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Report on
Geotechnical Investigation

Proposed Tamworth Hospital Redevelopment

Prepared for
Aurecon Group

Acting on Behalf of
Health Infrastructure NSW

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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
Author		
Reviewer		

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

Table of Contents

Report on Geotechnical Investigation
Proposed Tamworth Hospital Redevelopment

1. Introduction

This report details the methodology and results of a geotechnical investigation undertaken by Douglas Partners Pty Ltd (DP) for the proposed redevelopment of Tamworth Base Hospital. The investigation was requested by Health Infrastructure, owners of the site and was conducted in consultation with Aurecon Group Brand (Pty) Ltd [Aurecon], managers for the project and Taylor Thomson Whitting (NSW) Pty Ltd [TTW], designers for the project. The scope of work is based on DP's proposal, reference WYG120041 dated 2 March 2012 which was accepted by Aurecon Group Brand (Pty) Ltd, acting on behalf of Health Infrastructure on 5 March 2012.

This assessment was undertaken to support a development application for the construction of new hospital buildings at the site, and an associated ring road and car parking areas (identified in Drawing 1, Appendix A) and to assist with the design of works.

The geotechnical investigation was undertaken to provide information on the following issues:

- Subsurface conditions at test locations;
- Presence of groundwater;
- Information on geotechnical parameters for footings;
- Excavation conditions and support requirements;
- Safe batter slopes;
- Retaining wall design parameters;
- Design Subgrade CBR values for pavements; and
- Site preparation measures.

The investigation included a desktop review of available data, subsurface investigation including the drilling of thirty test bores and excavation of four test pits, followed by laboratory testing and engineering analysis.

DP has previously prepared a Phase 1 Contamination Assessment and Preliminary Geotechnical Investigation for the early works associated with this project. Further details of these assessments are provided in Section 4.1.

DP is also carrying out a concurrent Preliminary Contamination Assessment and Waste Classification Assessment for the project which will be reported under a separate cover.

2. Site Identification and Description

2.1 Site Identification and Proposed Development

Tamworth Base Hospital is located in the north-west of Tamworth and is bounded by Johnston Street to the south and Dean Street to the west. The site is also within the Tamworth Regional Local Government Area.

Undeveloped cleared land bounds the site to the north and a former quarry and present landfill site is located to the east. The landfill encroaches upon the hospital land and the proposed ring road passes through the western area of the landfill. Drawing 5 in Appendix B shows the lot boundaries in the vicinity of the proposed development. Drawing 1 of Appendix B shows the site features and the proposed development areas.

The overall hospital site comprises the following parcels of land:

- Lot 1 in DP533835
- Lot 2 in DP533835
- Lot 99 in DP753848;
- Lot 335 in DP735848

The landfill site comprises the following parcels of land:

- Lot 7008 in DP1076546
- Lot 108 in DP753848; and
- Lot 109 in DP753848

The land to the west of the hospital within which the proposed western car park will be constructed, comprises the following parcels of land:

- Lot 7306 in DP1159338; and
- Lot 357 in DP753848

The site area covered by the proposed development is shown on Drawing 1 in Appendix B. It covers areas within each of the allotments outlined above and comprises the following key components:-

- A new five storey Acute Care Building. Excavation of up to 6 m is proposed;
- The construction of a ring road commences at the intersection of Johnston Street and Smith Street and extends to the north for approximately 400 m to join up with the existing loop road near the Ambulance Maintenance Bay;
- The construction of a new staff car parking area to the east of the existing ambulance workshop;
- The re-sealing and extension of the existing central car parking area;
- The construction of a new western car park within the land to the north-west of the hospital (Lot 7306 in DP1159338 and Lot 357 in DP753848).

2.2 Site Description

The developed area of the hospital covers an area of approximately 37 hectares and is located on moderately undulating hill slopes which generally fall to the south, south-east and south-west. Surface levels within the hospital grounds range from approximately RL 420 m relative to Australian Height Datum (AHD) in the northern part of the site to approximately RL 390 m AHD in the south-western corner.

Acute Care Building
The proposed Acute Care building will be located in the central area of the hospital (refer Drawing 1). A number of existing buildings are located in this area and will required demolition to allow construction of the Acute Care building (refer Figure 1).

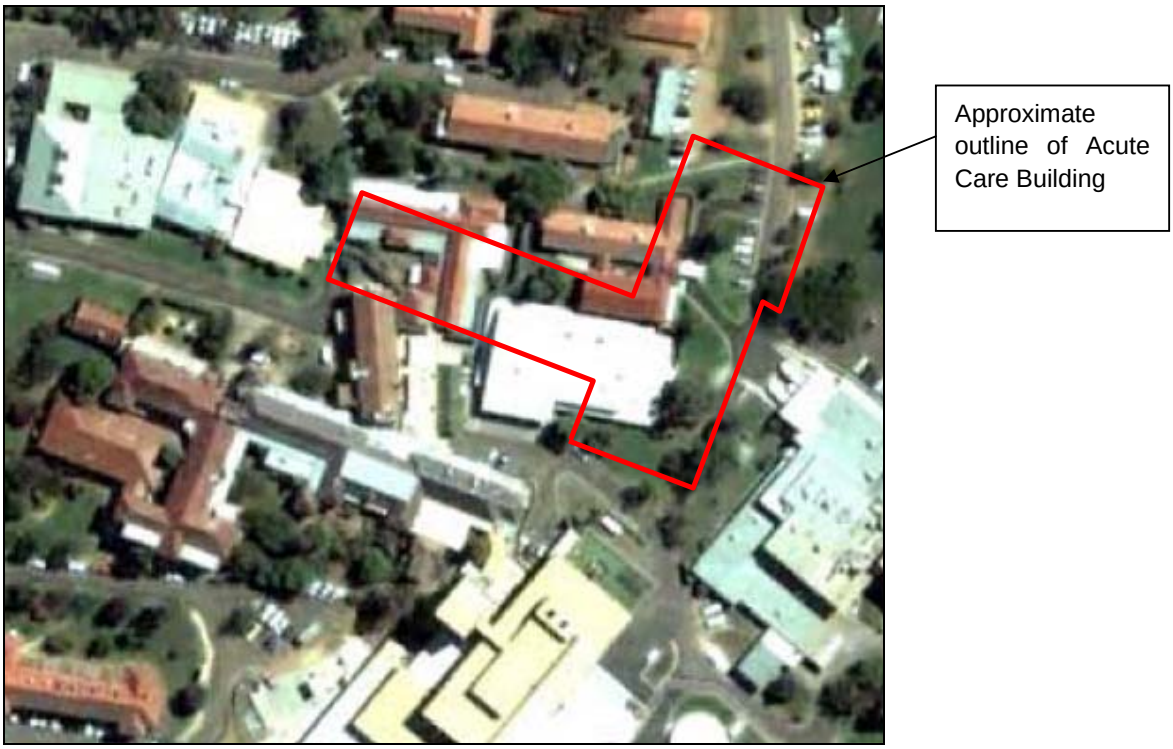

Figure 1: Approximate outlined of proposed Acute Care Building

A number of existing buildings are present within the proposed footprint of the Acute Care Building. These are a combination of single and two storey buildings, generally of masonry construction. Cut and fill earthworks appears to have been undertaken during the development of this area of the site, with a number of terraced areas and intermediate batters of up to 2 m in height.

The areas surrounding the existing buildings are generally either grassed or are within pavement alignments.

Ring Road and Staff Car Park

The new ring road will be located in the eastern and northern section of the hospital site (refer Drawing 1). The majority of the ring road alignment passes through either crown land or the eastern extents of the hospital grounds. The ring road alignment commences at the intersection of Johnston Street and Smith Street (assigned Ch 00m) and extends in a northerly direction for approximately 280 m, before turning to the north-west and passing to the south of the existing Ambulance Maintenance Bay, before connecting with the existing loop road. The first approximately 210 m of the proposed ring road will be located within the area which includes the boundary between the hospital site and a former quarry (present landfill site). This section of the proposed alignment predominantly has a sparse coverage of grass. From approximately Ch 210 to 300 m, the ground surface is bare earth (filling).

Based on the location of survey pegs placed by the project surveyor, it appears that the landfill site encroaches upon the hospital site. The survey pegs were placed within the stockpiles present within the western section of the former landfill (refer Figure 2 and Drawing 3).

Figure 2: Drilling rig at Bore 109 with stockpiles on hospital boundary

Beyond approximately CH 300 m the alignment passes through a recently constructed car park (refer Figure 3) with a spray seal wearing course and a batter slope to the north of the car park, which exposes a combination of gravelly clay and meta-siltstone bedrock.

Figure 3: Existing staff car park in north-eastern area of site

A new staff car parking area is to be constructed to the east of the Ambulance Workshop (refer Drawing 1).

Central Car Parking Area

The central car parking area is approximately 55 m by 45 m and is located within the north-western area of the hospital site (refer Figure 4).

Figure 4: Central car park, looking south

It has a spray seal wearing course and inspection of the area identified a number of defects in the pavement including crocodile cracking, rutting and aggregate loss. The car park will be extended to the east and west of its present extents into generally grass covered areas with scattered trees.

Western Car Park

The area of the new western car park is within partially cleared land to the west of the hospital and to the north of the gaol (refer Figure 5).

Figure 5: Access track to Bore 113 (western car park)

3. Physical Setting

3.1 Topography

Review of the local topographic mapping and a site survey plan indicates that the site is located on the southern flanks of an east-west trending ridge line. The ground surface within the hospital generally falls to the south at slopes of approximately 5°.

The existing car parking areas are essentially flat with slight cross falls to either the east or south-east.

Observation suggests that the natural surface levels throughout the site have been significantly modified, particularly in the area of the former quarry. Intrusive investigation in this area encountered up to 10.5 m of filling on the section of the ring road pavement alignment in the former quarry area. Similarly, filling of up to 3 m depth was encountered in the bores drilled in the recently constructed car park.

Minor terraces have been formed during the construction of the hospital with numerous batter slopes of less than 2 m in height observed around the site.

Any surface water entering the site of the proposed Acute Care building is anticipated to be collected in the formal drainage system. Surface water from the proposed ring road is anticipated to enter on-site drains and/or flow off site to the landfill site to the east, then enter the stormwater drainage system on Johnston Street.

3.2 Adjacent Site Uses

Surrounding land uses include the following:

- North (up slope) – Cleared land, probably formerly grazing.
- West (across slope and down slope) – Tamworth Base Hospital and Tamworth Gaol beyond Dean Street.
- South (down slope) – Combination of Tamworth Base Hospital and Johnston Street and beyond to residential development.
- East (across slope and down slope) – Former quarry, which has been progressively filled as a landfill site).

3.3 Regional Geology and Soil Landscape

Reference to the Tamworth 1:250,000 Series Geological Sheet indicates that the site is underlain by metamorphic rocks comprising greywackes, argillites, and limestones belonging to the Yarimite Formation of Devonian Age. The previous and present investigations at the site confirmed the mapping with bedrock comprising metasiltstones encountered in several of the bores undertaken for the present investigation and observed beneath the existing emergency department.

3.4 Acid Sulphate Soils

Given the elevation of the site, acid sulphate soils are not likely to be encountered within the natural soil profile.

3.5 Groundwater

Given the site's topography and geology it is considered unlikely that relatively shallow groundwater is present within the soil profile at the site. Permanent groundwater is, however, likely to be present within Yarimite Formation. Notwithstanding, some seepage may also be located at the interface of localised permeability boundaries such as at the interface of filling and residual soils, or residual soils and weathered bedrock which will be dependent on soil types and the prevailing weather conditions.

A search for registered groundwater bores in the Department of Natural Resources groundwater bore database [Note: this function has been taken up by NSW Office of Water] indicates that three licensed bores are located in close proximity to the hospital, as follows:

- GW057928 on Lot 99, DP753848 (hospital site);
- GW052834 on Lot 395, DP753848 (gaol site); and
- GW965054 on Lot 2, DP519841.

A copy of the search results is provided in Appendix E.

The bore reports indicated the subsurface profile consisted of soil to depths ranging from 1 m to 22m, underlain by shale and basalt. Groundwater was present at depths ranging from 15 m to 17 m below the ground surface.

It is anticipated that the regional groundwater flows to the south.

4. Site History

4.1 Previous Assessments

DP has undertaken a number of previous investigations at the site. The locations of the previous investigations are shown on Drawing 2 and are discussed below.

4.1.1 Proposed Development

- *Report on Preliminary Geotechnical Investigation, Proposed Early Works Programme, Tamworth Hospital Redevelopment, Tamworth*, Project No. 75393.02 dated April 2012. This investigation report was prepared using relevant information obtained from the intrusive investigation data available at the time of preparation. The purpose of the preliminary geotechnical investigation was to support a development application for the early works programme for the site, which

included the construction of the ring road, staff car parking, central car park modifications and western car park.

- *Report on Phase 1 Contamination Assessment, Proposed Early Works Programme, Tamworth Hospital Redevelopment, Tamworth*, Project No. 75393, Document No.1, dated April 2012. This investigation included a walk over inspection and site history together with comments on the areas of concern for contaminating activities in relation to the early works programme.

4.1.2 Previous Site Developments

- *Report on Geotechnical Investigation, Proposed Extensions to Emergency Department and Banksia Mental Health Unit, Tamworth Base Hospital*, Project No. 29745 dated June 2001. This investigation comprised the drilling of four test bores within the area around the Main Brudelin Wing (south-west of the proposed early works development area) and three bores within the Banksia Mental Health Unit (north-west of the proposed early works development area). The bores were drilled to depths ranging from 1.2 m to 5.3 m within the soil and weathered bedrock. Conditions encountered in the bores generally comprised filling including silty clays, silty sands and metasiltstone gravel with some ash to depths of up to 2.5 m, overlying stiff to very stiff residual clays and silty clays, which in turn was underlain by metasiltstone bedrock.
- *Report on Foundation Conditions, Proposed Hospital Extensions, Tamworth*, Project No. 2140 dated July 1969. This investigation comprised the excavation of fifteen (15) test pits to depths of up to 10 feet (3 m) within the area of the existing Brudelin Building and to the south-east and south of the workshops (engineering building). This area is to the west and south of the proposed early works development area. Conditions encountered in the pits included filling, comprising mainly ash and rubble to depths of up to 5 feet (1.5 m). The filling was underlain by residual clay with bedrock described as shale (probably meta-siltstone) encountered at depths ranging from 1.6 feet (0.5 m) to 9 feet (2.7 m).
- *Report on Subsoil Investigation, Tamworth Hospital*, Project No. 2405 dated December 1969. This investigation comprised the excavation of nine test pits to depths of up to 6 feet (1.8 m) within the area to the south-east and south of the workshops (engineering building). This area is to the west and south of the proposed early works development area. Conditions encountered in the pits included filling, comprising mainly ash with burnt garbage, scrap timber, metal and bottles to depths of up to 5 feet (1.5 m). The filling was underlain by residual clay.
- *Report on Foundation Conditions, Tamworth Hospital*, Project No. 673 dated September 1964. This investigation comprised the drilling of six test bores to depths of up to nearly 9 feet (2.7 m) within the area approximately 15 m to 60 m to the east of the former boiler room workshop. Conditions encountered in the pits included gravelly clay overlying bedrock described as shale (probably metasiltstone) at depths ranging from 1 to 6 feet (0.3 m to 1.8 m). Ash filling was encountered in one location approximately 15 m east of the former boiler room.
- *Report on Foundation Conditions, Proposed Nurse Home, Tamworth*, Project No. 266 dated 1961. This project included the drilling of four bores in the south-eastern area of the site (approximately 150 m to the west of the proposed loop road). Conditions encountered included residual clay soils overlying bedrock described as shale at depths ranging from about 3 to 4 feet (0.9 m to 1.2 m).

4.1.3 Reports by others

The client provided DP with a number of previous reports undertaken by others for the purposes of the present investigation. These previous reports included the following:

- *New England North West Regional Cancer Centre, Tamworth Rural Referral Hospital, Tamworth, Preliminary Site Contamination Assessment*, Report RGS00140.1-AE, prepared by Regional Geotechnical Solution and dated November 2010. The investigation included the collection of thirteen near surface samples from within the proposed Cancer centre footprint, located approximately 100 m to the west of the proposed ring road. Areas of concern for the site included mixed fill / hospital refuse owing to former waste dumps and incinerator waste (ash) and herbicide and pesticide use for the treatment of white ants or weed spraying. The results of the report indicated that there was a low likelihood of soil contamination in fill material or natural soils within the site of the proposed Cancer Centre.
- *New England North West Regional Cancer Centre, Tamworth Rural Referral Hospital, Tamworth, Geotechnical Investigation*, Report RGS00140.1-AD, prepared by Regional Geotechnical Solution and dated November 2010. This investigation included drilling of eleven test bores and three test pits in the footprint of the proposed cancer centre, located approximately 100m to the west of the proposed ring road. Conditions encountered in the pits and bores included filling comprising a mixture of gravel, clay and ash to depths ranging from 0.2 m to 2 m, overlying residual clay soils, which in turn were underlain by bedrock described as either sandstone or siltstone at depths ranging from 0.4 m to 2 m.
- *Tamworth Hospital Stage 2 and 3 – Preliminary Geotechnical Investigation, prepared by Coffey Projects*, dated December 2009. The investigation included excavation of seven test pits, located throughout the hospital grounds. A number of the pits were located near the southern section of the proposed ring road and encountered residual clay soils to depths of 0.7 m and 0.3 m, overlying extremely weathered or highly weathered bedrock, described as shale or argillite. A further test pit (Pit 5) excavated in the area of the recently constructed car park in the north-eastern area of the site encountered gravelly clay filling to 1.2 m overlying residual clay soils.

4.2 Oral Historical Information

As part of the *Preliminary Contamination Assessment* discussions were held with site representatives (including Mr Michael Page, Assistant Hub Manager, North West Hub, NSW Health) from Tamworth Hospital who have been employed at the site for between 20 and 30 years. The following information, pertinent to the current site area, as described in Section 1.2 and shown on Drawing 1 of Appendix B, was gathered during an interview and site walkover:

- The former landfill site was an unlicensed Tamworth Council landfill which has been in operation for several decades (evident in the 1968 photo). Discussion with Mr Darren Rickard of Tamworth Precision Excavations (TPE), who currently leases the landfill site, has indicated that TPE have been continuing to fill the site over the last five years or so using “clean” filling which did not include putrescible waste;
- No information in relation to the landfilling operations being carried out by Tamworth Council prior to TPE leasing the site have been made known to DP;
- A boiler was present within the hospital grounds to produce steam and was located to the east of the present engineering building. The ash from the boiler was progressively deposited over the

ground surface in the area to the south of the boiler, presently occupied by the helipad and the eastern extent of the Brudelin Building. Previous investigations at the site identified the presence of ash in this area;

- It is understood that the staff car park, located to the north of the linen building, was constructed by TPE about 5 to 6 years ago and included excavation into the hillside immediately to the south of the ambulance maintenance building and placement of filling within the area to create a uniform grade. Discussion with TPE personnel indicated that VENM material was used during the construction, however, no documentation to verify this has been provided to DP. Discussion with the ground staff at the hospital indicated that filling of up to several metres was placed in a former gully running in a roughly north-south orientation within the western area of the staff car park. It is understood that the filling was predominantly clay but also included concrete slabs, metal and bricks. The conditions encountered in Bores 212, 213 and 214 indicate that up to 2.1 m of filling in this area and significantly greater in the area of the former landfill;
- An existing building measuring about 16 m long by 5 m wide and located to the west of the staff car park was identified to contain asbestos by means of a sign placed on the eastern face of the building. It is unknown whether any previous testing for the presence of asbestos has been undertaken on this building which will require demolition for the construction of internal pavements. DP is currently undertaking a concurrent hazardous material assessment, the results of which will be provided in a separate report;

5. Field Work Methods

The fieldwork was undertaken between 19 and 23 March 2012 and comprised a combination of site inspection survey, drilling of test bores, excavation of test pits and in situ testing.

Site Inspection Survey

A site walkover of the proposed early works development area was undertaken by Michael Gawn of DP on the 20 March 2012. The site features observed during the inspection are summarised in Section 6.1.

Test Pits and Test Bores

The fieldwork comprised drilling of thirty test bores and excavation of four test pits. Complete bore hole and test pit logs are provided in Appendix C for reference.

Drawing 2 in Appendix B shows the location of the test pits and bores with an image overlay of the proposed development.

The majority of the bores were drilled using a track mounted drilling rig using 100 mm diameter spiral flight augers within the soils and weak bedrock, and NMLC diamond coring techniques in the underlying bedrock. Standard penetration tests (SPTs) were generally undertaken in the overburden at 1 m depth intervals from 1 m depth. The shallow bores (the 100 series tests) were drilled using a 3.5 tonne excavator fitted with a 250 mm diameter solid flight auger attachment.

The pits were excavated using a 3.5 tonne excavator fitted with a 450 mm bucket and spade teeth. Dynamic penetrometer testing or pocket penetrometer testing of samples was undertaken at selected

test pit and bore locations. Dynamic penetrometer testing (DCP) was undertaken adjacent to some of the bores and pits to provide information on the consistency of the material encountered.

The bores and pits were set out by a geotechnical engineer from Douglas Partners Pty Ltd (DP) at locations agreed upon between DP and TTW. The geotechnical engineer logged the subsurface profile in each bore and pit and took representative disturbed and undisturbed samples for identification purposes and laboratory testing.

Point load strength index testing was undertaken on samples of the bedrock retrieved from the bores. The results of this testing is presented on the attached test bore logs.

Photographs of the core retrieved from the bores are provided in Appendix C.

At the completion of field work, all test locations were reinstated with spoil from the drilling or excavation. Where the bores were drilled through existing pavements, the wearing course was reinstated using Cold-mix asphaltic concrete.

6. Field Work Results

6.1 Site Inspection

The site features pertinent to the geotechnical investigation of the site observed during the inspection are summarised below. General site topography was consistent with that described in Section 3.1. Reference should be made to Drawing 1, which shows the site features and areas of the site discussed below.

- The landfill site encroaches upon the hospital site as discussed in Section 2.1;
- A number of stockpiles of various sizes were present within the area of the proposed ring road (refer Figure 6).

Figure 6: Landfill site (looking south). The boundary of hospital passes though large stockpile on right

- The central car park was covered with a sealed wearing course. The areas to the north and east within which the car park will be extended are grass covered with some scattered trees;
- The area of the proposed western car park was within a grass covered area with scattered trees;
- Some lumps of asphalt and concrete were observed scattered on the surface. Similarly, the ground surface appeared to have been previously modified;

6.2 Test Pits and Bores

Details of the subsurface conditions encountered in the test bores and pits are presented in the report sheets in Appendix C. These should be read in conjunction with the explanatory notes, which define the descriptive terms and classification methods.

Geological sections through the proposed Acute Care Building are provided on Drawings 3 and 4 in Appendix B.

A summary of test pit and bore locations together with termination depth and depth to bedrock is presented in Table 1 below.

Table 1 – Summary of Test Locations

Bore / Pit	Location	Easting	Northing	Termination Depth (m)	Depth to Bedrock (m)
100	Johnston Street / Ring Road	302189	6560154	0.85	0.85
101	Ring Road (within landfill)	302216	6560268	2.3	NE
102	Internal Roads	302088	6560323	1.2	NE
103	Ring Road (within landfill)	302214	6560353	2.1	2.1
104	Internal Roads	301956	6560426	1.2	NE
105	Ring Road (within landfill)	302208	6560221	0.8	0.8
106	Behind Linen Building	302188	6560361	1.1	0.8
107	Internal Roads	302034	6560496	1.2	NE
108	Staff Car Park (within landfill)	302213	6560485	2	1.8
109	Ring Road (within landfill)	302222	6560423	11.3	11.3
110	Central Car Park	301979	6560516	1.2	1.2
111	Internal Roads	302085	6560491	1.2	NE
112	Ring Road (within existing car park)	302165	6560462	0.7	0.7
113	Western Car Park	301848	6560596	1.2	NE
114A	Central Car Park	301975	6560560	1.2	NE
115	Ring Road (within landfill)	302200	6560446	3	NE
115A	Ring Road (within landfill)	302201	656447	3.7	3.4
116	Ring Road (within landfill)	302213	6560438	9.1	9.1
200	Acute Care Building	302058	6560383	2.73	1.2
201	Acute Care Building	302077	6560369	4	1.8
202	Acute Care Building	301975	6560437	4	2.3
203	Acute Care Building	302079	6560409	2.6	1.9
204	Acute Care Building	302108	6560433	9	2
205	Acute Care Building	302084	6560442	1.6	1
206	Acute Care Building	302030	6560462	4.24	2.85
207	Acute Care Building	301987	6560478	2.6	2.2
208	Acute Care Building	302075	6560473	10	2.6
209	Acute Care Building	302127	6560477	11	1.8
210	Acute Care Building	302119	6560413	1.05	0.8
211	Acute Care Building	302019	6560389	4	1.8
212	Acute Care Building	302117	6560448	3.15	3.15
213	Ring Road (within existing car park)	302188	6560430	1.4	1.4
214	Within existing car park	302165	6560432	0.3	0.3
TC1	Cutting with former quarry	302245	6560547	N/A	N/A
TC2	Cutting with former quarry	302290	6560543	N/A	N/A

Note: Coordinates obtained from hand held GPS to UTM WGS84

A brief summary of the conditions encountered at test locations within key proposed development areas is provided in the following sections.

