



Douglas Partners

Geotechnics | Environment | Groundwater

Report on
Geotechnical Investigation
Proposed Gosford Hospital Redevelopment

(Including Preliminary Geotechnical Investigation
for Proposed Health & Wellbeing Precinct)

Holden Street, Gosford

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

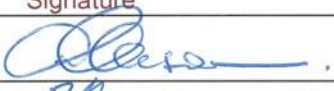
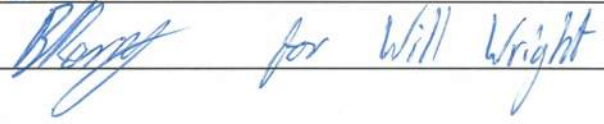
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Table of Contents

	Page
1. Introduction.....	1
2. Site Description	2
3. Regional Geology	6
4. Previous Investigations	7
5. Field Work Methods	8
6. Field Work Results	9
6.1 Boreholes for Proposed Multi-Storey Building	9
6.2 Borehole for Proposed New Access Road	11
6.3 Boreholes for Proposed Health & Wellbeing Precinct.....	11
7. Laboratory Testing	13
7.1 California Bearing Ratio	13
7.2 Reactivity.....	14
8. Proposed Development.....	14
9. Comments	18
9.1 Earthworks	18
9.1.1 Excavations	18
9.1.2 Filling	19
9.2 Vibrations	19
9.3 Traffickability	20
9.4 Groundwater	20
9.5 Batter Slopes.....	21
9.6 Retaining Walls	21
9.7 Foundations	22
9.8 Earthquake Design.....	24
9.9 Proposed Access Road.....	24
9.9.1 Subgrade Design CBR	24
9.9.2 Design Traffic	24
9.9.3 Flexible Pavement Thickness Design.....	25
9.9.4 Material Properties and Compaction Requirements.....	25
9.9.5 Pavement Drainage.....	26
10. References	26
11. Limitations	26
Appendix A:	About this Report
	Drawing 1 – Location of Tests
Appendix B:	Sampling Methods
	Soil Descriptions
	Rock Descriptions
	Symbols & Abbreviations
	Results of Field Work
Appendix C:	Results of Laboratory Tests

Report on Geotechnical Investigation

Proposed Gosford Hospital Redevelopment

Holden Street, Gosford

1. Introduction

This report presents the results of a geotechnical investigation undertaken by Douglas Partners Pty Ltd (DP) for the proposed redevelopment of Gosford Hospital. The investigation was commissioned by Health Infrastructure, and was carried out in consultation with Aurora Project, project managers, and Taylor Thomson Whitting, structural engineers.

A major extension to, and reconfiguration of Gosford Hospital is proposed, with a multi-storey building to be built in the north-western portion of the hospital site. As part of this project, DP undertook a geotechnical investigation and contamination assessment to provide information on site conditions for planning and design purposes. The work also included preliminary assessment of land for Stage 1 of the proposed Health & Wellbeing Precinct which will be to the east of the existing hospital.

It is understood that the hospital redevelopment will comprise the following:

- Demolition of several existing hospital buildings within an area broadly bounded by Racecourse Road to the north-west, Hospital Road to the south-east, and an existing Health Services Building to the north-east; followed by
- The construction of an 11 storey building connecting to the northern end of the existing main hospital building; and
- Development of Stage 1 of the Health & Wellbeing Precinct comprising a multi-level carpark (800 cars) office buildings and related retail for health and Government related uses.

The geotechnical investigation and contamination assessment focused primarily on the area of the proposed multi-storey hospital expansion, although, additional investigations were also undertaken within several hospital-owned properties within the Health & Wellbeing Precinct to provide preliminary information for future redevelopment planning.

Geotechnical investigation was carried out to provide information and advice on:

- Subsurface conditions including depth to bedrock and groundwater;
- Earthworks including excavation conditions and equipment;
- Vibration controls and monitoring;
- Traffickability during construction;
- Safe batter slopes and excavation support;
- Founding systems including design parameters and construction issues;
- Requirements for certifying of founding conditions during construction;
- Earthquake design parameters in accordance with AS 1170.4 (Ref 1); and
- Pavements

The geotechnical investigation comprised the drilling of cored boreholes within the areas of the proposed multi-storey building, a proposed expansion into the ambulatory care bay; and in hospital land along the eastern side of Holden Street. The boreholes included in situ testing and the collection of soil and rock samples for subsequent laboratory testing. The details of the field work and laboratory tests are presented in this report, together with comments relating to the issues listed above.

To assist with the investigation, DP was periodically provided with draft concept drawings showing the general layout of the proposed building, with more detailed concept design drawings issued at the time of preparing this report. The most recent concept drawings were prepared by Jacobs, and are identified as:

- Drawings NB98078-ECA-DG-1003 to NB98078-ECA-DG-1016 inclusive, showing a site plan and layout of each level of the proposed building; and
- Drawings NB98078-ECA-DG-10100 to NB98078-ECA-DG-10107 inclusive, showing sections and elevations through the building.

The above drawings were all noted as Revision 4 and dated 26 September 2014.

It is noted that the environmental investigation was carried out concurrent with the geotechnical investigation and is reported separately.

2. Site Description

Gosford Hospital is located on the crest of a low hill to the north-west of the Gosford Central Business District. It occupies an irregular shaped area of approximately 10 ha, and is generally bounded by Holden Street, Ward Street, Cape Street North, Beane Street West and Racecourse Road, however, parts of the hospital grounds extend beyond Holden Street to the east. The Main Northern Railway runs in a north-south direction between the hospital and Gosford CBD.

Figure 1 on the following page shows the location of the hospital and surround features including 2 m elevation contours showing the general landform.

