Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Parkes Hospital
Newell Highway, Parkes

Prepared for
Health Infrastructure

Project 73466.01
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Douglas Partners
Geotechnics / Environment / Groundwater

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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.

	Signature	Date
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Report on Geotechnical Investigation
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1. Introduction

This report describes the results of a geotechnical investigation undertaken for the proposed new Parkes Hospital off the Newell Highway, Parkes. The work was commissioned by Health Infrastructure, in consultation with TSA Management Pty Ltd, project managers.

The project involves the construction of a new hospital to service the Parkes district. The hospital will cover an area of approximately 8,300 m^2 and will incorporate 120 vehicle parking spaces. The proposed buildings are to be typically of single-storey construction. Cut-to-fill earthworks are likely to be required although the extent of earthworks has yet to be confirmed.

Investigation was undertaken to provide detailed information on the subsurface conditions on the site and included the drilling of cored and augered boreholes, laboratory testing and engineering analysis. Details of the field work and laboratory testing programme, and comments relevant to design and construction are provided in this report.

A Phase 2 Contamination Assessment was undertaken at the same time as the geotechnical investigation and is reported separately.

2. Previous Investigation

Douglas Partners Pty Ltd recently undertook a Preliminary Geotechnical and Phase 1 Contamination Assessment of the site as outlined in the report for Project 73466 dated May 2013. This previous investigation involved a desktop study and walkover assessment only. Information from the previous investigation has been used in this current report where relevant.

3. Site Description

The new hospital site is near-rectangular and approximately 9.8 ha in area. It is bounded by the Newell Highway to the west and generally vacant land to the north, south and east. The site slopes downwards to the north-west; the grades are generally steeper at the south-eastern corner and flatten towards the north-west.

At the time of the assessment the site was vacant apart from a small, partially demolished building midway along the northern portion of the site. There was established vegetation scattered across the majority of the site.

4. Regional Geology

The *Forbes 1:250 000 Geological Series Sheet* indicates that the site is close to a boundary between colluvial soils, and rocks of the Forbes Group and of the Cotton Formation. The Forbes Group comprises fine grained sandstone, siltstone, mudstone, polymictic calcareous conglomerate, sandstone and limestone lenses. The Cotton Formation comprises siltstone, chert, sandstone, marl, minor limestone and conglomerate. The colluvial soils are presumably underlain by one or both of these formations.

The *Forbes 1:250 000 Soil Landscape Series Sheet* indicates that the bedrock is overlain by erosional soils of the Parkes and Bald Hill groups. These soils are likely to be of residual origin and moderately to highly reactive to changes in moisture content. They are also likely to be prone to erosion.

5. Field Work Methods

The field work for the geotechnical investigation included the drilling of 12 cored boreholes (PG1 to PG12) and the drilling of eight augered boreholes (PP1 to PP8) at the locations shown on Drawing G1 in Appendix B. The cored boreholes were drilled at locations in which buildings are proposed. The augered boreholes were drilled to provide information on subsurface conditions in areas where pavements are proposed.

The cored boreholes were drilled to depths of 5.0 m to 6.0 m using a truck-mounted Scout drilling rig. They were commenced using solid flight augers to drill through the overburden materials. Disturbed soil samples were collected from the auger at regular depth intervals and Standard penetration tests were also undertaken. Once weathered rock was encountered, NMLC-sized diamond core drilling equipment was used to obtain 50 mm diameter continuous core samples of the rock for identification and strength testing purposes.

The augered boreholes were each drilled to a depth of 1.0 m using a Bobcat fitted with a 150 mm diameter solid flight auger. Disturbed and bulk soil samples were collected from the auger in these bores.

Although originally proposed, groundwater monitoring wells were not installed on the site as groundwater was not encountered within the depth of investigation.

6. 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 cored boreholes encountered:

- NATURAL SOILS – stiff and very stiff silty clay with rootlets and ironstone gravel to depths of 0.9 m to 2.3 m;

- BEDROCK – initially extremely low strength and extremely weathered andesite from depths of 0.9 m to 2.3 m, typically grading to stronger rock with depth. The stronger rock was generally low strength, although medium and high strength rock was encountered in bores PG5, PG7, PG8, PG10 and PG12.

Tables 1A and 1B summarise the levels at which the different materials were encountered in the cored boreholes.

Table 1A: Summary of Material Strata Levels

Strata	RL of Top of Strata (m, AHD)					
	PG1	PG2	PG3	PG4	PG5	PG6
Ground Surface	328.6	330.6	331.6	332.2	333.2	331.6
Natural Soil	328.6	330.6	331.6	332.2	333.2	331.6
ELS Rock	327.1	328.6	329.3	331.0	332.3	329.9
LS Rock	324.6	NE	326.9	NE	NE	NE
MS Rock	NE	NE	NE	NE	NE	NE
HS Rock	NE	NE	NE	NE	329.4	NE
Base of Borehole	322.6	325.2	326.1	327.0	328.2	326.1

Notes: ELS = extremely low strength; LS = low strength; MS = medium strength; HS = high strength; NE = not encountered

Table 1B: Summary of Material Strata Levels

Strata	RL of Top of Strata (m, AHD)					
	PG7	PG8	PG9	PG10	PG11	PG12
Ground Surface	332.8	334.0	334.8	331.2	330.0	327.2
Natural Soil	332.8	334.0	334.8	331.2	330.0	327.2
ELS Rock	331.3	332.6	333.5	329.7	328.4	325.5
LS Rock	NE	NE	330.5	NE	327.0	NE
MS Rock	329.0	331.5	NE	328.7	NE	324.6
HS Rock	NE	NE	NE	NE	NE	NE
Base of Borehole	327.8	328.8	329.8	325.6	324.6	322.0

Notes: ELS = extremely low strength; LS = low strength; MS = medium strength; HS = high strength; NE = not encountered

The augered boreholes encountered stiff and very stiff silty clay with rootlets and ironstone gravel to depths of 1.0 m.

Groundwater was not encountered in any of the test locations at the time of the field work which suggests that the groundwater table is below RL 322.0 m AHD.

7. Laboratory Testing

7.1 Rock Samples

Thirty-seven samples selected from the rock core were tested for axial point load strength index (Is_{50}). The results ranged between 0.1 MPa and 3.0 MPa which correspond to very low to low strength, and high to very high strength rock, respectively.

7.2 Soil Samples

Eight soil samples were analysed to assess the strength of the soils in the areas of proposed pavements, the plasticity and reactivity of the soils, and the aggressivity of the soils to buried steel and concrete elements. A summary of the results is provided in Tables 2 and 3.

Table 2: Summary of Laboratory Test Results for Physical Properties

Sample	Depth (m)	Type	CBR (%)	Swell (%)	W_L (%)	W_P (%)	PI (%)	LS (%)
PP1	0.3-0.6	Silty clay	5	0.0	35	17	18	9.5
PP2	0.3-0.6	Silty clay	4.5	0.1	36	17	19	11.5
PP3	0.4-0.7	Silty clay	5	0.0	40	19	21	11.5
PP4	0.3-0.6	Silty clay	7	0.0	42	20	22	12.0
PP5	0.3-0.7	Silty clay	15	0.2	31	14	17	9.0
PP6	0.3-0.6	Silty clay	10	0.2	-	-	-	-
PP7	0.3-0.6	Silty clay	7	0.3	-	-	-	-
PP8	0.3-0.6	Silty clay	6	0.0	-	-	-	-

Notes: CBR = California bearing ratio; W_L = liquid limit; W_P = plastic limit; PI = plasticity index; LS = linear shrinkage

Table 3: Summary of Laboratory Test Results for Chemical Properties

Sample	Depth (m)	Type	pH (pH units)	EC (µS/cm)	Chloride ion (mg/kg)	Sulphate ion (mg/kg)
PP1	0.3-0.6	Silty clay	6.3	72	7	8
PP6	0.3-0.6	Silty clay	6.4	53	3	6

Notes: EC = electrical conductivity; All samples mixed 1(soil):5(water) prior to testing

The detailed laboratory test results are provided in Appendix D.

8. Geotechnical Model

The site appears to be underlain by a thin layer of residual and/or colluvial soils overlying weathered andesite bedrock. The soils were generally silty clay with some gravel inclusions and of stiff to very stiff consistency. The laboratory test results indicate that the clayey soils are of low to medium plasticity, which suggests they are moderately reactive to changes in moisture content and lose strength upon saturation. Filling was not widely encountered on the site.

The bedrock was initially extremely low strength and extremely weathered. The weathering profile did vary across the area in which the cored bores were drilled; medium and high strength rock was encountered in only five of the borehole locations. The jointing in the rock generally exhibited dip angles in the range of 30^{o} to 70^{o}.

Groundwater was not encountered within the depth of investigation and is likely to be well below the bedrock surface.

9. Proposed Development

The project involves the construction of a new hospital to service the Parkes district. The hospital will cover an area of approximately 8,300 m^2 and will incorporate 120 vehicle parking spaces. The proposed buildings are to be typically of single-storey construction. Cut-to-fill earthworks are likely to be required although the extent of earthworks has yet to be confirmed.

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

10. Comments

10.1 Excavation

Excavation on the site will be required in clayey soils and weathered bedrock. The strength of rock requiring excavation will depend on the final design levels. Excavation in 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 such as a Caterpillar D7 dozer. Larger ripping equipment, hydraulic rock hammers and/or milling heads may be required if excavation is required within the medium to high strength rock encountered in several bores.

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* (DECCW, 2009).

10.2 Excavation Support

10.2.1 General

Vertical excavations in engineered filling and residual clayey soils are not expected to be self-supporting for any extended period of time. Temporary batters should be feasible on the site. A maximum temporary batter slope of 1(H):1(V) is recommended for cuts up to 3 m in height in the natural clay soils and filling comprising clay and weathered rock excavated from the site.

Permanent batters should be no steeper than 3(H):1(V) and should be covered with appropriate vegetation to reduce the risk of erosion and dispersion of the clayey soils.

The short-term stability of batter slopes in rock will be primarily dependent on the dip angles of bedding, foliations and joints within the rock mass. Temporary excavations parallel to the strike and acute to the dip can probably be cut at the dip angles present in the rock mass providing any wedges are assessed and stabilised (or removed) during excavation works. Temporary excavations normal to the strike or away from the dip will need to be battered at a slope of 1(H):1(V).

Steep permanent batters in rock will probably require surface protection with shotcrete to reduce the occurrence of spalling and erosion over time.

10.2.2 Earth Pressures

Temporary or permanent retaining walls may be required on the site. Suitable design parameters for retention systems are shown in Table 4.

Table 4: Design Parameters for Retaining Walls

Material	Coefficient of Active Earth Pressure (K_a)	Coefficient of Passive Earth Pressure (K_p)	Bulk Unit Weight (kN/m^3)
Engineered Filling	0.35	2.75	20
Stiff to Very Stiff Clays	0.30	3.33	20
Weathered Rock	0.15	300 kPa	20

Cantilevered retaining walls could be designed assuming a triangular lateral earth pressure distribution. Allowance for appropriate drainage, sloping ground surfaces and surcharge loads should also be made where applicable.

Passive pressures can only be used to provide lateral support to retaining walls that are founded below the ground surface at the base of the wall. The upper 1.5 m of soil in the passive zone should be ignored to account for soil shrinkage which could be expected to occur over time.

10.3 Site Preparation

Areas on the site that are to be filled to support structures, pavements and services should be stripped of vegetation, organic topsoil and any existing filling (if present). The exposed subgrade should be proof-rolled in the presence of an experienced geotechnical professional using a minimum 12 tonne pad-foot or steel smooth drum roller. Any areas on the site exhibiting excessive deflection should be excavated and replaced with suitable granular material compacted in layers. Specific remediation advice can be provided on site once the subgrade has been inspected.

Any filling required on the site should be placed in layers not exceeding a loose thickness of 250 mm and compacted to a dry density ratio of between 98% and 102% relative to Standard compaction. If the filling exhibits clay-like properties then it should be prepared within 2% of the Standard optimum moisture content.

