Douglas Partners
Geotechnics / Environment / Groundwater

Report on
Geotechnical Investigation

Proposed Commercial Development
3 Murray Rose Avenue, Sydney Olympic Park

Prepared for
Lend Lease Project Management & Construction
(Australia)

Project 45153.02
August 2012

Integrated Practical Solutions

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	45153.02	Document No.	1
Document title	Report on Geotechnical Investigation Proposed Commercial Development		
Site address	3 Murray Rose Avenue, Sydney Olympic Park		
Report prepared for	Lend Lease		
File name	P:\45153.02 SYDNEY OLYMPIC PARK, 3 Murray Rose Ave PMO\Docs\Murray Rose Geotechnical Report Rev0.doc		

Document status and review

Revision	Prepared by	Reviewed by	Date issued
DRAFT	P Oitmaa		23 July 2012
0	P Oitmaa	J Harvey	22 August 2012

Distribution of copies

Revision	Electronic	Paper	Issued to
DRAFT	1		Lend Lease
0	1		Lend Lease

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.

	Signature	Date
Author		22.8.2012
Reviewer	JPH	22.8.2012

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
96 Hermitage Road
West Ryde NSW 2114
PO Box 472
West Ryde NSW 1685
Phone (02) 9809 0666
Fax (02) 9809 4095

Table of Contents

Report on Geotechnical Investigation
Proposed Commercial Development
3 Murray Rose Avenue, Sydney Olympic Park

1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed commercial development at 3 Murray Rose Avenue, Sydney Olympic Park. The work was commissioned by Lend Lease Project Management & Construction (Australia).

The project involves the construction of a five-storey commercial office building over a three to four-level basement. The remainder of an existing commercial building, partially demolished during development works on an adjacent site, will be demolished as part of the project.

A geotechnical investigation was undertaken to provide information on the subsurface conditions on the site and included the drilling of boreholes, laboratory testing and engineering analysis. Details of the field work and comments relevant to design and construction are given in this report.

A contamination assessment was undertaken at the same time as the geotechnical investigation and is reported separately.

2. Previous Investigations

Douglas Partners Pty Ltd has previously undertaken geotechnical investigations for the ‘Quad’ series of developments on the southern side of Parkview Drive (Projects 37130, 37130A and 37130B), and for the recently completed commercial building immediately to the west (No.5 Murray Rose Avenue) of the current development site (Projects 45153 and 45153.01). Information from these investigations was used to assess the overall geological setting of the site.

3. Site Description and Geology

The site is near-rectangular and approximately 4,000 m^2 in area. It is bounded by Brickpit Park to the north, grassed and sealed carpark areas to the east, a partially demolished commercial building to the south, and a recently constructed commercial building to the west. The ground surface on the site currently slopes downwards to the south with an overall difference in levels of about 4 m between the northern and southern boundaries. The western side of the site has a relatively level bench which slopes steeply down to the lower level; the eastern side of the site has a relatively consistent grade.

Reference to the *Sydney 1:100 000 Geological Series Sheet* indicates that the site is underlain by Ashfield Shale of the Wianamatta Group. Ashfield Shale typically comprises black to dark grey shale and laminite.

4. Field Work Methods

The field work for the geotechnical investigation comprised five boreholes (G1 to G5) drilled at the locations shown on Drawing G1 in Appendix B. The bores were drilled to depths of 15.0 m to 15.1 m using a truck-mounted DT100 drilling rig. They were commenced using solid flight augers then continued using rotary wash-boring equipment inside top casing. Standard penetration tests were undertaken within the overburden at regular depth intervals. Soon after rock was encountered, the bores were advanced using NMLC-sized diamond core drilling equipment to obtain 50 mm diameter continuous samples of the rock for identification and strength testing purposes.

Boreholes G1, G2, G4 and G5 were converted into groundwater monitoring wells at the completion of drilling. This involved placing Class 18 uPVC screen and solid casing in each borehole. A gravel pack was placed around the screen and a bentonite plug was placed above the gravel. The remainder of the void was backfilled with drill cuttings and the top of the wells were finished with a steel cover mounted flush with the surface.

The ground surface levels at the bores were determined to Australian Height Datum (AHD) using an automatic level, relative to a benchmark (SS 87238) which was listed at RL 11.03 m on the Department of Lands survey database. It is noted that the Sydney Olympic Park Authority use a separate height datum (AHD + 100.078 m), although for the purposes of this report AHD is used.

5. Field Work Results

The subsurface conditions encountered in the boreholes are presented in the borehole logs in Appendix C. Notes defining descriptive terms and classification methods are included in Appendix A.

The subsurface conditions encountered on the site can be described as:

- FILLING – crushed shale, silty sandy clay, silty clay, clay and gravelly clay with sandstone, shale, roadbase and brick to depths of 0.6 m to 2.7 m;
- RESIDUAL SOIL – firm to stiff clay below the filling in boreholes G2, G3 and G5 to depths of 2.0 m to 3.5 m. Residual soil was not encountered in boreholes G1 and G4 where filling was directly underlain by bedrock; and
- BEDROCK – generally siltstone and/or shale bedrock from depths of 0.6 m to 3.5 m, to the base of the boreholes at 15.0 m to 15.1 m depth. The rock was initially weathered and generally of extremely low to very low strength, grading to fresh, medium to high strength rock as the depth of the boreholes increased. Numerous joints dipping in the range of 40^{o} to 70^{o} were observed in the core samples. Several very high strength sideritic bands were also present.

Table 1 summarises the levels at which different materials were encountered in the boreholes. The rock has been classified in accordance with a system developed by Pells, Douglas et al in the 1970s and updated by Pells et al (1998) which classifies rock strata depending on strength, fracturing and defects. Class V rock is typically very low strength, highly weathered and highly fractured rock whereas Class I rock is typically high strength, fresh and unbroken rock.

Table 1: Summary of Material Strata Levels and Rock Classifications

Stratum	RL of Top of Stratum (m, AHD)				
	G1	G2	G3	G4	G5
Ground Surface/ Filling	15.5	15.3	13.2	12.5	12.3
Residual Soil	NE	12.6	12.4	NE	10.9
Class V/IV Rock	13.2	11.8	11.2	11.9	10.0
Class III Rock	NE	9.6	NE	9.0	NE
Class II/I Rock	10.2	7.3	9.2	6.7	7.2
Base of Borehole	0.5	0.3	-1.8	-2.6	-2.7

Notes: Rock classification in accordance with Pells et al (1998); NE = not encountered

Free groundwater was not observed during augering and the use of drilling fluid prevented groundwater observations during rotary wash-boring and coring. The water levels measured in the monitoring wells are provided in Table 2.

Table 2: Groundwater Observations in Monitoring Wells (m, AHD)

Date	G1	G2	G4	G5
10 July 2012	8.1	NM	7.1	10.2

Notes: NM = not measured as monitoring well was inaccessible

6. Laboratory Testing

Sixty-seven (67) samples selected from the better quality rock core were tested for axial point load strength index (Is_{50}). The results for the siltstone/shale samples ranged from 0.2 MPa to 2.8 MPa which correspond to low strength to high strength rock. These Is_{50} results suggest an uniaxial compressive strength (UCS) in excess of 60 MPa for the high strength rock encountered during the investigation. It is noted that several very high strength sideritic bands were encountered in the core samples which exhibited Is_{50} results of between 3.1 MPa and 6.1 MPa which suggest UCS values in excess of 120 MPa.

7. Geotechnical Model

A geotechnical model for the site is presented in Sections A-A and B-B in Drawings G2 and G3 in Appendix B. A summary of the geotechnical model is provided in Table 3.

Table 3: Summary of Geotechnical Model

Geological Unit	Description
Unit 1	Filling comprising crushed shale, silty sandy clay, silty clay, clay and gravelly clay with sandstone, shale, roadbase and brick.
Unit 2	Firm to stiff clay with some ironstone gravels. Only encountered in bores G2, G3 and G5.
Unit 3	Class V and IV siltstone and shale bedrock of extremely low and very low strength with stronger bands (up to medium strength).
Unit 4	Class III siltstone and shale bedrock generally of low to medium strength.
Unit 5	Class II and I siltstone and shale bedrock of medium and high strength. Some very high strength bands.
Groundwater	Measured at depths of 2.1 m to 7.4 m below the ground surface (RL 7.1 m to RL 10.2 m AHD). The regional groundwater table is likely to be below bedrock surface.

8. Proposed Development

It is understood that the project involves the construction of a five-storey commercial office building over a three to four-level basement. The column loads have yet to be determined but based on the size of the proposed building are likely to be in the order of 3,000 kN to 6,000 kN (working). The remainder of an existing commercial building, partially demolished during development works on an adjacent site, will be demolished as part of the project.

The geotechnical issues considered relevant to the proposed development include excavation, excavation support, groundwater and foundations. Comments on seismicity are also provided.

9. Comments

9.1 Excavation

Excavation for the basement levels is expected to be required in filling, residual soil and rock of varying strength up to very high strength. Excavation in filling, soil and extremely low to very low strength rock should be readily achievable using conventional earthmoving equipment such as hydraulic excavators with bucket attachments.

Excavation in low strength and stronger rock will require the use of heavy ripping equipment, hydraulic rock hammers, milling heads and/or rock saws. The high strength bedrock and very high strength sideritic bands will require very large hammers and low productivity can be expected. Potential excavation contractors should be made aware that sideritic bands up to 150 mm thick and in excess of 120 MPa UCS were encountered on the site.

The use of such large equipment will cause vibrations which could possibly result in damage to nearby structures. It is suggested that vibrations be limited to a peak particle velocity (PPV) of 8 mm/s at the foundation level of the building to the west of the development site to protect the architectural features of the building and to reduce discomfort for the occupants. A site specific vibration monitoring trial will be required to determine vibration attenuation once excavation plant and methods have been finalised.

It should be noted that any off-site disposal of spoil will generally require assessment for re-use or classification in accordance with current *Waste Classification Guidelines* (NSW Department of Environment and Climate Change, 2009).

9.2 Excavation Support

9.2.1 General

Vertical excavations in filling, soil and weathered rock are not expected to be self-supporting for any extended period of time. Temporary batters of 1(H):1(V) could be used to support the sides of the excavation, although are unlikely to be practical for the depth of excavation proposed. Shoring support will therefore be required from the ground surface down to the bulk excavation level. Shoring extending to the base of the excavation is suggested due to the presence of unfavourable jointing in the rock core. Shoring will not be required along the western edge of the excavation if the proposed basement abuts the basement of the recently completed building and is of a similar level.

Soldier piles with infill reinforced shotcrete panels are commonly used to support excavations in siltstone/shale. The soldier piles would generally be spaced at about 2 m to 3 m centres and should be founded at least two pile diameters below the lowest excavation level (both bulk and detailed) adjacent to the pile location. Shotcreting will be needed over the full excavation depth and should be undertaken in approximately 2.5 m drops as excavation proceeds in order to reduce the risk of local slippages. Temporary ground anchors will be required to prevent excessive lateral deformation. It is understood that this was the method of temporary excavation support used on the adjacent 5 Murray Rose Avenue, immediately to the west.

9.2.2 Earth Pressures

Excavation faces retained either temporarily or permanently will be subjected to earth pressures from the ground surface down to the top of Class III rock. Table 4 outlines material and strength parameters that could be used for the preliminary design of excavation support structures.

Table 4: Material and Strength Parameters for Excavation Support Structures

Material	Bulk Density (kN/m^3)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Earth Pressure at Rest (K_o)	Ultimate Passive Earth Pressure (kPa)
Filling	20	0.35	0.6	-
Residual Soil	20	0.25	0.4	-
Class V/IV Rock	22	0.15^1	0.25^1	750^2
Class III Rock	23	0^1	0^1	$3,000^2$
Class II/I Rock	23	0^1	0^1	$6,000^2$

Notes: [1] Unless unfavourably jointed; [2] Only below bulk/detailed excavation level and where jointing is favourable

The design of temporary and permanent support will need to consider the possibility that 45° joints in the bedrock will daylight near the base of the excavation leading to large wedges of rock requiring support by the temporary and permanent retaining structures. Sufficient anchoring of the shoring wall should be undertaken to prevent movements along 45° joints, even though there is a low probability that a joint would run the full length and height of the excavation.

It is suggested that preliminary design be carried out such that the support system has a factor of safety of 1.1 against sliding along the most unfavourable 45° joint. The support system would typically comprise anchors spaced over the rock face. These anchors should have their bond lengths behind the projected 45° line from the bulk excavation level and should provide sufficient force to resist the movement of a wedge of rock projected at 45° from just below the anchor to the ground surface. The frictional resistance of the wedge along the joint may be calculated assuming an angle of friction of 20°. Regular rock-face inspections will be required during excavation to determine whether the assumed factor of safety is adequate. Additional anchors may be required to increase the factor of safety if large wedges are observed during excavation.

Rock sockets below the bulk excavation level for the purpose of passive restraint should have a minimum length of two pile diameters below the lowest level of any nearby excavation (including any detailed excavations).

It is likely that shoring in deep excavations will need to incorporate more than one row of anchors. The lateral pressure distribution on a multi-anchored or braced wall is complex and for preliminary design purposes a uniform distribution with depth (i.e. rectangular) could be assumed. It is recommended that a sophisticated software package such as FLAC or PLAXIS be used to analyse the shoring system to refine the preliminary design prior to commencement of construction.