6.3 Acute Care Building

The relevant bores for the Acute Care Building include Bores 200 to 212.

Detailed logs of the test bores, together with the results of point load index testing are provided in Appendix C. A summary of the conditions encountered in these bores is provided in Table 2 below.

Table 2: Summary of Subsurface Conditions for Acute Care Building

Test Bore	Surface Level at Test Location[(1)] (m AHD)	Depth to Filling/Clay Interface (m)	Extremely low Strength to Very Low Strength Rock		Low Strength or stronger Rock		Medium Strength or Stronger Rock	
			Depth (m)	Elevation (m AHD)	Depth (m)	Elevation (m AHD)	Depth (m)	Elevation (m AHD)
200	411	0.2	1.2	409.8	1.65	409.4	1.65	409.4
201	409.2	0.75	1.8	408.5	2.28	406.9	2.28	406.9
202	411.8	0.8	2.3	409.5	NE	-	NE	-
203	413.4	0.2	1.9	411.5	2.6*	410.8	NE	-
204	415.2	0.2	2.0	413.2	3.95	411.3	4.85	410.4
205	416.4	0.2	1.0	415.4	NE	-	NE	-
206	415.2	1.2	2.85	412.4	2.93	412.3	NE	-
207	412.8	0.2	2.2	410.6	2.6*	410.2	NE	-
208	417.8	NE	2.6	415.2	3.35	414.5	3.35	414.5
209	419.2	1.5	1.8	417.4	4.0	415.2	4.8	414.4
210	414.2	0.1	0.8	413.4	1.05*	413.2	NE	-
211	412.2	0.3	1.8	410.4	3.45	408.8	3.45	408.8
212	417.4	2.1	3.15	414.6	3.15*	414.6	NE	-

Notes to Table 2: * inferred from TC-bit auger refusal

[1] Surface levels interpolated from survey plan provided by client and should be confirmed by project surveyor

6.4 Ring Road and Eastern Car Park

The relevant test locations for the ring road and eastern car park include the following:

- Pits 101, 103, 105
- Bores 100, 108, 109, 112, 115, 115A, 116, 209, 212 to 214

A summary of the conditions encountered in these bores and pits is provided below.

Wearing Course — Spray seal wearing course in Bores 100, 112, 209 and 213 to depths ranging from 0.02 m to 0.05 m

Granular Pavement Material — Grey or brown sandy gravel to depths ranging from 0.09 m to 0.7 m in Bores 100, 112, 209 and 213.

Filling — Associated within the landfill (Pits 101, 103, 105 and Bores 108, 108A, 115, 115A, 116 and 209) ranging in depth from 0.7 m to 11.3 m. The depth of filling increased towards the northern area of the landfill site and was encountered at its greatest depth in Bore 109. It generally consisted of gravelly sandy clay with various amounts of non-putrescible inclusions

	such as brick fragments, metal, plastic, asphaltic concrete and concrete. Minor amounts of ash were encountered at 2 m depth in Bore 109 and the filling was predominantly grey silty clay with some gravel below about 4.5 m in Bore 109. The results of the DCP and SPT indicated that the filling was in a poorly to moderately compacted condition.
Residual Clay or Gravelly Clay	Very stiff to hard sandy gravelly clay in Bores 100, Pit 101, 103, 105 and Bore 209 at depths ranging from 0.09 m to 1.7 m.
Bedrock	Generally meta-siltstone, ranging in strength from very low to high strength in all bores and pits (except Pit 101) at depths ranging from 0.7 m to 11.3 m.

It is understood that the existing staff car park, through which the ring road will pass, was constructed within the last six years and included excavation into the hillside immediately to the south of the ambulance maintenance building and placement of filling within the area to create a uniform grade. Discussion with the civil contractor responsible for the construction of the car park (Total Precision Excavation) indicated that VENM material was used during the construction, however, no documentation to verify this has been provided to DP. Discussion with the ground staff at the hospital indicated that filling of up to several metres deep was placed in a former gully running in a roughly north-south orientation through the western area of the staff car park. The ground staff indicated that the filling was predominantly clay but also included concrete slabs, metal and bricks. Conditions encountered Bores 212, 213 and 214 indicated that up to 2.1 m of filling in this area.

6.5 Staff Car Park

Pit 108 and Bore 108 were drilled within the proposed staff car park area and the conditions encountered included the following:

Filling	Generally consisting of dark brown silty clay or silty sandy clay with traces of plastic, timber and metal, in a poorly compacted condition to depths of 1.8 m and 1.9 m in Bore 108 and Pit 108 respectively. Very low strength meta-siltstone was encountered in Bore 108 and 108A below the filling. In Bore 108, refusal of the auger string fitted with a tungsten carbide cutting tip occurred at 2 m depth, which indicates that the bedrock is of at least low strength.

6.6 Western Car Park

Bore 113 was drilled within the vicinity of the proposed eastern car park and the conditions encountered included the following:

Filling	Silty clay filling to 0.05 m depth. It should be noted that asphaltic concrete and concrete was noted on the ground surface in the vicinity of Bore 113.
Residual Clay	Hard orange brown gravelly sandy clay, which continued to termination of the bore at 1.2 m.

It should be noted that since the completion of field work, the position of the eastern car park has been moved to the south-west, resulting in Bore 113 being located approximately 20 m to the north-east of the car parking area. Whilst inspection of the general vicinity of the car park suggest that similar conditions may be present within the new proposed car park area, the subsurface conditions have not been specifically investigated.

6.7 Central Car Park

The relevant test locations for the ring road include Bores 110, 114A and 207

A summary of the conditions encountered in these bores and pits is provided below.

Wearing Course	Spray seal wearing course in Bore 114A to 0.02 m depth.
Granular Pavement Material	Light brown and grey sandy gravel in Bore 114A to 0.18 m depth.
Filling	Brown sandy clayey gravel or gravelly sandy clay in Bores 110 and 114A at the surface and 0.18 m depth respectively and continued to 0.15 m and 0.7 m depth respectively. The results of the DCT indicate that the filling was in a well compacted condition.
Residual Clay	Very stiff to hard brown or grey brown sandy clay or clay in all bores at depths ranging from 0.15 m to 0.7 m.
Bedrock	Meta-siltstone bedrock in Bore 207 from 2.2 m depth. Refusal of the auger string fitted with a tungsten carbide cutting tip occurred at 2.6 m depth, which indicates that the bedrock is of at least low strength.

6.8 Groundwater Observations

No free groundwater was observed during the drilling of the bores, although core drilling of the rock introduced water and therefore prevented groundwater observations in a number of the test bores. Similarly, no free groundwater was encountered in the test pits, which were limited to depths of less than 3 m. It should be noted that groundwater levels are variable and affected by climatic conditions and soil permeability.

7. Laboratory Testing

7.1 Geotechnical Testing

Sixteen bulk sample of the subgrade material retrieved from the bores drilled throughout the hospital site were submitted to the laboratory for measurement of California bearing ratio (CBR), including Standard Compaction and Field Moisture Content.

The samples were compacted to approximately 100% Standard dry density ratio at the estimated optimum moisture content and then soaked for four days under a surcharge loading of 4.5 kg prior to testing. Detailed results of laboratory testing are provided in Appendix D and summarised in Table 3, below together with CBR test results from previous investigations.

Table 3: Summary of California Bearing Ratio Testing

Pit / Bore	Depth (m)	Description	FMC (%)	MDD (t/m^3)	OMC (%)	CBR (%)	Swell during soaking (%)
100	0.3 – 0.8	Orange brown SANDY GRAVELLY CLAY	7.6	1.87	14.5	14	0
101	0.6 – 0.9	Light brown gravelly sandy clay FILLING	10.3	1.90	12.2	8	0.2
102	0.5 – 0.8	Brown and orange brown GRAVELLY CLAY	11.0	1.90	12.7	9	0.1
103	0.5 – 0.8	Dark brown sandy clay FILLING	10.3	1.93	12.6	9	-0.5
104	0.5 – 0.8	Orange and red brown CLAY with some sand	27.0	1.53	12.9	2[(1)]	0.9
105	0.3 – 0.5	Brown gravelly sandy clay FILLING	9.2	1.96	12.2	11	-0.3
106	0.5 – 0.8	Light brown SANDY CLAY	11.3	1.85	15.0	15	0.2
107	0.5 – 0.8	Light grey brown GRAVELLY CLAY	8.6	1.85	13.3	14	-0.6
108	0.5 – 0.8	Dark brown silty sandy clay FILLING	7.4	2.01	10.0	20	0
109	0.5 – 0.8	Dark brown silty sandy clay FILLING	14.3	1.78	17.5	8	0.2

Notes: FMC = Field moisture content MDD = Maximum dry density OMC = Optimum moisture content
CBR = California bearing ratio NR = Not recorded
[(1)]The CBR sample for Bore 104 was compacted wet of optimum moisture content which may have resulting in the low soaked CBR value

Table 3: Summary of California Bearing Ratio Testing (continued)

Pit / Bore	Depth (m)	Description	FMC (%)	MDD (t/m^3)	OMC (%)	CBR (%)	Swell during soaking (%)
110	0.5 – 0.8	Grey and brown SANDY CLAY with some gravel	12.5	1.81	15.3	3.5	1.4
111	0.5 – 0.8	Orange and red brown CLAY with some sand	14.1	1.73	18.3	4.5	1.0
112	0.3 – 0.6	Brown sandy gravel FILLING with some clay and cobbles	6.4	2.08	9.2	25	-0.1
113	0.5 – 0.8	Orange and light brown GRAVELLY SANDY CLAY	11.7	1.75	17.0	5	1.5
114A	0.7 – 1.0	Brown CLAY with some gravel and sand	15.9	1.70	12.9	1	1.6
115	0.6 – 1.0	Brown gravelly sandy clay FILLING	6.9	2.01	10.8	15	0.2
Douglas Partners Project 29745 dated June 2001 – Banksia Mental Health Unit							
101	0.8 – 1.2	Grey brown silty gravelly sand FILLING	-	1.87	14.0	20	-0.1
104	1 – 1.5	Brown gravelly silty clay FILLING	-	1.82	16.5	9	0.5
RGS Project RGS00140.1-AD dated November 2010 – Regional Cancer Centre							
3	0.5 – 1.3	Residual CLAY	10.6	-	13.7	11	0.6
10	0.5 – 1.0	Gravelly clay FILLING	11.7	-	13.1	13	0.7
Coffey report dated December 2009 – Staff Car Park and Nurses Accommodation							
5	0.5 – 0.7	Brown gravelly clay FILLING	NR	1.82	15.4	9	0.5
9	0.1 – 0.4	Brown SANDY CLAY AND CLAY	12.6	1.74	17.2	10	1.5

Notes: FMC = Field moisture content MDD = Maximum dry density OMC = Optimum moisture content
CBR = California bearing ratio NR = Not recorded

Testing for pH, chloride, and sulphates was carried out on four samples to provide information on the aggressiveness of the soils encountered in the bores.

Detailed results are included in Appendix D and are summarised in Table 4, below. Further comment on the results is made in Section 9.10.

Table 4 - Summary of Aggressivity Testing

Bore	Depth (m)	Description	pH (concrete)	pH (steel)	EC (dS/m)	Cl (ppm)	SO_3 (ppm)
203	1	Brown CLAY with trace sand	8.0	8.0	0.19	21	103
206	2	Red brown CLAY with trace sand	8.8	8.8	0.071	<2	11
207	2	Brown SANDY CLAY	8.5	8.5	0.16	12	16
212	1	Brown and grey gravelly sandy clay FILLING	7.8	7.8	0.083	15	7.5

Notes to Table 4 - Approximately 100 ppm SO_4 = 80 ppm SO_3
Scale of aggressivity based on threshold values given in AS 2159 – 2009: *Piling – Design and Installation.*

8. Proposed Development

The proposed development at the site includes demolition of a number of existing buildings at the site and construction of a new five storey Acute Care Building together with various pavements and car parking areas throughout the Tamworth Hospital Site.

The site area covered by the proposed development is shown on Drawing 1 in Appendix B.

The key components of the proposed development are as follows:-

- A new five storey Acute Care Building within the central area of the site. Excavation of up to 6 m will be required for the building (mainly in the north-eastern corner) and placement of up to 2 m of filling in the south-western corner;
- The building will have two basement levels. The higher basement will be located within the northern section of the building and will be at RL 413 m AHD. The lower basement will be limited to the southern area of the building and will have a finished floor level of RL 408.5 m;
- Column working loads in the order of 4,000 kN are anticipated for the proposed Acute Care Building;
- The construction of a ring road commencing at the intersection of Johnston Street and Smith Street and extending to the north for approximately 400 m to join up with the existing loop road near the ambulance workshop. The ring road will extend over the area of the existing landfill site and into the recently constructed staff car parking area;
- The proposed ring road will be at grade with the existing ground surface and cuts and fills will be less than 0.5 m;
- The construction of a new staff car parking area to the east of the existing ambulance workshop. The car park will be over the existing landfill area. Based on review of the “Concept Overall Plan” Drawing SD-CI-NE-SK-002 Revision 7 indicates that the finished levels of the car park will vary from RL 418 to 420 m AHD. The existing surface levels in the proposed car park area range from about RL 417 to 420 m AHD. Therefore, cut and fill in the order of 2 m may be required for the construction of the staff car park.

- The re-sealing and extension of the existing central car parking area. The extensions will be to the east and north of the existing car park by about 10 m in width;
- The construction of a new western car park within the land to the north-west of the hospital (Lot 7306 in DP1159338 and Lot 357 in DP753848). The construction of this car park will require placement of up to 1.5 m of filling.

9. Comments

9.1 Subgrade Conditions and Design CBR

Based on the results of the pits and bores, conditions anticipated to be exposed at subgrade levels are discussed for each development area below.

9.1.1 Ring Road and Staff Car Park

The conditions encountered in the pits and bores were generally silty clay or gravelly sandy clay, with an occasional capping of more granular material. It should be noted that up to 11.5 m of filling is present within the proposed ring road alignment. No records in relation to control of moisture content, compaction achieved or thickness of layers during placement have been made available to DP at the time of report preparation. Hence, this filling is deemed as “uncontrolled”. It is likely to exhibit variation in compaction levels and materials present, as noted in the test bores and pits. The filling appears to have been progressively placed over the last 50 years. Ongoing settlement of the filling is likely to have occurred over this time, although it is not currently possible to determine the magnitude of any future settlements of the filling. The results of the in-situ testing within the filling indicate that it is generally poorly to moderately compacted within the landfill area.

In order to provide uniform support for the proposed ring road pavement and to reduce the risk of future differential settlements, it is recommended that rigorous subgrade improvements are undertaken within the area of the existing landfill. These measures are discussed in Section 9.2 of this report.

It is noted that the ground surface rises within the western area of the proposed staff car park. Conditions encountered in Bore 112 included excavator refusal at 0.7 m depth. Furthermore, coring of the bedrock in the vicinity (Bores 209 and 204) indicates that the bedrock becomes low strength or stronger within the upper 2 m of the rock surface. Discussion with the civil contractor who operates the landfill (TPE) indicated that a band of high strength bedrock is present in this area. Hence, excavation of the bedrock for the staff car park, if encountered, may require the use of large excavation equipment. Reference should be made to the test bore report sheets provided in Appendix C in relation to the strength and level of bedrock encountered in the nearby bores.

The laboratory testing of samples of predominantly clay filling, which is anticipated at subgrade level returned soaked CBR values ranging from 8% to 25%.

A design subgrade CBR of 8% is suggested for the existing filling and residual clay soils provided that the rigorous subgrade preparation is carried out in accordance with Section 9.2 of this report.

9.1.2 Western Car Park

Based on the conditions encountered in Bore 113, residual clay soils are anticipated to be exposed at nominal subgrade level (based on construction of the car park at grade with existing surface levels). It should be noted, however, that Bore 113 was located approximately 20 m to the north-east of the car parking area. Whilst inspection of the general vicinity of the car park suggest that similar conditions may be present within the new proposed car park area, the subsurface conditions have not been specifically investigated.

The laboratory testing of a sample of sandy clay from Bore 113 returned a soaked CBR value of 5%, which is suggested for the design of the eastern car park. It is noted that up to 1.5 m of filling will be placed within the western area of this car park. Therefore, the design subgrade CBR value will also be dependent on the quality of the filling used during bulk earthworks. Such filling should have a soaked CBR value of at least 5%.

Provided that residual soils, where encountered at subgrade level, are of at least stiff consistency, it is suggested that the standard subgrade preparation measures outlined in Section 9.2 would be appropriate.

9.1.3 Central Car Park

Based on the conditions encountered in the bores drilled in the vicinity of the central car park, either residual clay soils or gravelly sandy clay filling is anticipated to be exposed at nominal subgrade level (based on construction of the car park at grade with existing surface levels).

The laboratory testing of samples of the clay soils encountered in Bores 110 and 114A returned soaked CBR values of 3.5% and 1% accordingly.

The results of DCPs undertaken within the bores were compared to correlation presented in Figure 5.3 of Austroads 2012 (Ref 1). They indicate in-situ CBR values ranging from 8% to greater than 15% at expected subgrade level.

Eleven samples of the natural residual clay soils have been CBR tested either during the present or past investigations at the site, returning soaked CBR values ranging from 1% to 15%.

The natural clay soils encountered within the bores across the site are reasonably uniform. The results of the CBR testing do not indicate an obvious trend for subgrade conditions across the sites. Therefore, a design value for subgrade CBR of 4% is considered suitable for the areas of extension of the Central Car Park.

Standard subgrade preparation outlined in Section 9.2 would be appropriate.

9.2 Subgrade Preparation

9.2.1 Standard Subgrade

Pavement subgrade preparation should be carried out in general accordance with the following methodology:

- Strip all vegetation and organic topsoils from the pavement alignment;
- Excavate to design subgrade level;
- Undertake geotechnical inspection of the exposed surface to assess the suitability of any existing filling to remain in place. This may require proof rolling of the exposed surface together with additional dynamic penetrometer testing at close spacing (say every 20 m);
- Where rock is encountered at formation level it should be ripped to a depth of 300 mm below the subgrade level and recompacted;
- In areas of natural ground at nominal subgrade level, roll the exposed subgrade surface with at least six passes of a minimum 10 tonne deadweight vibrating roller, with a final proof rolling pass undertaken at slow speed with careful visual inspection by a geotechnical engineer to allow the detection of any soft or compressible zones;
- In the event that sections of the exposed subgrade are deemed unsuitable to remain in place, additional excavation and replacement with approved filling will be required;
- Any subgrade replacement filling should be placed in horizontal layers of less than 250 mm loose thickness with each layer compacted to at least 100% Standard dry density ratio with moisture contents maintained within 2% of optimum moisture content for Standard compaction in accordance with AS3798-2007 (Ref 2);
- Adjust the moisture content of the exposed subgrade to within 2% of optimum moisture content;
- Compact the subgrade to a density ratio of at least 100% relative to Standard compaction with moisture contents within 2% of the optimum moisture content (for Standard compaction) in accordance with AS3798-2007 (Ref 2);
- Protect the area after subgrade preparation to maintain moisture contents as far as practicable. Previous experience suggests that shrinkage of clay soils may result if they are allowed to dry and then subsequently swell as they return to their equilibrium moisture content following completion of pavement construction. Therefore excessive surface drying should be avoided in pavement subgrade areas.

9.2.2 In Fill Areas

A more rigorous subgrade preparation will be required in the section of the loop road that encounter filling at subgrade level. Recompaction of at least the upper 1 m of the existing filling below nominal subgrade level, where suitable for re-use in terms of particle size, moisture condition and material types, is considered to be the minimum required to provide a relatively uniform support for the future pavement.

It should be recognised that construction of the pavement over the existing landfill will result in an increased, yet unquantifiable, risk of premature failure of the pavement owing to ongoing settlement of the filling. Such failures may lead to increased maintenance costs and the need to re-sheet the pavement at shorter intervals, possibly every three to five. Whilst the more rigorous subgrade preparation outlined below is aimed at reducing this risk, it cannot economically be completely eliminated and therefor the client must accept this increased risk.

The rigorous pavement subgrade preparation should include:

- Excavate to 1 m below the nominal subgrade level within the existing filling or to the natural soils in areas of proposed pavement and stockpile for assessment by a geotechnical engineer for its suitability for re-use;
- Remove any additional topsoil, overly wet or deleterious filling or other material;
- Where rock is encountered at formation level it should be ripped to a depth of 300 mm below the subgrade level and recompacted;
- Undertake a series of cone penetrometer tests (DCP) on a grid pattern (say 5 – 10 m centres) across the site to assess the condition of the underlying material and its suitability to act as a subgrade;
- Roll the exposed subgrade surface with at least six passes of a minimum 10 tonne deadweight vibrating roller, with a final proof rolling pass undertaken at slow speed with careful visual inspection by a geotechnical engineer to allow the detection of any soft or compressible zones;
- In the event that sections of the exposed subgrade are deemed unsuitable to remain in place as a result of either the DPT testing or the proof rolling, additional excavation and replacement with approved filling will be required or alternative measures such as the provision of a geogrid and geotextile layer will be required;
- A provisional rate for over excavation of additional unsuitable material and importation of suitable replacement filling should be included in the cost schedule for this site;
- Compact the exposed natural soils or existing filling deemed suitable to act as subgrade to a minimum dry density ratio of 100% Standard in accordance with AS3798-2007 (Ref 2);
- Any subgrade replacement filling should be placed in horizontal layers of less than 250 mm loose thickness with each layer compacted to at least 100% Standard dry density ratio with moisture contents maintained within 2% of optimum moisture content for Standard compaction;

Based on tactile assessment of the upper filling material encountered in the bores and the results of the CBR testing, the majority of the material is anticipated to be suitable for re-use within the improved subgrade provided that all deleterious, oversized and organic material is removed.

Compaction testing of all engineered filling and prepared subgrade surfaces should be carried out with sufficient density testing to justify that it is well compacted. AS 3798: *Guidelines on Earthworks for Commercial and Residential Developments* (Ref 2) provides information regarding the placement of filling. A Level 1 inspection and testing regime as defined in AS3798 is suggested for the rigorous subgrade preparation measures.

9.3 Site Preparation for Filling

Areas of the site will be raised by the placement of filling. These areas include for the proposed western car park, the staff car park and under the western areas of the Acute Care Building.

In areas where filling is to be placed, the following site preparation measures are recommended:
Given that the ground surface at the site is to be raised by up to 1 m, the following site preparation measures are recommended:

- Strip the existing topsoil at the site;
- Remove any additional wet or deleterious filling;
- Undertake a series of dynamic penetrometer testing (DPT) on a grid pattern (say 5 – 10 m centres) across the site to assess the condition of the underlying existing filling and its suitability to remain in place under the new filling;
- Roll the exposed subgrade surface with at least six passes of a minimum 10 tonne deadweight vibrating roller, with a final proof rolling pass undertaken at slow speed with careful visual inspection to allow for detection of any soft or compressible zones. It is recommended that this is performed under the guidance of a geotechnical engineer;
- Soft or compressible zones may require additional excavation and replacement with approved filling;
- Subsequent filling should comprise low reactivity material;
- All filling should be placed in horizontal layers not exceeding 250 mm loose thickness with each layer compacted to at least 100% Standard dry density ratio (cohesive soils) or 80% density index (cohesionless soils) with moisture contents maintained within 2% of optimum moisture content for Standard compaction;
- All filling that will be used for structural support should be placed under Level 1 conditions as defined in AS 3798 – 2007 (Ref 3).
- In areas of non-structural filling, a Level 2 testing regime as defined in AS 3798 – 2007 would be applicable.