The residual soil and weathered rock on the development site should be suitable for reuse from a geotechnical perspective providing all deleterious materials (e.g. particles greater than 150 mm diameter, organic material etc.) are removed from the filling prior to compaction. The Atterberg limit and linear shrinkage test results indicate that the soils on the site are moderately reactive to changes in moisture content and it is therefore important to place this material as close to optimum moisture as possible to reduce the potential for significant shrink/swell movements.

For the construction phase of the project, consideration should be given to placing a 150 mm thick layer of granular material (e.g. ripped or crushed rock) as the top layer of unformed roads in order to provide a trafficable surface that will be less prone to disturbance from construction machinery and wet weather.

Filling placed and compacted in accordance with this report may experience long-term settlements of 0.1% to 0.5% of the filling depth. This is in addition to settlement caused by the application of loads on the surface of the filling and from reactive soil movements.

Australian Standard AS 3798 – 2007 *Guidelines on earthworks for commercial and residential developments* provides guidance as to appropriate testing frequencies for the testing of filling. It is recommended that all compaction control testing in areas that will support buildings and pavements be undertaken at a Level 1 responsibility.

10.4 Groundwater

Groundwater was not observed on the site and is expected to be well below the bedrock surface. Seepage through the soils and weathered rock would be expected to occur during and following periods of significant rainfall and may be encountered in excavations and bored piles on the site.

A pump may need to be used during the construction of bored piles (if used) to remove seepage from the pile holes prior to pouring concrete. If significant water inflows eventuate then a tremie system may be needed to construct the piles.

10.5 Foundations

10.5.1 Spread Footings

Spread footings (e.g. pad footings and strip footings) should be suitable for supporting the majority of the structures on the site. The parameters provided in Table 5 could be used to design spread footings.

Table 5: Design Parameters for Spread Footings

Material	Allowable Bearing Pressure	Modulus of Elasticity
Engineered Filling	150 kPa	15 MPa
Stiff to Very Stiff Clays	150 kPa	15 MPa
ELS Rock	500 kPa	50 MPa
LS Rock	1000 kPa	100 MPa

Notes: ELS = extremely low strength; LS = low strength

The settlement of a spread footing is dependent on the loads applied to the footing, the foundation conditions below the footing and the footing dimensions. The total settlement of a spread footing designed using the parameters provided in this report would be expected to be less than about 10 mm upon application of the design load.

It is noted that the laboratory test results indicate moderately reactive soil conditions on the site which may be exacerbated by the removal of trees and the resulting increase in soil moisture content likely to be experienced. Australian Standard AS 2870 – 2011 *Residential slabs and footings* indicates unrestrained free-surface movements of 20 mm to 40 mm for sites of moderate reactivity. Allowance for some ground movement should therefore be made in the design of structural elements founded in the clayey soils.

10.5.2 Piles

Bored piles could be used to support heavier column loads or to provide uplift resistance if required. The parameters provided in Table 6 could be used to design bored piles. Parameters for both the working stress and limit-state approaches have been provided.

Table 6: Design Parameters for Bored Piles

Material	Allowable End-Bearing Pressure	Allowable Shaft Adhesion*	Ultimate End-Bearing Pressure	Ultimate Shaft Adhesion*	Modulus of Elasticity
Engineered Filling	NA	NA	NA	NA	NA
Stiff to Very Stiff Clays	NA	15 kPa	NA	30 kPa	15 MPa
ELS Rock	500 kPa	50 kPa	1500 kPa	150 kPa	50 MPa
LS Rock	1000 kPa	100 kPa	3000 kPa	300 kPa	100 MPa

Notes: ELS = extremely low strength; LS = low strength; NA = not applicable; *Reduce by 50% for tension piles

It should be noted that the serviceability limit-state is likely to govern the design of the piles and the ultimate bearing pressures provided in Table 6 are unlikely to be achieved in practice.

The 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 pile designed using the 'allowable' parameters in Table 6 would be expected to be less than 5 mm upon application of the design load.

It is recommended that the upper 1.5 m of clayey soil/filling be ignored in the design of the piles to account for soil shrinkage which could be expected to occur over time.

All footing and pile excavations should be inspected by a geotechnical engineer to check the adequacy of the foundation material and, in the case of piles relying on shaft adhesion, the socket roughness.

10.6 Pavements

The laboratory test results for CBR ranged from 4.5% to 15%, with an average value of 7%. It is recommended that a design subgrade CBR of 5% be adopted for the site to account for the weaker areas of subgrade encountered.

Pavement areas subjected only to light traffic (e.g. passenger vehicles and commercial vehicles up to 2 tonne gross vehicle mass) could be constructed by preparing the subgrade in accordance with Section 10.3 of this report and placing 200 mm of DGB20, less the thickness of the asphalt wearing surface, on the subgrade. The DGB20 should be compacted to a dry density ratio of at least 100% relative to Standard compaction.

Pavements subjected to heavier vehicles should be designed according to the proposed traffic loading, required design life and other operational factors.

Appropriate cross-fall and subsurface drainage should be provided to reduce the risk of the clayey subgrade becoming saturated during periods of wet weather. Good construction practice, such as installing subsurface drains around the perimeter of any garden or grassed areas, will also help to reduce the chance of subgrade deterioration caused by excessive irrigation.

10.7 Aggressivity

The laboratory test results for soil aggressivity were compared with the exposure classifications outlined in Australian Standard AS 2159 – 2009 *Piling – Design and installation*. The results indicate that the soils are non-aggressive to buried steel and concrete elements.

10.8 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 is expected to be Class B_e or Class C_e (depending on the final design levels).

11. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for the Parkes Hospital redevelopment project in accordance with DP's proposal dated 29 May 2013. The report is provided for the use of Health Infrastructure 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. 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 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.

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 a 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.

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Appendix A

About this Report

About this Report

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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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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.

Sampling Methods

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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

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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

Douglas Partners

Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General


Asphalt


Road base


Concrete


Filling

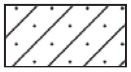
Soils


Topsoil

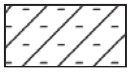

Peat


Clay


Silty clay

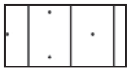

Sandy clay

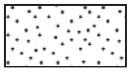

Gravelly clay

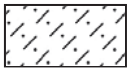

Shaly clay

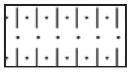

Silt


Clayey silt

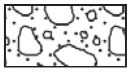

Sandy silt


Sand


Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

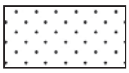

Talus

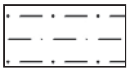
Sedimentary Rocks

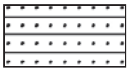

Boulder conglomerate

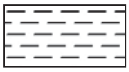

Conglomerate


Conglomeratic sandstone

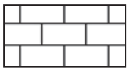

Sandstone


Siltstone

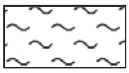

Laminite

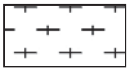

Mudstone, claystone, shale

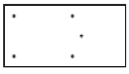

Coal


Limestone

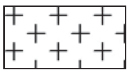
Metamorphic Rocks

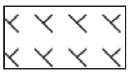

Slate, phyllite, schist

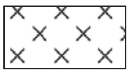

Gneiss

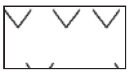

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite

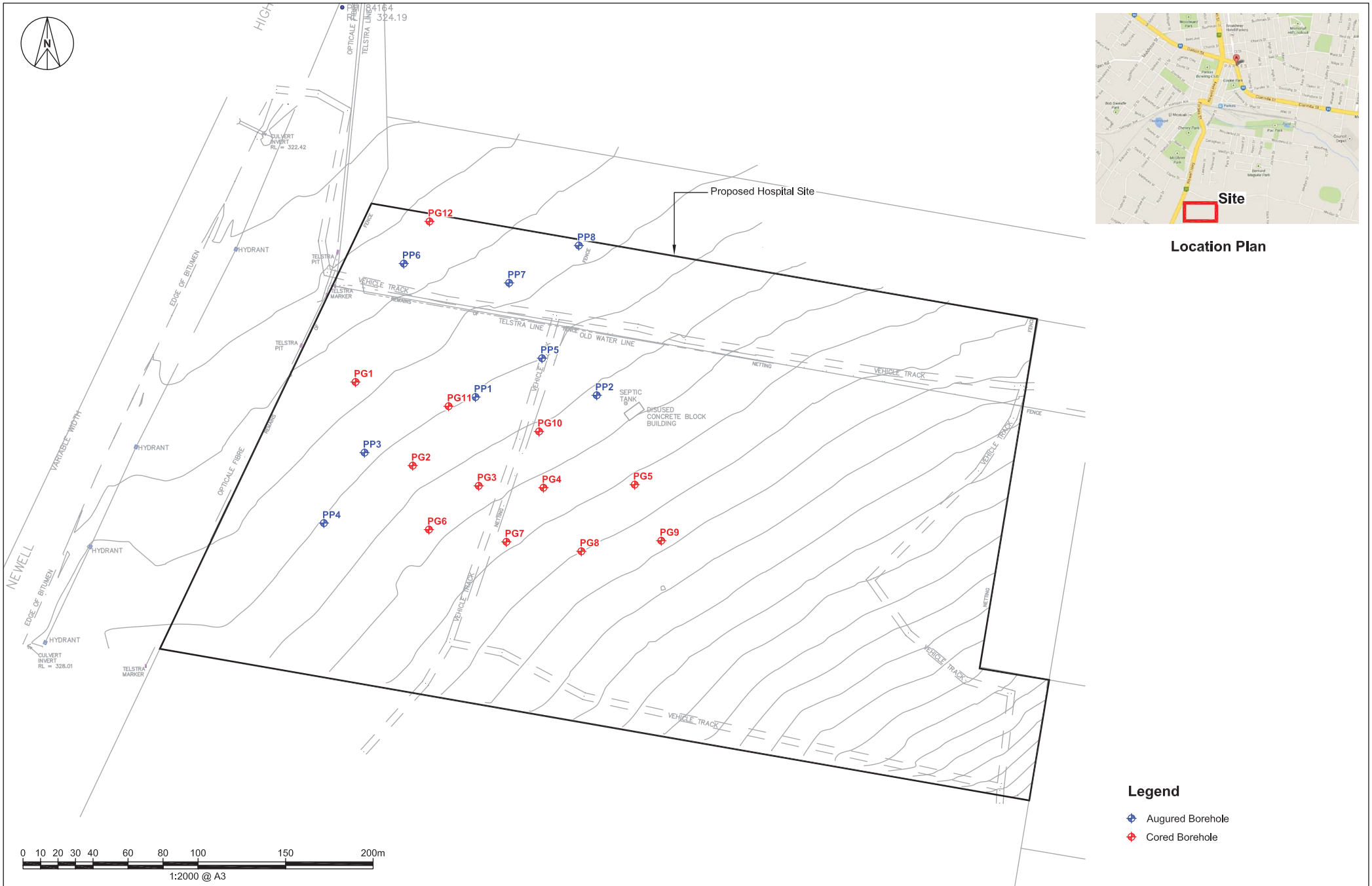

Dacite, epidote


Tuff, breccia


Porphyry

Appendix B

Drawing



Location Plan

Legend

- Augured Borehole
- Cored Borehole

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure	TITLE: **Locations of Boreholes**	PROJECT No: 73466.01
	OFFICE: Sydney / DRAWN BY: JCP	**Proposed Hospital Redevelopment**	DRAWING No: G1
	SCALE: As shown / DATE: 24.9.2013	**Newell Highway, Parkes**	REVISION: 1

Appendix C

Field Work Results

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 328.6 AHD
EASTING: 609015
NORTHING: 6331164
DIP/AZIMUTH: 90°/--