Lateral pressures due to surcharge loads from adjacent buildings, sloping ground surface, the proposed road corridor and construction machinery should be included where relevant. Hydrostatic pressure acting on the shoring walls should also be included in the design where adequate drainage is not provided behind the full height of the walls.

9.2.3 Ground Anchors

Where necessary, the use of inclined tie-back (ground) anchors is suggested for the lateral restraint of the perimeter piled walls. Such ground anchors should be inclined below the horizontal to allow anchorage into the stronger bedrock materials at depth. The design of temporary ground anchors for the support of piled wall systems may be carried out using the allowable average bond stresses at the grout-rock interface given in Table 5.

Table 5: Allowable Bond Stresses for Anchor Design

Material Description	Allowable Bond Stress (kPa)
Class V/IV Rock	100
Class III Rock	250
Class II/I Rock	500

Ground anchors should be designed to have a free length equal to their height above the base of the excavation and have a minimum 3 m bond length. After installation they should be proof loaded to 125% of the design working load and locked-off at no higher than 60% of the working load. Periodic checks should be carried out during the construction phase to ensure that the lock-off load is maintained and not lost due to creep effects or other causes.

The parameters given in Table 5 assume that the anchor holes are clean and adequately flushed, with grouting and other installation procedures carried out carefully and in accordance with good anchoring practice. Careful installation and close supervision by a geotechnical specialist may allow increased bond stresses to be adopted during construction, subject to testing.

In normal circumstances the building will restrain the basement excavation over the long term and therefore ground anchors are expected to be temporary only. The use of permanent anchors would require careful attention to corrosion protection. Further advice on design and specification should be sought if permanent anchors are to be employed at this site.

It will be necessary to obtain permission from neighbouring landowners prior to installing anchors that will extend beyond the perimeter of the site. In addition, care should be taken to avoid damaging buried services, pipes and subsurface structures during anchor installation. Care should also be taken when excavating adjacent to the basement at 5 Murray Rose Avenue; although it is understood that the temporary anchors have been de-stressed, the redundant anchors should be cut rather than pulled to avoid damaging the adjacent basement wall.

9.2.4 Stress Relief

Large in situ stresses which are created during deposition and formation are usually present in a rock mass. For a relatively major excavation such as is proposed, there is a possibility that there will be some horizontal movement within the rock due to stress relief effects. It is unlikely to be practicable to provide restraint for the relatively high in-situ horizontal stresses anticipated within the fresh Ashfield Shale. Release of these stresses due to the excavation will generally cause horizontal movements along the rock bedding surfaces and partings.

Based on monitoring experience for excavations in the Sydney region, an excavation of 10 m depth may give rise to lateral movements from stress relief in the order of 10 mm to 15 mm on the adjoining ground surface (i.e. behind the top of the excavation). Empirical data suggest that most of the movement occurs during or shortly after the bulk excavation phase.

Movements related to stress relief could cause damage to the surrounding infrastructure. It is recommended that appropriate allowance be made for the repair of pavements and public utilities where excavation is carried out close to such structures.

9.3 Groundwater

Although free groundwater was not observed during augering, the water levels measured in the groundwater monitoring wells suggest seepage will occur through and along strata boundaries on the site. The subsurface conditions encountered in the bores indicate seepage can probably be controlled using a sub-floor drainage and collection system in the lower basement level. Seepage through Wianamatta Group shales sometimes results in iron precipitates which have the potential to block drainage material and additional precautions (e.g. wash-out points etc.) should be taken to avoid blocking the drains in the medium to longer term.

Grouting of open joints and partings may be advisable if excessive water ingress is found to be an issue during excavation. A pump will be required to periodically remove stored water from the basement. A pump may also be needed to remove seepage from bored pile excavations prior to the placement of concrete, if bored piles are used for shoring support.

9.4 Foundations

9.4.1 Spread Footings

The proposed bulk excavation works are expected to expose Class II/I bedrock. Spread footings (i.e. pad or strip footings) within the excavation should be suitable for supporting the proposed building loads and could be designed on the basis of an allowable bearing pressure of 6,000 kPa in the Class II/I materials.

The allowable bearing pressure for Class II/I rock assumes there are no adverse defects below the footing. Spoon testing will be required in 30% to 50% of footings to check for the presence of defects within the zone of influence of the footings (i.e. a depth equal to 1.5 times the footing width).

Alternatively, the footings could be designed on the basis of an allowable bearing pressure of 3,500 kPa in the Class II/I rock and spoon testing would not be required in this case.

Settlement of a spread footing is dependent on the loads applied to the footing and the foundation conditions below the footing. The total settlement of a spread footing designed using the parameters provided in this report should be less than 5 mm to 10 mm upon application of the design load. Differential settlements between footings may be in the order of 50% of the value of total settlement.

All spread footings should be inspected by an experienced geotechnical professional to check the adequacy of the foundation material and to undertake spoon-testing as required.

It is understood that spread footings were used to support the majority of the columns on 5 Murray Rose Avenue and spread footings would be expected to be used on 3 Murray Rose Avenue as well.

9.4.2 Piles

Bored piles used for shoring support could also be used to support structural loads providing they are founded below the bulk excavation level. Piles could also be used to support structural loads outside the basement area. Bored piles could be proportioned on the basis of the design parameters provided in Table 6.

Table 6: Design Parameters for Bored Piles

Material Description	Allowable End-Bearing Pressure (kPa)	Allowable Shaft Adhesion[1] (kPa)
Class V/IV Rock	750	50
Class III Rock	3500	300
Class II/I Rock	6000	500

Notes: [1]Provided adequate socket roughness is achieved

Settlement of a pile is dependent on the loads applied to the pile and the foundation conditions in the socket zone and below the pile toe. The total settlement of a bored pile designed using the parameters provided in this report should be less than a few millimetres upon application of the design load.

All bored piles should be inspected by an experienced geotechnical professional during construction to check the adequacy of the foundation material and to check the socket cleanliness and roughness.

It is noted that bored piles were used to support selected columns outside the basement footprint on 5 Murray Rose Avenue and piles would be expected to be used for a similar purpose on 3 Murray Rose Avenue, if necessary.

9.5 Seismicity

A Hazard Factor (*Z*) of 0.08 would be appropriate for the development site in accordance with Australian Standard AS 1170.4 – 2007 *Structural design actions – Part 4: Earthquake actions in Australia*. The site sub-soil class would be Class B_e in the case that the building is fully supported on rock.

10. References

Pells et al (1998), *Foundations on Sandstone and Shale in the Sydney Region*, Australian Geomechanics, No.33 Part 3.

Sydney 1:100 000 Geological Series Sheet 9130, NSW Department of Mineral Resources, 1983.

Waste Classification Guidelines, Department of Environment and Climate Change NSW, 2009.

11. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for a project at 3 Murray Rose Avenue, Sydney Olympic Park in accordance with DP's proposal dated 5 March 2012 and subsequent acceptance received from Lend Lease. The report is provided for the use of Lend Lease Project Management & Construction (Australia), and its client GPT, for this project only and for the purpose(s) described in the report. It should not be used for other projects or by a third party.

The results provided in the report are indicative of the sub-surface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic 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 limited by undetected variations in ground conditions between sampling locations. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

Douglas Partners Pty Ltd

Appendix A

About this Report

About this Report

Introduction

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

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

Copyright

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

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

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.

Sampling Methods

Douglas Partners

Sampling

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

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

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

Test Pits

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

Large Diameter Augers

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

Continuous Spiral Flight Augers

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

Non-core Rotary Drilling

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

Continuous Core Drilling

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

Standard Penetration Tests

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

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

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

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

  15, 30/40 mm

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

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

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

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

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

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

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

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

Cohesive Soils

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

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

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

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

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

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

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

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

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

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

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

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

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

Stratification Spacing

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

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

Symbols & Abbreviations

Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

July 2010

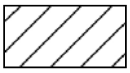
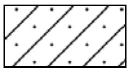
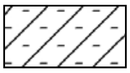
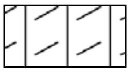
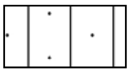
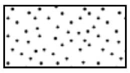
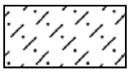
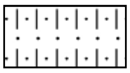
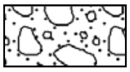
Symbols & Abbreviations

Graphic Symbols for Soil and Rock

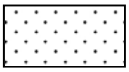
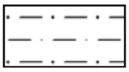
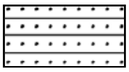
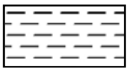
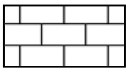
General

■	Asphalt
	Road base
	Concrete
	Filling

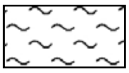
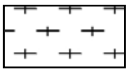
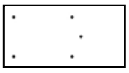
Soils

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

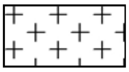
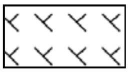
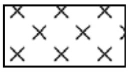
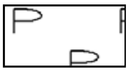
Sedimentary Rocks

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

Metamorphic Rocks

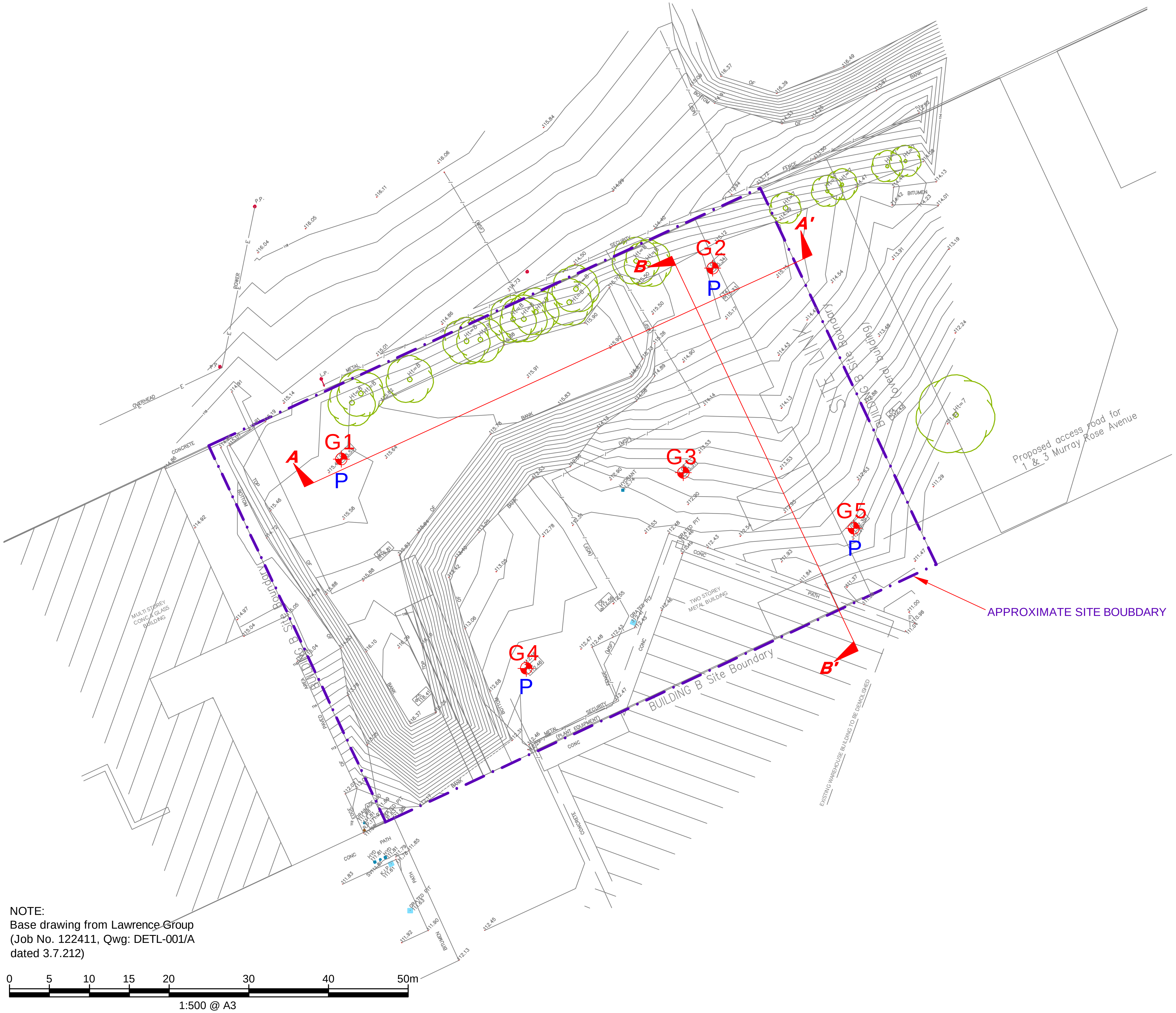
	Slate, phyllite, schist
	Gneiss
	Quartzite

