



# **Douglas Partners**

*Geotechnics | Environment | Groundwater*

Report on  
Geotechnical Investigation

Wagga Wagga Base Hospital – Stage 3  
Edward Street, Wagga Wagga

Prepared for  
Health Infrastructure

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Integrated Practical Solutions



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## **Report on Geotechnical Investigation**

### **Wagga Wagga Base Hospital – Stage 3**

### **Edward Street, Wagga Wagga**

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## **1. Introduction**

This report presents the results of a geotechnical investigation undertaken for Stage 3 of the Wagga Wagga Base Hospital redevelopment project at Edward Street, Wagga Wagga. The investigation work was commissioned by Health Infrastructure and was carried out in accordance with DP's proposal SYD140556 dated 19 May 2014.

It is understood that the Stage 3 redevelopment project will involve the demolition of existing hospital buildings in the north-western area of the campus and the construction of a new two to three-storey facility. A new on-grade carpark is also proposed in the south-western area of the hospital.

Geotechnical investigation was undertaken to provide information on the subsurface conditions on the site and included the drilling of boreholes, the installation of a groundwater monitoring well, laboratory testing and engineering analysis. Details of the current field work and comments relevant to design and construction are given in this report.

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

## **2. Previous Investigations**

Douglas Partners has undertaken several investigations at Wagga Wagga Base Hospital since 2011 as outlined in the various reports for the 72320 project series. Borehole logs from investigations undertaken in 2011 (Projects 72320.00 and 72320.03) and 2012 (Project 72320.06) have been used to develop the geotechnical model for the Stage 3 area and are included in Appendix D.

## **3. Site Description and Geology**

Wagga Wagga Base Hospital is located at the south-eastern corner of the intersection between Edward Street (Sturt Highway) and Docker Street. The Stage 3 development areas are located in the north-western and south-western portions of the campus. The ground surface levels generally fall at gentle grades to the north; the difference in levels is approximately 2 m over a distance of 200 m.

At the time of the current investigation the north-western portion of the site was occupied by several adjoining hospital buildings constructed at or close to the ground surface levels. The south-western area contained several smaller buildings, an on-grade carpark and a storage area for the Stage 2 development works which were underway.

The *Wagga Wagga 1:250 000 Geological Series Sheet* (SI 55-15) indicates that the site is underlain by unconsolidated sand, silt, clay and gravel (floodplain sediments) and includes high-level Tertiary aged terrace sediments of the Murray Valley comprising gravel, sand, silt and clay. The Wagga Marginal Base Formation comprising shale, slate, quartzite, sandstone and sub-greywacke is shown to the south.

Regional groundwater and surface water is expected to flow in a north-easterly direction towards the Murrumbidgee River.

#### **4. Current Field Work Methods**

The field work for the current geotechnical investigation included the drilling of nine boreholes (BH401 to BH409) at the locations shown on Drawing 1 in Appendix B. The bores in the area of the proposed building were drilled to depths of 10.3 m to 15.0 m using a DT250 drilling rig. They were commenced using solid flight augers then continued using rotary wash-boring equipment inside top casing. Standard penetration tests were undertaken at regular depth intervals.

The bores in the area of the proposed pavement were drilled to depths of 1.0 m to 1.5 m using either a DT250 drilling rig or a hand-auger. Dynamic penetrometer tests were undertaken at these locations.

Bore BH405 was converted into groundwater monitoring well at the completion of drilling. This involved placing Class 18 uPVC screen and solid casing in the borehole. A gravel pack was placed around the screen and a bentonite plug was placed above the gravel. The remainder of the void was backfilled with drill cuttings and the top of the well was finished with a steel cover mounted flush with the surface.

The ground surface levels at the bores were measured to AHD using an automatic level relative to known benchmarks on the site.

#### **5. Field Work Results**

The subsurface conditions encountered in the boreholes are presented in the borehole logs in Appendix C (current investigation) and Appendix D (previous investigations). Notes defining descriptive terms and classification methods are included in Appendix A.

The subsurface conditions encountered in the area of the proposed building can be described as follows:

- **FILLING** – silty sand, gravelly clay, silty clay and clayey sand filling with gravel, rootlets, coal, concrete and tile to depths of 0.2 m to 1.2 m;
- **NATURAL SOIL** – stiff, very stiff and hard silty clay with gravel and sand to depths of 10.0 m to 10.4 m, underlain by dense gravelly sand, sandy gravel, sand and clayey sand to the base of the deeper bores at 10.0 m to 15.5 m depth.

The subsurface conditions encountered in the area of the proposed carpark included silty clay and silty sand filling to depths of 0.2 m to 0.5 m, underlain by stiff silty clay.

Table 1 summarises the levels at which different materials were encountered in the deeper boreholes.

**Table 1: Summary of Material Strata Levels**

Stratum	RL of Top of Stratum (m, AHD)							
	BH401	BH402	BH403	BH404	BH405	BH105	BH106	BH108
Ground Surface/ Filling	181.0	181.5	181.6	181.7	181.6	181.5	182.6	181.8
Natural Clay <sup>1</sup>	180.7	181.3	181.3	180.9	181.1	180.3	182.4	181.4
Natural Sand or Gravel <sup>2</sup>	170.8	171.1	171.4	171.7	171.3	171.5	172.2	NE
Base of Borehole	170.7	171.1	166.6	167.2	171.1	171.0	167.1	171.3

Notes: <sup>1</sup>Stiff, very stiff or hard; <sup>2</sup>Dense; NE = not encountered

Free groundwater was not observed during augering and the use of drilling fluid prevented groundwater observations during rotary wash-boring. The monitoring well installed in BH405 was purged following installation and remained dry during the remainder of the field work.

The water levels measured during the previous investigations are provided in Table 2.

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

Date	BH101	BH106
31 March 2011	176.4	NM
6 April 2011	NM	176.3
7 April 2011	176.3	NM
20 September 2011	175.7	176.8

Notes: NM = not measured

## 6. Laboratory Testing

Four soil samples obtained from the bores in the area of the proposed carpark were tested to determine the California bearing ratio (CBR) of the soil. The samples were compacted to a dry density ratio of 100% relative to Standard compaction, subjected to a 4.5 kg surcharge and were soaked in a water bath for 4 days prior to testing. The results of the analysis are summarised in Table 3.

**Table 3: Laboratory Test Results for California Bearing Ratio**

<b>Sample/Depth (m)</b>	<b>Material Description</b>	<b>Maximum Dry Density (t/m<sup>3</sup>)</b>	<b>California Bearing Ratio (%)</b>	<b>Swell (%)</b>
BH406/0.5-0.8	Silty clay	1.78	9	0.4
BH407/0.5-0.8	Silty clay	1.83	19	0.8
BH408/0.3-1.0	Silty clay	1.70	8	0.2
BH409/0.5-0.9	Silty clay	1.85	13	0.3

## 7. Geotechnical Model

The development areas are underlain by a minor depth of filling over stiff, very stiff and hard alluvial silty clays to depths of about 10 m. Previous laboratory test results suggest that the clayey soils are of moderate plasticity. The clays are underlain by sands and gravels to the base of the deeper bores at depths of up to 15.5 m. Due to their alluvial origin these soil materials are expected to be variable across the site, varying in depth, thickness and extent, depending on the alignment and size of ancient river channels.

Groundwater was not observed during the current investigation but has previously been encountered between RL 175.7 m and RL 176.8 m AHD.

## 8. Proposed Development

It is understood that the Stage 3 redevelopment project will involve the demolition of existing hospital buildings in the north-western area of the campus and the construction of a new two to three-storey facility. A new on-grade carpark is also proposed in the south-western area of the hospital.

The geotechnical issues considered relevant to the proposed development include site preparation, excavation, excavation support, groundwater, foundations and pavements.

## 9. Comments

### 9.1 Site Preparation

The existing filling is considered to be uncontrolled as there is no evidence to suggest that it has been placed and compacted to an engineering specification. If the existing filling is required to support new pavements and building slabs then it will need to be reworked. The following process could be undertaken:

- Excavate the existing filling to expose natural clay soils;

- Prepare the subgrade by rolling with a large roller (e.g. 12 tonne deadweight) and ensure there are no areas that exhibit heaving under the roller;
- Place suitable filling in 250 mm thick layers (loose) and compact to achieve a dry density ratio of at least 98% relative to Standard compaction. This should be increased to 100% relative to Standard compaction for the top 300 mm of pavement subgrade;
- If the filling exhibits clay-like properties then the moisture content should be within 2% of optimum.

It is noted that the existing filling should be suitable for re-use provided that any deleterious materials (e.g. particles larger than 100 mm, waste, organic material etc.) are removed prior to or during placement.