BORE No: PG1
PROJECT No: 73466.01
DATE: 12/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
328	0.4	SILTY CLAY - stiff, dark red-brown, silty clay, damp (with some rootlets in top 100mm)							A/E			
		SILTY CLAY - stiff, red-brown silty clay with some ironstone gravel, damp							A/E			
328	1	- very stiff below 1.0m							A			
									S			7,7,8 N = 15
327	1.5	ANDESITE - extremely low strength, light brown andesite with low strength bands										
	2								A			
326	2.5	ANDESITE - extremely low to low strength, extremely then moderately weathered, fractured and slightly fractured, orange brown porphyritic andesite						2.8m: J80°, pl, ro, fe, 2mm 3m: CORE LOSS: 400mm	C	71	0	
	3											
	3.4	ANDESITE - low strength with very low and medium strength bands, moderately weathered, fractured and slightly fractured, orange brown porphyritic andesite						3.45m: J80°, pl, ro, fe, 2mm 3.75m: J70°, pl, ro, fe, 1mm				PL(A) = 0.6
325	4							4.3-4.4m: J(x3)30°, pl, fe, 1mm 4.6-5.0m: J(x7)20-30°, pl, ro, fe, 1mm	C	100	33	PL(A) = 0.5
324	5							5.1-5.3m: J(x4)30°-40°, pl, ro, fe, 1mm				PL(A) = 0.6
323	6											
	6.0	Bore discontinued at 6.0m										
322	7											
321	8											
320	9											
319												

RIG: Scout 4 **DRILLER:** RE&KE **LOGGED:** PGH/AG **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC bit) to 2.5m; NMLC coring to 6.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	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: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 330.6 AHD
EASTING: 609048
NORTHING: 6331116
DIP/AZIMUTH: 90°/--

BORE No: PG2
PROJECT No: 73466.01
DATE: 13/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
330	0.4	SILTY CLAY - stiff, red-brown silty clay, damp (with some rootlets in top 50mm)							A/E			
	1	SILTY CLAY - stiff, red-brown silty clay with some fine ironstone gravel - very stiff below 1.0m							S			4,5,7 N = 12
329	2.0	ANDESITE - extremely low strength, light brown andesite with low strength bands										
	2											
328	2.5											
	2.6	ANDESITE - extremely low to very low strength, extremely and highly weathered, brown and pale green porphyritic andesite						2.5m: CORE LOSS: 100mm	C	96	0	
	3											
327	4											
326	4.86	ANDESITE - very low strength, moderately weathered, pale green porphyritic andesite										PL(A) = 0.2
	5							5.15m: He 10mm 5.21m: He 5-10mm				
	5.35	Bore discontinued at 5.35m										
325	6											
324	7											
323	8											
322	9											
321												

RIG: Scout 4 **DRILLER:** RE&KE **LOGGED:** PGH **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC bit) to 2.5m; NMLC coring to 5.35m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	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: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 331.6 AHD
EASTING: 609085
NORTHING: 6331105
DIP/AZIMUTH: 90°/--

BORE No: PG3
PROJECT No: 73466.01
DATE: 13/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
331	0.4	SILTY CLAY- stiff, brown silty clay, damp (with some rootlets in top 100mm)							A/E			
		SILTY CLAY - stiff, red-brown silty clay with some fine ironstone gravel, damp							A/E			
330	1	- very stiff below 1.0m							S			5,7,8 N = 15
	2.3	ANDESITE - extremely low strength, light brown andesite with low strength bands										
329	2.5	ANDESITE - very low and low strength, highly then slightly weathered, slightly fractured, orange brown porphyritic andesite						2.85m: He, 10mm 3.13m: Cz(?), 100mm 3.35m: J80°, pl, s, t, cln 3.36m: J33°, pl, ro, fe, 1mm	C	100	0	
328	4											PL(A) = 0.3
327	5							4.43m: J20°, pl, ro, fe, 1mm	C	100	80	PL(A) = 0.2
	5.5	Bore discontinued at 5.5m										PL(A) = 0.2
326	6											
325	7											
324	8											
323	9											
322												

RIG: Scout 4 **DRILLER:** RE&KE **LOGGED:** AG/PGH **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC bit) to 2.5m; NMLC coring to 5.5m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	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: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 332.2 AHD
EASTING: 609122
NORTHING: 6331104
DIP/AZIMUTH: 90°/--

BORE No: PG4
PROJECT No: 73466.01
DATE: 13/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
332	0	SILTY CLAY - stiff, brown silty clay, damp (with some rootlets in top 100mm)							A/E			
	0.5	SILTY CLAY - stiff, red-brown silty clay with some fine ironstone gravel, damp - hard below 1.0m							*A/E			
331	1								S			6,10,18 N = 28
	1.2	ANDESITE - extremely low strength, light brown andesite with some low strength bands										
330	2											
	2.5	ANDESITE - very low and low strength with medium strength bands, moderately and slightly weathered, slightly fractured, orange brown, porphyritic andesite						2.69m: J29°, pl, ro, fe, 1mm 3.14m: J33°, pl, ro, fe, 1mm 3.6m: J25°, pl, ro, fe,1mm 3.73m: J40°, pl, ro, fe, 1mm 3.94m: J72°, pl, ro, fe, 1mm 4.4m: J75°, pl, ro, fe, 1mm 4.61m: J70°, pl, ro, fe, 1mm 5.05m: J10°, pl, ro, fe, 1mm	C	100	27	PL(A) = 0.5 PL(A) = 0.5 PL(A) = 0.1 PL(A) = 0.1
329	3											
328	4											
327	5											
	5.15	Bore discontinued at 5.15m										
326	6											
325	7											
324	8											
323	9											

RIG: Scout 4 **DRILLER:** RE&KE **LOGGED:** AG **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC bit) to 2.5m; NMLC coring to 5.15m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 333.2 AHD
EASTING: 609175
NORTHING: 6331105
DIP/AZIMUTH: 90°/--

BORE No: PG5
PROJECT No: 73466.01
DATE: 14/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
333	0.3	SILTY CLAY - stiff brown silty clay, damp (with some rootlets in top 100mm)							A/E			
		SILTY CLAY - stiff, red-brown silty clay with some fine to medium ironstone gravel, damp							A/E			
332	0.9	ANDESITE - extremely low strength, light brown andesite with medium strength bands							S			8,16,20 N = 36
331	2.5	ANDESITE - extremely low and low strength, extremely and highly weathered, slightly fractured, brown and tan porphyritic andesite						2.64m: J35°, pl, ro, fe, 1-2mm 2.85m: J85°, pl, ro, fe, 1mm				
330	3.75	ANDESITE - high strength, slightly weathered, slightly fractured, brown porphyritic andesite						3.65m: J85°, pl, ro, fe, 1mm 3.85m: J50°, pl, ro, fe, 1mm 4.1m: J30°, pl, ro, fe, 1mm 4.27m: J45°, pl, ro, fe, 1mm 4.3m: J45°, pl, ro, fe, 1mm	C	100	50	PL(A) = 1.7 PL(A) = 3
329	5.0	Bore discontinued at 5.0m						4.46m: J20°, pl, ro, fe, 1mm 4.7m: J50°, pl, ro, fe, 1mm 4.85m: J30°, pl, ro, fe, 1mm				
328												
327												
326												
325												
324												

RIG: Scout 4 **DRILLER:** RE&KE **LOGGED:** AG **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC bit) to 2.5m; NMLC coring to 5.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 331.6 AHD
EASTING: 609057
NORTHING: 6331080
DIP/AZIMUTH: 90°/--

BORE No: PG6
PROJECT No: 73466.01
DATE: 13 - 14/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
331	0.4	SILTY CLAY - stiff, brown silty clay, damp (with some rootlets in top 200mm)							A/E			
		SILTY CLAY - stiff, red brown silty clay with some fine to medium ironstone gravel, damp							A/E			
330	1.7	ANDESITE - extremely low strength, light brown andesite with low strength bands							S			5,7,7 N = 14
329	2.5	ANDESITE - very low strength, extremely weathered, slightly fractured, brown porphyritic andesite (clay)							C	100	0	PL(A) = 0.09
328	3.75							3.55m: CORE LOSS: 200mm				
327	4.9							4.7m: CORE LOSS: 200mm 5.02m: J45°, pl, ro fe 1mm	C	79	0	PL(A) = 0.08 PL(A) = 0.06
326	5.45	Bore discontinued at 5.45m										

RIG: Scout 4 **DRILLER:** RE&KE **LOGGED:** AG **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC bit) to 2.5m; NMLC coring to 5.45m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 332.8 AHD
EASTING: 609101
NORTHING: 6331073
DIP/AZIMUTH: 90°/--

BORE No: PG7
PROJECT No: 73466.01
DATE: 14/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
332	0.4	SILTY CLAY - stiff, brown silty clay, damp (with some rootlets in top 200mm)							A/E			
		SILTY CLAY - stiff, red-brown silty clay with some fine to medium ironstone gravel ,damp							A/E			
331	1	- very stiff below 1.0m							S			7,14,14 N = 28
	1.5	ANDESITE - extremely low strength, light brown andesite with low strength bands										
330	2.5	ANDESITE - extremely low and very low strength, extremely to moderately weathered, slightly fractured, brown porphyritic andesite						3.05m: J55°, pl, ro, fe, 1mm 3.3m: J80°, pl, ro, fe, 1mm 3.45m: J35°, pl, ro, fe, 1mm 3.7-4.00m: J(x7) 80°, pl, ro, fe, 1mm	C	100	40	PL(A) = 0.1 PL(A) = 0.8 PL(A) = 0.4
329	3.75	ANDESITE - medium then very low strength, slightly weathered, slightly fractured, light orange brown porphyritic andesite										
328	5.0	Bore discontinued at 5.0m						4.82m: J30°, pl, ro, fe, 1mm				PL(A) = 0.1
327	6											
326	7											
325	8											
324	9											
323												

RIG: Scout 4 **DRILLER:** RE&KE **LOGGED:** AG **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC bit) to 2.5m; NMLC coring to 5.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 334.0 AHD
EASTING: 609144
NORTHING: 6331067
DIP/AZIMUTH: 90°/--

BORE No: PG8
PROJECT No: 73466.01
DATE: 14/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
334	0.0	SILTY CLAY - stiff, brown silty clay, damp (with rootlets in top 200mm)							A/E			
	0.4	SILTY CLAY - stiff, red-brown silty clay with a trace of fine ironstone gravel, damp							A/E			
333	1	- very stiff below 1.0m							S			6,8,19 N = 27
	1.4	ANDESITE - extremely low strength, light brown andesite with some low strength bands										
332	2											
	2.5	ANDESITE - medium strength, slightly weathered, slightly fractured, light brown porphyritic andesite						2.78m: J70°, pl, ro, fe, 1mm 2.96m: J55°, pl, ro, fe, 1mm 3.16m: Ds, 20mm	C	100	98	PL(A) = 1
331	3							3.46m: J50°, pl, ro, fe, 1mm 3.71m: J42°, pl, ro, fe, 1mm	C	100	92	PL(A) = 0.8
330	4							4.18m: J45°, pl, ro, fe, 1mm				
	4.6	ANDESITE - high strength, slightly weathered, fractured then slightly fractured, light brown porphyritic andesite						4.6m: J55°, pl, ro, fe, 1mm 4.75m: J(x4) 45°, pl, ro, fe, 1mm	C	100	100	PL(A) = 1 PL(A) = 1.5
329	5											
	5.2	Bore discontinued at 5.2m										
328	6											
327	7											
326	8											
325	9											

RIG: Scout 4 **DRILLER:** RE&KE **LOGGED:** AG **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC bit) to 2.5m; NMLC coring to 5.2m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 334.8 AHD
EASTING: 609190
NORTHING: 6331073
DIP/AZIMUTH: 90°/--

BORE No: PG9
PROJECT No: 73466.01
DATE: 14/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
334	0.3	SILTY CLAY - stiff, brown, silty clay, damp (with some rootlets in top 200mm)							A/E			
		SILTY CLAY - stiff, red-brown silty clay with a trace of fine to medium ironstone gravel, damp							A/E			
333	1	- very stiff below 1.0m							S			10,14,17 N = 31
	1.3	ANDESITE - extremely low strength, light brown andesite with low strength bands										
332	2.5	ANDESITE - extremely low to low and very low strength, extremely to moderately weathered, slightly fractured, orange brown porphyritic andesite						2.65m: J45°, pl, ro, fe, 1mm 3.3m: J70°, pl, ro, fe, 1mm 3.6m: J50°, pl, ro, fe, 1mm 3.75m: J50°, pl, ro, fe, 1mm 3.92m: J55°, pl, ro, fe, 1mm 4.24m: J70°, pl, ro, fe, 1mm 4.47m: J80°, pl, ro, fe, 1mm 4.65m: J45°, pl, ro, fe, 1mm	C	100	60	PL(A) = 0.09 PL(A) = 0.2
331	4.3	ANDESITE - low strength, slightly weathered, slightly fractured, light orange brown porphyritic andesite										
330	5.0	Bore discontinued at 5.0m										
329												
328												
327												
326												
325												