Igneous Rocks

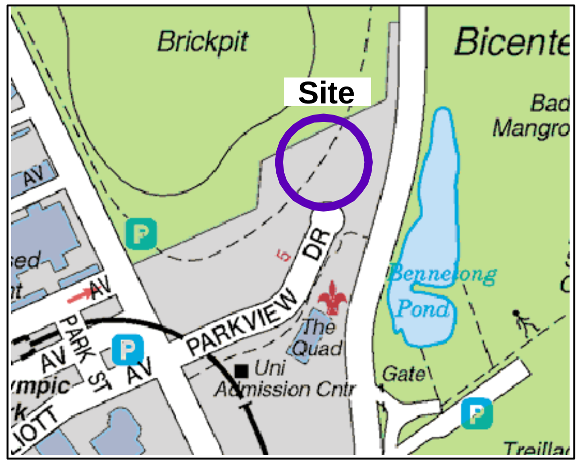
	Granite
	Dolerite, basalt, andesite
	Dacite, epidote
	Tuff, breccia
	Porphyry

Appendix B

Drawings



NOTE:
Base drawing from Lawrence Group
(Job No. 122411, Qwg: DETL-001/A
dated 3.7.212)



Locality Plan

LEGEND

- ⊕ Geotechnical Borehole Location
- P Standpipe Piezometer

Douglas Partners
Geotechnics | Environment | Groundwater

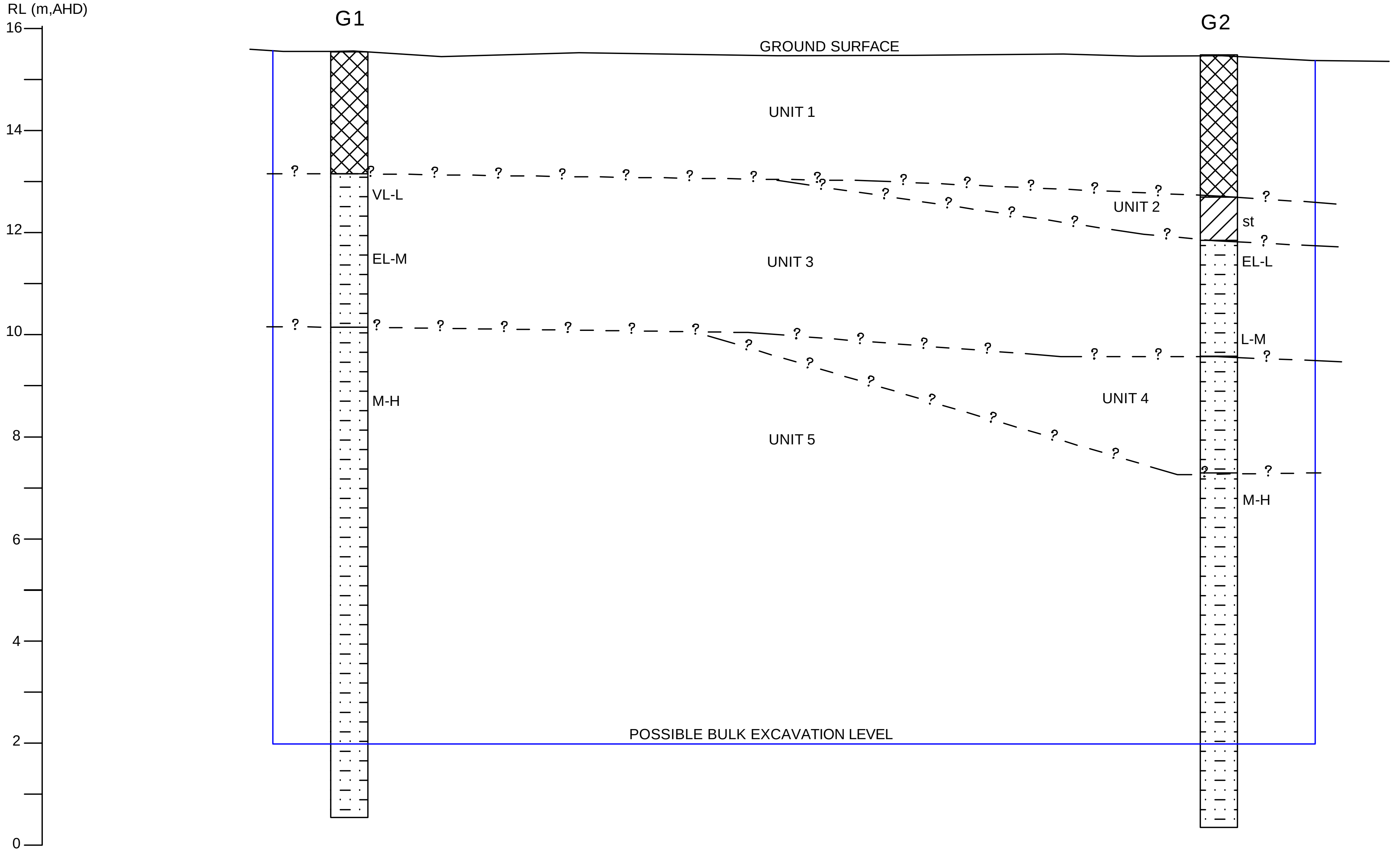
CLIENT: Lend Lease
OFFICE: Sydney
DRAWN BY: PSCH
SCALE: As shown
DATE: 23.7.2012

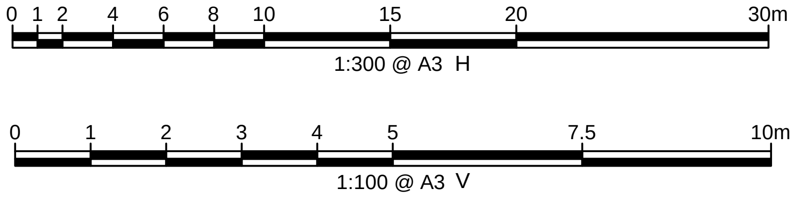
TITLE: **Location of Geotechnical Boreholes**
Proposed Commercial Development
3 Murray Rose Avenue, SYDNEY OLYMPIC PARK

N

PROJECT No: 45153.02
DRAWING No: G1
REVISION: 0

P:\45153.02 SYDNEY OLYMPIC PARK, 3 Murray Rose Ave PMO\Drawings\45153.02-1.dwg, 23/07/2012 2:46:09 PM





LEGEND

Unit Descriptions

UNIT 1	Filling
UNIT 2	Residual Soil
UNIT 3	Class V/IV Rock
UNIT 4	Class III Rock
UNIT 5	Class II/I Rock

▩	FILLING
▨	CLAY
▤	SILTSTONE/SHALE
– ? – –	Inferred strata boundary

st stiff
EL Extremely low strength
VL Very low strength
L Low strength
M Medium strength
H High strength

Note: Strata boundaries are inferred.
Depths accurate only at test locations.

Douglas Partners
Geotechnics / Environment / Groundwater

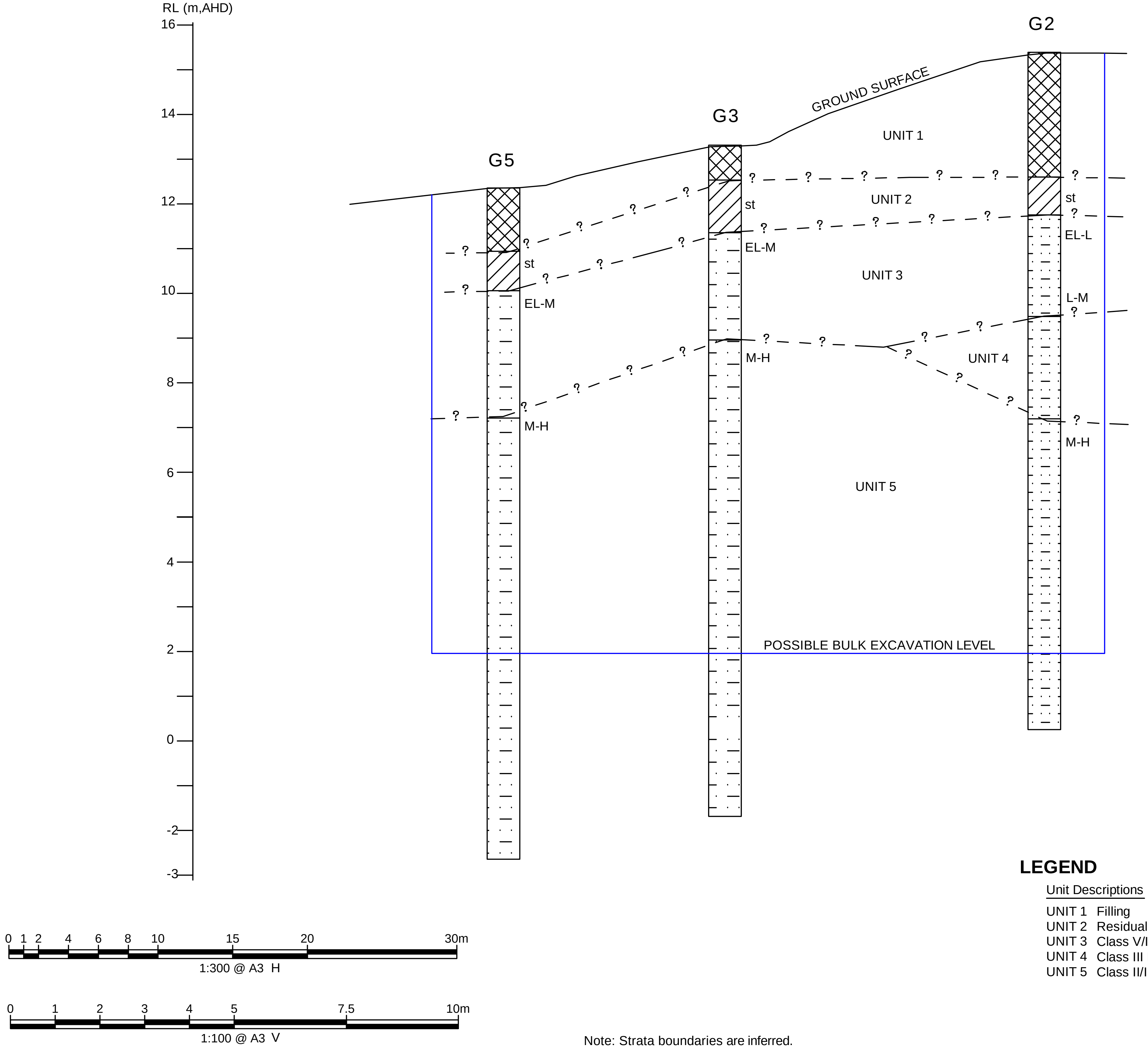
CLIENT: Lend Lease	
OFFICE: Sydney	DRAWN BY: PSCH
SCALE: As shown	DATE: 23.7.2012

TITLE: **Cross-Section A-A'**
Proposed Commercial Development
3 Murray Rose Avenue, SYDNEY OLYMPIC PARK

N

PROJECT No:	45153.02
DRAWING No:	G2
REVISION:	0

P:\45153.02 SYDNEY OLYMPIC PARK, 3 Murray Rose Ave PMO\Drawings\45153.02-G2.dwg, 23/07/2012 2:47:07 PM



LEGEND

Unit Descriptions

UNIT 1	Filling
UNIT 2	Residual Soil
UNIT 3	Class V/IV Rock
UNIT 4	Class III Rock
UNIT 5	Class II/I Rock

▩	FILLING
▨	CLAY
⁝	SILTSTONE/SHALE

– ? – – Inferred strata boundary

st stiff
EL Extremely low strength
VL Very low strength
L Low strength
M Medium strength
H High strength

Note: Strata boundaries are inferred.
Depths accurate only at test locations.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Lend Lease
OFFICE: Sydney
DRAWN BY: PSCH
SCALE: As shown
DATE: 23.7.2012

TITLE: **Cross-Section B-B'**
Proposed Commercial Development
3 Murray Rose Avenue, SYDNEY OLYMPIC PARK

N

PROJECT No: 45153.02
DRAWING No: G3
REVISION: 0

P:\45153.02 SYDNEY OLYMPIC PARK, 3 Murray Rose Ave PMO\Drawings\45153.02-G3.dwg, 23/07/2012 2:47:34 PM

Appendix C

Results of Field Work

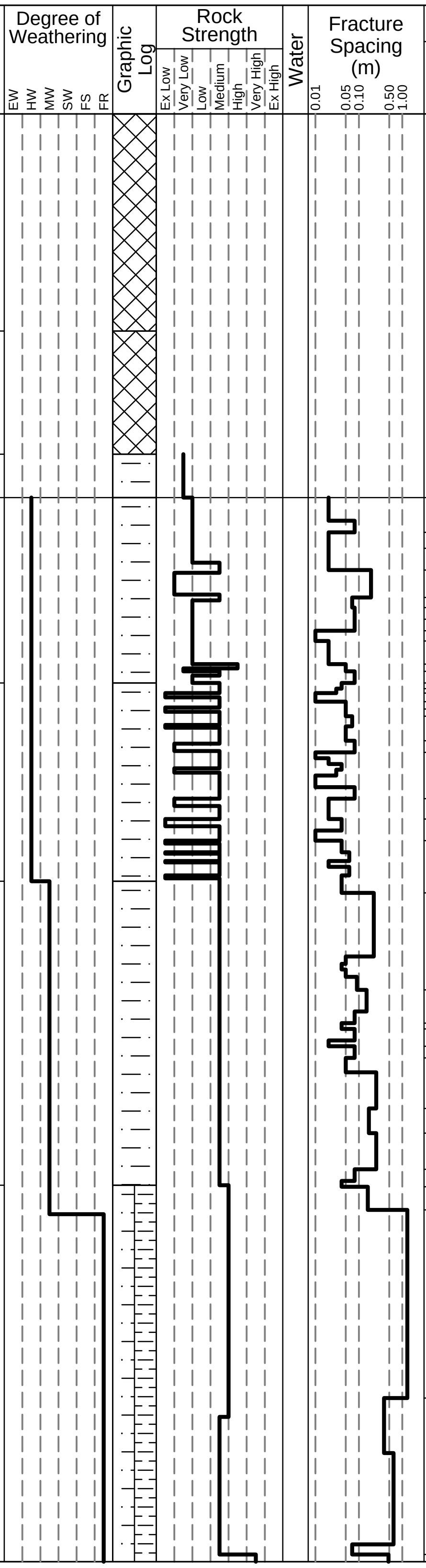
BOREHOLE LOG

CLIENT: Lend Lease
PROJECT: Proposed Commercial Development
LOCATION: 3 Murray Rose Avenue, Sydney Olympic Park