Any new filling could also be placed in accordance with the procedure outlined above.

It is suggested that a working platform comprising a layer of crushed rock or recycled crushed concrete be placed over areas of the site where machinery and personnel traffic is expected, due to the risk of poor trafficability over the clays when wet.

## 9.2 Excavation

Excavation works for the new building and carpark may be required within filling and clayey soils which should be readily achievable using conventional earthmoving equipment such as a hydraulic excavator with bucket attachment. Bulk excavation in bedrock will not be required.

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

## 9.3 Excavation Support

Vertical excavations in filling and soil are not expected to be stable for an extended period of time. Temporary batters of 1(H):1(V) could be used to support the sides of the excavations in these materials for cuts up to 2 m deep. The silty clay will be susceptible to significant slaking and erosion from exposure to air and water flows from run-off. Any permanent or semi-permanent batter slopes will need to be covered with either shotcrete pinned to the face, or preferably battered to 3(H):1(V) or flatter, to allow the establishment of topsoil and vegetation (e.g. grass).

Excavations or embankments retained either temporarily or permanently will be subjected to earth pressures down to the base of the excavation. Table 4 outlines material and strength parameters that could be used for the design of retaining structures.



**Table 4: Material and Strength Parameters for Retaining Structures**

Material	Bulk Density (kN/m <sup>3</sup> )	Coefficient of Active Earth Pressure ( $K_a$ )	Coefficient of Earth Pressure at Rest ( $K_o$ )	Ultimate Passive Earth Pressure (kPa)
Filling	20	0.4	0.6	-
Alluvial Clays	20	0.3	0.45	200 <sup>1</sup>

Notes: <sup>1</sup>Only below excavation/ground level

The lateral earth pressure distribution for cantilevered walls and for walls with a single row of support could be assumed to be triangular (i.e. increase with depth). Lateral pressures due to surcharge loads from adjacent buildings, road corridors and construction machinery should be included where relevant. Hydrostatic pressure acting on retaining walls should also be included in the design where adequate drainage is not provided behind the full height of the walls.

## 9.4 Groundwater

Groundwater appears to be at least 6 m below the ground surface, and possibly deeper, and is therefore not expected to be an issue for the proposed structures. However, seepage into bored pile holes (if applicable) may be an issue and will need to be removed prior to pouring concrete unless a tremie is used.

## 9.5 Foundations

### 9.5.1 Spread Footings

Depending on the design column loads, spread footings (e.g. pad footings and strip footings) may be suitable for supporting the proposed structure and could be designed using the parameters shown in Table 5.

**Table 5: Design Parameters for Spread Footings**

Material	Allowable Bearing Pressure (kPa)	Modulus of Elasticity (MPa)
Engineered Filling	150	15
Stiff Clays	200	20
Very Stiff/Hard Clays	400	50

Settlements can be determined using the moduli of elasticity provided in Table 5. All spread footings should be inspected by a geotechnical engineer to confirm the strength of the foundation material.

### 9.5.2 Raft Slabs

A raft slab could be used to support the proposed building. The modulus of subgrade reaction ( $k_s$ ) associated with a raft slab is dependent upon the column loads and the area over which the raft transfers the loads. Previous analysis on earlier stages of the hospital redevelopment project suggested that  $k_s$  values of between 1.5 kPa/mm and 3 kPa/mm were appropriate and it is suggested that these values are used in the first instance. Further refinement should be made once column loads and slab efficiencies have been determined.

### 9.5.3 Piles

Buildings constructed during previous stages of the development project are supported by continuous flight auger (CFA) piles. Presumably similar piles would be used to support the Stage 3 building, if piles are required, and would be founded in the stiff to hard clays and dense sands and gravels.

Preliminary pile design could be undertaken using the following parameters:

- Ultimate end-bearing pressure: 2250 kPa
- Average ultimate shaft adhesion (compression): 30 kPa (ignore top 3 m of pile shaft)
- Average ultimate shaft adhesion (tension): 20 kPa (ignore top 3 m of pile shaft)

These parameters were derived from the interpretation of cone penetration test (CPT) data from previous investigations and do include a degree of conservatism as some CFA piling contractors are more experienced than others. Higher parameters may be able to be justified by some contractors on the basis of previous experience, load test results etc.

An appropriate geotechnical strength reduction factor will need to be calculated by the pile designer in accordance with the procedure outlined in Australian Standard AS 2159 – 2009 *Piling – Design and installation*. The serviceability limit state will also require consideration to ensure settlements are within an acceptable range.

## 9.6 Pavements

The current boreholes drilled in the proposed carpark area indicate minor depths of filling over stiff silty clay. The laboratory testing on the clay samples indicated four-day soaked CBR values of between 8% and 19%. Previous testing provided CBR results of between 4% and 10%. The current CBR test results are higher than would generally be expected for medium to high plasticity clays. Subject to the subgrade preparation outlined below, it is recommended that the design of a pavement on a clayey subgrade be based on a CBR value of 3%.

Site preparation for pavement areas should be undertaken in accordance with Section 9.1 of this report. Appropriate cross-fall and subsurface drainage should be installed to reduce the risk of the clayey subgrade becoming saturated during periods of wet weather.

## 10. Limitations

Douglas Partners (DP) has prepared this report for the Stage 3 redevelopment project at Wagga Wagga Base Hospital, NSW in accordance with DP's proposal dated 19 May 2014. 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.

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

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

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

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

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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**Douglas Partners Pty Ltd**

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## Appendix A

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About this Report

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# About this Report

# Douglas Partners



## Introduction

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

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

## Copyright

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

## Borehole and Test Pit Logs

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

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

## Groundwater

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

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

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

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

## Reports

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

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

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

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

# *About this Report*

## **Site Anomalies**

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

## **Information for Contractual Purposes**

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

## **Site Inspection**

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



## 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

# *Sampling Methods*

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.





## 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.

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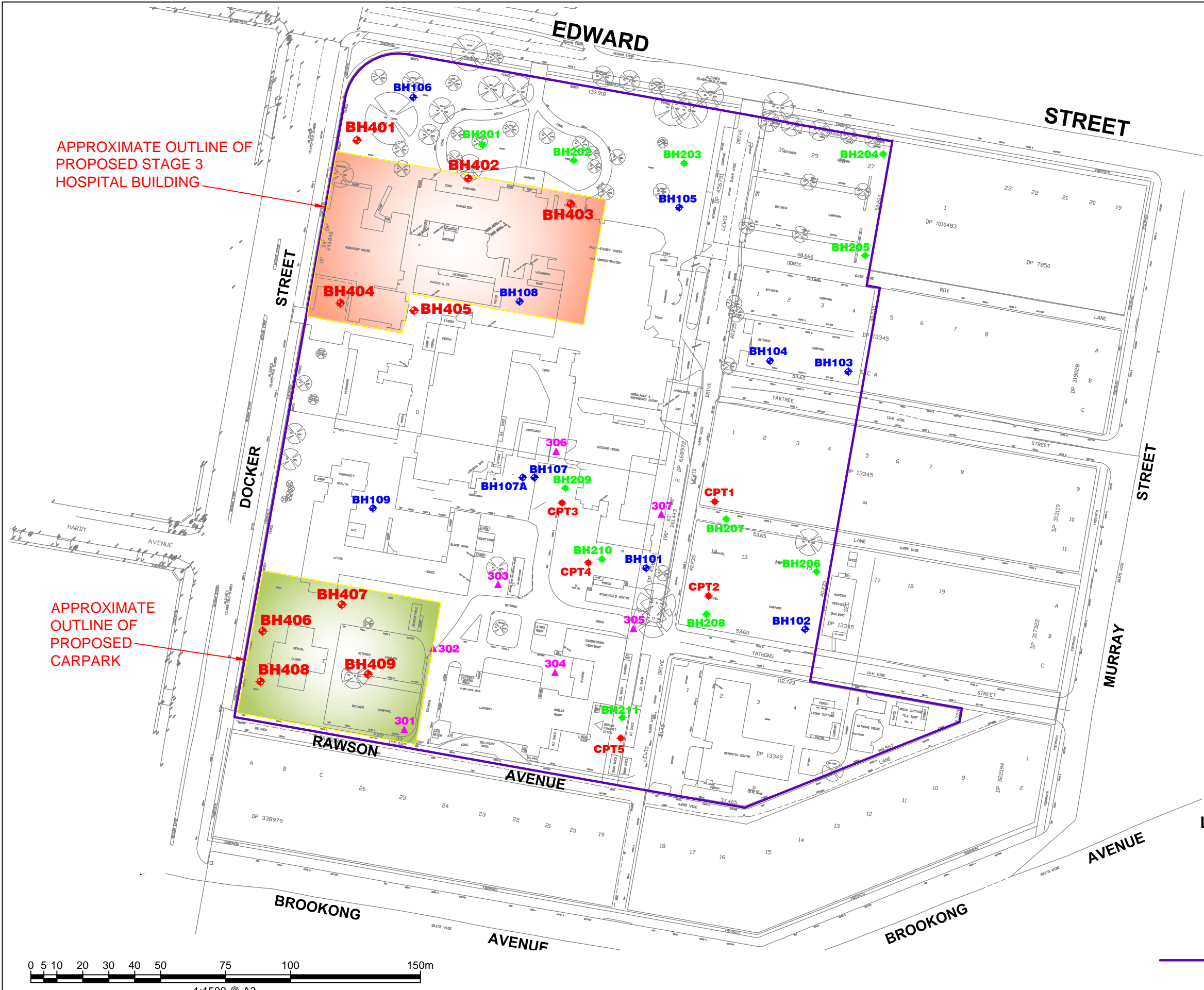
## Appendix B