RIG: Scout 4 **DRILLER:** RE&KE **LOGGED:** AG **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC bit) to 2.5m; NMLC coring to 5.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 331.2 AHD
EASTING: 609120
NORTHING: 6331136
DIP/AZIMUTH: 90°/--

BORE No: PG10
PROJECT No: 73466.01
DATE: 15/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
331	0.4	SILTY CLAY - stiff, brown silty clay with a trace of fine ironstone gravel, damp (with some rootlets in top 200mm)							A/E			
		SILTY CLAY - stiff, red-brown silty clay with some fine to medium ironstone gravel damp - very stiff below 1.0m							A/E S			7,9,11 N = 20
330	1.5	ANDESITE - extremely low strength, light brown andesite with some low strength bands										
329	2.5	ANDESITE - medium strength, moderately then slightly weathered, slightly fractured, brown and light green, porphyritic andesite						3.14m: Ds 20mm 3.61m: J35°, pl, ro, fe, 1mm 3.7m: J55°, pl, ro, fe, 1mm 3.85m: J40°, pl, ro, fe, 1mm 4.06m: J30°, pl, ro, fe, 1mm 4.3m: Ds, 15° 4.54m: J15°, pl, ro, fe, 1mm 4.83m: J10°, pl, ro, fe, 1mm 5.24m: cly 15mm 5.38m: J80°, pl, ro, fe, 1mm	C	100	92	PL(A) = 1 PL(A) = 0.8
328												
327									C	100	93	PL(A) = 0.7
326	5.55	Bore discontinued at 5.55m										PL(A) = 0.5
325												
324												
323												
322												

RIG: Scout 4 **DRILLER:** RE&KE **LOGGED:** PGH/AG **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC bit) to 2.5m; NMLC coring to 5.55m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 330.0 AHD
EASTING: 609068
NORTHING: 6331150
DIP/AZIMUTH: 90°/--

BORE No: PG11
PROJECT No: 73466.01
DATE: 15/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
330	0.0	SILTY CLAY - brown silty clay							A/E			
	0.4	SILTY CLAY - stiff, red-brown silty clay with a trace of fine ironstone gravel, damp							A/E			
329	1											
	1.6	ANDESITE - extremely low strength, light brown andesite										
328	2											
	2.5	ANDESITE - very low to low strength, highly weathered with some extremely low strength bands, slightly fractured, red brown and brown, porphyritc andesite						3.07m: J45°, pl, ro, fe, 2mm 3.1m: J(x5) 30°, pl, ro, fe, 1mm 4.2m: J70°, pl, r,o fe, 3mm 4.44m: J70°, pl, ro, fe, 2mm 4.9m: J55°, pl, ro, fe, 3mm	C	100	64	PL(A) = 0.1 PL(A) = 0.1 PL(A) = 0.1 PL(A) = 0.1
327	3											
326	4											
325	5											
	5.35	Bore discontinued at 5.35m										
324	6											
323	7											
322	8											
321	9											

RIG: Scout 4 **DRILLER:** RE&KE **LOGGED:** AG/PGH **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC bit) to 2.5m; NMLC coring to 5.35m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 327.2 AHD
EASTING: 609062
NORTHING: 6331265
DIP/AZIMUTH: 90°/--

BORE No: PG12
PROJECT No: 73466.01
DATE: 15/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
327	0.0	SILTY CLAY - stiff, brown silty clay, damp (with some rootlets in top 200mm)							A/E			
	0.4	SILTY CLAY - stiff, red-brown silty clay with a trace of fine to medium ironstone gravel, damp							A/E			
326	1	- very stiff below 1.0m							S			9,9,12 N = 21
	1.7	ANDESITE - extremely low strength, light brown andesite with low strength bands										
325	2											
	2.5											
	2.6	ANDESITE - low and medium strength, extremely to moderately weathered, brown and pale green porphyritic andesite						2.5m: CORE LOSS: 100mm 2.66m: J45°, pl, ro, fe, 1mm 3.19m: J30°, pl, ro, fe, 1mm 3.49m: J70°, pl, ro, fe, 1mm 3.6m: J85°, pl, ro, fe, 1mm 3.82m: J55°, pl, ro, fe, 1mm 3.9m: J30°, pl, ro, fe, 1mm 4.33m: possible crushed zone 70mm 4.8m: possible crushed zone 70mm	C	100	72	PL(A) = 0.4 PL(A) = 1
324	3											
323	4								C	100	90	PL(A) = 0.3
	4.86	ANDESITE - low strength, moderately weathered, pale green porphyritic andesite										
322	5											
	5.2	Bore discontinued at 5.2m										
321	6											
320	7											
319	8											
318	9											

RIG: Scout 4 **DRILLER:** RE&KE **LOGGED:** PGH **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC bit) to 2.5m; NMLC coring to 5.2m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 330.0 AHD
EASTING: 609084
NORTHING: 6331155
DIP/AZIMUTH: 90°/--

BORE No: PP1
PROJECT No: 73466.01
DATE: 14/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
330	0.2	SILTY CLAY - stiff, brown silty clay, damp (with some rootlets in top 100mm)		E	0.1				
		SILTY CLAY - stiff, red-brown silty clay with a trace of fine to medium ironstone gravel, damp			0.2				
					0.3				
				B					
					0.6				
				E	0.7				
329	1 1.0	Bore discontinued at 1.0m- target depth reached							1
328	2								2
327	3								3
326	4								4

RIG: Bobcat **DRILLER:** KA **LOGGED:** AG **CASING:** -

TYPE OF BORING: Solid flight auger to 1.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	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: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 331.2 AHD
EASTING: 609153
NORTHING: 6331156
DIP/AZIMUTH: 90°/--

BORE No: PP2
PROJECT No: 73466.01
DATE: 19/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
331	0.0	SILTY CLAY - stiff, brown silty clay, damp (with some rootlets, in top 200mm)		E	0.1 0.2				
	0.3	SILTY CLAY - stiff, red-brown silty clay, damp		B E	0.3 0.5 0.6				
		- very stiff and slightly gravely below 0.7m							
	1.0	Bore discontinued at 1.0m- target depth reached							
330	1								1
329	2								2
328	3								3
327	4								4

RIG: Bobcat **DRILLER:** KA **LOGGED:** AG **CASING:** -

TYPE OF BORING: Solid flight auger to 1.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 329.8 AHD
EASTING: 609020
NORTHING: 6331124
DIP/AZIMUTH: 90°/--

BORE No: PP3
PROJECT No: 73466.01
DATE: 15/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
329	0.3	SILTY CLAY - stiff, brown silty clay with a trace of fine to medium ironstone gravel, damp (with some rootlets in top 200mm)		E	0.1 0.2				
		SILTY CLAY - stiff, red-brown silty clay with some fine to medium ironstone gravel, damp - very stiff below 0.6m		B E	0.3 0.5 0.6 0.7				
	1.0	Bore discontinued at 1.0m- target depth reached							

RIG: Bobcat **DRILLER:** KA **LOGGED:** AG **CASING:** -

TYPE OF BORING: Solid flight auger to 1.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 330.0 AHD
EASTING: 608997
NORTHING: 6331083
DIP/AZIMUTH: 90°/--

BORE No: PP4
PROJECT No: 73466.01
DATE: 15/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
330		SILTY CLAY - stiff, brown silty clay, damp (with some rootlets in top 200mm)		E	0.1 0.2				
	0.3	SILTY CLAY - stiff, red-brown silty clay with some fine to medium ironstone gravel, damp		B E	0.3 0.5 0.6				
329	1 1.0	Bore discontinued at 1.0m- target depth reached							1
328	2								2
327	3								3
326	4								4

RIG: Bobcat **DRILLER:** KA **LOGGED:** AG **CASING:** -

TYPE OF BORING: Solid flight auger to 1.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	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: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 330.0 AHD
EASTING: 609122
NORTHING: 6331178
DIP/AZIMUTH: 90°/--

BORE No: PP5
PROJECT No: 73466.01
DATE: 15/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
330		GRAVELLY CLAY - very stiff, red-brown gravelly (ironstone) silty clay, humid (with some rootlets in top 100mm)		*E	0.0 0.1				
		- hard below 0.4m			0.3				
				B	0.5				
				E	0.6				
					0.7				
329	1 1.0	Bore discontinued at 1.0m- target depth reached							1
328	2								2
327	3								3
326	4								4

RIG: Bobcat **DRILLER:** KA **LOGGED:** AG **CASING:** -

TYPE OF BORING: Solid flight auger to 1.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *TS7A, TS7B are triplicate samples of E 0.0-0.1m

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 327.4 AHD
EASTING: 609043
NORTHING: 6331232
DIP/AZIMUTH: 90°/--

BORE No: PP6
PROJECT No: 73466.01
DATE: 20/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
327	0.0	SILTY CLAY - stiff, red-brown silty clay with some medium ironstone gravel, humid (with some rootlets in top 200mm)		E	0.0 0.1				
	0.3	SILTY CLAY - stiff, red-brown silty clay with some medium ironstone gravel, damp - very stiff below 0.5m		B E	0.3 0.5 0.6				
	1.0	Bore discontinued at 1.0m- target depth reached							

RIG: Bobcat **DRILLER:** KA **LOGGED:** AG **CASING:** -

TYPE OF BORING: Solid flight auger to 1.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 328.6 AHD
EASTING: 609103
NORTHING: 6331221
DIP/AZIMUTH: 90°/--

BORE No: PP7
PROJECT No: 73466.01
DATE: 20/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
328	0.0	SILTY CLAY - stiff, brown silty clay with some medium ironstone gravel, damp (with some rootlets in top 200mm)		*E	0.0-0.1				
	0.3	SILTY CLAY - stiff, red-brown silty clay with some medium ironstone gravel, damp		B	0.3-0.5				
		- very stiff below 0.8m		E	0.5-0.6				
	1.0	Bore discontinued at 1.0m- target depth reached							

RIG: Bobcat **DRILLER:** KA **LOGGED:** AG **CASING:** -

TYPE OF BORING: Solid flight auger to 1.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *TS19A, TS19B are triplicate samples of E 0.0-0.1m

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Parkes Hospital Redevelopment
LOCATION: Newell Highway, Parkes

SURFACE LEVEL: 328.6 AHD
EASTING: 609144
NORTHING: 6331251
DIP/AZIMUTH: 90°/--

BORE No: PP8
PROJECT No: 73466.01
DATE: 19/8/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
328	0.0	SILTY CLAY - stiff, brown silty clay with some medium ironstone gravel, damp (with some rootlets, in top 200mm)		E	0.0 0.1				
	0.3	SILTY CLAY - stiff, red-brown silty clay with some medium ironstone gravel, damp - very stiff below 0.6m		B E	0.3 0.5 0.6				
327	1.0	Bore discontinued at 1.0m- target depth reached							
326									
325									
324									