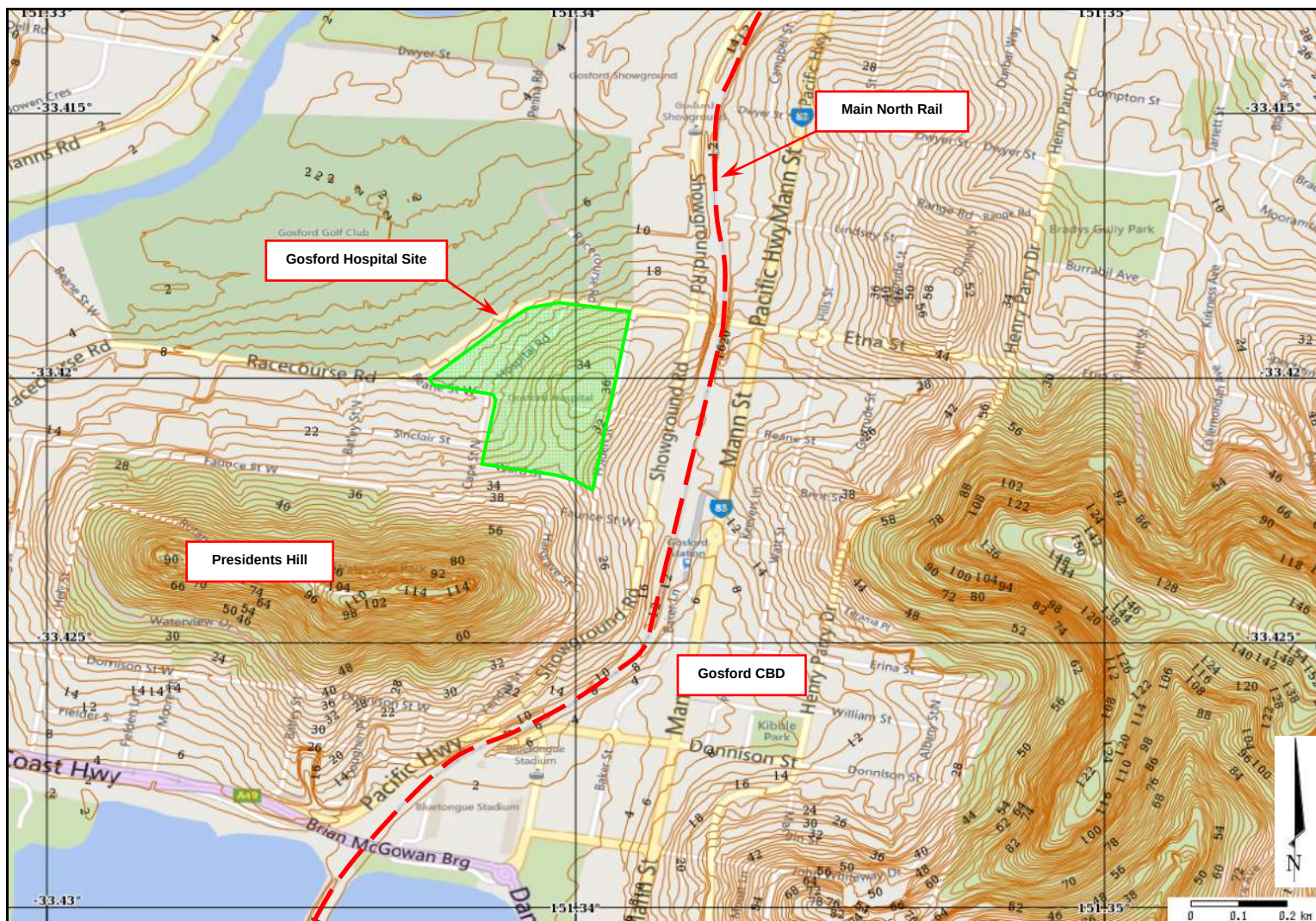


Figure 1: Site Location

(Image sourced from Microsoft Virtual Earth with 2m elevation contours)

Gosford Hospital is generally situated on the crest and flanking slopes of a north-trending spur of Presidents Hill. Natural slopes in the locality of the site are typically flat at the ridge crest (approximately RL 32 m relative to Australian Height Datum (AHD)) and then sloping down at gradients of 5 – 20% towards Holden Street (eastward), Racecourse Road (north-westward) and Cape Street North (westward).

It is understood that the main redevelopment is proposed in the following areas:

- The proposed main redevelopment area is located to the north-west of the hospital complex and estimated to be approximately 1.6 ha. It comprises parts of Lot 100 in Deposited Plan (DP) 1028293, Lot 1 in DP 246244, Lot 101 in DP 1034362 and Lot 1 in DP 1076023. Existing site features comprising several hospital buildings (Pathology Building, Education Centre, Harry Mattocks Building, and IT Department Information Systems Building), internal roads (Hospital Road), car parking and staff amenity/recreation facilities. Surface gradients typically slope down to the north-west, with surface levels falling from about RL 28 m within a turning loop to the south-west of the existing Pathology Building, down to about RL 16 m along the north-western edge of the proposed building, a vertical difference of about 12 m.
- A proposed access road off Holden Street is estimated to be approximately 2,000 m², and is identified as part of Lot 100 in DP 1028293. Existing site features comprise a four storey brick building (LHD Administration Building) with surrounding landscaping and access walkways. Surface gradients typically slope down to the north-west, with average surface gradients estimated to be approximately 15%.
- An area of potential expansion into the Main Building entrance area is estimated to be approximately 2,000 m². The area is identified as part of Lot 100 in DP 1028293. Existing site features comprise part of the existing Main Building (i.e. Accident and Emergency), and ambulatory care and patient car parking bays. This area is relatively level and at about RL 32 m. The main patient parking area comprises an asphalt car park whereas the ambulance parking area has a concrete pavement.

In addition to the main multi-storey development within the north-western portion of the hospital, future development is earmarked for land located on the eastern side of Holden Street (referred to as the proposed 'Health & Wellbeing Precinct'). This land includes numerous cottages/dwellings that have been acquired by the hospital for ancillary services. It also includes existing on-grade carparks adjacent to Racecourse Road and Beane Street West, and the former psychiatric department (Mandala Clinic) near the intersection of Ward Street. This area generally slopes down to the east at gradients of about 20%.

The main redevelopment area is identified in Figure 2, with a closer view given in Figure 3.

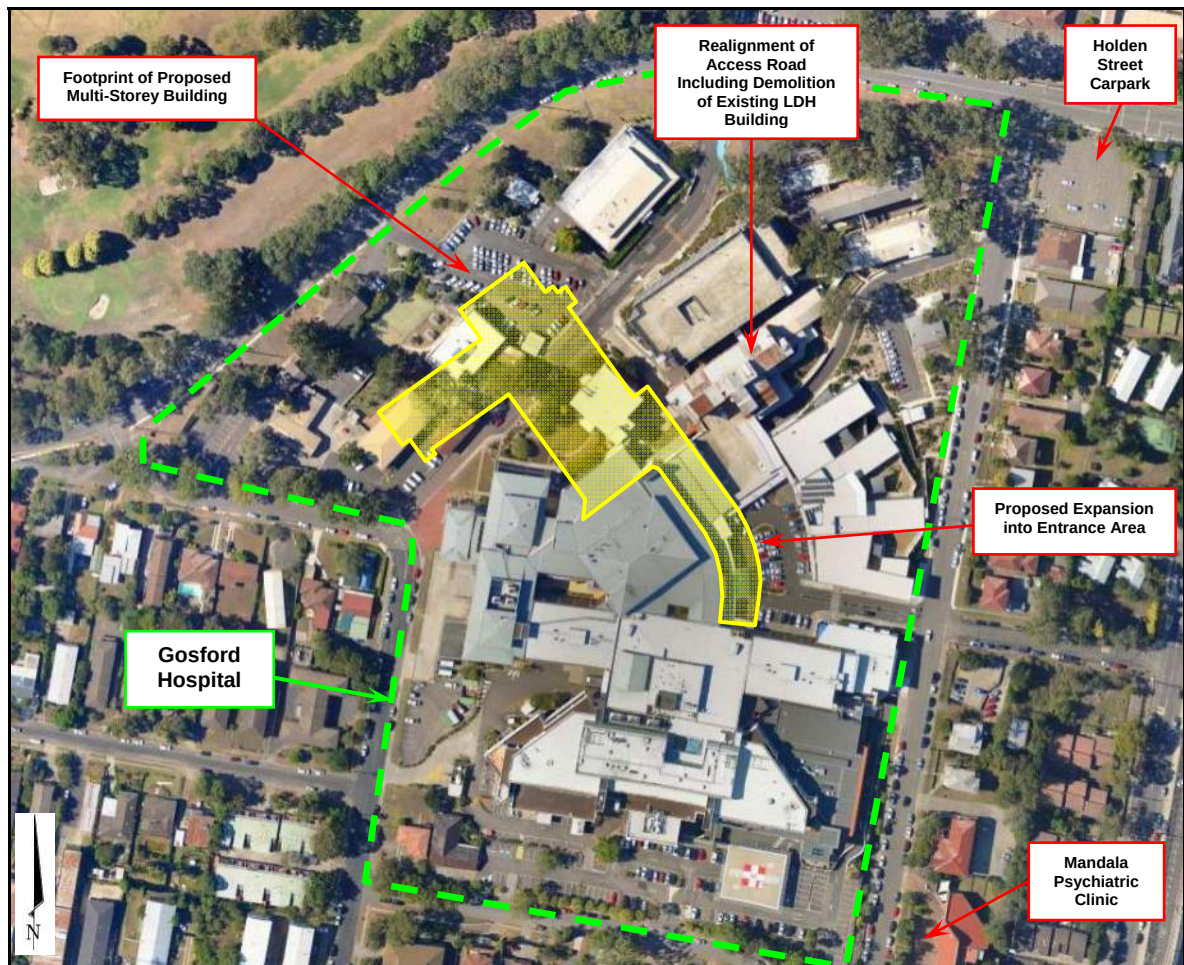


Figure 2: Aerial view of the hospital site showing area of proposed development.

(Images sourced from Nearmap Photomaps and dated 9 February 2014)



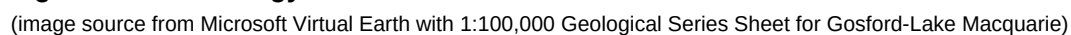
Figure 3: Closer aerial view site showing proposed development area.

(Images sourced from Nearmap Photomaps and dated 9 February 2014)

3. Regional Geology

The provisional 1:100,000 scale Geological Series Sheet for Gosford-Lake Macquarie indicates that the site is underlain by rocks of the Terrigal Formation (Rnt – refer to Figure 4) of the Narrabeen Group. The Terrigal Formation typically comprises sandstone, siltstone, claystone and conglomerate, and weathers to form medium and high plasticity clays.

