

Geotechnical Assessment

Douglas Partners



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Geotechnics | Environment | Groundwater

Report on
Desktop Study

Western Sydney Stadium
O'Connell Street, Parramatta

Prepared for
Lend Lease Building Pty Ltd

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Integrated Practical Solutions



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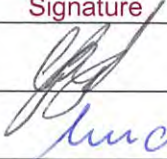
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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Report on Desktop Study

Western Sydney Stadium

11 to 13 O'Connell Street, Parramatta

1. Introduction

This geotechnical report presents the results of a desktop study carried out by Douglas Partners Pty Ltd (DP) for the Western Sydney Stadium at 11 to 13 O'Connell Street, Parramatta. The study was commissioned by Lend Lease Building Pty Ltd (LLB).

DP has carried out a number of geotechnical investigations in connection with the existing stadium and surrounding areas. This desktop study is based on information from previous investigations on and around the site. DP has been commissioned by LLB to carry out a geotechnical investigation over the footprint of the site, however, will not be finalised until April 2017 due to site access constraints.

This report supports a State Significant Development (SSD) Development Application (DA) submitted to the Minister for Planning pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Application (referred to as SSDA16_8175) follows the approval of a Stage 1 SSD DA (SSDA16_7534) in December 2016. The Stage 1 SSDA sets out a Concept Proposal for the redevelopment of the Western Sydney Stadium and future supporting uses. In summary, the Stage 1 Consent includes the following components:

- **Concept Proposal** for the Western Sydney Stadium, including building envelopes, a new 30,000 seat stadium, 500 surface car parking spaces, access, ancillary infrastructure and landscaping; and
- **Detailed works** for staged demolition and removal of the existing stadium and associated infrastructure and the Parramatta Swimming Centre.

2. Overview of Proposed Development

The proposal relates to a detailed ('Stage 2') DA for the detailed design and construction of the stadium. This SSD DA seeks approval for the following components of the development:

- Detailed design of the stadium, public domain and car parking spaces;
- Construction and use of the 30,000 seat stadium including:
 - General Admission Facilities including bars, food and drink stalls, amenities and viewing areas;
 - A function centre and kitchen facility;
 - Associated Stadium facilities including player and coaching facilities, media and press conference rooms, security and stadium managers facilities;
 - Waste storage and loading dock;

- Construction and embellishment of the public domain including;
 - Outdoor sporting and recreation facilities;
 - Public plazas and entertainment areas;
 - General landscaping works;
 - Provision of up to 500 car parking spaces with vehicle access to the development from O'Connell Street and internal roads for vehicular circulation;
 - Provision of signage zones, lighting and other ancillary stadium elements;
 - Pedestrian access and footpath upgrades along O'Connell Street; and
 - Extension and augmentation of physical infrastructure / utilities as required.

3. Background

Stadia Strategy

The stadium is the first project to be delivered under the NSW Government's \$1.6 billion Stadia Strategy, the largest investment in sporting infrastructure since the 2000 Olympics. The new Western Sydney Stadium will:

- be able to cater for bigger crowds, provide an improved game day experience and bring major benefits to the Western Sydney economy;
- generate approximately 1,200 jobs during construction and between 600 and 900 jobs once operational for sporting event days and major events;
- cater for a range of sporting and community uses within the precinct.

Concept Proposal (SSDA 16_7534)

Infrastructure NSW (iNSW) on behalf of Venues NSW submitted a State Significant Development Application (SSDA) for the Stage 1 concept proposal and demolition of the existing stadium in July 2016. Consent for the Stage 1 SSDA was granted by the Minister for Planning on 7 December 2016 and includes:

- A maximum total Gross Floor Area (GFA) of approximately 60,000 m² (excluding the playing pitch) for the stadium development, including:
 - additional seating for approximately 10,000 more spectators in a seating bowl with 30,000 seats, including 27,000 general admission seats and 3,000 corporate seats;
 - playing pitch;
 - five levels of premium box/terrace, function/lounge offerings and a number of suite offerings;
 - flood lighting, stadium video screens and other ancillary fittings;
 - additional facilities for team, media, administration and amenity, including:
 - i. police facility and security office;
 - ii. players changing rooms;
 - iii. ticket gates and ticket boxes;
 - iv. media interview rooms;
 - v. green room;
 - vi. production suite and joint operation control room;
 - vii. event briefing rooms;
 - viii. hirers office and patron services offices;

- ix. first aid facilities;
 - x. loading docks for deliveries; and
 - xi. food, beverage and retail facilities.
- a maximum GFA of approximately 20,000 m² for future development of ancillary uses within the northern corner of the Site;
 - transport, parking and accessibility;
 - public domain elements; and
 - landscaping elements throughout the Site.

Design Excellence and Project Tender Phase

Since receiving the development consent for Stage 1, Venues NSW have appointed Lend Lease as the contractor for the Stage 2 detailed design and the demolition and construction of the stadium. The tender process also served as a competitive design process in accordance with the Director General's Design Excellence Guidelines and Clause 7.10 of the *Parramatta Local Environmental Plan 2011*.

Site Establishment works Modification

A modification application (MOD 1) was made to the Stage 1 DA pursuant to Section 96(2) of the EP&A Act in February 2017. The modification seeks to expand the approved range of site preparation works to include piling and remediation/earthworks, as outlined below:

- Remediation works comprising the excavation and storage of contaminated materials and bulk excavation. Contaminated materials will be stored on site and capped below ground in accordance with the recommendations outlined in the Remedial Action Plan.
- Piling works which will comprise the driving and drilling of concrete piles to establish foundations for the construction of a stadium located within the Stage 1 building envelope.

The modification application is currently under assessment by the Department of Planning and Environment (DPE) and is awaiting determination.

4. Previous Investigations

In July 1984 DP carried out an investigation for the Parramatta Stadium on behalf of the Public Works Department following the demolition of Cumberland Oval. A total of nineteen test bores were drilled during that investigation, both in and around the stadium.

The Cumberland Oval Redevelopment involved lowering the playing surface by up to 4 m, to reduce the visual impact of grandstands around a rectangular shaped playing field. It is understood that the existing grandstands on the east and west of the arena are supported on enlarged-base Franki-piles, founded at or near the bedrock surface.

In 1991 DP performed a supplementary geotechnical investigation for a proposed Function Centre to be sited on the raised mound at the northern end of the Stadium. The field investigation comprised

five electric friction cone (EFC) penetrometer, or cone penetration tests (CPTs). The Function Centre development was subsequently abandoned.

Although the ground layout of the Stadium has not been altered since the redevelopment, anecdotal reports indicate that part of the mound at the northern end was partially removed for a concert held in around 1993, to accommodate the stage.

In December 2002, work began on converting the formerly grassed hill areas at the northern and southern ends (The Brett Kenny Hill and The Peter Sterling Hill) into seated terrace areas.

The geotechnical reports prepared directly for the Stadium are attached in Appendix C.

5. Site Description and Geology

The Western Sydney Stadium is located at 11-13 O'Connell Street, within the Parramatta Park on the north-eastern edge of the Parramatta CBD. It is bound to the south and west by the Parramatta Park and the Parramatta River, the Parramatta Leagues Club to the north and O'Connell Street to the east.

The Site is located within the City of Parramatta local government area (LGA).

A locational context plan is provided at Figure 1 below.

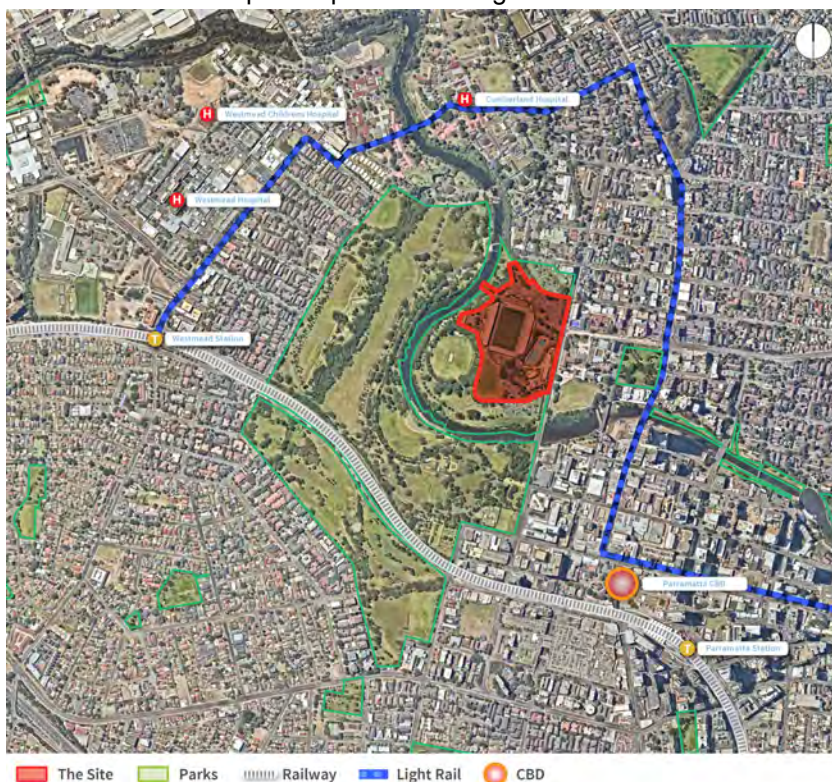


Figure 1 – Site Context Plan

The site has an area of approximately 95,000m² and owned by Venues NSW and The Parramatta Park Trust.

The site is irregular in shape and is illustrated in **Figure 2** below.



Figure 2 – Site Aerial Plan

6. Geology

Reference to the Penrith 1:100 000 Geological Series Sheet, indicates that the site is located close to the boundary between the Hawkesbury Sandstone Formation and the Ashfield Shale Formation. These rock units are often separated by Mittagong Formation sandstone.

The Hawkesbury Sandstone Formation consists predominantly of medium and coarse grained quartz sandstone. The Mittagong Formation comprises fine to medium grained inter-laminated sandstone and black siltstone. The Ashfield Shale consists of black to dark grey sideritic claystone and siltstone which is slightly carbonaceous at the base.

The acid sulphate soils map indicates that the sediments in the nearby Parramatta River have a high probability of being acid sulphate soils, but does not indicate any occurrence in the immediate vicinity of the Stadium.

7. Geotechnical Model

The bores from various investigations have been drilled on the site and the locations are shown on Drawing No. 1 in Appendix B.

The general subsurface profile is characterised by very stiff or hard clay filling, overlying interbedded very stiff alluvial clay and medium dense alluvial sand, overlying weathered shale and medium strength sandstone.

In the area under the old western grandstand, there was about 3.0 m to 5.5 m of sand and clayey sand filling over interbedded sands, clayey sands and sandy clays to about 7 m to 13 m depths. The underlying rock was highly weathered shale becoming medium strength about 2 m below the rock surface. Medium to high strength sandstone was generally encountered below the shale at levels between RL -0.6 m and RL 1.6 m.

In the area under the eastern grandstand, there was up to about 5.5 m of filling over interbedded sands, clayey sands and sandy clays to about 16 m depths (about RL -2 m to RL -4 m). The underlying rock has been logged as medium to high strength sandstone.

The general subsurface profile encountered at the northern end is characterised by between 1 m and 2 m of very stiff or hard clay filling, overlying interbedded very stiff alluvial clay and medium dense alluvial sand. There are some layers of hard clays and very dense sands below 4 m depth. Rock is interpreted as being at about RL 0 m and RL 5 m.

The subsurface profile at the southern mound is generally similar to that at the northern end of the arena. The filling comprised variably compacted clayey sand and clay soil of up to 2 m depth. Below the upper 2 m, the investigations generally indicated the presence of an interbedded sequence of alluvial clays of a stiff to hard consistency and sands in a medium dense to very dense condition. Weathered bedrock was interpreted from cone testing and other tests at below 10 m depth (approximately RL -1 m and RL 3.5 m).

The bores originally drilled in the playing area of the oval had about 1.5 m to 2.5 m of filling overlying the natural clays. The filling would have been removed when the playing level was dropped by about 4 m.

Groundwater was observed in some of the tests over a period of time and has been recorded at levels between about RL 5.0 m and RL 9.0 m. Groundwater levels can vary over time and they may be outside the previous range that was previously measured.

Another consideration is the potential for acid sulphate soils. The current stadium is located on a flood plan and the presence of acid sulphate soils in the nearby Parramatta River could suggest an aggressive environment for concrete and steel.

It is noted that most of the investigation bores and tests which are reported above, were drilled before the current stadium was constructed and therefore surface levels and the top of the subsurface profile have changed. However, below the disturbed level caused by the current Stadium development, the subsurface profile is expected to have remained unchanged.

8. Comments

8.1 General

The new Western Sydney Stadium (WSS) has been positioned to the south-east of the existing Parramatta Stadium (refer Drawing 1 in Appendix B). DP has been commissioned by LLB to carry out a geotechnical investigation of the WSS, however, access to part of the site (the existing swimming pool area) will not be available for investigation until after 1 April 2017. Therefore, this report provides preliminary information only. Detailed design should be based on the results of DP's geotechnical investigation once finalised.

8.2 Existing Conditions

It is expected that demolition of the existing grandstands and seating areas will occur. Piles founded closed to the rock surface are expected in the ground under the grandstands. Consideration could be given to re-using the piles, but would require significant investigation and testing to justify their re-use.

Leaving the piles in the ground could interfere with the construction of the new stadium. Removing the piles will create much disturbance to the ground. Consideration will be required on the best approach concerning the existing piles in the ground. If the existing piles are reused, extreme care will be needed during demolition work to prevent cracking of the pile concrete as this could result in rusting of the reinforcement.

8.3 Site Preparation and Earthworks

The filling and alluvial soils are expected to be readily excavated by conventional earthmoving equipment. It is expected that the exposed soils will be moderately sensitive to softening and poor trafficability if subjected to wet weather. Working platforms of crushed rock, concrete or similar will probably be required on the site.

Excavations below the groundwater table, which has been recorded in the past at levels ranging from RL 5 m to RL 9 m, would be expected to have substantial groundwater inflows due to the sand layers within the alluvial soils.

Even above the groundwater table, seepage through the sandy layers could be expected, particularly after heavy rainfall.

The excavated soils from site are expected to comprise mixed sands and clays, which could provide reasonable quality general purposes fill, subject to validation testing. No such testing has been performed as a part of the present commission. Although no extraneous materials were noted in the filling at the bore locations at the time of the investigation, NSW EPA requirements dictate that waste facilities receiving any material from excavation works require a Waste Classification Assessment. Depending on the destination of the excavated material it may be necessary to carry out chemical analyses and a Waste Classification Assessment. It may also be prudent to check for potential acid sulphate soils.

8.4 Temporary and Permanent Unsupported Batter

Where there are no space limitations, batters could be used in short and long term slopes. The following typical maximum batter slopes are suggested in Table 1.

Table 1: Typical Maximum Batter Slopes

Material	Height	Typical Safe Batter Slope (H:V)	
		Short Term Temporary	Long Term Permanent
Filling, Clayey Sand	< 3 m	1.5:1	2:1
Stiff Clay	< 2 m	1:1	1.5:1
	2 – 3 m	1.5:1	1.75:1
Very Stiff to Hard Clay	< 2 m	0.75:1	1.25:1
	2 – 4 m	1:1	1.75:1

Permanent batter slopes in soils will generally require protection in the form of vegetation or reinforced shotcrete if they are to remain exposed or are subjected to concentrated water flows.

8.5 Retaining Structures

Retaining structures could be required as part of the final structure, and may be used to temporarily support the excavation during the excavation and construction phase. It is anticipated that any retaining walls may be designed as “active” walls that are capable of some small amount of lateral (inward) movement during construction, until they are propped by the final structure.

The design of cantilevered or retaining walls with a single row of tieback anchors could be based upon an average bulk unit weight of 20 kN/m³ for soil, with a triangular earth pressure distribution based on typical lateral earth pressure coefficients given in Table 2.

Table 2: Typical Earth Pressure Coefficients

Material Type	Lateral Earth Pressure Coefficient (K _a)	
	Temporary Support	Permanent Support
Filling	0.35	0.4
Alluvium (Stiff Clay / Medium Dense Sand)	0.3	0.35

The horizontal pressures acting on the wall can be calculated based on the following formula:

$$\delta_z = K z \gamma$$

Where, δ_z = Horizontal Pressure at Depth z

K = Earth Pressure Coefficient

Z = Depth (m)

γ = Unit Weight of Soil

Additional pressure should be allowed for where surcharging occurs either from traffic or other loads. Unless positive drainage measures can be incorporated to prevent water pressure build up behind the walls, full hydrostatic head should be allowed for in design, but with the soil density then reduced to the buoyant condition.

8.6 Foundation

8.6.1 Site Classification

Although the proposed development is generally outside the scope of AS2870 – Residential Slabs and Footings, classification of the site provides a useful categorisation of expected soil behaviour in response to seasonal moisture variation. This information may be useful to the designer to assess minimum embedment depths for high level footings, together with appropriate levels of articulation and site maintenance (e.g. paving, vegetation) and drainage requirements.

Based on the depth of apparently uncontrolled filling encountered, the site would be classified as “Class P” sites. Previous laboratory tests confirm that the upper alluvial clay and filling is likely to behave as a low to moderately reactive material. In other words the site soils are expected to exhibit a low to moderate potential for volume change in response to soil moisture variation. It is noted that soil moisture variation can be caused by things other than seasonal changes, such as broken or blocked service or irrigation lines, trees, excavation or other factors.

8.6.2 High Level Footings

Founding on filling is generally considered to be poor engineering practice unless the filling is verified as well compacted (controlled). Although the filling has been in place for many years, the filling is considered to be uncontrolled. Therefore, if shallow footings are to be adopted on site, they should be founded on undisturbed natural soils.

Based on the field work results it will be possible to support moderate column loads with high level footings (e.g. pads, strips) on very stiff clays or medium dense sands. They may still be suitable for heavier loadings but footings may become very large and / or settlement may become unacceptable.

Strip or pad footings founded on at least very stiff clay or medium dense sand at a depth of 1 m may be proportioned on the basis of a maximum allowable bearing pressure of the order of 150 kPa to 200 kPa.

8.6.3 Pile Foundations

For large loads or for where uplift loads dictate, it may be appropriate to adopt pile foundations. With the groundwater table within the alluvial soils, uncased bored pile types are generally considered unsuitable due to the expected caving conditions and need for major dewatering or underwater (tremie) concrete placement.

Suitable pile types may be grout or concrete injected (CFA) piles founded within the underlying bedrock, or driven precast concrete, or steel joists piles, subject to noise and vibration concerns.

Other suitable piles types could include proprietary pile systems such as enlarged based Frankipiles or concrete screw piles. The choice between alternative systems will depend on relative cost and suitability in relation to the proposed construction.

Continuous flight auger (CFA) grout or concrete injected piles would be expected to be taken to refusal on at least medium strength rock using a suitable rig. Typical allowable design parameters for a CFA pile are shown in Table 3.

Table 3: Typical Allowable Parameters for CFA Piles

Material	Typical Allowable Pressure (kPa)	
	End Bearing	Shaft Adhesion
Very Stiff Clay / Medium Dense Sand	-	25
Very Low to Low Strength Rock	1000	10
Medium Strength Rock	3500	350
Medium to High Strength Rock	6000	600

The settlement of such rock socketed piles would be expected to be less than 1% of the piles diameter, with differential settlement between adjacent (new) column of not more than half of this value.

Design for uplift or tension loads for CFA piles may be based on 70% of the shaft adhesion values shown above.

The use of precast concrete piles driven to refusal on rock or to refusal within the very dense sand layers encountered may provide a suitable foundation. Where piles achieve practical refusal, the pile capacity should be determined on the basis of a pile driving analysis (PDA) and subsequent wave equation analysis using software such as CAPWAP, or by use of a dynamic formula (e.g. Hiley) with an appropriate factor of safety.

For proprietary type piles, their suppliers should be consulted about their capacity.

8.7 Earthquake Factor

In accordance with the Earthquake Loading Standard, AS1170.4 - 2007 the site is assessed to have a hazard factor (z) of 0.08 and a subsoil class "Ce".