9.4 Pavement Drainage

The pavement should be designed to incorporate the provision of adequate surface and subsoil drainage so as to maintain the subgrade as close to the optimum moisture content as possible and to ensure that the pavement layers do not become saturated.

Normally, subsoil drainage should be installed at least 0.5 m below subgrade level adjacent to pavements. Preparation of subgrade surfaces should be such that adequate crossfalls for surface drainage are achieved across the final pavement.

Given the presence of deep, uncontrolled filling within the ring road alignment, it is suggested that subsurface drainage is installed with a slightly steeper grade than is normally required to reduce the risk of reversal of drainage paths in the event that ongoing settlement occurs within the filling.

9.5 Excavation Conditions

Excavation of up to 6 m will be required for the proposed Acute Care Building. The depth of excavation required generally increases towards the north-east within the proposed building footprint (refer Figure 1 and Drawing 1). The higher basement (finished floor level of RL 413 m AHD) is anticipated to cover the majority of the Acute Care Building footprint.

Based on the conditions encountered in the bores, conditions anticipated at the base of bulk excavation are summarized in Table 3. Reference should also be made to Drawings 3 and 4 of Appendix B which provide a geological section through the proposed Acute Care Building.

Table 5: Anticipated Conditions at Bulk Excavation Levels

Test Bore	Interpolated Surface Level at Test Location (m AHD)	Anticipated Bulk Excavation Level (m AHD)	Depth of Excavation (m)	Anticipated Conditions Exposed at Bulk Excavation Level
200	411	408.5	2.5	Medium strength rock
201	409.2	408.5	0.7	Very stiff to hard clay
202	411.8	413	1.2 (Fill)	Filling (to be placed)
203	413.4	408.5	4.9	Unknown strength bedrock
204	415.2	413	2.2	Extremely low to very low strength rock
205	416.4	413	3.4	Unknown strength bedrock
206	415.2	413	2.2	Stiff to very stiff clay
207	412.8	413	0.2 (Fill)	Filling (to be placed)
208	417.8	413	4.8	High strength rock
209	419.2	413	6.2	Medium to high strength rock
210	414.2	413	1.2	Medium strength rock
211	412.2	413	0.8 (Fill)	High strength rock
212	417.4	413	4.4	Medium strength rock

Notes to Table 5: Surface levels at bore locations have been interpolated from survey plan provided by client.
Anticipated bulk excavation levels have been interpolated from sections provided by client

Excavation will be predominantly through existing filling, residual soils and meta-siltstone bedrock. Based on the conditions encountered within the cored bores, and the anticipated excavation levels at

outlined in Table 5 above, excavation will be through predominantly extremely low, very low or low strength bedrock which is moderately to highly fractured. Excavation of medium to high strength rock will be required in the north-eastern corner of the proposed Acute Care Building.

Prospective earthworks contractors should make their own assessment of the equipment and methodologies required to carry out the proposed excavation. In order to assist with this assessment, the retrieved core samples are available at the Douglas Partners Wyong office for inspection by prospective contractors. The following comments are provided as a preliminary guide only to possible excavation equipment required for the excavation.

Excavation through the filling, soil and extremely low to very low strength bedrock should be readily achieved using conventional earthmoving equipment, such as tracked hydraulic excavators. Excavation of low strength bedrock may require medium ripping (with a D9 or similar).

The ease of excavation of the medium to high strength bedrock will be dependent on the fracture spacing of the bedrock encountered. Within the core recovered from the bores, the fracture spacing within the medium to high strength rock ranged from 0.05 m to 0.5 m, with occasional seams with fracture spacing of greater than 1 m. Excavation of these units may require heavy ripping (with a D9L or larger). Detailed excavation within the medium to high strength bedrock is likely to necessitate the use of heavy excavation equipment such as a 30 tonne excavator fitted with a narrow bucket and "tiger teeth" and the use of a rock hammer. It is noted that owing to hospital operations and adjacent buildings blasting will not be suitable to assist with excavation. Similarly, there may be restrictions on the use of rock breakers.

Based on information provided by the earthworks contractor who currently operates the adjacent landfill and constructed the existing staff car park in the north-eastern area of the site, it is understood that during the excavation for the car park and landfill, difficulty was encountered excavating high strength bedrock units in the vicinity of the existing Ambulance Maintenance Workshop.

9.6 Construction Batter Slopes

It is expected that it would be practicable to allow for short term (construction) battering of excavations at this location, provided that the excavation is sufficiently distant from site boundaries, adjacent structures or in-ground services. In areas where ground slopes above the proposed excavation are steeper than 5°, account for the surcharge loading of the sloping ground surface should be made.

It is noted that the bedrock present at the site is highly fractured and the predominant jointing present within the core samples ranged from 60° to 80° below the horizontal. Inspection of two cuttings within the bedrock, located within the former quarry (designated at TC1 and TC2 on Drawing 2) and under the existing Brudelin Wing of the hospital was undertaken by a senior geotechnical engineer from DP (refer Figures 7 and 8).

Figure 7: Steeply bedded, fractured rock in base of quarry (TC1 on Drawing 2)

Figure 8: Existing cutting under Brudelin Wing at 0.6H:1V

The batter slopes outlined in Table 6 below are suggested for preliminary design purposes.

Table 6 – Suggested Preliminary Temporary Safe Batter Slopes

Material	Safe Temporary Batter Slope (H:V)
Filling and stiff (or weaker) clay	2:1
Very stiff or stronger clay	1:1
Extremely low and very low strength rock	1:1
Low and medium strength rock	0.75:1*
High strength rock	0.5:1*

* - subject to detailed inspection by an engineering geologist during construction

Adoption of the temporary batter slopes for low, medium and high strength rock shown in Table 6 must be accompanied by geological inspection to assess any adverse jointing which could give rise to localised instability such as block fallout or wedge failure. The support of these locally unstable blocks and wedges, or extremely low and very low strength bands can then provided by in-situ stabilisation techniques utilising dowelled mesh, rock bolts and/or sprayed concrete.

Excavation faces should be protected from weathering by means of upslope diversion drainage or possibly shotcrete.

9.7 Retaining Walls

Excavation will be to within a few metres of existing buildings and to depths of up to 6 m. For these locations a retaining wall system will be needed because battering will be insufficient.

9.7.1 Construction

It is considered likely that the most suitable construction system would incorporate bored soldier piles predrilled on the perimeter of the excavation, at about 2.5 m centres to provide restraint and anchorage points for tie back anchors. Infill panels between the soldier piles are progressively provided by sprayed reinforced concrete as the excavation reaches critical levels for the installation of tie back anchors.

Based on the conditions encountered in the bores, it is expected that the clay and weathered rock exposed between the soldier piles over the depth of anchoring will be self supporting for the short term. Adverse jointing can sometimes give rise to localised instability in the exposed rock, which may require some stabilisation works prior to shotcreting. It is suggested that regular inspections of the exposed faces be made by an engineering geologist at 2 m depth increments as the excavation progresses.

Soldier piles are normally drilled with a minimum “toe in” below the base of the excavation in order to provide lateral restraint, with the depth of “toe in” dictated by the retained height and passive resistance of the rock in which the “toe in” is developed.

Where high strength rock is encountered, it may be feasible to terminate the soldier piles above the base of the excavation and provide lateral restraint to the toe of the piles by anchoring. Further investigation of the continuity and degree of fracturing in the high strength rock will also be necessary prior to adoption of this system. If further investigation indicates that this system is feasible, additional geological inspections must be carried once excavation has extended no greater than 1 m below the toe of piles to assess any adverse jointing which may require additional support.

Drilling of the piers is expected to be relatively straightforward in the overburden filling and clays. Penetration of the underlying medium to high strength rock may be accomplished with the use of medium to heavy duty drilling plant, such as a tracked mounted piling rig.

9.7.2 Design

It is suggested that design of retaining structures be based on an average bulk unit weight for the retained material of 22 kN/m^3. Cantilevered support should be designed on a triangular earth pressure distribution and anchored or propped support should be designed on a trapezoidal earth pressure distribution (increasing linearly from zero pressure to full pressure over the upper 0.25H, then decreasing linearly to zero pressure over the lowest 0.25H – where H is the retained height in metres). The earth pressure coefficients to be adopted for design will be dependent upon the nature and strength of the retained materials, as shown in Table 7 below.

Table 7 – Preliminary Active Earth Pressure Coefficients for Retaining Wall Design

Retained Material	Long Term Earth Pressure Coefficient
Filling and clays	0.35
Extremely low and very low strength rock	0.25
Low and medium strength rock	0.1*
High strength rock	0.0*

* - subject to further investigation

Additional pressures should be allowed for where surcharging of the wall system results from the proximity of the proposed structure itself near changes in excavation level, to reduce the risk of damage occurring to these structures. To increase the wall stiffness and thereby reduce lateral (inward) wall deflection, the active earth pressure coefficients shown in Table 7 should generally be increased by 50% to represent the “at rest” condition. Further, allowance should be made in the wall design for estimated footing loads.

The parameters given above are based on the assumption that full drainage will be provided behind the retaining walls.

The calculation of the ultimate lateral capacity of piles embedded below the bulk excavation should be based on an ultimate lateral resistance pressures given in Table 8 below. Design should incorporate an appropriate factor of safety, and the capacity developed within the first or upper 1 m of bulk excavation level should be disregarded in the calculation of lateral capacity.

Table 8 – Ultimate Lateral Resistance Pressure for Retaining Wall Design

Material	Ultimate Lateral Resistance (kPa)
Low strength rock	2000
Medium strength rock	4500
High strength rock	6000

9.7.3 Anchoring

It is likely that the soldier piles may be designed as cantilevers in the shallower sections of the excavation where support to adjoining structures is not required, but where excavation depths exceed 2 – 3 m or where structures adjoin the excavation, anchoring will possibly be required.

The use of inclined prestressed tie-back anchors is suggested as one method of anchoring support with minimal deflection. Anchors need only be of temporary construction, since it is assumed that permanent support will be provided by the building itself. They should be designed to have a free length equal to their height above the base of the excavation or base of retaining system (minimum of 3 m), and after installation they should be check stressed to 125% of the nominal working load and locked off at 60% of working load up until the anchors are decommissioned. For those anchors supporting piles adjacent to the neighbouring and retained structures, lock off values should be 90% of working load. Regular checks should be made to ensure that load is maintained in the anchors and not lost due to creep effects.

The design of bond lengths for anchors should be based on a maximum allowable bond stress of 600 kPa where anchors have a minimum 3 m bond length and derive their capacity in medium strength bedrock. A maximum allowable bond stress of 1000 kPa would be appropriate for anchors in high strength bedrock. It may be more appropriate for estimation of maximum allowable bond stress to be made by the contractor installing anchors, at the time of construction, as bond stress achieved often depends on installation techniques and contractor expertise. Regardless of who performs anchor design, all anchors should be stress tested to the satisfaction of the geotechnical designer.

9.8 Excavation Vibration

It would be prudent to allow for dilapidation surveys to be carried out on the nearby buildings and existing services to document their condition prior to the commencement of all work.

It is expected that the rock encountered in the bores should break readily along natural partings such as clay filled joints and bedding planes observed at 0.05 – 0.20 m spacings. However, the use of rock breaking and pneumatic equipment for side trimming and footing excavation in medium strength and high strength rock normally has the potential to affect structures adjoining the proposed excavation.

As a guide, the damage threshold due to vibration is dependent on the quality of the building foundations and construction of the building as well as the wavelength of the vibration and the source distance. The longer the wavelength, the more likely a building is to resonate and suffer damage. For construction equipment (generally in the high frequency or short wavelength range), the damage

threshold is 40 mm/sec to 80 mm/sec for buildings founded on rock. Most vibration codes set safe limits for building vibrations at lower levels.

The Standards Australia explosives code recommends the maximum peak particle velocities for various structures subjected to blasting vibration (generally a low frequency vibration).

It should be noted that humans are very sensitive to vibration and consequently may be disturbed by vibration levels which are considered relatively insignificant for buildings. It may therefore be beneficial to carry out vibration monitoring to confirm vibration levels during site works. In addition, the site is within an existing hospital which has very sensitive medical equipment and particularly sensitive patients. These potential restraints can be tested by a properly designed trial.

9.9 Foundations

9.9.1 High Level Footings

It is understood that the anticipated working loads for the Acute Care Building will be in the order of 4,000 kN (ultimate load of 5,400 kN).

Based on conditions encountered in the bores and the proposed earthworks, the conditions exposed at bulk excavation level will be a combination of residual clay soils, bedrock ranging in strength from extremely low to high strength and engineered filling.

It is preferable that all footings found on material of similar stiffness, (ie all footings to bear on the bedrock). Careful consideration of detailing and articulation of the structures would be needed during the design to allow the structures to tolerate the differential movements which could result from founding on materials of differing stiffness, such as bedrock and clay or filling.

Spread footings founded within the relevant strata should be designed for the following ultimate limit state bearing pressures:

- Extremely low strength or stronger meta-siltstone 1800 kPa;
- Medium strength metasiltstone 5000 kPa.

Settlements for pad or pile footings apportioned in accordance with the maximum allowable bearing pressure given above are not expected to exceed a few millimetres.

9.9.1 Piles

Concrete bored piles may be suitable for the support of the proposed Acute Care Building, founded within the meta-siltstone or granite bedrock.

Table 9 provides the ultimate limit state end bearing pressures and shaft adhesion values for piles socketed into the underlying bedrock.

Table 9: Design Pressures and Depths for Founding Strata

Strata	Ultimate End Bearing Pressure (kPa)	Ultimate Shaft Adhesion (kPa)
Extremely low strength rock	2000	200
Very low to low strength rock	5000	500
Medium strength or stronger rock	15000	800

Rock classification based on Pells Douglas et al (Ref. 4)

Piles that are constructed in a manner that does not enable inspection or checking of the pile socket, or those that are likely to have an increased amount of smear over the length of the socket, should be designed based on parameters that are 20% lower than those given in Table 9. This would include piles installed using bentonite slurry.

Where large diameter bored piles are installed at the site, it is possible that columns could be supported by a single pile rather than a group of piles. For example, a single 0.6 m diameter bored pile socketed 2 m into medium strength rock would have a design geotechnical strength of about 3,400 kN. Similarly, a 0.6 m diameter piles socketed 4 m into very low strength rock would have a design geotechnical strength of about 2,400 kN. Piles up to about 1.5 m in diameter could be drilled using tracked piling rigs, however, there could be a trade off between the size of the pile and the ability for the piling equipment to drill into the stronger rock at greater depth.

9.9.2 Design Geotechnical Strength Reduction Factor

In the current Piling Code (November 2009 - Ref 3), the design geotechnical strength of a pile ($R_{d,g}$) is the ultimate geotechnical strength ($R_{d,ug}$) multiplied by the geotechnical strength reduction factor (ϕ_g), such that:

$$R_{d,g} = \phi_g \, . \, R_{d,ug}$$

The calculated value $R_{d,g}$ must equal or exceed the structural design action effect E_d.

Selection of the geotechnical strength reduction factor (ϕ_g) is based on a series of individual risk ratings (IRR) which are weighted and lead to an average risk rating (ARR). The individual risk ratings and final value of ϕ_g depend on the following factors:

- Site: the type, quantity and quality of testing;
- Design: design methods and parameter selection;
- Installation: construction control and monitoring;
- Pile testing regime; testing benefit factor based on percentage of piles tested and the type of testing; and
- Redundancy: whether other piles can take up load if a given pile settles of fails.

Using the methodology outlined in the piling code, an average risk rating of 3.07 (Moderate Category) has been assessed. A geotechnical strength reduction factor, ϕ_g, of 0.48 is applicable for low redundancy.

9.10 Aggressive Soil Conditions

The results of the laboratory testing indicate that the soils tested are non-aggressive to buried steel or concrete structures.

9.11 Earthquake Design

Sections 3 and 4 of AS 1170.4 – 2007: "Structural Design Actions – Part 4 Earthquake Actions in Australia" (Ref. 5) provides details regarding hazard factors and site sub-soil classes.

Reference to Table 3.2 of AS 1170.4 (Ref. 5) indicates that a hazard factor, Z, of 0.07 would be applicable for earthquake design at this site, as the site would fall under the location of "Tamworth".

Conditions encountered in the bores indicate the presence of about 1 - 4 m of uncontrolled filling underlain by residual clay soils. Bedrock at the site is generally present at depths ranging from about 1 to 4 m below the existing ground surface.

Reference to Section 4 of AS 1170.4 then indicates that the site would be classed as a shallow soil site, for which a sub-soil Class C_e would apply.

10. Limitations

Douglas Partners (DP) has prepared this report for the redevelopment of the Tamworth Base Hospital in accordance with DP's proposal WYG120041 dated 2 March 2012 and an email dated 30 March 2012, which was accepted by Aurecon Group Brand (Pty) Ltd, acting on behalf of Health Infrastructure on 4 April 2012.

The report is provided for the exclusive use of Health Infrastructure and their agents 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 only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions

between sampling locations. 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.

11. References

1. *Austroads*, *Guide to Pavement Technology Part 2: Pavement Structural Design*, Austroads Publication No. AGPT02/10, Revised 2010
2. *Australian Standard AS 3798 – 2007: Guidelines for Earthworks for Commercial and Residential Developments,* Standards Association of Australia.
3. *Australian Standard AS 2159 – 2009: Piling – Design and Installation,* Standards Association of Australia.
4. *Foundations on Sandstone and Shale in the Sydney Region*, Pells, Douglas, et al, Australian Geomechanics Society 1998.
5. *Australian Standard AS 1170.4 – 2007: Structural Design Actions – Part 4 Earthquake Actions in Australia,* Standards Association of Australia.

Douglas Partners Pty Ltd

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.

Copyright

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

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:

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

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

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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

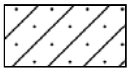
Soils


Topsoil

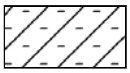

Peat


Clay

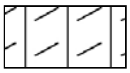

Silty clay

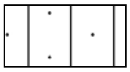

Sandy clay

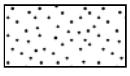

Gravelly clay

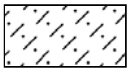

Shaly clay

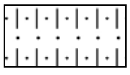

Silt


Clayey silt


Sandy silt

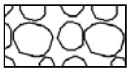

Sand

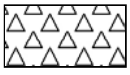

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

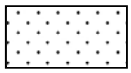

Talus

Sedimentary Rocks

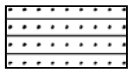

Boulder conglomerate

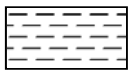

Conglomerate


Conglomeratic sandstone

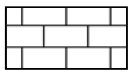

Sandstone


Siltstone


Laminite

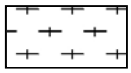

Mudstone, claystone, shale

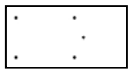

Coal


Limestone

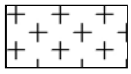
Metamorphic Rocks

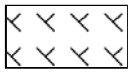

Slate, phyllite, schist

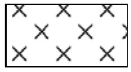

Gneiss

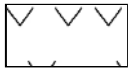

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite

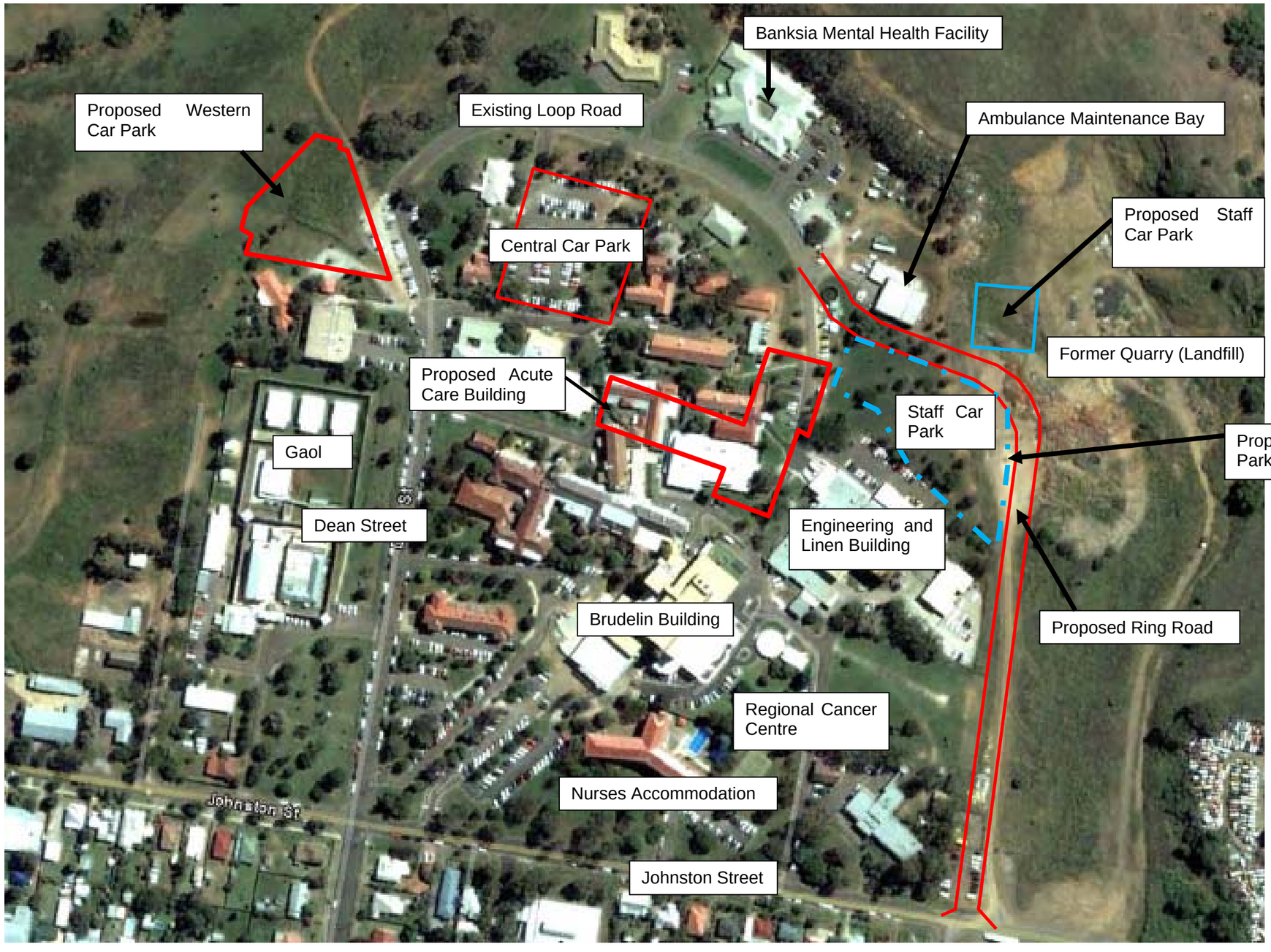

Dacite, epidote

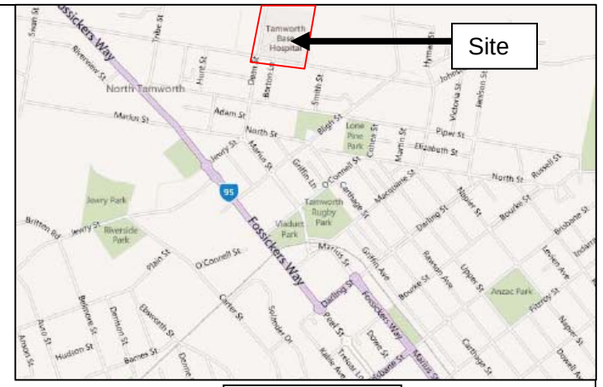

Tuff, breccia


Porphyry

Appendix B

Drawings

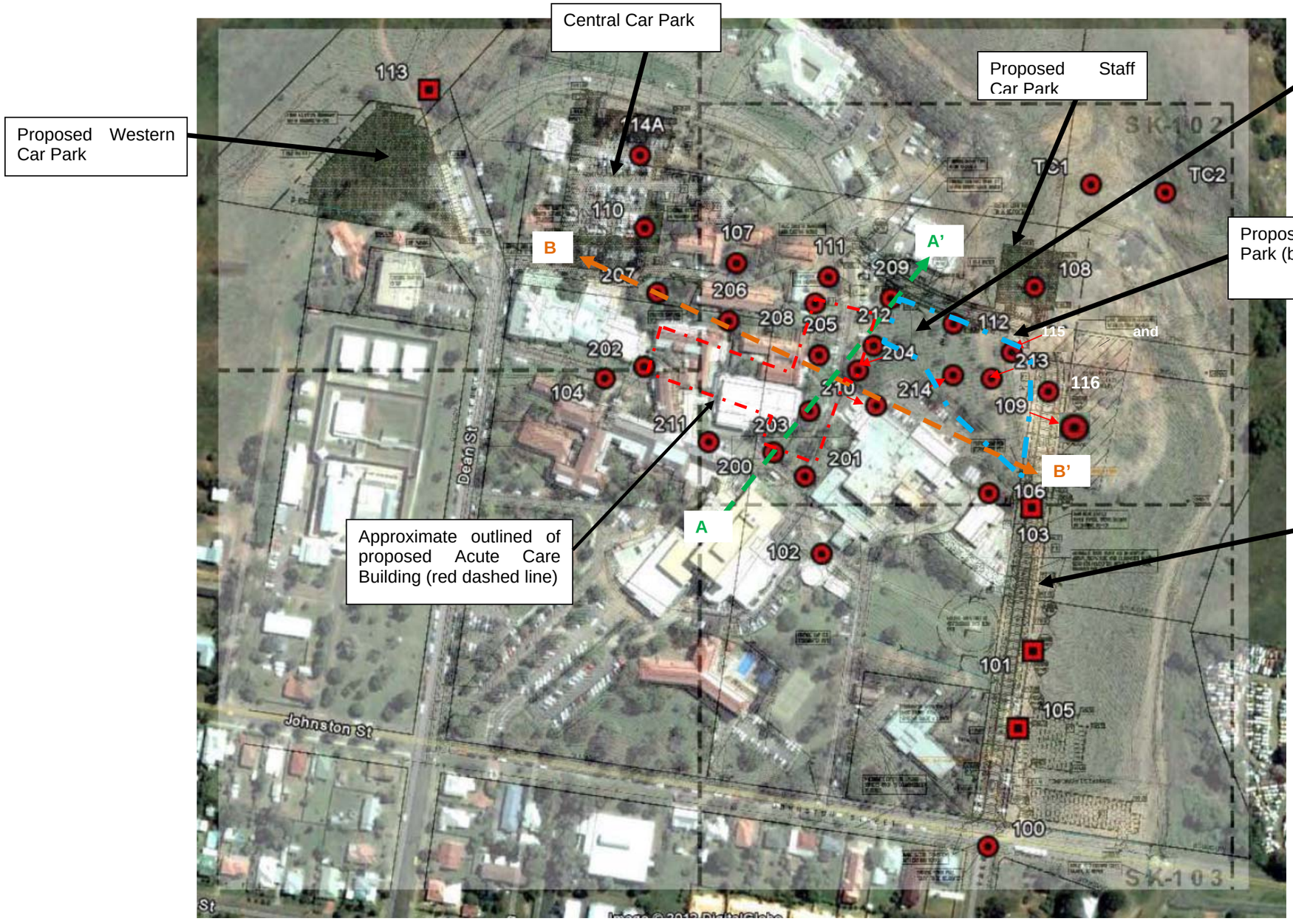




Locality Plan

N

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure		TITLE: **Site Features Plan**	PROJECT No:	75393.00
	OFFICE: Wyong	DRAWN BY: MPG	**Geotechnical Investigation – Tamworth Hospital Redevelopment**	DRAWING No:	1
	SCALE: NTS	DATE: 20.04.12	**Tamworth Hospital**	REVISION:	A