RIG: Bobcat **DRILLER:** KA **LOGGED:** AG **CASING:** -

TYPE OF BORING: Solid flight auger to 1.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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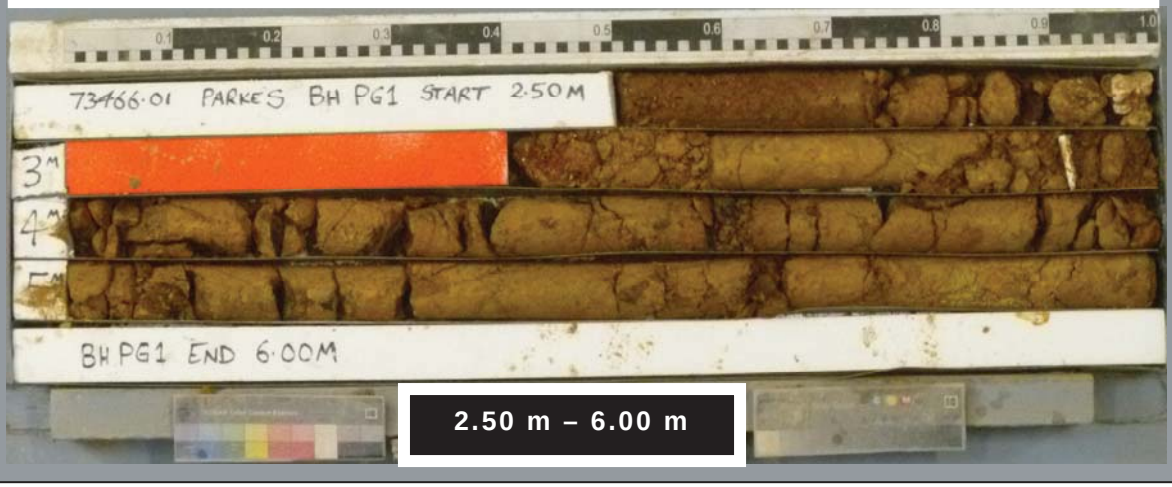
NEWELL HIGHWAY, PARKES

BORE PG1 PROJECT 73466.01 AUGUST 2013



2.50 m – 6.00 m

DOUGLAS PARTNERS PTY LTD
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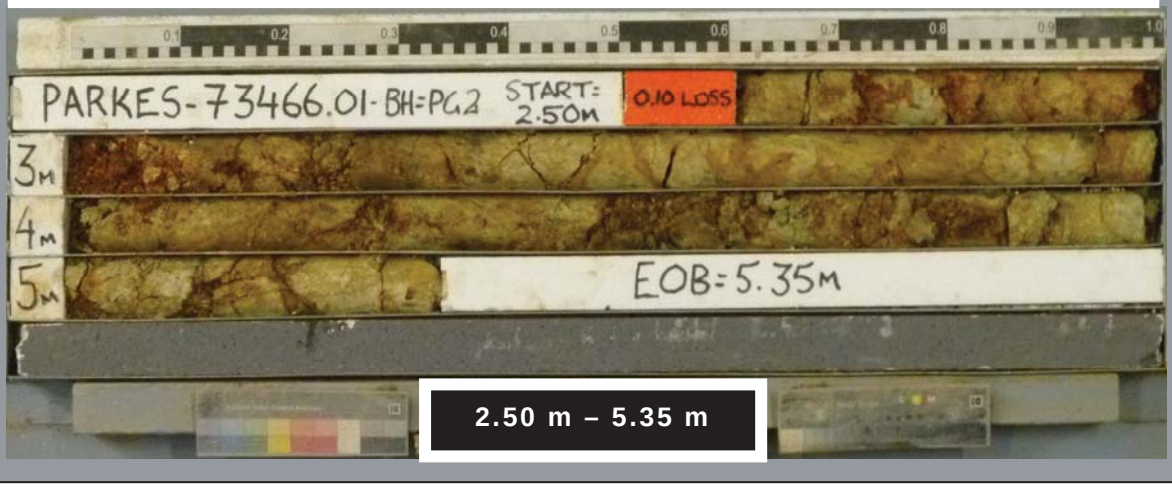
NEWELL HIGHWAY, PARKES

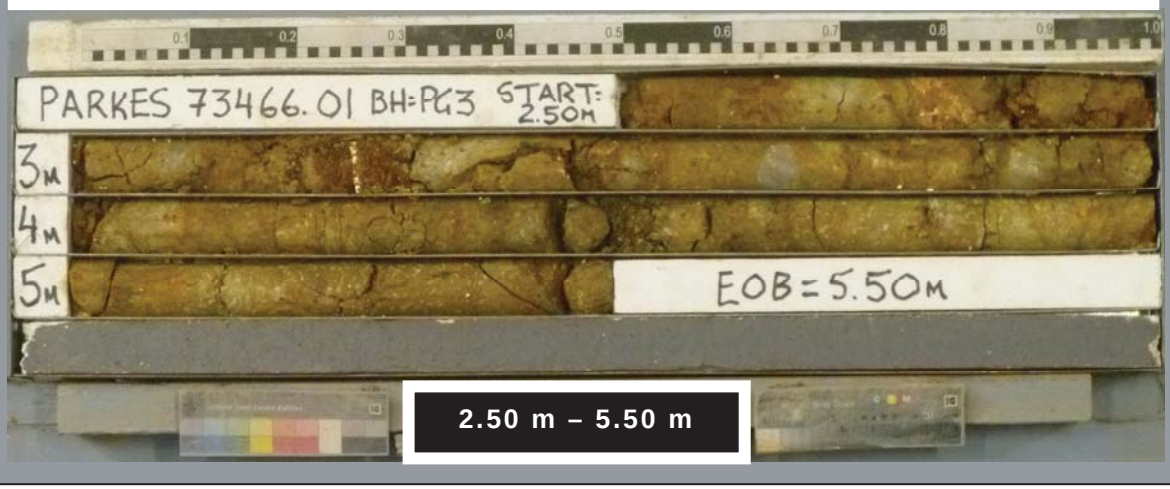
BORE PG2 PROJECT 73466.01 AUGUST 2013



2.50 m – 5.35 m

DOUGLAS PARTNERS PTY LTD
PARKES HOSPITAL REDEVELOPMENT
NEWELL HIGHWAY, PARKES

BORE PG3 PROJECT 73466.01 AUGUST 2013



2.50 m – 5.50 m

DOUGLAS PARTNERS PTY LTD
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NEWELL HIGHWAY, PARKES

BORE PG4 PROJECT 73466.01 AUGUST 2013

2.50 m – 5.15 m

DOUGLAS PARTNERS PTY LTD
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NEWELL HIGHWAY, PARKES

BORE PG5 PROJECT 73466.01 AUGUST 2013

2.50 m – 5.00 m

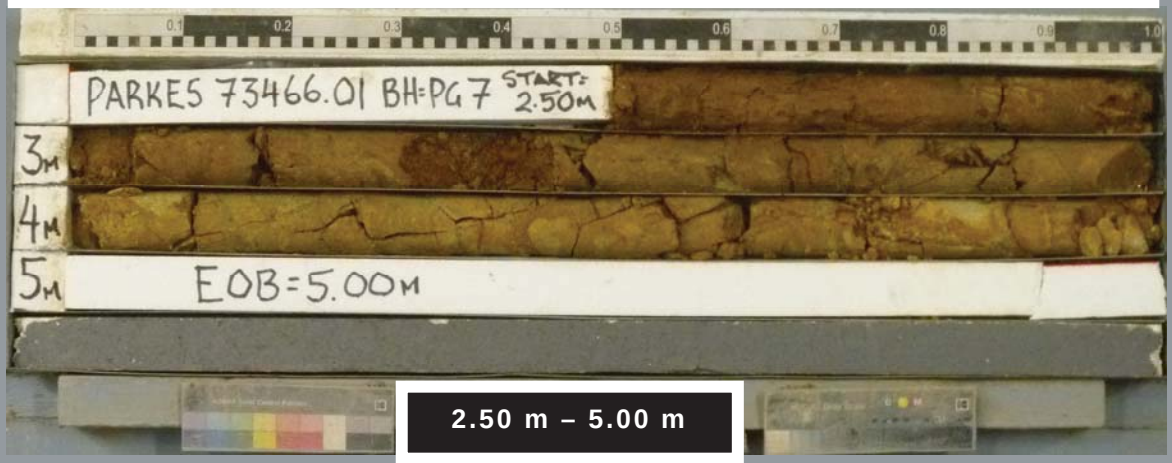
DOUGLAS PARTNERS PTY LTD
PARKES HOSPITAL REDEVELOPMENT
NEWELL HIGHWAY, PARKES

BORE PG6 PROJECT 73466.01 AUGUST 2013

2.50 m – 5.45 m

DOUGLAS PARTNERS PTY LTD
PARKES HOSPITAL REDEVELOPMENT
NEWELL HIGHWAY, PARKES

BORE PG7 PROJECT 73466.01 AUGUST 2013



2.50 m – 5.00 m

DOUGLAS PARTNERS PTY LTD
PARKES HOSPITAL REDEVELOPMENT
NEWELL HIGHWAY, PARKES

BORE PG8 PROJECT 73466.01 AUGUST 2013

2.50 m – 5.20 m

DOUGLAS PARTNERS PTY LTD
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NEWELL HIGHWAY, PARKES

BORE PG9 PROJECT 73466.01 AUGUST 2013

2.50 m – 5.00 m

DOUGLAS PARTNERS PTY LTD
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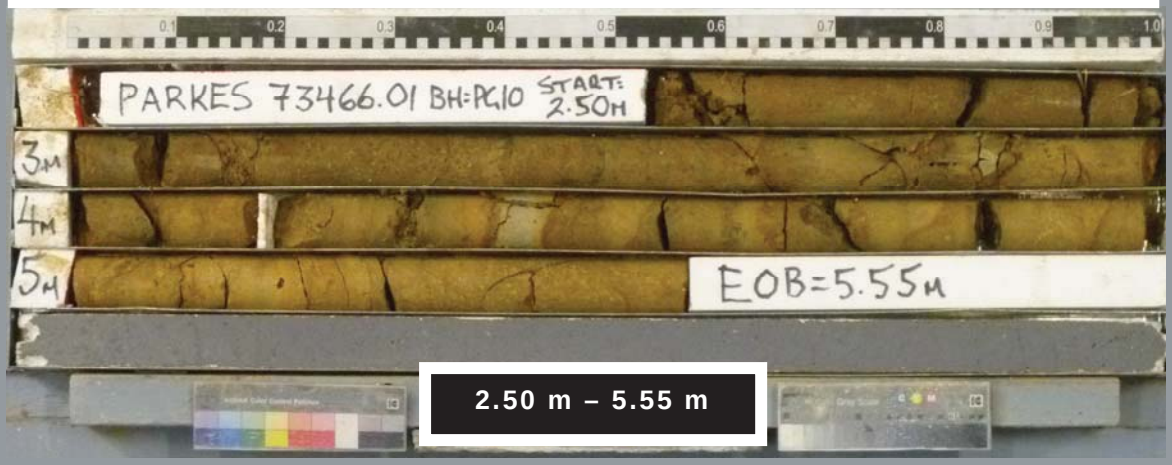
NEWELL HIGHWAY, PARKES

BORE PG10 PROJECT 73466.01 AUGUST 2013



2.50 m – 5.55 m

DOUGLAS PARTNERS PTY LTD
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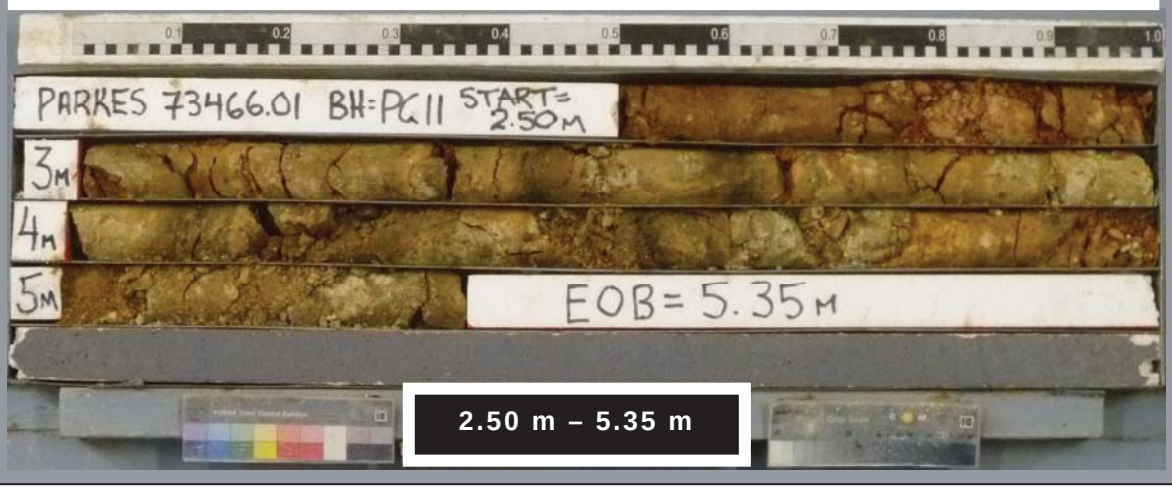
NEWELL HIGHWAY, PARKES