9. Limitations

Douglas Partners (DP) has prepared this report (or services) for this project at in accordance with DP's proposal dated and acceptance received from dated xxx. The work was carried out under DP's Conditions of Engagement (or contract No xyz, dated). This report is provided for the exclusive use of for this project only and for the purposes as described in the report. It should not be used by or relied

upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners



Introduction

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

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

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

Borehole and Test Pit Logs

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

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

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

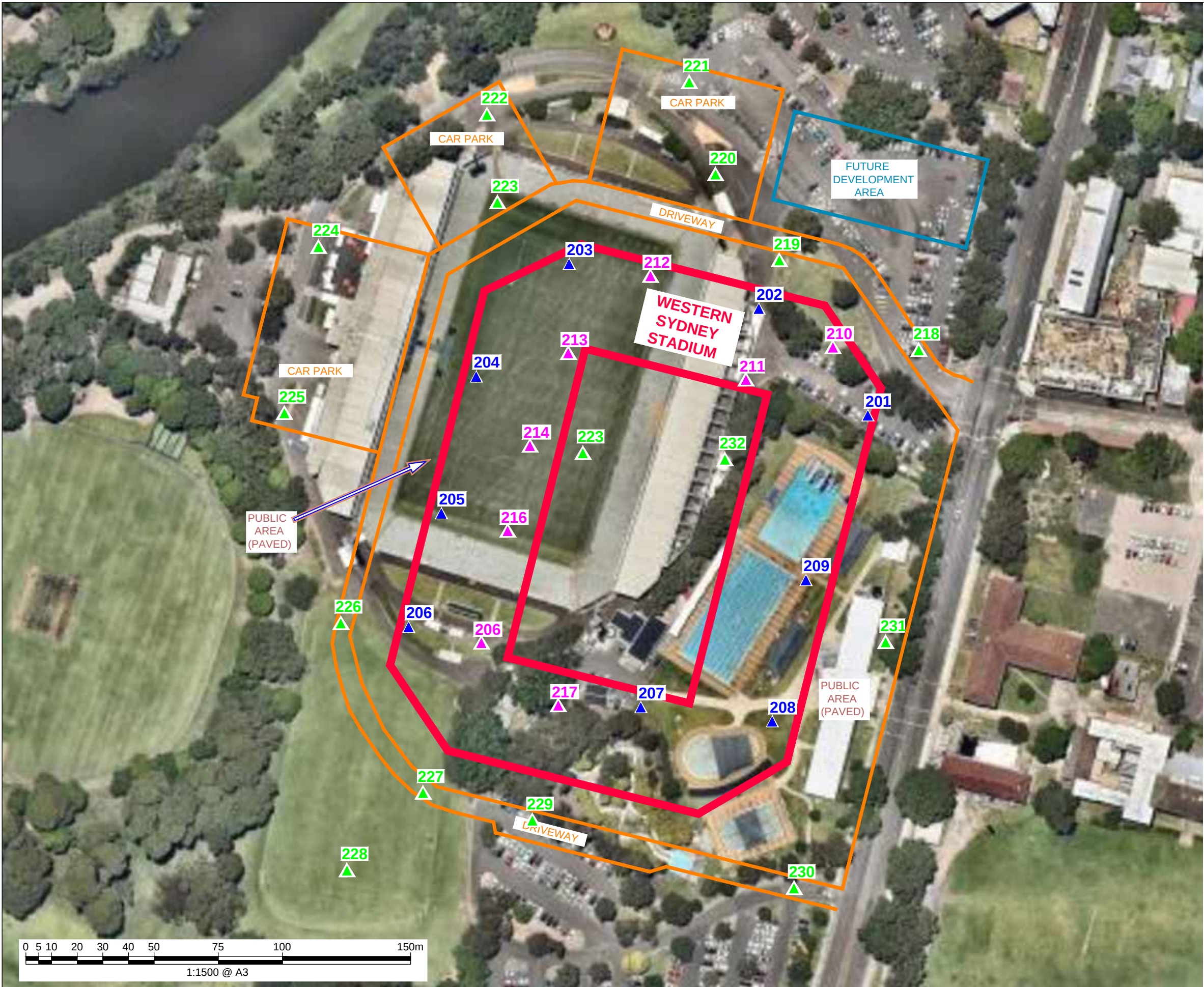
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate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

Site Inspection

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

Appendix B

Drawings



NOTE: Base drawing from Near Map (Dated Tuesday 19 January 2016)

LEGEND

PROPOSED TEST LOCATIONS:
(OPTION 2)

- ▲ Cored borehole
- ▲ Cone penetration test
- ▲ Shallow borehole



Appendix C

Previous Reports



DJD/mdb
SSI/8502
30th July, 1984

REPORT ON SITE INVESTIGATION
CUMBERLAND OVAL REDEVELOPMENT
PARRAMATTA

1. INTRODUCTION

This report details the results of site investigation carried out for the Department of Public Works, N.S.W. at the Cumberland Oval, O'Connell Street, Parramatta.

It is proposed to invite tenders for design and construction of new facilities on the site and the site investigation was carried out to provide information on excavation conditions in the playing field area and foundations for a proposed grandstand.



2. TOPOGRAPHY AND GEOLOGY

The site is located about 150 m from the Parramatta River with the main site level about 8 m above river level. The existing oval is surrounded by grassed banks 2 - 3 m high. The centre line of the new development is some 10 m north of the centre line of the existing playing field and some of the boreholes in the structural zone were therefore located on the existing embankment.

Published geological information⁽¹⁾ indicates that the site is bisected by a geological boundary. Bedrock underlying the north-east portion of the site is the Hawkesbury Sandstone Formation, whilst the south-west portion of the site is underlain by the Mittagong Formation and lowest unit of the Ashfield Shale Formation. Stratigraphically, the Hawkesbury Sandstone is overlain by the Mittagong Formation which is overlain by Ashfield Shale. All the rocks are of Triassic Age.

The Hawkesbury Sandstone Formation consists predominantly of medium and coarse grained quartz sandstone. The Mittagong Formation comprises fine to medium grained laminated sandstone and black siltstone. The lowest unit within the Ashfield Shale consists of black to dark grey sideritic claystone and siltstone which is slightly carbonaceous at the base.

The investigation described hereunder has generally confirmed this mapping. Samples recovered from bores extended into the rock consisted mainly of Ashfield Shale and Mittagong Formation Sandstone. The medium grained sandstone from below 12 - 13 m in some bores is probably part of the Hawkesbury Sandstone Formation.

(1) Herbert, C. 1980 "Geology of the Sydney 1:100,000 Sheet 9130", Geol. Survey of N.S.W.



3. SITE INVESTIGATION

The site investigation comprised nineteen boreholes as shown on the attached drawing 8502/1. The work included:-

- . Bores 1 to 8 on a 20 m x 40 m grid in the area proposed for the Stadium structure. These bores were taken to rock at depths of 7 - 13 m with core drilling thereafter into the rock.
- . Bores 9 to 14 in the main arena area drilled to depths of 5 m to check excavation conditions.
- . Bores 15 to 19 around the perimeter of the development to check subgrade conditions and were taken to depths of 1.2 - 2 m.

The boreholes were drilled with truck mounted auger/rotary drilling rigs, drilling the upper soils either with continuous spiral flight augers or with a continuous sampler which produced a 100 mm diameter continuous core sample of the soil. Standard penetration tests and undisturbed samples were also taken in some of the bores in the upper soils. Core drilling in the underlying rock was carried out using NMLC equipment to give 50 mm diameter core samples.

4. SUBSURFACE CONDITIONS

Details of the conditions encountered in the bores are given in the attached test bore report sheets and the terms used to classify the strata are defined in the attached notes. Levels at bore surfaces were determined relative to A.H.D.

Bores 1 - 8 were located in the area of the proposed stand. They were drilled from differing levels, Bores 2 and 3 being on the playing field, Bores 1, 6 and 4, on the existing embankment and the remainder on the level area behind the embankment, approximately at the same level as the playing field. The bores encountered the following general succession of strata:-

- . Filling - mainly dark brown and red brown sand and clayey sand in a loose or moderately compact condition. It is apparently of local origin and is noted to occur elsewhere in the area. The interface with natural material could not always be reliably defined. The depth of fill ranges from 3.0 - 5.5 m, part of this being the existing embankment.
- . Natural soils - these comprise red brown sands and clayey sands and sandy clays in a medium dense or very stiff condition. They are apparently alluvial river terrace deposits and extend to depths of 7.3 - 12.8 m (R.L.1.3 - R.L.5.5).
- . Rock - generally 1 - 3 m of shale, in a highly weathered condition for the first 1 - 2 m, but thereafter medium strong. Strong sandstone was encountered under the shale in most of the bores, mainly at R.L.-0.6 to R.L.1.6, but significantly higher in Bore 8 at R.L.4.9.

A summary of the levels of the main strata is given below and a cross sectional drawing is given in drawing 8502/2. Point load strength index tests were carried out on typical core samples and the results are given in Table 1.



Bore No.	Surface Level	Underside of Fill	Surface of Rock	Surface of Strong Rock
	R.L.	R.L.	R.L.	R.L.
1	15.73	12.5	4.0	1.6
2	12.62	9.6	3.3	0.9
3	12.52	8.6	4.8	
4	14.07	11.3	1.3	-0.6
5	12.65	8.4	3.9	0.3
6	14.64	9.0	3.7	0.7
7	12.99	7.5	1.6	0.1
8	12.78	9.9	5.5	4.9

Bores 11 to 14 in the main playing field area encountered a lesser depth of filling, with generally 1.5 - 2.5 m of silty or clayey sand overlying natural clayey sands and sandy clays.

Bores 15 and 16, west of the stadium area encountered sand filling for the full depth of investigation of 2 m.

Bores 17 - 20, north and east of the stadium area encountered natural soils almost from the surface, overlying mainly stiff clays and sandy clays to depths of 1.2 m.

Ground water was encountered only in some of the deeper bores in the stadium area and in most of these, ground water was noted encountered during the period of auger drilling. Later observations indicated a ground water level at around R.L.7 to R.L.8, but with a higher level in Bore 1 due to an apparent perched water table condition following heavy rainfall.



5. COMMENTS

It is understood that redevelopment of the site will incorporate a single main viewing stand on the western side of the arena, with the level of the arena lowered by up to 4 m from its present level.

Structural details for the stand have yet to be developed, but for the purposes of the following assessment, it is assumed that the structure will have its lowest floor level at the new playing field level and that column loadings will be of the order of 5000 - 10,000 kN. There may be uplift loadings at some locations.

5.1 Excavation Conditions

Excavation of the playing field area by up to 4 m is expected to be relatively straightforward and can readily be accomplished with conventional earthmoving equipment. The excavated soils comprise mainly sands, clayey sands and sandy clays, which could provide good quality general purpose fill elsewhere if required.

Ground water incidence is not expected, either as a short term problem during construction or as a long term occurrence. Measured ground water levels were not consistent over the site, but with one exception, were at or well below intended excavation level. In Bore 1, the measured level at R.L.12.4 was after several days heavy rainfall and is apparently a localised "perched" table.

The ground water table would be expected to fall across the site toward the river. It is possible that there may be a higher water table level in the area east of the stadium, with a possibility (after heavy rainfall) of seepage flow emanating from the cut slope on the eastern side. It would be advisable therefore to provide subsurface drainage at the toe of the cut on this side to a depth of about 1 m to avoid this problem.

5.2 Grandstand - Shallow Foundations

Excavation to depths of about 4 m will expose natural soils which are mainly sands and clayey sands with some sandy clay, these being in a medium dense or very stiff condition. It is considered that they would be suitable for the support of minor to moderate foundation loadings from building structures, probably for unit loadings up to about 1000 kN. They may still be suitable for heavier loadings but footings may become overly large and/or settlements may become unacceptable.

As a broad guide, it is suggested that pad footings at about R.L.8.5 could support design bearing pressures of 300 - 400 kPa. For loadings of the order of 1000 kN, settlements are estimated to be around 10 - 15 mm. It should be noted however that the investigation work so far has been aimed at providing primarily broad general information on stratification and that supplementary investigation would be advisable in relation to any specific proposal for heavily loaded shallow foundations.

5.3 Grandstand - Deep Foundations

For major loadings, it is considered likely that the use of piles will be required, carried down to the underlying rock. Conditions are suitable for the use of large diameter bored piles and for unit loads in excess of 3000 - 4000 kN, the use of single bored piles will probably be preferable to the use of groups of smaller diameter piles (driven or bored) with a connecting pile cap.

The investigation has indicated relatively straightforward conditions for bored pile construction and the upper soils will probably stand without casing. However, there is likely to be minor inflow of ground water, with a tendency for caving conditions shortly after drilling. It is likely then that there would be a need to place a temporary casing

after drilling to the rock surface has been completed.

Depending on load requirements, bored piles could act in end bearing on the rock surface, or could be extended into the rock to carry load in shaft adhesion. The following design bearing pressures are suggested for compression loadings:-

	SAFE DESIGN PRESSURE	
	End Bearing MPa	Shaft Adhesion kPa
Weak shale	1.0	150
Medium strong shale or sandstone	3.5	350
Strong shale or sandstone	6.0	-

For uplift loadings, adhesion values above should be reduced by 25%.

Relatively heavy drilling equipment (e.g. Watson, Williams, Caldwell) would be required to penetrate the medium strong rock for socket construction. It is considered that it would not be feasible to construct sockets in rock described as "strong" with any available mechanical augering equipment.

For the higher levels of bearing pressure, there will be a need to adopt rock proving techniques either before or during construction, to ensure rock quality and continuity.

As an alternative to large diameter bored piles, the use of groups of smaller capacity piles may be considered. Pile systems suitable for use on this site would include:-

- . Driven cast in-situ - these would be founded on the surface of the rock, with unit load capacities of 1000 - 1800 kN.
- . Driven steel joist piles - these would probably penetrate slightly into medium strong rock and, depending on section employed, would support loadings of up to 2500 - 3000 kN/pile.



- . Augered grouted piles - these would extend to or slightly into the medium strong rock and would be suitable for unit loads of the order of 1100 kN (500 mm) to 1500 kN (600 mm).

The choice between alternative systems will depend on relative cost and suitability in relation to the proposed construction.

5.4 Pavements

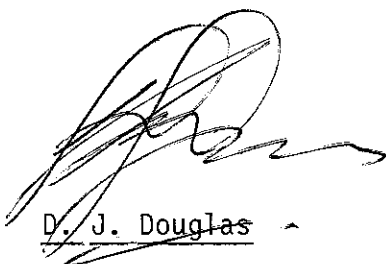
Bores elsewhere on the site have indicated relatively favourable subgrade conditions for pavement construction. Whilst a more extensive survey would be advisable as part of the detailed design, it is considered that preliminary design could be based on an assumed C.B.R. for the subgrade of 8%.

For flexible pavement construction, the following pavement thicknesses are suggested:-

Carpark areas	100 mm
Carpark access	150 mm
Light duty truck access	200 mm

For the design of any concrete pavements, the modulus of subgrade reaction of the compacted subgrade is estimated to be of the order of 50 kPa/mm.

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TABLE 1
RESULTS OF POINT LOAD STRENGTH TESTS
CUMBERLAND OVAL

Bore	Depth	Description	Point Load Strength
			$I_s(50)$ MPa
1	13.4	Medium strong shale	0.37
1	14.7	Strong grey sandstone	2.3
2	11.0	Medium strong shale	1.1
2	12.3	Strong grey sandstone	3.0
3	10.1	Medium strong grey shale	0.8
7	11.7	Strong grey sandstone	1.4
7	14.1	Strong grey sandstone	1.8

TEST BORE REPORT

BORE No. 1

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 11/7/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 15.73

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - topsoil	S.L. 0.20				
FILLING - brown silty fine and medium grained sand with grey sandstone fragments to 0.90mm	0.90				
FILLING - very stiff mottled brown and grey sandy clay filling	3.20	CS	S.L.-5.50		100
SANDY SILT - grey brown fine sandy silt - possibly filling	4.80				
SANDY CLAY - hard red-brown sandy clay	7.00				
SAND - loose to medium dense brown slightly clayey sand	8.60				
SANDY CLAY - stiff to very stiff brown sandy clay	10.00	C	10.00-10.92		38
Continued					

RIG B40 Ford DRILLER Lamb CASING NW to 11.00 m
TYPE OF BORING Continuous sampler to 5.50 m, then flight auger to 9.00 m,
then NMLC core drilling
WATER LEVEL OBSERVATIONS No free ground water observed during drilling.
REMARKS Standing water level at 3.40 m after 3 weeks
(probably perched water level after heavy rain).

TYPE

- A - auger sample
- S - standard penetration test sample
- U - mm diameter undisturbed sample
- C - continuous diamond core
- V - field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).

TEST BORE REPORT

BORE No. 1 (Cont'd).

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 11/7/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L.15.73

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
Continued SHALEY CLAY - hard grey mottled brown sandy shaley clay *10.92; 11.36; 30mm and 20mm shale layer	10.00	C	10.92-12.42		100
CLAYEY SHALE - extremely to very weak light grey and brown clayey shale *12.32 m: 80 mm very stiff clay seam *12.42 m: 25 mm weak sandy shale seam	11.70				
SHALE - weak grey-brown highly fractured sandy shale *12.45 m; 12.49 m; 25mm stiff grey clay seams	12.42	C	12.42-13.62		100
SHALE - medium strong grey fractured shale becoming sandier with depth *13.72 m; 13.82 m; 13.88 m; narrow extremely weak clayey shale seams	12.96				
SANDSTONE - strong grey fine fractured sandstone	14.16	C	13.62-15.12		100
	15.12				
<u>Bore discontinued at 15.12 metres.</u>					

RIG B40 Ford DRILLER Lamb CASING NW to 11.00 m
TYPE OF BORING Continuous sampler to 5.50 m, then flight auger to 9.00 m, then NMLC core drilling
WATER LEVEL OBSERVATIONS No free ground water observed during drilling.
REMARKS Standing water level at 3.40 m after 3 weeks (probably perched water level after heavy rain).

TYPE
A — auger sample
S — standard penetration test sample
U — mm diameter undisturbed sample
C — continuous diamond core
V — field vane shear test

"N" VALUE
blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).

TEST BORE REPORT

BORE No. 2

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 29/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 12.62

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - brown silty sand topsoil	S.L.				
	0.40				
FILLING - brown slightly clayey fine sand	1.10	U	1.00-1.37	0,1,3 N = 4	
FILLING - loose red-brown and brown slightly clayey sand	3.00	U	2.00-2.37	1,1,4 N = 5	
		U	3.50-3.80	2,8,10 refusal	
CLAYEY SAND - medium dense red-brown and brown slightly clayey sand	5.20	U	5.00-5.37	2,6,14 N = 20	
		U	6.50-6.87	6,12,15 N = 27	
		S	7.00-7.30	8,23	150mm
CLAY - very stiff light grey mottled brown slightly sandy clay; with traces of weathered siltstone and gravel	9.30	S	8.50-8.92	9,13,20 N = 33	
(Continued)					

RIG B40 Ford DRILLER Lamb CASING NW to 6.50 m
TYPE OF BORING Flight auger to 6.50 m; then rotary drilling to 10.10 m;
then NMLC core drilling
WATER LEVEL OBSERVATIONS No free ground water observed
REMARKS

TYPE	"N" VALUE
A — auger sample	blows of a 63.5 kg hammer falling
S — standard penetration test sample	760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).
U — mm diameter undisturbed sample	
C — continuous diamond core	
V — field vane shear test	

TEST BORE REPORT

BORE No. 2 (Cont'd)..

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION PARRAMATTA

DATE 29/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 12.62

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
Continued... CLAYEY SHALE - extremely weak grey clayey shale	9.30 10.10	 S C	 10.00-10.10 10.10-11.65	 20 - refusal	 90
SHALE - weak and medium strong light grey highly fractured to fractured shale *10.44 m; 20 mm very stiff shaley clay seam *11.58 m; 50 mm extremely weak clayey shale *11.75 m; 70° dipping fracture	 11.70	 C	 11.65-13.15		 100
SANDSTONE - strong grey fractured to slightly fractured fine grained sand- stone - becoming medium grained below 12.70 m	 13.15				
Bore discontinued at 13.15 metres.					