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Drawings

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P:\72320.09 WAGGA WAGGA Base Hospital Stage 3 PMO Drawings\7232009-1.dwg, 26/08/2014 8:28:21 AM, DWG1616.DWG



Site

Locality Plan

LEGEND

- Current Borehole Location
- Previous Test Location (CPT & Shallow borehole)
- Previous Borehole Location (April 2011)
- Previous CPT Location (September 2011)
- Previous Borehole Location (September 2011)
- Approximate Hospital Boundary



CLIENT: Health Infrastructure	
OFFICE: Sydney	DRAWN BY: PSCH
SCALE: As shown	DATE: 18.8.2014

TITLE: Test Location Plan
Wagga Wagga Base Hospital - Stage 3
Edward Street, Wagga Wagga



PROJECT No:	72320.09
DRAWING No:	1
REVISION:	0

---

## Appendix C

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Results of Current Field Work

# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.0 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH401  
**PROJECT No:** 72320.09  
**DATE:** 23/7/2014  
**SHEET** 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
181	0.3	SILTY CLAY - firm to stiff, dark brown, silty clay with some fine grained sand, damp (with some rootlets in top 100mm)		A/E*	0.1				
					0.2				
		SILTY CLAY - stiff to very stiff, red-brown, silty clay, humid		A/E	0.5				
					0.6				
180	1			A/E	0.9				
					1.0				
				S			5,6,12 N = 18		
					1.45				
179	2	SILTY CLAY - hard, brown to red-brown, silty clay with some quartz/ironstone gravel and fine grained sand, humid							
				S	2.5		18,23,26 N = 49		
					2.95				
178	3								
		- very stiff below 3.5m							
177	4			S	4.0		5,7,10 N = 17		
					4.45				
176	5	- brown and grey mottled below 5.0m							
				S	5.5		6,8,13 N = 21		
					5.95				
175	6	6.3-6.8m: hard band							
174	7	- orange-brown and grey mottled below 7.0m		S	7.0		7,8,13 N = 21		
					7.45				
173	8	- hard below 8.0m							
		- slightly sandy below 8.5m		S	8.5		10,21,26 N = 47		
					8.95				
172	9								

**RIG:** DT250

**DRILLER:** SY

**LOGGED:** AG

**CASING:** HW to 2.5m

**TYPE OF BORING:** Hand auger to 0.7m; Solid flight auger to 2.5m; Rotary to 10.0m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering, drilling fluid prevented the observation of groundwater below 2.5m

**REMARKS:** \*TSA/230714, TSB/230714 are triplicate samples of 0.1-0.2m

## SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	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	W	Water seep	sp	Standard penetration test
E	Environmental sample	W	Water level	S	Shear vane (kPa)




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# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.0 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH401  
**PROJECT No:** 72320.09  
**DATE:** 23/7/2014  
**SHEET 2 OF 2**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
111				S	10.0		18,29/150mm refusal		
	10.2 10.3	GRAVELLY SAND - dense, orange-brown, medium to coarse grained, gravelly (quartz) sand Bore discontinued at 10.3m - target depth reached			10.3				
170	11							11	
169	12							12	
168	13							13	
167	14							14	
166	15							15	
165	16							16	
164	17							17	
163	18							18	
162	19							19	

**RIG:** DT250

**DRILLER: SY**

**LOGGED: AG**

**CASING:** HW to 2.5m

**TYPE OF BORING:** Hand auger to 0.7m; Solid flight auger to 2.5m; Rotary to 10.0m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering, drilling fluid prevented the observation of groundwater below 2.5m

**REMARKS:** \*TSA/230714, TSB/230714 are triplicate samples of 0.1-0.2m

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



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# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.5 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH402  
**PROJECT No:** 72320.09  
**DATE:** 23/7/2014  
**SHEET** 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
181	0.2	FILLING - brown, fine to medium grained, silty sand filling with some quartz gravel, moist (with some rootlets in top 100mm)		A/E	0.0					
	0.6	SILTY CLAY - firm, orange-brown, silty clay, moist (possible filling)		A/E	0.1					
				A/E	0.4					
				A/E	0.5					
				A/E	0.6					
				A/E	0.7					
				A/E	0.9					
				A/E	1.0					
		SILTY CLAY - stiff, red-brown, silty clay, humid		S	1.45		5,6,9 N = 15			
		- very stiff below 1.5m								
180	2.0	SILTY CLAY - hard, brown to red-brown, silty clay with some quartz/ironstone gravel and fine grained sand, humid								
				S	2.5		13,22,28 N = 50			
					2.95					
		- very stiff below 3.0m								
					4.0		6,9,12 N = 21			
				S	4.45					
		- brown and grey mottled below 4.0m								
				S	5.5		6,8,9 N = 17			
					5.95					
					7.0		6,10,12 N = 22			
				S	7.45					
		- grey-brown and orange-brown below 7.0m								
					8.5		9,10,9 N = 19			
				S	8.95					

**RIG:** DT250

**DRILLER:** SY

**LOGGED:** AG

**CASING:** HW to 2.5m

**TYPE OF BORING:** Hand auger to 0.7m; Solid flight auger to 2.5m; Rotary to 10.0m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering, drilling fluid prevented the observation of groundwater below 2.5m

**REMARKS:**

## SAMPLING & IN SITU TESTING LEGEND

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



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# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.5 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH402  
**PROJECT No:** 72320.09  
**DATE:** 23/7/2014  
**SHEET** 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments		
		- hard below 10.0m			10.0		6,11,22 N = 33		
171	10.4	GRAVELLY SAND - dense, orange-brown, gravelly (quartz) sand Bore discontinued at 10.45m - target depth reached		S	10.45				
170	10.45								
11									
170									
12									
169									
13									
168									
14									
167									
15									
166									
16									
165									
17									
164									
18									
163									
19									
162									

**RIG:** DT250

**DRILLER:** SY

**LOGGED:** AG

**CASING:** HW to 2.5m

**TYPE OF BORING:** Hand auger to 0.7m; Solid flight auger to 2.5m; Rotary to 10.0m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering, drilling fluid prevented the observation of groundwater below 2.5m

**REMARKS:**

## SAMPLING & IN SITU TESTING LEGEND

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



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# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.6 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH403  
**PROJECT No:** 72320.09  
**DATE:** 23/7/2014  
**SHEET** 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
181.6	0.3	FILLING - dark brown, fine to medium grained, silty sand filling with some quartz gravel, damp (with some rootlets in top 100mm)		A/E	0.1					
				A/E	0.2					
		SILTY CLAY - stiff, red-brown, silty clay, humid		A/E	0.5					
				A/E	0.6					
180	1	- with some quartz gravel below 1.0m		A/E	0.9					
				S	1.0		3,4,10 N = 14			
					1.45					
179	2	- very stiff below 2.5m			2.5		11,12,16 N = 28			
				S	2.95					
178	3									
					4.0		8,12,18 N = 30			
		- brown and grey mottled below 4.0m		S	4.45					
177	4									
					5.5		7,12,14 N = 26			
				S	5.95					
176	5									
					7.0		8,10,13 N = 23			
		- slightly sandy below 7.0m		S	7.45					
175	6									
					8.5		7,11,12 N = 23			
		- orange-brown and grey mottled below 8.5m		S	8.95					
174	7									
173	8									
172	9									

**RIG:** DT250

**DRILLER:** SY

**LOGGED:** AG

**CASING:** HW to 2.5m; HQ to 14.0m

**TYPE OF BORING:** Hand auger to 0.7m; Solid flight auger to 2.5m; Rotary to 14.5m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering, drilling fluid prevented the observation of groundwater below 2.5m