The geological mapping also shows that an area of Quaternary Alluvium (Qa – refer to Figure 4) associated with the Narara Creek floodplain is located about 150 - 200 m further to the north-west of the main development site.



4. Previous Investigations

- Report on Geotechnical Investigation for Gosford Hospital Redevelopment prepared by Coffey Geosciences Pty Ltd, dated 3 September 2001 (Coffey Ref: GO1236/1-AB);
- Report on Geotechnical Investigation for Central Coast Regional Cancer Centre and Car parks, Gosford Hospital, prepared by RCA Australia, dated 18 February 2011 (RCA Report Ref: 8296-201/1); and
- Report on In situ Waste Classification – Site D, Gosford Hospital, prepared by Coffey Environments Australia Pty Ltd, dated 6 April 2011 (Coffey Report Ref: ENAUWARA04052AB-L01).

In addition to the reports listed above, DP also reviewed report files sourced from DP's project archives. These were:

- Report on Geotechnical Investigation for Proposed Hospital Extensions, prepared by Douglas Partners Pty Ltd, dated 14 February 2003 (DP Report Ref: 34628); and
- Report on Foundation Conditions for Proposed Extensions to Gosford District Hospital, prepared by Douglas Partners Pty Ltd, dated 13 July 1976 (DP Report Ref: SSI/1-5317).

A desktop review of these reports was carried out prior to undertaking the current geotechnical investigation. Comments regarding expected subsurface conditions in the area of the proposed multi-storey hospital building were provided in a report dated July 2014 together with preliminary comments relating to design and construction.

Relevant information from the previous investigations has been used in the preparation of the current report.

5. Field Work Methods

The field work for the current geotechnical investigation comprised the following main activities:

- Drilling of nine boreholes (Bores 1 – 9) in the area of the proposed multi-storey building. Bores 1, 2, 4, 6 and 8 were taken to target depths of 10 m into rock, whereas Bores 3, 5 and 7 were taken to target depths of 5 m into rock. Bore 9 was drilled near the Ambulatory Car Bay and was taken 3 m into the rock. Measured from the ground surface, the total depth of these boreholes ranged from 4.18 m (Bore 9) to 14.9 m (Bore 6).
- Drilling of nine boreholes (Bores 101 – 109) within various properties to the east of Holden Street. Bores 101, 103, 104, 105, 107 and 109 had a target of 3 m into the rock profile, whereas Bores 102, 106 and 108 had targets of 10 m into rock. The total depth of these boreholes ranged from 4.0 m (Bore 109) to 18.07 m (Bore 105).

These boreholes were drilled using a combination of 100 mm diameter spiral flight augers (SFA) within the soil profile and then NMLC diamond coring within the underlying rock profile. The approximate locations and target depths of the boreholes were nominated by TTW, structural engineers. The purpose of these boreholes was mainly to obtain information on the depth and strength of rock. Standard penetration tests (SPTs) were carried out at 1.5 m depth intervals to provide information on the relative strengths and densities of the soils encountered.

In addition to the cored boreholes, a borehole (Bore 28) was undertaken adjacent to the existing LDH building. Due to access restrictions, this was drilled using a 75 mm diameter hand auger and was taken to 0.75 m depth. This borehole was drilled in conjunction with several other boreholes (Bores 10 – 29) scattered throughout the hospital site for contamination assessment purposes. From a geotechnical perspective, Bore 28 was carried out to provide information on subgrade conditions for a proposed new access road.

Conditions encountered in the boreholes were logged by a geotechnical officer from Douglas Partners who also directed sampling together with in situ testing of the soil profile. Rock core recovered from the boreholes was placed into steel core trays, after which it was photographed prior to undertaking destructive point load strength testing on various sections of the rock. The core was then transported to DP's Tuggerah office for storage.

As part of the contamination assessment, groundwater monitoring wells were installed to approximately 6 m depth in Bores 6, 12, 22 and 30. Monitoring wells were also installed in Bores 103 and Bore 108 to the east of Holden Street as part of the geotechnical investigation.

The locations of the geotechnical boreholes are shown on Drawing 1 included in Appendix A.

For detailed information on the boreholes drilled as part of the contamination assessment, reference should be made to that report (Report 75799.01).

Surface levels at the bore locations were interpolated from spot elevations shown on a set of detailed survey plans produced by Trehu Ingold Neate.

6. Field Work Results

Details of the conditions encountered in the boreholes are given in the borehole logs in Appendix B. These logs should be read in conjunction with the explanatory notes, which define the descriptive terms and classification methods.

6.1 Boreholes for Proposed Multi-Storey Building

Bores 1 – 8 were drilled in the area of the proposed multi-storey hospital building to the north-west of the existing main building. The subsurface conditions encountered in these boreholes are broadly summarised in order of depth as follows:

- **FILLING** - associated with vehicular pavements and comprising either two coat seal or asphalt wearing course overlying roadbase gravel. The total thickness of the pavement materials ranged from 0.2 m to 0.6 m depth. At Bore 5, the pavement was underlying by gravelly clayey silty sand filling to 0.6 m depth. Filling was not encountered at Bore 1.
- **COLLUVIUM** - topsoil and silty sand present at Bore 1 to 0.45 m depth and at Bore 4 below pavement materials from 0.25 – 0.6 m depth.
- **RESIDUAL SOIL** - mainly stiff then very stiff clay, silty clay or sandy clay. These soils extended to depths of about 2 – 3 m, but were only to about 1.4 m depth at Bores 7 and 8 which were drilled along Hospital Road.
- **EXTREMELY or HIGHLY WEATHERED SANDSTONE AND SILTSTONE** - generally extremely low and very low strength sandstone and siltstone with some low, medium or high strength iron-cemented (ferruginous) bands. This material was encountered in all of the boreholes drilled in the area of the proposed multi-storey building.

- MODERATELY WEATHERED TO FRESH SANDSTONE - medium or high strength sandstone encountered in each of the five deeper cored boreholes (Bores 1, 2, 4, 6 and 8) and at depths below 5.9 m (Bore 1) to 11.2 m (Bore 8).

Conditions at Bore 9 that was drilled in the area of the Ambulatory Care Bay were different from those at the other eight boreholes, with the strength of the near surface rock layers stronger than those at the other eight locations. At this location, subsurface conditions comprised pavement materials to 0.3 m depth overlying silty sand filling to 0.6 m depth. This was underlain by low to medium strength siltstone to 1.9 m depth and then medium to high strength sandstone to 4.18 m depth.

No free groundwater was observed in any of the nine boreholes during the course of drilling, however, the introduction of drilling fluid during the rock coring process precluding such observations. Stabilised groundwater was observed within the four environmental monitoring wells during a subsequent visit to site several days after completion of drilling, at which time groundwater was measured at depths of 1.8 – 2.4 m below the ground surface.

A summary of the rock profile encountered in the boreholes is presented in Table 1.

Table 1: Summary of Bedrock Profile

Test Location	Surface Level at Test Location (m AHD)	Depth to Top of Extremely and Highly Weathered Rock (m)	Depth to Top of Moderately Weathered to Fresh Rock (m)	Elevation Top of Extremely and Highly Weathered (m AHD)	Elevation of Top of Moderately Weathered to Fresh Rock (m AHD)
Bore 1	16.2	3.1	5.9	13.1	10.3
Bore 2	18.1	2.1	7.8	16.0	10.3
Bore 3	19.4	3.1	N/E	16.3	N/E
Bore 4	16.8	3.0	7.3	13.8	9.5
Bore 5	18.7	3.0	N/E	15.7	N/E
Bore 6	20.2	2.0	10.3	18.2	9.9
Bore 7	21.1	1.3	N/E	19.8	N/E
Bore 8	21.5	1.45	11.2	20.05	10.3
Bore 9	32.0	0.6	1.9	31.4	30.1

N/E = Not Encountered in Borehole.

Groundwater observations from the four wells installed in the area of the proposed multi-storey hospital building as part of the contamination assessment are presented in Table 2.

Table 2: Groundwater Observations

Test Location	Surface Level at Test Location (m AHD)	Date of Groundwater Observations	Depth to Groundwater from Ground Surface (m)	Approximate Elevation of Standing Groundwater (m AHD)
Bore 6	20.2	19.09.2014	2.4	17.8
Bore 12	13.0	19.09.2014	2.3	10.7
Bore 22	15.2	19.09.2014	1.8	13.4
Bore 30	17.2	19.09.2014	2.3	14.9

It should be noted that groundwater levels are affected by factors such as soil permeability and rainfall and therefore vary over time.