RIG B40 Ford DRILLER Lamb CASING NW to 6.50 m
TYPE OF BORING Flight auger to 6.50 m; then rotary drilling to 10.10 m;
then NMLC core drilling
WATER LEVEL OBSERVATIONS No free ground water observed
REMARKS

TYPE	"N" VALUE
A — auger sample	blows of a 63.5 kg hammer falling
S — standard penetration test	760 mm to drive a standard 50 mm O.D.
U — mm diameter undisturbed	split penetrometer for the last 300 mm
sample	of test (where thin walled undisturbed
C — continuous diamond core	sample tubes are driven in the same
V — field vane shear test	manner, the values are shown bracketed).

 D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 3

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 6/7/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 12.52

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - brown-grey sandy loam topsoil	S.L. 0.50				
FILLING - light brown clayey sand	1.20				
FILLING - stiff to very stiff brown and red-brown slightly sandy clay	3.90				
SAND - light brown and grey minor red brown mottled, slightly clayey sand, with gravel below 5.50 m	6.30	CS A	S.L.- 5.30 6.00		
SANDY CLAY - hard grey sandy clay, grading to extremely weak fine grained sandstone	7.70	A C	7.00 7.50-8.75		92
SHALE - very weak and weak brown and grey sandy shale *7.78; 7.84; 8.04; stiff grey clay seams to 25 mm	8.07				
Continued ...					

RIG B 40 Ford

DRILLER Lamb

CASING NW to 7.00 m

TYPE OF BORING Continuous sampler to 5.30m; flight auger to 7.00 m, rotary drilling to 7.50 m, then NMLC core drilling

WATER LEVEL OBSERVATIONS Free ground water level at 3.40 m after 6 days and at 6.70 m after 3 weeks

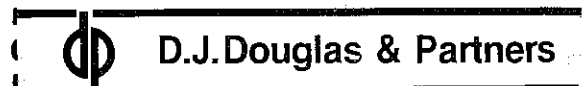
REMARKS

TYPE

- A - auger sample
- S - standard penetration test sample
- U - mm diameter undisturbed sample
- C - continuous diamond core
- V - field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



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TEST BORE REPORT

BORE No. 3.. Cont'd..

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 6/7/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 12.52

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery
Continued ...	8.07				%
SHALE - very weak grey-brown fractured sandy shale		C	8.75-10.00		100
	9.70	C	10.00-10.80		100
SHALE - medium strong slightly fractured dark grey shale, becoming sandy with depth *10.46; 20mm grey clayey shale *10.48; 250mm very weak highly fractured shale	10.80				
<u>Bore discontinued at 10.80 metres.</u>					

RIG B 40 Ford DRILLER Lamb CASING NW to 7.00 m
TYPE OF BORING Continuous sampler to 5.30 m; flight auger to 7.00 m, rotary drilling to 7.50 m, then NMLC core drilling
WATER LEVEL OBSERVATIONS Free ground water level at 3.40 m after 6 days and at 3.90 m after 3 weeks
REMARKS

TYPE
A — auger sample
S — standard penetration test sample
U — mm diameter undisturbed sample
C — continuous diamond core
V — field vane shear test

"N" VALUE
blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



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TEST BORE REPORT

BORE No. 4

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 6/7/84
CONTRACT No. SSI/8502
SURFACE LEVEL

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - sands, clays, cemented gravel	S.L.				
	1.70	S	1.00-1.45	4,8,15 N = 23	
FILLING - loose dark brown fine and medium grained sand	2.80	U	2.00-2.37	1,1,1 N = 2	
CLAYEY SAND - lightly cemented brown mottled slightly clayey sand, possibly filling	4.30	U	3.50-3.87	4,8,17 N = 25	
SAND - medium dense red-brown medium grained slightly clayey sand	6.50	S	5.00-5.45	10,15,19 N = 34	
	9.00	S	6.50-6.95	5,7,11 N = 18	
SANDY CLAY - very stiff light grey and brown, mottled red brown sandy clay with shaley clay and some gravel	10.80	S	8.00-8.45	7,8,8 N = 16	
CLAYEY SAND - loose to medium dense grey and brown clayey sand with some gravel		S	9.50-9.95	8,4,5 N = 9	
Continued..					

RIG B40 Ford DRILLER Lamb CASING NW to 13.00 m
TYPE OF BORING Flight auger to 8.00 m, then rotary drilling to 13.00 m, then NMLC core drilling
WATER LEVEL OBSERVATIONS Free ground water level at 8.30 m after 6 days and at 6.70 m after 3 weeks
REMARKS

TYPE

- A — auger sample
- S — standard penetration test sample
- U — mm diameter undisturbed sample
- C — continuous diamond core
- V — field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



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TEST BORE REPORT

BORE No. 4 .. Cont'd.

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 6/7/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 14.07

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
Continued ...	10.80				
SAND - medium dense grey medium and coarse grained sand		S	11.00-11.45	3,7,11 N = 18	
	12.80				
SHALE - very weak grey-brown shale		S	13.00-13.03	20/30mm	
	13.05	C	13.05-14.55		80
SHALE - medium strong to strong slightly fractured grey shale		C	14.55-16.05		100
	14.70				
SANDSTONE - strong slightly fractured light grey fine grained sandstone					
	16.05				
Bore discontinued at 16.05 metres.					

RIG B40 Ford DRILLER Lamb CASING NW to 13.00 m
TYPE OF BORING Flight auger to 8.00 m, then rotary drilling to 13.00 m, then NMLC core drilling
WATER LEVEL OBSERVATIONS Free ground water level at 8.30 m after 6 days and at 6.70 m after 3 weeks
REMARKS

TYPE	"N" VALUE
A - auger sample	blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).
S - standard penetration test sample	
U - mm diameter undisturbed sample	
C - continuous diamond core	
V - field vane shear test	

TEST BORE REPORT

BORE No. 5

CLIENT DEPARTMENT OF PUBLIC WORKS

SITE CUMBERLAND OVAL

LOCATION O'CONNELL STREET, PARRAMATTA

DATE 12 - 19/7/84

CONTRACT No. SSI/8502

SURFACE LEVEL R.L. 12.65

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - road base	S.L.				
	0.30				
FILLING - brown fine sand and silt		A	0.50-1.50		
		A	1.00		
	1.50				
		A	2.00		
FILLING - red brown slightly clayey medium grained sand		A	3.00		
		A	4.00		
	4.20				
SAND - brown slightly silty sand - possibly filling		A	5.00		
	5.40	A	5.40-6.00		
SANDY CLAY - very stiff red brown and grey sandy clay		A	6.00-6.60		
	6.50	A	6.60-7.60		
Continued		A	7.60		

RIG B 40/ X2

DRILLER Lamb/Saxon CASING

TYPE OF BORING Flight auger to 9.90 m; then NMLC core drilling

WATER LEVEL OBSERVATIONS Free ground water observed at 9.70 m

REMARKS

TYPE

- A — auger sample
- S — standard penetration test sample
- U — mm diameter undisturbed sample
- C — continuous diamond core
- V — field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 5 .. Cont'd.

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 12 - 19/7/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 12.65

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
Continued ...	6.50				
SANDY CLAY - very stiff grey sandy clay with weathered brown-grey siltstone	8.80				
SILTSTONE - very weak grey-brown silt- stone with very stiff grey sandy clay seams	9.90	C	9.90-12.90	100	
SHALE AND SANDSTONE - strong fractured to slightly fractured interbedded grey shale and fine grained sandstone *11.60 m: 50° dipping fracture	12.30				
SANDSTONE - strong slightly fractured grey-brown medium grained sandstone	12.90				
Bore discontinued at 12.90 metres.					

RIG B 40 / X2

DRILLER Lamb/Saxon CASING

TYPE OF BORING Flight auger to 9.90 m; then NMLC core drilling

WATER LEVEL OBSERVATIONS Free ground water observed at 9.70 m

REMARKS

TYPE

- A — auger sample
- S — standard penetration test sample
- U — mm diameter undisturbed sample
- C — continuous diamond core
- V — field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



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TEST BORE REPORT

BORE No. 6

CLIENT DEPARTMENT OF PUBLIC WORKS
 SITE CUMBERLAND OVAL
 LOCATION O'CONNELL STREET, PARRAMATTA

DATE 31.7.84
 CONTRACT No. SSI/8502
 SURFACE LEVEL R.L. 14.64

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - sand, clay and concrete filling	S.L.	S	2.00 - 2.45	3,5,7 N =12	
	2.50				
FILLING - medium dense red-brown and brown medium grained sand		S	4.00 - 4.45	4,5,8 N =13	
	5.60				
SANDY CLAY - very stiff grey and brown fine sandy clay with traces of weathered brown siltstone		S	6.00 - 6.45	4,5,8 N =13	
	7.50				
SANDY CLAY - very stiff brown and grey very sandy clay		S	8.00 - 8.45	7,8,14 N =22	
	10.30				
SILTSTONE and CLAY - extremely weak brown siltstone and very stiff grey clay		S	10.00 -10.45	4,6,15 N =21	
	10.92				
SHALE and SANDSTONE - very weak to weak fractured grey interbedded shale and sandstone		C	10.92 -14.02		100
	12.25				
Continued					

RIG Pioneer

DRILLER Puc

CASING N.W. to 12.00

TYPE OF BORING Flight auger to 10.92 m; then NMLC core drilling

WATER LEVEL OBSERVATIONS Free ground water observed at 8.85 m.

REMARKS

TYPE

- A — auger sample
- S — standard penetration test sample
- U — mm diameter undisturbed sample
- C — continuous diamond core
- V — field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).

**D.J. Douglas & Partners**

TEST BORE REPORT

BORE No. 6 Continued

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 31.7.84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 14.64

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
SANDSTONE - medium strong fractured grey fine grained sandstone with weak shale bands to 20mm * 13.47m and 13.52m : 15mm clay seams * 13.59m : 10mm clay seam	12.25				
	13.92				
		C	14.02 - 15.42		100
SANDSTONE - strong slightly fractured grey fine and medium grained sandstone * 14.47m : 200mm interbedded strong sandstone and weak grey shale * 14.89 and 15.05m : 10mm very weak grey shale bands	15.42				
<u>Bore discontinued at 15.42 metres</u>					

RIG Pioneer DRILLER Puc CASING N.W. to 12.00
TYPE OF BORING Flight auger to 10.92 m; then NMLC core drilling
WATER LEVEL OBSERVATIONS Free ground water observed at 8.85 m.
REMARKS

TYPE

A — auger sample
S — standard penetration test sample
U — mm diameter undisturbed sample
C — continuous diamond core
V — field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).

TEST BORE REPORT

BORE No. 7

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 11/7/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L.12.99

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - road base	S.L.				
	0.50	A	1.00		
FILLING - brown fine and medium grained sand	1.70	A	2.00		
FILLING - red-brown medium grained clayey sand	3.50	A	4.00		
	5.50	A	5.00		
FILLING - red brown and brown medium grained sand		A	6.00		
		A	7.00		
SANDY CLAY - stiff to very stiff brown mottled sandy clay - very sandy clay below 7.50 m		A	8.00		
		A	9.00		
		A	10.00		
	11.40	C	11.00-11.90		55

Continued..

RIG B 40

DRILLER Lamb

CASING NW to 11.00 m

TYPE OF BORING Flight auger to 8.00 m; then rotary drilling to 11.00 m;
then NMLC core drilling

WATER LEVEL OBSERVATIONS No free ground water observed during drilling.

REMARKS Standing water level at 5.50 m after 3 weeks.

TYPE
A — auger sample
S — standard penetration test sample
U — mm diameter undisturbed sample
C — continuous diamond core
V — field vane shear test

"N" VALUE
blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 7 .. Cont'd.

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 11/7/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L.12.99

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery
Continued ...	11.40				%
SANDSTONE - medium strong fractured grey fine grained sandstone	12.00	C	11.90-13.05		100
SANDSTONE - weak to medium strong fractured grey fine grained sandstone		C	13.05-14.55		100
*12.05 m; 80mm very weak clayey shale seam					
*12.70 m; 15mm grey clayey seam					
	12.75				
SANDSTONE - strong slightly fractured grey fine grained sandstone		C	13.05-14.55		100
*13.15 m; 600mm medium strong grey sandy shale seam					
	14.55				
<u>Bore discontinued at 14.55 metres.</u>					

RIG B 40 DRILLER Lamb CASING NW to 11.0 m
TYPE OF BORING Flight auger to 8.00 m; then rotary drilling to 11.00 m;
then NMLC core drilling
WATER LEVEL OBSERVATIONS No free ground water observed during drilling.
REMARKS Standing water level at 5.50m after 3 weeks.

TYPE	"N" VALUE
A — auger sample	blows of a 63.5 kg hammer falling
S — standard penetration test	760 mm to drive a standard 50 mm O.D.
U — mm diameter undisturbed	split penetrometer for the last 300 mm
sample	of test (where thin walled undisturbed
C — continuous diamond core	sample tubes are driven in the same
V — field vane shear test	manner, the values are shown bracketed).

 **D.J. Douglas & Partners**

TEST BORE REPORT

BORE No. 8

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 20/7/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 12.78

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - road base and sand filling	S.L.				
	0.60	S	1.00-1.45	2,2,2 N = 4	
FILLING - loose red-brown fine and medium grained sand		S	2.00-2.45	3,4,5 N = 9	
	2.80	S	3.20-3.65	11,12,17 N = 29	
CLAYEY SAND - medium dense lightly cemented brown mottled medium grained clayey sand with some gravels - possibly filling		S	4.40-4.85	9,8,10 N = 18	
	4.80	A	4.80-5.00		
SANDY CLAY - very stiff brown mottled red-brown sandy clay, with weathered siltstone and ironstone gravel below 5.50 m		S	5.60-6.05	10,16,22 N = 38	
	6.20	A	6.20-7.50		
SHALEY CLAY - very stiff grey shaley clay with very weak shale		S	7.00-7.10	15/100mm	
	7.30	C	7.50-10.50		100
SILTSTONE - medium strong fractured grey and brown siltstone	7.92				
SANDSTONE - strong slightly fractured grey-brown medium grained sandstone *12.92 m; 90mm weak sandstone band *12.96 m; 10mm grey clay seam	8.77				
Continued					

RIG X2

DRILLER Saxon

CASING

TYPE OF BORING Flight auger to 7.50 m; then NMLC core drilling

WATER LEVEL OBSERVATIONS No free ground water observed

REMARKS

TYPE

- A - auger sample
- S - standard penetration test sample
- U - mm diameter undisturbed sample
- C - continuous diamond core
- V - field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 8 ..Cont'd.

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 20/7/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 12.78

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
.Continued..	8.77				
SANDSTONE - medium strong to strong fractured to slightly fractured grey fine grained sandstone					
*8.77 m; 15mm grey clay seam	10.50				
<u>Bore discontinued at 10.50 metres.</u>					

RIG X2 DRILLER Saxon CASING
TYPE OF BORING Flight auger to 7.50 m; then NMLC core drilling
WATER LEVEL OBSERVATIONS No free ground water observed
REMARKS

TYPE	"N" VALUE
A — auger sample	blows of a 63.5 kg hammer falling
S — standard penetration test	760 mm to drive a standard 50 mm O.D.
U — mm diameter undisturbed	split penetrometer for the last 300 mm
sample	of test (where thin walled undisturbed
C — continuous diamond core	sample tubes are driven in the same
V — field vane shear test	manner, the values are shown bracketed).

TEST BORE REPORT

BORE No. 9

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 28/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 12.96

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - dark brown fine and medium grained sand	S.L.				
	0.70	CS	S.L.-1.55		80
FILLING - mottled brown silty fine grained sand	1.50	A	1.55-2.00		
FILLING - mottled brown fine sandy silt	2.00	A	2.00-2.50		
CLAYEY SILT - very stiff red-brown and grey clayey silt	3.00	A	2.50-3.00		
Bore discontinued at 3.00 metres.					

RIG B 40 Ford DRILLER Lamb CASING -
TYPE OF BORING Continuous sampler to 1.55 m, then flight auger
WATER LEVEL OBSERVATIONS No free ground water observed
REMARKS

TYPE

A — auger sample
S — standard penetration test
U — mm diameter undisturbed
sample
C — continuous diamond core
V — field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling
760 mm to drive a standard 50 mm O.D.
split penetrometer for the last 300 mm
of test (where thin walled undisturbed
sample tubes are driven in the same
manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 10

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 28/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 12.40

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - dark brown silty sand	S.L.				
	0.15				
FILLING - grey brown silty fine grained sand		A	0.50		
	0.70				
CLAYEY SAND - red-brown mottled brown clayey fine grained sand	1.20				
SANDY CLAY - firm to stiff red-brown fine sandy clay	2.10	A	1.50		
		A	2.50		
SANDY CLAY - very stiff red-brown sandy clay. Minor grey mottling below 3.0m		A	4.00		
		A	4.50		
	5.00	A	5.00		
<u>Bore discontinued at 5.00 metres</u>					

RIG B 40 Ford

DRILLER Lamb

CASING

TYPE OF BORING Flight auger

WATER LEVEL OBSERVATIONS No free ground water observed

REMARKS

TYPE

- A — auger sample
- S — standard penetration test sample
- U — mm diameter undisturbed sample
- C — continuous diamond core
- V — field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 11

CLIENT DEPARTMENT OF PUBLIC WORKS,
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 28/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 12.27

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - dark brown silty loam topsoil	S.L.				
	0.07				
FILLING - dark brown slightly clayey fine and medium grained sand					
	1.20				
FILLING - dark brown medium grained sand		CS	S.L.-4.15		
	3.00				
SAND - dark brown sand with rootlets					
	3.10				
SILTY CLAY - soft light grey-brown silty clay					
*3.45 m; 50mm sand seam					
*3.75 m; 100mm stiff red-brown clay seam					
	4.05				
CLAY - very stiff to hard red-brown mottled brown clay with fine ironstone gravel		A	4.15		
	5.00				
<u>Bore discontinued at 5.00 metres</u>					

RIG B 40 Ford

DRILLER Lamb

CASING

TYPE OF BORING Continuous sampler to 4.15 m, then flight auger

WATER LEVEL OBSERVATIONS No free ground water observed

REMARKS

TYPE

- A — auger sample
- S — standard penetration test sample
- U — mm diameter undisturbed sample
- C — continuous diamond core
- V — field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 12

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 29/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 13.06

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - dark brown loam topsoil	S.L.				
	0.10				
FILLING - light brown silty fine grain- ed sand					
	1.20				
FILLING - brown silty fine grained sand					
	1.70				
CLAYEY SAND - red-brown silty clayey fine grained sand					
	3.50				
SANDY CLAY - stiff red-brown, mottled grey sandy clay					
	4.50				
SAND - brown, mottled red-brown fine and medium grained sand					
	5.00				
<u>Bore discontinued at 5.00 metres.</u>					

RIG B 40 Ford

DRILLER Lamb

CASING -

TYPE OF BORING Flight auger

WATER LEVEL OBSERVATIONS No free ground water observed

REMARKS

TYPE
A — auger sample
S — standard penetration test
sample
U — mm diameter undisturbed
sample
C — continuous diamond core
V — field vane shear test

"N" VALUE
blows of a 63.5 kg hammer falling
760 mm to drive a standard 50 mm O.D.
split penetrometer for the last 300 mm
of test (where thin walled undisturbed
sample tubes are driven in the same
manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. -13

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 28/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 12.83

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - dark brown sand	S.L.				
FILLING - 40mm crushed dolerite	0.40				
	0.90				
TOPSOIL - dark brown silty fine and medium grained sand with rootlets	1.10				
CLAY - stiff red-brown slightly sandy clay, becoming very stiff below 2.00 m	3.00	CS	S.L.-5.00		
SANDY CLAY - very stiff red-brown mottled brown sandy clay	5.00				
<u>Bore discontinued at 5.00 metres.</u>					

RIG B 40 Ford

DRILLER Lamb

CASING -

TYPE OF BORING Continuous sampler to 5.00 m

WATER LEVEL OBSERVATIONS No free ground water observed

REMARKS

TYPE

- A — auger sample
- S — standard penetration test
sample
- U — mm diameter undisturbed
sample
- C — continuous diamond core
- V — field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling
760 mm to drive a standard 50 mm O.D.
split penetrometer for the last 300 mm
of test (where thin walled undisturbed
sample tubes are driven in the same
manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 14