**REMARKS:**

## SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
BB	Bulk sample	P	Piston sample	PL(A)	Point load axial test 1s(50) (MPa)
BLK	Block sample	U <sub>s</sub>	Tube sample (x mm dia.)	PL(D)	Point load diametral test 1s(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W <sub>s</sub>	Water seep	S	Standard penetration test
E	Environmental sample	W <sub>l</sub>	Water level	V	Shear vane (kPa)




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# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.6 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH403  
**PROJECT No:** 72320.09  
**DATE:** 23/7/2014  
**SHEET** 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
171 170 169 168 167 166 165 164 163 162	10.2	SILTY CLAY - stiff, red-brown, silty clay, humid (continued)		S	10.0		22,33 refusal			
					10.3					
	11.0	GRAVELLY SAND - dense, orange-brown, medium to coarse grained, gravelly (quartz) sand								
	11.5	SANDY GRAVEL - dense and very dense, brown, orange-brown and light grey, medium to coarse grained, sandy gravel (quartz)		S	11.5		16,23,25/80mm refusal			
					11.88		No sample return			
	13.0			S	13.0		25/90mm refusal			
					13.09		No sample return			
	14.5			S	14.5		13,17,27 N = 44			
	14.95	Bore discontinued at 14.95m - refusal due to borehole collapsing in gravels			14.95					

**RIG:** DT250

**DRILLER:** SY

**LOGGED:** AG

**CASING:** HW to 2.5m; HQ to 14.0m

**TYPE OF BORING:** Hand auger to 0.7m; Solid flight auger to 2.5m; Rotary to 14.5m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering, drilling fluid prevented the observation of groundwater below 2.5m

**REMARKS:**

## SAMPLING & IN SITU TESTING LEGEND

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



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# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.7 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH404  
**PROJECT No:** 72320.09  
**DATE:** 25/7/2014  
**SHEET** 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
181 180 179 178 177 176 175 174 173 172	0.1	ASPHALT		A/E	0.1 0.2					
		FILLING - light brown, gravelly clay filling, humid		A/E	0.5 0.6					
	0.5	FILLING - dark brown, gravelly clay filling with a trace of coal fragments, humid		A/E	0.9 1.0		7,11,14 N = 25			
	0.8	SILTY CLAY - very stiff, red-brown, silty clay with some ironstone gravel, humid		S	1.45					
	1.8	SILTY CLAY - hard, brown, silty clay with some ironstone gravel, humid		A/E	1.9 2.0					
				S	2.5 2.72		23,15/70mm refusal			
		- brown and grey mottled below 4.0m		S	4.0 4.45		10,15,28 N = 43			
		- very stiff below 5.0m		S	5.5 5.95		8,9,14 N = 23			
		- orange-brown and grey mottled below 7.0m								
		- stiff below 8.5m		S	8.5 8.95		4,5,7 N = 12			
	10.0									

**RIG:** DT250

**DRILLER:** SY

**LOGGED:** AG

**CASING:** HW to 2.5m; HQ to 14.0m

**TYPE OF BORING:** Hand tools to 0.6m; Solid flight auger to 2.5m; Rotary to 14.5m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering, drilling fluid prevented the observation of groundwater below 2.5m

**REMARKS:**

## SAMPLING & IN SITU TESTING LEGEND

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



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# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.7 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH404  
**PROJECT No:** 72320.09  
**DATE:** 25/7/2014  
**SHEET** 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
171		SAND - dense, orange-brown, medium to coarse grained, slightly clayey sand		S	10.0		14,18,16 N = 34			
					10.45					
11 11.0		SANDY GRAVEL - dense, brown, orange-brown and light grey, medium to coarse grained, sandy gravel (quartz)								
				S	11.5		15,19,27 N = 46			
12					11.95					
				S	13.0		15,18,25 N = 43			
					13.45					
14.5		Bore discontinued at 14.5m - refusal due to borehole collapsing in gravels								
15										
16										
17										
18										
19										

**RIG:** DT250

**DRILLER:** SY

**LOGGED:** AG

**CASING:** HW to 2.5m; HQ to 14.0m

**TYPE OF BORING:** Hand tools to 0.6m; Solid flight auger to 2.5m; Rotary to 14.5m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering, drilling fluid prevented the observation of groundwater below 2.5m

**REMARKS:**

## SAMPLING & IN SITU TESTING LEGEND

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



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# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.6 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH405  
**PROJECT No:** 72320.09  
**DATE:** 25/7/2014  
**SHEET** 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
181	0.05	FILLING - light grey, orange-brown and dark grey, medium to coarse gravel (quartz) filling, humid		A/E	0.1				Gatic cover
	0.2				0.2				
180	0.5	FILLING - orange-brown, gravelly clay filling, humid		A/E	0.5				Backfill Blank 0.0-1.0m
	0.6				0.6				
1	0.9	SILTY CLAY - very stiff, orange-brown, silty clay with some ironstone and quartz gravel, humid		A/E	0.9				Bentonite
	1.0				1.0		4,9,20 N = 29		
2	1.45	- red-brown below 1.0m		S	1.45				
	2.5				2.5		16,22,29 N = 51		
3	2.95	- hard below 2.5m		S	2.95				Backfilled with gravel
	4.0				4.0		8,14,19 N = 33		
4	4.45	- brown and grey mottled below 4.0m		S	4.45				
	5.5				5.5		9,14,17 N = 31		
5	5.95	- very stiff below 5.0m		S	5.95				Machine slotted PVC screen
	7.0				7.0		9,11,14 N = 25		
6	7.45			S	7.45				
	8.5				8.5		5,6,8 N = 14		
7	8.95	- stiff below 8.5m		S	8.95				
172									End cap

**RIG:** DT250

**DRILLER:** SY

**LOGGED:** AG

**CASING:** HW to 2.5m

**TYPE OF BORING:** Hand tools to 0.6m; Solid flight auger to 2.5m; Rotary to 10.0m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering, drilling fluid prevented the observation of groundwater below 2.5m

**REMARKS:** Standpipe pumped dry, no recharge prior to leaving site

## SAMPLING & IN SITU TESTING LEGEND

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



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# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.6 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH405  
**PROJECT No:** 72320.09  
**DATE:** 25/7/2014  
**SHEET** 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
		- very stiff and slightly sandy below 10.0m			10.0				
	10.3								
	10.45	CLAYEY SAND - dense, orange-brown, fine to medium grained, clayey sand		S	10.45		6,10,20 N = 30		
		Bore discontinued at 10.45m							
		- target depth reached							
	11								
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								

**RIG:** DT250

**DRILLER:** SY

**LOGGED:** AG

**CASING:** HW to 2.5m

**TYPE OF BORING:** Hand tools to 0.6m; Solid flight auger to 2.5m; Rotary to 10.0m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering, drilling fluid prevented the observation of groundwater below 2.5m

**REMARKS:** Standpipe pumped dry, no recharge prior to leaving site

## SAMPLING & IN SITU TESTING LEGEND

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

# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 182.6 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH406  
**PROJECT No:** 72320.09  
**DATE:** 26/7/2014  
**SHEET 1 OF 1**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Dynamic Penetrometer Test (blows per 150mm)				
				Type	Depth	Sample		Results & Comments	5	10	15	20
182	0.2	FILLING - brown, silty clay (topsoil) filling with some fine grained sand and rootlets, damp		A/E	0.0 0.1		0.5-0.8m: Bulk sample					
	A/E	0.4 0.5										
	A/E	0.9 1.0										
1	1.0	Bore discontinued at 1.0m - virtual hand auger refusal										
181												
180	2											
179	3											
178	4											
177	5											
176	6											
175	7											
174	8											
173	9											

**CASING:** Uncased

**TYPE OF BORING:** Hand auger to 1.0m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3  
☒ Cone Penetrometer AS1289.6.3.2

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



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# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 182.8 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH407  
**PROJECT No:** 72320.09  
**DATE:** 26/7/2014  
**SHEET** 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
182 181 180 179 178 177 176 175 174 173	0.2	FILLING - brown, silty clay filling with some steel fragments, fine grained sand and rootlets, damp		A/E	0.1		Bulk sample collected from 0.5m-0.8m					
				A/E	0.2							
				A/E	0.4							
				B	0.5							
				A/E	0.8							
	1.0	SILTY CLAY - stiff, brown, silty clay, humid - light brown to orange-brown below 0.5m			0.9							
		Bore discontinued at 1.0m - virtual hand auger refusal										

**RIG:** Hand tools

**DRILLER:** AG

**LOGGED:** AG

**CASING:** Uncased

**TYPE OF BORING:** Hand auger to 1.0m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3  
☒ Cone Penetrometer AS1289.6.3.2