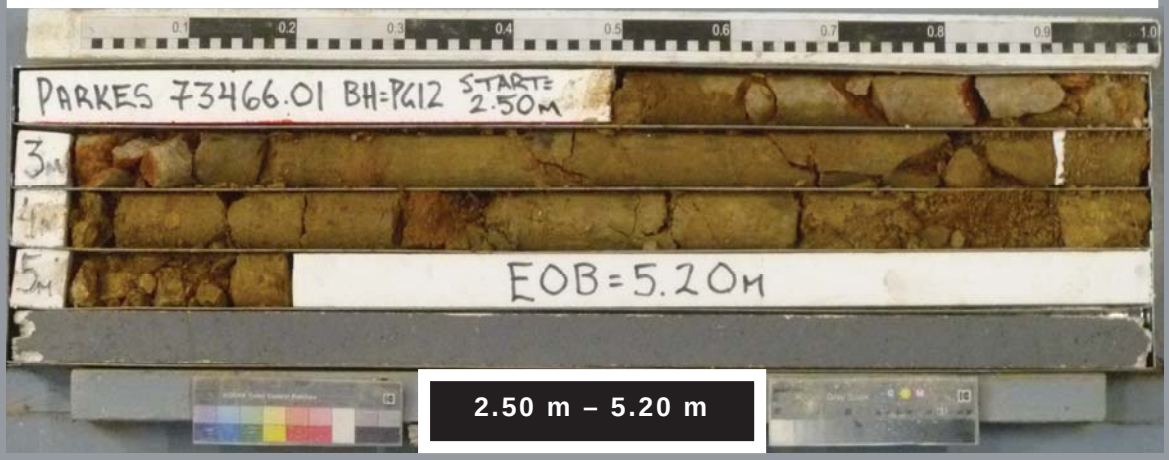
BORE PG11 PROJECT 73466.01 AUGUST 2013



2.50 m – 5.35 m

DOUGLAS PARTNERS PTY LTD
PARKES HOSPITAL REDEVELOPMENT
NEWELL HIGHWAY, PARKES

BORE PG12 PROJECT 73466.01 AUGUST 2013



2.50 m – 5.20 m

Appendix D

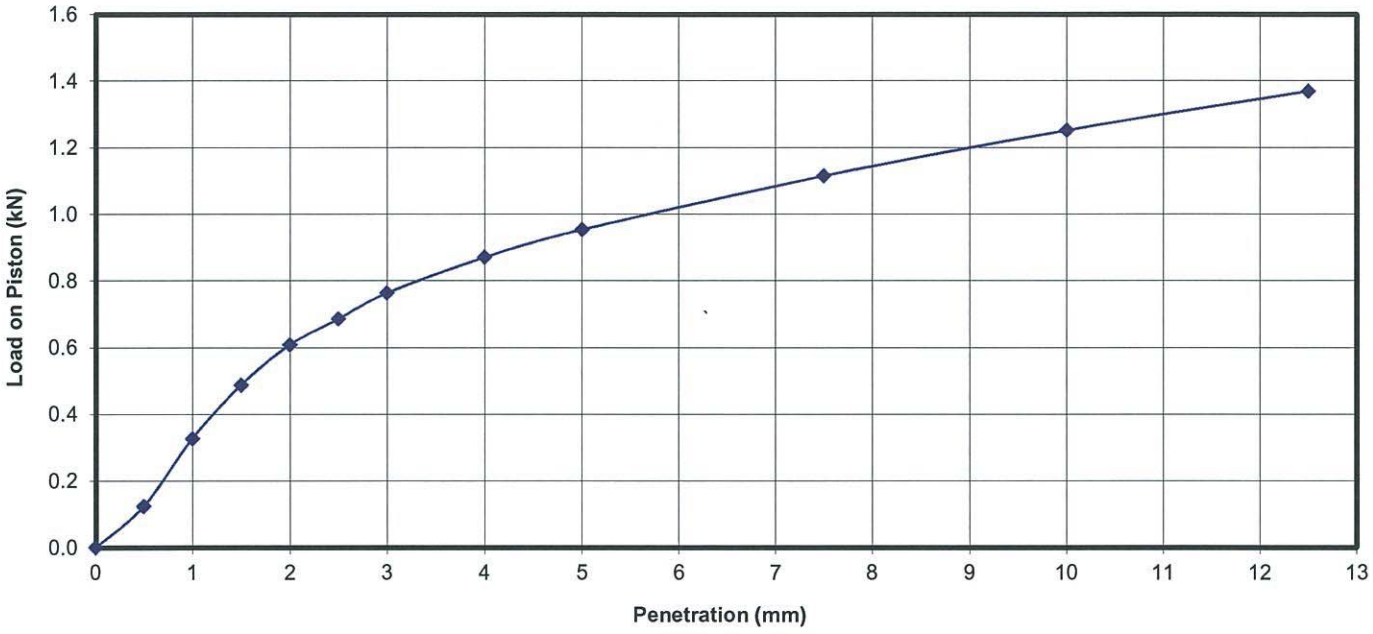
Laboratory Test Results

Douglas Partners
Geotechnics / Environment / Groundwater

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

Results of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	73466.01
		Report No. :	1
Project :	Parkes Hospital Development	**Report Date :**	23/09/2013
		Date Sampled :	28/08/2013
Location :	Newell Highway, Parkes	**Date of Test:**	14/09/2013
Test Location :	PP1		
Depth / Layer :	0.3 - 0.6m	**Page:**	1 of 1



Description: Red brown silty clay with trace of gravel

Test Method(s): AS1289 6.1.1, AS1289 5.1.1, AS1289 2.1.1

Sampling Method(s): Sampled by Engineering Department

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 101% of STD MDD
MOISTURE RATIO: 98% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: 0.0%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		17.0	1.79
After soaking		19.7	1.79
After test	Top 30mm of sample	19.6	-
	Remainder of sample	17.6	-
Field values		18.8	-
Standard Compaction		17.3	1.78

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**5**
	5.0 mm	**5**

NATA Accredited Laboratory No 828
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025

Norman Weimann
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

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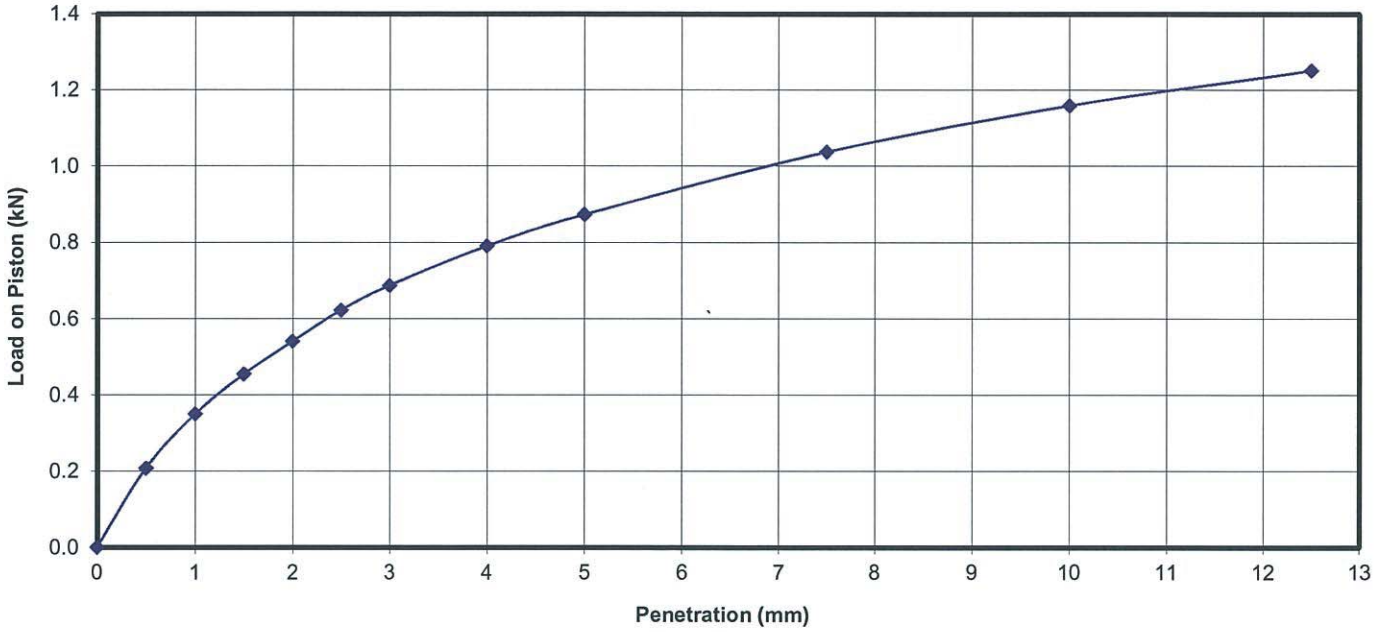
Results of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	73466.01
		Report No. :	2
Project :	Parkes Hospital Development	**Report Date :**	20/09/2013
		Date Sampled :	28/08/2013
Location :	Newell Highway, Parkes	**Date of Test:**	13/09/2013
Test Location :	PP2		
Depth / Layer :	0.3 - 0.6m	**Page:**	1 of 1



Description: Red brown silty clay

Test Method(s): AS1289 6.1.1, AS1289 5.1.1, AS1289 2.1.1

Sampling Method(s): Sampled by Engineering Department

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 99% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: 0.1%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		17.8	1.78
After soaking		18.7	1.78
After test	Top 30mm of sample	18.8	-
	Remainder of sample	18.0	-
Field values		18.9	-
Standard Compaction		18.0	1.77

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**4.5**
	5.0 mm	**4.5**

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Brett Hughes
Laboratory Manager

Douglas Partners
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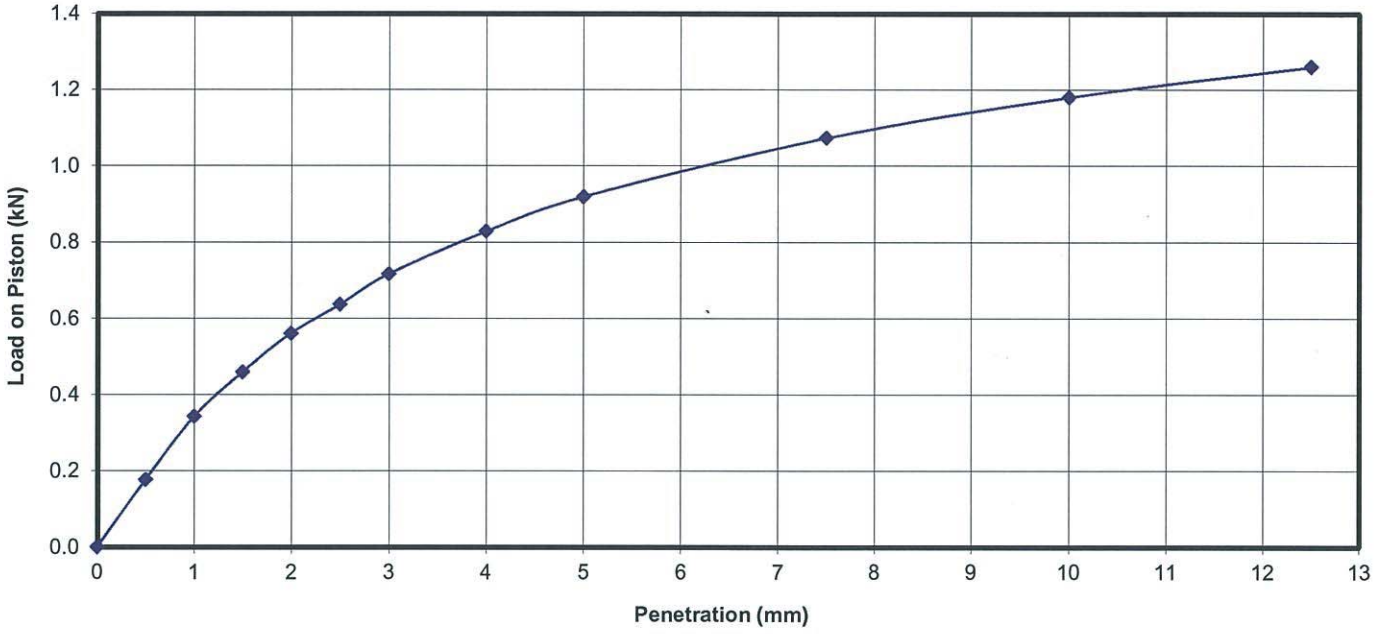
Results of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	73466.01
		Report No. :	3
Project :	Parkes Hospital Development	**Report Date :**	20/09/2013
		Date Sampled :	28/08/2013
Location :	Newell Highway, Parkes	**Date of Test:**	13/09/2013
Test Location :	PP3		
Depth / Layer :	0.4 - 0.7m	**Page:**	1 of 1