6.2 Borehole for Proposed New Access Road

Bore 28 was drilled near the existing LDH Administration Building and encountered silty sand filling to 0.1 m depth overlying clay filling to 0.4 m depth then very stiff natural clay. Drilling was terminated due to auger refusal at 0.75 m depth on weathered rock.

A bulk sample of the natural clay was collected from 0.5 – 0.75 m depth at this location.

No free groundwater or seepage was observed prior to backfilling of this borehole.

6.3 Boreholes for Proposed Health & Wellbeing Precinct

Bores 101 – 109 were scattered throughout various properties along the eastern side of Holden Street, with one of the boreholes (Bore 105) drilled within a property off Showground Road.

The subsurface conditions encountered in these boreholes are broadly summarised in order of depth as follows:

- **FILLING** – up to 0.3 m depth in five of the boreholes, and to about 1 m depth at Bores 101 and 106. The filling was associated with existing pavements at Bores 102, 106 and 107. No filling was encountered at Bores 104 and 105.
- **COLLUVIUM** - topsoil or silty sand present at Bores 104, 105 and 107 only, and as a 0.1 - 0.2 m thick layer.
- **RESIDUAL SOIL** - mainly stiff then very stiff clay, silty clay or sandy clay. These soils extended to about 0.6 m depth near the high point along Holden Street (Bore 109) increasing to typically about 2 - 4 m depth both northward and southward away from Bore 109. The residual soils were

significantly deeper at Bores 105 and 106 located on the southern parts of the site, where they were encountered to depths of 10.1 m and 7.0 m, respectively.

- **EXTREMELY or HIGHLY WEATHERED SANDSTONE AND SILTSTONE** - generally extremely low and very low strength sandstone and siltstone with some low, medium or high strength iron-cemented (ferruginous) bands. This material was encountered in all of the boreholes drilled in the area to the east of Holden Street, with most of the cores being wholly within this material.
- **MODERATELY WEATHERED TO FRESH SANDSTONE** - as with the boreholes drilled for the multi-storey hospital building, moderately weathered to fresh sandstone, medium or high strength sandstone was encountered in the deeper cored boreholes (Bores 102, 106 and 108). This was generally at depths below about 8 – 10 m.

The main difference to the generalised profile given above was at Bores 108 and 109 which were drilled nearest the high point along Holden Street. At this locations, the upper sequences of the bedrock were stronger, comprising medium and high strength sandstone. This was probably a capping over weaker rock layers, as indicated by the presence of very low and low strength sandstone below 4.1 m depth at Bore 108.

Free groundwater was not observed whilst auger drilling at any of the nine boreholes located east of Holden Street, and the introduction of water with the conversion to NMLC coring precluded any further such observations during the course of drilling. During a later visit to site, stabilised groundwater was measured within the standpipes at Bores 103 and 107 at 2.8 m and 2.6 m depth, respectively. It is noted that groundwater levels are affected rainfall and therefore vary over time.

A summary of the rock profile encountered in the boreholes drilled to the east of Holden Street is presented in Table 3.

Table 3: Summary of Bedrock Profile

Test Location	Surface Level at Test Location (m AHD)	Depth to Top of Extremely and Highly Weathered Rock (m)	Depth to Top of Moderately Weathered to Fresh Rock (m)	Elevation Top of Extremely and Highly Weathered (m AHD)	Elevation of Top of Moderately Weathered to Fresh Rock (m AHD)
Bore 101	25.0	1.7	N/E	23.3	N/E
Bore 102	24.0	0.7	8.5	23.3	15.5
Bore 103	17.9	3.5	N/E	14.4	N/E
Bore 104	18.8	3.6	N/E	15.2	N/E
Bore 105	10.3	10.1	N/E	0.2	N/E
Bore 106	18.7	7.0	10.0	11.7	8.7
Bore 107	25.4	2.8	N/E	22.6	N/E
Bore 108	29.3	1.2	9.7*	28.1	19.6
Bore 109	31.3	1.0	N/E*	30.3	N/E

N/E = Not Encountered in Borehole.

* Upper layer of medium or high strength sandstone encountered above this depth (refer to earlier comments).

7. Laboratory Testing

Laboratory testing was carried out to provide information on the geotechnical properties of the subgrade materials for pavement design purposes, and also to provide information on the reactivity of the natural residual clay soils.

The various laboratory tests carried out for this project are described below, along with the results of the tests and relevant results from previous investigations. Detailed results of the laboratory tests and test certificates are given in Appendix C.

7.1 California Bearing Ratio

Bulk samples of the subgrade material from Bores 1, 8 and 28 were submitted to Douglas Partners' NATA accredited soils and aggregate testing laboratory for measurement of compaction properties and California bearing ratio (CBR). The samples were taken from approximately about 0.5 – 0.9 m depth at each of these locations.

The samples were compacted to approximately 100% Standard dry density ratio at the estimated optimum moisture content. They were then soaked for four days under a surcharge loading of 4.5 kg prior to testing. A summary of the results of this testing is given in Table 4, below.

Table 4: Summary of California Bearing Ratio Tests

Sample Location	Depth (m)	Description	Field Moisture Content (%)	MDD (t/m ³)	OMC (%)	CBR (%)
Bore 1	0.6 – 0.9	Brown SANDY CLAY	17.9	1.85	14.2	9
Bore 8	0.6 – 1.0	Light grey and red brown SILTY CLAY	14.2	1.89	14.1	3
Bore 28	0.5 – 0.75	Light brown CLAY	22.0	1.67	21.0	8

Note: MDD = maximum dry density OMC = Optimum moisture content CBR = California bearing ratio

It is noted that the sample from Bore 8 exhibited a 3.7% swell following the four day soaking period for the CBR test.

Previous laboratory testing carried out by Coffey Geoscience in 2001 returned CBR values 3.5% and 5% for two samples of high plasticity residual sandy clay, and a CBR value of 15% on a sample of low plasticity gravelly sandy clay. The Coffey report noted that the low plasticity clay sample with the higher CBR value was sampled closer to the level of the underlying weathered rock than were the other two samples.

7.2 Reactivity

Undisturbed samples of the natural clay soils were taken from Bores 3, 4 and 5 in the area of the proposed multi-storey building and submitted to Douglas Partners' NATA accredited soils and aggregate testing laboratory for testing of shrink-swell index. A summary of the results of the testing is given in Table 5 below. Pocket penetrometer readings were taken prior to and following soaking to assess the change in strength between these moisture conditions.

Table 5: Summary of Shrink-Swell Index Testing

Sample Location	Sample Depth (m)	Description	I_{ss} (% per ΔpF)	Initial Pocket Penetrometer Reading (kPa)	Final Pocket Penetrometer Reading (kPa)
Bore 3	1.0 – 1.45	Orange brown CLAY	1.5	240	220
Bore 4	1.5 - 1.95	Orange brown SANDY CLAY	1.4	400	310
Bore 5	1.0 - 1.4	Orange brown CLAY	1.3	400	380

Note: I_{ss} = Shrink-swell index

This testing indicates that the residual clay soils at the site are moderately reactive.

8. Proposed Development

It is understood that the main hospital redevelopment will comprise the following:

- An eleven (11) storey building extending out to the north-west of the existing main hospital building. Based on information provided by TTW, column working loads for this building are expected to be in the order of 7000 - 8000 kN.
- Levels 1 and 2 of the proposed building will be below the level of the adjoining existing building, with Level 1 having a design floor level at RL 19.65 m.
- Excavations for the building will be to depths of between 1 m and 3 m along Hospital Road, increasing to about 6 m as the proposed two lower levels (Levels 1 and 2) extend back into the slope towards the existing main building. The excavation for the proposed building is expected to be about 6 - 15 m away from other nearby buildings (existing multi-storey carpark and existing main hospital building). Floor levels for the lower level of the existing buildings in the vicinity of the proposed excavation are as follows:
 - Pathology Building RL 22.8 m
 - Multi-storey Carpark RL 23.25 m
 - Main Hospital Building (Existing Specialist Clinics and Oncology Department) RL 28.05 m
- Filling is expected to be carried out to raise site levels at the northern end of the proposed building, given that Level 1 for the proposed building will be at RL 19.65 m and that existing

ground surface levels in this area are as low as RL 15.5 m. It is noted that the south-western end of the building will have an even lower level (Level 0) at RL 15.45 m which will include a plant room and detention tank.