Douglas Partners Geotechnics / Environment / Groundwater	CLIENT:	Health Infrastructure		TITLE:	**Test Location Plan**	PROJECT No:	75393.00
	OFFICE:	Wyong	DRAWN BY: MPG		**Geotechnical Investigation**	DRAWING No:	2
	SCALE:	NTS	DATE: 19.4.12		**Tamworth Hospital**	REVISION:	A

A

A'

ELEVATION (AHD)

422
420
418
416
414
412
410
408
406
404
402

200
Offset 0.0m
vst-h
refusal
EL
VL
M
Bottom Depth 2.73 m

203
Offset - 0.3m
vst
h
N = 19
VL
Bottom Depth 2.6 m

204
Offset - 8.1m
st-vst
N = 6
refusal
EL-VL
M
Bottom Depth 9 m

212
Offset - 5.8m
N = 9
N = 23
h
refusal
Bottom Depth 3.15 m

209
Offset 4.4m
N = 16
h
refusal
VL
M-H
H
Bottom Depth 11 m

FINISHED FLOOR LEVEL
GROUND FLOOR

FINISHED FLOOR LEVEL
LOWER GROUND FLOOR

0 20 40 60 80 100 120 140 160

DISTANCE ALONG PROFILE (m)

NOTE: Summary logs only. Should be read in conjunction with detailed logs.

LEGEND

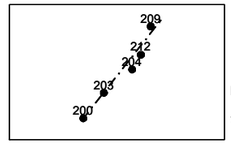
- Core Loss
- Clay
- Clayey Sand
- Concrete
- Filling
- Quartzite
- Gravel
- Mudstone
- Sandy Clay
- Silt
- Siltstone

ROCK STRENGTH
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High

SOIL CONSISTENCY
vs - very soft
s - soft
f - firm
st - stiff
vst - very stiff
h - hard
vl - very loose
l - loose
md - medium dense
d - dense
vd - very dense

TESTS / OTHER
N - Standard penetration test value
▽ - Water level

SITE MAP



0 10
Horizontal Scale (metres)
Vertical Exaggeration = 5.0

STANDARD CROSS-SECTION PITS & BORES 200-212 MICHAEL GAWN.GPJ DPTEMPLATE2010 V3.GDT 19/4/12

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Health Infrastructure		TITLE: **Cross Section A-A'**	PROJECT No: 75393.00
OFFICE: Central Coast	DRAWN BY: MG/LD	**Tamworth Hospital Redevelopment**	DRAWING No: 3
SCALE: 1:500 (H) 1:100 (V) @ A3	DATE: 19.04.2012	**Tamworth Hospital**	REVISION:

B

B'

ELEVATION (AHD)

422
420
418
416
414
412
410
408
406
404
402

GROUND FLOOR FINISHED SURFACE LEVEL

207
Offset - 0.7m
vst
N = 29
refusal
Bottom Depth 2.6 m

206
Offset 7.2m
N = 5
st
N = 18
VL
Bottom Depth 4.24 m

205
Offset 17.1m
vst
refusal
Bottom Depth 1.6 m

204
Offset 21.5m
st-vst
N = 6
refusal
EL-VL
M
Bottom Depth 9 m

210
Offset 9.8m
vst
L
refusal
Bottom Depth 1.05 m

0 20 40 60 80 100 120 140 160

DISTANCE ALONG PROFILE (m)

NOTE: Summary logs only. Should be read in conjunction with detailed logs.

LEGEND

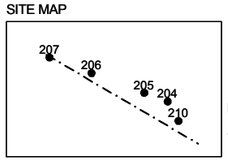
- Filling
- Sandy Clay
- Siltstone
- Gravel
- Silt
- Clay
- Topsoil
- Asphaltic Concrete
- Gravelly Silty Clay

ROCK STRENGTH
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High

SOIL CONSISTENCY
vs - very soft
s - soft
f - firm
st - stiff
vst - very stiff
h - hard
vl - very loose
l - loose
md - medium dense
d - dense
vd - very dense

TESTS / OTHER
N - Standard penetration test value
▽ - Water level

SITE MAP

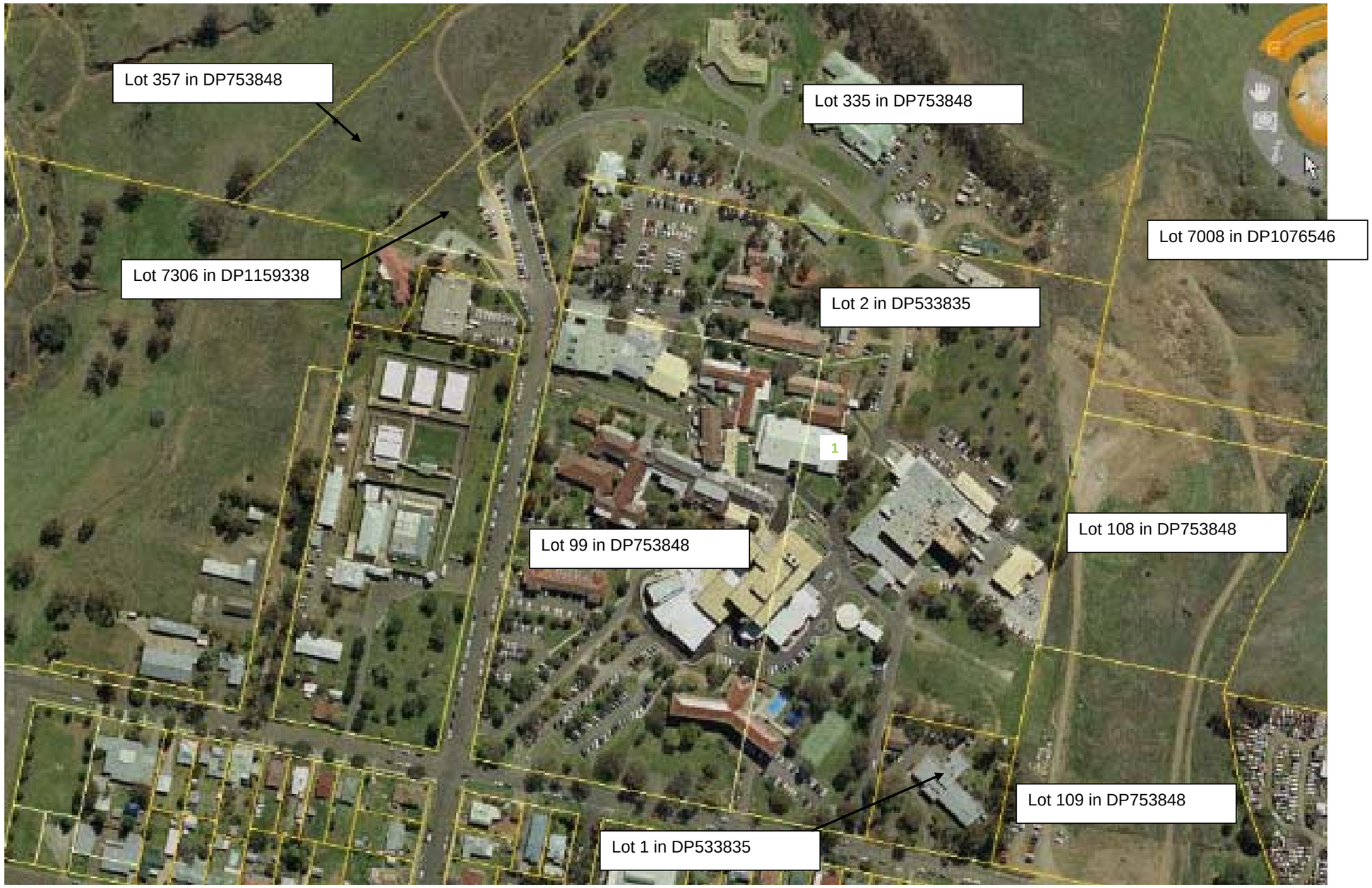


0 10
Horizontal Scale (metres)
Vertical Exaggeration = 5.0

STANDARD CROSS-SECTION PITS & BORES 200-212 MICHAEL GAWN.GPJ DPTEMPLATE2010_V3.GDT 19/4/12

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Health Infrastructure		TITLE: **Geotechnical Section B-B'**	PROJECT No: 75393.00
OFFICE: Central Coast	DRAWN BY: MG/LD	**Proposed Acute Care Centre**	DRAWING No: 4
SCALE: 1:500 (H) 1:100 (V) @ A3	DATE: 19.04.2012	**Tamworth Hospital**	REVISION:



Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Health Infrastructure			TITLE:	**Site Identification**
OFFICE:	Wyong	DRAWN BY:	MPG		**Tamworth Base Hospital Redevelopment**
SCALE:	NTS	DATE:	19.04.12		**Tamworth**

PROJECT No:	75393
DRAWING No:	5
REVISION:	A

Appendix C

Relevant Test Pit and Test Bore Logs

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 100
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
	0.02	SPRAY SEAL							>>
	0.09	FILLING: Grey and brown sandy gravel filling, dry							
		SANDY GRAVELLY CLAY: Very stiff to hard, orange brown sandy gravelly clay, M<Wp		B	0.3				
					0.8				
	0.85	Bore discontinued at 0.85m. Refusal on bedrock							
	1								1
	2								2
	3								3
	4								4

RIG: 3.5 Tonne excavator **DRILLER:** Colin **LOGGED:** TDM **CASING:**

TYPE OF BORING: 250mmϕ Solid Flight 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_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

TEST PIT LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

PIT No: 101
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	FILLING: Generally comprising, light brown gravelly sandy clay with occasional brick fragments, plastic and star picket		A	0.3				
		- from 0.4m depth, dark grey		A	0.5				
					0.6				
		- from 0.7m depth, brown		D					
					0.9				
	1	- concrete approx. 2.5m diameter at 1.2m depth							
	1.7	SANDY GRAVELLY CLAY: Very stiff to hard, light brown, fine to medium sized sandy gravelly clay, M=Wp		D	2.0		PID= 0.4ppm		
	2								
	2.3	Pit discontinued at 2.3m. Limit of investigation							
	3								
	4								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 3 Tonne Excavator fitted with 300mm bucket with teeth
LOGGED: MPG
SURVEY DATUM: MGA94

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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 102
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.05	ASPHALTIC CONCRETE							
		FILLING: Brown silty gravel filling, humid							
	0.23	GRAVELLY CLAY: Hard, brown and orange brown gravelly caly (possibly filling), M<Wp		D	0.5		PID = 2.6 ppm		
				B	0.8				
	1.2	Bore discontinued at 1.2m. Limit of investigation							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 3.5 Tonne excavator **DRILLER:** Colin **LOGGED:** TDM **CASING:**

TYPE OF BORING: 250mmϕ Solid Flight 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_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

TEST PIT LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

PIT No: 103
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0	FILLING: Generally comprising, dark brown sandy clay with traces of gravel, M<Wp (in a poorly compaction condition)		B	0.5				
					0.8				
	1.5	CLAY: Very stiff to hard, dark brown, mottled red brown clay with traces of sand and fine sized gravel, M<Wp		D	1.8				
	2.1	Pit discontinued at 2.1m. Excavator refusal on probable bedrock							

RIG: 3 Tonne Excavator fitted with 300mm bucket with teeth
LOGGED: MPG
SURVEY DATUM: MGA94

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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 104
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.02	ASPHALTIC CONCRETE		D	0.1		PID = 3.9 ppm		
	0.15	FILLING: Brown sandy gravel filling, dry - some crushed brick and coal from 0.08m							
	0.3	FILLING: Brown and grey slightly cemented gravelly sand filling, dry		D	0.4		PID = 2.5 ppm		
		CLAY: Very stiff to hard, orange and red brown clay with some sand, M<Wp			0.5				
				B					
		- light brown and gravelly from 0.8m			0.8				
	1								1
	1.2	Bore discontinued at 1.2m. Limit of investigation							
	2								2
	3								3
	4								4

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 3.5 Tonne excavator **DRILLER:** Colin **LOGGED:** TDM **CASING:**

TYPE OF BORING: 250mmϕ Solid Flight 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_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

TEST PIT LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

PIT No: 105
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		FILLING: Generally comprising, brown gravelly sandy clay with traces of metal pieces, asphalt pieces on surface		A	0.1		PID= 0.8ppm		
					0.3				
				B					
					0.5				
				A	0.6		PID= 0.5ppm		
	0.7								
	0.8	GRAVELLY SANDY CLAY: Very stiff, light brown gravelly sandy clay, M<Wp							
	1	Pit discontinued at 0.8m. Excavator refusal on low to medium strength bedrock							
	2								
	3								
	4								

RIG: 3 Tonne Excavator fitted with 300mm bucket with teeth

LOGGED: MPG

SURVEY DATUM: MGA94

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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 106
PROJECT No: 75393.00
DATE: 19/3/2012
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
		SANDY CLAY: Very stiff, light brown, fine to medium grained sandy clay, M<Wp		A	0.1		PID= 0.6ppm		
				A(QA1)	0.5		PID= 0.2ppm		
	0.8	SILTSTONE: Very low strength, highly weathered, orange brown siltstone							
	1			S	1.0		20 refusal		1
	1.1	Bore discontinued at 1.1m. TC bit refusal			1.1				
	2								2
	3								3
	4								4

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** Nil
TYPE OF BORING: Solid Flight Auger to 1.1m
WATER OBSERVATIONS: No Free Groundwater 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 107
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL/FILLING: Brown silty sand topsoil/filling, dry							
		FILLING: Brown/orange gravelly sandy clay filling with some brick and glass fragments, M<Wp		D	0.3		PID = 3.2 ppm		
	0.5	GRAVELLY SANDY CLAY: Hard, light grey brown gravelly sandy clay, M<WP		D	0.5		PID = 2.7 ppm		
				B	0.8				
	1.2	Bore discontinued at 1.2m. Limit of investigation							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 3.5 Tonne excavator **DRILLER:** Colin **LOGGED:** TDM **CASING:**

TYPE OF BORING: 250mmϕ Solid Flight 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 108
PROJECT No: 75393.00
DATE: 19/3/2012
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
		FILLING: Generally comprising, dark brown silty clay with traces of plastic, timber and metal, M<Wp (in a poorly compacted condition)		A(QA2)	0.1		PID= 0.3ppm		
				A	0.5		PID= 0.		
	1	- from 1.0m depth, sandy clay filling, only, moist content increasing - metal piping and wire at 1.2m depth			1.0				1
				S			1,2,2 N = 4		
					1.45				
	1.8	META - SILTSTONE: Very low strength, highly fractured light brown meta-siltstone							
	2 2.0	Bore discontinued at 2.0m. TC bit refusal auger refusal							2
	3								3
	4								4

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:**
TYPE OF BORING: Solid Flight Auger to 1.9m
WATER OBSERVATIONS: No Free Groundwater 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_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

TEST PIT LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

PIT No: 108A
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		FILLING: Generally comprising, dark brown silty sandy clay with traces of plastic, timber and metal		A	0.1				
				A	0.5				
	1	- metal piping and wire at 1.2m depth							1
	1.9	Pit discontinued at 1.9m. Excavator refusal on possible bedrock							
	2								2
	3								3
	4								4

RIG: 3 Tonne Excavator fitted with 300mm bucket with teeth
LOGGED: MPG
SURVEY DATUM: MGA94

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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 109
PROJECT No: 75393.00
DATE: 19/3/2012
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING: Generally comprising, dark brown silty sandy clay with traces of gravel, M<Wp (in a poorly compacted condition)		D	0.1		PID= 0.6ppm		
				D	0.5		PID= 0.1ppm		
		- from 0.6m depth, becoming grey mottled brown							
	1	- from 1.0m depth, dark brown			1.0				1
				S			5,10,16 N = 26		
				D	1.45 1.5				
	2	- at 2.0m depth, brick fragments, ash & gravel			2.0				2
				S			6,5,5 N = 10		
					2.45				
	3	- from 3.0m depth, in a poorly compacted condition)			3.0				3
				S			4,3,3 N = 6		
					3.45				
	4				4.0				4
				S			2,2,2 N = 4 PID= 0.5ppm		
					4.45				
		- from 4.8m depth, predominantly grey silty clay with some gravel (possible cobble)							

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** Nil
TYPE OF BORING: Solid Flight Auger
WATER OBSERVATIONS: No Free Groundwater 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_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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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 109
PROJECT No: 75393.00
DATE: 19/3/2012
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING: Generally comprising, dark brown silty sandy clay with traces of gravel, M<Wp (in a poorly compacted condition) *(continued)*			5.0				
		- at 5.0m depth, SPT little recovery		S			14,8,7 N = 15 PID= 0.2ppm		
		- from 5.0m depth, in a moderately compacted condition			5.45				
	6				6.0				6
				S			2,4,4 N = 8 PID= 0.4ppm		
					6.45				
	7				7.0				7
				S			3,4,4 N = 8 PID= 1.0ppm		
					7.45				
	8				8.0				8
				S			3,4,6 N = 10 PID= 0.5ppm		
					8.45				
	9								9

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** Nil

TYPE OF BORING: Solid Flight Auger

WATER OBSERVATIONS: No Free Groundwater 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 109
PROJECT No: 75393.00
DATE: 19/3/2012
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING: Generally comprising, dark brown silty sandy clay with traces of gravel, M<Wp (in a poorly compacted condition) *(continued)*		S	10.0 10.45		4,5,21 N = 26		
	11								11
	11.3	- from 11.2m depth, hard drilling							
		Bore discontinued at 11.3m. TC bit refusal on probable bedrock							
	12								12
	13								13
	14								14

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** Nil
TYPE OF BORING: Solid Flight Auger
WATER OBSERVATIONS: No Free Groundwater 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 110
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.15	FILLING: Brown sandy clayey gravel filling, dry							
		SANDY CLAY: Very stiff to hard, grey and brown sandy clay with some gravel, M<Wp		D	0.3		PID = 2.4 ppm		
		- from 0.5m depth, hard		B	0.5				
	1				0.8				
	1.2	Bore discontinued at 1.2m							
	2								
	3								
	4								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 3.5 Tonne excavator **DRILLER:** Colin **LOGGED:** TDM **CASING:**

TYPE OF BORING: 250mmϕ Solid Flight 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 111
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.15	TOPSOIL/FILLING: Brown sandy silt topsoil/filling, dry							
		FILLING: Light brown gravelly sandy silt filling, dry		D	0.2		PID = 2.1 ppm		
	0.5	CLAY: Hard, orange and red brown clay with some sand, M<Wp		D	0.5				
				B	0.6		PID = 1.8 ppm		
	1				0.8				1
	1.2	Bore discontinued at 1.2m. Limit of investigation							
	2								2
	3								3
	4								4

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; >>

RIG: 3.5 Tonne excavator **DRILLER:** Colin **LOGGED:** TDM **CASING:**

TYPE OF BORING: 250mmϕ Solid Flight 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 112
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.02	2 COAT SPRAY SEAL							
	0.15	FILLING: Grey sandy gravel filling, moist							
		FILLING: Brown sandy gravel filling with some clay and cobbles, humid		D	0.3		PID = 2.9 ppm		
				B					
					0.6				
	0.7	Bore discontinued at 0.7m. Refusal on bedrock							
	1								
	2								
	3								
	4								

RIG: 3.5 Tonne excavator **DRILLER:** Colin **LOGGED:** TDM **CASING:**
TYPE OF BORING: 250mmϕ Solid Flight Auger
WATER OBSERVATIONS: No Free Groundwater 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 113
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.05	FILLING: Brown gravelly silty clay filling, M<Wp							
		GRAVELLY SANDY CLAY: Hard, orange and light brown gravelly sandy clay, M<Wp		D	0.5		PID = 4.4 ppm		
				B	0.8				
	1								1
	1.2	Bore discontinued at 1.2m. Limit of investigation							
	2								2
	3								3
	4								4

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 3.5 Tonne excavator **DRILLER:** Colin **LOGGED:** TDM **CASING:**

TYPE OF BORING: 250mmϕ Solid Flight 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 114A
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.02	2 COAT SPRAY SEAL							
	0.18	FILLING: Light brown and grey sandy gravel filling, dry							
		FILLING: Orange brown gravelly sandy clay filling, M<Wp			0.3				
				B					
				D(QA3)	0.5		PID = 2.2 ppm		
					0.6				
	0.7	CLAY: Hard, brown clay with some gravel and sand, M<Wp			0.7				
				D	0.8		PID = 2.4 ppm		
				B					
	1				1.0				
	1.2	Bore discontinued at 1.2m. Limit of investigation							
	2								
	3								
	4								

RIG: 3.5 Tonne excavator **DRILLER:** Colin **LOGGED:** TDM **CASING:**

TYPE OF BORING: 250mmϕ Solid Flight 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_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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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 115
PROJECT No: 75393.00
DATE: 21/3/2012
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
		FILLING: Light brown sandy gravel filling, dry							
	0.5	FILLING: Brown gravelly sandy clay filling with some asphaltic concrete, M<Wp		B	0.6				
	1				1.0				
	2								
	3								
	3.0	Bore discontinued at 3.0m. Limit of investigation							
	4								

