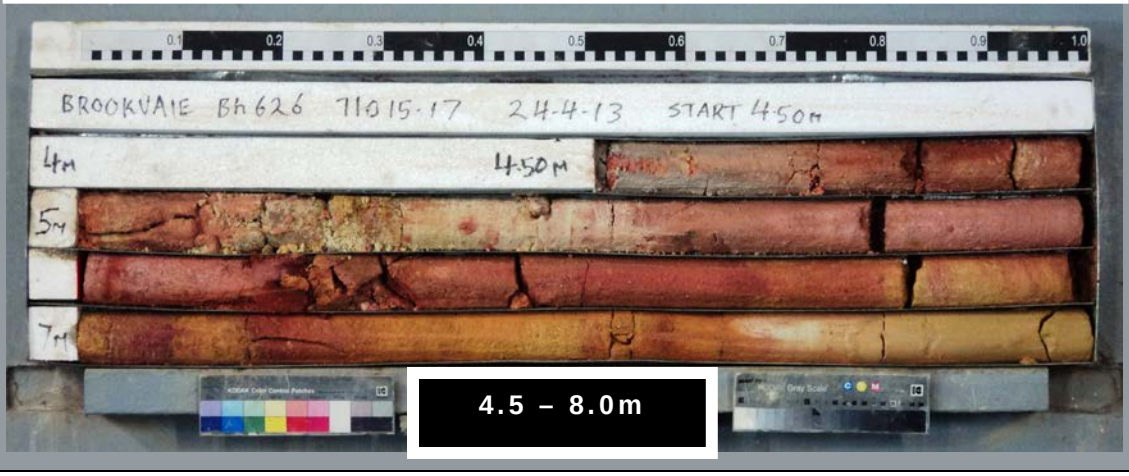
WARRINGAH MALL REDEVELOPMENT - BROOKVALE

BORE 626 PROJECT 71015.17 APR 2013

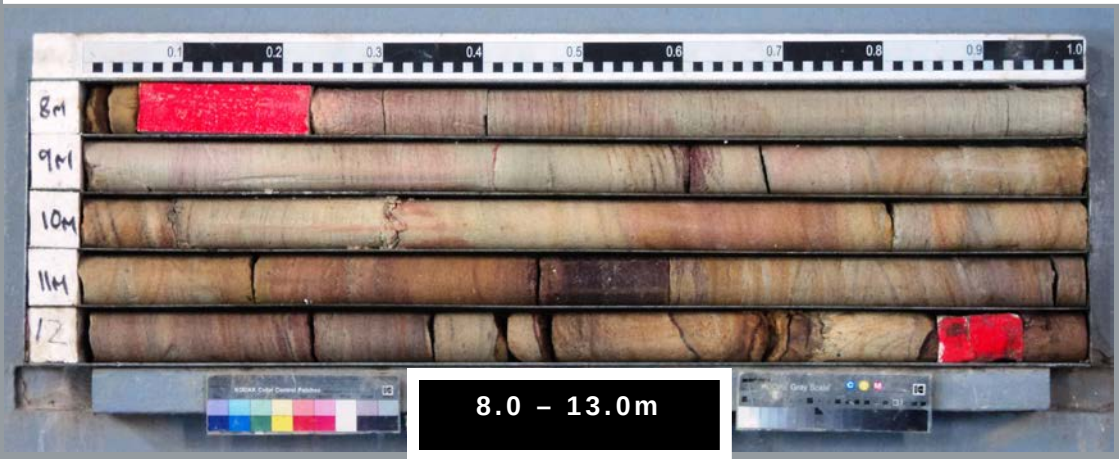


4.5 – 8.0m

DOUGLAS PARTNERS PTY LTD

WARRINGAH MALL REDEVELOPMENT - BROOKVALE

BORE 626 PROJECT 71015.17 APR 2013



8.0 – 13.0m

BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 9.5*
EASTING: 339630
NORTHING: 6262300
DIP/AZIMUTH: 90°/--

BORE No: 626
PROJECT No: 71015.17
DATE: 24/4/2013
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.05	ASPHALTIC CONCRETE							A			
	0.35	ROADBASE GRAVEL							A			
	0.9	FILLING - light grey brown, fine to medium grained sand filling with some concrete gravel, humid							A			
1		FILLING - moderately compacted, light grey brown, crushed shale fragment filling, humid							S			10,12,5 N = 17
	1.6	SANDY CLAY - very stiff, light grey, fine to medium grained sandy clay, moist										
2									S			2,6,10 N = 16
3												
4	4.0	SANDSTONE - very low strength, light grey brown, fine to medium, grained sandstone						Unless otherwise stated rock is fractured along rough planar bedding dipping at 0°-10°	S			4,6,25/100mm refusal
	4.5	SANDSTONE - very low strength, highly weathered, slightly fractured, light brown, red brown and yellow brown, medium grained sandstone							C	100	0	
5								5.0m to 5.4m: J70°-85°, un, ro, fe				
									C	100	0	
6								6.3m: J50°, pl, ro, fe				
7								7.16m: J85°-90°, pl, ro ,fe	C	92	0	
8								8.05m: CORE LOSS: 170mm				
	8.22	SANDSTONE - low to medium then medium strength, moderately to slightly weathered, slightly fractured, light grey and brown, medium grained sandstone										PL(A) = 0.6
9								8.92m: J70°, pl, sm, cly	C	99	90	
								9.41m: B0°, fe, cly 9.6m: B5°, fe 9.68m: B5°, cly vn 9.88m: B5°, cly co 1mm				PL(A) = 0.8

RIG: DT100 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary drilling to 4.5m; NMLC-Coring to 13.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 9.5*
EASTING: 339630
NORTHING: 6262300
DIP/AZIMUTH: 90°/--

BORE No: 626
PROJECT No: 71015.17
DATE: 24/4/2013
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		SANDSTONE - low to medium then medium strength, moderately to slightly weathered, slightly fractured, light grey and brown, medium grained sandstone *(continued)*						10.1m: B0°, cly 10mm 10.3m: B0°, cly 10mm 10.8m: B5°, cly 10mm	C	99	90	PL(A) = 0.4
11	11.0	SANDSTONE - medium strength, moderately to slightly weathered, slightly fractured, light grey brown, medium to coarse grained sandstone. Some very low strength bands										
								11.86m: B15°, cly vn	C	91	77	PL(A) = 0.8 PL(A) = 0.7
12								12.4m: J30°, pl, ro, fe 12.45m: J30°, pl, ro, fe 12.65m: J45°, un, ro, fe 12.73m: B5°, cly 12.84m: CORE LOSS: 80mm				
13	12.92 13.0	Bore discontinued at 13.0m										
14												
15												
16												
17												
18												
19												

RIG: DT100 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary drilling to 4.5m; NMLC-Coring to 13.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
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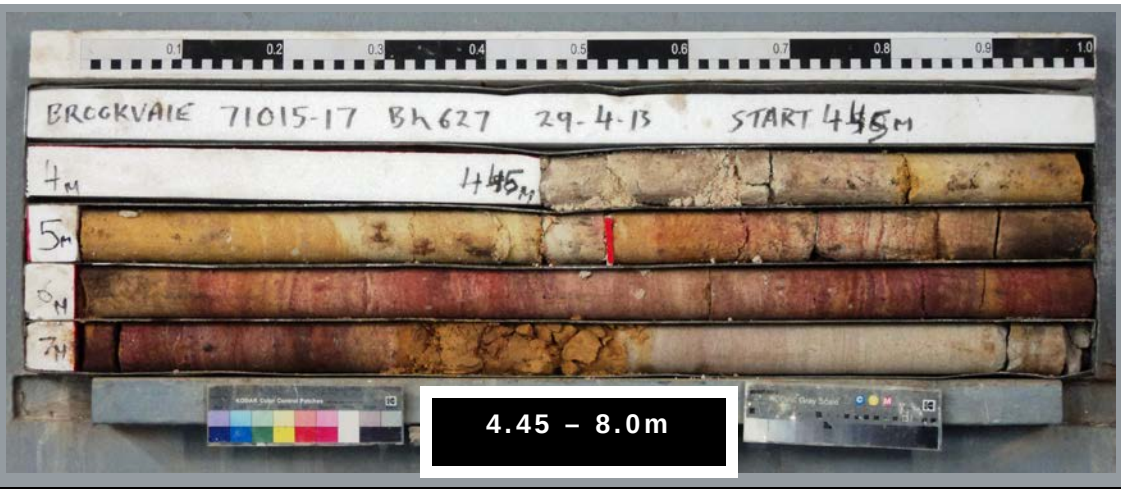
DOUGLAS PARTNERS PTY LTD

WARRINGAH MALL REDEVELOPMENT - BROOKVALE

BORE 627 PROJECT 71015.17 APR 2013



4.45 – 8.0m

DOUGLAS PARTNERS PTY LTD

WARRINGAH MALL REDEVELOPMENT - BROOKVALE

BORE 627 PROJECT 71015.17 APR 2013

8.0 – 13.0m

BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 9.4*
EASTING: 339603
NORTHING: 6262270
DIP/AZIMUTH: 90°/--

BORE No: 627
PROJECT No: 71015.17
DATE: 29/4/2013
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.05	ASPHALTIC CONCRETE							A			
	0.15	ROADBASE GRAVEL							A			
	0.5	FILLING - crushed sandstone filling with some clay							A			
		CLAY - very stiff, red brown clay, moist							S			2,8,10 N = 18
	1.7	SANDSTONE - extremely low strength, extremely weathered, light grey, fine to medium grained sandstone (stiff clay properties)							S			6,7,7 N = 14
		4.0m: very low strength						Unless otherwise stated rock is fractured along rough planar bedding dipping at 0°-10°	S			25/120mm refusal
	4.45	SANDSTONE - very low then low strength, highly and moderately weathered, slightly fractured, light grey and orange brown, medium to coarse grained sandstone							C	100	94	PL(D) = 1 PL(D) = 0.1
	5.41	SANDSTONE - medium to high strength, moderately weathered, slightly fractured and unbroken, light grey and red brown, medium to coarse grained sandstone						5.45m: B0°, cly				PL(D) = 0.1
									C	100	90	PL(D) = 1.1
		7.3 to 7.55m: extremely low strength, extremely weathered yellow brown sandstone						7.35m: fg, 150mm				
	7.55	SANDSTONE - medium strength, fresh, slightly fractured and unbroken, light grey and orange brown, medium to coarse grained sandstone. Some extremely low strength bands										PL(D) = 1 PL(D) = 0.8
								8.65m: B0°-5°, cly 15mm	C	100	90	
	9.75	SANDSTONE (see next page)						>>				