- About 1 – 1.5 m of filling is also expected to be placed within the region between the existing main building and Level 2 of the proposed building.
- Buildings to be demolished to make way for the proposed redevelopment include:
 - Pathology Building (4 storeys)
 - LHD Administration Building (4 storeys)
 - Harry Mattocks Building (2 storeys)
 - Education Centre Building (2 storeys)
 - IT Department Information Systems Building (two storeys)
 - 'Nunyara' Aboriginal Health Building (single storey cottage)
 - Fleet Services Office (single storey portable building)
- Levels 4 and 5 of the proposed building will extend southward into the existing Emergency Department and Ambulatory Care parking area. The floor level for the proposed extension in this area will be close to the level of the existing vehicular pavement, hence no significant cutting or filling is required in this area.
- Realignment and extension of an existing access road from Holden Street following the demolition of the LDH Building. This will become the Emergency Department Main Entry.

The footprint of the proposed multi-storey hospital building is shown in Figure 5. Figures 1 and 2 presented earlier in this report also show the outline of the proposed building overlaid onto aerial photographs of the hospital. Figure 6 shows a cross-section through the proposed building, for the section line shown on Figure 5.

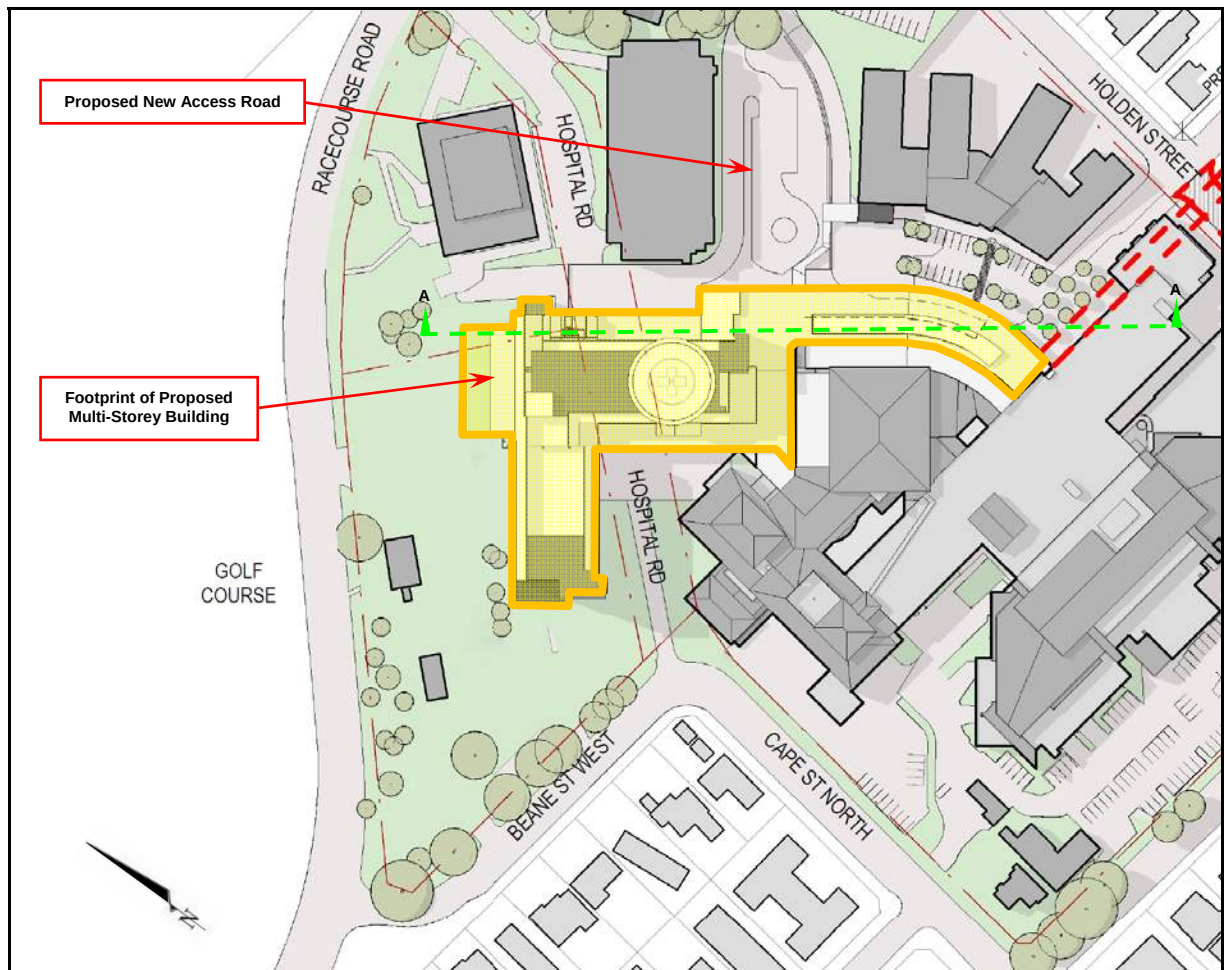


Figure 5: Plan view showing the approximate extent of proposed multi-storey building.

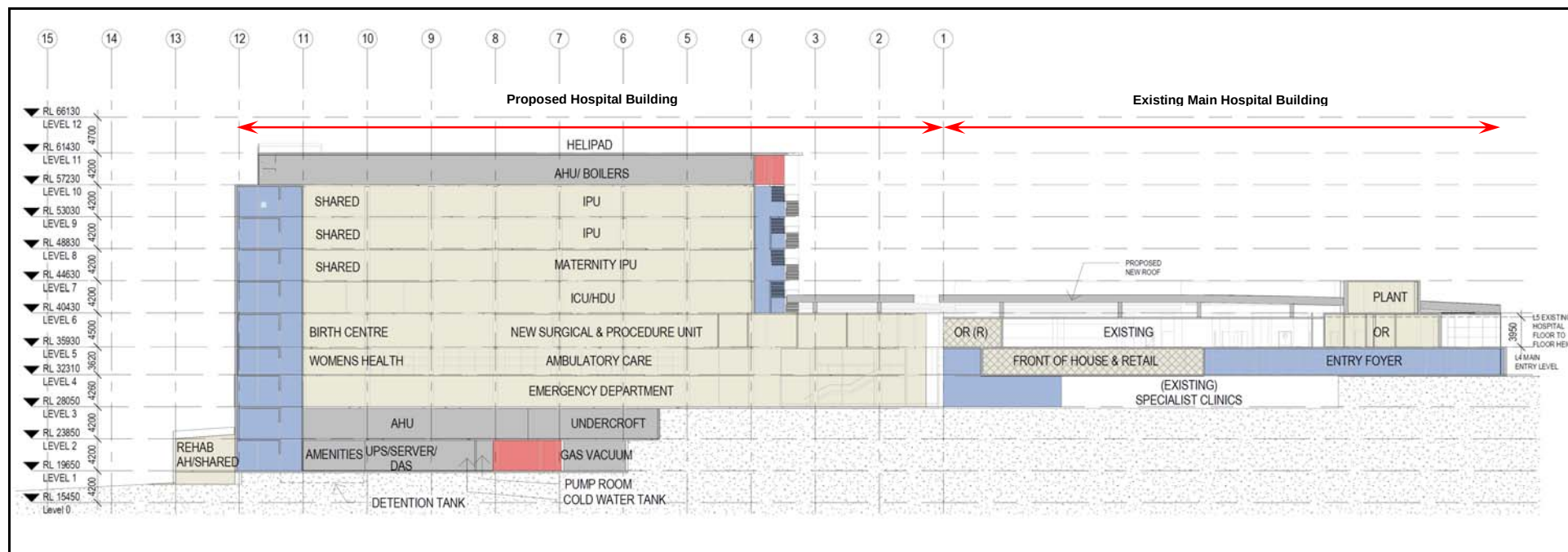


Figure 6: Cross-section A-A through the proposed multi-storey building.