RIG: 3 Tonne excavator **DRILLER:** Colin **LOGGED:** TDM **CASING:**
TYPE OF BORING: 250mmϕ Solid Flight Auger
WATER OBSERVATIONS: No Free Groundwater 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 116
PROJECT No: 75393.00
DATE: 22/3/2012
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
		FILLING: Light brown sandy gravel filling, dry		D	0.5		PID = 2.9 ppm		
	0.8	FILLING: Dark grey and brown gravelly sandy clay filling with a trace of asphaltic concrete, M=Wp (in a moderately compacted condition)		S	1.5 1.95		8,8,7 N = 15 PID = 1.6 ppm		
		- from 3.0m depth, in a poorly compacted condition		S	3.0 3.45		1,2,2 N = 4 PID = 1.0 ppm		
				S	6.0 6.45		2,1,2 N = 3 PID = 1.2 ppm		
		- hard drilling and possibly highly fractured meta-siltstone from 8.2m							
	9.1	Bore discontinued at 9.1m. Refusal on bedrock							

RIG: Track Mounted **DRILLER:** SK **LOGGED:** TDM **CASING:**
TYPE OF BORING: 100mmϕ Solid Flight Auger
WATER OBSERVATIONS: No Free Groundwater 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_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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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 200
PROJECT No: 75393.00
DATE: 19/3/2012
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
		FILLING: Generally comprising, brown silty sand with some gravel and pieces of concrete							A			PID= 0.2ppm
	0.2	SANDY CLAY: Very stiff to hard, brown, fine to medium grained sandy clay, M<Wp							A			PID= 1.2ppm
	1								S			40 refusal
	1.2	SILTSTONE: Extremely low strength, extremely weathered, brown mottled orange siltstone (moderately fractured)										PID= 0.9ppm
	1.3							1.3m: CORE LOSS: 90mm	C	84	0	
	1.39	CORE LOSS from 1.3m to 1.39m										
		SILTSTONE: Very low strength, highly weathered, brown siltstone - from 1.56m depth, basalt band 50mm thick - from 1.65m depth, moderately strength, medium weathered highly fractured						1.81m: J15°,un,ro 1.86m: J20°,un,ro 1.95m: J, healed 60°,un 2m: J, healed 60°,un CORE LOSS: 160mm	C	100	60	PL(A) = 0.19
	2											
	2.0											
	2.16	CORE LOSS from 2.0m to 2.16m										
		SILTSTONE: Medium strength, highly weathered, brown siltstone							C	57	0	PL(A) = 0.68 PL(D) = 0.32
	2.73	Bore discontinued at 2.73m. Limit of investigation										
	3											
	4											

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** HW to 1.1m

TYPE OF BORING: Solid Flight Auger to 1.1m, then NMLC coring

WATER OBSERVATIONS: No Free Groundwater 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_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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BORE 200 GEOTECHNICAL INVESTIGATION 19/3/12
TAMWORTH BASE HOSPITAL

1.15 – 2.73m

Douglas Partners Geotechnics / Environment / Groundwater	**Rock Core Photograph**	PROJECT: 75393
	Geotechnical Investigation	PLATE No: 1
	Tamworth Base Hospital	REV: A
	CLIENT: Health Infrastructure	DATE: 2/4/12

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 201
PROJECT No: 75393.00
DATE: 19/3/2012
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
		FILLING: Generally comprising, brown sandy clay with traces of brick fragments, coal and gravel, dry							A			PID= 0.4ppm
									A			PID= 0.9ppm
	0.75	SANDY CLAY: Very stiff to hard, brown, fine to medium grained sandy clay, M<<Wp (clay content decreasing with depth)							A			PID= 0.2ppm
	1								S			7,14,18 N = 32 PID= 1.0ppm
		- grading into weathered bedrock at 1.8m depth										
	2.08	CORE LOSS						2.08m: CORE LOSS: 200mm	C	75	0	PL(A) = 0.21
	2.28	SILTSTONE: Medium strength, highly weathered, highly fractured brown siltstone						2.28m: 2.28m-3.46m J's at 0.05 to 0.1m spacing 15° to 70°, pl,ro,ir				
	3								C	72	0	PL(A) = 0.81
	3.26	CORE LOSS						3.26m: CORE LOSS: 200mm				
	3.46	SILTSTONE: Medium strength, highly weathered, highly fractured brown siltstone							C	85	0	
		- from 3.7m depth, very low strength										PL(A) = 0.58
		- from 3.8m depth, low strength							C	100	0	
	4 4.0	Bore discontinued at 4.0m. Limit of investigation										

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** HW to 2.08m

TYPE OF BORING: Solid Flight Auger to 2.28m, then NMLC coring

WATER OBSERVATIONS: No Free Groundwater 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_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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BORE 201 GEOTECHNICAL INVESTIGATION 19/3/12
TAMWORTH BASE HOSPITAL

2.08 – 4.0m

Douglas Partners Geotechnics / Environment / Groundwater	**Rock Core Photograph**	PROJECT:	75393
	Geotechnical Investigation	PLATE No:	2
	Tamworth Base Hospital	REV:	A
	CLIENT: Health Infrastructure	DATE:	2/4/12

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 202
PROJECT No: 75393.00
DATE: 22/3/2012
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
		TOPSOIL/FILLING: Brown silty sand topsoil/filling with some rootlets, dry							D			PID = 4.8 ppm
	0.15	FILLING: Brown gravelly sandy clay filling with some brick fragments, M=Wp							D			PID = 4.3 ppm
	0.8	CLAY: Hard, light brown and orange clay, M=Wp										
	1								S			3,6,11 N = 17 PID = 5.3 ppm
	2								S			14,Ref refusal ~~PID = 5.1 ppm~~
	2.3	START CORING AT 2.3M META-SILTSTONE: Very low strength, highly weathered, highly fractured, brown, fine grained meta-siltstone - extremely low strength, clayey band from 2.6 - 2.75m							C	100	0	
	3											
	3.09	CORE LOSS						3.09m: CORE LOSS: 60mm				
	3.15	META-SILTSTONE: Extremely low to very low strength, highly weathered, highly fracturede, brown, fine grained meta-siltstone						3.31m: JT,60°, pl,ro 3.42m: JT,60°,pl,ro 3.44m: fractured zone (closely spaced) to 3.56 3.65m: fractured zone (closely spaced) to 3.73 3.76m: fractured zone (closely spaced) to 4.0	C	93	0	
	4											
	4.0	Bore discontinued at 4.0m. Limit of investigation										

RIG: Track Mounted **DRILLER:** Scott **LOGGED:** TDM **CASING:** HW to 2.3m

TYPE OF BORING: Solid Flight Auger to 2.3m, then NMCL coring

WATER OBSERVATIONS: No Free Groundwater 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_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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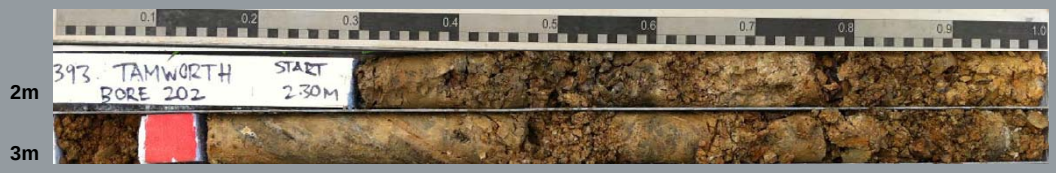
BORE 202 GEOTECHNICAL INVESTIGATION 22/3/12
TAMWORTH BASE HOSPITAL



2.3 – 4.0 m

Douglas Partners Geotechnics / Environment / Groundwater	**Rock Core Photograph**	PROJECT:	75393
	Geotechnical Investigation	PLATE No:	3
	Tamworth Base Hospital	REV:	A
	CLIENT: Health Infrastructure	DATE:	2/4/12

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 203
PROJECT No: 75393.00
DATE: 19/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	FILLING: Generally comprising, brown gravelly silt		A	0.1		PID= 0.1ppm		
		CLAYEY SANDY SILT: Very stiff, brown mottled orange clayey sandy silt with traces of gravel, dry		A	0.5		PID= 0.5ppm		
	0.8	CLAY: Hard brown clay with traces of fine to medium grained sand, M<Wp							
	1			S	1.0		5,7,12 N = 19		
					1.45				
	1.9	SILTSTONE: Very low strength meta-siltstone		A	2.0		PID= 1.2ppm		
	2.6	Bore discontinued at 2.6m. Refusal							

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** Nil

TYPE OF BORING: Solid Flight Auger to 2.28m, then NMLC coring

WATER OBSERVATIONS: No Free Groundwater 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 204
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		FILLING: Generally comprising brown sandy gravelly clay filling, dry							A			PID= 0.4ppm
	0.2	SANDY CLAY: Stiff to very stiff, red brown, fine grained sand clay, M=Wp										
		- moisture content decreasing with depth							A			PID= 0.2ppm
	1								S			7,3,3 N = 6 PID= 1.0ppm
	2											
	2.0	META-SILTSTONE: Extremely low to very low strength, light brown meta-siltstone							S			25,Ref refusal PID= 0.4ppm
		- from 2.8m depth, very low strength, highly weathered, highly fractured							C	100	0	
	3	- from 3.35m depth, extremely low strength										
		- from 3.55m depth, very low strength, highly fragmented							C	100	0	
	4	- from 3.95m depth, low strength, highly weathered										
		- from 4.12m to 4.5m depth, with dark grey/black interbeds						4.2m: J,70°,pl,ro				
								4.48m: J,70°,pl,ro	C	100	20	
		- from 4.85m depth, medium to high strength, moderately							C	100	34	PL(D) = 0.22

RIG: Track Mounted **DRILLER:** Tracess **LOGGED:** MPG **CASING:** HW to 2.5m

TYPE OF BORING: Solid Flight Auger to 2.8m then NMLC from 2.8m to 9.0m

WATER OBSERVATIONS: No Free Groundwater 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 204
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		weathered META-SILTSTONE: Extremely low to very low strength, light brown meta-siltstone *(continued)*						4.95m: J,70°,pl,ro 5.15m: J,60°,pl,ro	C	100	34	PL(A) = 1.6 PL(D) = 2
	6								C	100	84	
								6.54m: J,60°,pl,ro 6.57m: J,sh,un,clay filled 20mm thick				
	7 7.0	META-SILTSTONE: Medium strength, highly weathered, light brown meta-siltstone						6.97m: J,45°,pl,ro 7.29m: J,15°,un,ro	C	100	10	PL(A) = 1.1 PL(D) = 0.47
		- from 7.45m depth, low strength, highly fragmented to 8.0m						7.45m: fragmented to 7.8	C	100	0	
								7.9m: J,70°,pl,ro,ir	C	100	0	
	8							8m: J,70°,pl,ro,ir 8.22m: J,70°,pl,ro,ir	C	100	50	PL(A) = 0.08 PL(D) = 0.04
		- from 8.5m depth, dark grey (meta-mudstone) to 8.85m depth						8.47m: J,45°,pl,ro 8.75m: J,60°,pl,ro 8.89m: J,70°,pl,ro	C	100	50	
	9 9.0	Bore discontinued at 9.0m										

RIG: Track Mounted **DRILLER:** Tracess **LOGGED:** MPG **CASING:** HW to 2.5m

TYPE OF BORING: Solid Flight Auger to 2.8m then NMLC from 2.8m to 9.0m

WATER OBSERVATIONS: No Free Groundwater 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_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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BORE 204 GEOTECHNICAL INVESTIGATION 21/3/12
TAMWORTH BASE HOSPITAL

2.8 – 9.0m

Douglas Partners Geotechnics / Environment / Groundwater	**Rock Core Photograph**	PROJECT: 75393
	Geotechnical Investigation	PLATE No: 4
	Tamworth Base Hospital	REV: A
	CLIENT: Health Infrastructure	DATE: 2/4/12

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 205
PROJECT No: 75393.00
DATE: 19/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	FILLING: Generally comprising, brown mottled orange silty gravel, dry		A	0.1		PID= 0.1ppm		
		GRAVELLY SILT: Very stiff, orange brown, fine to medium sized subangular gravelly silt		A	0.5		PID= 0.5ppm		
				A	0.8		PID= 0.2ppm		
	1	- from 1.0m depth, grading to extremely weathered siltstone		S	1.0		13,20 refusal		1
					1.3				
	1.6	Bore discontinued at 1.6m. Limit of investigation							
	2								2
	3								3
	4								4

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** Nil
TYPE OF BORING: 100m diameter auger
WATER OBSERVATIONS: No Free Groundwater 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 206
PROJECT No: 75393.00
DATE: 22/3/2012
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
	0.1	TOPSOIL/FILLING: Brown sandy silty clay topsoil/filling with some rootlets							D			PID = 7.4 ppm
		FILLING: Red brown and dark grey clay filling with some coal fragments and gravel, M=Wp (n a poorly compacted condition)							D			PID = 6.7 ppm
									D			PID = 7.8 ppm
1												
	1.2	CLAY: Stiff, red brown clay with a trace of sand, M=Wp							S			1,2,3 N = 5 PID = 8.6 ppm
		- orang brown and sandy, M<Wp from 1.8m										
2									S			3,5,13 N = 18 PID = 7.7 ppm
	2.85	START CORING AT 2.85M										
3		META-SILTSTONE: Very low strength, highly weathered, fractgured brown fine grained meta-siltstone - low strength from 2.93m						2.93m: JT,45°,pl,ro 3.04m: JT,60°,pl,ro,clay filled (10mm) 3.13m: JT,60°,pl,ro 3.2m: JT,20°,pl,ro 3.29m: JT,45°,pl,ro 3.33m: JT,45°,pl,ro,ironstained 3.42m: JT,45°,pl,ro,ironstained 3.5m: JT,45°,pl,ro,ironstained 3.55m: JT,45°,pl,ro,clay filled 3.6m: JT,60°,pl,ro,ironstained 3.73m: JT,30°,pl,ro 3.76m: JT,20°,pl,ro,ironstained 3.83m: JT,45°,pl,ro,ironstained 3.87m: JT,45°,pl,ro,ironstained 3.93m: JT,60°,pl,ro,ironstained	C	100	0	PL(D) = 0.25
4	4.24	Bore discontinued at 4.24m. Limit of investigation										PL(D) = 0.21

RIG: Track Mounted **DRILLER:** SK **LOGGED:** TDM **CASING:** HW to 2.8m

TYPE OF BORING: Solid Flight Auger to 2.8m, then NMCL coring

WATER OBSERVATIONS: No Free Groundwater 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_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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BORE 206 GEOTECHNICAL INVESTIGATION 22/3/12
TAMWORTH BASE HOSPITAL

2.85– 4.24m

Douglas Partners Geotechnics / Environment / Groundwater	**Rock Core Photograph**	PROJECT:	75393
	Geotechnical Investigation	PLATE No:	5
	Tamworth Base Hospital	REV:	A
	CLIENT: Health Infrastructure	DATE:	2/4/12

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 207
PROJECT No: 75393.00
DATE: 19/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	FILLING: Generally comprising, brown sandy clay, M<Wp		A	0.1				
		SANDY CLAY: Very stiff, brown sandy clay, lithic fragments, M<Wp		A	0.5				
	1	- from 1.0m depth, hard		S	1.0		13,13,16 N = 29		
					1.45				
	2	- from 2.2m depth, grading to meta-siltstone bedrock		S	2.0		2,20 refusal		
	2.6	Bore discontinued at 2.6m. TC bit refusal			2.3				
	3								
	4								

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** Nil
TYPE OF BORING: Solid Flight Auger to 2.6m
WATER OBSERVATIONS: No Free Groundwater 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 208
PROJECT No: 75393.00
DATE: 19/3/2012
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
			EW HW MW SW FS FR		Ex Low / Very Low / Low / Medium / High / Very High / Ex High		0.01 / 0.05 / 0.10 / 0.50 / 1.00	B - Bedding J - Joint S - Shear F - Fault				
	0	CLAY: Very stiff, red brown clay with some fine to medium grained sand, M<Wp							A			PID= 1.5ppm
									A			
	1								S			6,10,17 N = 27 PID= 0.9ppm
	2								A			PID= 1.1ppm
	2.6	META-SILTSTONE: Very low strength, highly weathered, light brown meta-siltstone - from 2.79m depth, medium strength - from 2.89m depth, very low strength, dark brown/black (organic) - from 3.05m depth, extremely low strength, extremely weathered - from 3.35m depth, high strength, moderately weathered						2.67m: clay seam 25mm wide 2.76m: J,30°, un.ro 2.85m: J,45°,pl,clay filled 2.91m: J,70°,pl,clay lined 3m: J,60°,pl,ir 3.15m: clay seam, sh, 15mm wide 3.2m: J,70°,pl,ro 3.23m: J,40°,pl,ro 3.34m: J,45°,pl,ro 3.4m: clay seam,sh, 8mm wide 3.52m: J,15°,pl,ro 3.56m: J,sh,un,ro 3.83m: J,60°,pl,clay lined 3.92m: J,60°,pl,ro,ir 4.15m: J,60°,pl,ir,clay lined 4.22m: J,60°,pl,ir,clay lined 4.29m: J,60°,pl,ir,clay lined 4.34m: clay seam to 4.46 4.55m: J,15°,pl,st 4.75m: J,70°,pl,ro 4.93m: J,70°,pl,ro 4.99m: J,80°,pl,ro 5.23m: J,70°,pl,ro,ir 5.38m: J,60°,pl,ro,clay lined 5.46m: J,30°,pl,clay lined 5.57m: clay seam 30mm wide 5.75m: J,20°pl,ro,ir	C	100	20	PL(A) = 1.4 PL(D) = 0.31
	3	- at 4.34m depth, clay seam to 4.46m - at 4.75m depth, high strength, grey basalt to 4.93m (fractured)							C	100	0	
	4	- from 4.99m depth, basalt to 5.21m							C	100	0	
	5	- from 5.44m depth, low strength - from 5.62m depth, high strength, moderately weathered							C	100	50	

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** HW to 2.6m

TYPE OF BORING: Solid Flight Auger to 2.6m, then NMCL coring

WATER OBSERVATIONS: No Free Groundwater 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 208
PROJECT No: 75393.00
DATE: 19/3/2012
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		META-SILTSTONE: Very low strength, highly weathered, light brown meta-siltstone *(continued)*						6m: J,60°,pl,ro				
		= from 6.0m depth, high to very high strength, slightly weathered						6.24m: J,60°,pl,ro,ir 6.29m: J,60°,pl,ro	C	100	50	
								6.76m: J,15°				PL(A) = 2.7 PL(D) = 3.2
	7								C	100	60	
		- at 7.9m depth, extremely low strength, seam to 7.94m										PL(A) = 1.6 PL(D) = 3.1
	8							8.32m: J,15°,pl,ro				
								8.47m: J,80°,pl,ro,clay filled 3mm wide 8.55m: clay seam 15mm wide 8.62m: J,45°,pl,ro 8.74m: J,70°,pl,ro	C	100	45	
	9							9.35m: J,15°,pl, ro				
									C	100	90	
								9.81m: J,10°,pl,un				PL(A) = 3.1 PL(D) = 2.2
	10 10.0	Bore discontinued at 10.0m. Limit of investigation										
	11											

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** HW to 2.6m

TYPE OF BORING: Solid Flight Auger to 2.6m, then NMCL coring

WATER OBSERVATIONS: No Free Groundwater 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_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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BORE 208 GEOTECHNICAL INVESTIGATION 19/3/12
TAMWORTH BASE HOSPITAL

2.6– 10m

Douglas Partners Geotechnics / Environment / Groundwater	**Rock Core Photograph**	PROJECT: 75393
	Geotechnical Investigation	PLATE No: 6
	Tamworth Base Hospital	REV: A
	CLIENT: Health Infrastructure	DATE: 2/4/12

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 209
PROJECT No: 75393.00
DATE: 20/3/2012
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
	0.02	2 COAT SPRAY SEAL							A			PID= 0.2ppm
	0.15	FILLING: Generally comprising dark brown sandy grvel filling with some clay										
	0.22	GRAVEL: Light grey, fine to medium grained, subangular gravel with some sand (possibly stabilised)							A			PID= 0.5ppm
	1	FILLING: Generally comprising dark brown fine to medium grained sandy silty clay filling with occasional gravel and timber, M<WP							S			4,7,9 N = 16 PID= 0.3pp,
	1.5	SANDY CLAY: Hard, light brown, fine to medium grained sandy clay, M<wP										
	1.8	META-SILTSTONE: Very low strength, highly weathered, light brown meta-siltstone										
	2								S			25/50,Ref refusal
	3	- from 2.95m depth, very low strength, highly weathered										
		- from 3.03m depth, low strength						3.04m: clay seam, 20mm thick				PL(D) = 0.93
		- from 3.35m depth, very low strength						3.21m: J,sh,un,ro 3.35m: J,45°,pl,ro 3.44m: J,40°,pl,ro 3.5m: J,60°,pl,clay filled, 15mm thick 3.66m: J,70°,pl,ro 3.71m: J,10°,pl,clay filled 12mm wide 3.87m: J,60°,pl,ro 3.93m: J,45°,pl,ro	C	100	28	
	4	- from 4.0m depth, low strength						4.2m: J,70°,pl,ro 4.32m: J,45°,pl,ro 4.43m: J,15°,un,clay filled 8mm wide 4.6m: J,60°,pl,clay filled 40mm wide 4.78m: J,70°,pl,ro 4.84m: J,70°,pl,ro	C	100	67	PL(D) = 0.08
	4.8	META-MUDSTONE: Medium to high strength, highly weathered, highly fractured, dark grey meta-mudstone						5.2m: J,60°,pl,clay filled 30mm wide 5.4m: J's, 45°, to 70°, at 5mm to 50oomm spacing to 6.16m	C	100	0	PL(A) = 0.69
	5								C	100	0	

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** HW to 2.5m

TYPE OF BORING: Solid Flight Auger to 2.5m, then NMCL coring

WATER OBSERVATIONS: No Free Groundwater 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_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 209
PROJECT No: 75393.00
DATE: 20/3/2012
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
		META-MUDSTONE: Medium to high strength, highly weathered, highly fractured, dark grey meta-mudstone *(continued)*						6.25m: J,60°,pl,ro,ir 6.35m: J,60°,pl,ro,ir 6.4m: J,60°,pl,ro,ir 6.48m: J,60°,pl,ro,ir 6.55m: J,60°,pl,ro,ir 6.6m: J's at 5mm to 50mm spacing, 45°, to 70°, pl,ro,ir	C	100	0	PL(A) = 1.2
	7	- from 7.0m depth, medium to high strength, highly fractured and fragmented						7m: J's at 5mm to 50mm spacing, 70°, pl,ro,ir to 9.15m	C	100	0	
	8								C	100	0	
									C	100	0	
									C	100	0	
									C	100	0	PL(A) = 2.6
	9	- at 9.34m depth, high strength, meta-siltstone to 9.6m depth						9.45m: J,70°,pl,ro				PL(A) = 0.62 PL(D) = 0.16
	10	- from 9.8m depth, low strength						9.67m: J,70°,pl,ro 9.72m: J,70°,pl,ro,ir 9.74m: J,70°,pl,ro,ir 9.8m: J,70°,pl,ir 9.9m: J,70°,pl,ro,ir 10.08m: J,70°,pl,ro,ir	C	100	60	
	10.1	GRANITE: High strength, slightly weathered grey granite						10.52m: J,5°,pl,ro,clay filled 5mm wide 10.55m: J,60°,pl,ro 10.66m: J,70°,pl,ro				PL(D) = 5.2
	11 11.0	Bore discontinued at 11.0m. Limit of investigation						10.87m: J,45°,pl,ro	C	100	90	

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** HW to 2.5m

TYPE OF BORING: Solid Flight Auger to 2.5m, then NMCL coring

WATER OBSERVATIONS: No Free Groundwater 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_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

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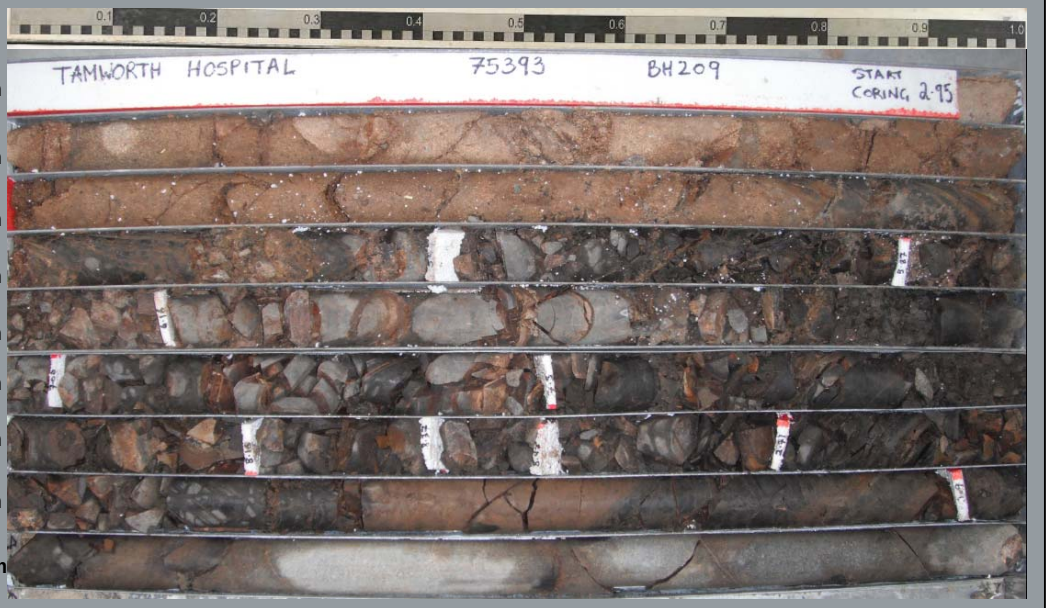
BORE 209 GEOTECHNICAL INVESTIGATION 20/3/12
TAMWORTH BASE HOSPITAL