SURFACE LEVEL: 15.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: G1
PROJECT No: 45153.02
DATE: 8/6/2012
SHEET 1 OF 2

Depth (m)	Description of Strata
	FILLING - light grey-brown, crushed shale filling
1.5	FILLING - grey-brown, silty sandy clay filling with crushed shale and sandstone fragments, moist
2.35	SILTSTONE - very low strength, grey brown siltstone
2.65	SILTSTONE - very low to low strength, highly weathered, highly fractured and fractured, light grey and brown siltstone with some medium and high strength bands
3.93	SILTSTONE - alternate bands of extremely low and medium strength, highly weathered, highly fractured and fractured, grey-brown siltstone
5.3	SILTSTONE - medium strength, moderately weathered, fractured and slightly fractured, grey brown siltstone
7.4	SILTSTONE/SHALE - medium and medium to high strength, fresh, slightly fractured and unbroken, grey siltstone/shale with approximately 5-10% fine grained sandstone laminae. Some very high strength sideritic bands



Discontinuities

B - Bedding J - Joint
S - Shear F - Fault

Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping at 0°-10°

2.65m: J70°, ro, un, cln
2.81m: B0°, Cz, 15mm
2.89m: B0°, fe & J70°, he
3.0-3.15m: fg, fe, cly
3.15-3.34m: Ds, 190mm
3.34m: J85°, ro, un, fe
3.41m: B5°, fe, cly, 10mm
3.49m: J25°, ro, pl, fe
3.57m: J, sv, ro, un, fe
3.64m: J45°, ro, un, fe, cly
3.8m: J45°, ro, pl, cly
3.85m: B0°, cly, 5mm
3.93m: B5°, fe, cly, 5mm
3.97m: B5°, fe, cly co
4m: B0°- 5°, cly, 15mm
4.06m: B0°, cly co
4.11m: B5°, cly, 15mm
4.16-4.28m: B(x3) 5°, fe, cly co
4.33-4.39m: Ds, 60mm
4.41-4.73m: B0°- 5°, fe, cly, 3-5mm
4.73-4.78m: Ds, 50mm
4.87-4.92m: Ds, 50mm
5.02-5.26m: B (x6) 0°- 5°, cly, 5-10mm
5.38-5.87m: B (x5) 0°- 5°, cly vn
6.05 & 6.20m: B0°- 5°, fe, cly vn
6.28m: J30°, ro, pl, fe
6.32m: J70°, he, fe
6.44m: J (x2) 55° & 90°, he/ti
6.52 & 6.62m: B5°, fe, cly
6.87m: J85°, ro, pl, fe
7.04m: J85°, ro, un, fe
7.29 & 7.37m: J (x2) 10°- 20°, ro, pl, fe
7.41m: B0°, fe
7.57m: J (x2) 35°, ro, pl, fe
8.87m: J40°, ro, pl, fe
9.25m: J70°, ro, un, fe
9.88m: B5°, cly, 5mm

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
A			
A			
A			
S			14,8/30mm refusal
S			25/150mm refusal
C	100	0	PL(A) = 2
C	100	26	PL(A) = 0.5 PL(A) = 0.6 PL(A) = 0.4
C	100	94	PL(A) = 1 PL(A) = 1 PL(A) = 0.8

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 2.5m
TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 2.65m; NMLC-Coring to 15.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Standpipe installed to 15.0m

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

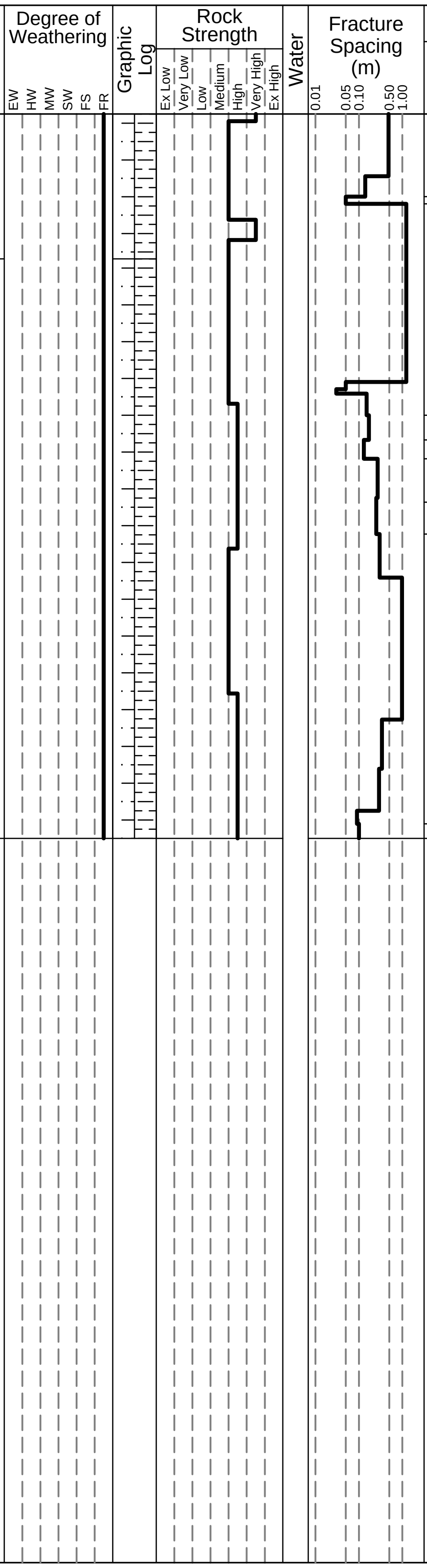
BOREHOLE LOG

CLIENT: Lend Lease
PROJECT: Proposed Commercial Development
LOCATION: 3 Murray Rose Avenue, Sydney Olympic Park

SURFACE LEVEL: 15.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: G1
PROJECT No: 45153.02
DATE: 8/6/2012
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
5			9.95m: J85°, he 10.45m: J75°- 80°, ro, un, cln 10.57m: J45°, ro, pl, cln 10.62m: B0°, cly, Cz, 10mm				PL(A) = 4.1
4	11.0	SILTSTONE/SHALE - medium to high and high strength, fresh, slightly fractured, grey siltstone/shale with trace of fine grained sandstone laminations		C	100	97	PL(A) = 1
3	12		11.85 & 11.93m: J (x3) 30°- 40°, ro, pl, cln 12.08m: J65°, sm, pl, cln 12.25m: J30°, sm, pl, cln 12.38m: J30°, sm, pl, cln 12.68m: J50°, sm, pl, cly 12.9m: J90°, ro, pl, si				PL(A) = 1.2
2	13						PL(A) = 0.9
1	14		14.18m: J45°, sm, pl, cln 14.52m: J70°, ro, pl, cln 14.81m: J35°, sm, pl, cln 14.9m: J30°, sm, pl, cln	C	100	95	PL(A) = 1.2
0	15.0	Bore discontinued at 15.0m					
-1	16						
-2	17						
-3	18						
-4	19						



RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 2.5m
TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 2.65m; NMLC-Coring to 15.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Standpipe installed to 15.0m

SAMPLING & IN SITU TESTING LEGEND

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

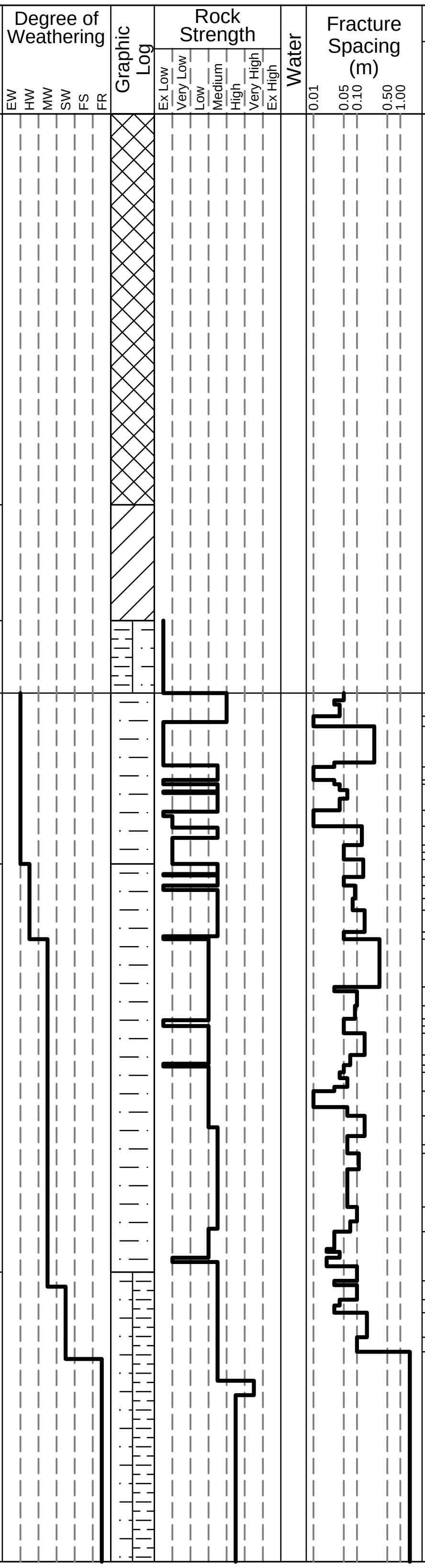
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Lend Lease
PROJECT: Proposed Commercial Development
LOCATION: 3 Murray Rose Avenue, Sydney Olympic Park

SURFACE LEVEL: 15.3 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: G2
PROJECT No: 45153.02
DATE: 5 - 6/6/2012
SHEET 1 OF 2



Discontinuities: B - Bedding, J - Joint, S - Shear, F - Fault

RL	Depth (m)	Description of Strata	Discontinuities	Type	Core Rec. %	RQD %	Test Results & Comments
15	0.0	FILLING - grey to grey-brown, silty clay filling with some crushed shale and sandstone fragments, moist		A A A			
14	1			S			2,5,6 N = 11
13	2						
				S			3,4,7 N = 11
12	2.7	CLAY - stiff, light grey-brown clay with a trace of ironstone gravel, moist	Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping at 0°-10°				
	3.5	SHALE/SILTSTONE - extremely low strength, grey-brown shale/siltstone					
11	4.0	SILTSTONE - extremely low and extremely to very low strength, extremely to highly weathered, fragmented to fractured, light grey and brown siltstone with some medium and medium to high strength bands	4.05-4.12m: B (x3) 0°, cly co, 1-2mm 4.16m: J70°, ro, un, cly 4.16-4.23m: fg 4.23-4.48m: Ds, 250mm 4.51m: J55°, ro, un, cly co 4.51-4.6m: fg, fe 4.6m: B0°, cly, 15mm 4.63-4.81m: B0°, cly, 1-2mm 4.81m: B5°, cly, 20mm 4.92m: B5°, cly, 5mm 5.05m: B10°, fe 5.1m: B0°, Ds, 25mm 5.15m: J40°, he	C	100	26	PL(A) = 1
10	5.18	SILTSTONE - low to medium and medium strength, highly then moderately weathered, fractured and slightly fractured, grey-brown siltstone with some extremely low and extremely low to very low strength bands	5.27m: B0°- 5°, fe, cly 5.33m: B5°, Ds, 25mm 5.42m: B0°, cly, 2mm 5.5m: B0°, fe 5.65m: J35°, ro, un, cly 5.7m: J85°, ro, un, cln 6.03 & 6.06m: B5°, fe 6.16m: J40°, sm, pl, cln 6.25m: B5°, Ds, 40mm 6.3m: J, sv, ro, un, cly 6.35m: J75°, ro, pl, cln 6.5m: J75°, ro, un, fe 6.57m: B0, fe, cly, 10mm 6.62 & 6.67m: J (x2) 50°, ro, pl, fe, he 6.75-6.86m: fg, fe 6.92m: J30°, sm, pl, fe 7.12m: J25°, sm, pl, fe 7.18 & 7.29m: B0°, fe 7.55m: J30°- 70°, cu, ro, fe 7.72m: J70°, ro, pl, fe 7.72-7.96m: B (x9) 0°-10°, fe, cly vn	C	100	67	PL(A) = 0.5 PL(A) = 0.3 PL(A) = 0.7
8	8.0	SILTSTONE/SHALE - medium then high strength, slightly weathered then fresh, slightly fractured and unbroken, grey siltstone/shale with approximately 5% fine grained sandstone laminations. Some very high strength sideritic bands	8.06 & 8.09m: B0°, fe 8.19 & 8.23m: J (x2) 35°- 40°, he/ti	C	100	93	PL(A) = 0.5 PL(A) = 6.1 PL(A) = 1.1