## SAMPLING & IN SITU TESTING LEGEND

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

# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 183.0 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH408  
**PROJECT No:** 72320.09  
**DATE:** 25/7/2014  
**SHEET** 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
183	0.3	FILLING - dark brown, silty sand filling with a trace of clay, damp (with some rootlets in top 200mm)		A/E*	0.1		0.3-1.0m: Bulk sample collected					
				A/E	0.2							
				A/E	0.3							
				A/E	0.4							
				A/E	0.5							
182	1	SILTY CLAY - stiff, brown and grey, silty clay, humid - red-brown below 0.5m			1.0							
					1.1							
181	1.5	Bore discontinued at 1.5m - target depth reached										
180	2											
179	3											
178	4											
177	5											
176	6											
175	7											
174	8											
	9											

**RIG:** DT250

**DRILLER:** SY

**LOGGED:** AG

**CASING:** Uncased

**TYPE OF BORING:** Hand auger to 0.5m; Solid flight auger to 1.5m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering

**REMARKS:** \*TSA/250714, TSB/250714 are triplicate samples of 0.1-0.2m

☐ Sand Penetrometer AS1289.6.3.3  
☒ Cone Penetrometer AS1289.6.3.2

## SAMPLING & IN SITU TESTING LEGEND

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



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# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital - Stage 3  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 183.0 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** BH409  
**PROJECT No:** 72320.09  
**DATE:** 26/7/2014  
**SHEET** 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
183	0.2	MULCH										
	0.3	FILLING - orange-brown, silty clay/gravelly clay filling with some fine grained sand, rootlets and organics, humid		A/E*	0.2							
	0.4			A/E	0.3							
	0.5			B	0.4							
	0.9	SILTY CLAY - stiff, light brown to orange-brown, silty clay, humid		A/E	0.5		Bulk sample collected					
182	1.0	Bore discontinued at 1.0m - virtual hand auger refusal			0.9							
	1.0				1.0							
181	2											
180	3											
179	4											
178	5											
177	6											
176	7											
175	8											
174	9											

**RIG:** Hand tools

**DRILLER:** AG

**LOGGED:** AG

**CASING:** Uncased

**TYPE OF BORING:** Hand auger to 1.0m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering

**REMARKS:** \*TSA/260714, TSB/260714 are triplicate samples of 0.2m-0.3m

☐ Sand Penetrometer AS1289.6.3.3  
☒ Cone Penetrometer AS1289.6.3.2

## SAMPLING & IN SITU TESTING LEGEND

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

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## Appendix D

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Results of Previous Field Work

# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital Redevelopment  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.5 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** 105  
**PROJECT No:** 72320.00  
**DATE:** 31/3/2011  
**SHEET 1 OF 2**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
181	0.15	FILLING (TOPSOIL) - poorly compacted, brown, sandy silt filling with some grass rootlets, dry		E	0.2				
					0.3				
1		FILLING - poorly compacted, orange brown, silty clay filling with some building rubble (concrete, tile) and quartz gravel, dry		E	0.8				
					0.9				
180	1.2	SILTY CLAY - very stiff, orange brown, silty clay with a trace of ironstone gravel, dry		S	1.2				
					1.65				
2				E	2.0				
					2.2				
179	2.5	SILTY CLAY - hard, orange brown silty clay, dry		S	2.5				
					2.95				
3									
178	4.0	SILTY CLAY - very stiff to hard, orange brown silty clay		S	4.0				
					4.45				
4									
5									
176	5.5	SILTY CLAY - very stiff, brown silty clay, dry		S	5.5				
					5.95				
6		6.0m: becoming moist							
7				S	7.0				
					7.45				
8									
174									
9				S	8.5				
					8.95				
10.0									

RIG: Scout

DRILLER: JS

LOGGED: PGH

CASING: Uncased

TYPE OF BORING: Solid flight auger (TC-bit) to 10.0m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:


SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U <sub>s</sub>	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
CO	Disturbed sample	D	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital Redevelopment  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.5 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** 105  
**PROJECT No:** 72320.00  
**DATE:** 31/3/2011  
**SHEET 2 OF 2**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
171	10.45	SAND - medium dense, orange brown, medium to coarse grained sand with a trace of clay, moist		S	10.45		8,9,11 N = 20 (no sample recovered)			
11		Bore discontinued at 10.45m - target depth achieved								
170										
12										
169										
13										
168										
14										
167										
15										
166										
16										
165										
17										
164										
18										
163										
19										
162										

**RIG:** Scout

**DRILLER:** JS

**LOGGED:** PGH

**CASING:** Uncased

**TYPE OF BORING:** Solid flight auger (TC-bit) to 10.0m

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:**

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
BB	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
EE	Environmental sample	≡	Water level	V	Shear vane (kPa)

# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital Redevelopment  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 182.6 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** 106  
**PROJECT No:** 72320.00  
**DATE:** 5/4/2011  
**SHEET 1 OF 2**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details
				Type	Depth	Sample	Results & Comments	
182.6	0.2	FILLING (TOPSOIL) - poorly compacted, brown, silty clay filling with some sand		E*	0.1			Gatic cover Concrete
	0.2			B	0.2			
	0.4	SILTY CLAY - hard, orange brown silty clay, dry			0.3			
181.0	1.0	SILTY CLAY - hard, orange brown, silty clay with a trace of ironstone gravel, dry			1.3		7,22,20 N = 42	Bentonite
				S	1.75			
		2.0m: very stiff		E	2.0			
					2.5		16,29,25 N = 54	
				S	2.95			
179.0	4.0	SILTY CLAY - stiff, mottled orange brown and grey, silty clay with a trace of ironstone gravel and sand, moist			4.0		4,4,5 N = 9	
				S	4.45			
177.0	5.5	SILTY CLAY - very stiff, brown silty clay, moist			5.5		5,8,12 N = 20	
				S	5.95			
175.0	7.0	SILTY CLAY - hard, brown, silty clay with a trace of sand, dry			7.0		10,13,21 N = 34	
				S	7.45			
174.0	8.5				8.5		8,16,19 N = 35	Backfilled with gravel
				S	8.95			
173.0	10.0				10.0			

**RIG:** Scout

**DRILLER:** JS

**LOGGED:** PGH

**CASING:** HQ to 15.0m

**TYPE OF BORING:** Pot holing to 1.2m; Solid flight auger to 14.50m; Rotary (water) to 15.50m

**WATER OBSERVATIONS:** Free groundwater observed at 13.10m

**REMARKS:** \*Denotes field replicate sample BD2/5.4.11 collected. Standpipe piezometer installed: solid 0.0-6.0m; Slotted 6.0-15.5m; Bentonite plug 0.3-1.0m; Quick-set concrete 0.0-0.3m with gatic cover

## SAMPLING & IN SITU TESTING LEGEND







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

# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital Redevelopment  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 182.6 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** 106  
**PROJECT No:** 72320.00  
**DATE:** 5/4/2011  
**SHEET 2 OF 2**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
172	10.35	SILTY CLAY - hard, brown, silty clay with a trace of sand, dry ( <i>continued</i> )		S			14,23,25 N = 48		Machine slotted PVC screen	
		SAND - dense, medium to coarse grained sand, dry			10.45					
171	11	10.95m: rounded quartz gravel								
				S	11.5		16,25,25 N = 50			
170	12				11.95					
				A	12.5				▼	
169	13				13.0					
	13.1	SAND - dense, medium to coarse grained, brown sand with some clay and rounded quartz gravel (to 50mm diameter), saturated		S	13.45		12,12,19 N = 31			
168	14									
	14.4	CLAYEY SAND - dense, medium to coarse grained, clayey sand with some rounded quartz gravel, wet		A	14.4					
167	15			S	14.5		10,15,25 N = 40 (no sample recovered)			
					14.95					
166	15.5	Bore discontinued at 15.5m - target depth achieved							End cap	
165	16									
164	17									
163	18									
	19									

**RIG:** Scout

**DRILLER:** JS

**LOGGED:** PGH

**CASING:** HQ to 15.0m

**TYPE OF BORING:** Pot holing to 1.2m; Solid flight auger to 14.50m; Rotary (water) to 15.50m

**WATER OBSERVATIONS:** Free groundwater observed at 13.10m

**REMARKS:** \*Denotes field replicate sample BD2/5.4.11 collected. Standpipe piezometer installed: solid 0.0-6.0m; Slotted 6.0-15.5m; Bentonite plug 0.3-1.0m; Quick-set concrete 0.0-0.3m with gatic cover

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 <sub>s</sub>	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)



# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital Redevelopment  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.8 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** 108  
**PROJECT No:** 72320.00  
**DATE:** 6/4/2011  
**SHEET 1 OF 2**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
181	0.4	FILLING - poorly compacted, medium grained clayey sand filling, moist		A	0.1 0.2					
180	1.4	SILTY CLAY - apparently hard, red brown silty clay, dry								
179	2.5	SILTY CLAY - hard, red brown silty clay, dry		S	1.4 1.85 2.0 2.2		5,17,22 N = 39			
178	2.5	2.5m: with a trace of ironstone gravel		S	2.5 2.95		10,13,25 N = 38			
177	4.0	SILTY CLAY - very stiff, brown silty clay, moist		S	4.0 4.45		5,9,13 N = 22			
176	5.5			S	5.5 5.95		5,7,13 N = 20			
175	7.0	7.0m: becoming grey brown		S	7.0 7.45		4,8,12 N = 20			
174	8.5	SILTY CLAY - stiff, brown silty clay, moist		S	8.5 8.95		5,6,8 N = 14			
173	10.0				10.0					

**RIG:** Scout

**DRILLER:** JS

**LOGGED:** PGH

**CASING:** Uncased

**TYPE OF BORING:** Pot holing to 1.2m; Solid flight auger (TC-bit) to 10.0m

**WATER OBSERVATIONS:** No free groundwater observed whilst auger drilling

**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 <sub>s</sub>	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	W <sub>s</sub>	Water seep	S	Standard penetration test
E	Environmental sample	W <sub>l</sub>	Water level	V	Shear vane (kPa)

# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital Redevelopment  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.8 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** 108  
**PROJECT No:** 72320.00  
**DATE:** 6/4/2011  
**SHEET 2 OF 2**

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
		SILTY CLAY - stiff, brown silty clay, moist(continued)		S			3,5,6 N = 11			
10.45		Bore discontinued at 10.45m - target depth achieved			10.45					
11										
12										
13										
14										
15										
16										
17										
18										
19										

RIG: Scout

DRILLER: JS

LOGGED: PGH

CASING: Uncased

TYPE OF BORING: Pot boring to 1.2m; Solid flight auger (TC-bit) to 10.0m

WATER OBSERVATIONS: No free groundwater observed whilst auger drilling

REMARKS:


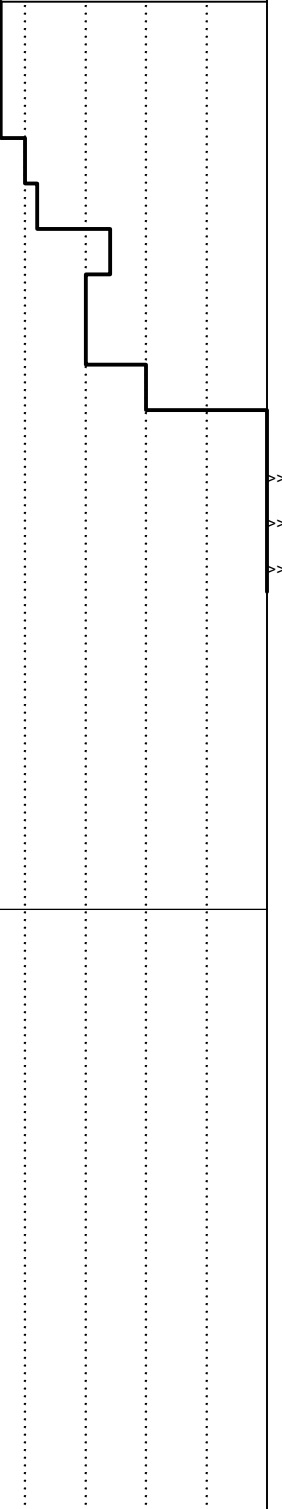

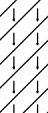
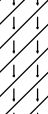
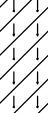
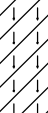
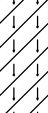
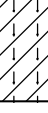
SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U <sub>t</sub>	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
DC	Disturbed sample	D	Water seep	S	Standard penetration test
Env	Environmental sample	W	Water level	V	Shear vane (kPa)

# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital Redevelopment  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.4 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** 201  
**PROJECT No:** 72320.03  
**DATE:** 21/9/2011  
**SHEET** 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
181	0.3	FILLING (TOPSOIL) - poorly compacted, brown, sandy silt filling with some rootlets, dry		E	0.1		PID<1		
				E	0.2		PID<1		
				E	0.3		PID<1		
				E	0.4		PID<1		
1	0.8	FILLING - poorly compacted, brown, silty clay filling with some sand, moist		E	0.4		PID<1		
				E	0.4		PID<1		
				E	0.4		PID<1		
				E	0.4		PID<1		
180	0.8	SILTY CLAY - very stiff, orange brown silty clay, dry		A	0.8		0.8-1.1m: Bulk sample		
				A	0.9		0.8-1.1m: Bulk sample		
				A	0.9		0.8-1.1m: Bulk sample		
				A	0.9		0.8-1.1m: Bulk sample		
179	1.2	- hard from 1.2m		A	1.2				
				A	1.2				
				A	1.2				
				A	1.2				
2	1.5			A	1.5				
				A	1.5				
				A	1.5				
				A	1.5				
178	1.6			A	1.6				
				A	1.6				
				A	1.6				
				A	1.6				
3	2.9			A	2.9				
				A	2.9				
				A	2.9				
				A	2.9				
177	3.0	Bore discontinued at 3.0m - target depth achieved		A	3.0				
				A	3.0				
				A	3.0				
				A	3.0				

**RIG:** 5 tonne Excavator

**DRILLER:** John Rapley

**LOGGED:** PGH

**CASING:** Uncased

**TYPE OF BORING:** 200mm diameter auger

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3  
☒ Cone Penetrometer AS1289.6.3.2

## SAMPLING & IN SITU TESTING LEGEND

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

# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital Redevelopment  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.5 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** 202  
**PROJECT No:** 72320.03  
**DATE:** 21/9/2011  
**SHEET** 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
181	0.3	FILLING (TOPSOIL) - poorly compacted, brown, sandy silt filling with rootlets, dry		E*	0.1		PID<1		
					0.2				
				E	0.3		PID<1		
				D	0.4				
	0.6	FILLING - poorly compacted, brown clay filling with some silt, moist			0.6				
				D	0.7				
	0.8	FILLING - poorly compacted, red brown, silty clay filling with some silt and sand, moist		E	0.8		PID<1		
	1.1	SILTY CLAY - very stiff then hard, orange brown, silty clay, moist		B	1.1				
180	2.0				1.9				
				D	2.0				
179	3.0	Bore discontinued at 3.0m - target depth achieved							
178	4								
177	4								

**RIG:** 5 tonne Excavator

**DRILLER:** John Rapley

**LOGGED:** PGH

**CASING:** Uncased

**TYPE OF BORING:** 200mm diameter auger

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** \*Denotes field replicate sample BD1/21911 collected

☐ Sand Penetrometer AS1289.6.3.3  
☒ Cone Penetrometer AS1289.6.3.2

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

# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital Redevelopment  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 181.5 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** 203  
**PROJECT No:** 72320.03  
**DATE:** 21/9/2011  
**SHEET** 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
181   <									

**RIG:** 5 tonne Excavator

**DRILLER:** John Rapley

**LOGGED:** PGH

**CASING:** Uncased

**TYPE OF BORING:** 200mm diameter auger

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:**

☐ Sand Penetrometer AS1289.6.3.3  
☒ Cone Penetrometer AS1289.6.3.2

## SAMPLING & IN SITU TESTING LEGEND

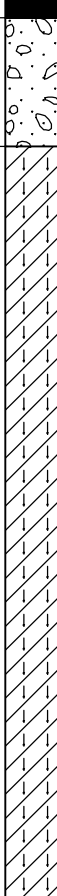
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
BB	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample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

# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital Redevelopment  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 182.9 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** 301  
**PROJECT No:** 72320.06  
**DATE:** 7/11/2012  
**SHEET** 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
182	0.03	ASPHALTIC CONCRETE							
		ROADBASE - sandy gravel roadbase							
	0.2	SILTY CLAY - orange brown silty clay							
1									
181	1.2	Bore discontinued at 1.2m - target depth							

**RIG:** Sucker Truck

**DRILLER:** WWDD

**LOGGED: TS**

**CASING:** Uncased

**TYPE OF BORING:** Hand tool and water blast/ vacuum truck

**WATER OBSERVATIONS:** No free ground water observed

REMARKS: \*BD2/ 071112

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



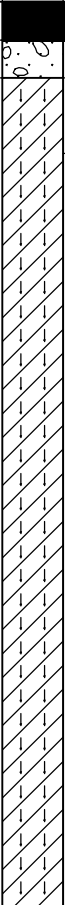
**Douglas Partners**  
Geotechnics | Environment | Groundwater