2.95– 11m

Douglas Partners Geotechnics / Environment / Groundwater	**Rock Core Photograph**	PROJECT: 75393
	Geotechnical Investigation	PLATE No: 7
	Tamworth Base Hospital	REV: A
	CLIENT: Health Infrastructure	DATE: 2/4/12

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 210
PROJECT No: 75393.00
DATE: 19/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.02	TWO COAT SPRAY SEAL							
	0.1	FILLING: Generally comprising, grey and light brown gravel filling		A	0.1		PID= 0.1ppm		
		GRAVELLY CLAY: Very stiff to hard, brown, fine to medium sized gravelly clay, M<Wp		A	0.5				
	0.8	META-SILTSTONE: Low strength, highly weathered light brown meta-siltstone							
1				S	1.0		25,50		1
	1.05	Bore discontinued at 1.05m. TC bit refusal			1.05		refusal		
2									2
3									3
4									4

RIG: Track Mounted **DRILLER:** MPG **LOGGED:** MPG **CASING:** Nil
TYPE OF BORING: Solid Flight Auger
WATER OBSERVATIONS: No Free Groundwater 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 211
PROJECT No: 75393.00
DATE: 22/3/2012
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
	0.02	ASPHALTIC CONCRETE										
		FILLING: Generally comprising, grey sandy gravel filling, dry							D			PID = 4.8 ppm
	0.3	SANDY CLAY: Very stiff, orange and red brown clay with some sand, M=Wp							D			PID = 4.8 ppm
		- from 0.8m depth, M<Wp										
	1								S			4,5,8 N = 13 PID = 5.3 ppm
		- from 1.8m depth, grading into meta-siltstone										
	2								S			9,24,Ref refusal PID = 4.5 ppm
	2.45	START CORING AT 2.45M										
		META-SILTSTONE: Very low strength, highly weathered, highly fractured, light brown, fine grained meta-siltstone							C	100	0	
	3 3.0	CORE LOSS						3m: CORE LOSS: 150mm				
	3.15	META-SILTSTONE: Very low strength, highly weathered, fractured, brown fine grained meta-siltstone						3.22m: JT,60°,pl,ro,clay lined 3.26m: JT,45°,pl,ro,clay lined				PL(D) = 0.03
		- from 3.45m depth, medium strength						3.53m: JT,45°,pl,ro,clay lined	C	85	55	PL(D) = 0.64
		- from 3.68m depth, high strength, slightly weathered						3.65m: clay band, 10mm thick 3.73m: JT,30°,pl,ro 3.82m: JT,60°,pl,ro 3.94m: JT,30°,pl,ro				PL(A) = 1.5
	4 4.0	Bore discontinued at 4.0m. Limit of investigation										

RIG: Track Mounted **DRILLER:** SK **LOGGED:** TDM **CASING:** HW to 2.45m

TYPE OF BORING: Solid Flight Auger to 2.45m, then NMCL coring

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_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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BORE 211 GEOTECHNICAL INVESTIGATION 22/3/12
TAMWORTH BASE HOSPITAL

2m

3m

2.45– 4m

Douglas Partners Geotechnics / Environment / Groundwater	**Rock Core Photograph**	PROJECT:	75393
	Geotechnical Investigation	PLATE No:	8
	Tamworth Base Hospital	REV:	A
	CLIENT: Health Infrastructure	DATE:	2/4/12

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 212
PROJECT No: 75393.00
DATE: 22/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.02	2 COAT SPRAY SEAL							
		FILLING: Grey and brown sandy gravel filling		D	0.1		PID = 8.2 ppm		
		- grey, possibly stabilised from 0.15m							
	0.28	FILLING: Brown and grey gravelly sandy clay filling with some brick fragments, M<Wp (in a moderately compacted condition)		D	0.5		PID = 6.4 ppm		
	1				1.0				1
				S			3,3,6 N = 9 PID = 4.7 ppm		
					1.45				
	2				2.0				2
	2.1	SANDY CLAY: Hard, light brown sandy clay with some gravel, M<Wp		S			3,9,14 N = 23 PID = 5.7 ppm		
					2.45				
	3				3.0				3
				S			26,Ref refusal PID = 6.2 ppm		
	3.15	Bore discontinued at 3.15m. Refusal on bedrock (meta-siltstone)			3.15				
	4								4

RIG: Track Mounted **DRILLER:** SK **LOGGED:** TDM **CASING:**
TYPE OF BORING: 100m diameter Solid Flight Auger
WATER OBSERVATIONS: No Free Groundwater 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 213
PROJECT No: 75393.00
DATE: 21/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.05	2 COAT SPRAY SEAL							
	0.2	FILLING: Grey and brown sandy gravel filling, damp							
		FILLING: Dense, light brown sandy gravel filling with some clay, dry		D	0.3		PID = 1.8 ppm		
	0.5	GRAVELLY CLAYEY SAND: Dense, light brown/orange gravelly clayey sand, dry							
	1								1
	1.4	Bore discontinued at 1.4m. Refusal on bedrock							
	2								2
	3								3
	4								4

RIG: 3.5 Tonne excavator **DRILLER:** Colin **LOGGED:** TDM **CASING:**
TYPE OF BORING: 250mmϕ Solid Flight Auger
WATER OBSERVATIONS: No Free Groundwater 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_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: Tamworth Hospital Redevelopment
LOCATION: Tamworth Hospital

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

BORE No: 214
PROJECT No: 75393.00
DATE: 22/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.02	2 COAT SPRAY SEAL		D	0.1		PID = 9.4 ppm		
		FILLING: Orange brown sandy gravel filling with a trace of clay							
	0.3	Bore discontinued at 0.3m. Refusal on bedrock							
	1								
	2								
	3								
	4								

RIG: Track Mounted **DRILLER:** SK **LOGGED:** TDM **CASING:**
TYPE OF BORING: 100m diameter Solid Flight Auger
WATER OBSERVATIONS: No Free Groundwater 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_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
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Appendix D

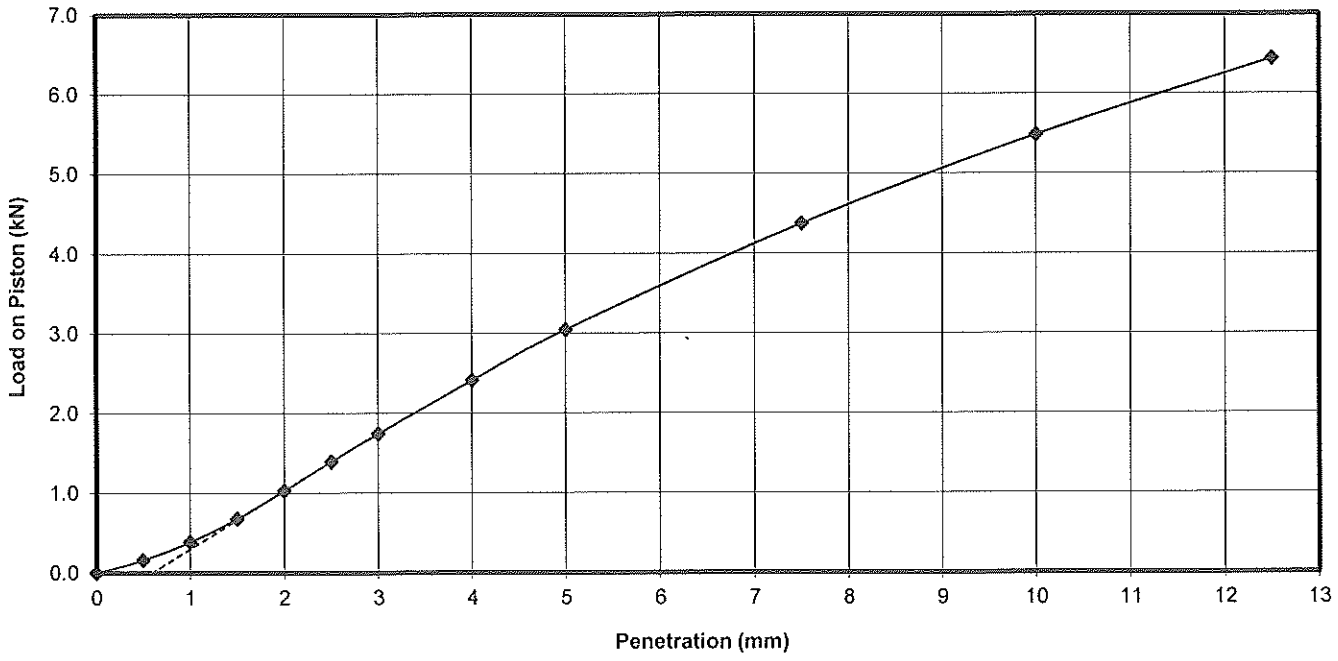
Results of Laboratory Testing

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

Result of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_1
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	26.3.2012
Test Location :	100		
Depth / Layer :	0.3m - 0.8m	**Page:**	1 of 1



Description: SANDY GRAVELLY CLAY - Orange brown sandy gravelly clay

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 100% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** 0.0%
MOISTURE RATIO: 98% of STD OMC **SOAKING PERIOD:** 4 days

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		14.2	1.87
After soaking		15.3	1.87
After test	Top 30mm of sample	15.4	-
	Remainder of sample	15.5	-
Field values		7.6	-
Standard Compaction		14.5	1.87

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	14
	5.0 mm	17

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Checked:	DR

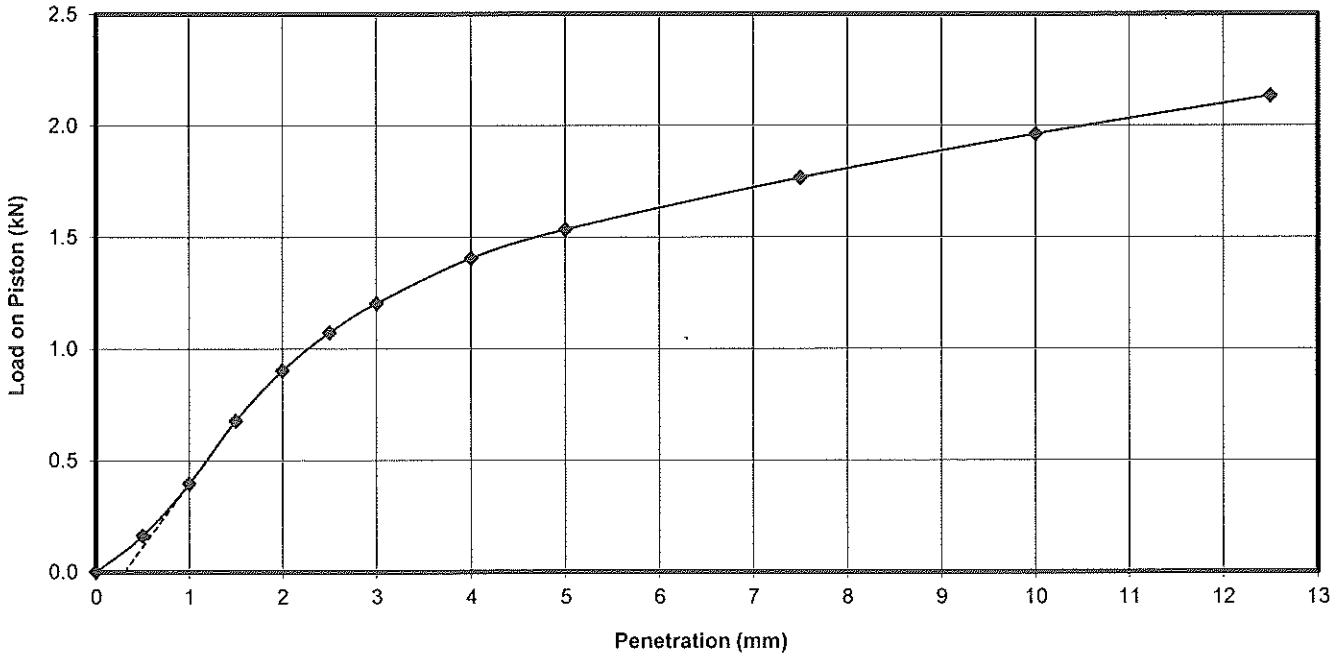
Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

Result of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_2
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	26.3.2012
Test Location :	101		
Depth / Layer :	0.6m - 0.9m	**Page:**	1 of 1



Description: FILLING - Light brown gravelly sandy clay filling

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 100% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** 0.2%
MOISTURE RATIO: 102% of STD OMC **SOAKING PERIOD:** 4 days

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		12.4	1.90
After soaking		15.2	1.89
After test	Top 30mm of sample	15.1	-
	Remainder of sample	15.5	-
Field values		10.3	-
Standard Compaction		12.2	1.90

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	9
	5.0 mm	8

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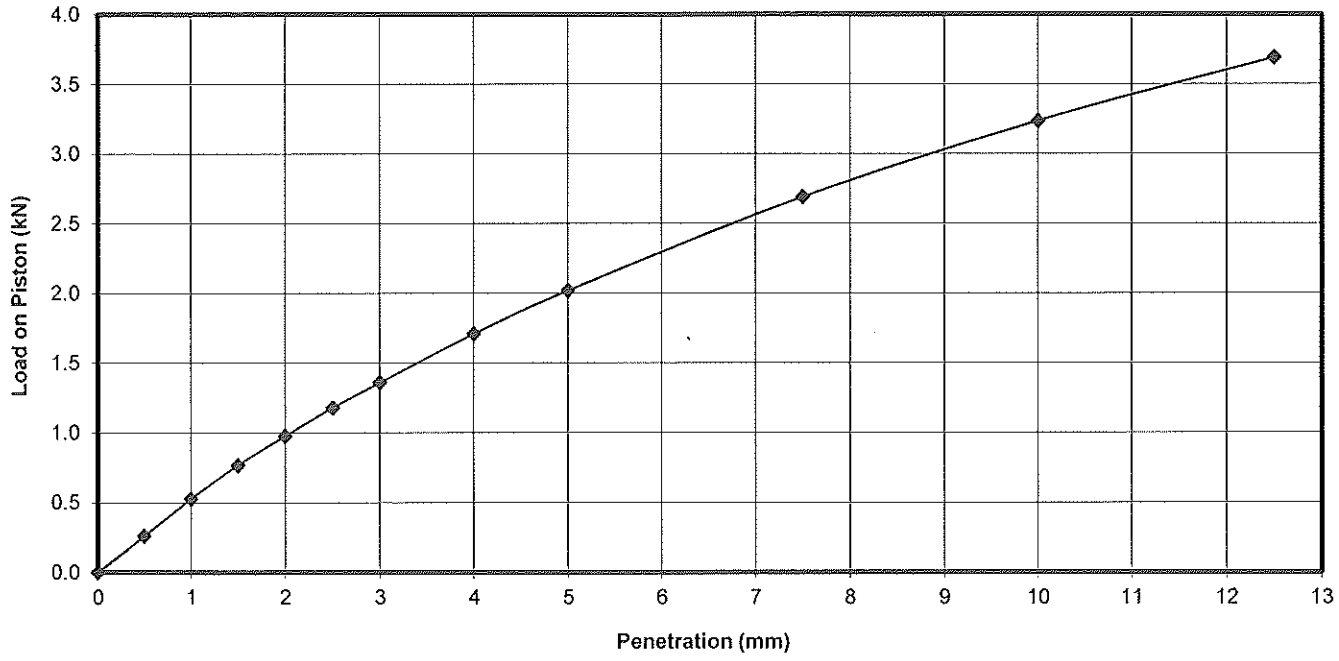
Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

Result of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_3
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	13.4.2012
Test Location :	102		
Depth / Layer :	0.5m- 0.8m	**Page:**	1 of 1



Description: GRAVELLY CLAY - Brown and orange brown gravely clay

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 101% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** 0.1%
MOISTURE RATIO: 99% of STD OMC **SOAKING PERIOD:** 4 days

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		12.6	1.92
After soaking		14.1	1.92
After test	Top 30mm of sample	14.8	-
	Remainder of sample	15.4	-
Field values		11.0	-
Standard Compaction		12.7	1.90

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

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Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

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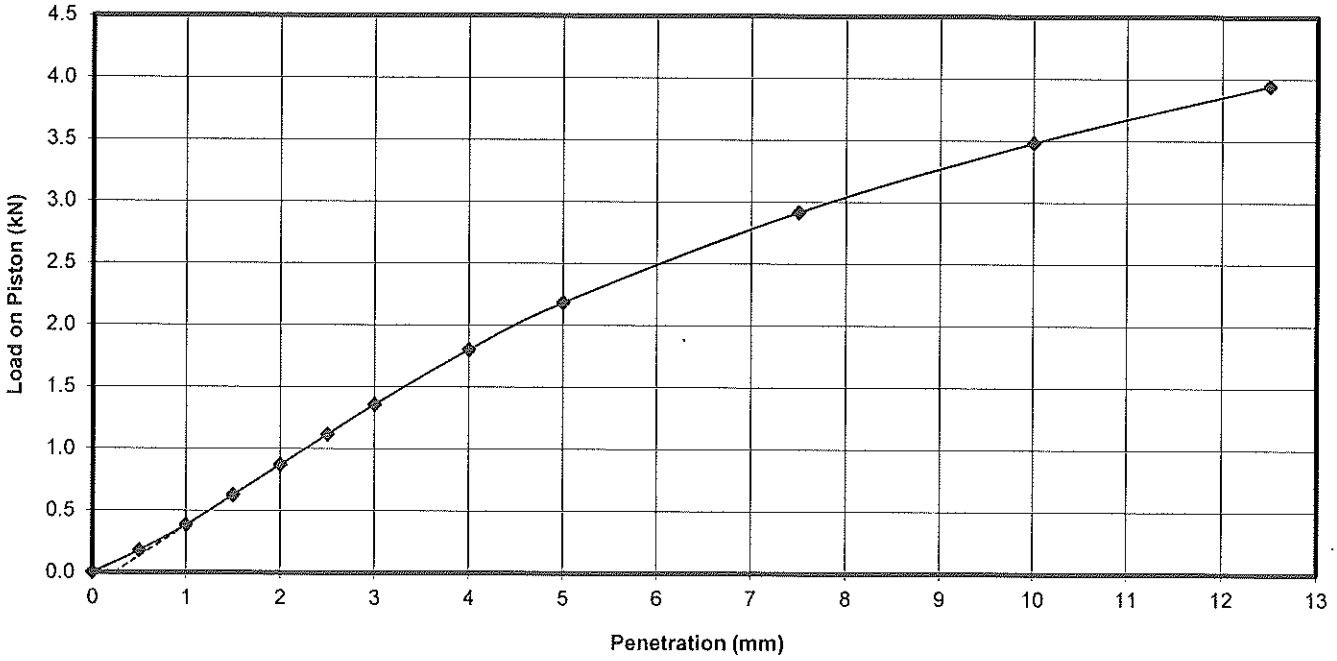
Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_4
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	26.3.2012
Test Location :	103		
Depth / Layer :	0.5m - 0.8m	**Page:**	1 of 1



Description: FILLING - Dark brown sandy clay filling

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): AS 1289.1.2.1, AS 1289.1.1

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: 0.4%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		12.3	1.93
After soaking		13.2	1.93
After test	Top 30mm of sample	12.3	-
	Remainder of sample	12.8	-
Field values		10.3	-
Standard Compaction		12.6	1.93

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	9
	5.0 mm	11

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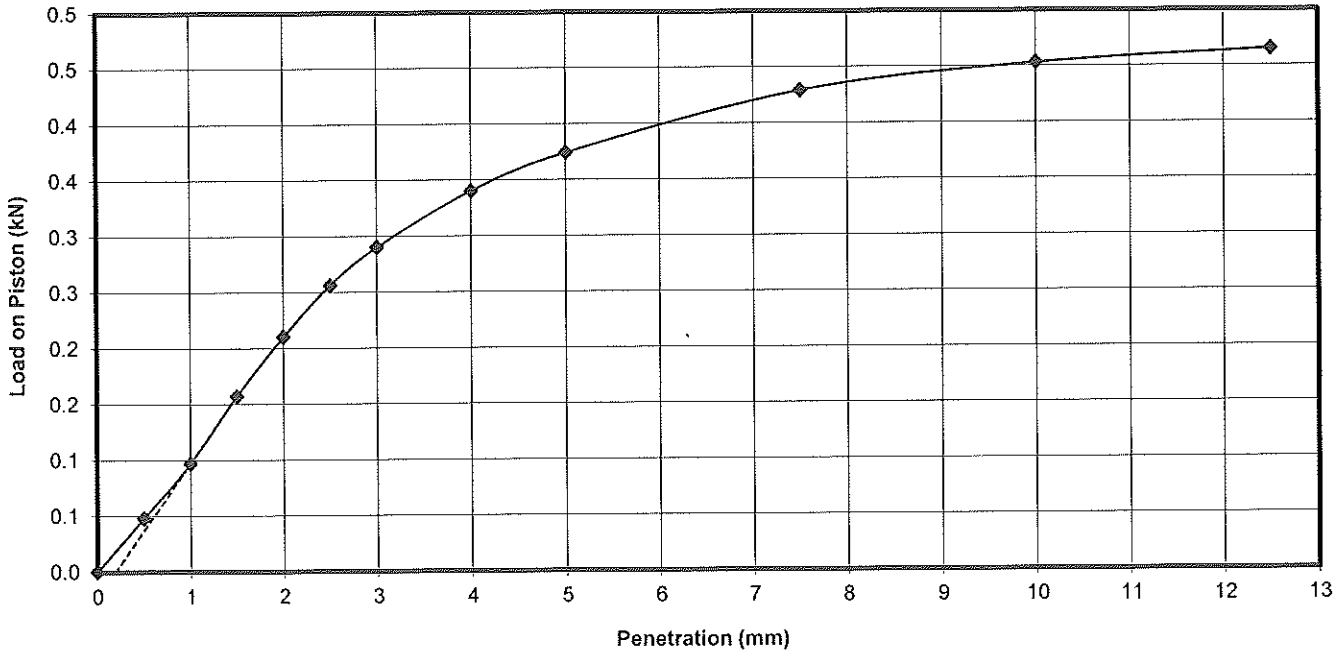
Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

Result of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_5
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	13.4.2012
Test Location :	104		
Depth / Layer :	0.5m - 0.8m	**Page:**	1 of 1



Description: CLAY - Orange & red brown clay with sand

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 94% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** 0.9%
MOISTURE RATIO: 152% of STD OMC **SOAKING PERIOD:** 4 days

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		19.6	1.44
After soaking		27.9	1.43
After test	Top 30mm of sample	29.4	-
	Remainder of sample	27.6	-
Field values		27.0	-
Standard Compaction		12.9	1.53

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	2.0
	5.0 mm	2.0

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Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