It is understood that the proposed Health & Wellbeing Precinct (HWP) within the area adjacent to Holden Street is only in preliminary planning. Future development within this area may include on-grade carparks or multi-storey parking buildings and/or other hospital buildings. The extent of the development, buildings heights, and areas of cutting and/or filling are not known at this stage.

9. Comments

9.1 Earthworks

9.1.1 Excavations

Excavations for the proposed multi-storey building will generally be confined to the area between Hospital Road and in the existing main hospital building, with a maximum depth of about 6 m to accommodate the Levels 1 and 2 of the proposed building. A plant room, detention tank and lift pit are also proposed below Level 1 (this is identified on the concept plans as 'Level 0'), and this will require localised excavation to about 2 – 3 m depth.

Based on the conditions encountered in the current boreholes by Douglas Partners and those in previous investigation by Coffey, excavations at the site will be mainly within the residual soil profile and the extremely and highly weathered sandstone. Borehole CG-10 was drilled during the 2001 investigation to the rear (south-east) of the existing Pathology Building and encountered filling overlying residual soils then extremely weathered sandstone, with this borehole terminated at 3.8 m depth (RL 25.5 m) due to refusal of the tungsten carbide (TC) auger bit.

The extremely and highly weathered sandstone is generally characterised by extremely low and very low to low strength sandstone and siltstone with some low, medium or high strength iron-cemented (ferruginous) bands. The thickness of the ferruginous bands typically range from about 100 - 300 mm, however, in some parts they were found to be more than 500 mm thick. Based on the results of the current investigation, it appears that Bore CG-10 was terminated due to TC-bit refusal on a medium or high strength ferruginous band within the extremely and highly weathered sequences, rather than on the moderately to fresh sandstone that was encountered at greater depths in the deeper cored boreholes.

Excavation within the soil profile and extremely and highly weathered rock is expected to be able to be carried out using hydraulic excavators of about 20 tonne fitted with digging buckets. Ripping into stronger ferruginous bands (eg medium or high strength bands) may present some difficulty and require the assistance of a ripping tyne, or, in the event of encountering the thicker ferruginous bands, a hydraulic rock hammer. Hammers would likely be required for the removal of the stronger bands encountered within detailed excavations.

The above comments relating to excavatability are for guidance only. Civil contractors should undertake a thorough review of the available information before selecting equipment, and this may also be based on their methods and operator skill.

9.1.2 Filling

Filling should be placed and compacted in accordance with AS 3798 – 2007: *Guidelines on Earthworks for Commercial and Residential Developments* (Ref 2).

The following measures with respect to placing filling should be adopted for this project:

- Strip any vegetation and remove root networks;
- Strip any topsoils and existing filling (unless existing filling can be established as 'controlled' engineered filling) to expose the underlying residual clay soils;
- Roll the exposed subgrade using a roller having a deadweight of at least 12 tonnes (as per the requirements of AS 3798 (Ref 2), with a final pass ('test' roll or 'proof' roll) carried out in the presence of a geotechnical engineer to check for any unsuitable material such as soft or compressible areas. Unsuitable material should be removed and replaced with approved filling.
- Place filling on the prepared subgrade in horizontal layers with maximum loose thickness of 250 mm. Each layer of filling should be compacted as follows:
 - 100% Standard density ratio under vehicular pavements (top 0.5 m of subgrade formation)
 - 98% Standard density ratio under structures and at depth below vehicular pavements
 - 95% Standard density ratio elsewhere
 - Moisture contents maintained within 2% of the Optimum Moisture Content for Standard compaction.
- Where filling is to be placed on a slope, the slope should be progressively benched to allow the filling to be carried out in near horizontal layers of filling. Material cut from the slope to form the bench could then be used as filling for the upcoming layer.

Measures should be adopted to protect exposed areas from becoming excessively wet as a result of rainfall. This should include grading of the areas to facilitate shedding of water, and ensuring that materials are not left in a loose state when rain is expected.

9.2 Vibrations

Where excavation is able to be carried out using buckets and tynes, vibrations generated by the excavation process are expected to be relatively low. Notwithstanding this, the magnitude of the vibrations is also affected by other activities including the tracking of machinery and the use of compaction equipment such as vibrating rollers.

The effects of such vibrations depends on several factors including the distance to the structure(s), type and size of the building, type of foundations, and sensitivity of occupants and equipment within the building.

It is considered that the most sensitive of the structures in proximity to the proposed excavation would be the existing main hospital building. This appraisal assumes that all buildings that are to be demolished as part of the hospital redevelopment, are vacated prior to commencing construction works (including demolition and excavation). The main hospital building in the vicinity of the proposed building was constructed in 2002 - 2003 and is of reinforced concrete construction (rather than brick construction common to many of the older buildings at the site). It is expected that this would tolerate vibrations associated with excavation and tying with negligible damage eventuating. Rock hammers and vibratory rollers are expected to present the greatest potential for damaging vibrations, and where sensitive structures or equipment are located nearby, it is common practice to install vibration sensors together with an alarm system to allow vibrations to be monitored and to manage construction activities. In some instances, it may also be prudent to conduct trials with the various construction machinery to determine if vibration levels are potentially damaging – the threshold levels for which would be determined following an assessment of the buildings and hospital equipment and discussions with hospital and construction personnel.

9.3 Traffickability

During and following bulk earthworks, the building footprint will essentially be wholly within residual clay soils and, where excavations are more than about 1 – 2 m deep, extremely and highly weathered sandstone and siltstone.

Shrink-swell index tests carried out on samples of the residual clays returned values of about 1.5% per ΔpF , whilst several current and previous CBR tests had reported swells in the range of 3.7% to 4.9%, with CBR values as low as 3%. Based on these results, and previous experience with similar soils in the local area, it is expected that the clays and the extremely low strength rock (particularly siltstone layers) would be prone to moisture related softening and fretting. In such circumstances, traffickability of the site would be adversely affected.

Bulk excavation is not likely to generate any significant quantity of good quality material that could be used as a durable trafficking surface. Therefore, granular material such as ripped medium strength sandstone or crushed concrete, would likely need to be imported to facilitate access, particularly in high traffic areas. A layer of such material about 100 – 200 mm thick would normally be required for this purpose.

9.4 Groundwater

Groundwater was observed within about 2 m of the ground surface in all of the monitoring wells installed in the area of the proposed multi-storey building. Given that excavation into the slope will be to depths of up to 6 m, groundwater seepage zones would probably be encountered during the bulk excavation. Accordingly, long term measures to control groundwater should include the installation of underslab drainage lines to remove any seepage that migrates beneath the building. Intercepted seepage should be diverted away (downslope) from the building. The floor slab should also be waterproofed.

During construction, seepage flows into the excavation are expected to be relatively low, and likely to be managed by either a cut-off drain at the rear of the excavation, or by pumping of accumulated water from a purpose dug sump.

9.5 Batter Slopes

Based on the depths of the proposed excavations and distance to existing buildings, it is expected that the sides of the excavation would be temporarily battered prior to the construction of retaining walls in front of the excavation.

Recommended temporary and long-term batter slopes are provided in Table 6.

Table 6: Recommended Batter Slopes

Material	Temporary Batters	Long-Term or Permanent Batters
Existing filling, new filling and colluvial soils	1.5H:1V	2H:1V
Stiff or very stiff residual clay soils	1H:1V	2H:1V
Extremely or highly weathered siltstone or sandstone	0.75H:1V	2H:1V

Where excavations exceed 3 m, in addition to the batters given above, 1 m wide horizontal benches should be provided at approximately 2 m vertical intervals. Notwithstanding these comments on excavation stability, the civil contractor or builder undertaking the work should comply with statutory requirements with regard to workers within excavations.

Permanent batters should be protected against erosion by the establishment of vegetation and provision of adequate surface drainage. Concentrated runoff flows should not be permitted to travel down the face of the batter, rather, they should be diverted away from the slope.

9.6 Retaining Walls

It is expected that retaining walls for Levels 1 and 2 will each be up to 4.2 m high. Design of retaining walls prior to the installation of lateral restraint, should be based on triangular earth pressure distributions and using the parameters given in Table 7.