# BOREHOLE LOG

**CLIENT:** Health Infrastructure  
**PROJECT:** Wagga Wagga Base Hospital Redevelopment  
**LOCATION:** Edward Street, Wagga Wagga

**SURFACE LEVEL:** 182.5 AHD  
**EASTING:**  
**NORTHING:**  
**DIP/AZIMUTH:** 90°/--

**BORE No:** 302  
**PROJECT No:** 72320.06  
**DATE:** 7/11/2012  
**SHEET** 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
182	0.05	ASPHALTIC CONCRETE		E/A	0.1					
	0.1	ROADBASE - sandy gravel roadbase								
	0.2	SILTY CLAY - orange brown silty clay								
181	1.2	Bore discontinued at 1.2m - target depth								

**RIG:** Sucker Truck

**DRILLER:** WWDD

**LOGGED:** TS

**CASING:** Uncased

**TYPE OF BORING:** Hand tool and water blast/ vacuum truck

**WATER OBSERVATIONS:** No free ground water observed

**REMARKS:**

## SAMPLING & IN SITU TESTING LEGEND

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



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## Appendix E

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### Laboratory Test Results

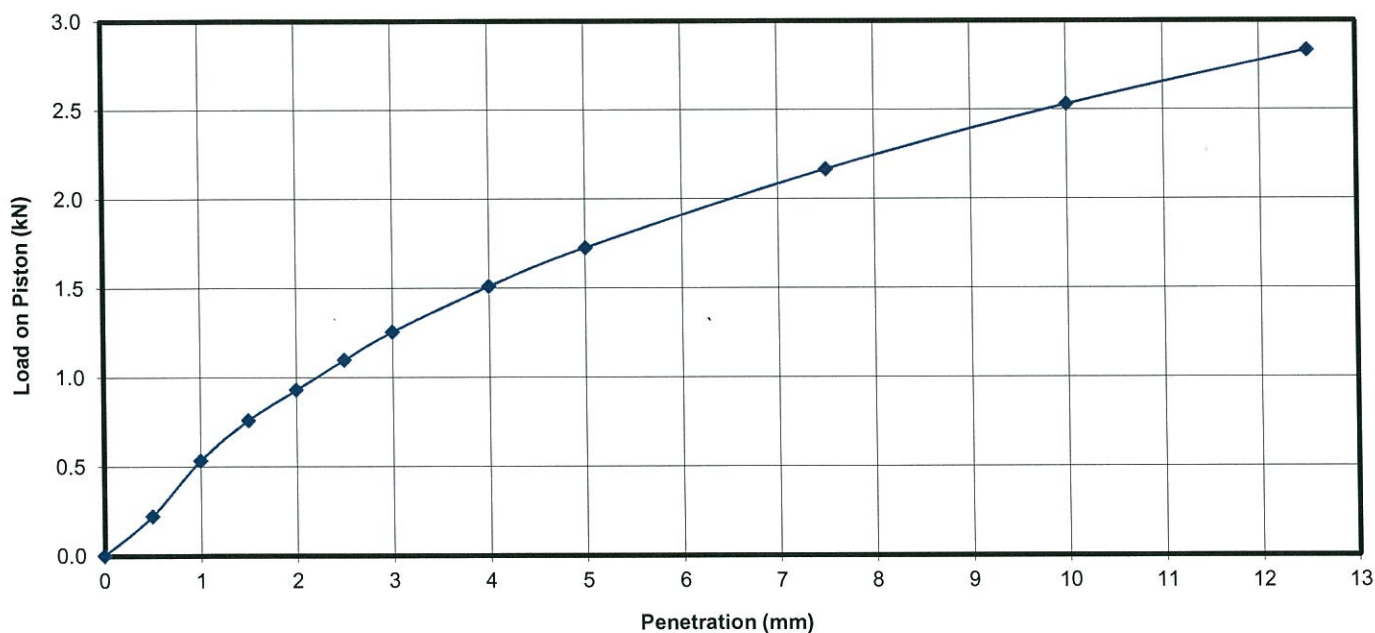
DRAFT



## Results of California Bearing Ratio Test

**Client :** Health Infrastructure (ABN 89600377397)  
**Project :** WAGGA WAGGA Base Hospital Stage 3  
**Location :** Edward Street, WAGGA WAGGA  
**Test Location :** BH406  
**Depth / Layer :** 0.5 - 0.8m

**Project No. :** 72320.09  
**Report No. :** 1  
**Report Date :** 7/08/2014  
**Date Sampled :** 25/07/2014  
**Date of Test:** 4/08/2014  
**Page:** 1 of 1



**Description:** Orange 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% Excluded

**LEVEL OF COMPACTION:** 100% of STD MDD

**SURCHARGE:** 4.5 kg

**SWELL:** 0.4%

**MOISTURE RATIO:** 98% of STD OMC

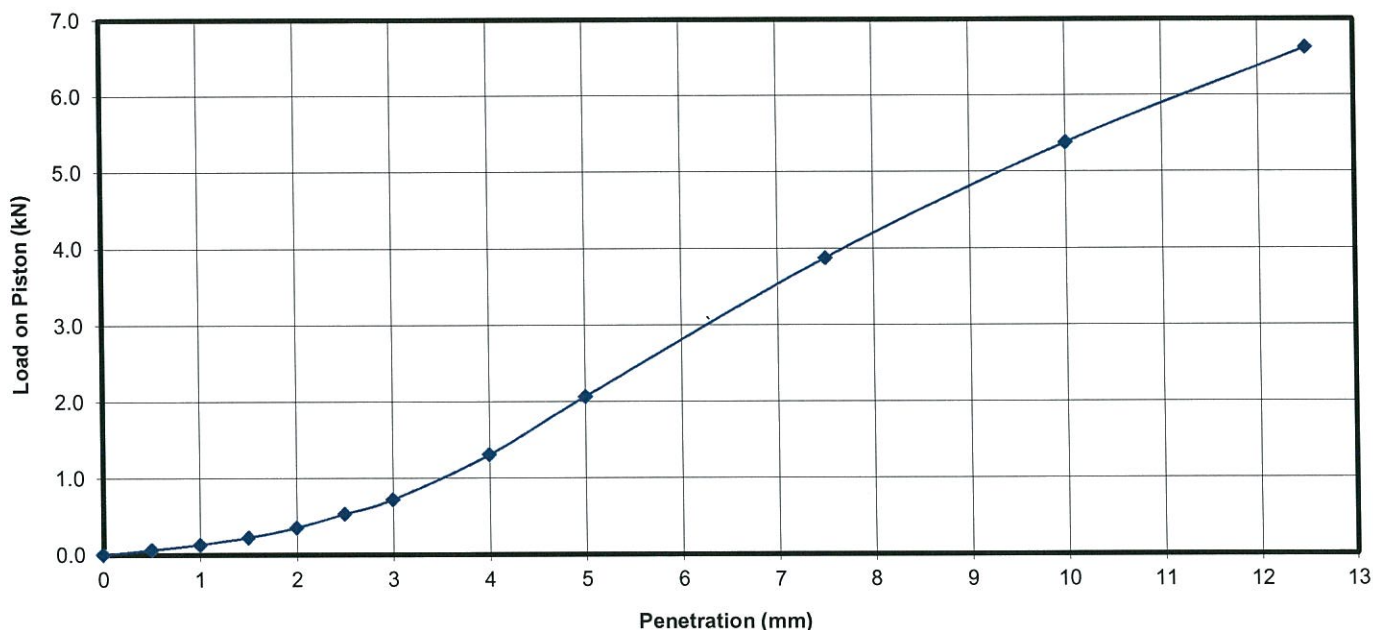
**SOAKING PERIOD:** 4 days

CONDITION	MOISTURE CONTENT %	DRY DENSITY t/m <sup>3</sup>
At compaction	16.6	1.78
After soaking	18.5	1.78
After test	19.3	-
Top 30mm of sample	17.2	-
Remainder of sample	20.3	-
Field values	16.9	1.78
Standard Compaction		

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	5.0 mm	9

## Results of California Bearing Ratio Test

<b>Client :</b>	Health Infrastructure (ABN 89600377397)	<b>Project No. :</b>	72320.09
<b>Project :</b>	WAGGA WAGGA Base Hospital Stage 3	<b>Report No. :</b>	2
<b>Location :</b>	Edward Street, WAGGA WAGGA	<b>Report Date :</b>	7/08/2014
<b>Test Location :</b>	BH407	<b>Date Sampled :</b>	25/07/2014
<b>Depth / Layer :</b>	0.5 - 0.8m	<b>Date of Test:</b>	5/08/2014
		<b>Page:</b>	1 of 1