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 29/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 12.44

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - dark brown silty sand topsoil	S.L.				
	0.70				
FILLING - red-brown slightly clayey fine sand					
	1.40				
SANDY CLAY - firm to stiff red-brown sandy clay					
	3.70				
SANDY CLAY - stiff red-brown mottled brown and grey sandy clay					
	4.50				
CLAYEY SAND - brown, red-brown and grey mottled clayey sand					
	5.00				
<u>Bore discontinued at 5.00 metres.</u>					

RIG B 40 Ford

DRILLER

Lamb

CASING

-

TYPE OF BORING Flight auger

WATER LEVEL OBSERVATIONS No free ground water boserved

REMARKS

TYPE

- A — auger sample
- S — standard penetration test sample
- U — mm diameter undisturbed sample
- C — continuous diamond core
- V — field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 15

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 29/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL —

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery
FILLING - brown fine and medium grained sand with gravel	S.L. 0.15	CS	S.L.-2.00		%
FILLING - brown fine and medium grained sand	1.20				
SANDY CLAY - very stiff brown very sandy clay - possible filling	2.00				
<u>Bore discontinued at 2.00 metres.</u>					

RIG B40 Ford DRILLER Lamb CASING -
TYPE OF BORING Continuous sampler to 2.00 m
WATER LEVEL OBSERVATIONS No free ground water observed
REMARKS

TYPE	"N" VALUE
A — auger sample	blows of a 63.5 kg hammer falling
S — standard penetration test	760 mm to drive a standard 50 mm O.D.
U — mm diameter undisturbed	split penetrometer for the last 300 mm
sample	of test (where thin walled undisturbed
C — continuous diamond core	sample tubes are driven in the same
V — field vane shear test	manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 16

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 29/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL —

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - brown sand and gravel	S.L.	CS	S.L.- 2.00		100
	0.20				
FILLING - brown fine and medium grained sand	0.45				
FILLING - red-brown and brown mottled sand, becoming clayey below 1.70 m	2.00				
<u>Bore discontinued at 2.00 metres.</u>					

RIG B 40 Ford

DRILLER Lamb

CASING

TYPE OF BORING Continuous sampler to 2.00 m

WATER LEVEL OBSERVATIONS No free ground water observed

REMARKS

TYPE

- A — auger sample
- S — standard penetration test sample
- U — mm diameter undisturbed sample
- C — continuous diamond core
- V — field vane shear test

"N" VALUE

blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 17

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 29/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL —

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - brown fine and medium grained sand with gravel	S.L.				
SANDY CLAY - firm to stiff mottled brown sandy clay	0.40				
	0.60				
CLAY - hard light grey and brown clay		CS	S.L.-2.00		100
	1.60				
SANDY CLAY - very stiff grey gravelly clay	2.00				
Bore discontinued at 2.00 metres					

RIG B 40 Ford

DRILLER Lamb

CASING -

TYPE OF BORING Continuous sampler to 2.00 m

WATER LEVEL OBSERVATIONS No free ground water observed

REMARKS

TYPE
A — auger sample
S — standard penetration test sample
U — mm diameter undisturbed sample
C — continuous diamond core
V — field vane shear test

"N" VALUE
blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 18

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 29/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 13.26

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
FILLING - grey brown sand with clay and gravel	S.L.				
	0.20				
CLAY - firm to stiff light brown mottled grey slightly sandy clay - possible filling					
	0.75	CS	S.L.-1.20		100
CLAY - very stiff to hard grey and red-brown clay					
	1.20				
Bore discontinued at 1.20 metres.					

RIG B 40 Ford

DRILLER Lamb

CASING -

TYPE OF BORING Continuous sampler to 1.20 m

WATER LEVEL OBSERVATIONS No free ground water observed

REMARKS

TYPE
A — auger sample
S — standard penetration test sample
U — mm diameter undisturbed sample
C — continuous diamond core
V — field vane shear test

"N" VALUE
blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 19

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 29/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 13.20

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery
TOPSOIL - brown silty sand	S.L.	CS	S.L.-1.20		%
	0.25				
SANDY CLAY - firm grey brown fine grained very sandy clay - possible filling	0.50				
SANDY CLAY - very stiff to hard grey and brown clay, sandy in parts. Increased ironstone below 0.90 m	1.20				
<u>Bore discontinued at 1.20 metres.</u>					

RIG B 40 Ford

DRILLER Lamb

CASING -

TYPE OF BORING Continuous sampler to 1.20 m

WATER LEVEL OBSERVATIONS No free ground water observed

REMARKS

TYPE
A — auger sample
S — standard penetration test
sample
U — mm diameter undisturbed
sample
C — continuous diamond core
V — field vane shear test

"N" VALUE
blows of a 63.5 kg hammer falling
760 mm to drive a standard 50 mm O.D.
split penetrometer for the last 300 mm
of test (where thin walled undisturbed
sample tubes are driven in the same
manner, the values are shown bracketed).



D.J. Douglas & Partners

TEST BORE REPORT

BORE No. 20

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 29/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 13.00

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	'N' value	Core recovery %
TOPSOIL - dark brown then brown silty sand	S.L.				
	0.30				
SANDY CLAY - hard mottled brown slightly sandy clay	0.75	CS	S.L.-1.20		100
SANDY CLAY - hard grey and red-brown slightly sandy clay with ferruginous nodules	1.20				
<u>Bore discontinued at 1.20 metres.</u>					

RIG B 40 Ford

DRILLER Lamb

CASING -

TYPE OF BORING Continuous sampler to 1.20 m

WATER LEVEL OBSERVATIONS No free ground water observed

REMARKS

TYPE
A — auger sample
S — standard penetration test sample
U — mm diameter undisturbed sample
C — continuous diamond core
V — field vane shear test

"N" VALUE
blows of a 63.5 kg hammer falling 760 mm to drive a standard 50 mm O.D. split penetrometer for the last 300 mm of test (where thin walled undisturbed sample tubes are driven in the same manner, the values are shown bracketed).



D.J. Douglas & Partners

← Ross St.

← Victoria Rd.

O'Connell

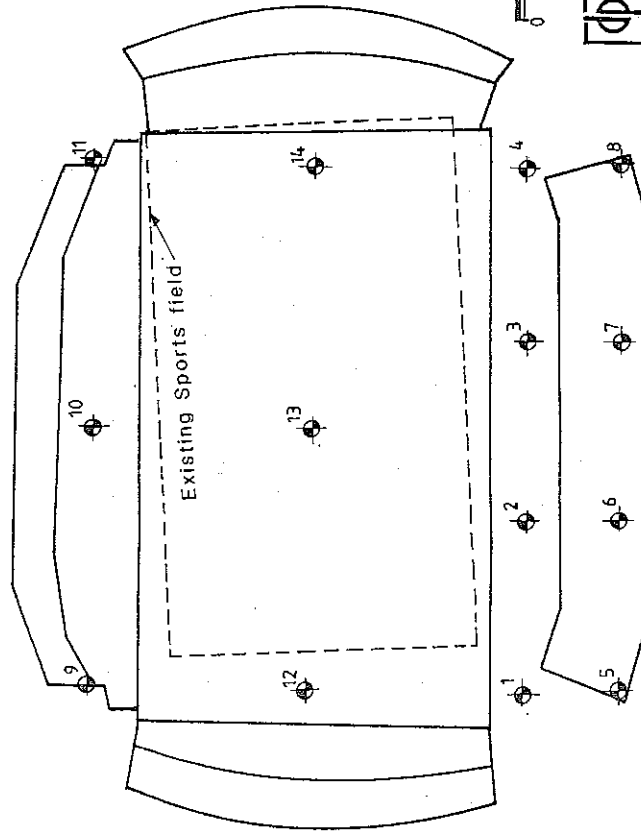
Street

18

19

20

17



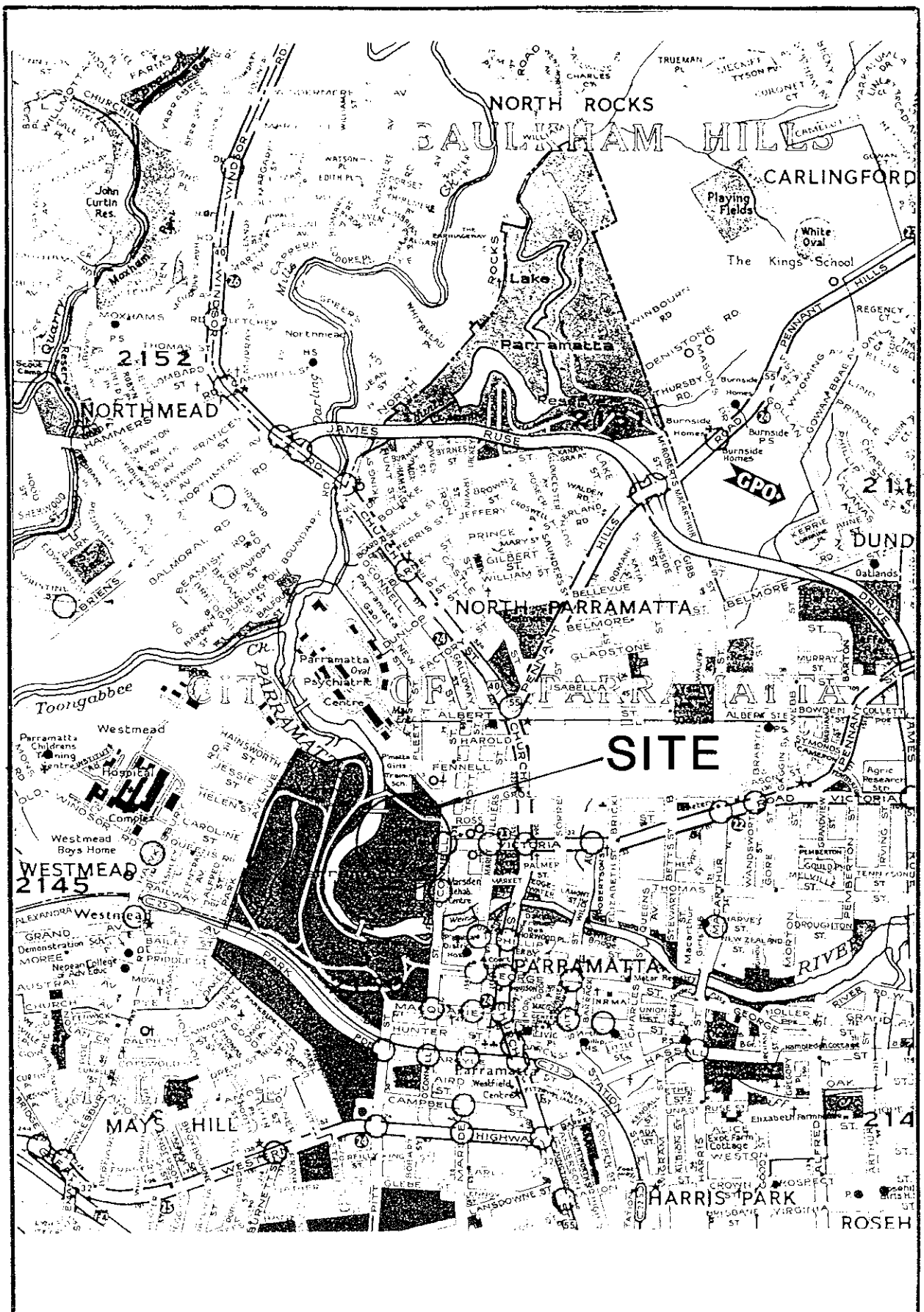
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Parramatta River

CUMBERLAND OVAL REDEVELOPMENT LOCATION OF TEST BORES

Scale As shown

Plan No. 8502/1



CUMBERLAND OVAL REDEVELOPMENT LOCALITY MAP

Plan No. 8502/3



D.J. Douglas & Partners

**REPORT
ON
GEOTECHNICAL INVESTIGATION**

**EXTENSIONS TO PARRAMATTA STADIUM
O'CONNELL STREET, PARRAMATTA**

**Prepared for
HUGHES TRUEMAN PTY LTD**

**Project 8502B
September, 2002**

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MM:BJM:mu

Project 8502B

10 September, 2002

**REPORT ON GEOTECHNICAL INVESTIGATION
EXTENSIONS TO PARRAMATTA STADIUM
O'CONNELL STREET, PARRAMATTA**

1 INTRODUCTION

This report presents the results of a geotechnical investigation carried out at Parramatta Stadium for the proposed extensions at the north and south ends of the existing football field. The work was requested by Hughes Trueman Pty Ltd (HT), structural engineers for the project, on behalf of the Client, Parramatta Stadium Trust.

It is understood that the proposed development will comprise new stands and terraced seating that is similar to the existing stands on the east and west sides of the ground. The supplied architectural drawings by Bligh Voller Nield indicate that a lower tier of terraced seating will be constructed on top of the existing earth mounds at either end of the ground. The HT Brief describes a single tier of seats under a lightweight cantilever roof to be constructed over the podium at the northern end of the ground. The southern stand is to be of similar form, however, a gymnasium and change rooms are to be located below the concourse at approximately the level of the playing field.

The investigation was carried out to provide information on the subsurface conditions for design of foundations, pavements, excavation, batters and retaining structures.

The investigation comprised cone penetration tests and test bores. Details of the field work and subsequent analysis are given in the report together with recommendations on design and construction practice.

Douglas Partners Pty Ltd (DP) have performed several previous geotechnical investigations at the site including that for the original Cumberland Oval Redevelopment in 1984. As part of the current investigation, data from the earlier investigations have been researched and have been incorporated into the current study, where found applicable.

2 BACKGROUND

In July 1984, an investigation was carried out by this Company for the original site development on behalf of the Public Works Department. A total of nineteen test bores were drilled during that investigation, both in and around the stadium. The subsurface conditions encountered comprised generally alluvial clayey sands, sands and sandy clays, mainly in a stiff or medium dense condition, with rock at depths of 9 - 13 m. The natural soils were overlain by filling in parts of the site, which was generally in a relatively loose condition. The water table was encountered at a depth of around 6 - 8 m.

The Cumberland Oval Redevelopment involved lowering the playing surface by up to 4 m, to reduce the visual impact of grandstands around the arena. It is understood that the existing grandstands on the east and west of the arena are supported on enlarged-base Franki type piles, founded at or near the bedrock surface.

In 1991 DP performed a supplementary geotechnical investigation for a proposed Function Centre to be sited on the raised mound at the northern end of the Stadium. The field investigation comprised five electric friction cone (EFC) penetrometer, or cone penetration tests (CPTs). The Function Centre development was subsequently abandoned.

The CPT results from the 1991 investigation and some of the relevant bore information from the 1984 work by DP are presented in Appendix A for reference, and have been used in the preparation of this report.

Although the ground layout of the Stadium has not been altered since the most recent investigation, anecdotal reports indicate that the lower part of the mound at the northern end was partially removed for a concert held in around 1993, to accommodate the stage.

3 SITE DESCRIPTION AND GEOLOGY

The site is located approximately 150 m to the south east of the Parramatta River, within the Parramatta Park precinct. The proposed development areas, at the north and south ends of the football field are currently in the form of grassed mounds rising to about 6 m above the pitch level and about 2 m above the ground level outside the stadium. The mounds rise uniformly from the pitch level at a slope of between 12° and 15° and extend for a distance of approximately 25 m.

Reference to the Penrith 1:100 000 Geological Series Sheet, indicates that the site is located close to the boundary between the Hawkesbury Sandstone Formation and the Ashfield Shale Formation. These rock units are often separated by Mittagong Formation sandstone and it is possible that the rock underlying the site belongs to this formation.

The Hawkesbury Sandstone Formation consists predominantly of medium and coarse grained quartz sandstone. The Mittagong Formation comprises fine to medium grained laminated sandstone and black siltstone. The Ashfield Shale consists of black to dark grey sideritic claystone and siltstone which is slightly carbonaceous at the base.

The investigation carried out in 1984 confirmed the mapping and samples recovered from the bores consisted mainly of Ashfield Shale and Mittagong Formation sandstone. Medium grained sandstone encountered below 12 - 13 m in some of the bores was considered to be Hawkesbury Sandstone.

Experience in the area has indicated that the bedrock is covered by deep alluvial river terrace deposits extending to depths of between 7 m and 14 m.

4 FIELD INVESTIGATION

4.1 Methods

The field investigation comprised five cone penetration tests (CPT101 to CPT105) to depths of between 5 m and 12.0 m. In the cone penetration tests a 35 mm diameter cone is pushed continuously into the soil by hydraulic thrust from a ballasted truck mounted test rig. Continuous measurements are made of the end-bearing pressure on the cone and the friction on a 135 mm long sleeve immediately behind the cone. The cone and friction readings are displayed on a digital monitor and are stored in computer memory for subsequent plotting.

In addition, seven bores were drilled (Bores 106 to 112) from existing ground surface levels using truck mounted auger/rotary drilling equipment. The bores were drilled using a 110 mm spiral flight auger to depths of between 3.5 m and 6.0 m. Identification of the overburden was from auger samples or disturbed samples taken from the standard penetration test (SPT) split spoon, generally at 1.5 m intervals.

The locations of the bores and CPTs are shown in Drawing 1. Bores and CPTs from previous investigations by DP are also shown in Drawing 1.

The reduced level (RL) at the locations of the CPTs and bores was determined using levelling techniques with reference to an RL supplied for Bore 109 (RL +13.61 mAHd) by consulting surveyors, Degotardi, Smith & Partners.

4.2 Results

Details of the conditions encountered in the bores and cone penetration tests (CPTs) are given in the report sheets in Appendix B. Also included with the results are notes which define the terms used to classify the strata and the methods of interpretation.

The general subsurface profile encountered at the northern mound is characterised by between 1 m and 2 m of very stiff or hard clay filling, overlying interbedded very stiff alluvial clay and medium dense alluvial sand. Numerous pipes and services trenches transect the northern mound, typically founded at between 1 m to 2 m depth. CPT104 and CPT105

indicate the presence of some layers of cemented, hard clays and very dense sands below 4 m depth. The profile described above is generally consistent with that of the 1991 investigation by DP for the abandoned Function Centre at the top of the mound. The 1991 investigation noted groundwater inflows to the CPT holes at depths of 7.8 m to 8.3 m (i.e. approximately RL +6 m).

Based on the current investigation data the subsurface profile at the southern mound is generally similar to that at the northern end of the arena. The filling however, was only encountered towards the upper half of the mound and at CPT103, in the middle of the mound. The filling comprised variably compacted clayey sand and clay soil of up to 2 m depth. Bores 106 to 108, located towards the lower part of the slope encountered very stiff and hard alluvial silty clay over the upper 2 m. Below the upper 2 m, the bores and CPTs generally indicated the presence of an interbedded sequence of alluvial clays of a stiff to hard consistency and sands in a medium dense to very dense condition. Again some localised cementation of the sands and clays was evident below about 4 m depth. Weathered bedrock was interpreted from the CPT results at 10.6 m depth at CPT102.

Bore 109 located approximately 20 m to the south of the Stadium encountered 2.8 m of variable and poorly compacted filling, overlying firm alluvial silty clay.

Groundwater was observed in some of the open bore/CPT holes at the completion of the drilling/penetration. At CPT102, free groundwater was recorded at 8.4 m depth (RL +5.7 m) and at Bore 108 groundwater was noted at 5.1 m depth (RL +5.4 m). A standpipe piezometer was installed in Bore 108 to a depth of 6.0 m, with the lower 3 m screened and slotted. The groundwater level was measured at Bore 108 on 9 September 2002 at 4.8 m depth (RL +5.7 m AHD).

5 LABORATORY TESTING

Laboratory soil testing comprised three Atterberg limit tests and two Shrink-Swell Index (Iss) tests on selected bore samples. The results of the tests are presented in Appendix C and are summarised in Table 1.