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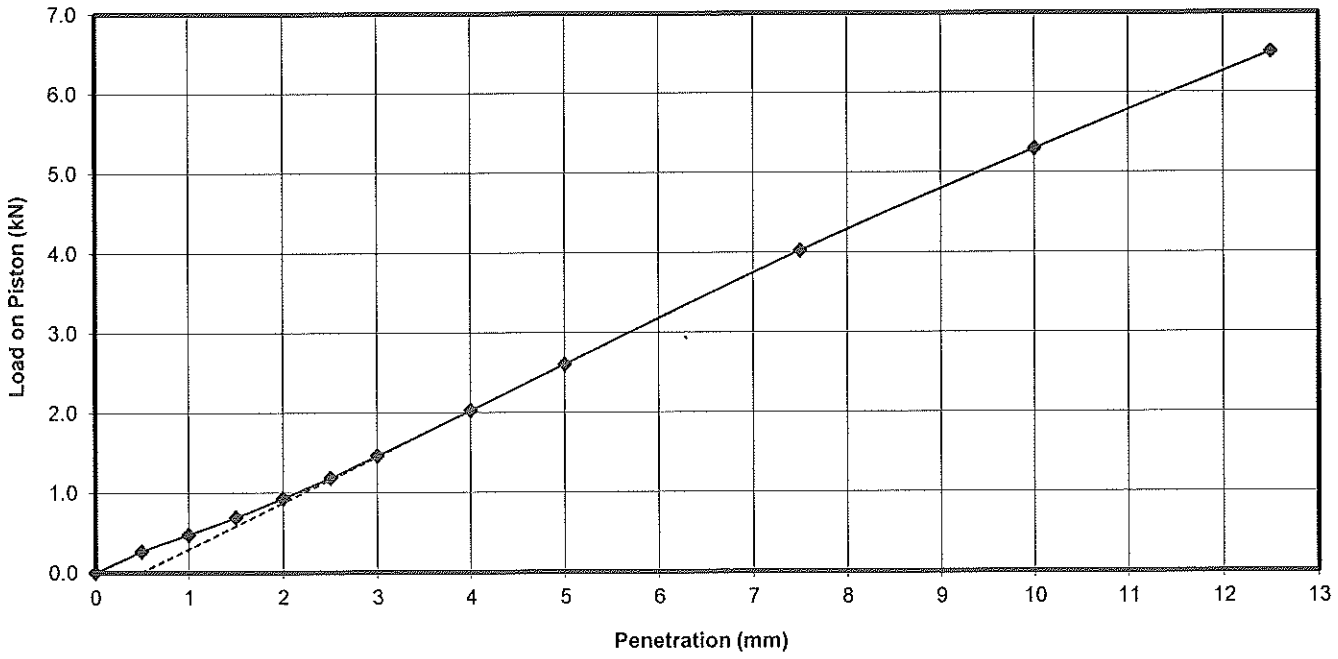
Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_6
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	26.3.2012
Test Location :	105		
Depth / Layer :	0.3m- 0.5m	**Page:**	1 of 1



Description: FILLING - Brown gravelly sandy clay filling

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 101% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: 2.0%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m³
At compaction		12.3	1.96
After soaking		13.4	1.92
After test	Top 30mm of sample	13.6	-
	Remainder of sample	13.7	-
Field values		9.2	-
Standard Compaction		12.2	1.96

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	11
	5.0 mm	15

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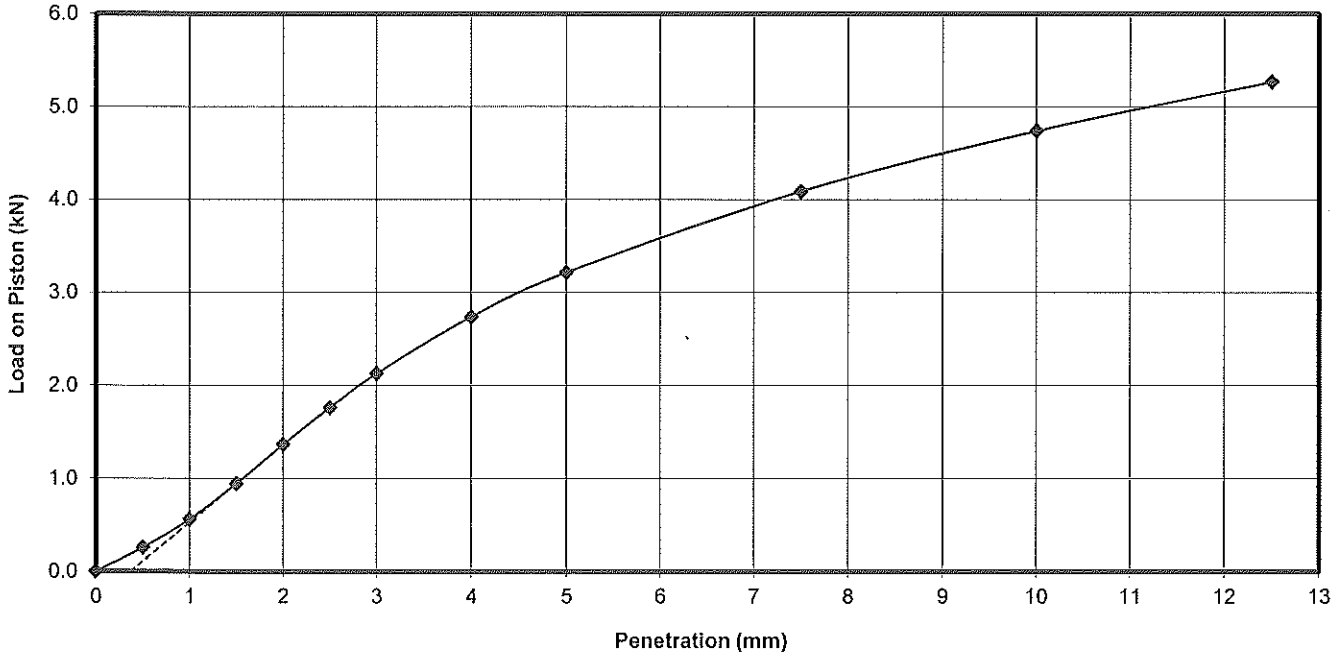
Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

Result of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_7
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	13.4.2012
Test Location :	106		
Depth / Layer :	0.5m - 0.8m	**Page:**	1 of 1



Description: SANDY CLAY - Light brown sandy clay

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 100% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** 0.2%
MOISTURE RATIO: 103% of STD OMC **SOAKING PERIOD:** 4 days

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		15.4	1.85
After soaking		16.8	1.84
After test	Top 30mm of sample	17.4	-
	Remainder of sample	17.1	-
Field values		11.0	-
Standard Compaction		15.0	1.85

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	15
	5.0 mm	17

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Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

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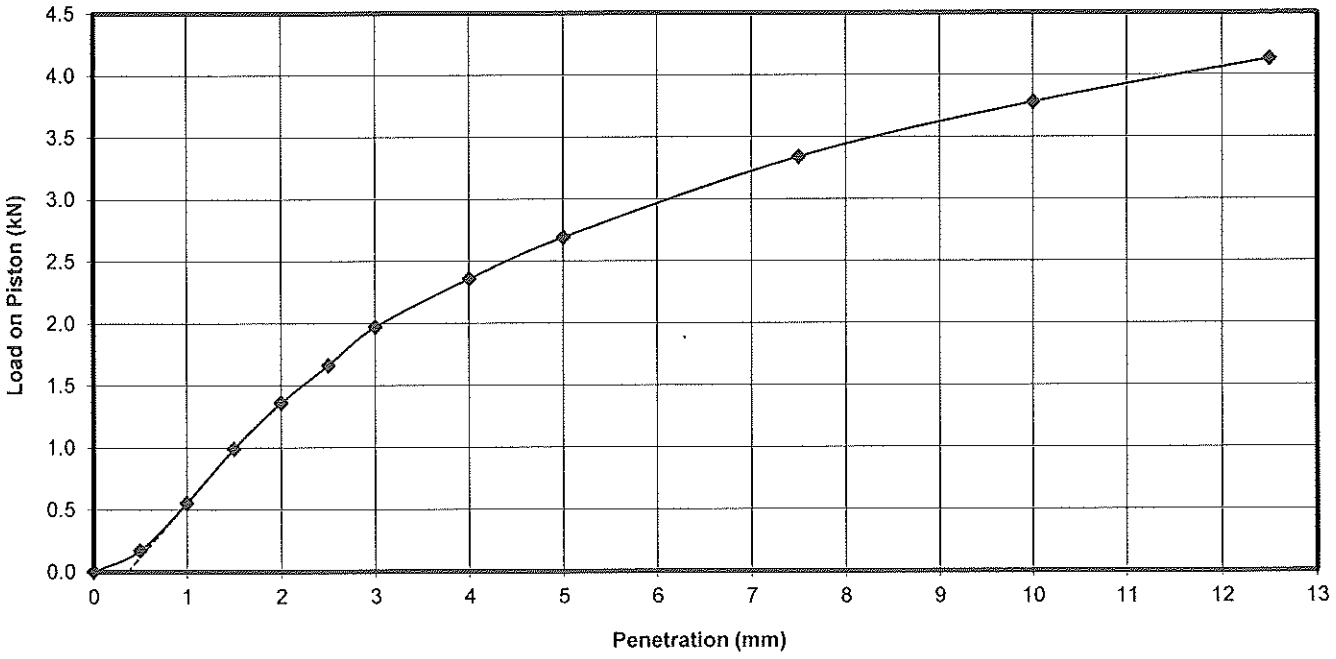
Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_8
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	13.4.2012
Test Location :	107		
Depth / Layer :	0.5m - 0.8m	**Page:**	1 of 1



Description: GRAVELLY CLAY - Light grey brown gravelly clay

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 103% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: -0.6%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		13.7	1.84
After soaking		15.5	1.85
After test	Top 30mm of sample	15.1	-
	Remainder of sample	15.9	-
Field values		8.6	-
Standard Compaction		13.3	1.85

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

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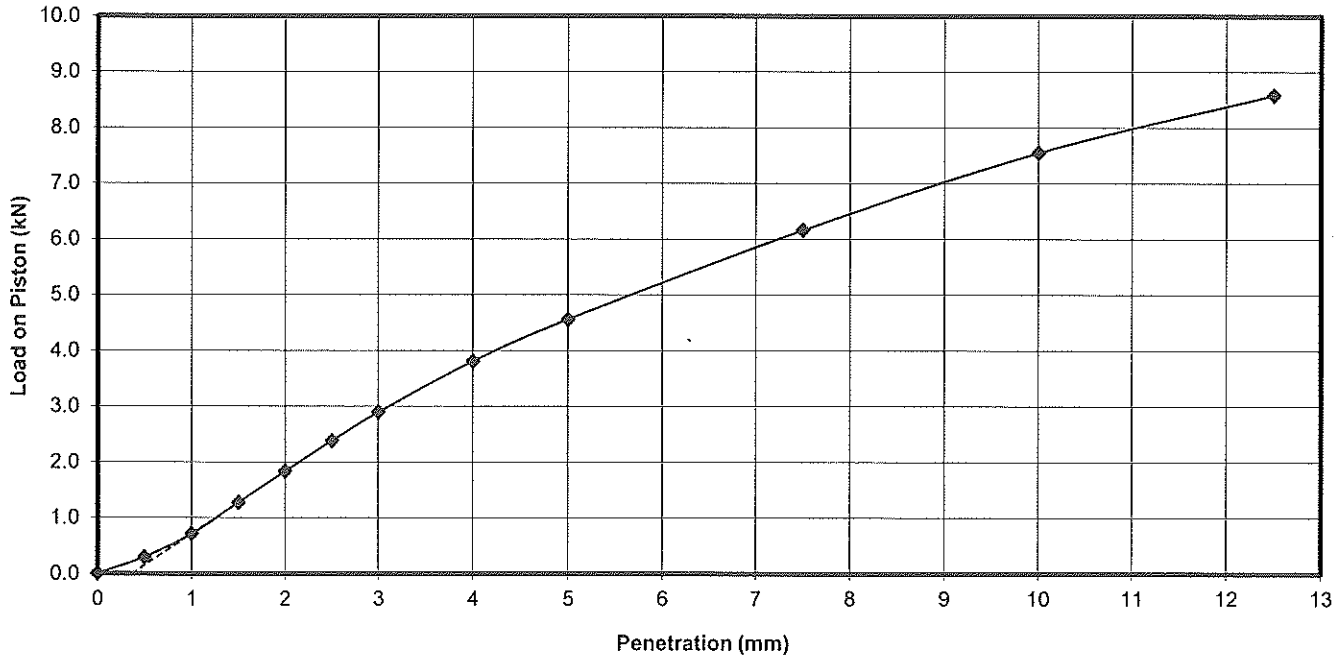
Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

Result of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_9
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	26.3.2012
Test Location :	108		
Depth / Layer :	0.5m - 0.8m	**Page:**	1 of 1



Description: FILLING - Dark brown silty sandy clay filling

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

Percentage > 19mm: 0.0%

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

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		9.9	2.01
After soaking		10.5	2.01
After test	Top 30mm of sample	10.4	-
	Remainder of sample	9.7	-
Field values		7.4	-
Standard Compaction		10.0	2.01

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	20
	5.0 mm	25

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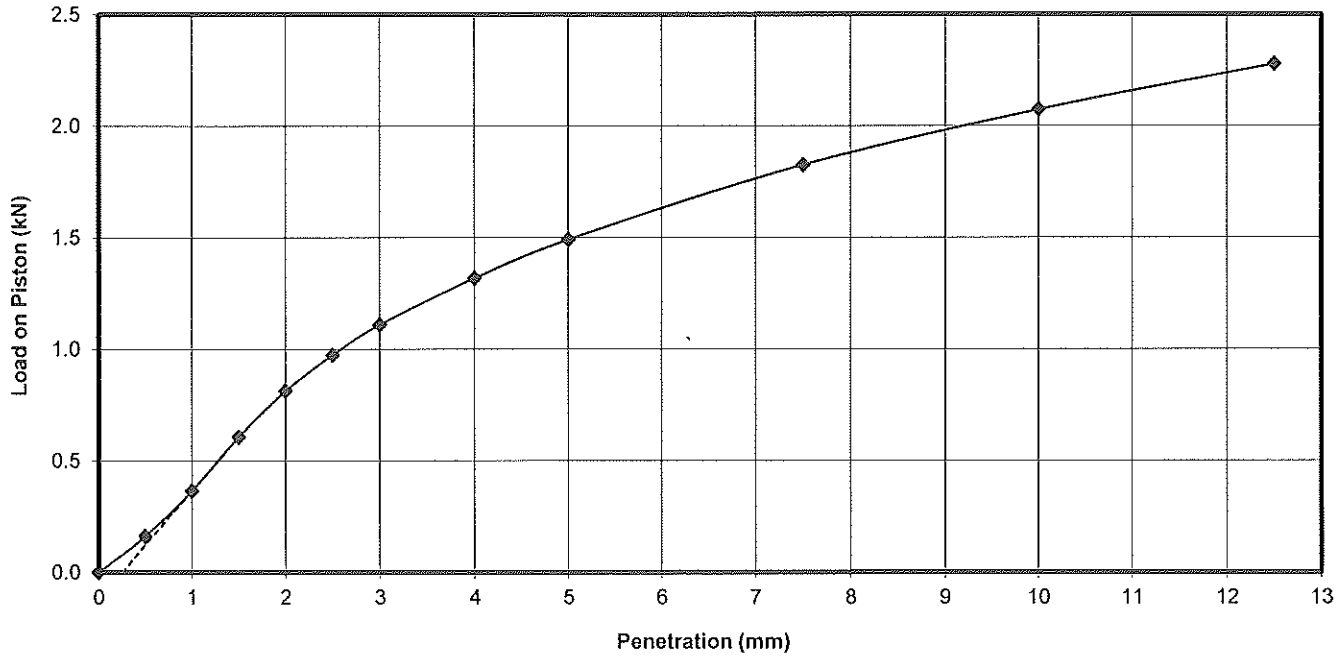
Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

Result of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_10
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	26.3.2012
Test Location :	109		
Depth / Layer :	0.5m - 0.8m	**Page:**	1 of 1



Description: FILLING - Dark brown silty sandy clay filling

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

Percentage > 19mm: 0.0%

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

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		17.2	1.78
After soaking		19.0	1.78
After test	Top 30mm of sample	17.2	-
	Remainder of sample	18.7	-
Field values		14.3	-
Standard Compaction		17.5	1.78

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	8
	5.0 mm	8

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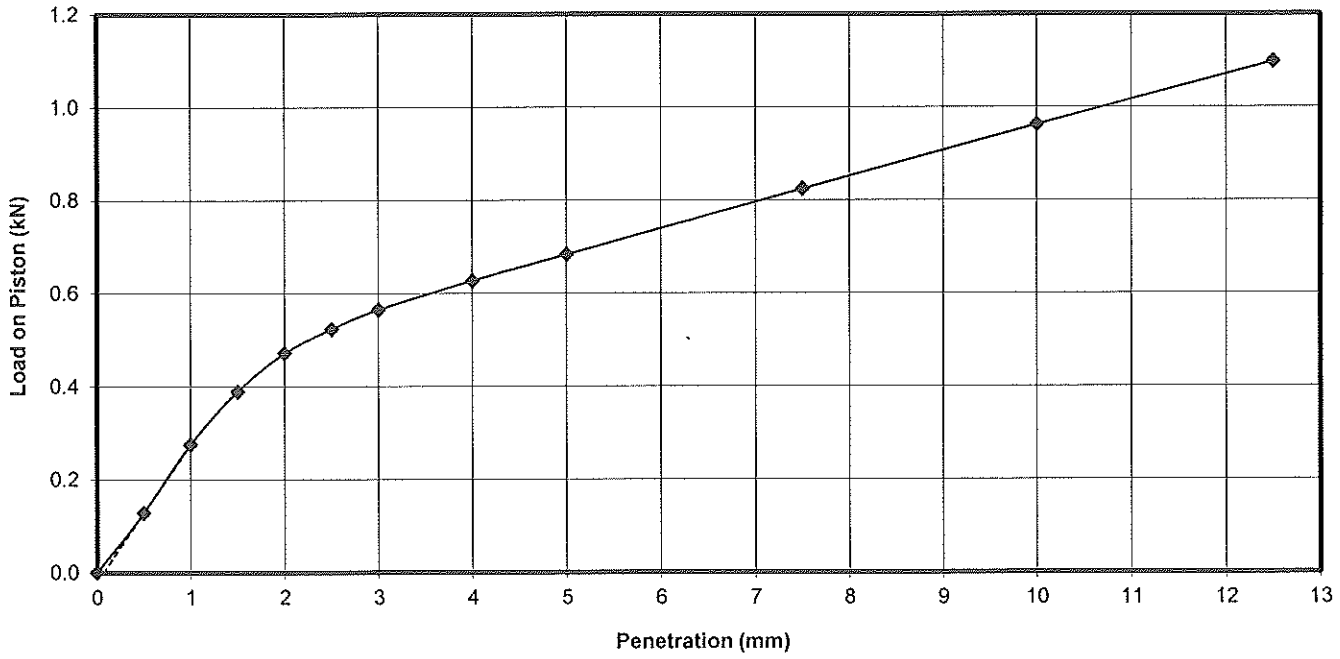
Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

Result of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_11
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	13.4.2012
Test Location :	110		
Depth / Layer :	0.5m - 0.8m	**Page:**	1 of 1



Description: SANDY CLAY - Grey and brown sandy clay

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

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: 1.4%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		14.9	1.80
After soaking		17.1	1.78
After test	Top 30mm of sample	20.6	-
	Remainder of sample	17.5	-
Field values		12.5	-
Standard Compaction		15.3	1.81

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	4.0
	5.0 mm	3.5

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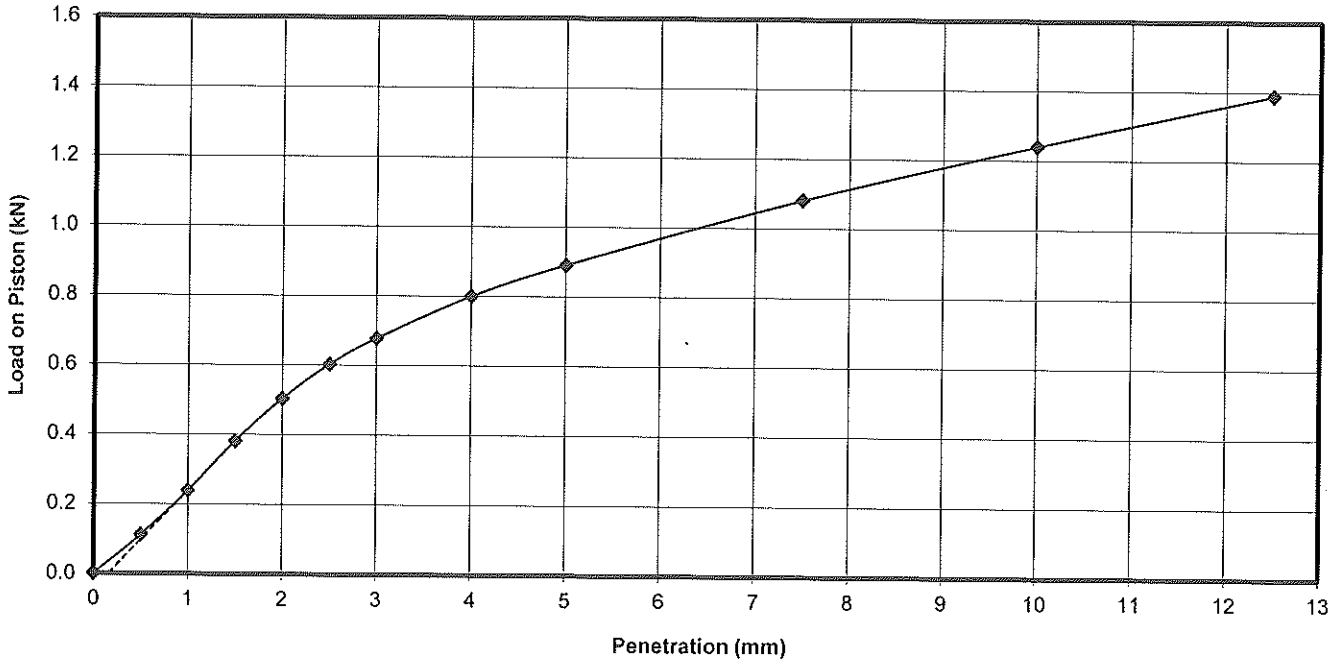
Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

Result of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_12
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	13.4.2012
Test Location :	111		
Depth / Layer :	0.5m - 0.8m	**Page:**	1 of 1



Description: CLAY - Orange and red brown clay with some sand

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

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: 1.0%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		17.9	1.73
After soaking		20.1	1.72
After test	Top 30mm of sample	21.9	-
	Remainder of sample	20.2	-
Field values		14.1	-
Standard Compaction		18.3	1.73

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

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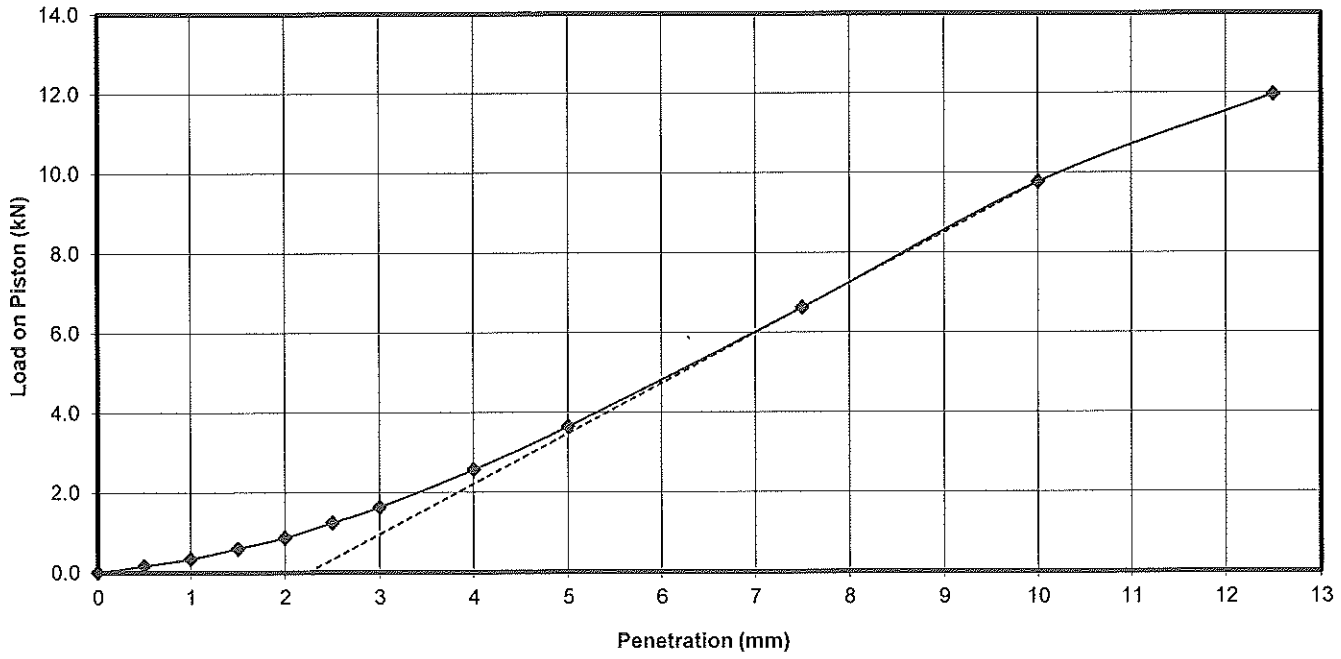
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