RIG: DT100 **DRILLER:** SS **LOGGED:** PGH **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary drilling to 4.45m; NMLC-Coring to 14.15m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

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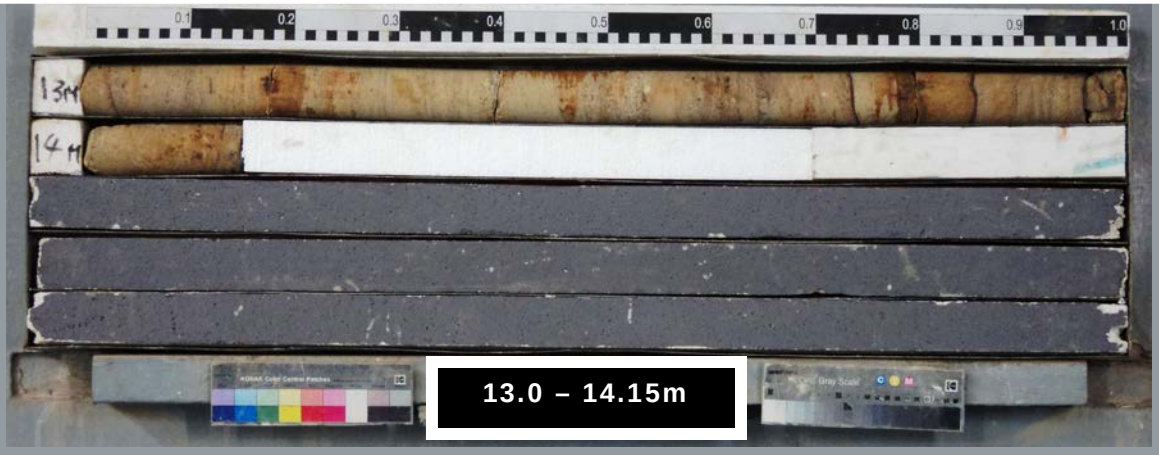
DOUGLAS PARTNERS PTY LTD

WARRINGAH MALL REWDEVELOPMENT - BROOKVALE

BORE 627 PROJECT 71015.17 APR 2013



13.0 – 14.15m

BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 9.4*
EASTING: 339603
NORTHING: 6262270
DIP/AZIMUTH: 90°/--

BORE No: 627
PROJECT No: 71015.17
DATE: 29/4/2013
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		SANDSTONE - high strength, slightly weathered and fresh, slightly fractured and unbroken, light grey and orange brown, medium to coarse grained sandstone *(continued)*							C	100	90	PL(D) = 1.4
	11											
	11.41							11.41m: CORE LOSS: 290mm				PL(D) = 1.1
	11.7											
	12							12.25m: B0°, cly 5mm 12.4m: B0°-5°, cly 3mm	C	91	88	PL(D) = 1.1
	13							12.73m: B0°, cly 5-8mm				
	14											
	14.15	Bore discontinued at 14.15m										
	15											
	16											
	17											
	18											
	19											

RIG: DT100 **DRILLER:** SS **LOGGED:** PGH **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary drilling to 4.45m; NMLC-Coring to 14.15m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

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DOUGLAS PARTNERS PTY LTD

WARRINGAH MALL REDEVELOPMENT - BROOKVALE

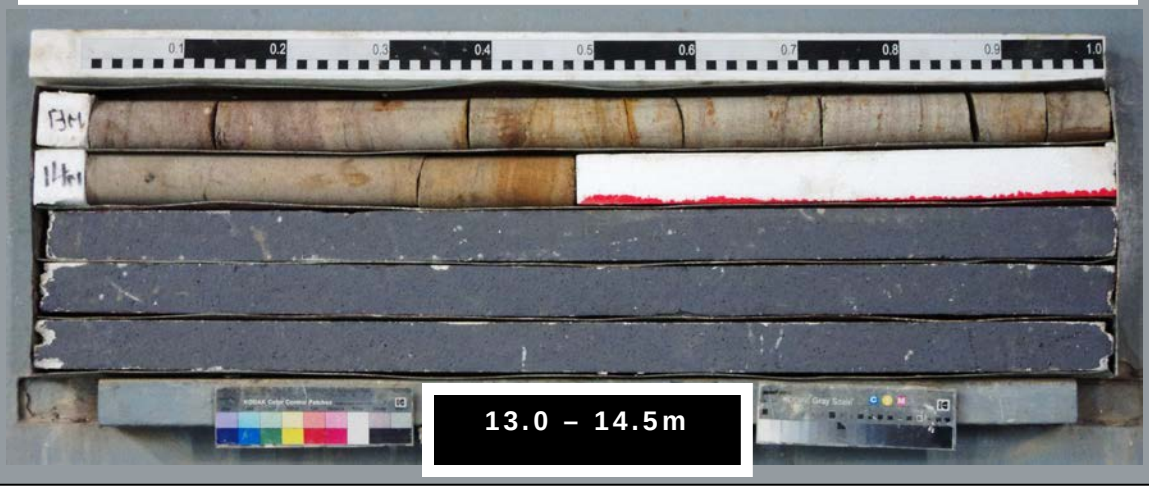
BORE 628 PROJECT 71015.17 APR 2013

9.7 – 13.0m

DOUGLAS PARTNERS PTY LTD

WARRINGAH MALL REDEVELOPMENT - BROOKVALE

BORE 628 PROJECT 71015.17 APR 2013



13.0 – 14.5m

BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 9.5*
EASTING: 339555
NORTHING: 6262169
DIP/AZIMUTH: 90°/--

BORE No: 628
PROJECT No: 71015.17
DATE: 30/4/2013
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
	0.05	ASPHALTIC CONCRETE										
	0.15	FILLING - slightly brown sandy, gravel filling, humid							A			
		FILLING - brown silty sand filling with subrounded and angular gravel, dry							A			
	0.85	FILLING - dark grey sand with some clay and charcoal, humid							S			6,10,15 N = 25
	3.1	SILTY SAND - very loose, dark grey to black, fine to medium grained silty sand with a trace of clay, humid				30-04-13			S			2,4,4 N = 8
	4.7	PEATY CLAY - very soft, black peaty clay							S			0,1,1 N = 2
	6.4	SAND - very loose, black, medium to coarse grained sand							S			0,0,0 N = 0
	8.0	SAND - very loose, grey, coarse grained sand							S			2,1,2 N = 3
	9.3	SANDSTONE - extremely low strength, light grey brown, fine to medium grained sandstone						Unless otherwise stated rock is fractured along rough planar bedding dipping at 0°-10°	S			2,1,2 N = 3
	9.7	SANDSTONE - (see next page)							C	100	95	PL(A) = 0.5

RIG: DT100 **DRILLER:** SS **LOGGED:** PGH **CASING:** HW to 4.0m

TYPE OF BORING: Solid flight auger to 4.0m; Rotary drilling to 9.2m; NMLC-Coring to 14.5m

WATER OBSERVATIONS: Free groundwater observed at 3.75 whilst augering

REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Westfield Design & Construction Pty Ltd
PROJECT: Warringah Mall Redevelopment
LOCATION: Condamine Street, Brookvale

SURFACE LEVEL: RL 9.5*
EASTING: 339555
NORTHING: 6262169
DIP/AZIMUTH: 90°/--

BORE No: 628
PROJECT No: 71015.17
DATE: 30/4/2013
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		SANDSTONE - medium and high strength, slightly weathered and fresh, slightly fractured then unbroken, light grey, medium to coarse grained sandstone *(continued)*						10.15m: B0°, cly 5mm 10.66m: B0°-5°, cly 5mm 11.1m: B0°, cly 5mm 12.32m: J75°, pl, ro, cln 12.45m: J75°, pl, ro, cln 12.6m: J45°, pl, ro, cln 12.7m: B0°. cly 2mm	C	100	95	PL(A) = 0.7 PL(A) = 0.8 PL(A) = 2.1
	14.5	Bore discontinued at 14.5m							C	100	94	PL(A) = 0.8 PL(A) = 1.6

RIG: DT100 **DRILLER:** SS **LOGGED:** PGH **CASING:** HW to 4.0m

TYPE OF BORING: Solid flight auger to 4.0m; Rotary drilling to 9.2m; NMLC-Coring to 14.5m