Table 7: Retaining Wall Design Parameters - Unfactored

Material	Active Earth Pressure Coefficient, K_a	Passive Earth Pressure Coefficient, K_p	Bulk Unit Weight, γ_b (kN/m³)
Filling and colluvium	0.35	2.5	20
Residual clay soils	0.3	3.0	20
Extremely and highly weathered rock	0.2	5.0	22

Following the construction of the floor slabs connecting to the top of the retaining walls, lateral pressures may redistribute to a trapezoidal distribution. The maximum earth pressure in the trapezoidal distribution is determined using the active earth pressure coefficient multiplied both by the height (H) of the excavation and the unit weight of the retained material. This pressure is applied over the central half of the walls and increases linearly from zero to full pressure over the upper 0.25H, then decreases linearly to zero pressure over the lowest 0.25H.

Retaining walls should include adequate subsurface and surface drainage behind the wall to prevent buildup of water pressure. The subsoil drainage could include a subsoil line and free draining aggregate (10 / 12mm single sized) encapsulated in geofabric. A number of suitable drainage alternatives are provided in Appendix G of AS 4678 - 2002 (Ref 3). Alternatively, the design of the walls should account for the separate hydrostatic pressures behind the walls.

Retaining walls should take into account lateral pressures associated with surcharge loading from structures or machinery adjacent to the wall, including those induced by compacting backfill materials. With regard to the latter, compaction plant used within about 0.6 m of the wall should be limited to lightweight or handheld equipment.

9.7 Foundations

It is understood that the adjoining sections of the hospital building are supported by footings and piles bearing on the rock profile. Given the magnitude of the structural loads associated with this project, it is considered that the building would need to derive support from the underlying moderately weathered to fresh, medium or high strength sandstone.

Due to the depth of the founding stratum below the level of the proposed building, piled footings would be required. Large diameter concrete bored piles are considered to be suitable for this site.

Bored piles could be designed based on the design parameters given in Table 8.

Table 8: Geotechnical Design Parameters for Bored Piles

Founding Strata	Maximum Allowable End Bearing Pressure (kPa)	Maximum Allowable Shaft Adhesion (kPa)	
		Piles in Compression	Piles in Tension
Extremely or highly weathered rock (typically extremely low or very low strength sandstone)	800	80	50
Moderately weathered to fresh rock* (medium or high strength sandstone)	4000*	500*	300*

* Piles designed to found on or within this strata will require careful scrutiny/assessment during piling.

The design values given in Table 8 are based on total settlements of less than 1% of the pile diameter. This can be further refined once specific loads, pile configurations and allowable settlements are known.

For piles designed to include the contribution from shaft adhesion, the design parameters given in the above table are based on sockets having a roughness category R2 or better.

Using these parameters, it is envisaged that twin 1200 mm diameter bored piles founding on the moderately weathered to fresh, medium or high strength sandstone would be required to carry the proposed column loads.

Table 1, presented earlier in Section 6.1 of this report, shows that the moderately weathered to fresh, medium or high strength sandstone was encountered below RL 9.5 m to RL 10.3 m. Allowing for a floor level for Level 1 at RL 19.65 m, piles would be approximately 10 m deep in order to reach this layer.

In order to verify that the piles have been founded on the design founding strata, they should be socketed nominally 0.5 m into the target strata. This is to guard against the possible presence of weaker rock layers close to the expected surface of the design layer.

Given the presence of medium and high strength rock, combined with the length expected for the piles, it is considered a crawler crane piling rig would be required to undertake pile drilling. A cleaning barrel is also recommended for this project.

Bored piles should be inspected by a geotechnical engineer to verify that they have been taken to adequate depth to found on suitable material. Pouring of concrete should not be carried out until the geotechnical engineer has verified that the pile has achieved the design requirements and has been adequately cleaned. On completion of the work, at least 50% of the piles should then be subject to integrity testing. The loss in structural capacity from a defective piles would need to be compensated for, possibly by installing additional/replacement piles, which may also require some redesigning of pile caps.

In the area of the existing Emergency Department and Ambulatory Care Bay, the proposed building will only be two or three storeys high, and structural loads considerably less than those for the multi-storey building. In this area, Douglas Partners Bore 9 and previous Coffey Geoscience Bore CG-13 indicate that bedrock would likely be present immediately below the existing pavement. Shallow pad footings or bored piers founding on at least low strength sandstone or siltstone could be designed based on an allowable end bearing pressure of 1200 kPa.

9.8 Earthquake Design

Sections 3 and 4 of AS 1170.4 – 2007: *Structural Design Actions – Part 4 Earthquake Actions in Australia* (Ref. 1) provides details regarding hazard factors and site sub-soil classes.

Reference to Table 3.2 of AS 1170.4 (Ref. 1) indicates that a hazard factor, Z , of 0.09 would be applicable for earthquake design at this site, as the site would fall under the location of “Gosford”.

Conditions encountered in the boreholes indicate a soil profile consisting of mainly stiff or very stiff clays underlain by weathered siltstone and sandstone at about 1 – 3 m depth. No very soft clay or very loose sand was encountered. 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.

Although the overall depth of the soil profile was relatively greater at Bores 105 and 106, the same earthquake sub-soil classification (C_e) would apply for the area of the proposed HWP.

9.9 Proposed Access Road

It is understood that an existing access road off Holden Street will be realigned and extended through to the proposed multi-storey building following the demolition of the existing four storey LHD Administration Building. It is expected that new filling will be required to reach design subgrade level, following removal of the building together with its footing and floor slabs.

9.9.1 Subgrade Design CBR

Laboratory testing indicates that the residual clay, silty clay or sandy clay soils at the site have soaked CBR values of about 3% - 9%. Assuming that clay soils won from other areas of excavation are to be reused as filling, it is suggested that the pavements be designed based on a subgrade CBR value of 3.5%.

Subgrade preparation should be undertaken in accordance with the methodology given in Section 9.1.2

9.9.2 Design Traffic

Based on a review of geotechnical reports prepared for the previous geotechnical investigations, as described in Section 4, recently constructed flexible pavements at the hospital were designed based

on traffic loads in the range 6×10^4 ESA to 3×10^5 ESA (where ESA = Equivalent Standard Axle repetitions).

Given that the new access road will serve as the main access, a design traffic load of 3×10^5 ESA has been adopted for pavement design purposes. This is the same traffic loading as that suggested by Austroads (Ref 4) for a local access in a light industrial area.

9.9.3 Flexible Pavement Thickness Design

The suggested pavement thickness design for the proposed new access road is presented in Table 9, and is based on the procedures given in AUSTROADS 2012: *Guide to Pavement Technology – Part 2: Pavement Structural Design* (Ref 4), a design subgrade CBR of 3.5%, and subgrade preparation in accordance with Section 9.1.2 of this report.

Table 9: Flexible Pavement Thickness Design

Road	Design Traffic Load (ESAs)	Subgrade CBR (%)	Total Pavement Thickness (mm)	Layer Component		
				Wearing Course (mm)	Basecourse (mm)	Subbase Course (mm)
New Emergency Department Access Road	3×10^5	3.5	420	30mm AC10	150	240

Note: A 7 mm primer seal should be applied over the basecourse prior to placing the asphalt wearing course

9.9.4 Material Properties and Compaction Requirements

Table 10 presents the material quality and compaction requirements for the various pavement layers for the proposed new access road.

Table 10: Material Quality and Compaction Requirements

Layer	Material Quality	Compaction
Asphalt Wearing Course	Conform to RTA Spec R116 with Class 320 Bitumen	RTA Spec R116
Granular Basecourse	Conform to RMS Spec. 3051 with minimum soaked CBR 80%	Minimum 98% Modified Compaction (AS 1289.5.2.1)
Granular Subbase Course	Conform to RMS Spec. 3051 with minimum soaked CBR 50%	Minimum 95% Modified Compaction (AS 1289.5.2.1)
Subgrade	Minimum Soaked CBR of 3.5%	Minimum 100% Standard Compaction (AS 1289.5.1.1)

Geotechnical verification of the work would include conducting an inspection of the subgrade ('test' roll) followed by density testing of each layer at about 20 m spacings. The various pavement layers should be presented for testing immediately after they have been placed and compacted.

9.9.5 Pavement Drainage

The performance of vehicular pavements is highly dependent on maintaining adequate surface and subsurface drainage to maintain the subgrade as close to the optimum moisture content as possible and to ensure that the pavement layers do not become saturated.