Table 1 - Summary of Laboratory Test Results

Bore	Sample Depth	Description	Iss (%)	FMC ⁽¹⁾ (%)	W _L ⁽²⁾ (%)	W _p ⁽³⁾ (%)	I _p ⁽⁴⁾ (%)
BH106	1.0 - 1.35	Sandy silty CLAY; very stiff, red brown mottled grey, with some gravel	1.5	17.4	-	-	-
BH108	1.0 - 1.35	Sandy silty CLAY; hard, low to medium plasticity, red brown mottled grey, with some gravel	-	15.9	34	20	14
BH110	0.8 - 1.15	Sandy silty CLAY; very stiff, low to medium plasticity, red brown mottled grey, with some gravel	1.1	18.9	28	17	11
BH110	1.5 - 1.95	Sandy silty CLAY; stiff to very stiff, low to medium plasticity, red brown mottled grey, with some gravel	-	17.5	36	19	17

⁽¹⁾ FMC = Field Moisture Content

⁽²⁾ W_L = Liquid Limit

⁽³⁾ W_p = Plastic Limit

⁽⁴⁾ I_p = Plasticity Index

6 PROPOSED DEVELOPMENT

It is understood that the proposed development will consist of the construction of new stands and terraced seating at the north and south ends of the existing oval, of similar form to the existing stands and seating on the east and western sides of the ground.

At the northern end, the structures consist of a concourse at ground level leading to terraced seating constructed on top of the existing earth mounds. A single tier of seats with a lightweight cantilever roof is to be constructed over the podium.

The southern stand is to be of similar form, however, a gymnasium and players change rooms are to be located below the concourse at approximately the level of the playing field. Maximum excavation depths for the gymnasium and change rooms are expected to be between 5 m to 6 m as shown in Drawing 2. Retaining walls are expected to be required at the front and back of the basement excavation for the gym and change rooms, with battered excavations shown on the east and west sides of the basement.

An access ramp will rise from the basement level gymnasium to the playing fields behind the southern mound and it is expected that retaining walls will be required to form the tunnel.

Some roadworks and paving are indicated although the extent is not indicated on the supplied drawings or HT Brief.

Advice from HT (facsimile 29/8/02) is such that the maximum (working) column load will be limited to 2500 kN. It is expected that this would coincide with the main support columns for the new grandstand at the southern end of the arena.

7 GEOLOGICAL MODEL FOR SOUTH STAND

Based on the proposed extent of bulk earthworks at the southern mound an interpreted geological cross-section is presented in Drawing 2. The orientation of Cross-Section A-A is shown on the location plan (Drawing 1). The cross-section indicates the likely materials to be excavated and retained, together with the founding stratum available at and below the proposed bulk excavation level (BEL).

8 COMMENTS

8.1 Site Preparation and Earthworks

Based on the available bore and CPT data, the filling and natural soils forming the existing mounds at the north and south ends of the ground are generally in a moderately compacted, very stiff condition. Consequently, the new lower tier of terraced seating, at the north and south ends should be able to be supported on high level footings (e.g. pads or strip footings), without the need for major excavation or pile foundations. Also, the 1991 and current CPT results at the top of the northern mound indicate that the filling should be adequate for the support of slab on ground construction to form the proposed concourse.

Site preparation at the northern mound should involve stripping of all vegetation and topsoil, estimated to be 100 - 150 mm thick, from the proposed building areas. The exposed surface should then be proof rolled with at least six passes of a minimum 10 tonne smooth-drum roller, under the surveillance and inspection of an experienced geotechnical professional.

Any soft or compressible zones encountered should be locally excavated and replaced with granular material compacted in layers to a minimum 100% standard dry density ratio (DDR).

The proposed excavation depths of up to 5 - 6 m at the southern mound should expose a combination of very stiff to hard alluvial clays and medium dense clayey sands. It is expected that the exposed soils will be moderately sensitive to softening and poor trafficability if subjected to wet weather. It is therefore recommended that a blinding layer of crushed rock or concrete of at least 100 mm thickness be placed immediately after exposure to seal the soils at the BEL. The blinding layer may be sacrificial or permanent such that it is incorporated within the floor slab design.

Similar comments on protecting the exposed subgrade materials apply to the clayey filling likely to be exposed beneath the concourse at the northern mound.

Excavation for the gymnasium construction is expected to be within surface filling, and alluvium consisting of clayey and silty sands and sandy and silty clays down to the proposed bulk excavation level (BEL), as shown in Drawing 2. It is considered that these materials should be readily excavated using conventional earthmoving equipment, such as medium sized dozers and hydraulic excavators. Some of the cemented layers of soil may require light ripping to break up.

Based on the current and previous field investigations, substantial groundwater inflows to proposed excavations are not anticipated. With groundwater levels indicated to be below RL +5 to +6 m(AHD) the incidence of groundwater inflows to basements is not expected, either as a short term problem during construction or as a long term design issue. This comment does not apply to open pile excavations if required, as described in Section 8.4.3.

Given the presence of sand layers within the southern mound, minor seepage inflows are expected into the basement excavation, particularly after heavy rainfall. During construction normal sump-and-pump methods are expected to be adequate to dewater the basement excavation. For the longer term, subsurface drainage is recommended along the toe of the cuts to a depth of about 1 m, with wall drains constructed behind the base of retaining walls.

The excavated soils from both mounds comprise mixed sands and clays, which could provide good quality general purpose fill elsewhere subject to validation testing. No such

testing has been performed as a part of the present commission. Although no extraneous materials were noted in the filling at the bore locations, NSW EPA requirements dictate that waste facilities receiving any material from excavation works require a Waste Classification Assessment. Depending on the destination of the excavated material it may be necessary to carry out chemical analyses and a Waste Classification Assessment.

8.2 Temporary and Permanent Unsupported Batters

The likely range of materials expected for the basement excavation at the southern mound are indicated on the bores and CPTs. Also, the interpreted geological cross-section (A-A) shows diagrammatically the typical materials expected to remain unsupported in the form of excavation batters.

Where there are no space limitations, batters could be used in the short and the long term. The following maximum batter slopes are suggested in Table 2.

Table 2 - Recommended Maximum Batter Slopes

Material	Height (m)	Safe Batter Slope (H:V)	
		Short Term Temporary	Long Term Permanent
Filling, clayey sand	<3m	1.5:1	2:1
Stiff clay	<2m	1:1	1.5:1
	2-3m	1.5:1	1.75:1
Very stiff to hard clay	<2m	0.75:1	1.25:1
	2-4m	1:1	1.75:1

Permanent batter slopes in soils will generally require protection in the form of vegetation or reinforced shotcrete if they are to remain exposed or are subjected to concentrated water flows.

8.3 Retaining Structures

The overburden materials in the area around the excavation for the gymnasium will require both temporary and permanent lateral support during excavation and as part of the final

construction. The investigation findings suggest that shoring will be required for the full depth of the excavation.

Retaining structures will be required as part of the final structure, and may be used to temporarily support the excavation during the excavation and construction phase. It is anticipated that any retaining walls may be designed as "active" walls that are capable of some small amount of lateral (inward) movement during construction, until they are propped by the final structure.

The use of a temporary sheetpile, Geocast or a soldier pile system with shotcrete panels could be employed to form the basement. The soldiers could be conventional bored or CFA piers founded above the water table, with infill panels consisting of sprayed concrete. The first panel excavated should not exceed 1.5 m with subsequent panels not exceeding 2.5 m in height. Typical spacing for soldier piles of up to 2.5 m can be used depending on founding conditions.

It is suggested that the design of cantilevered or retaining walls with a single row of tieback anchors be based upon an average bulk unit weight of 20 kN/m³ for soil, with a triangular earth pressure distribution based on lateral earth pressure coefficient as follows:

Table 3 - Recommended Earth Pressure Coefficients

Material Type	Lateral Earth Pressure Coefficient (K_a)	
	Temporary Support	Permanent Support
Filling	0.35	0.4
Alluvium (stiff clay/medium dense sand)	0.3	0.35

The horizontal pressures acting on the wall can be calculated based on the following formula:

$$\sigma_z = K z \gamma$$

Where, σ_z = Horizontal pressure at depth z
 K = Earth pressure coefficient
 z = Depth (m)
 γ = Unit weight of soil

Additional pressure should be allowed for where surcharging occurs either from existing footings, traffic or other loads. Unless positive drainage measures can be incorporated to

prevent water pressure build up behind the walls, full hydrostatic head should be allowed for in design, but with the soil density then reduced to the buoyant condition.

Drainage is normally provided behind shotcrete walls. The sprayed concrete wall should provide adequate structural support, however it may be appropriate to install a false wall (single brickwork or block work) for aesthetic purposes and to avoid dampness.

8.4 Foundations

8.4.1 Site Classification

Although the proposed development is generally outside the scope of AS2870 - Residential Slabs and Footings, classification of the site provides a useful categorisation of expected soil behaviour in response to seasonal moisture variation. This information may be useful to the designer to assess minimum embedment depths for high level footings, together with appropriate levels of articulation and site maintenance (e.g. paving, vegetation) and drainage requirements.

Based on the depth of apparently uncontrolled filling encountered (>0.4 m) both mounds would be classified as "Class P" sites. The results of the I_{ss} and Atterberg limits tests confirm that the upper alluvial clay and filling is likely to behave as a low to moderately reactive material. In other words the site soils are expected to exhibit a low to moderate potential for volume change in response to soil moisture variation. It is noted that soil moisture variation can be caused by things other than seasonal changes, such as broken or blocked service or irrigation lines, trees, excavation or other factors.

Based on the limited amount of testing conducted it is considered prudent that any high level foundations (e.g. pads) at this site be designed to accommodate "Class M" (Moderately Reactive) movements (i.e. free surface movement (y_s) = 20 mm to 40 mm).

8.4.2 High Level Footings

Excavation for the basement at the southern mound should generally expose very stiff to hard clays or, sands in at least a medium dense condition. Alluvial soils in a similar condition were typically encountered directly below the topsoil at the lower half of the southern mound.

Only CPT103 found filling (to 1.4 m depth) over the footprint of the proposed lower tier of terraced seating. At the northern mound however, generally very stiff filling to depths of 1.0 m to 1.3 m was noted at the bores located at the proposed terraced seating. On the top of the northern mound, previous and current investigations both indicate the presence of about 2 m of filling, which appears to be at least moderately compacted.

Based on the field work results it will be possible to support column (working) loads of up to about 1000 kN with high level footings (e.g. pads, strips). They may still be suitable for heavier loadings but footings may become overly large and/or settlement may become unacceptable.

Strip footings founded on at least very stiff clay or medium dense sand at a depth of 1 m may be proportioned on the basis of a maximum allowable bearing pressure of 200 kPa. Pad footings founded similarly may be proportioned for a maximum allowable bearing pressure of 250 kPa. For typical loadings of the order of 1000 kN, total settlements are estimated to be generally less than 15 mm and differential settlements between adjacent new columns generally less than 10 mm.

The existing terraced seating has been in place for over ten years and is understood to be supported on piles, such that differential movements between new and old areas of terraced seating could be as high as the total settlements indicated above, depending on the actual loading and soil profile in the area in question.

Considering that the depth of filling noted in Bores 110 to 112 was between 1.0 m and 1.3 m, practicality would dictate that the footings for the terraced seating at the northern mound be taken down to the alluvium. Due to the inherent variability of filling and to a lesser extent alluvium, it is recommended that every footing be subjected to proving by dynamic penetrometer testing (DPT).

All footing excavations should remain open for a maximum of 12 hours to avoid softening of the exposed soils. Alternatively, a blinding layer of concrete may be placed to seal and protect the materials at the base of the footing.

8.4.3 Pile Foundations

For loads of over 1000 kN or for where uplift loads dictate, it may be necessary to adopt pile foundations. With the inferred groundwater table at approximately RL +5 to +6 m uncased bored pile types are generally not considered suitable due to the expected caving conditions and need for major dewatering or underwater (tremie) concrete placement.

Suitable pile types may be grout or concrete injected (CFA) piles founded within the underlying bedrock, or driven precast concrete, or steel joists piles, subject to noise and vibration concerns. The choice between alternative systems will depend on relative cost and suitability in relation to the proposed construction.

Continuous flight auger (CFA) grout or concrete injected piles should be taken to refusal on at least medium strength rock using a rig with at least 18 tonne.metre torque capacity. CFA piles may be proportioned on the basis of allowable design parameters shown in Table 4.

Table 4 - Recommended Maximum Allowable Parameters for CFA Piles

Material	Allowable Pressure (kPa)	
	End Bearing	Shaft Adhesion
Very stiff clay/medium dense sand	-	25
Very low to low strength rock	1000	100
Medium strength rock	3500	350
Medium to high strength rock	6000	- ⁽¹⁾

⁽¹⁾ - Penetration into this stratum not expected

By way of example, a 600 mm diameter CFA pile founded 2 m into medium strength rock, with a minimum 7 m length in very stiff clay overburden would safely carry a working load of 2500 kN.

The settlement of such rock socketed piles would be expected to be less than 1% of the pile diameter (e.g. 6 mm for the above example), with differential settlement between adjacent (new) columns of not more than half of this value.

Design for uplift or tension loads for CFA piles may be based on 70% of the shaft adhesion values shown above.

The use of precast concrete piles driven to refusal on rock or to refusal within the very dense (or cemented) sand layers encountered may provide a suitable foundation. Where piles achieve practical refusal, the pile capacity should be determined on the basis of a pile driving analysis (PDA) and subsequent wave equation analysis using software such as CAPWAP, or by use of a dynamic formula (e.g. Hiley) with an appropriate factor of safety. By way of example a 350 mm square precast pile that has met practical refusal on rock would have a working load capacity of between 1500 kN and 2000 kN at this site. Higher capacities of up to 3000 kN/pile would be possible for steel joists (H-sections) driven into medium strength rock.

The bearing capacity of piles can be influenced by the presence of weak layers at, or just below the pile founding level and in general, a minimum clearance of 4 - 5 pile diameters should be maintained above a weak layer within the founding strata in order that the full end bearing capacity can be mobilised.

The use of CFA piling techniques will generally necessitate further cored bore drilling ahead of construction to determine bedrock levels and the quality of the upper 4 - 5 m of rock. This is because CFA piling is a "blind" piling technique where progressive inspection of cuttings cannot generally be undertaken by the geotechnical engineer.

CPT102 indicated the presence of weathered rock at 10.6 m (RL +3.5 m) in the vicinity of the main columns for the southern stand. However, CPT101 on the opposite (i.e. eastern) side of the proposed basement did not encounter bedrock within the 12 m depth of investigation (i.e. rock is below RL +1.4 m). Given the variability in bedrock depths indicated by previous and current investigations it would be prudent to carry out further drilling, or CPT testing regardless of the pile type adopted to define expected pile depths.

8.5 Ground Slabs and Pavements

Provided the subgrade surface is proof rolled to detect any soft or compressible layers which should be replaced with granular material compacted in layers, pavements could be designed using a CBR of 5% for the subgrade compacted to 100% standard density ratio.

Based on the laboratory test results and experience with similar materials external flexible pavements for vehicle access could be designed based on a California bearing ratio (CBR) of 5%. For the design of concrete pavements, the modulus of subgrade reaction is estimated to be 30 - 50 kPa/mm. These parameters assume the provision of adequate surface and subsoil drainage to all pavement areas. Subsoil drainage, to a depth of 1 m below subgrade level is recommended along the high side of all pavement areas, to prevent the subgrade becoming over wet and losing strength.

For the design of concrete floor slabs to support column and floor slab loadings, a modulus of subgrade reaction in the order of 5 - 10 kPa is recommended, but will be dependent on the area of the floor slab subject to loading.

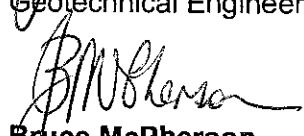
The subgrade surface of all pavement areas (and for where ground slabs are supported on filling as described in Section 8.1) should be subject to proof rolling as outlined previously. Any soft or compressible areas should be excavated to a depth of 600 mm and replaced with granular material compacted to 98% standard DDR.

8.6 Earthquake Factor

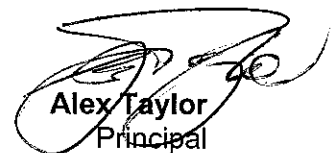
Based on the subsurface conditions encountered at the test locations, it is recommended that a Site Factor of 1.0 be adopted for design of structures at this site, in accordance with AS 1170.4 (Minimum Design Loads on Structures: Part 4 – Earthquake Loads). Further, an Acceleration Coefficient of 0.08 is prescribed for Sydney by AS 1170.4.

DOUGLAS PARTNERS PTY LTD


Mariette Marais
Geotechnical Engineer


Bruce McPherson
Senior Associate

Reviewed by


Alex Taylor
Principal

APPENDIX A
Results from Previous Investigation

TEST BORE REPORT

BORE No. 14

CLIENT DEPARTMENT OF PUBLIC WORKS
SITE CUMBERLAND OVAL
LOCATION O'CONNELL STREET, PARRAMATTA

DATE 29/6/84
CONTRACT No. SSI/8502
SURFACE LEVEL R.L. 12.44

Description of Strata	Depth metres	Sampling and in-situ Testing			
		Type	Depth	N' value	Core recovery %
FILLING - dark brown silty sand topsoil	S.L.				
	0.70				
FILLING - red-brown slightly clayey fine sand					
	1.40				
SANDY CLAY - firm to stiff red-brown sandy clay					
	3.70				
SANDY CLAY - stiff red-brown mottled brown and grey sandy clay					
	4.50				
CLAYEY SAND - brown, red-brown and grey mottled clayey sand					
	5.00				
<u>Bore discontinued at 5.00 metres.</u>					

RIG B 40 Ford DRILLER Lamb CASING -
TYPE OF BORING Flight auger
WATER LEVEL OBSERVATIONS No free ground water boserved
REMARKS

TYPE
A — auger sample
S — standard penetration test
sample
U — mm diameter undisturbed
sample
C — continuous diamond core
sample

"N" VALUE
blows of a 63.5 kg hammer falling
760 mm to drive a standard 50 mm O.D.
split penetrometer for the last 300 mm
of test (where thin walled undisturbed
sample tubes are driven in the same
manner, the values are shown bracketed).