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 4.0m; NMLC-Coring to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 15.0m

SAMPLING & IN SITU TESTING LEGEND

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

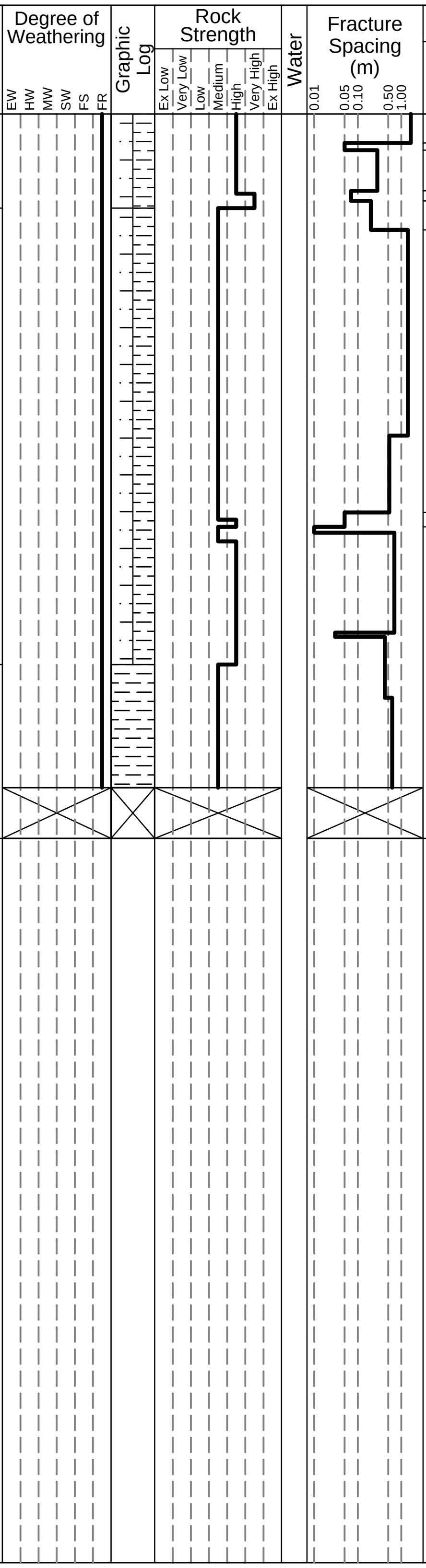
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Lend Lease
PROJECT: Proposed Commercial Development
LOCATION: 3 Murray Rose Avenue, Sydney Olympic Park

SURFACE LEVEL: 15.3 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: G2
PROJECT No: 45153.02
DATE: 5 - 6/6/2012
SHEET 2 OF 2



Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
		8.28m: J35°- 75°, cu, ro, fe 8.45m: J90°, ro, pl, cln 8.55m: B0°, fe 10.2m: J50°, ro, pl, cln				PL(A) = 1.1
10.65	SILTSTONE/SHALE - medium then high strength, fresh, slightly fractured and unbroken, grey siltstone/shale with a trace of fine grained sandstone laminations	10.25m: J80°, ro, pl, cln 10.53m: J30°, sm, pl, cln 10.6m: J75°, ro, pl, cln 10.8m: J70°, ro, pl, cln	C	100	93	PL(A) = 0.9 PL(A) = 0.8
		12.72m: J75°, ro, pl, cln 12.75m: J45°, sl, sm, cln 12.85-12.89m: Cz, 40mm 13.58m: J50°, sm, pl, cln	C	84	79	PL(A) = 2.8 PL(A) = 1.3
13.8	SHALE - medium strength, fresh, slightly fractured, grey shale	14.03m: J30°, sm, pl, cln				PL(A) = 0.6
	14.65-15.0m: core left down the hole	14.65m: CORE LOSS: 350mm 14.65-15.0m: core left down hole				
15.0	Bore discontinued at 15.0m					

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 2.5m
TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 4.0m; NMLC-Coring to 15.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Standpipe installed to 15.0m

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

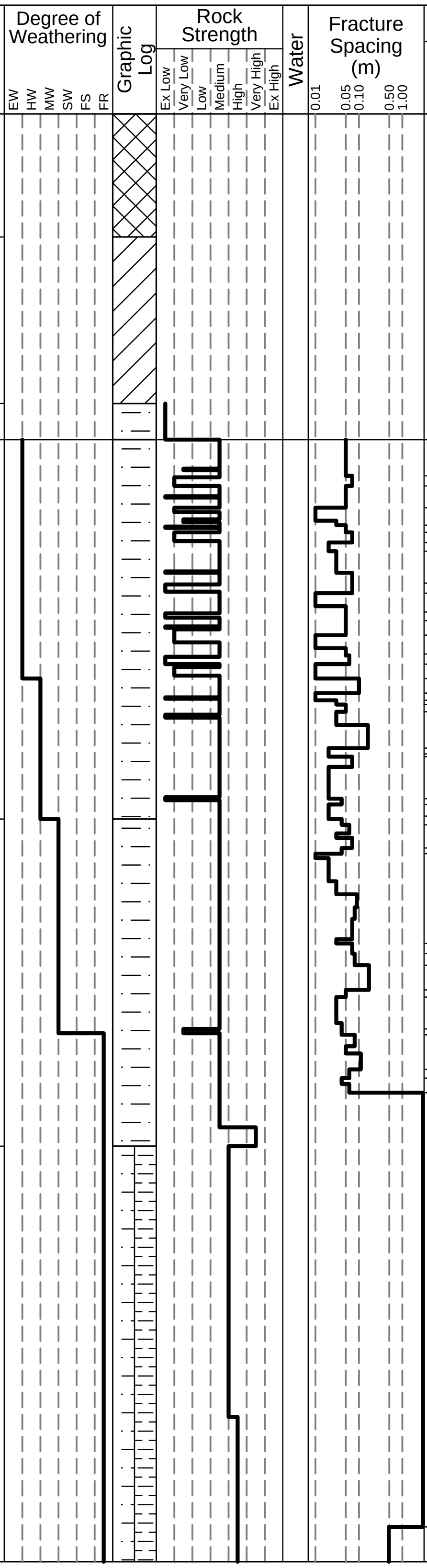
BOREHOLE LOG

CLIENT: Lend Lease
PROJECT: Proposed Commercial Development
LOCATION: 3 Murray Rose Avenue, Sydney Olympic Park

SURFACE LEVEL: 13.2 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: G3
PROJECT No: 45153.02
DATE: 4 - 5/6/2012
SHEET 1 OF 2

Depth (m)	Description of Strata
0.0	FILLING - grey to grey-brown, clay filling with a trace of roadbase gravel and brick fragments, moist to wet
0.85	CLAY - firm to stiff, light brown and red-brown clay, moist 1.8m: becoming shaly clay
2.0	SILTSTONE - extremely low strength, light grey-brown siltstone
2.25	SILTSTONE - alternate bands of extremely low to very low and medium strength, extremely to highly then highly to moderately weathered, fragmented to fractured, light grey and brown siltstone
4.87	SILTSTONE - medium strength, moderately to slightly weathered then fresh, highly fractured to fractured, grey-brown then grey siltstone 7.0-7.13m: very high strength siderite band
7.13	SILTSTONE/SHALE - medium to high then high strength, fresh, slightly fractured and unbroken, grey siltstone/shale with approximately 5% fine grained sandstone laminations



Discontinuities

B - Bedding J - Joint
S - Shear F - Fault

Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping at 0°-10°

2.25-2.5m: B/J (x5) 0°-15°, fe, cly vn
2.5-2.57m: Ds, 70mm
2.57-2.72m: B (x5) 0°, fe, cly vn
2.72-2.81m: fg, fe, cly
2.84m: B0°, cly, 5mm
2.89m: B5°, fe, Ds, 40mm
2.96m: J30°, ro, un, fe, cly
3.02-3.17m: B/J (x4) 0°-15°, cly co, 1-3mm, he
3.24m: J25°- 30°, ro, pl, fe, Ds, 50mm
3.31m: J35°, ro, un, fe
3.31-3.4m: fg, fe, cly
3.44m: J20°, ro, pl, fe, cly, 15mm
3.5 & 3.6m: B0°, cly, 2-5mm
3.6-3.69m: fg, fe, cly co, 2-5mm
3.73m: J25°, ro, un, fe, Ds, 40mm
3.8-3.9m: fg, fe, cly
3.9m: J35°, ro, un, fe
4m: J30°, ro, pl, fe
4.05m: B0°, fe, cly, 5mm
4.08m: J, sv, ro, un, cln
4.13m: B5°, fe, cly, 15mm
4.13-4.22m: B/J 0°- 15°, fe, he
4.38m: J30°, ro, un, cln
4.42m: J45°, sl, sm, Cz, 30mm, cly
4.44-4.71m: B (x11) 0°, cly vn, fe
4.73m: B0°, cly, 15mm
4.77-4.85m: B/J 0°- 25°, fe
4.85m: J30°, ro, pl, fe
4.91m: B0°, cly co, 2mm
5.07m: J60°, ro, pl, cln
5.11-5.7m: B (x17) 0°, fe, cly vn
5.73m: J65°, ro, pl, cln
5.8m: J25°, ro, pl, cln
5.88m: J25°, sm, pl, cln
6.05m: J25°, sm, pl, cly co
6.1-6.28m: B (x6) 0°-10°, fe, cly vn
6.32m: B0°, fe, Cz,

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
A			
A			
A			
S			1,4,4 N = 8
C	100	0	PL(A) = 0.9 PL(A) = 0.8
C	100	29	PL(A) = 0.4 PL(A) = 0.6 PL(A) = 0.4
C	100	100	PL(A) = 4.4 PL(A) = 1 PL(A) = 1.1

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 2.25m
TYPE OF BORING: Solid flight auger to 2.25m; NMLC-Coring to 14.95m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: 60% water loss from 4.2m

SAMPLING & IN SITU TESTING LEGEND

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

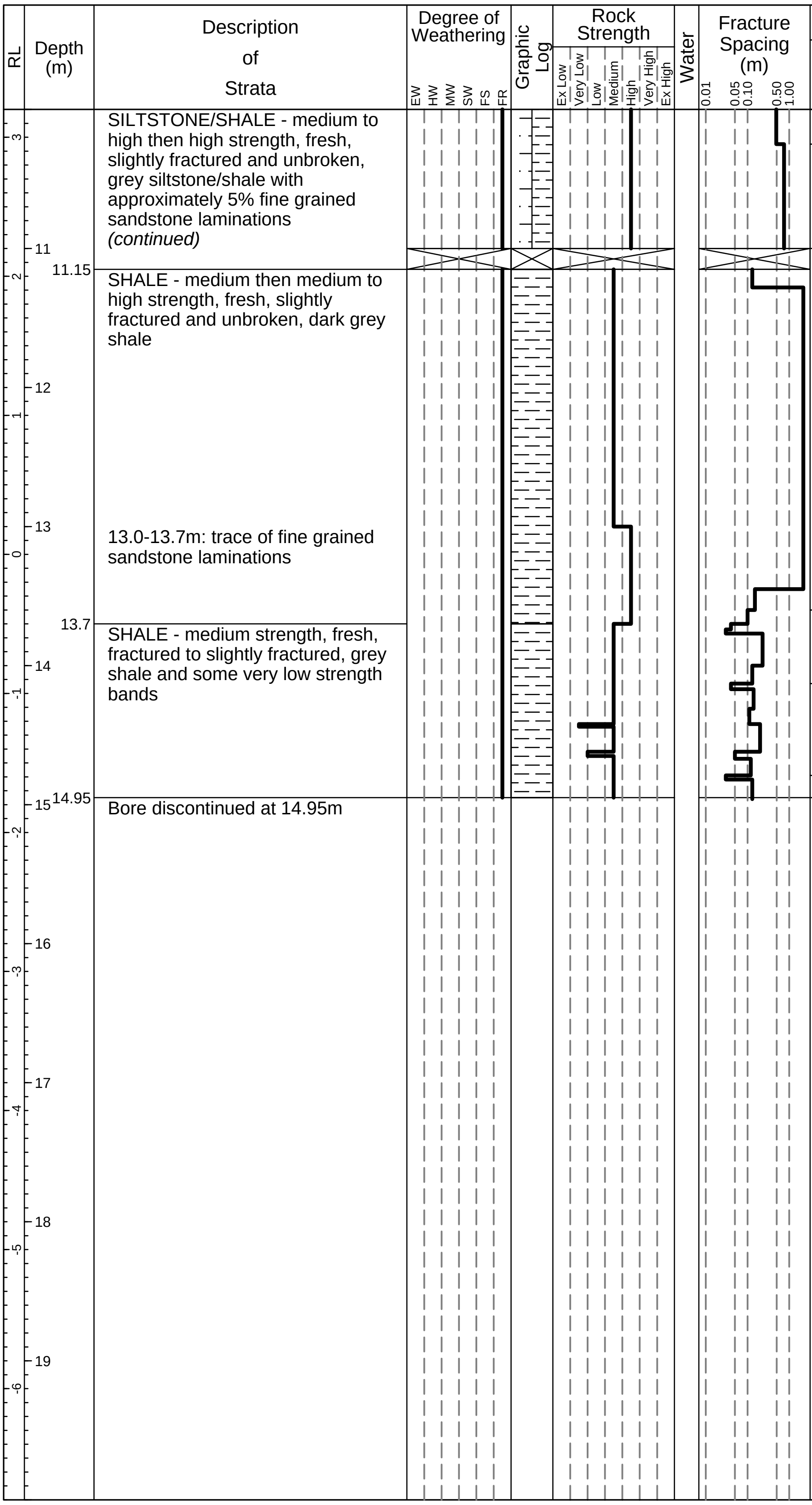
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Lend Lease
PROJECT: Proposed Commercial Development
LOCATION: 3 Murray Rose Avenue, Sydney Olympic Park