**Description:** Orange 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%

**LEVEL OF COMPACTION:** 100% of STD MDD

**SURCHARGE:** 4.5 kg

**SWELL:** 0.8%

**MOISTURE RATIO:** 98% of STD OMC

**SOAKING PERIOD:** 4 days

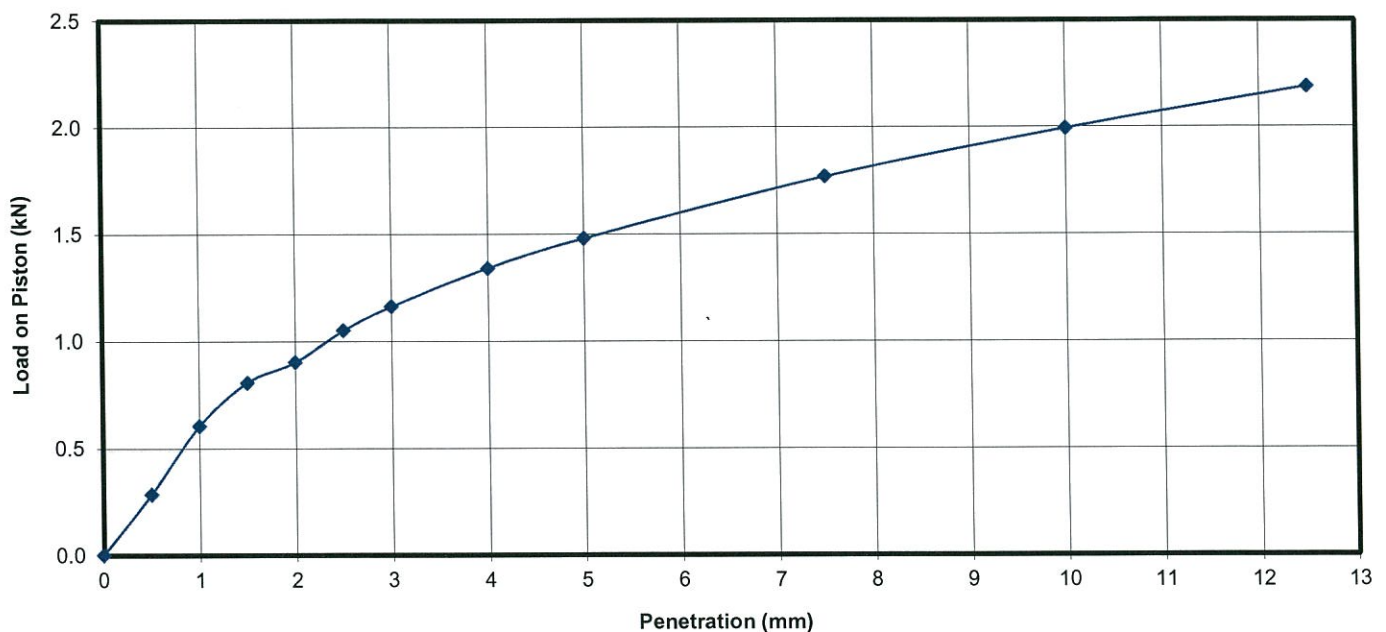
CONDITION	MOISTURE CONTENT %	DRY DENSITY t/m <sup>3</sup>
At compaction	14.0	1.83
After soaking	16.4	1.83
After test	17.1	-
Top 30mm of sample	15.8	-
Remainder of sample	20.5	-
Field values	14.2	1.83
Standard Compaction		

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	5.0 mm	19



## Results of California Bearing Ratio Test

<b>Client :</b>	Health Infrastructure (ABN 89600377397)	<b>Project No. :</b>	72320.09
<b>Project :</b>	WAGGA WAGGA Base Hospital Stage 3	<b>Report No. :</b>	3
<b>Location :</b>	Edward Street, WAGGA WAGGA	<b>Report Date :</b>	5/08/2014
<b>Test Location :</b>	BH408	<b>Date Sampled :</b>	25/07/2014
<b>Depth / Layer :</b>	0.3 - 1.0m	<b>Date of Test:</b>	4/08/2014
		<b>Page:</b>	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%

**LEVEL OF COMPACTION:** 100% of STD MDD  
**MOISTURE RATIO:** 97% of STD OMC

**SURCHARGE:** 4.5 kg  
**SOAKING PERIOD:** 4 days

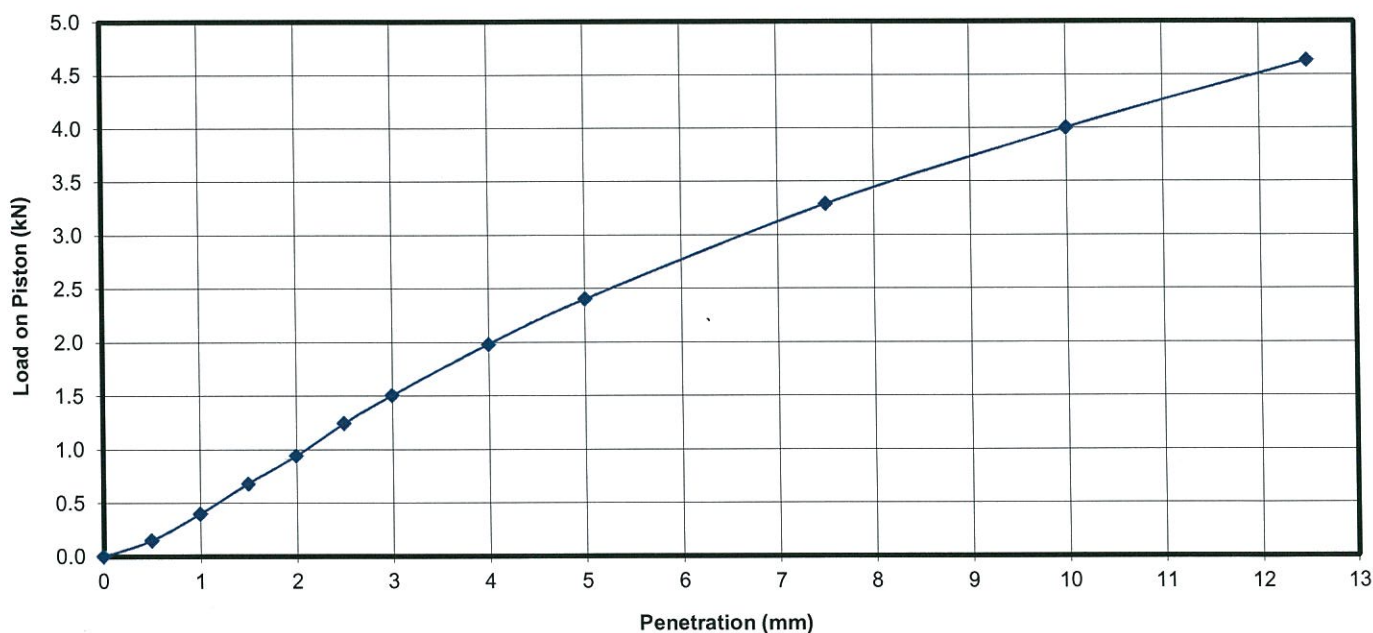
**SWELL:** 0.2%

CONDITION	MOISTURE CONTENT %	DRY DENSITY t/m <sup>3</sup>
At compaction	19.3	1.70
After soaking	21.6	1.70
After test	21.3	-
Top 30mm of sample	20.8	-
Remainder of sample	22.5	-
Field values	20.0	1.70
Standard Compaction		

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	5.0 mm	8

## Results of California Bearing Ratio Test

<b>Client :</b>	Health Infrastructure (ABN 89600377397)	<b>Project No. :</b>	72320.09
<b>Project :</b>	WAGGA WAGGA Base Hospital Stage 3	<b>Report No. :</b>	4
<b>Location :</b>	Edward Street, WAGGA WAGGA	<b>Report Date :</b>	5/08/2014
<b>Test Location :</b>	BH409	<b>Date Sampled :</b>	25/07/2014
<b>Depth / Layer :</b>	0.5 - 0.9m	<b>Date of Test:</b>	4/08/2014
		<b>Page:</b>	1 of 1



**Description:** Light brown to orange 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%

**LEVEL OF COMPACTION:** 100% of STD MDD

**SURCHARGE:** 4.5 kg

**SWELL:** 0.3%

**MOISTURE RATIO:** 98% of STD OMC

**SOAKING PERIOD:** 4 days

CONDITION	MOISTURE CONTENT %	DRY DENSITY t/m <sup>3</sup>
At compaction	14.5	1.85
After soaking	16.3	1.85
After test		
Top 30mm of sample	16.6	-
Remainder of sample	15.3	-
Field values	16.8	-
Standard Compaction	14.7	1.85

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	5.0 mm	13