D.J. Douglas & Partners

APPENDIX B
Field Work Results

CONE PENETRATION TEST

CLIENT: HUGHES TRUEMAN P/L FOR PARRAMATTA STADIUM TRUST

PROJECT: EXTENSIONS TO PARRAMATTA STADIUM

LOCATION: O'CONNELL STREET, PARRAMATTA

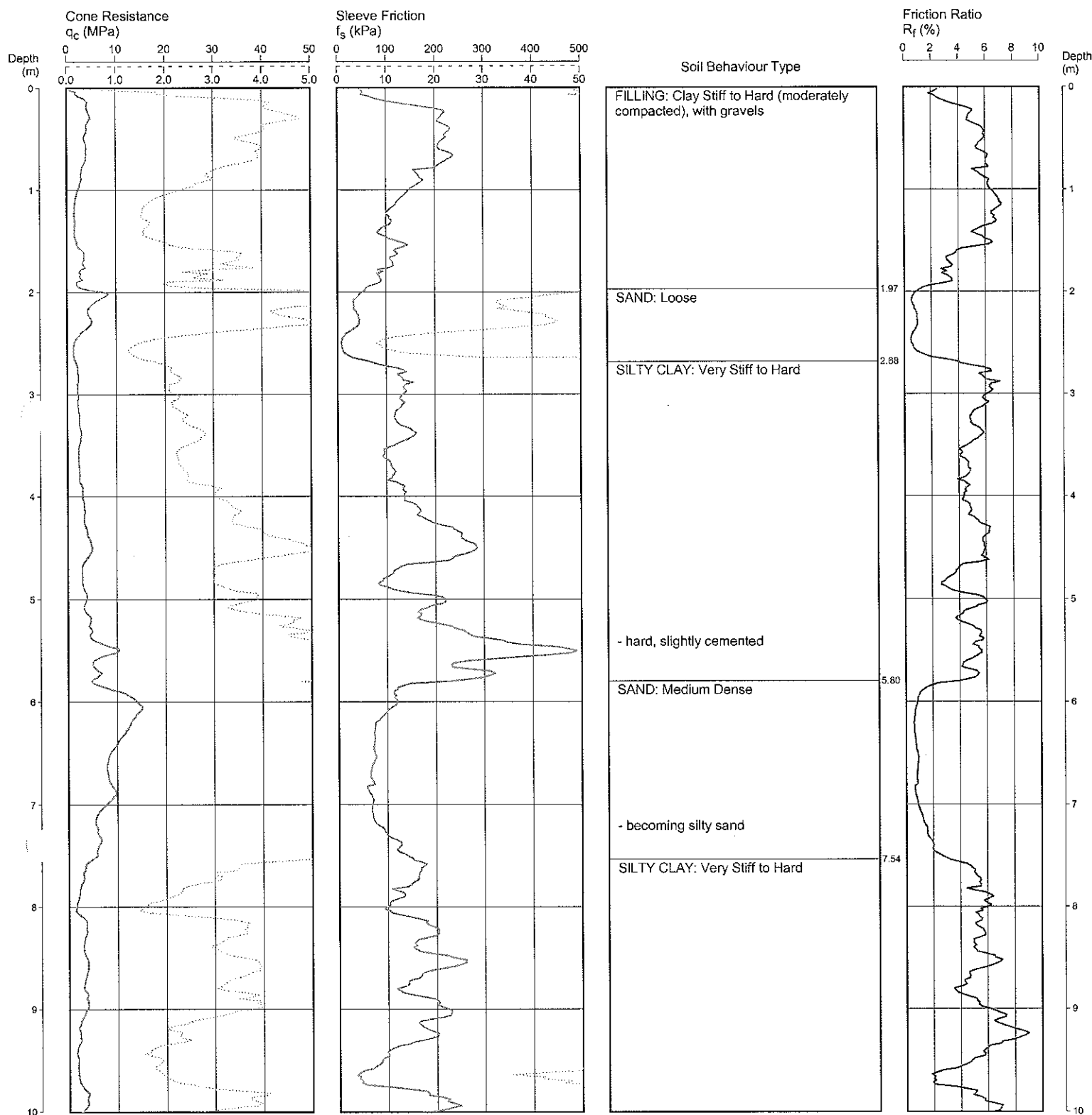
PROJECT No: 8502B

101

Page 1 of 2

DATE 8/6/02

SURFACE RL: 13.4 AHD*



REMARKS: *SURFACE LEVELS BASED ON SUPPLIED RL FOR BORE 109 FROM DEGOTARDI, SMITH & PARTNERS

Date 28/8/02
Plotted MM
Checked BTM

File: A:\8502b\101.CP5
Cone ID: CONE-204 Type: 2 Standard

ConePlot Version 5.2.4
© 2001 Douglas Partners Pty Ltd



Douglas Partners
Geotechnics • Environment • Groundwater

CONE PENETRATION TEST

CLIENT: HUGHES TRUEMAN P/L FOR PARRAMATTA STADIUM TRUST

PROJECT: EXTENSIONS TO PARRAMATTA STADIUM

LOCATION: O'CONNELL STREET, PARRAMATTA

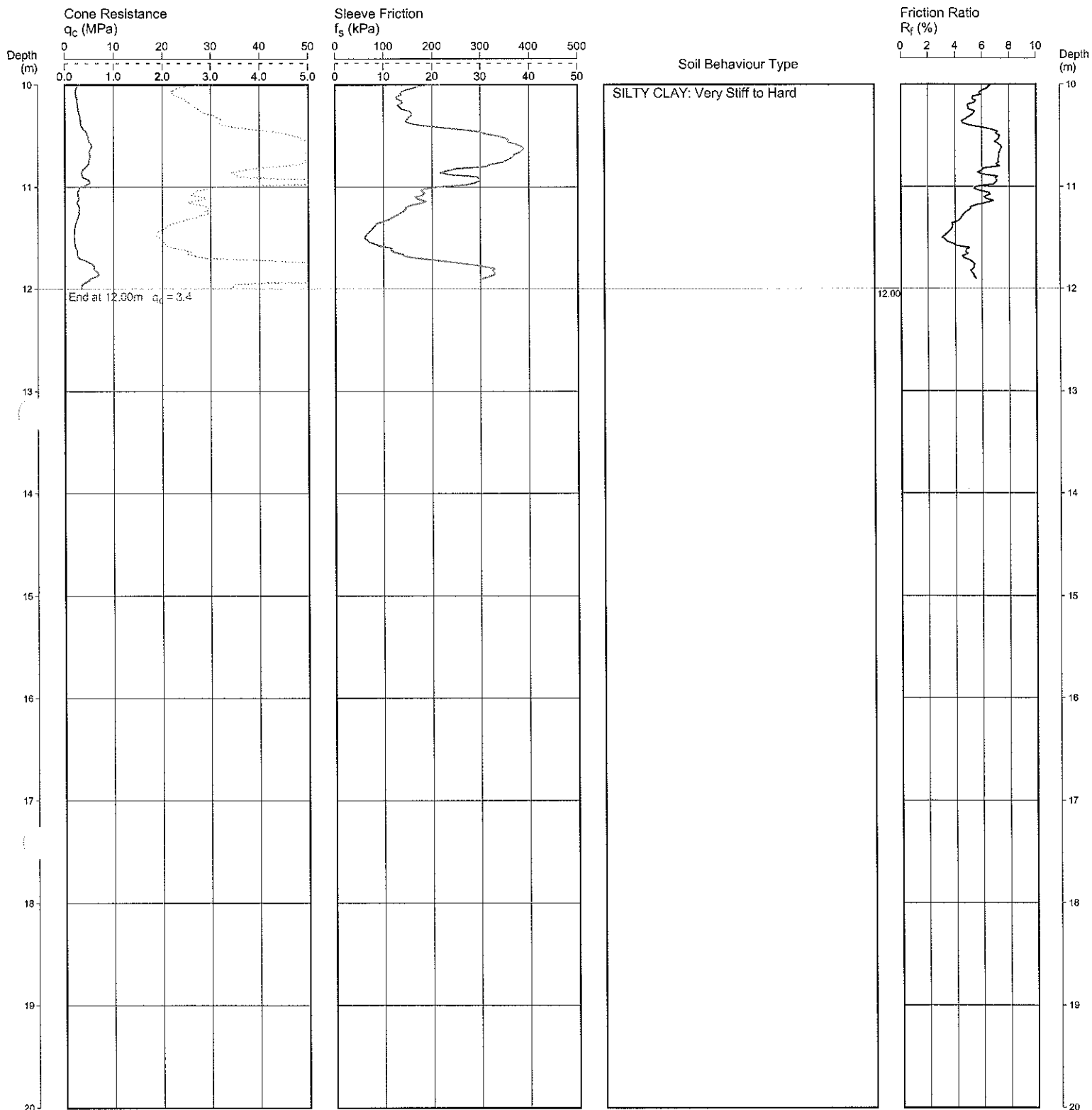
PROJECT No: 8502B

101

Page 2 of 2

DATE 6/6/02

SURFACE RL: 13.4 AHD*



REMARKS: *SURFACE LEVELS BASED ON SUPPLIED RL FOR BORE 109 FROM DEGOTARDI, SMITH & PARTNERS

Date 23/8/02
Plotted MM
Checked JM

File: A\8502b101.CP5
Cone ID: CONE-204 Type: 2 Standard

ConePlot Version 5.2.4
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CONE PENETRATION TEST

CLIENT: HUGHES TRUEMAN P/L FOR PARRAMATTA STADIUM TRUST

PROJECT: EXTENSIONS TO PARAMATTA STADIUM

LOCATION: O'CONNELL STREET, PARRAMATTA

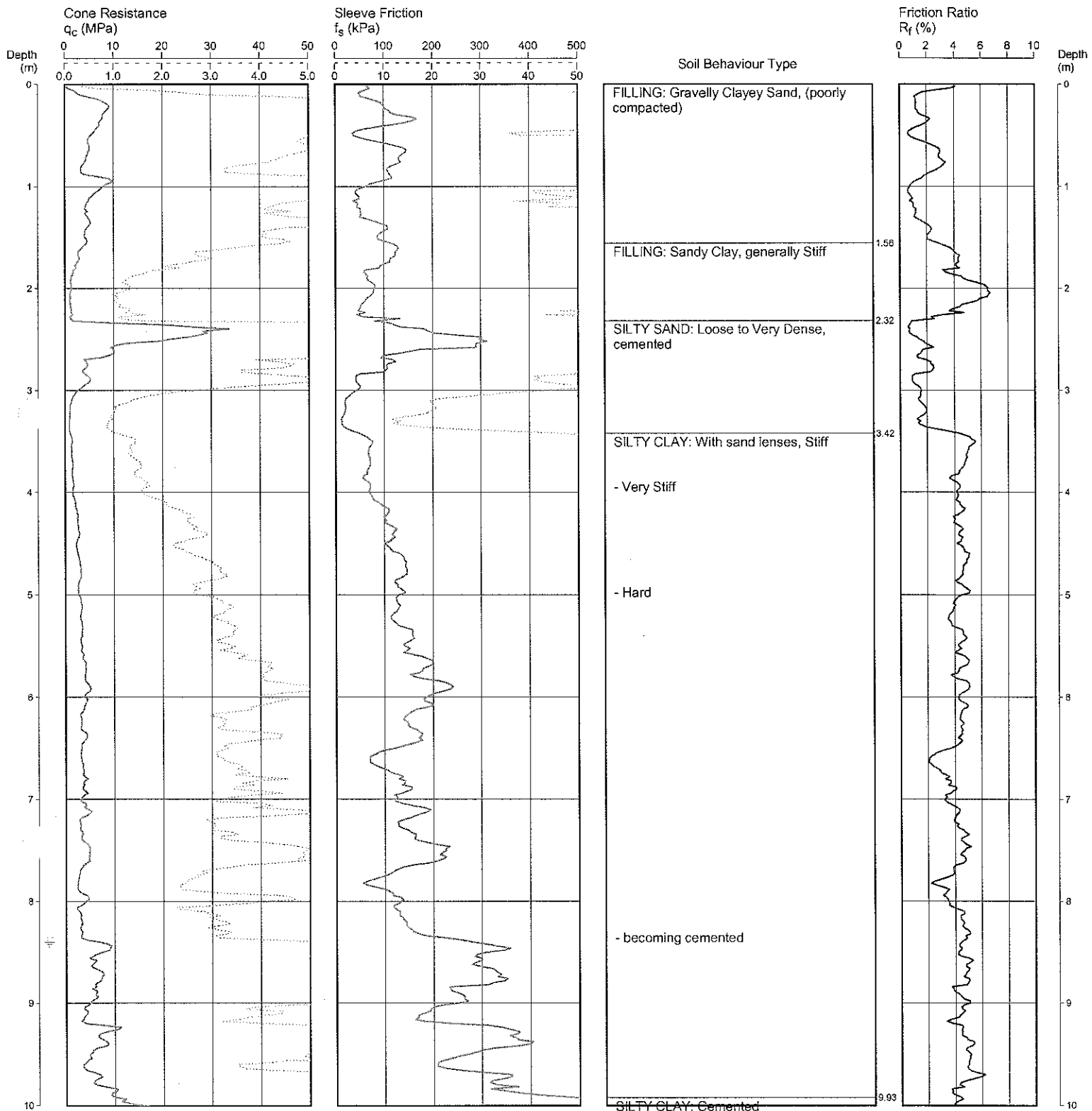
PROJECT No: 8502B

CPT 102

Page 1 of 2

DATE 6 August, 2002

SURFACE RL: 14.1 AHD*



REMARKS: WATER LEVEL AT END OF TEST: 8.4 m
* SURFACE LEVELS BASED ON SUPPLIED RL FOR BORE 109 FROM DEGOTARDI, SMITH & PARTNERS

Date 28-8-02
Plotted MM
Checked BJM

File: A:\8502b\102.CP5
Cone ID: CONE-204 Type: 2 Standard
ConePlot Version 5.2.4
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CONE PENETRATION TEST

CLIENT: HUGHES TRUEMAN P/L FOR PARRAMATTA STADIUM TRUST

PROJECT: EXTENSIONS TO PARAMATTA STADIUM

LOCATION: O'CONNELL STREET, PARRAMATTA

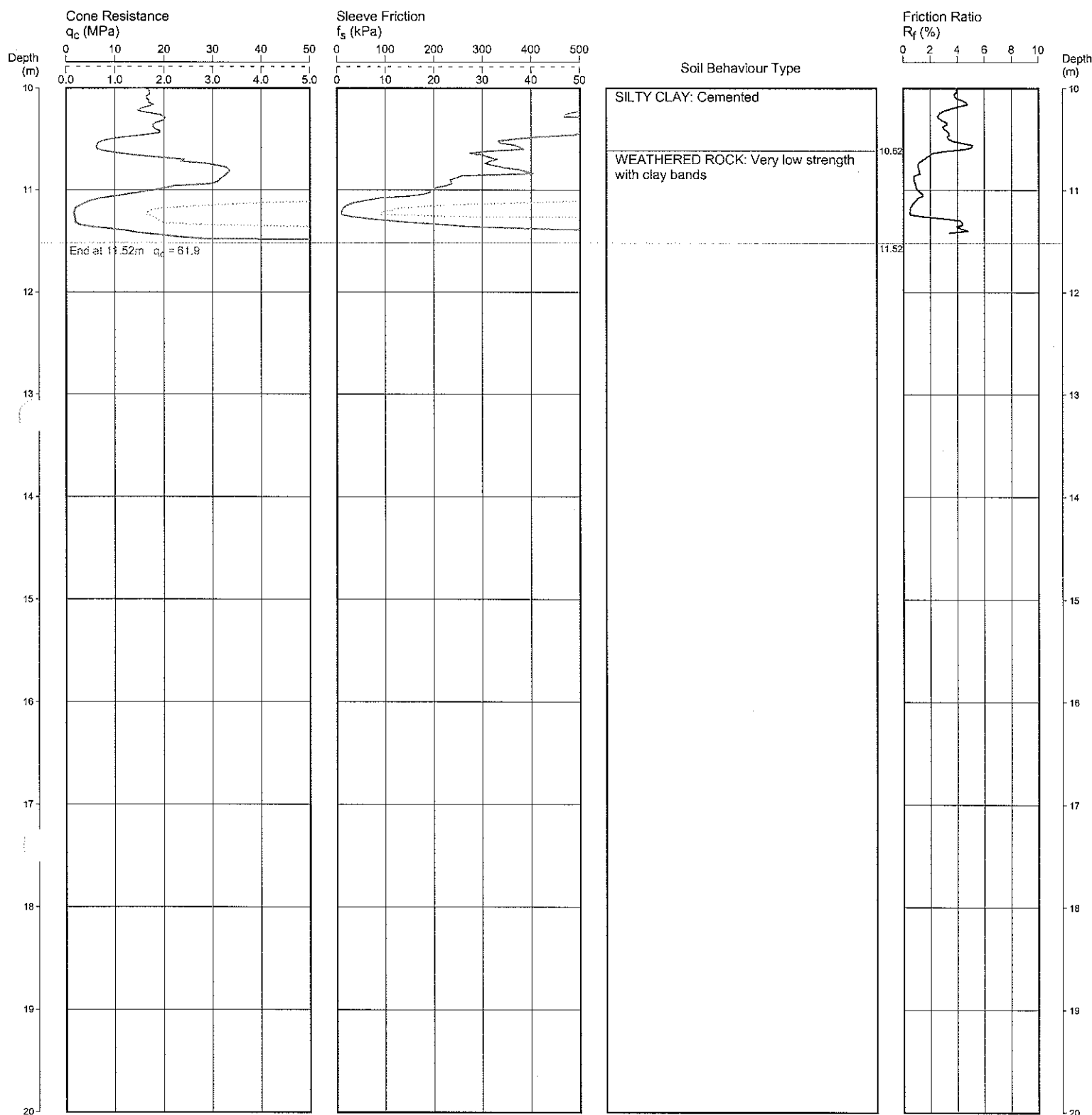
PROJECT No: 8502B

CPT 102

Page 2 of 2

DATE 6 August, 2002

SURFACE RL: 14.1 AHD*



REMARKS: WATER LEVEL AT END OF TEST: 8.4 m
* SURFACE LEVELS BASED ON SUPPLIED RL FOR BORE 109 FROM DEGOTARDI, SMITH & PARTNERS

Date **28-8-02**
Plotted **MM**
Checked **BTM**

File: A:8502b102.CP5
Cone ID: CONE-204 Type: 2 Standard
ConePlot Version 5.2.4
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CONE PENETRATION TEST

CLIENT: HUGHES TRUEMAN P/L FOR PARRAMATTA STADIUM TRUST

PROJECT: EXTENSIONS TO PARAMATTA STADIUM

LOCATION: O'CONNELL STREET, PARRAMATTA

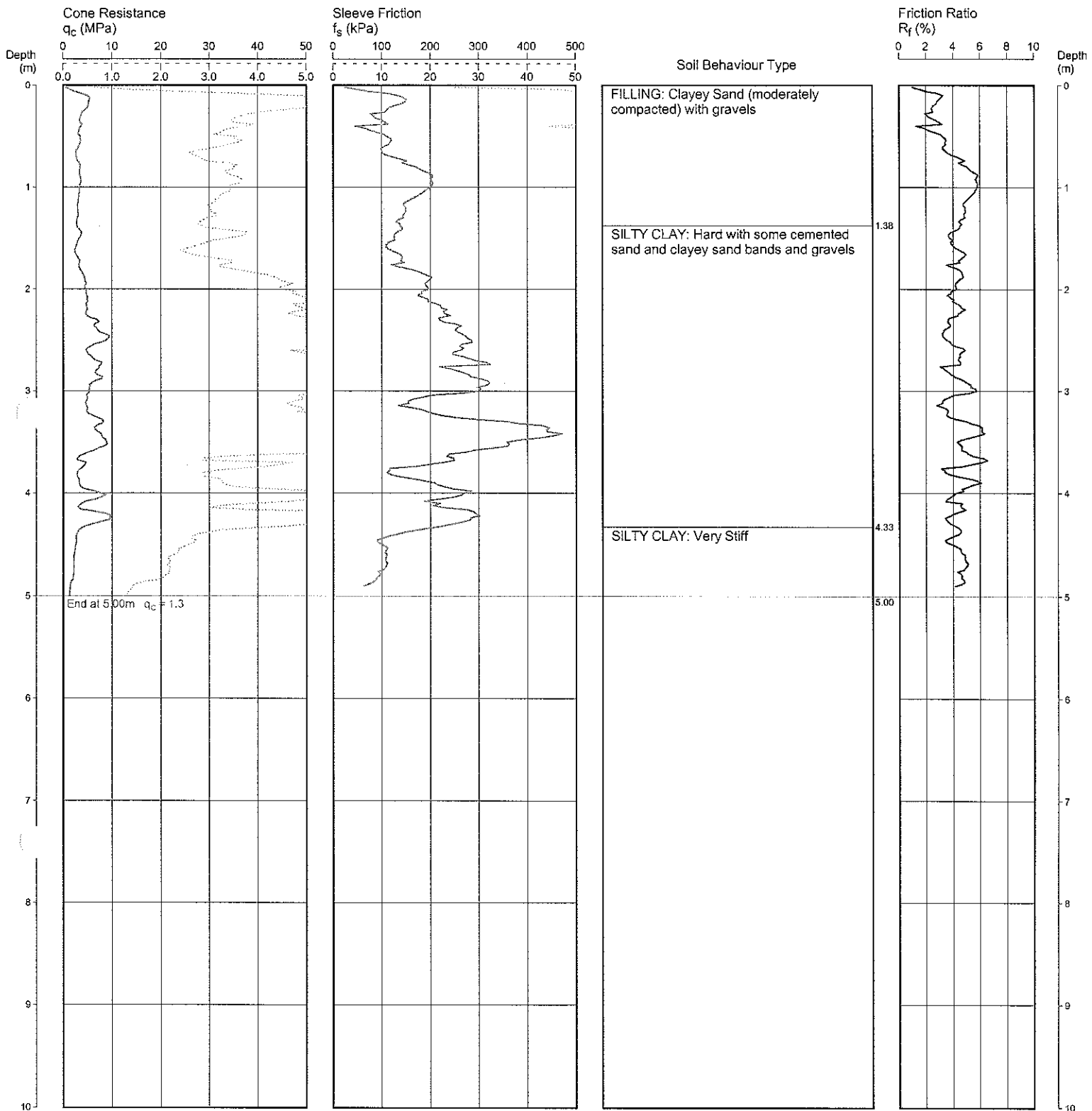
PROJECT No: 8502B

CPT 103

Page 1 of 1

DATE 6 August, 2002

SURFACE RL: 10.1 AHD*



REMARKS: NO FREE GROUND WATER OBSERVED

* SURFACE LEVELS BASED ON SUPPLIED RL FOR BORE 109 FROM DEGOTARDI, SMITH & PARTNERS

Date 28-8-02
Plotted MM
Checked BTM

File: A:\8502b\103.CP5
Cone ID: CONE-204 Type: 2 Standard
ConePlot Version 5.2.4
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CONE PENETRATION TEST