Result of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_13
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	13.4.2012
Test Location :	112		
Depth / Layer :	0.3m - 0.6m	**Page:**	1 of 1



Description: SANDY GRAVEL - Brown sandy gravel with some clay

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 98% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** -0.1%
MOISTURE RATIO: 118% of STD OMC **SOAKING PERIOD:** 4 days

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		10.9	2.05
After soaking		11.8	2.05
After test	Top 30mm of sample	11.6	-
	Remainder of sample	11.6	-
Field values		6.4	-
Standard Compaction		9.2	2.08

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	25
	5.0 mm	30

NATA Accredited Laboratory Number: 828

This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Tested:	BB
Checked:	DR

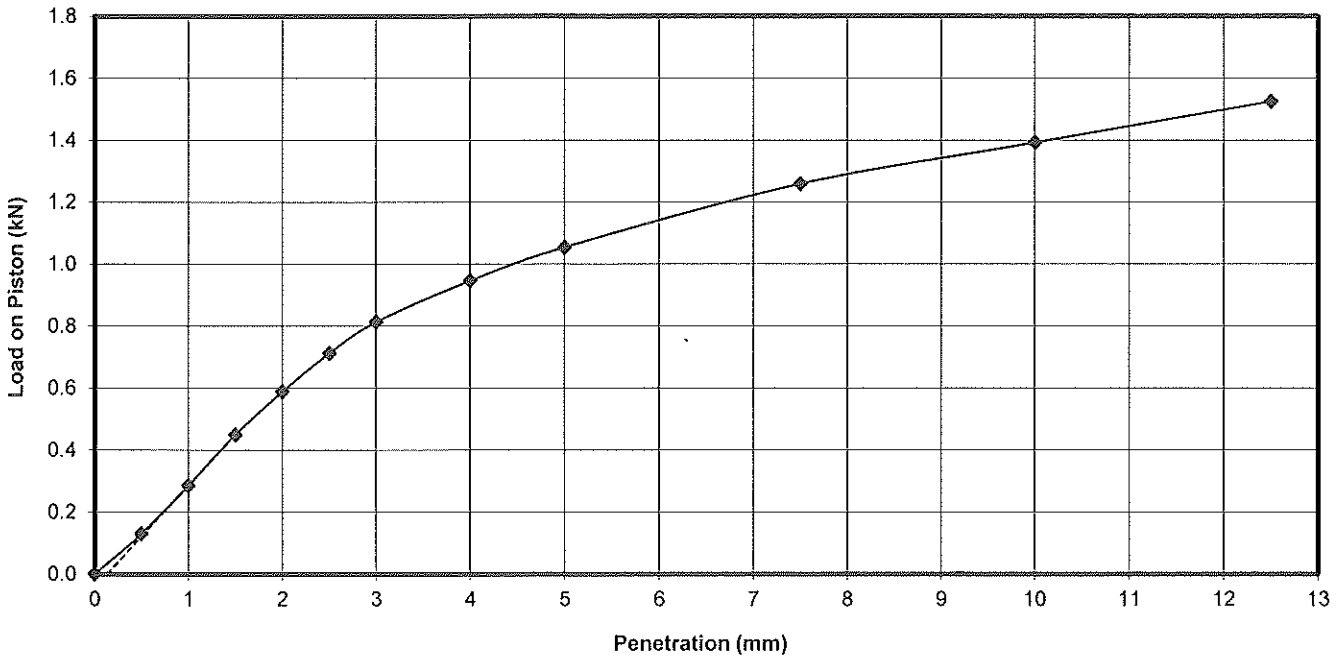
Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

Result of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_14
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	13.4.2012
Test Location :	113		
Depth / Layer :	0.5m - 0.8m	**Page:**	1 of 1



Description: GRAVELLY SANDY CLAY - Orange and light brown gravelly sandy clay

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 99% of STD MDD
MOISTURE RATIO: 98% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: 1.5%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		16.7	1.73
After soaking		20.3	1.70
After test	Top 30mm of sample	23.2	-
	Remainder of sample	20.5	-
Field values		13.8	-
Standard Compaction		17.0	1.75

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

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory Number: 828

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Accredited for compliance with ISO/IEC 17025

Tested:	BB
Checked:	DR

Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

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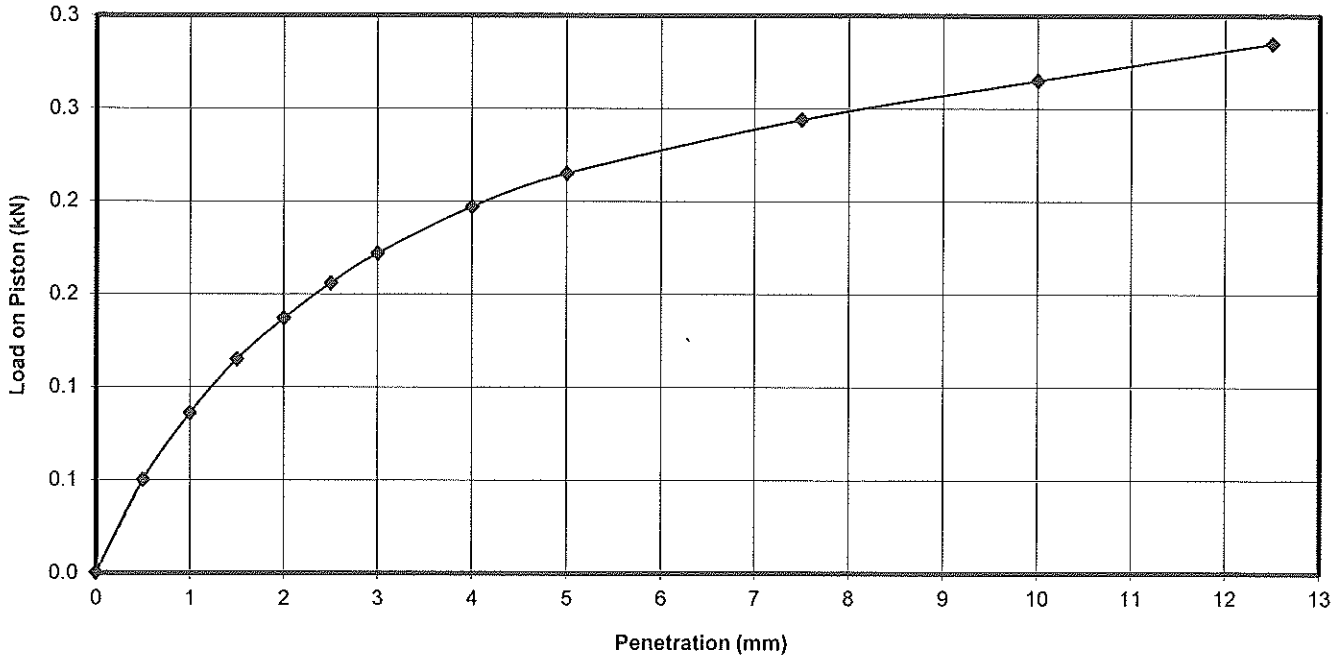
ABN 75 053 980 117
www.douglaspartners.com.au
Unit D, 7 Donaldson Street
North Wyong NSW 2259
Phone (02) 4351 1422
Fax (02) 4351 1410

Result of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_15
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	13.4.2012
Test Location :	114A		
Depth / Layer :	0.7m - 1.0m	**Page:**	1 of 1



Description: CLAY - Brown clay with some sand and gravel

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 98% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** 1.6%
MOISTURE RATIO: 102% of STD OMC **SOAKING PERIOD:** 4 days

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		15.6	1.67
After soaking		23.2	1.65
After test	Top 30mm of sample	27.5	-
	Remainder of sample	20.3	-
Field values		15.9	-
Standard Compaction		15.3	1.70

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	1.0
	5.0 mm	1.0

NATA Accredited Laboratory Number: 828

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Accredited for compliance with ISO/IEC 17025

Tested:	BB
Checked:	DR

Darren Rapp
Senior Technician

Douglas Partners
Geotechnics / Environment / Groundwater

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www.douglaspartners.com.au
Unit D, 7 Donaldson Street
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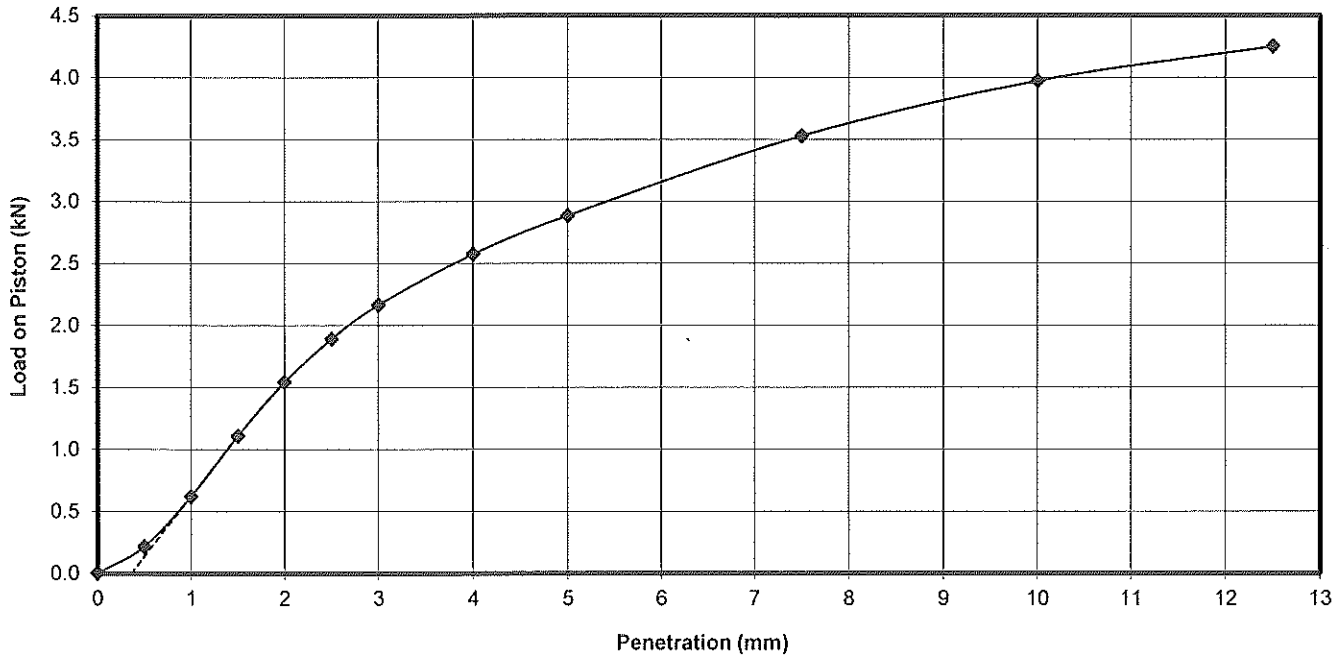
Phone (02) 4351 1422
Fax (02) 4351 1410

Result of California Bearing Ratio Test

Client :	Health Infrastructure	**Project No. :**	75393
		Report No. :	CC12-028_16
Project :	Proposed Redevelopment of Hospital	**Report Date :**	19.4.2012
		Date Sampled :	21.3.2012
Location :	Tamworth	**Date of Test:**	13.4.2012
Test Location :	115		
Depth / Layer :	0.6m - 1.0m	**Page:**	1 of 1



Description: FILLING - Brown gravelly sandy clay filling

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): Sampled by Douglas Partners' Engineers

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 100% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** 0.2%
MOISTURE RATIO: 93% of STD OMC **SOAKING PERIOD:** 4 days

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		10.0	2.01
After soaking		11.6	2.00
After test	Top 30mm of sample	11.9	-
	Remainder of sample	11.2	-
Field values		7.2	-
Standard Compaction		10.8	2.01

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	16
	5.0 mm	15

NATA Accredited Laboratory Number: 828

This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Tested:	BB
Checked:	DR

Darren Rapp
Senior Technician

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

CERTIFICATE OF ANALYSIS 71826

Client:
Douglas Partners Tuggerah
Unit D, 7 Donaldson St
Wyong North
NSW 2259

Attention: Michael Gawn

Sample log in details:

Your Reference:	**75393, Tamworth Hospital**		
No. of samples:	1 soil		
Date samples received / completed instructions received	17/04/12	/	17/04/12

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:	24/04/12	/	24/04/12
Date of Preliminary Report:	Not Issued		

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Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Nick Sarlamis
Inorganics Supervisor

Miscellaneous Inorg - soil		
Our Reference:	UNITS	71826-1
Your Reference	----------	BH207/2
Type of sample	----------	Soil
Date prepared	-	23/04/2012
Date analysed	-	23/04/2012
pH 1:5 soil:water	pH Units	8.5
Electrical Conductivity 1:5 soil:water	µS/cm	160
Chloride, Cl 1:5 soil:water	mg/kg	12
Sulphate, SO4 1:5 soil:water	mg/kg	13

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 21st ED, 4500-H+.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA 21st ED 2510 and Rayment & Higginson.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 21st 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	-			23/04/2012	[NT]	[NT]	LCS-1	23/04/2012
Date analysed	-			23/04/2012	[NT]	[NT]	LCS-1	23/04/2012
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	LCS-1	102%
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	LCS-1	105%
Chloride, Cl 1:5 soil:water	mg/kg	2	Inorg-081	<2	[NT]	[NT]	LCS-1	96%
Sulphate, SO4 1:5 soil:water	mg/kg	2	Inorg-081	<2	[NT]	[NT]	LCS-1	110%

Report Comments:

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

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

Quality Control Definitions

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

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

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

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

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

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batched of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

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

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

CERTIFICATE OF ANALYSIS 71013-A

Client:
Douglas Partners Tuggerah
Unit D, 7 Donaldson St
Wyong North
NSW 2259

Attention: Michael Gawn

Sample log in details:

Your Reference:	**75393, Tamworth Hospital**
No. of samples:	Additonal testing on 3 Soils
Date samples received / completed instructions received	28/03/2012 / 13/04/12

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:	20/04/12 / 20/04/12
Date of Preliminary Report:	Not Issued

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Results Approved By:

Giovanni Agosti
Technical Manager

Miscellaneous Inorg - soil				
Our Reference:	UNITS	71013-A-16	71013-A-20	71013-A-26
Your Reference	----------	BH203	BH206	BH212
Depth	----------	1.0	2-2.45	1.0-1.45
Type of sample		Soil	Soil	Soil
Date prepared	-	19/04/2012	19/04/2012	19/04/2012
Date analysed	-	19/04/2012	19/04/2012	19/04/2012
pH 1:5 soil:water	pH Units	8.0	8.8	7.8
Electrical Conductivity 1:5 soil:water	µS/cm	190	71	83
Sulphate, SO4 1:5 soil:water	mg/kg	83	9	6
Chloride, Cl 1:5 soil:water	mg/kg	21	<2	15

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 21st ED, 4500-H+.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA 21st ED 2510 and Rayment & Higginson.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 21st 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	-			19/04/2012	[NT]	[NT]	LCS-1	19/04/2012
Date analysed	-			19/04/2012	[NT]	[NT]	LCS-1	19/04/2012
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	106%
Sulphate, SO4 1:5 soil:water	mg/kg	2	Inorg-081	<2	[NT]	[NT]	LCS-1	93%
Chloride, Cl 1:5 soil:water	mg/kg	2	Inorg-081	<2	[NT]	[NT]	LCS-1	85%

Report Comments:

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

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

Quality Control Definitions

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

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

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

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

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

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batched of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

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

Douglas Partners
Geotechnics · Environment · Groundwater

CHAIN OF CUSTODY DESPATCH SHEET (2)

Project Name: Tamworth Hospital Redevelopment
Project No: 75393
DP Contact Person: Michael Gawn
Prior Storage: esky / fridge / **shelved** (Bold)

To: Envirolab Services
12 Ashley Street
Chatswood NSW
Ph: 9910 6200
Attn: Sample Reciept

Sample ID	Sample Type S-soil W-water	Lab ID	Analytes: Chloride 1:5 soluble	pH (1:5 soil:water)	EC (1:5 soil:water)	Sulphate – water soluble									Notes
BH203/1		16	√	√	√	√									
BH206/2		20	√	√	√	√									
BH207/2			√	√	√	√									71013 A
BH212/1		26	√	√	√	√									Std T/A due
PQL (S)	mg/kg														
PQL (W)	mg/L														

PQL = practical quantitation limit, *As per Laboratory Method Detection Limit

Date relinquished: Three samples in Envirolab storage one sent 16/4/12

Total number of samples in container: 3 (Envirolab storage) and 1 (courier)

Results required by: Standard Turnaround

SAMPLES RECEIVED
Please sign and date to acknowledge receipt of samples and return by fax

Signature: .....

Date: ..... Lab Ref: .....

Send results to: Michael Gawn
Douglas Partners Pty Ltd
Address:
Unit D, 7 Donaldson Street
Wyong North NSW 2259

Email:
brent.kerry@douglaspartners.com.au

Douglas Partners
Geotechnics · Environment · Groundwater

CHAIN OF CUSTODY DESPATCH SHEET (2)

Project Name: Tamworth Hospital Redevelopment
Project No: 75393
DP Contact Person: Michael Gawn
Prior Storage: esky / fridge / **shelved** (Bold)

To: Envirolab Services
12 Ashley Street
Chatswood NSW
Ph: 9910 6200
Attn: Sample Reciept

Sample ID	Sample Type S-soil W-water	Lab ID	Analytes: Chloride 1:5 soluble	pH (1:5 soil:water)	EC (1:5 soil:water)	Sulphate – water soluble									Notes
BH203/1			√	√	√	√									
BH206/2			√	√	√	√									
BH207/2		1	√	√	√	√									
BH212/1			√	√	√	√									
PQL (S)	mg/kg														
PQL (W)	mg/L														

ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 71826
Date Received: 17/4/12
Time Received: 11:25
Received by: AH
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

PQL = practical quantitation limit, *As per Laboratory Method Detection Limit
Date relinquished: Three samples in Envirolab storage one sent 16/4/12
Total number of samples in container: 3 (Envirolab storage) and 1 (courier)
Results required by: Standard Turnaround

SAMPLES RECEIVED
Please sign and date to acknowledge receipt of samples and return by fax
Signature:
Date: 17/4/12 Lab Ref: Alex W

Send results to: Michael Gawn
Douglas Partners Pty Ltd
Address:
Unit D, 7 Donaldson Street
Wyong North NSW 2259
Email:
brent.kerry@douglaspartners.com.au

Appendix E

Groundwater Bore Desktop Information

NSW OFFICE OF WATER
Work Summary

GW965054

Licence :90BL250216

Licence Status Converted

Authorised Purpose(s): DOMESTIC

Intended Purpose(s): INDUSTRIAL

Work Type :Bore
Work Status :(Unknown)
Construct. Method :(Unknown)
Owner Type :

Commenced Date :
Completion Date :01-May-1995

Final Depth : 22.86 m
Drilled Depth :

Contractor Name :
Driller : eacott, g
Assistant Driller's Name :

Property : - LOT 2 DP 519841
GWMA : -
GW Zone : -

Standing Water Level : 13.70 m
Salinity :
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :		
	Licensed :INGLIS	TAMWORTH	2 519841

Region :90 - BARWON
River Basin :
Area / District :

CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :

Northing :6560072
Easting :302074

Latitude (S) :31° 4' 35"
Longitude (E) :150° 55' 31"

GS Map :
MGA Zone :56
Coordinate Source :

Construction

Negative depths indicate Above Ground Level;

H-Hole,P-Pipe,OD-Outside Diameter,ID-Inside Diameter,C-Cemented;SL-Slot Length;A-Aperture,GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component Type		From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	22.86	152			(Unknown)
1	1	Casing	PVC Class 6	0.00	22.86	152			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments

Remarks

*** End of GW965054 ***

NSW OFFICE OF WATER
Work Summary

GW057928

Converted From HYDSYS

Licence :90BL125593

Licence Status Converted

	Authorised Purpose(s)	Intended Purpose(s)
Work Type :Bore	INDUSTRIAL (LOW SECURITY)	GENERAL USE
Work Status :(Unknown)	IRRIGATION	
Construct. Method :Rotary Air		
Owner Type :Private		

Commenced Date :
Completion Date :01-Mar-1983
Final Depth : 38.00 m
Drilled Depth : 38.00 m

Contractor Name :
Driller :1547 MANNION, Leonard George
Assistant Driller's Name :

Property : - N/A
GWMA :005 - PEEL VALLEY
GW Zone :002 - PEEL CATCHMENT MISCELLANEOUS FR

Standing Water Level :
Salinity : 1001-3000 ppm
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :INGLIS	TAMWORTH	99
	Licensed :INGLIS	TAMWORTH	99 753848

Region :90 - BARWON
River Basin :419 - NAMOI RIVER
Area / District :

CMA Map :9035-1N TAMWORTH
Grid Zone :56/1
Scale :1:25,000

Elevation :
Elevation Source :(Unknown)

Northing :6560256
Easting :302017

Latitude (S) :31° 4' 29"
Longitude (E) :150° 55' 29"

GS Map :0033D1 MGA Zone :56

Coordinate Source :GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe,OD-Outside Diameter,ID-Inside Diameter,C-Cemented;SL-Slot Length;A-Aperture,GS-Grain Size,Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Threaded Steel	0.00	27.40	150			Driven into Hole
1	1	Opening	Slots - Vertical	25.00	27.40	150		1	Oxy-Acetylene Slotted; SL: 0mm; A: 5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
26.20	26.50	0.30	Fractured	15.20		1.25			1001-3000 ppm

Drillers Log

From (m)	To (m)	Thickness(m	Drillers Description	Geological Material	Comments
0.00	1.00	1.00	Soil	Soil	
1.00	18.60	17.60	Shale Yellow	Shale	
18.60	26.20	7.60	Shale Hard	Shale	
26.20	26.50	0.30	Basalt Water Supply	Basalt	
26.50	38.00	11.50	Basalt Hard	Basalt	

Remarks

***** End of GW057928 *****

NSW OFFICE OF WATER
Work Summary

GW052834

Converted From HYDSYS

Licence : 90BL115058
Licence Status Converted
Work Type : Bore
Work Status : (Unknown)
Construct. Method : Cable Tool
Owner Type : Private

Authorised Purpose(s)	Intended Purpose(s)
IRRIGATION	GENERAL USE

Commenced Date :
Completion Date : 01-Aug-1980
Final Depth : 34.50 m
Drilled Depth : 34.50 m

Contractor Name :
Driller : 1429 FRANCIS, David William
Assistant Driller's Name :

Property : - N/A
GWMA : 005 - PEEL VALLEY
GW Zone : 002 - PEEL CATCHMENT MISCELLANEOUS FR
Standing Water Level :
Salinity : 7001-10000 ppm
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : INGLIS	TAMWORTH	395
	Licensed : INGLIS	TAMWORTH	395 753848

Region : 90 - BARWON
River Basin : 419 - NAMOI RIVER
Area / District :
CMA Map : 9035-1N TAMWORTH
Grid Zone : 56/1
Scale : 1:25,000

Elevation :
Elevation Source : (Unknown)
Northing : 6560252
Easting : 301832
Latitude (S) : 31° 4' 29"
Longitude (E) : 150° 55' 22"

GS Map : 0033D1 **MGA Zone :** 56
Coordinate Source : GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Corrugated	-0.40	22.50	160			Driven into Hole
1	1	Casing	Galvanised Iron	22.50	34.50	125			Seated on Bottom
1	1	Opening	Slots - Horizontal	29.50	34.00	125		1	Mechanically Slotted; SL: 0mm; A: 2mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
24.50	34.00	9.50	Fractured	17.00		1.25			(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m	Drillers Description	Geological Material	Comments
0.00	0.60	0.60	Topsoil	Topsoil	
0.60	7.50	6.90	Clay Sandy	Clay	
7.50	22.00	14.50	Clay Some Shale	Clay	
22.00	34.00	12.00	Shale Water Supply	Shale	
34.00	34.50	0.50	Basalt Black	Basalt	

Remarks

*** End of GW052834 ***