WATER OBSERVATIONS: Free groundwater observed at 3.75 whilst augering

REMARKS: *Surface level m AHD

SAMPLING & IN SITU TESTING LEGEND

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

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CONE PENETRATION TEST

CLIENT: SCENTRE GROUP PTY LTD

PROJECT: PROPOSED CULVERT MODIFICATION

LOCATION: CONDAMINE STREET, BROOKVALE

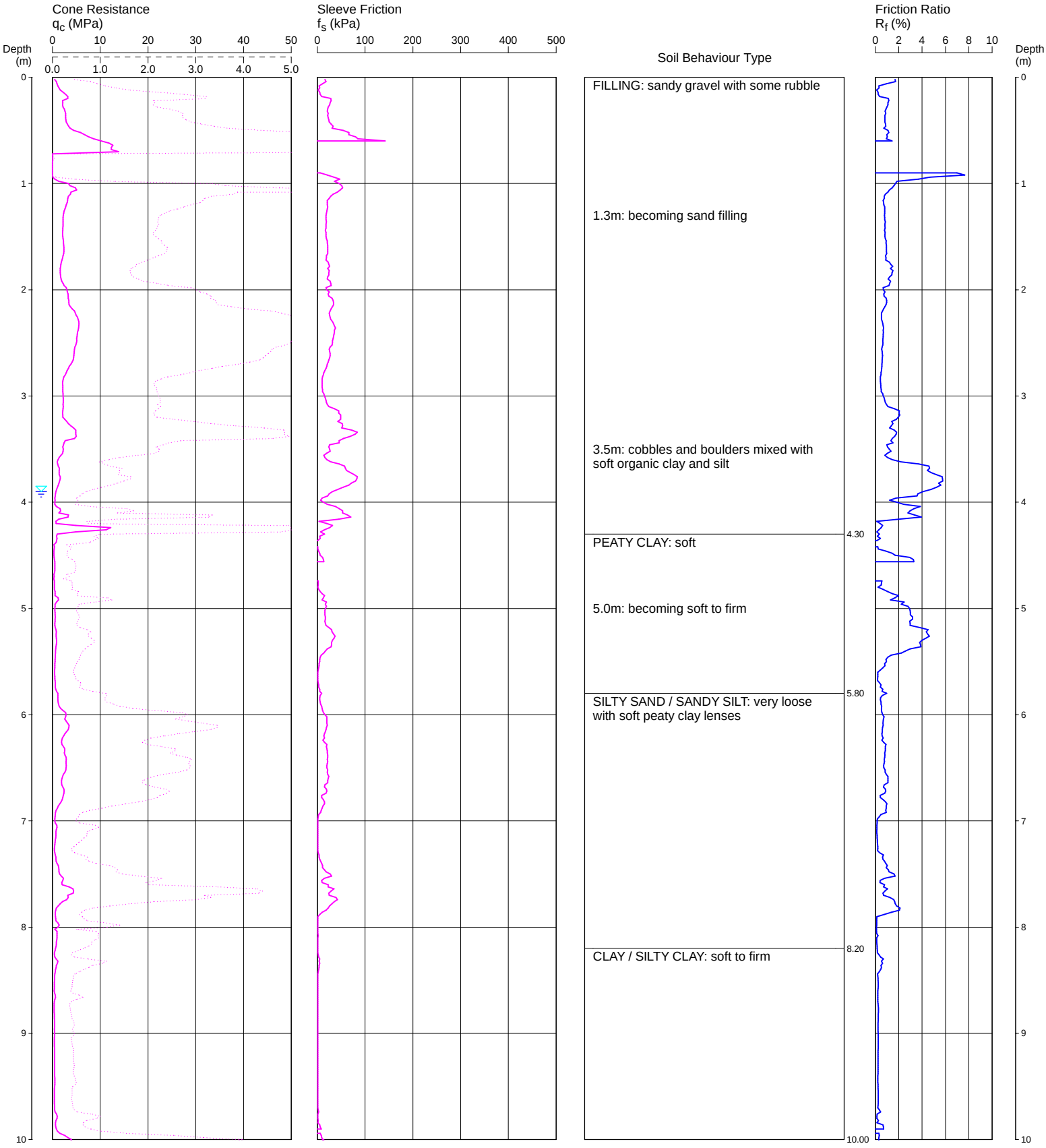
REDUCED LEVEL: 9.1

COORDINATES:

CPT1

DATE 21/8/2014

PROJECT No: 71015.22



REMARKS: DUMMY CONE USED FROM 0.70 m TO 1.0 m DEPTH TO PENETRATE FILLING; GROUNDWATER OBSERVED AT 3.9 m DEPTH AFTER WITHDRAWAL OF RODS.

Water depth after test: 3.90m depth (measured)

File: P:\71015.22 BROOKVALE, Condamine Street Culvert SCP\Field\CPT\CPT1.CP5

Cone ID: 120624 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: SCENTRE GROUP PTY LTD

PROJECT: PROPOSED CULVERT MODIFICATION

LOCATION: CONDAMINE STREET, BROOKVALE

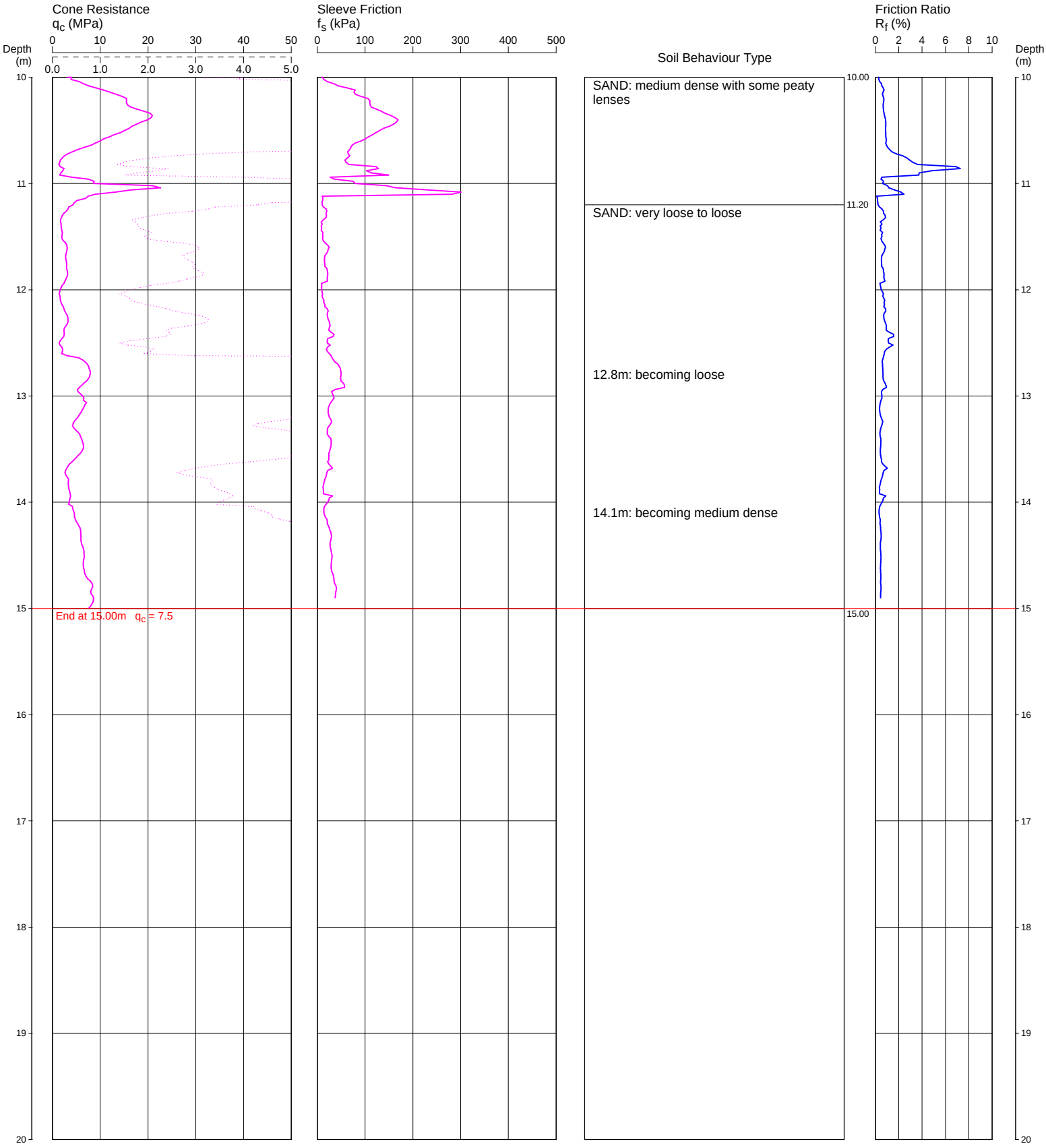
REDUCED LEVEL: 9.1

COORDINATES:

CPT1

DATE 21/8/2014

PROJECT No: 71015.22



REMARKS: DUMMY CONE USED FROM 0.70 m TO 1.0 m DEPTH TO PENETRATE FILLING; GROUNDWATER OBSERVED AT 3.9 m DEPTH AFTER WITHDRAWAL OF RODS.

Water depth after test: 3.90m depth (measured)

File: P:\71015.22 BROOKVALE, Condamine Street Culvert SCP\Field\CPT\CPT1.CP5

Cone ID: 120624 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
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BOREHOLE LOG

CLIENT: Vibropile (Australia) Pty Ltd
PROJECT: Zone 2 Palm Tree Car Park
LOCATION: Cross Street, Brookvale

SURFACE LEVEL: 9.6 AHD
EASTING: 339473
NORTHING: 6262414
DIP/AZIMUTH: 90°/--

BORE No: VP4
PROJECT No: 71015.30
DATE: 11/9/2015
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.08	ASPHALT										
	0.2	FILLING - road base										
		FILLING - gravelly sand filling, grey										
	1.0	Clayey SAND - grey-brown, fine to medium clayey sand										
	2.0	Sandy CLAY - orange-brown, sandy clay										
	3.0	SAND - grey, fine to medium sand with occasional clay bands										
	8.0	SAND - pale grey, coarse sand										
	8.3	SANDSTONE - extremely low strength, fresh, pale grey, fractured, fine grained sandstone						8.46m: CORE LOSS: 280mm				
	8.74											
	9.05	SANDSTONE - medium and medium to high strength, fresh, pale grey, slightly fractured, medium grained sandstone						9.05m: B0°, pl ro, 5mm clay	C	88	88	PL(A) = 0.5 PL(D) = 0.5

RIG: Landcruiser **DRILLER:** Tightsite **LOGGED:** L James-Hall **CASING:** HQ to 8.2m

TYPE OF BORING: SFA to 8.40m; R to 8.46m; NMLC to 11.76m

WATER OBSERVATIONS: Water observed at 3.0m whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	FID	Flame ionisation detector (ppm)
BLK	Block sample	U_x	Tube sample (x mm dia.)	DYE	Test jar for VOC
C	Core drilling	W	Water sample	NR	No reaction
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Vibropile (Australia) Pty Ltd
PROJECT: Zone 2 Palm Tree Car Park
LOCATION: Cross Street, Brookvale