SURFACE LEVEL: 13.2 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: G3
PROJECT No: 45153.02
DATE: 4 - 5/6/2012
SHEET 2 OF 2



Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
	SILTSTONE/SHALE - medium to high then high strength, fresh, slightly fractured and unbroken, grey siltstone/shale with approximately 5% fine grained sandstone laminations *(continued)*	30mm 6.36-6.55m: J75°, sm, pl, cln, he 6.6m: J60°, ro, un, cln 6.66m: J40°, sm, pl, cln 6.76m: J30°, sm, pl, cln 9.76m: J35°, sm, un, cln 10.25m: J75°, sm, pl, cln 11m: CORE LOSS: 150mm	C	95	95	PL(A) = 1.3
11.15	SHALE - medium then medium to high strength, fresh, slightly fractured and unbroken, dark grey shale					PL(A) = 0.8 PL(A) = 0.8
	13.0-13.7m: trace of fine grained sandstone laminations	13.45m: J (x2) 35° & 85°, ro, pl, cln 13.6-13.77m: J (x4) 30°- 35°, ro, pl, cln	C	100	85	PL(A) = 1
13.7	SHALE - medium strength, fresh, fractured to slightly fractured, grey shale and some very low strength bands	14m: J35°, sm, pl, cly co 14.13m: J (x2) 65° & 75°, ro, un, cln 14.62-14.67m: J (x2) 30°- 40°, sm, pl, Cz, 20mm 14.79 & 14.82m: J (x2) 35°- 50°, sm, pl, Cz, 5mm, cly				PL(A) = 0.8 PL(A) = 0.4
14.95	Bore discontinued at 14.95m					

RIG: DT 100
DRILLER: S Salib
LOGGED: SI
CASING: HW to 2.25m

TYPE OF BORING: Solid flight auger to 2.25m; NMLC-Coring to 14.95m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: 60% water loss from 4.2m

SAMPLING & IN SITU TESTING LEGEND

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

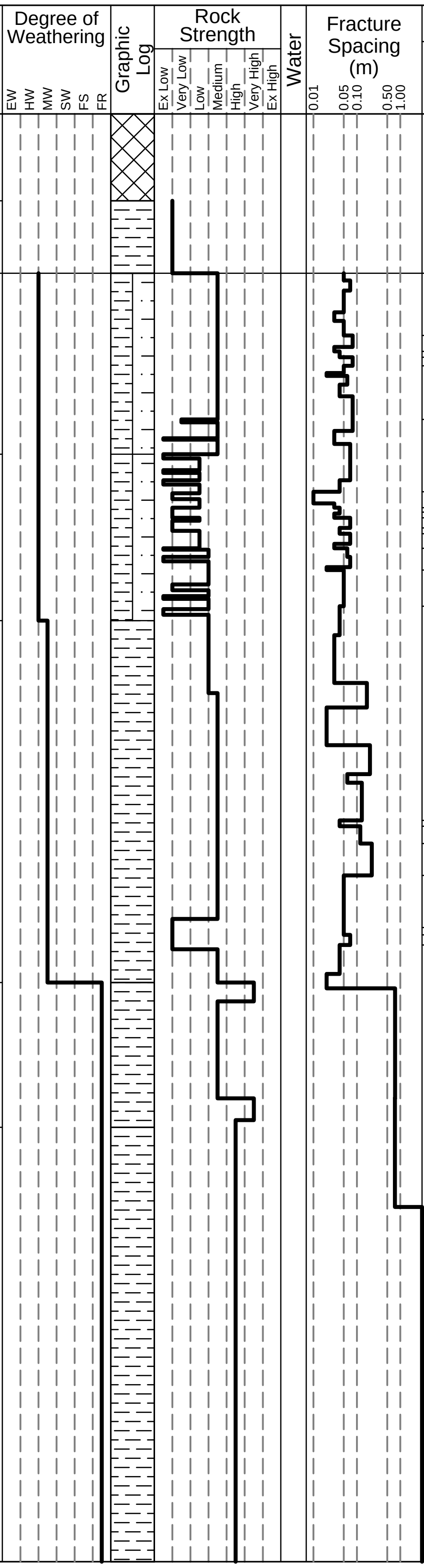
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Lend Lease
PROJECT: Proposed Commercial Development
LOCATION: 3 Murray Rose Avenue, Sydney Olympic Park

SURFACE LEVEL: 12.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: G4
PROJECT No: 45153.02
DATE: 25/6/2012
SHEET 1 OF 2



Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
	FILLING - dark grey and brown, gravelly clay filling	Note: Unless otherwise stated, rock is fractured along rough planar bedding planes dipping 0°- 10°	A A			
0.6	SHALE - extremely low to very low strength, light grey-brown shale		A			
1.1	SHALE/SILTSTONE - medium strength, highly to moderately weathered, highly fractured and fractured, light grey and brown shale/siltstone	1.1-1.43m: B (x8) 0°- 5°, cly vn, fe 1.43m: J60°, ro, un, cly 1.53m: J65°, ro, un, cln 1.64m: J40°, ro, un, cln 1.68m: J35°, ro, un, cln 1.74-2.03m: B (x10) 0°- 5°, cly vn, fe 2.11-2.53m: B (x5) 0°- 5°, fe, cly, 3-10mm	C	100	0	PL(A) = 0.8 PL(A) = 0.2
2.35	SHALE/SILTSTONE - low then low to medium strength, highly to moderately weathered, highly fractured and fractured, grey-brown shale/siltstone interbedded with some extremely low strength bands	2.57m: J, sv, ro, cu, fe 2.61-2.69m: fg, cly, fe 2.72m: B0°, fe, cly, 5mm 2.75-2.79m: Ds, 40mm 2.79m: J30°, ro, un, fe, cly, 10mm 2.86m: B0°, fe, cly, 10mm 2.9m: J35°, ro, un, fe				PL(A) = 0.3
3.5	SHALE - medium strength, moderately weathered, fractured and slightly fractured, grey brown shale 5.56-5.77m: extremely low to very low strength band	3.0-3.4m: B (x7) 0°- 5°, fe, cly, 5-30mm 3.15m: J45°, ro, un, fe 3.4-4.62m: B (x28) 0°, fe, cly vn 4.75m: J25°, ro, pl, cln 4.88m: J30°, sm, pl, cln 4.92m: J50°, ro, un, cln 5.04m: J90°, ro, pl, cln 5.26m: J25°, sm, pl, cln 5.55m: J50°, sm, pl, cly, 2mm & J70°, ro, un, Cz, 5mm 5.62m: J35°, ro, un, fe 5.67m: J35°, sm, pl, cln, ti 5.74-6.04m: B (x6) 0°- 5°, fe	C	100	74	PL(A) = 0.5 PL(A) = 0.8
6.0	SHALE - medium strength, fresh, slightly fractured, grey shale with very high strength sideritic bands	6.8-7.0m: J85°, ro, un, fe				PL(A) = 4.4 PL(A) = 0.8
7.0	SHALE - high strength, fresh, unbroken, grey shale with trace of fine grained sandstone laminations	7.55m: B0°, fe >>	C	100	100	PL(A) = 1.1 PL(A) = 1.2 PL(A) = 1.9
10.0						

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 1.0m

TYPE OF BORING: Solid flight auger to 1.0m; Rotary to 1.10m; NMLC-Coring to 15.10m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 15.10m

SAMPLING & IN SITU TESTING LEGEND

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

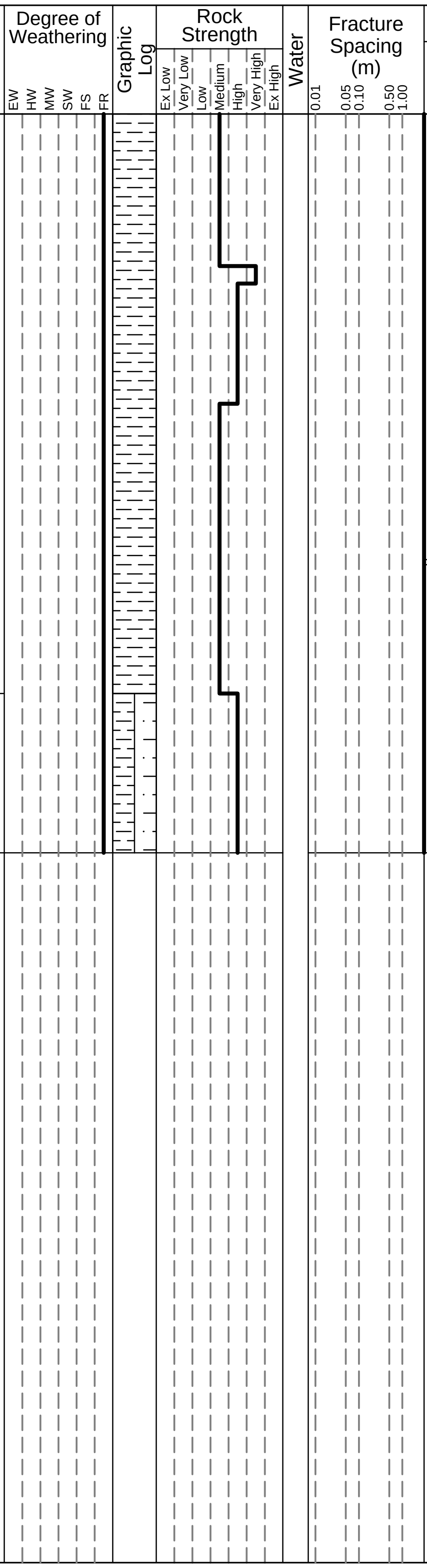
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Lend Lease
PROJECT: Proposed Commercial Development
LOCATION: 3 Murray Rose Avenue, Sydney Olympic Park

SURFACE LEVEL: 12.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: G4
PROJECT No: 45153.02
DATE: 25/6/2012
SHEET 2 OF 2



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
		SHALE - medium and high strength, fresh, unbroken, grey shale					PL(A) = 0.9
2	11	11.05-11.17m: very high strength sideritic band	11.08m: J85°, ro, un, cln				PL(A) = 3.1
1				C	100	100	PL(A) = 1.2
0	12						PL(A) = 0.8
-1	13		>>				PL(A) = 0.8
-2	14 14.0	SHALE/SILTSTONE - high strength, fresh, unbroken, grey shale/siltstone with some fine grained sandstone laminations		C	100	100	PL(A) = 1.4
	15 15.1	Bore discontinued at 15.1m					PL(A) = 1.8
-3	16						
-4	17						
-5	18						
-6	19						
-7							

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 1.0m

TYPE OF BORING: Solid flight auger to 1.0m; Rotary to 1.10m; NMLC-Coring to 15.10m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 15.10m