Description: Red brown silty clay with trace of gravel

Test Method(s): AS1289 6.1.1, AS1289 5.1.1, AS1289 2.1.1

Sampling Method(s): Sampled by Engineering Department

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 99% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: 0.0%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		20.6	1.67
After soaking		21.8	1.67
After test	Top 30mm of sample	22.0	-
	Remainder of sample	0.0	-
Field values		21.9	-
Standard Compaction		20.8	1.67

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**5**
	5.0 mm	**4.5**

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Accredited for compliance with ISO/IEC 17025

Brett Hughes
Laboratory Manager

Douglas Partners
Geotechnics / Environment / Groundwater

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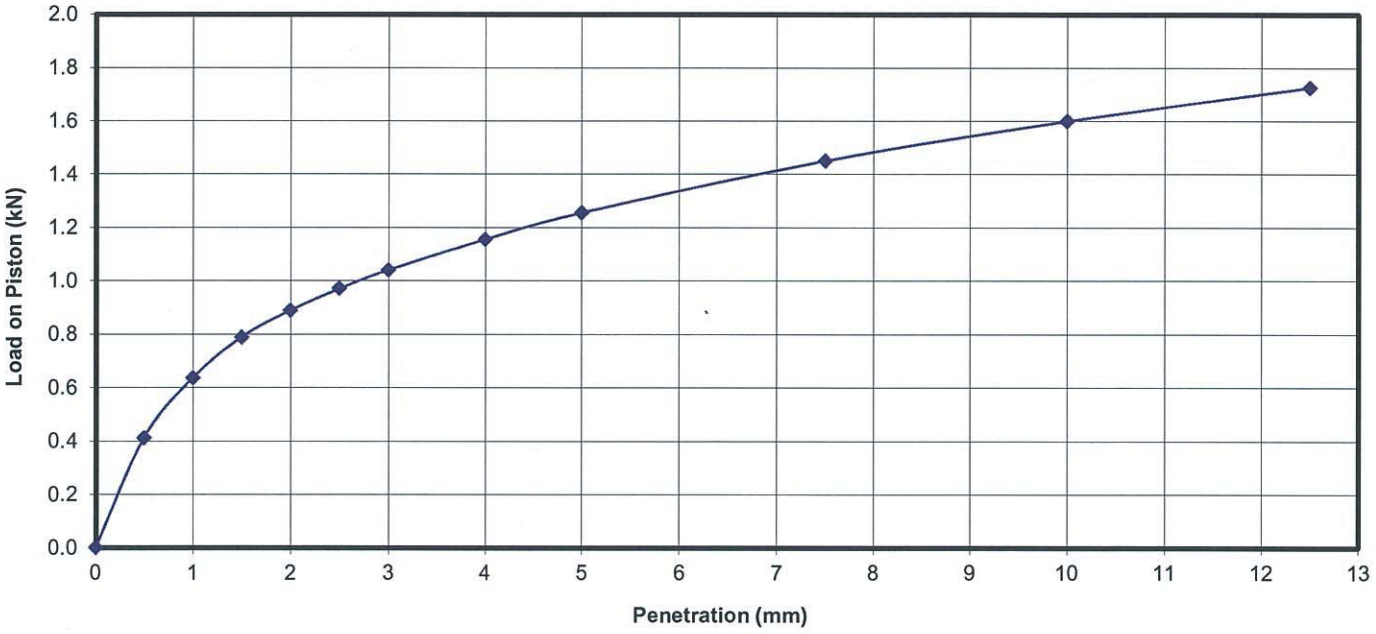
Results of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	73466.01
		Report No. :	4
Project :	Parkes Hospital Development	**Report Date :**	20/09/2013
		Date Sampled :	28/08/2013
Location :	Newell Highway, Parkes	**Date of Test:**	13/09/2013
Test Location :	PP4		
Depth / Layer :	0.3 - 0.6m	**Page:**	1 of 1



Description: Red brown silty clay with trace of gravel

Test Method(s): AS1289 6.1.1, AS1289 5.1.1, AS1289 2.1.1

Sampling Method(s): Sampled by Engineering Department

Percentage > 19mm: 1.0% Excluded

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 100% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: -0.1%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		19.5	1.70
After soaking		21.4	1.70
After test	Top 30mm of sample	22.3	-
	Remainder of sample	20.6	-
Field values		20.6	-
Standard Compaction		19.4	1.70

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**7**
	5.0 mm	**6**

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Brett Hughes
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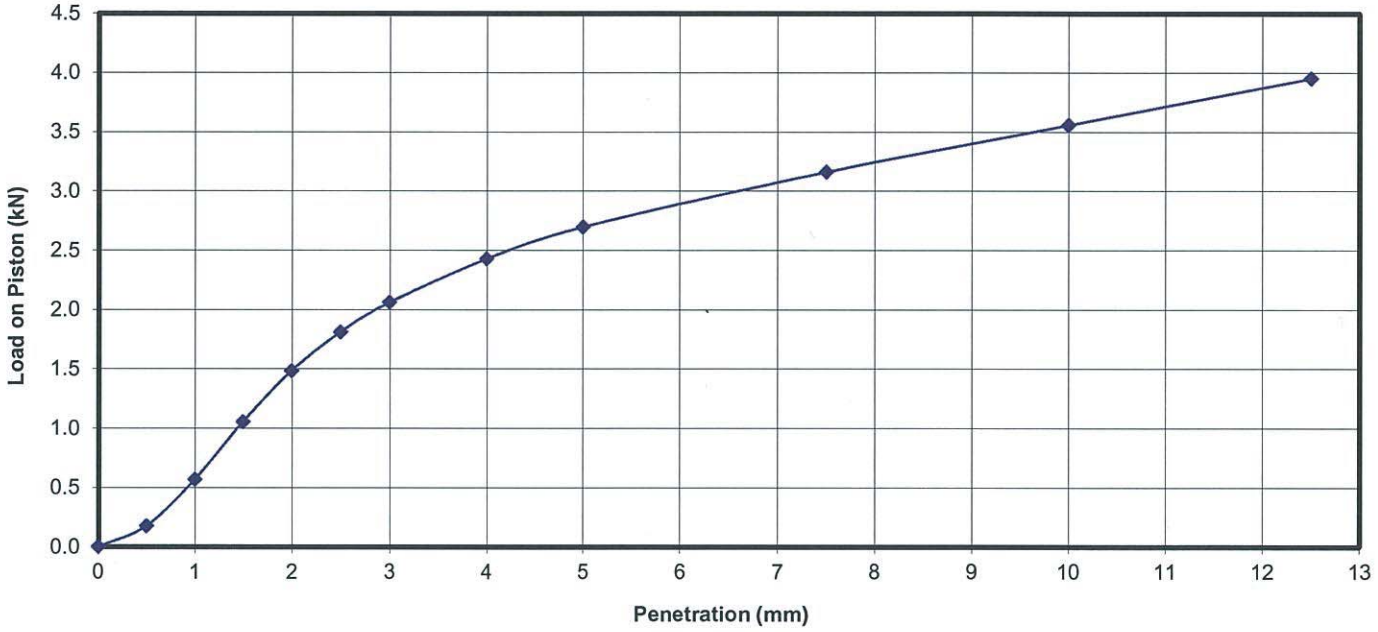
Results of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	73466.01
		Report No. :	5
Project :	Parkes Hospital Development	**Report Date :**	20/09/2013
		Date Sampled :	28/08/2013
Location :	Newell Highway, Parkes	**Date of Test:**	13/09/2013
Test Location :	PP5		
Depth / Layer :	0.3 - 0.7m	**Page:**	1 of 1



Description: Red brown gravelly silty clay

Test Method(s): AS1289 6.1.1, AS1289 5.1.1, AS1289 2.1.1

Sampling Method(s): Sampled by Engineering Department

Percentage > 19mm: 1.0% Excluded

LEVEL OF COMPACTION: 101% of STD MDD
MOISTURE RATIO: 98% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: 0.2%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		12.6	1.89
After soaking		15.6	1.89
After test	Top 30mm of sample	15.8	-
	Remainder of sample	14.3	-
Field values		9.5	-
Standard Compaction		12.9	1.87

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**15**
	5.0 mm	**14**

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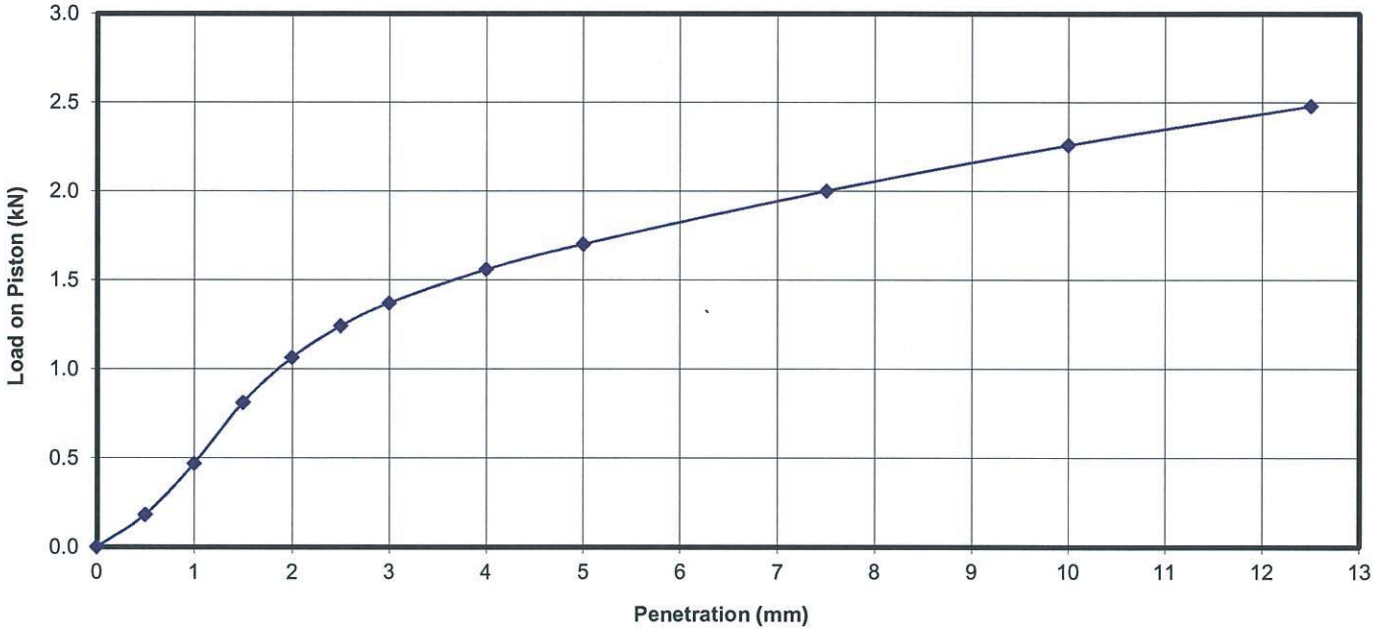
Results of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	73466.01
		Report No. :	6
Project :	Parkes Hospital Development	**Report Date :**	20/09/2013
		Date Sampled :	28/08/2013
Location :	Newell Highway, Parkes	**Date of Test:**	14/09/2013
Test Location :	PP6		
Depth / Layer :	0.3 - 0.6m	**Page:**	1 of 1