SURFACE LEVEL: 9.6 AHD
EASTING: 339473
NORTHING: 6262414
DIP/AZIMUTH: 90°/--

BORE No: VP4
PROJECT No: 71015.30
DATE: 11/9/2015
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
-1		SANDSTONE - medium and medium to high strength, fresh, pale grey, slightly fractured, medium grained sandstone *(continued)*						10m: B0°, pl ro, 1mm clay	C	88	88	PL(A) = 1 PL(D) = 0.9
	10.65											
		SANDSTONE - medium strength, moderately to slightly weathered, brown and brown-grey, slightly fractured, coarse grained sandstone										PL(A) = 0.9 PL(D) = 0.7
-2	11								C	100	100	
								11.37m: B0°, pl, fe healed				PL(A) = 0.8 PL(D) = 0.6
	11.76							11.65m: to 11.73m; B0°-20°, pl, fe, healed				
		Bore discontinued at 11.76m										
	12											
-3	13											
-4	14											
-5	15											
-6	16											
-7	17											
-8	18											
-9	19											
-10												

RIG: Landcruiser **DRILLER:** Tightsite **LOGGED:** L James-Hall **CASING:** HQ to 8.2m

TYPE OF BORING: SFA to 8.40m; R to 8.46m; NMLC to 11.76m

WATER OBSERVATIONS: Water observed at 3.0m whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	FID	Flame ionisation detector (ppm)
BLK	Block sample	U_x	Tube sample (x mm dia.)	DYE	Test jar for VOC
C	Core drilling	W	Water sample	NR	No reaction
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

DOUGLAS PARTNERS PTY LTD

WARRINGAH MALL

BORE VP4 PROJECT 71015.30 SEP 2015

CONE PENETRATION TEST

CLIENT: SCENTRE DESIGN & CONSTRUCTION

PROJECT: PROPOSED SEWER DIVERSION

LOCATION: WESTFIELD WARRINGAH MALL

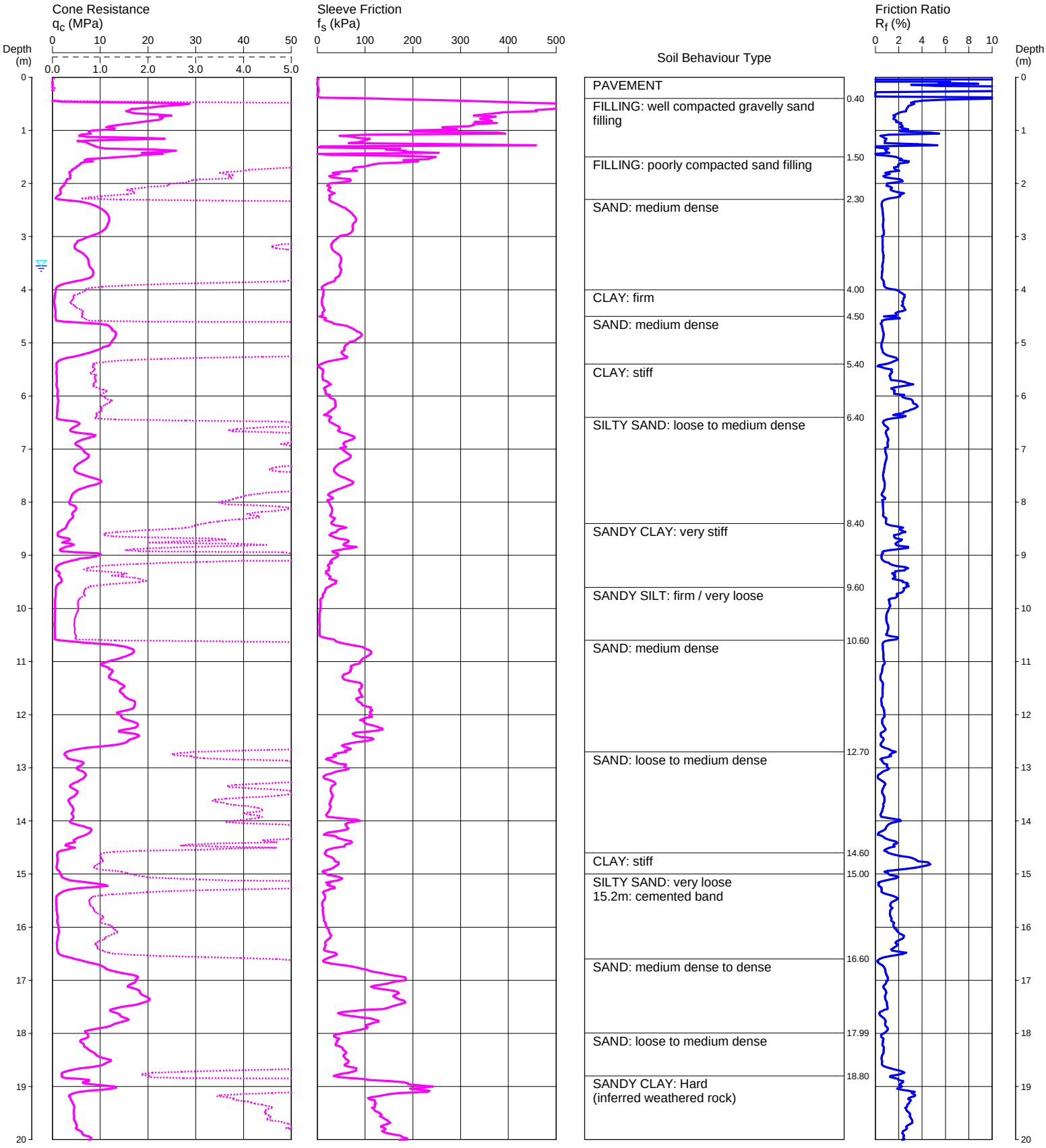
REDUCED LEVEL: 8.7

COORDINATES: 339499E 6262115N

CPTZ11-1

DATE 10/12/2015

PROJECT No: 71015.31



REMARKS: DUMMY CONE USED FROM 0 m TO 0.5 m DEPTH TO PENETRATE FILLING.
GROUNDWATER OBSERVED AT 3.55 m DEPTH AFTER WITHDRAWAL OF RODS.

Water depth after test: 3.55m depth (measured)

File: \\DPSYDNAS01\Projects\71015.31 BROOKVALE, WMall Stage 1 Main Works\4.0 Field Work\71015.31 BROOKVALE cpt\CPTZ11-1.CP5

Cone ID: 120620 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
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CONE PENETRATION TEST

CLIENT: SCENTRE DESIGN & CONSTRUCTION

PROJECT: PROPOSED SEWER DIVERSION

LOCATION: WESTFIELD WARRINGAH MALL

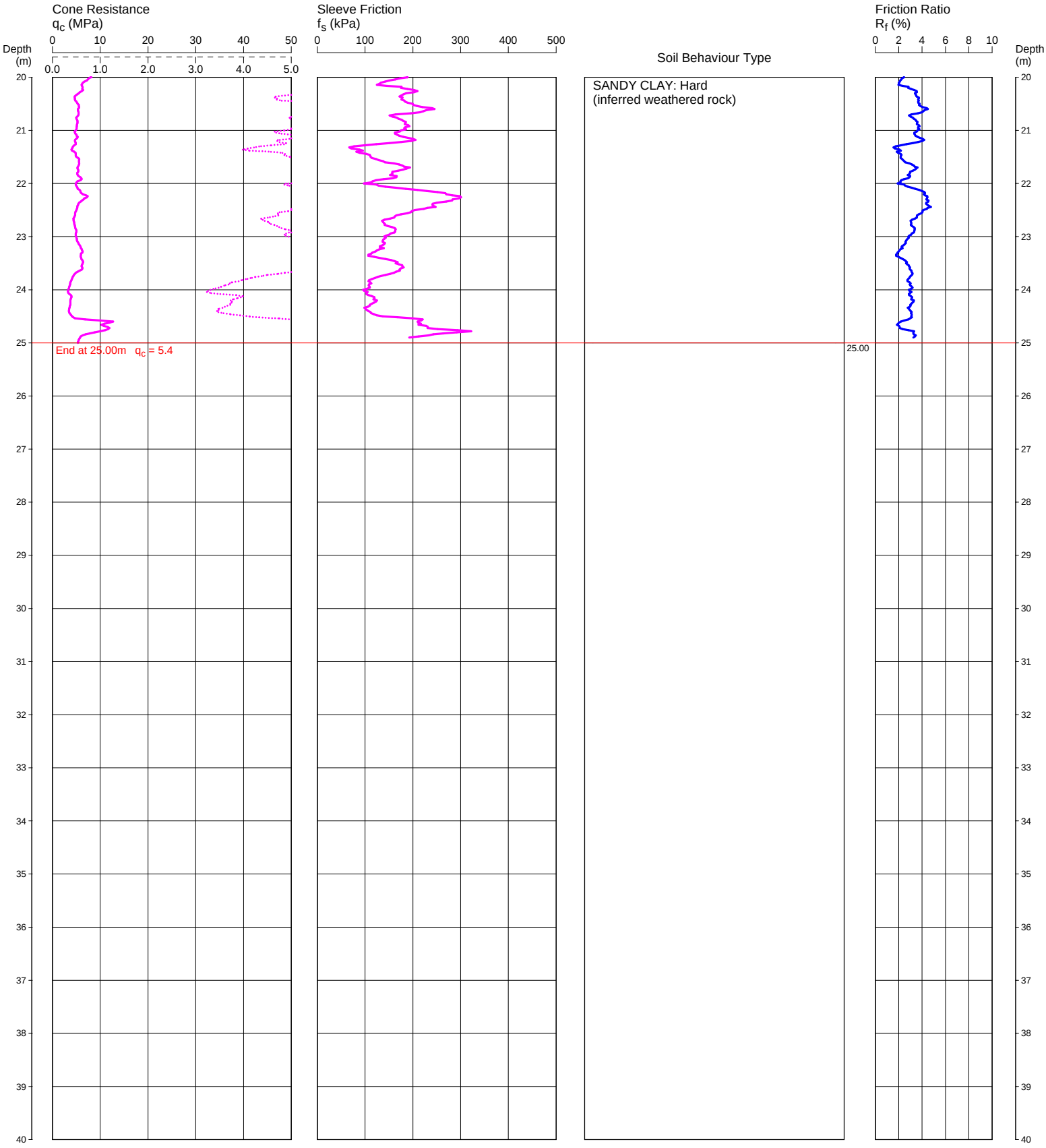
REDUCED LEVEL: 8.7

COORDINATES: 339499E 6262115N

CPTZ11-1

DATE 10/12/2015

PROJECT No: 71015.31



REMARKS: DUMMY CONE USED FROM 0 m TO 0.5 m DEPTH TO PENETRATE FILLING.
GROUNDWATER OBSERVED AT 3.55 m DEPTH AFTER WITHDRAWAL OF RODS.