SAMPLING & IN SITU TESTING LEGEND

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

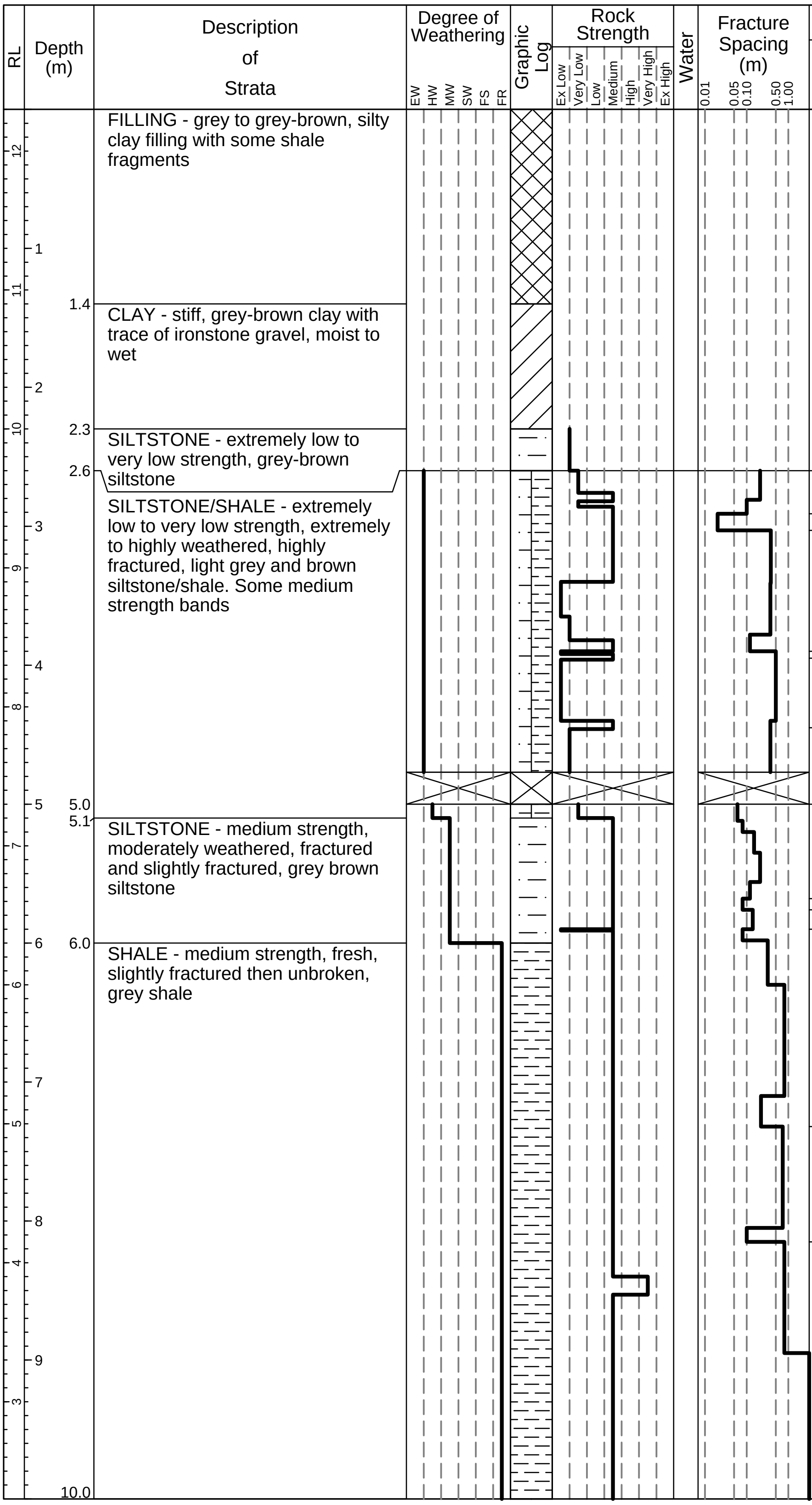
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Lend Lease
PROJECT: Proposed Commercial Development
LOCATION: 3 Murray Rose Avenue, Sydney Olympic Park

SURFACE LEVEL: 12.3 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: G5
PROJECT No: 45153.02
DATE: 6 - 8/6/2012
SHEET 1 OF 2



Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
	FILLING - grey to grey-brown, silty clay filling with some shale fragments		A A A S			3,5,7 N = 12
1.4	CLAY - stiff, grey-brown clay with trace of ironstone gravel, moist to wet	Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping at 0°-10°				
2.3	SILTSTONE - extremely low to very low strength, grey-brown siltstone		S			15/80mm refusal
2.6	SILTSTONE/SHALE - extremely low to very low strength, extremely to highly weathered, highly fractured, light grey and brown siltstone/shale. Some medium strength bands	2.81m: J25°, ro, un, fe 2.91m: J70°, ro, un, cln 3.03m: J50°, ro, un, cln	C	100	0	
		3.41m: B0°, Ds, 50mm 3.78m: J30°, sm, pl, cly	C	100	0	
		3.9m: B0°, fe 3.95-4.4m: Ds, 450mm 4.4m: B0°- 5°, fe 4.45-4.77m: Ds, 320mm 4.77m: CORE LOSS: 230mm	C	77	0	
5.0 5.1	SILTSTONE - medium strength, moderately weathered, fractured and slightly fractured, grey brown siltstone	5.0-5.12m: B0°- 5°, fe 5.2m: J75°, ro, un, cln 5.35m: J25°, ro, pl, fe 5.56m: J85°, ro, pl, cln 5.68m: J50°, ro, pl, cln 5.76m: J30°, ro, pl, cln 5.9m: B0°, cly, 10mm	C	100	87	PL(A) = 0.4
6.0	SHALE - medium strength, fresh, slightly fractured then unbroken, grey shale	6.3-6.6m: J (x2) 75°, ro, pl, cln 7.1-7.25m: J80°, ro, pl, cln 7.32-7.95m: J85°- 90°, un, ro, cln				PL(A) = 0.7 PL(A) = 0.6
		8.05m: J65°, sm, pl, cln 8.15m: J60°, sm, pl, cln 8.95m: J90°, sm, pl, cln	C	100	100	PL(A) = 0.8 PL(A) = 4 PL(A) = 0.9
10.0						

RIG: DT 100 **DRILLER:** LC **LOGGED:** SI **CASING:** HW to 2.5m
TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 2.6m; NMLC-Coring to 15.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Standpipe installed to 15.0m

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

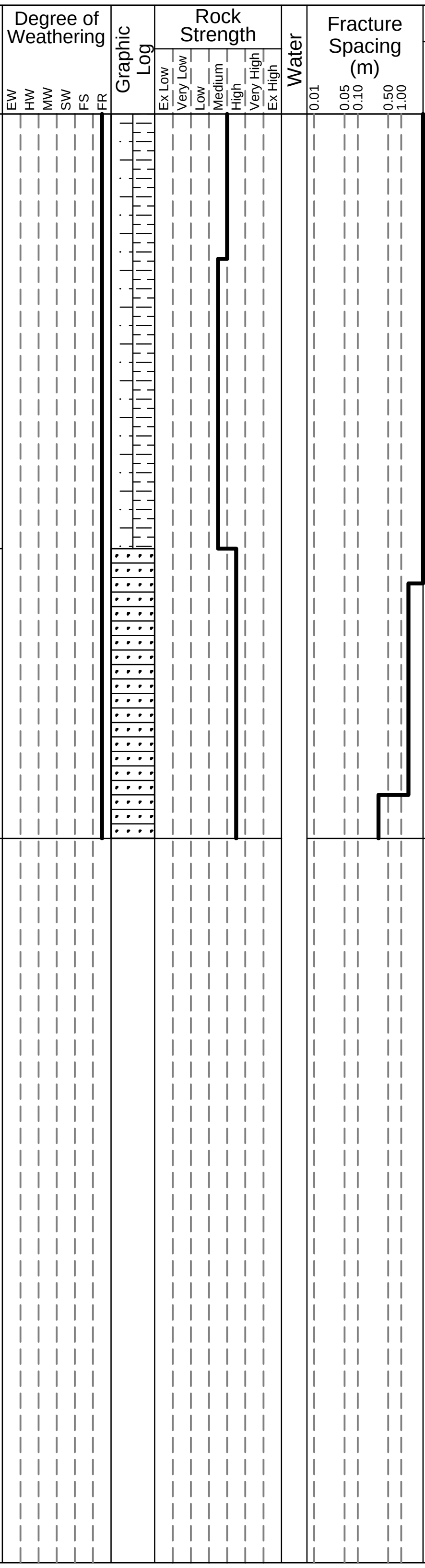
BOREHOLE LOG

CLIENT: Lend Lease
PROJECT: Proposed Commercial Development
LOCATION: 3 Murray Rose Avenue, Sydney Olympic Park

SURFACE LEVEL: 12.3 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: G5
PROJECT No: 45153.02
DATE: 6 - 8/6/2012
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
		SILTSTONE/SHALE - medium to high then medium strength, fresh, unbroken, grey siltstone/shale with approximately 10% fine grained sandstone laminations		C	100	100	PL(A) = 1
	11		>>	C	100	100	PL(A) = 0.9 PL(A) = 0.8
	13.0	LAMINITE - high strength, fresh, slightly fractured and unbroken, light grey and grey laminite with approximately 30% fine grained sandstone laminations	13.24m: B0°, cly vn 13.7m: J30°, sm, pl, cln	C	100	100	PL(A) = 1.6 PL(A) = 2.5
	15.0	Bore discontinued at 15.0m					



RIG: DT 100 **DRILLER:** LC **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 2.6m; NMLC-Coring to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 15.0m

SAMPLING & IN SITU TESTING LEGEND

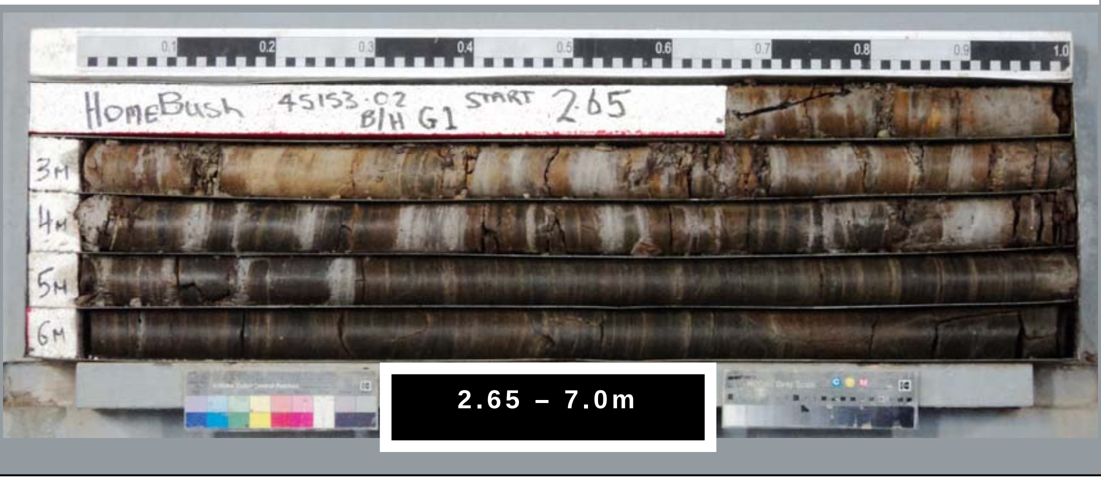
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample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