CLIENT: HUGHES TRUEMAN P/L FOR PARRAMATTA STADIUM TRUST

PROJECT: EXTENSIONS TO PARAMATTA STADIUM

LOCATION: O'CONNELL STREET, PARRAMATTA

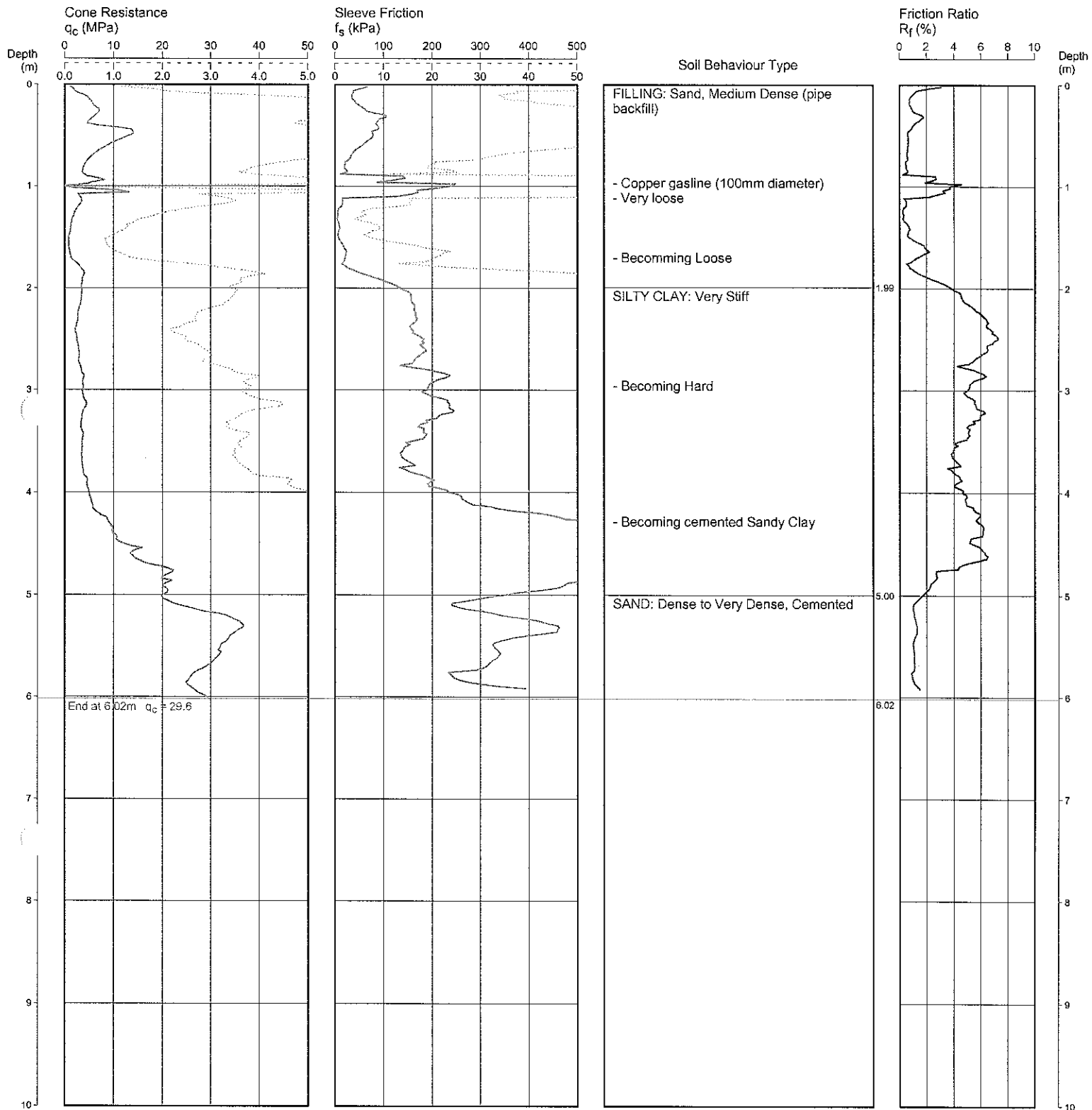
PROJECT No: 8502B

CPT 104

Page 1 of 1

DATE 6 August, 2002

SURFACE RL: 12.9 AHD*



REMARKS: NO FREE GROUND WATER OBSERVED

*SURFACE LEVELS BASED ON SUPPLIED RL FOR BORE 109 FROM DEGOTARDI, SMITH & PARTNERS

Date 28-8-02
Plotted MM
Checked BJM

File: A:\8502b\104.CP5
Cone ID: CONE-204 Type: 2 Standard
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CONE PENETRATION TEST

CLIENT: HUGHES TRUEMAN P/L FOR PARRAMATTA STADIUM TRUST

PROJECT: EXTENSIONS TO PARAMATTA STADIUM

LOCATION: O'CONNELL STREET, PARRAMATTA

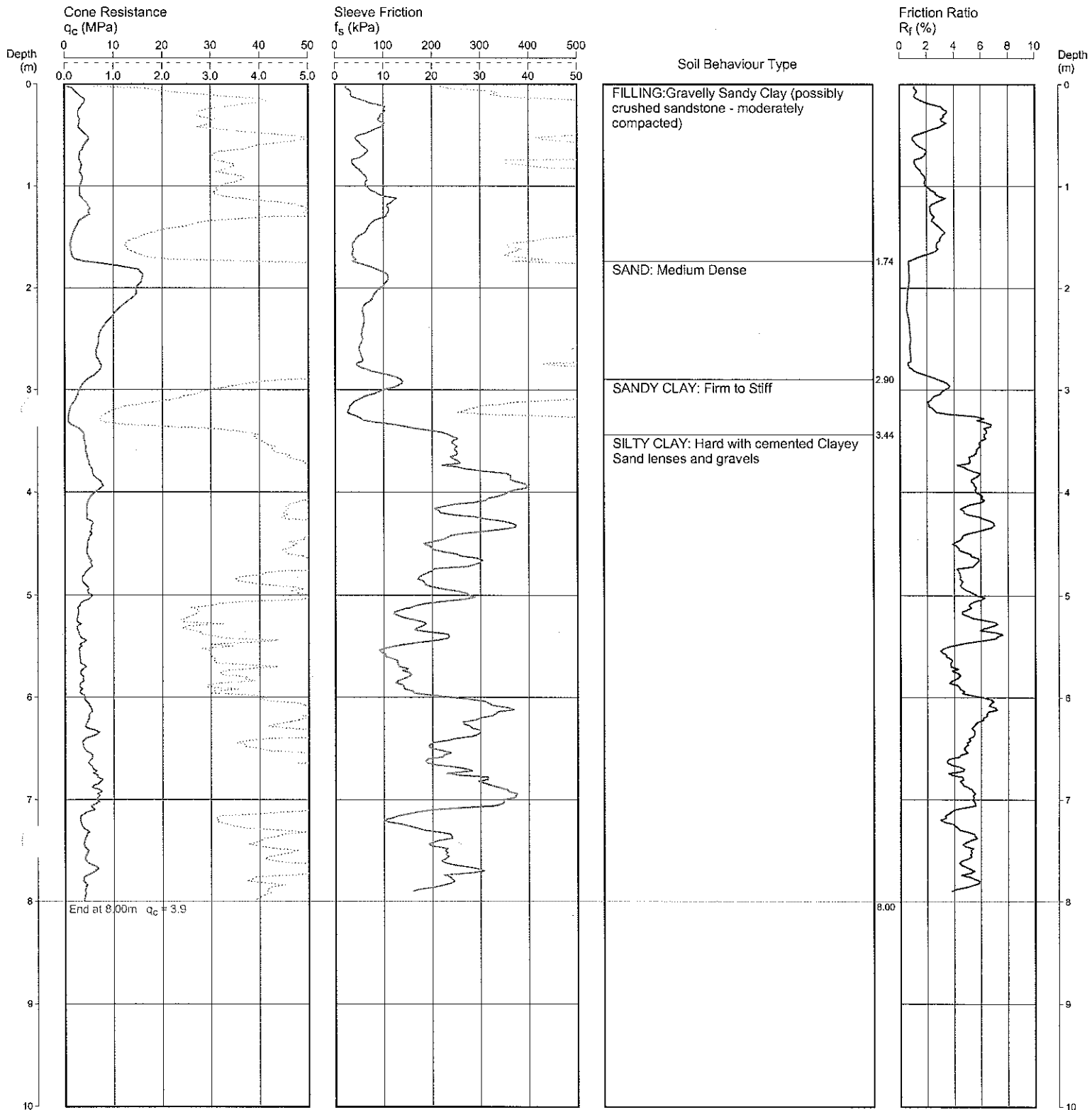
PROJECT No: 8502B

CPT 105

Page 1 of 1

DATE 6 August, 2002

SURFACE RL: 14.4 AHD*



REMARKS: NO FREE GROUND WATER OBSERVED

* SURFACE LEVELS BASED ON SUPPLIED RL FOR BORE 109 FROM DEGOTARDI, SMITH & PARTNERS

Date 25-8-02
Plotted MM
Checked BJM

File: A:\8502b105.CP5
Cone ID: CONE-204 Type: 2 Standard

ConePlot Version 5.2.4
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TEST BORE REPORT

CLIENT: PARRAMATTA STADIUM TRUST
PROJECT: EXTENSIONS TO PARRAMATTA STADIUM
LOCATION: O'CONNELL STREET, PARRAMATTA

DATE: 8 AUGUST 02
PROJECT No.: 8502B
SURFACE LEVEL: 10.6 AHD

BORE No. 108
SHEET 1 OF 1

Depth m	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results	Core Recovery %
0	0.15				
	TOPSOIL - brown silty sand				
	SANDY SILTY CLAY - red brown, sandy silty clay, damp (alluvium)				
1	- very stiff from 1.0 to 2.0m	U ₅₀	1.0	pp=375kPa	
			1.35		
2	2.0	S	2.0	5,9,13 N=22	
	SANDY CLAY - very stiff, mottled grey yellow to red brown sandy clay, with some ironstone gravel, damp (alluvium)		2.45		
3		S	3.0	5,6,13 N=19	
			3.45		
4					
	- stiff from 4.5 to 4.95	S	4.5	4,5,5 N=10	
5	4.95		4.95		
	TEST BORE DISCONTINUED AT 4.95 METRES				
6					
7					
8					
9					
10					

RIG: SCOUT **DRILLER:** G COOPER **LOGGED:** PARMAR **CASING:** UNCASSED
TYPE OF BORING: SPIRAL FLIGHT AUGER TO 4.5m
GROUND WATER OBSERVATIONS: NO FREE GROUNDWATER OBSERVED
REMARKS: SURFACE LEVELS BASED ON SUPPLIED RL FOR BORE 109
 FROM DEGOTARDI SMITH & PARTNERS

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
 B Bulk sample
 D Disturbed sample
 HV Hand Vane
 M Moisture content (%)
 pp Pocket Penetration (kPa)
 Ux x mm dia. tube
 Wp Plastic limit (%)

CHECKED:

Initials: *BM*

Date: *28/8/02*



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TEST BORE REPORT

CLIENT: PARRAMATTA STADIUM TRUST
PROJECT: EXTENSIONS TO PARRAMATTA STADIUM
LOCATION: O'CONNELL STREET, PARRAMATTA

DATE: 8 AUGUST 02
PROJECT No.: 8502B
SURFACE LEVEL: 10.0 AHD

BORE No. 107
SHEET 1 OF 1

Depth m	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results	Core Recovery %
0	0.15				
	TOPSOIL – brown, silty sand				
	SANDY SILTY CLAY – red brown mottled grey and yellow, sandy silty clay with a trace of ironstone gravel, damp (alluvium)				
1	– very stiff from 1.0m	S	1.0	6,12,12 N=24	
			1.45		
1.6					
	CLAYEY SAND – medium dense, light yellow brown mottled red, clayey sand, damp (alluvium)	S	2.0	6,9,13 N=22	
2			2.45		
			3.0	9,9,10 N=19	
3		S	3.45		
4					
			4.5	5,9,12 N=21	
4.60		S	4.95		
5	4.95				
	CLAY – very stiff, light grey mottled red brown clay with a trace of silt, sand and ironstone gravel, damp (alluvium)				
	TEST BORE DISCONTINUED AT 4.95 METRES				
6					
7					
8					
9					
10					

RIG: SCOUT **DRILLER:** G COOPER **LOGGED:** PARMAR **CASING:** UNCASED
TYPE OF BORING: SPIRAL FLIGHT AUGER TO 4.5m
GROUND WATER OBSERVATIONS: NO FREE GROUNDWATER OBSERVED
REMARKS: SURFACE LEVELS BASED ON SUPPLIED RL FOR BORE 109
 FROM DEGOTARDI SMITH & PARTNERS

SAMPLING & IN SITU TESTING LEGEND

A Auger sample	M Moisture content (%)
B Bulk sample	pp Pocket Penetration (kPa)
D Disturbed sample	Ux x mm dia. tube
HV Hand Vane	Wp Plastic limit (%)

CHECKED:

Initials:

Date:



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TEST BORE REPORT

CLIENT: PARRAMATTA STADIUM TRUST
PROJECT: EXTENSIONS TO PARRAMATTA STADIUM
LOCATION: O'CONNELL STREET, PARRAMATTA

DATE: 8 AUGUST 02
PROJECT No.: 8502B
SURFACE LEVEL: 10.5 AHD

BORE No. 108
SHEET 1 OF 1

Depth m	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results	Core Recovery %
0.15	TOPSOIL – brown, silty sand				
	SANDY SILTY CLAY – brown, sandy silty clay with ironstone gravel, humid (alluvium)				
1	– hard from 1.0 to 2.0m	U50	1.0	pp>400kPa	
			1.35		
2	2.0	S	2.0	4,6,9 N=15	
	SANDY CLAY – stiff to very stiff, mottled yellow to red brown and grey sandy clay with ironstone gravel, damp (alluvium)		2.45		
3	– stiff, light grey mottled yellow from 3.0 to 4.2m	S	3.0	4,7,6 N=13	
			3.45		
4					
4.2		S	4.5	4,6,10 N=16	
5	SANDY SILTY CLAY – stiff to very stiff, yellow brown, sandy silty clay with ironstone gravel (alluvium)		4.95		
6	6.0				
	TEST BORE DISCONTINUED AT 6.0 METRES				
7					
8					
9					
10					

RIG: SCOUT **DRILLER:** G COOPER **LOGGED:** PARMAR **CASING:** UNCASSED
TYPE OF BORING: SPIRAL FLIGHT AUGER TO 6.0m
GROUND WATER OBSERVATIONS: FREE GROUNDWATER OBSERVED AT 5.1m
REMARKS: PIEZOMETER INSTALLED TO 6.0m, SLOTTED FROM 3.0 TO 6.0m. SURFACE LEVELS
 BASED ON SUPPLIED RL FOR BORE 109 FROM DEGOTARDI SMITH & PARTNERS

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
 B Bulk sample
 D Disturbed sample
 HV Hand Vane
 M Moisture content (%)
 pp Pocket Penetration (kPa)
 Ux x mm dia. tube
 Wp Plastic limit (%)

CHECKED:

Initials: *BM*
 Date: 28/8/02



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TEST BORE REPORT

CLIENT: PARRAMATTA STADIUM TRUST
PROJECT: EXTENSIONS TO PARRAMATTA STADIUM
LOCATION: O'CONNELL STREET, PARRAMATTA

DATE: 9 AUGUST 02
PROJECT No.: 8502B
SURFACE LEVEL: 13.6 AHD

BORE No. 109
SHEET 1 OF 1

Depth m	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results	Core Recovery %
0	TOPSOIL - brown, silty sand	B	0.5	2,3,5 N=8	
0.15	FILLING - brown, gravelly sandy clay, brick pieces and gravel filling, damp		1.0		
1					
2					
2.75	SILTY CLAY - firm to stiff, yellow brown silty clay with some sand, damp (alluvium)	S	3.0		
3			3.45		
3.45	TEST BORE DISCONTINUED AT 3.45 METRES				
4					
5					
6					
7					
8					
9					
10					

RIG: SCOUT

DRILLER: G COOPER

LOGGED: PARMAR

CASING: UNCASSED

TYPE OF BORING: SPIRAL FLIGHT AUGER TO 3.0m

GROUND WATER OBSERVATIONS: NO FREE GROUNDWATER OBSERVED

REMARKS: SURFACE LEVELS BASED ON SUPPLIED RL FOR BORE 109
 FROM DEGOTARDI SMITH & PARTNERS

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
 B Bulk sample
 D Disturbed sample
 HV Hand Vane
 M Moisture content (%)
 pp Pocket Penetration (kPa)
 Ux x mm dia. tube
 Wp Plastic limit (%)

CHECKED:

Initials: *BM*

Date: 28/8/02



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TEST BORE REPORT

CLIENT: PARRAMATTA STADIUM TRUST
PROJECT: EXTENSIONS TO PARRAMATTA STADIUM
LOCATION: O'CONNELL STREET, PARRAMATTA

DATE: 8 AUGUST 02
PROJECT No.: 8502B
SURFACE LEVEL: 10.5 AHD

BORE No. 110
SHEET 1 OF 1

Depth m	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results	Core Recovery %
0.15	TOPSOIL - dark brown, silty sand				
1.10	SANDY SILTY CLAY - very stiff, red brown mottled grey, sandy silty clay with a trace of ironstone gravel, damp (alluvium - possible filling)	U ₅₀	0.8	pp=275kPa	
			1.15		
	SILTY CLAY - stiff to very stiff, mottled red brown and grey, silty clay with some sand and ironstone gravel, damp (alluvium)	S	1.5	5,7,8 N=15	
			1.95		
			2.5	7,8,10 N=18	
2.8		S	2.95		
	SANDY CLAY/CLAYEY SAND - very stiff/medium dense, light grey mottled yellow and red brown, sandy clay/clayey sand, damp (alluvium)				
			3.5	8,8,9 N=17	
3.95	TEST BORE DISCONTINUED AT 3.95 METRES		3.95		

RIG: SCOUT

DRILLER: G COOPER

LOGGED: PARMAR

CASING: UNCASSED

TYPE OF BORING: SPIRAL FLIGHT AUGER TO 3.0m

GROUND WATER OBSERVATIONS: NO FREE GROUNDWATER OBSERVED

REMARKS: SURFACE LEVELS BASED ON SUPPLIED RL FOR BORE 109
 FROM DEGOTARDI SMITH & PARTNERS

SAMPLING & IN SITU TESTING LEGEND

A Auger sample	M Moisture content (%)
B Bulk sample	pp Pocket Penetration (kPa)
D Disturbed sample	Ux x mm dia. tube
HV Hand Vane	Wp Plastic limit (%)

CHECKED:

Initials: *BM*

Date: 28/8/02



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TEST BORE REPORT

CLIENT: PARRAMATTA STADIUM TRUST
PROJECT: EXTENSIONS TO PARRAMATTA STADIUM
LOCATION: O'CONNELL STREET, PARRAMATTA

DATE: 8 AUGUST 02
PROJECT No.: 8502B
SURFACE LEVEL: 10.5 AHD

BORE No. III
SHEET 1 OF 1

Depth m	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results	Core Recovery %
0	TOPSOIL - dark brown silty sand				
0.15	FILLING - dark brown and grey brown, sandy clay filling with some roadbase gravel, damp				
1	- moderately compacted from 0.8 to 1.2m	U50	0.8	pp=275kPa	
1.20			1.15		
2	CLAYEY SAND/SANDY CLAY - very stiff, light grey mottled red brown sandy clay/clayey sand with ironstone gravel, damp (alluvium)	S	1.50	7,13,14 N=27	
2.10			1.95		
3	CLAYEY SAND/SANDY CLAY - medium dense to dense, very stiff to hard, yellow brown mottled red, fine to medium grained, clayey sand/sandy clay, damp (alluvium)	S	2.50	12,14,16 N=30	
			2.95		
4		S	3.5	5,10,14 N=24	
3.95	TEST BORE DISCONTINUED AT 3.95 METRES		3.95		
5					
6					
7					
8					
9					
10					