Water depth after test: 3.55m depth (measured)

File: \\DPSYDNAS01\Projects\71015.31 BROOKVALE, WMall Stage 1 Main Works\4.0 Field Work\71015.31 BROOKVALE cpt\CPTZ11-1.CP5

Cone ID: 120620 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
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CONE PENETRATION TEST

CLIENT: SCENTRE DESIGN & CONSTRUCTION

PROJECT: PROPOSED SEWER DIVERSION

LOCATION: WESTFIELD WARRINGAH MALL

REDUCED LEVEL: 8.8

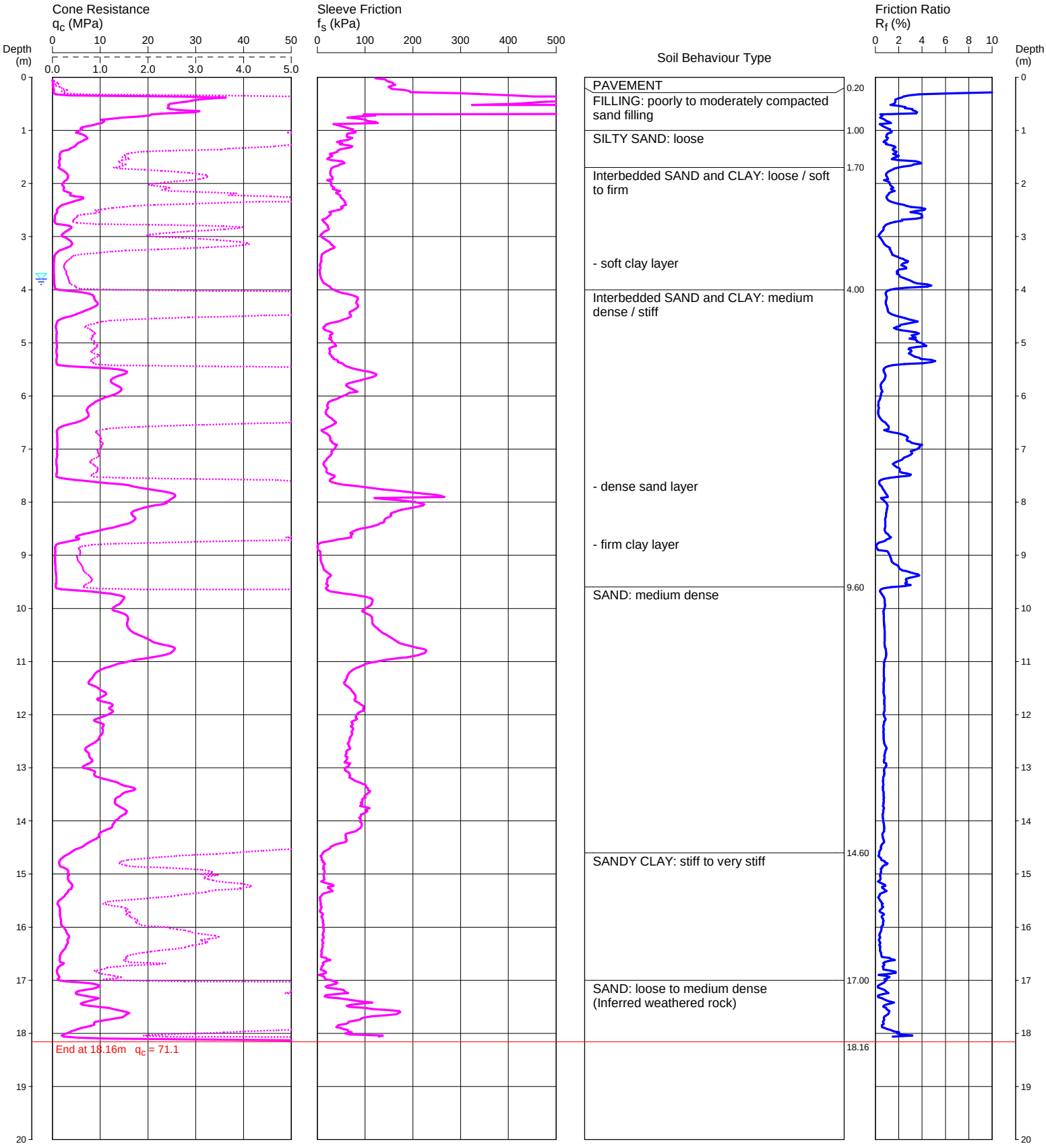
COORDINATES: 339510E 6262133N

CPTZ11-2

Page 1 of 1

DATE 10/12/2015

PROJECT No: 71015.31



REMARKS: DUMMY CONE USED FROM 0 m TO 0.4 m DEPTH TO PENETRATE FILLING; HOLE DISCONTINUED DUE TO CONE TIP REFUSAL. GROUNDWATER OBSERVED AT 3.8 m DEPTH AFTER WITHDRAWAL OF RODS.

Water depth after test: 3.80m depth (measured)

File: \\DPSYDNAS01\Projects\71015.31 BROOKVALE, WMall Stage 1 Main Works\4.0 Field Work\71015.31 BROOKVALE cpt\CPTZ11-2.CP5

Cone ID: 120620 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: SCENTRE DESIGN & CONSTRUCTION

PROJECT: PROPOSED SEWER DIVERSION

LOCATION: WESTFIELD WARRINGAH MALL

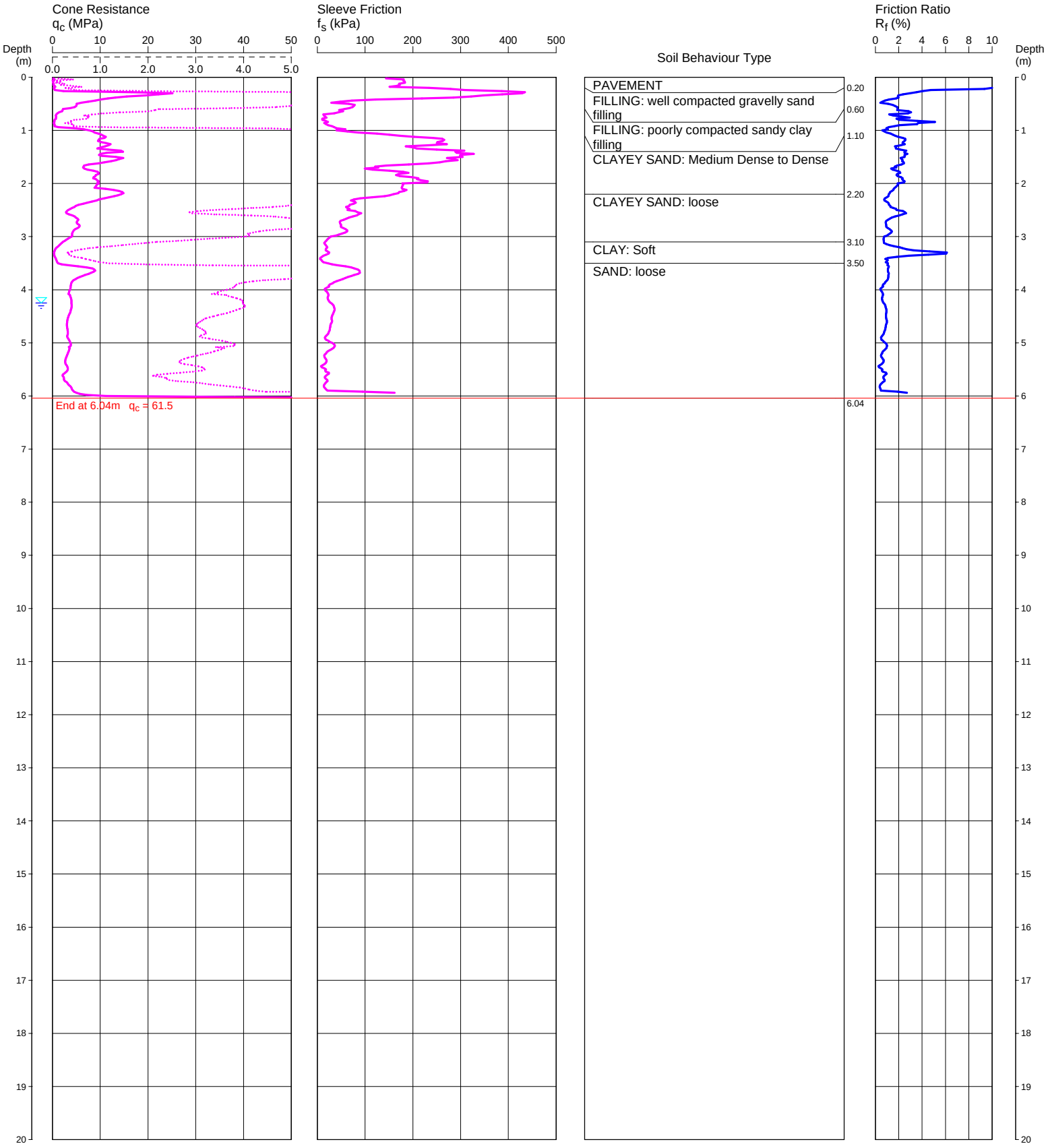
REDUCED LEVEL: 9.7

COORDINATES: 339564E 6262180N

CPTZ11-3

DATE 10/12/2015

PROJECT No: 71015.31



REMARKS: DUMMY CONE USED FROM 0 m TO 0.3 m DEPTH TO PENETRATE FILLING; HOLE DISCONTINUED DUE TO CONE TIP REFUSAL. GROUNDWATER OBSERVED AT 4.25 m DEPTH AFTER WITHDRAWAL OF RODS.