Douglas Partners
Geotechnics / Environment / Groundwater

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

BORE G1 PROJECT 45153.02 JUN 2012

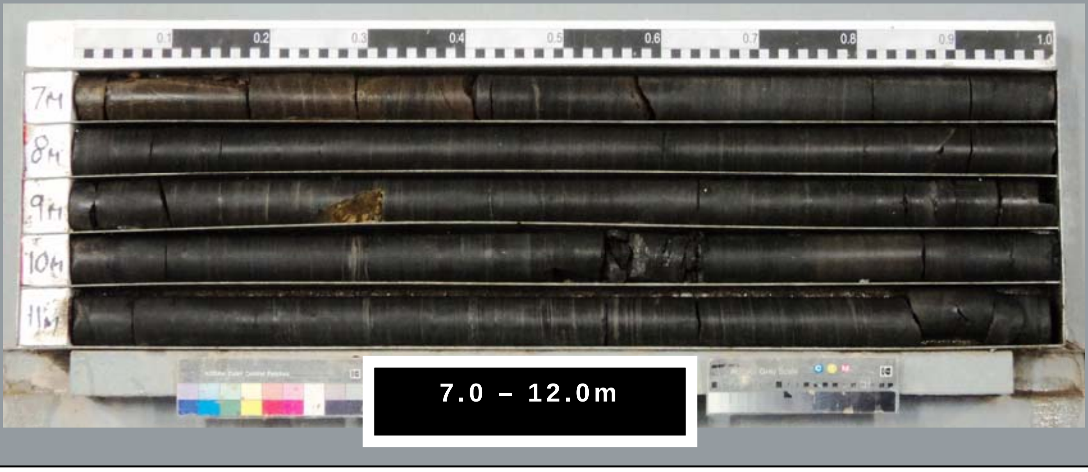


2.65 – 7.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

BORE G1 PROJECT 45153.02 JUN 2012

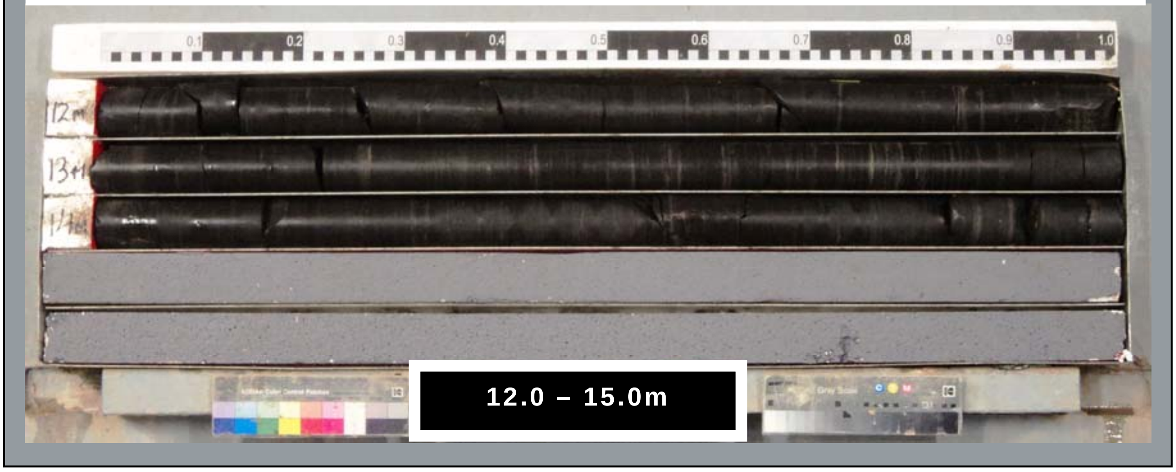


7.0 – 12.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

BORE G1 PROJECT 45153.02 JUN 2012



12.0 – 15.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

BORE G2 PROJECT 45153.02 JUN 2012

4.0 – 8.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

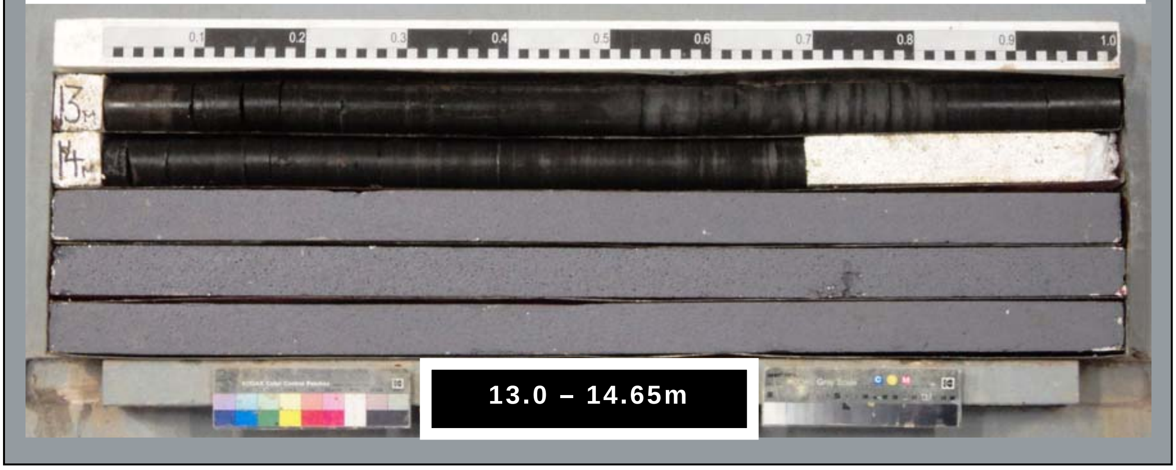
BORE G2 PROJECT 45153.02 JUN 2012

8.0 – 13.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

BORE G2 PROJECT 45153.02 JUN 2012



13.0 – 14.65m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

BORE G3 **PROJECT 45153.02** **JUN 2012**

2.25 – 6.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

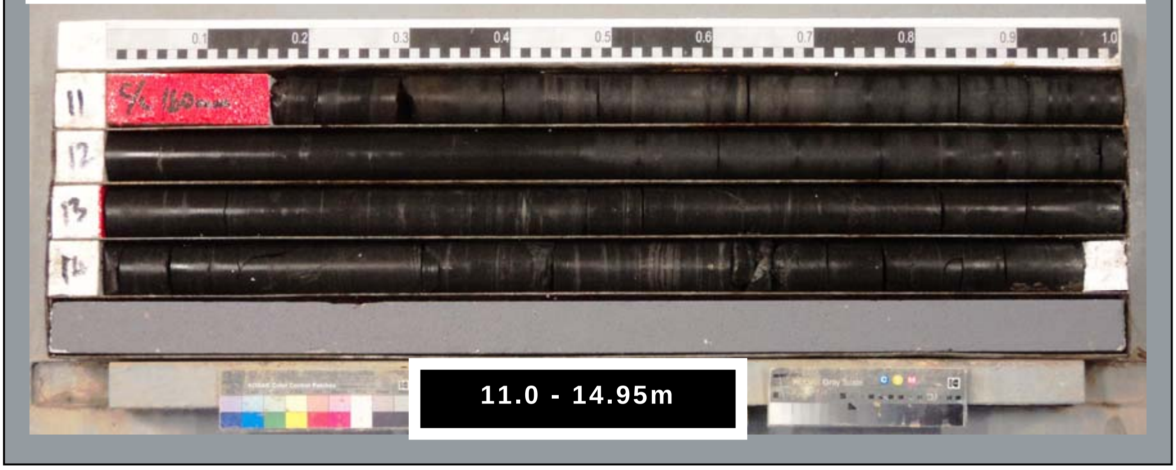
BORE G3 **PROJECT 45153.02** **JUN 2012**

6.0 – 11.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

BORE G3 PROJECT 45153.02 JUN 2012

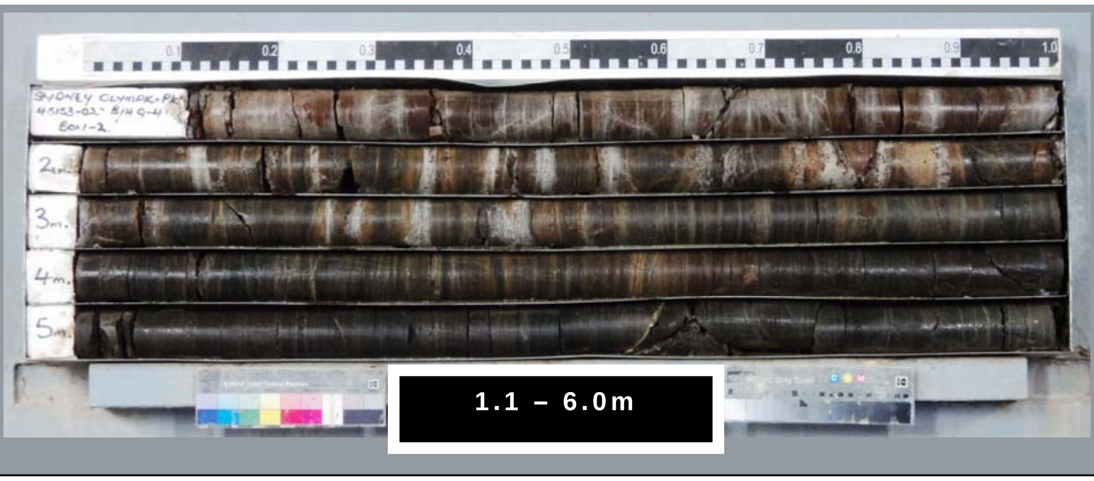


11.0 - 14.95m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

BORE G4 PROJECT 45153.02 JUN 2012

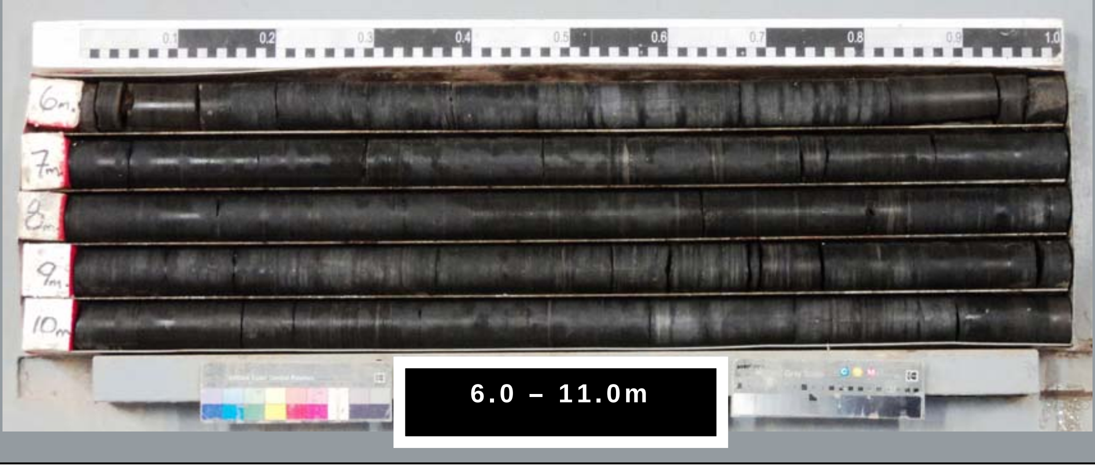


1.1 – 6.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

BORE G4 PROJECT 45153.02 JUN 2012

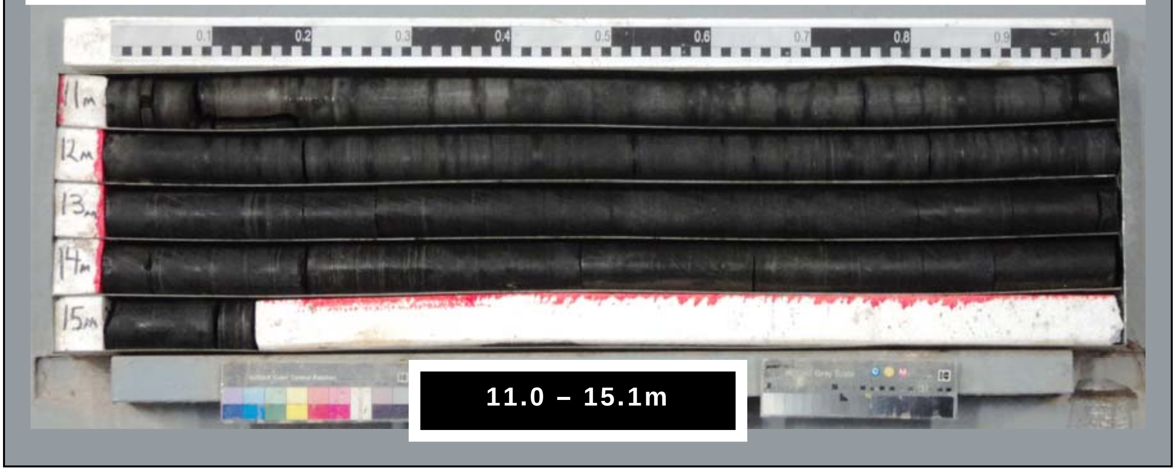


6.0 – 11.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

BORE G4 PROJECT 45153.02 JUN 2012



11.0 – 15.1m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

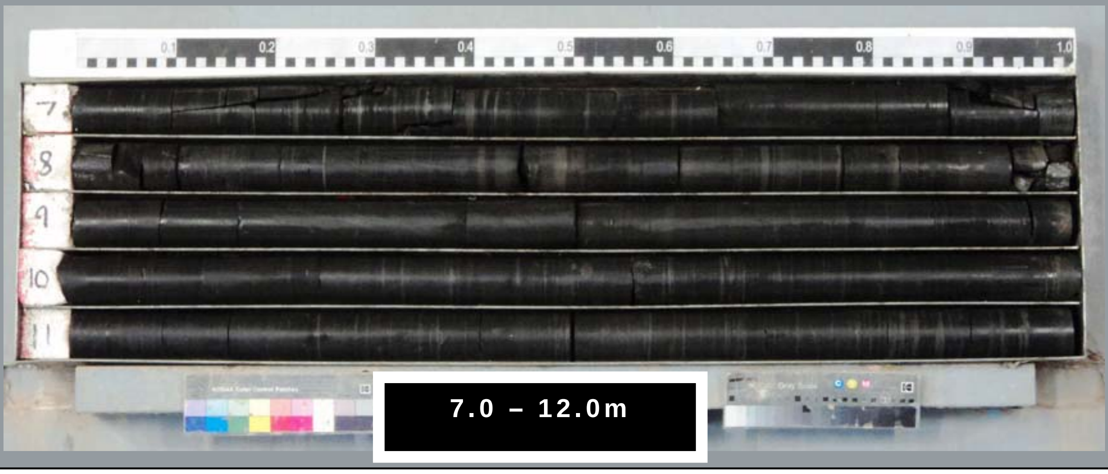
BORE G5 **PROJECT 45153.02** **JUN 2012**

2.6 – 7.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

BORE G5 **PROJECT 45153.02** **JUN 2012**

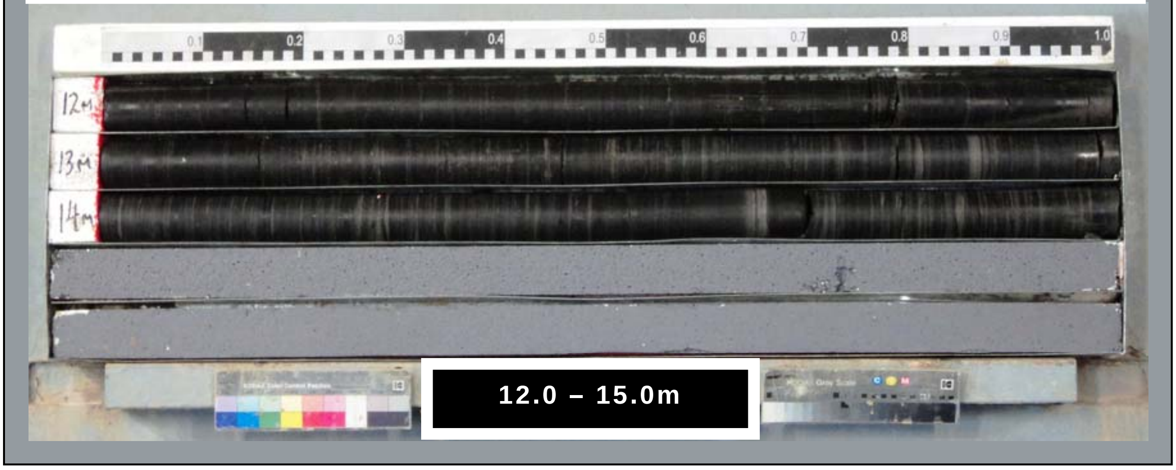


7.0 – 12.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED COMMERCIAL DEVELOPMENT – SYDNEY OLYMPIC PARK

BORE G5 **PROJECT 45153.02** **JUN 2012**



12.0 – 15.0m