RIG: SCOUT

DRILLER: G COOPER

LOGGED: PARMAR

CASING: UNCASSED

TYPE OF BORING: SPIRAL FLIGHT AUGER TO 3.5m

GROUND WATER OBSERVATIONS: NO FREE GROUNDWATER OBSERVED

REMARKS: SURFACE LEVELS BASED ON SUPPLIED RL FOR BORE 109
 FROM DEGOTARDI SMITH & PARTNERS

SAMPLING & IN SITU TESTING LEGEND

A Auger sample	M Moisture content (%)
B Bulk sample	pp Pocket Penetration (kPa)
D Disturbed sample	Ux x mm dia. tube
HV Hand Vane	Wp Plastic limit (%)

CHECKED:

Initials: *BM*

Date: *28/8/02*



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TEST BORE REPORT

CLIENT: PARRAMATTA STADIUM TRUST
PROJECT: EXTENSIONS TO PARRAMATTA STADIUM
LOCATION: O'CONNELL STREET, PARRAMATTA

DATE: 8 AUGUST 02
PROJECT No.: 8502B
SURFACE LEVEL: 10.5 AHD

BORE No. 112
SHEET 1 OF 1

Depth m	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results	Core Recovery %
0	0.10				
	TOPSOIL - dark brown silty sand				
	FILLING - grey brown and red, sandy clay filling with some fine gravel, damp				
	- moderately to well compacted from 0.8m				
1		U50	0.8	pp>400kPa	
			1.15		
1.3			1.5	7,11,14 N=25	
	CLAYEY SAND - medium dense, red brown, medium grained clayey sand (alluvium)	S	1.95		
2			2.5	11,14,10 N=24	
		S	2.95		
2.8			3.5	5,5,10 N=15	
3	SANDY CLAY - very stiff, yellow to red brown mottled red sandy clay, damp (alluvium)		3.95		
	- stiff from 3.5m	S			
4	3.95				
	TEST BORE DISCONTINUED AT 3.95 METRES				
5					
6					
7					
8					
9					
10					

RIG: SCOUT

DRILLER: G COOPER

LOGGED: PARMAR

CASING: UNCASSED

TYPE OF BORING: SPIRAL FLIGHT AUGER TO 3.5m

GROUND WATER OBSERVATIONS: NO FREE GROUNDWATER OBSERVED

REMARKS: SURFACE LEVELS BASED ON SUPPLIED RL FOR BORE 109
 FROM DEGOTARDI SMITH & PARTNERS

SAMPLING & IN SITU TESTING LEGEND

A Auger sample	M Moisture content (%)
B Bulk sample	pp Pocket Penetration (kPa)
D Disturbed sample	Ux x mm dia. tube
HV Hand Vane	Wp Plastic limit (%)

CHECKED:

Initials: *BM*

Date: 28/8/02



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APPENDIX C
Results of Laboratory Testing

RESULTS OF MOISTURE CONTENT, PLASTICITY AND LINEAR SHRINKAGE TESTS

CLIENT: PARRAMATTA STADIUM TRUST
PROJECT: EXTENSIONS TO PARRAMATTA STADIUM
LOCATION: O'CONNELL STREET, PARRAMATTA

DATE: 27/08/02
PROJECT NO: 8502B
PAGE: 1 of 1

TEST LOC	DEPTH (m)	DESCRIPTION	CODE	W %	W _L %	W _p %	I _p %	*LS %
BH110	0.8-1.15	SANDY SILTY CLAY – Low to medium plasticity, red brown mottled grey sandy silty clay, with some gravel.	2,5	18.9	28	17	11	-
BH108	1.0 –1.35	SANDY SILTY CLAY – Low to medium plasticity, red brown mottled grey sandy silty clay, with some gravel.	2,5	15.9	34	20	14	-
BH110	1.5 –1.95	SANDY SILTY CLAY – Low to medium plasticity, red brown mottled grey sandy silty clay, with some gravel.	2,5	17.5	36	19	17	-

Legend:

W Moisture Content
W_L Liquid limit
W_p Plastic limit
I_p Plasticity index
LS Linear shrinkage from liquid limit condition (Mould length 250mm)

Test Methods:

Moisture Content: AS 1289.2.1.1 - 1992
Liquid Limit: AS 1289.3.1.2 - 1995
Plastic Limit: AS 1289.3.2.1 - 1995
Plasticity Index: AS 1289.3.3.1 - 1995
Linear shrinkage: AS 1289.3.4.1 - 1995

* Specify if sample crumbled CR or curled CU

Code**Sample history for plasticity tests**

1. Air dried
2. Low temperature (<50°C) oven dried
3. Oven (105°C) dried
4. Unknown

Method of preparation for plasticity tests

5. Dry sieved
6. Wet sieved
7. Natural

Report No:S02-296c

TESTED BY: MBG

CHECKED BY: NW

Signed: N.WEIMANN
Laboratory Manager.



NATA Accredited Laboratory
Number: SYDNEY 828

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RESULTS OF INSTABILITY INDEX DETERMINATION

CLIENT: PARRAMATTA STADIUM TRUST DATE: 27/08/02
PROJECT: EXTENSIONS TO PARRAMATTA STADIUM PROJECT No: 8502B
LOCATION: O'CONNELL STREET, PARRAMATTA LOC No: BH106
DEPTH: 1.0 - 1.35m m

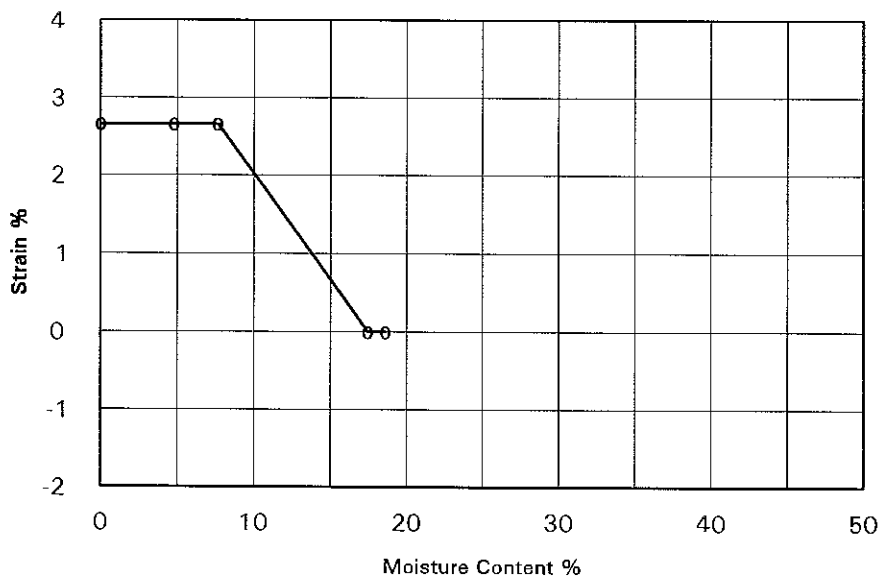
Description: SILTY CLAY- Red brown mottled grey sandy silty clay with some gravel.

CORE SHRINKAGE TEST

Shrinkage - air dried	2.7 %
Shrinkage - oven dried	2.7 %
Significant inert inclusions	- %
Extent of cracking	- %
Extent of soil crumbling	- %
Moisture content of core	17.4 %

SWELL TEST

Pocket penetrometer reading at initial moisture content	>400 kPa
Pocket penetrometer reading at final moisture content	>400 kPa
Initial Moisture Content	16.7 %
Final moisture content	18.7 %
Swell under 25kPa	-0.0 %



SHRINK-SWELL INDEX I_{ss} 1.5 % per Δ pF

Remarks: Sample was of low to medium plasticity.

Test Method: AS1289 7.1.1-1998

TESTED BY: MBG DATE: 17/8/02
CHECKED BY: NW DATE: 27/8/02

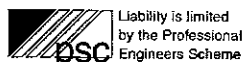
LABORATORY: SYDNEY - 828

REPORT NO: S02-296B

N. Weimann
N. WEIMANN



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RESULTS OF INSTABILITY INDEX DETERMINATION

CLIENT: PARRAMATTA STADIUM TRUST DATE: 27/08/02
PROJECT: EXTENSIONS TO PARRAMATTA STADIUM PROJECT No: 8502B
LOCATION: O'CONNELL STREET, PARRAMATTA LOC No: BH110
DEPTH: 0.8 - 1.15m m

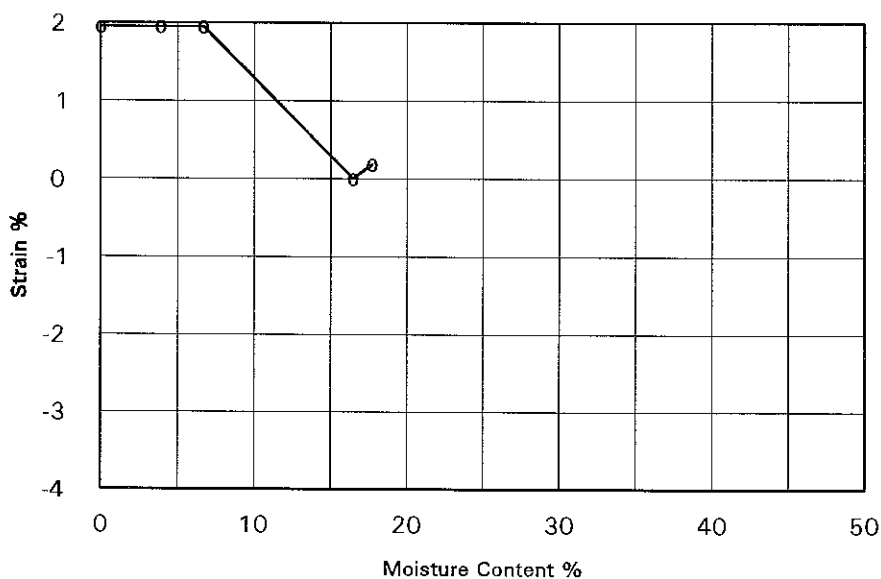
Description: SILTY CLAY- Red brown mottled grey sandy silty clay with some gravel.

CORE SHRINKAGE TEST

Shrinkage - air dried	1.9 %
Shrinkage - oven dried	1.9 %
Significant inert inclusions	- %
Extent of cracking	- %
Extent of soil crumbling	- %
Moisture content of core	16.4 %

SWELL TEST

Pocket penetrometer reading at initial moisture content	350 kPa
Pocket penetrometer reading at final moisture content	200 kPa
Initial Moisture Content	18.9 %
Final moisture content	17.7 %
Swell under 25kPa	-0.2 %



SHRINK-SWELL INDEX I_{ss} 1.1 % per Δ pF

Remarks: Sample was of low to medium plasticity.

Test Method: AS1289 7.1.1-1998

TESTED BY: MBG DATE: 17/8/02
CHECKED BY: NW DATE: 27/8/02

LABORATORY: SYDNEY - 828

REPORT NO: S02-296A

N. Weimann
N. WEIMANN



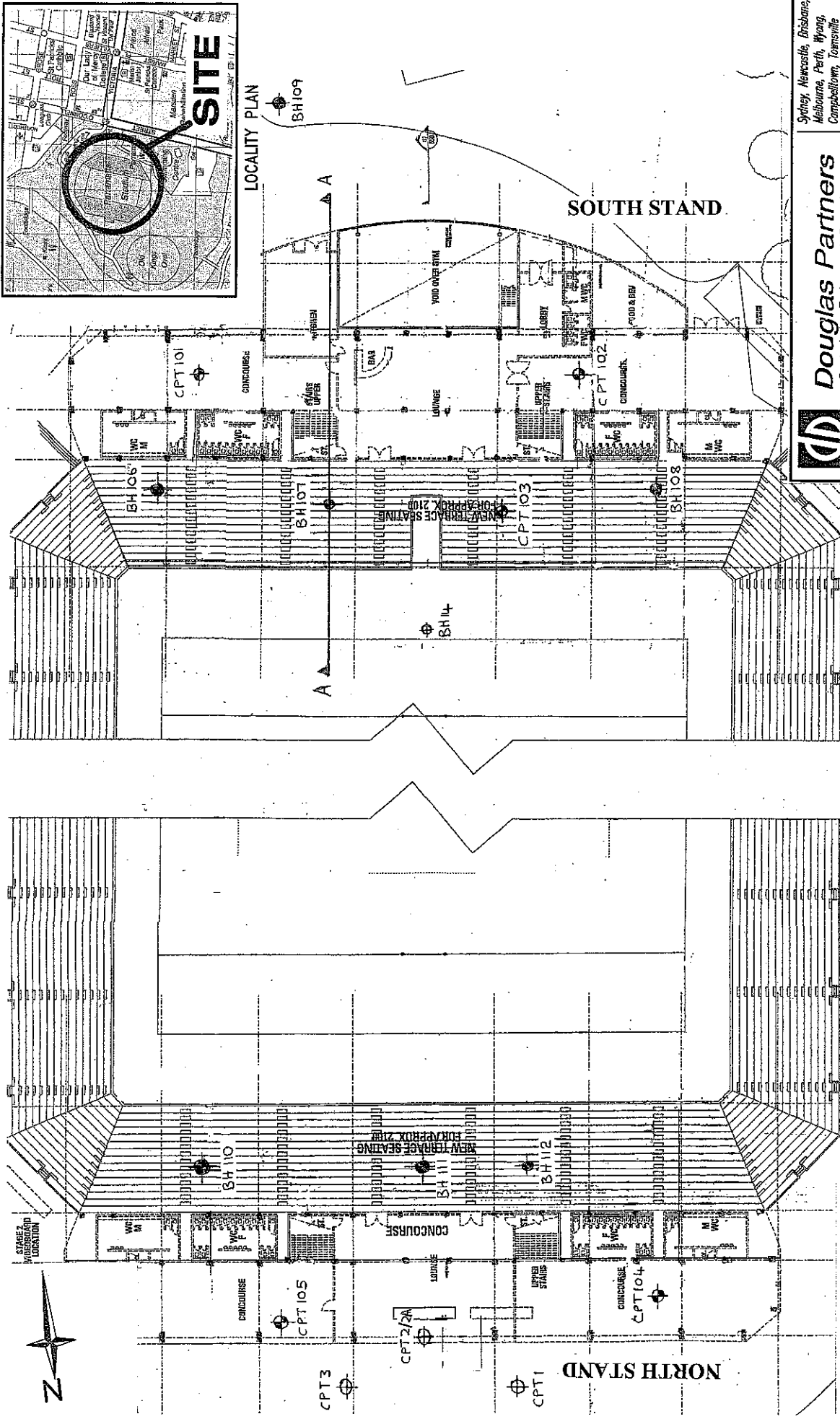
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Campbelltown, Townsville
Cairns, Wollongong

Douglas Partners
Geotechnics, Environment, Groundwater

Title:

Location of Test Bores & CPTs
Extensions to Parramatta Stadium
O'Connell Street
PARRAMATTA

CLIENT: Parramatta Stadium Trust

DRAWN BY: PSCH SCALE: As shown

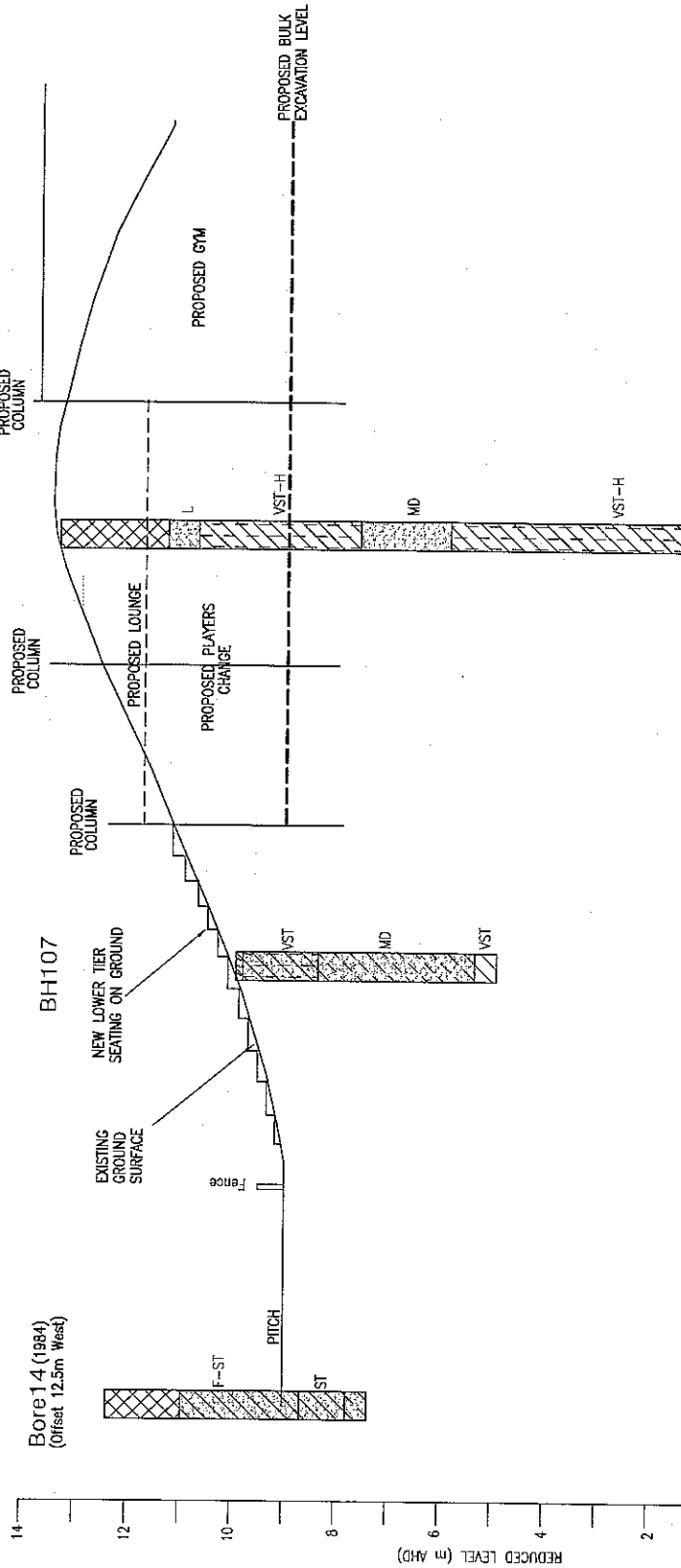
APPROVED BY: *DAVID*

DRAWING No: 1

LEGEND

- ⊕ TEST FROM PREVIOUS INVESTIGATION
- ⊙ BORE LOCATION
- ⊙ CONE PENETRATION TEST LOCATION

CPT101
(Offset 17m East)



INTERPRETED GEOLOGICAL CROSS-SECTION A-A FOR SOUTH STAND



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Cairns, Wollongong

TITLE:		Interpreted Geological Cross-Section A-A Extensions to Parramatta Stadium O'Connell Street PARRAMATTA	
CLIENT:	Parramatta Stadium Trust	PROJECT No:	B502B
DRAWN BY:	PSCH	SCALE:	As shown
APPROVED BY:	<i>BMH</i>	DATE:	4.9.2002
		OFFICE:	SYDNEY
		DRAWING No: 2	

LEGEND

CONSISTENCY/DENSITY	
F	FIRM
ST	STIFF
VST	VERY STIFF
H	HARD
L	LOOSE
MD	MEDIUM
TOPSOIL	
FILLING	
SAND	
CLAY	
SILTY CLAY	
CLAYEY SAND	
SANDY CLAY	
SANDY SILTY CLAY	