Water depth after test: 4.25m depth (measured)

File: \\DPSYDNAS01\Projects\71015.31 BROOKVALE, WMall Stage 1 Main Works\4.0 Field Work\71015.31 BROOKVALE cpt\CPTZ11-3.CP5

Cone ID: 120620 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: SCENTRE DESIGN & CONSTRUCTION

PROJECT: PROPOSED SEWER DIVERSION

LOCATION: WESTFIELD WARRINGAH MALL

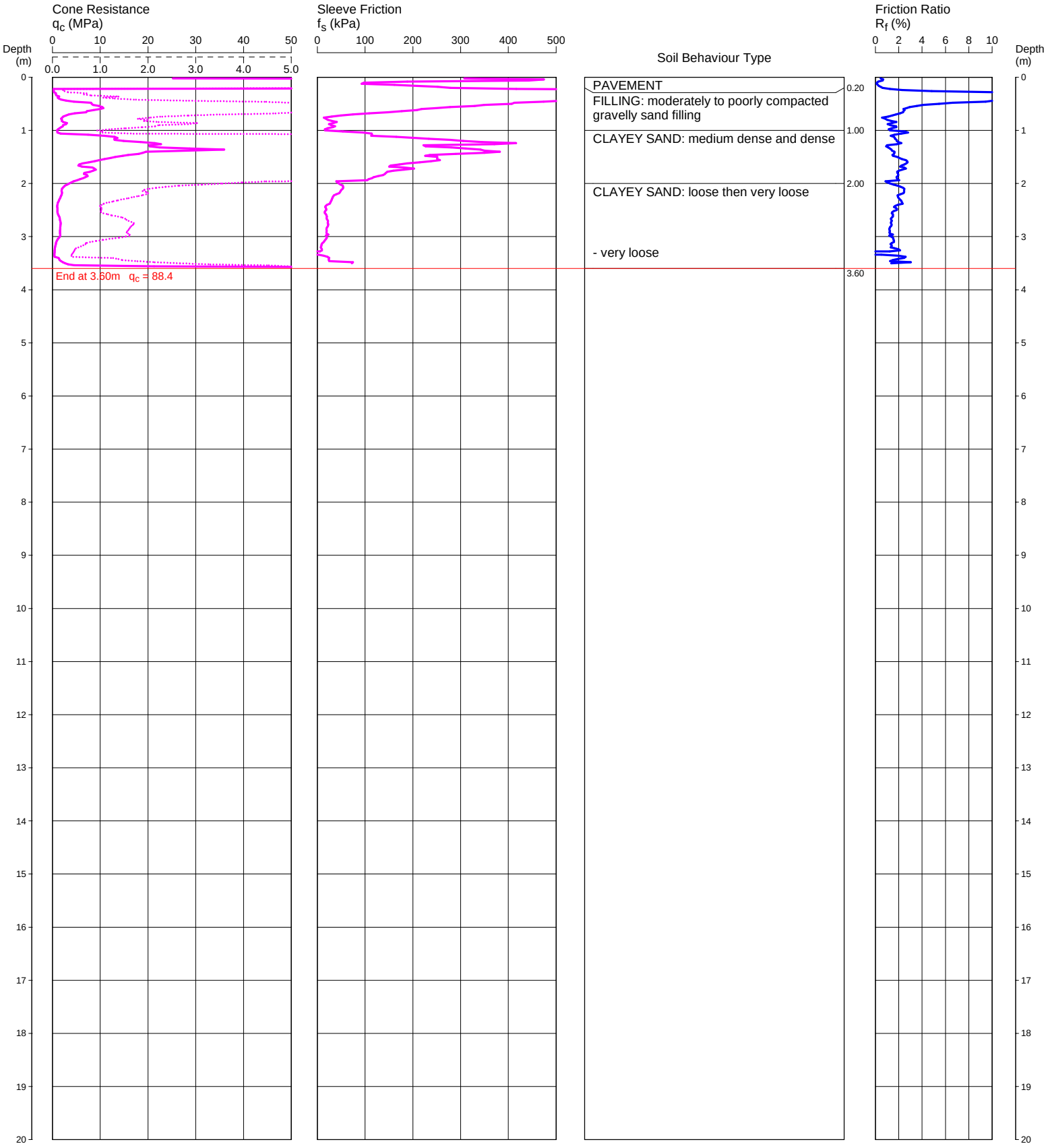
REDUCED LEVEL: 9.6

COORDINATES: 339575E 6262195N

CPTZ11-4

DATE 10/12/2015

PROJECT No: 71015.31



REMARKS: DUMMY CONE USED FROM 0.2 m TO 0.48 m DEPTH TO PENETRATE FILLING; HOLE DISCONTINUED DUE TO CONE TIP REFUSAL.
NO WATER OBSERVED IN CPT HOLE AFTER WITHDRAWAL OF RODS.

File: \\DPSYDNAS01\Projects\71015.31 BROOKVALE, WMall Stage 1 Main Works\4.0 Field Work\71015.31 BROOKVALE cpt\CPTZ11-4.CP5
Cone ID: 120620 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: SCENTRE DESIGN & CONSTRUCTION

PROJECT: PROPOSED SEWER DIVERSION

LOCATION: WESTFIELD WARRINGAH MALL

REDUCED LEVEL: 9.8

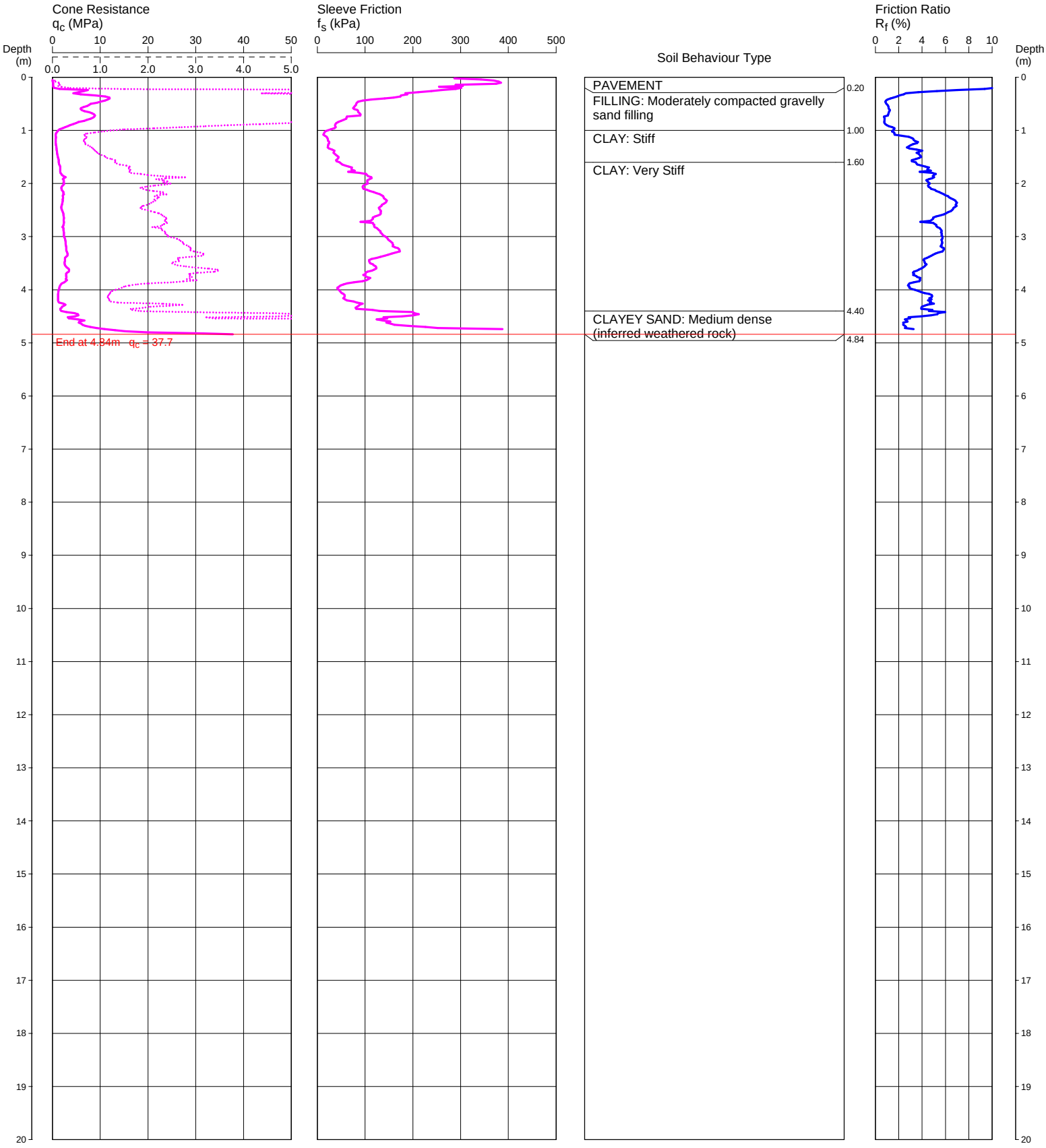
COORDINATES: 339647E 6262302N

CPTZ7-1

Page 1 of 1

DATE 10/12/2015

PROJECT No: 71015.31



REMARKS: DUMMY CONE USED FROM 0 m TO 0.3 m DEPTH TO PENETRATE FILLING; HOLE DISCONTINUED DUE TO CONE TIP REFUSAL. HOLE COLLAPSE AT 1.2 m DEPTH AFTER WITHDRAWAL OF RODS.