Description: Red brown silty clay with trace of gravel

Test Method(s): AS1289 6.1.1, AS1289 5.1.1, AS1289 2.1.1

Sampling Method(s): Sampled by Engineering Department

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 98% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: 0.2%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		20.4	1.67
After soaking		23.1	1.67
After test	Top 30mm of sample	26.0	-
	Remainder of sample	22.4	-
Field values		21.6	-
Standard Compaction		20.9	1.67

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**10**
	5.0 mm	**9**

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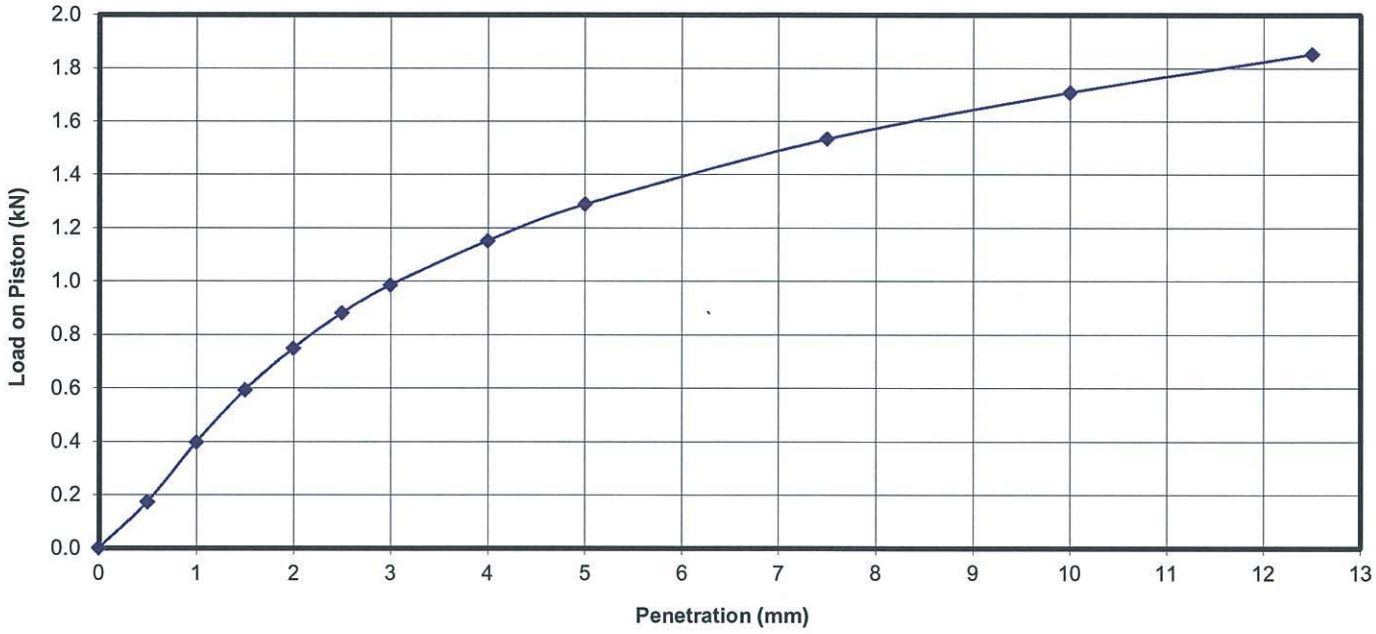
Results of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	73466.01
		Report No. :	7
Project :	Parkes Hospital Development	**Report Date :**	20/09/2013
		Date Sampled :	28/08/2013
Location :	Newell Highway, Parkes	**Date of Test:**	13/09/2013
Test Location :	PP7		
Depth / Layer :	0.3 - 0.6m	**Page:**	1 of 1



Description: Red brown silty clay with trace of gravel

Test Method(s): AS1289 6.1.1, AS1289 5.1.1, AS1289 2.1.1

Sampling Method(s): Sampled by Engineering Department

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 97% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: 0.3%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		19.8	1.71
After soaking		22.5	1.71
After test	Top 30mm of sample	22.6	-
	Remainder of sample	21.2	-
Field values		20.0	-
Standard Compaction		20.4	1.70

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**7**
	5.0 mm	**7**

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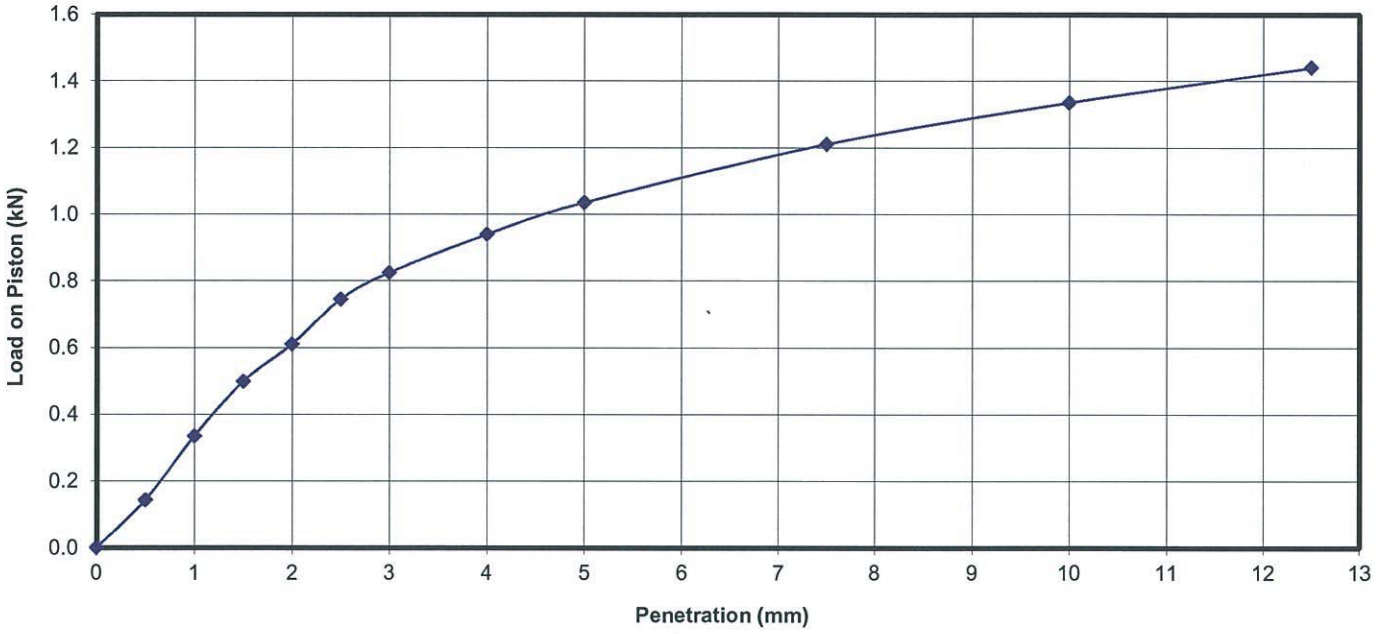
Results of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	73466.01
		Report No. :	8
Project :	Parkes Hospital Development	**Report Date :**	20/09/2013
		Date Sampled :	28/08/2013
Location :	Newell Highway, Parkes	**Date of Test:**	14/09/2013
Test Location :	PP8		
Depth / Layer :	0.3 - 0.6m	**Page:**	1 of 1



Description: Red brown silty clay with some gravel

Test Method(s): AS1289 6.1.1, AS1289 5.1.1, AS1289 2.1.1

Sampling Method(s): Sampled by Engineering Department

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 100% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: 0.0%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		18.4	1.77
After soaking		19.3	1.77
After test	Top 30mm of sample	19.8	-
	Remainder of sample	18.3	-
Field values		19.2	-
Standard Compaction		18.4	1.77

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**6**
	5.0 mm	**5**

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Results of Moisture Content, Plasticity and Linear Shrinkage Tests

Client:	**Health Infrastructure**	**Project No:**	73466.01
		Report No:	9
Project:	Parkes Hospital Development	**Report Date:**	20/9
		Date Sampled:	28/08/13
Location:	Newell Highway, Parkes	**Date of Test:**	18/09/13
		Page:	1 of 1

Test Location	Depth (m)	Description	Code	W_F %	W_L %	W_P %	PI %	*LS %
PP1	0.3-0.6	Red brown silty clay with trace of gravel	2,5	-	35	17	18	9.5
PP2	0.3-0.6	Red brown silty clay	2,5	-	36	17	19	11.5
PP3	0.4-0.7	Red brown silty clay with trace of gravel	2,5	-	40	19	21	11.5
PP4	0.3-0.6	Red brown silty clay with trace of gravel	2,5	-	42	20	22	12.0
PP5	0.3-0.7	Red brown gravelly silty clay	2,5	-	31	14	17	9.0

Legend:

W_F Field Moisture Content
W_L Liquid limit
W_P Plastic limit
PI Plasticity index
LS Linear shrinkage from liquid limit condition (Mould length125mm)

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

*Specify if sample crumbled CR or curled CU

Test Methods:

Moisture Content:	AS 1289 2.1.1
Liquid Limit:	AS 1289 3.1.2
Plastic Limit:	AS 1289 3.2.1
Plasticity Index:	AS 1289 3.3.1
Linear Shrinkage:	AS 1289 3.4.1

Sampling Methods: AS 1289.1.2.1, AS 1289.1.1

Remarks:

NATA Accredited Laboratory Number: 828

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Tested: LW
Checked: BH

Brett Hughes
Laboratory Manager

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12 Ashley St Chatswood NSW 2067
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CERTIFICATE OF ANALYSIS 97388

Client:
Douglas Partners Pty Ltd
96 Hermitage Rd
West Ryde
NSW 2114

Attention: Clean Lab

Sample log in details:

Your Reference:	**73466.01, Parkes Hospital Redevelopment**
No. of samples:	2 Soils
Date samples received / completed instructions received	12/09/2013 / 12/09/2013

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

Report Details:

Date results requested by: / Issue Date:	20/09/13 / 19/09/13
Date of Preliminary Report:	None Issued

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Results Approved By:

Jacinta Hurst
Laboratory Manager

Miscellaneous Inorg - soil			
Our Reference:	UNITS	97388-1	97388-2
Your Reference	----------	PP1	PP6
Depth	----------	0.3-0.6	0.3-0.6
Date Sampled		28/08/2013	28/08/2013
Type of sample		Soil	Soil
Date prepared	-	16/09/2013	16/09/2013
Date analysed	-	16/09/2013	16/09/2013
pH 1:5 soil:water	pH Units	6.3	6.4
Electrical Conductivity 1:5 soil:water	µS/cm	72	53
Chloride, Cl 1:5 soil:water	mg/kg	7	3
Sulphate, SO4 1:5 soil:water	mg/kg	8	6

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

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			16/09/2013	[NT]	[NT]	LCS-1	17/09/2013
Date analysed	-			17/09/2013	[NT]	[NT]	LCS-1	17/09/2013
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	LCS-1	100%
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	LCS-1	102%
Chloride, Cl 1:5 soil:water	mg/kg	2	Inorg-081	<2	[NT]	[NT]	LCS-1	95%
Sulphate, SO4 1:5 soil:water	mg/kg	2	Inorg-081	<2	[NT]	[NT]	LCS-1	103%

Report Comments:

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

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

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

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

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

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