File: \\DPSYDNAS01\Projects\71015.31 BROOKVALE, WMall Stage 1 Main Works\4.0 Field Work\71015.31 BROOKVALE cpt\CPTZ7-1.CP5
Cone ID: 120620 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: SCENTRE DESIGN & CONSTRUCTION

PROJECT: PROPOSED SEWER DIVERSION

LOCATION: WESTFIELD WARRINGAH MALL

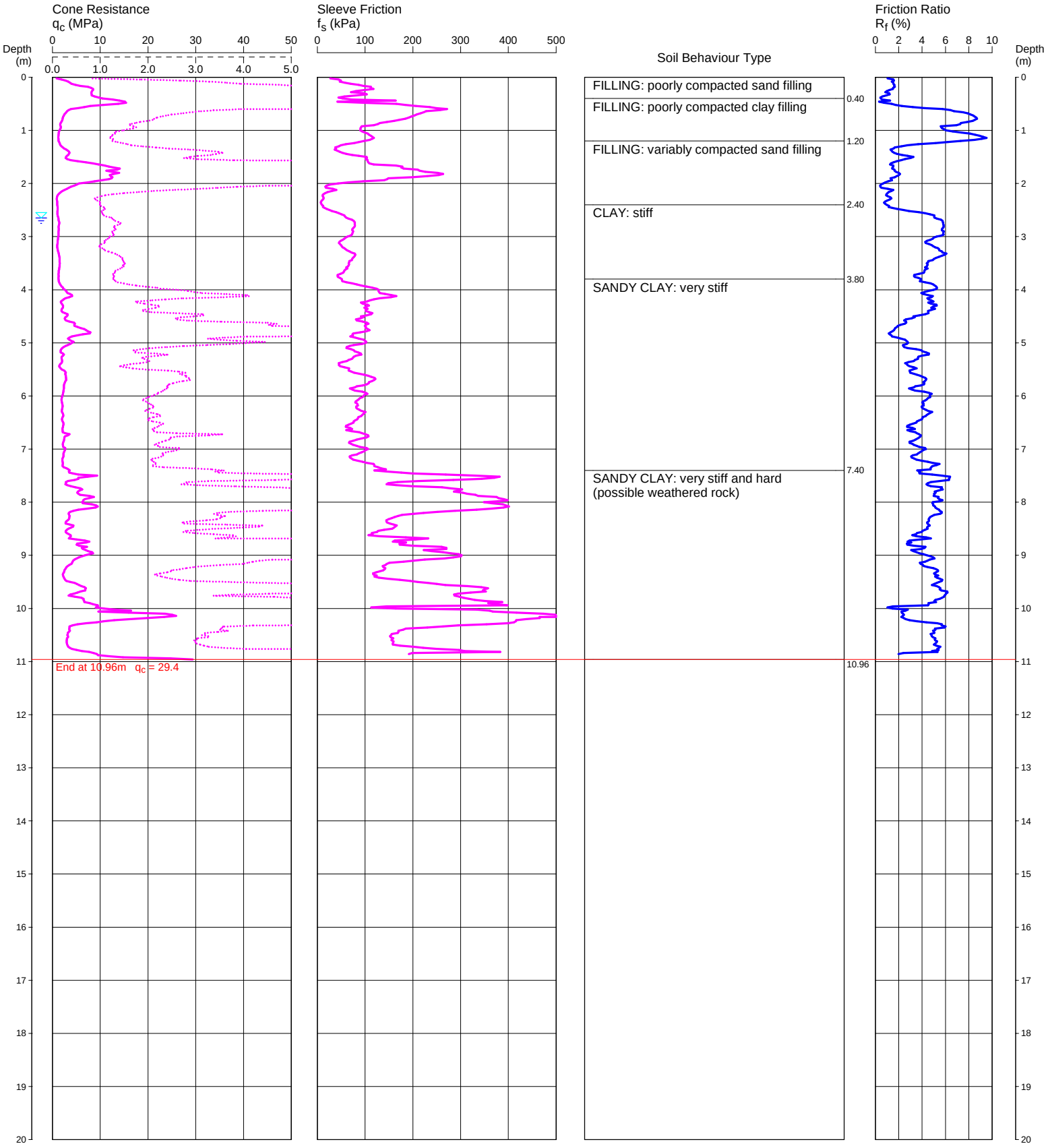
REDUCED LEVEL: 10.1

COORDINATES: 339659E 6262316N

CPTZ7-2

DATE 10/12/2015

PROJECT No: 71015.31



REMARKS: HOLE DISCONTINUED DUE TO BENDING IN WEATHERED ROCK.
GROUNDWATER OBSERVED AT 2.65 m DEPTH AFTER WITHDRAWAL OF RODS.

Water depth after test: 2.65m depth (measured)

File: \\DPSYDNAS01\Projects\71015.31 BROOKVALE, WMall Stage 1 Main Works\4.0 Field Work\71015.31 BROOKVALE cpt\CPTZ7-2.CP5

Cone ID: 120620 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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Appendix D

Summary Laboratory Test Results

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Table D1: Summary of Results for Acid Sulphate Soils Testing in Stage 2 Area

Sample Location	Depth (m)	Soil Description (see logs for full description)	Screening Tests			sPOCAS Laboratory Results										
			pH_F	pH_{FOX}	Strength of Reaction (1,2,3,4; F)*	pH_{KCl}	pH_{Ox}	TAA (moles H^+/t)	TSA (moles H^+/t)	TPA (moles H^+/t)	a-S_{NAS} (moles H^+/t)	a-ANC_E (moles H^+/t)	a-Net Acidity (moles H^+/t)	S_{KCl} (%w/w S)	S_{POS} (%w/w S)	S_P (%w/w S)
740	0.4-0.5	Clay filling, trace silt, sand & gravel	7.1	4.6	1	-	-	-	-	-	-	-	-	-	-	-
	0.9-1.0	Sand filling, some gravel, trace brick, terracotta, glass	6.5	4.3	1	-	-	-	-	-	-	-	-	-	-	-
	1.4-1.5	Sand and clay filling (possibly reworked natural)	6.4	4.0	1	-	-	-	-	-	-	-	-	-	-	-
	1.9-2.0	Clayey sand, moist	10.7	10.7	2-3F	-	-	-	-	-	-	-	-	-	-	-
	2.4-2.5		11.2	10.3	2-3F	-	-	-	-	-	-	-	-	-	-	-
	2.9-3.0		10.0	7.0	2-3F	-	-	-	-	-	-	-	-	-	-	-
	3.4-3.5		9.4	5.4	1	-	-	-	-	-	-	-	-	-	-	-
	3.9-4.0		9.2	6.8	1	-	-	-	-	-	-	-	-	-	-	-
	4.4-4.5	Clayey sand, saturated	8.8	3.8	2-3F	-	-	-	-	-	-	-	-	-	-	-
	4.9-5.0	Clayey sand, saturated, very slight hydrocarbon odour	8.4	2.9	1	3.9	4.3	25	<5	17	<5	<0.05	**25**	0.02	<0.005	0.02
	5.4-5.5		7.9	3.1	2-3F	-	-	-	-	-	-	-	-	-	-	-
	5.9-6.0		7.8	3.0	2-3F	-	-	-	-	-	-	-	-	-	-	-
752	0.4-0.5	Sandy gravel filling (roadbase)	7.2	2.4	2-3F	-	-	-	-	-	-	-	-	-	-	-
	0.6-0.7	Clayey sand filling, trace rock fragments (ripped sandstone)	7.4	3.0	2-3F	-	-	-	-	-	-	-	-	-	-	-
	0.9-1.0	Clayey sand, moist	7.2	3.0	2-3F	-	-	-	-	-	-	-	-	-	-	-
	1.4-1.5	Sandy clay, moist	7.0	3.2	2-3F	4.1	4.5	5	32	37	6	<5	**19**	0.02	0.01	0.03
	1.9-2.0	Clayey sand , moist	6.6	6.9	1	-	-	-	-	-	-	-	-	-	-	-
	2.4-2.5		8.3	7.4	1	-	-	-	-	-	-	-	-	-	-	-
	2.9-3.0	Sandstone	8.1	6.2	1	-	-	-	-	-	-	-	-	-	-	-
763	0.4-0.5	Sandy gravel filling (roadbase)	6.7	4.2	1	-	-	-	-	-	-	-	-	-	-	-
	0.9-1.0		6.5	3.4	1-2	-	-	-	-	-	-	-	-	-	-	-
	1.4-1.5	Sand filling, trace clay and sandstone fragments	5.1	3.5	3-4	-	-	-	-	-	-	-	-	-	-	-
	1.9-2.0		5.4	3.6	3-4	-	-	-	-	-	-	-	-	-	-	-
	2.1-2.3	Sand filling, trace rock fragments	5.3	3.6	3-4	-	-	-	-	-	-	-	-	-	-	-
	2.4-2.5	Sand, trace silt (possible filling)	5.1	3.5	3	-	-	-	-	-	-	-	-	-	-	-
	2.9-3.0		5.2	3.6	1	-	-	-	-	-	-	-	-	-	-	-
	3.4-3.5	Sand, trace silt & clay, moist to wet	5.1	3.0	1	5.8	3.5	10	12	22	NT	<5	**27**	<0.005	0.03	0.03
	3.9-4.0		5.1	3.5	1	-	-	-	-	-	-	-	-	-	-	-
	4.4-4.5	Sand, some silt & clay, wet to saturated	10.0	9.0	3-4F	5.6	2.5	<5	590	600	NT	<5	**250**	0.01	0.4	0.41
	4.9-5.0	Sandy clay (probably with some peat), saturated	8.8	7.1	1	-	-	-	-	-	-	-	-	-	-	-
	5.4-5.5		8.6	5.5	1	-	-	-	-	-	-	-	-	-	-	-
	5.9-6.0		8.2	4.5	1	-	-	-	-	-	-	-	-	-	-	-

Notes:

pH_F	Field pH (pH of soil and deionised water solution)
pH_{FOX}	Field pH (pH of soil and hydrogen peroxide solution)
pH_{Ox}	pH of soil and hydrogen peroxide solution
pH_{KCl}	pH of solution of soil and KCl
*(1,2,3,4; F)	1 - denotes no or slight effervescence
	2 - denotes moderate effervescence
	3 - denotes vigorous effervescence
	4 - denotes very vigorous effervescence with gas evolution and heat
	F - denotes "frothy" reaction, indicative of organics

TAA	Total Actual Acidity
TSA	Total Sulphidic Acidity (TPA - TAA)
TPA	Total Potential Acidity
a-S_{NAS}	Retained Acidity
a-ANC_E	Acid Neutralising Capacity
S_{KCl}	KCl extractable sulfur
S_{POS}	Peroxide oxidisable sulfur
S_P	Peroxide oxidation sulfur
NT	Not tested
-	Not analysed / not applicable
BOLD	Exceedance of *Action Criteria* (a-Net Acidity of 18 moles H^+/tonne) for the disturbance of more than 1000 tonnes of material for all soil textures (ASSMAC)

Table D2: Summary Results of Chemical Aggressivity Tests

Borehole	Depth	Description	pH	SO4 (mg/kg)	Cl (mg/kg)	EC (µS/cm)
624	1.0-1.45	Clayey sand	8	110	8	160
	5.5-5.95	Sandy clay	5	140	12	84
625	2.5-2.95	Clay	4.8	170	15	110
	7.0-7.45	Sand	6.1	7	7	15
626	1.0-1.45	Filling - crushed shale	10.8	1000	35	690
	2.5-2.95	Sandy clay	5.2	83	25	64
627	1.0-1.45	Clay	5.2	47	9	37
	2.5-2.95	Sandstone	4.8	72	9	46
628	0.5	Filling - silty sand	11.3	640	110	1100
	5.5-5.95	Peaty clay	6.6	76	19	88

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www.envirolabservices.com.au

CERTIFICATE OF ANALYSIS 89537

Client:
Douglas Partners
96 Hermitage Rd
West Ryde
NSW 2114

Attention: Sally Peacock

Sample log in details:

Your Reference:	**71015.17, Warringah Mall Redevelopment, Brook**
No. of samples:	13 Soils
Date samples received / completed instructions received	23/04/2013 / 23/04/2013

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	1/05/13 / 1/05/13
Date of Preliminary Report:	Not issued

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Results Approved By:

Nick Sarlamis
Inorganics Supervisor

Miscellaneous Inorg - soil						
Our Reference:	UNITS	89537-1	89537-2	89537-3	89537-4	89537-5
Your Reference	----------	620	620	621	621	622
Depth	----------	2.5-2.95	5.5-5.95	2.5-2.95	8.5-8.95	5.5-5.95
Date Sampled		18/04/2013	18/04/2013	15/04/2013	15/04/2013	16/04/2013
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	27/04/2013	27/04/2013	27/04/2013	27/04/2013	27/04/2013
Date analysed	-	27/04/2013	27/04/2013	27/04/2013	27/04/2013	27/04/2013
pH 1:5 soil:water	pH Units	6.2	5.8	4.8	5.8	5.5
Electrical Conductivity 1:5 soil:water	µS/cm	57	18	330	19	32
Chloride, Cl 1:5 soil:water	mg/kg	18	7	71	10	18
Sulphate, SO4 1:5 soil:water	mg/kg	80	13	510	14	22

Miscellaneous Inorg - soil						
Our Reference:	UNITS	89537-6	89537-7	89537-8	89537-9	89537-10
Your Reference	----------	622	623	623	624	624
Depth	----------	7.0-7.12	1.0-1.45	2.5-2.95	1.0-1.45	5.5-5.95
Date Sampled		16/04/2013	17/04/2013	17/04/2013	19/04/2013	19/04/2013
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	27/04/2013	27/04/2013	27/04/2013	27/04/2013	27/04/2013
Date analysed	-	27/04/2013	27/04/2013	27/04/2013	27/04/2013	27/04/2013
pH 1:5 soil:water	pH Units	5.8	6.8	6.0	8.0	5.0
Electrical Conductivity 1:5 soil:water	µS/cm	21	230	43	160	84
Chloride, Cl 1:5 soil:water	mg/kg	7	11	17	8	12
Sulphate, SO4 1:5 soil:water	mg/kg	19	70	36	110	140

Miscellaneous Inorg - soil				
Our Reference:	UNITS	89537-11	89537-12	89537-13
Your Reference	----------	629	629	629
Depth	----------	7.0-7.45	16.0-16.45	21.0-21.45
Date Sampled		17/04/2013	18/04/2013	18/04/2013
Type of sample		Soil	Soil	Soil
Date prepared	-	27/04/2013	27/04/2013	27/04/2013
Date analysed	-	27/04/2013	27/04/2013	27/04/2013
pH 1:5 soil:water	pH Units	4.9	4.8	5.2
Electrical Conductivity 1:5 soil:water	µS/cm	250	780	37
Chloride, Cl 1:5 soil:water	mg/kg	68	86	11
Sulphate, SO4 1:5 soil:water	mg/kg	420	2,400	65

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 22nd ED, 4500-H+.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA 22nd ED 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 22nd ED, 4110 -B.

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			30/04/2013	89537-1	27/04/2013 || 27/04/2013	LCS-1	30/04/2013
Date analysed	-			30/04/2013	89537-1	27/04/2013 || 27/04/2013	LCS-1	30/04/2013
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	89537-1	6.2 || 6.2 || RPD: 0	LCS-1	101%
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	89537-1	57 || 55 || RPD: 4	LCS-1	97%
Chloride, Cl 1:5 soil:water	mg/kg	2	Inorg-081	<2	89537-1	18 || 13 || RPD: 32	LCS-1	102%
Sulphate, SO4 1:5 soil:water	mg/kg	2	Inorg-081	<2	89537-1	80 || 72 || RPD: 11	LCS-1	94%

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	89537-11	27/04/2013 || 27/04/2013	89537-2	30/04/2013
Date analysed	-	89537-11	27/04/2013 || 27/04/2013	89537-2	30/04/2013
pH 1:5 soil:water	pH Units	89537-11	4.9 || 4.9 || RPD: 0	[NR]	[NR]
Electrical Conductivity 1:5 soil:water	µS/cm	89537-11	250 || 220 || RPD: 13	[NR]	[NR]
Chloride, Cl 1:5 soil:water	mg/kg	89537-11	68 || 70 || RPD: 3	89537-2	132%
Sulphate, SO4 1:5 soil:water	mg/kg	89537-11	420 || 390 || RPD: 7	89537-2	97%

Report Comments:

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

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.

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 batched 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: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.

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CERTIFICATE OF ANALYSIS 89991

Client:
Douglas Partners
96 Hermitage Rd
West Ryde
NSW 2114

Attention: Sally Peacock

Sample log in details:

Your Reference:	**71015.17, Warringah Mall, Brookvale**
No. of samples:	10 Soils
Date samples received / completed instructions received	02/05/13 / 02/05/13

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	9/05/13 / 9/05/13
Date of Preliminary Report:	Not issued

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Results Approved By:

Nick Sarlamis
Inorganics Supervisor

Miscellaneous Inorg - soil						
Our Reference:	UNITS	89991-1	89991-2	89991-3	89991-4	89991-5
Your Reference	----------	625	625	626	626	628
Depth	----------	2.5-2.95	7.0-7.45	2.5-2.95	1.0-1.45	5.5-5.95
Date Sampled		23/04/2013	23/04/2013	24/04/2013	24/04/2013	30/04/2013
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	04/05/2013	04/05/2013	04/05/2013	04/05/2013	04/05/2013
Date analysed	-	04/05/2013	04/05/2013	04/05/2013	04/05/2013	04/05/2013
pH 1:5 soil:water	pH Units	4.8	6.1	5.2	10.8	6.6
Electrical Conductivity 1:5 soil:water	µS/cm	110	15	64	690	88
Sulphate, SO4 1:5 soil:water	mg/kg	170	7	83	1,000	76
Chloride, Cl 1:5 soil:water	mg/kg	15	7	25	35	19

Miscellaneous Inorg - soil						
Our Reference:	UNITS	89991-6	89991-7	89991-8	89991-9	89991-10
Your Reference	----------	628	630	630	627	627
Depth	----------	0.5	2.5-2.95	10.0-10.45	1.0-1.45	2.5-2.95
Date Sampled		30/04/2013	23/04/2013	24/04/2013	29/04/2013	29/04/2013
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	04/05/2013	04/05/2013	04/05/2013	04/05/2013	04/05/2013
Date analysed	-	04/05/2013	04/05/2013	04/05/2013	04/05/2013	04/05/2013
pH 1:5 soil:water	pH Units	11.3	8.0	6.5	5.2	4.8
Electrical Conductivity 1:5 soil:water	µS/cm	1,100	90	30	37	46
Sulphate, SO4 1:5 soil:water	mg/kg	640	68	20	47	72
Chloride, Cl 1:5 soil:water	mg/kg	110	13	8	9	9

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 22nd ED, 4500-H+.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA 22nd ED 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 22nd ED, 4110 -B.

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			04/05/2013	89991-1	04/05/2013 || 04/05/2013	LCS-1	04/05/2013
Date analysed	-			04/05/2013	89991-1	04/05/2013 || 04/05/2013	LCS-1	04/05/2013
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	89991-1	4.8 || 4.8 || RPD: 0	LCS-1	100%
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	89991-1	110 || 110 || RPD: 0	LCS-1	101%
Sulphate, SO4 1:5 soil:water	mg/kg	2	Inorg-081	<2	89991-1	170 || 180 || RPD: 6	LCS-1	105%
Chloride, Cl 1:5 soil:water	mg/kg	2	Inorg-081	<2	89991-1	15 || 16 || RPD: 6	LCS-1	111%

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	89991-2	04/05/2013
Date analysed	-	[NT]	[NT]	89991-2	04/05/2013
pH 1:5 soil:water	pH Units	[NT]	[NT]	[NR]	[NR]
Electrical Conductivity 1:5 soil:water	µS/cm	[NT]	[NT]	[NR]	[NR]
Sulphate, SO4 1:5 soil:water	mg/kg	[NT]	[NT]	89991-2	100%
Chloride, Cl 1:5 soil:water	mg/kg	[NT]	[NT]	89991-2	113%

Report Comments:

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

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.

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 batched 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: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.