Subsurface drainage should be installed at approximately 0.5 m below subgrade level adjacent to pavements. Particular attention should be made to locating subsurface drainage around landscaped areas.

Preparation of subgrade surfaces should be such that adequate cross-falls for surface drainage are achieved across the final pavement.

10. References

1. Australian Standard AS 1170.4 – 2007: *Structural Design Actions – Part 4 Earthquake Actions in Australia*, Standards Association of Australia.
2. Australian Standard AS 3798 - 2007: *Guidelines on Earthworks for Commercial and Residential Developments*, Standards Association of Australia.
3. Australian Standard AS 4678 – 2002: *Earth - Retaining Structures*, Standards Association of Australia
4. AUSTROADS: *Guide to Pavement Technology Part 2: Pavement Structural Design*, Austroads Publication No. AGPT02-12, Austroads Ltd, 2012.

11. Limitations

Douglas Partners (DP) has prepared this report in connection with the redevelopment of Gosford Hospital located at Holden Street, Gosford, NSW in accordance with DP's proposal dated 16 April 2014 and subsequent acceptance received from Mr Dominic Longo of Health Infrastructure. The report is provided for the exclusive use of Health Infrastructure and its agents (Aurora Projects and Taylor Thomson Whitting) 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 geotechnical investigation and report was carried out under a Consultancy Agreement (Contract Number HI14143).

The results provided in the report are indicative of the subsurface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological conditions and also as a result of human activities. 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.

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

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires a risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About this Report

Drawing 1 – Locations of Tests

About this Report

Douglas Partners



Introduction

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

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

Copyright

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

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

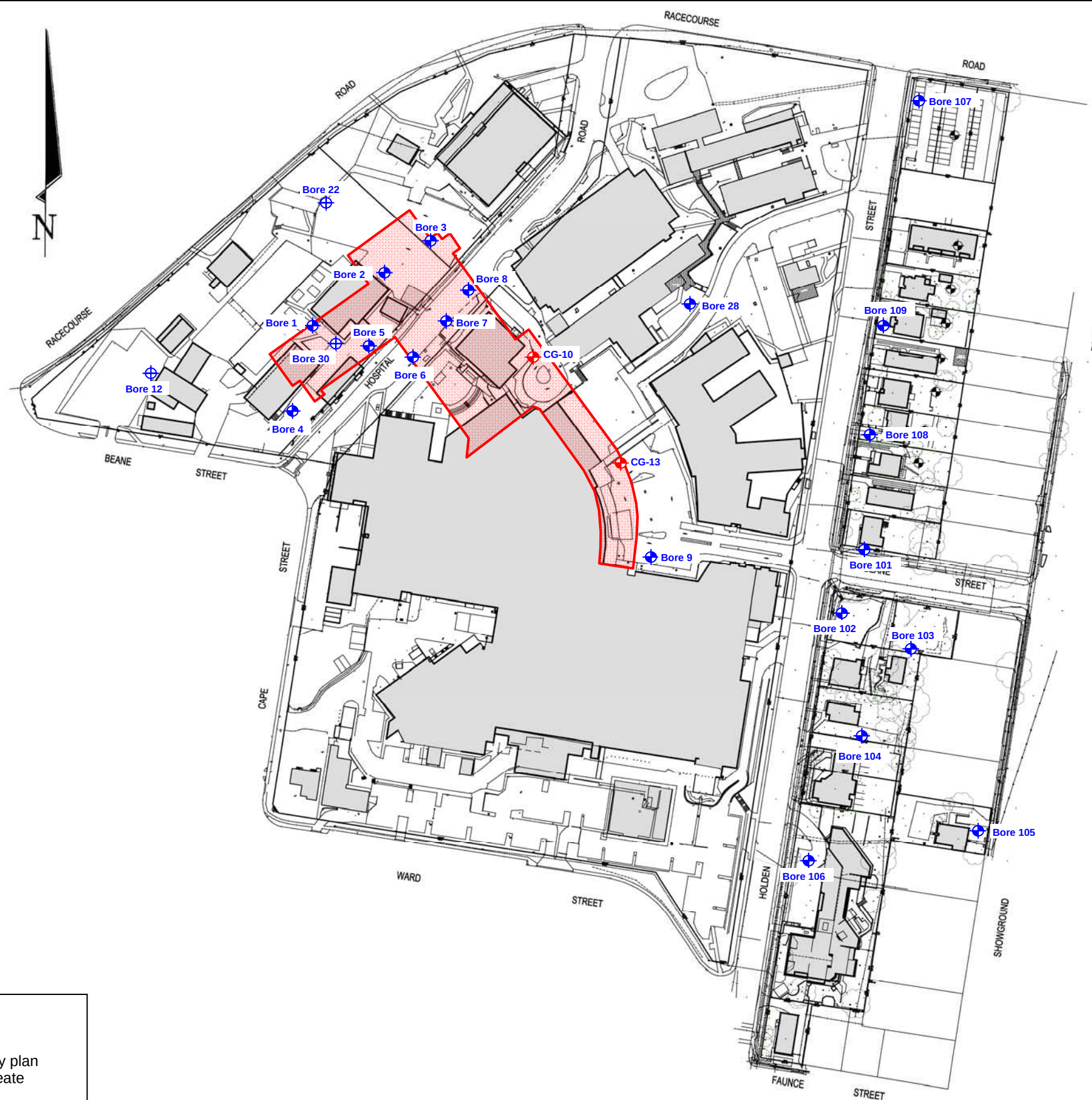
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later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

Information for Contractual Purposes

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

Site Inspection

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



NOTES

- Drawing adapted from survey plan produced by Trehy Ingold Neate

LEGEND

- Location of Current Douglas Partners Borehole
- Location of Monitoring Well (Installed for Contamination Assessment)
- Approximate Location of previous Coffey Geoscience Borehole referenced in DP Report (2001 Investigation)
- Approximate Area of Proposed Multi-Storey Hospital Building

Appendix B

Sampling Methods

Soil Descriptions

Rock Descriptions

Symbols & Abbreviations

Results of Field Work



Sampling

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

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

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

Test Pits

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

Large Diameter Augers

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

Continuous Spiral Flight Augers

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

reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

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

Continuous Core Drilling

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

Standard Penetration Tests

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

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

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:
4,6,7
N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:
15, 30/40 mm

Sampling Methods

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

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



Description and Classification Methods

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

Soil Types

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

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

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

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

The proportions of secondary constituents of soils are described as:

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

Definitions of grading terms used are:

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

Cohesive Soils

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

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

Cohesionless Soils

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

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

Soil Descriptions

Soil Origin

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

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

Transported soils may be further subdivided into:

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



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 longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

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

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

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

Stratification Spacing

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

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

Symbols & Abbreviations

Douglas Partners



Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General



Asphalt



Road base



Concrete



Filling

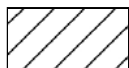
Soils



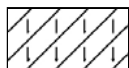
Topsoil



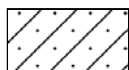
Peat



Clay



Silty clay



Sandy clay



Gravelly clay



Shaly clay



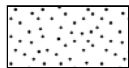
Silt



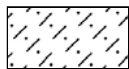
Clayey silt



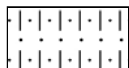
Sandy silt



Sand



Clayey sand



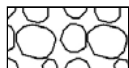
Silty sand



Gravel



Sandy gravel

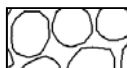


Cobbles, boulders



Talus

Sedimentary Rocks



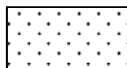
Boulder conglomerate



Conglomerate



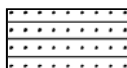
Conglomeratic sandstone



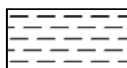
Sandstone



Siltstone



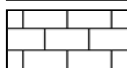
Laminite



Mudstone, claystone, shale

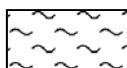


Coal

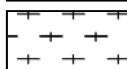


Limestone

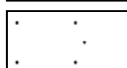
Metamorphic Rocks



Slate, phyllite, schist

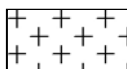


Gneiss

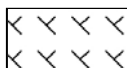


Quartzite

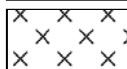
Igneous Rocks



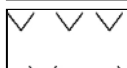
Granite



Dolerite, basalt, andesite



Dacite, epidote



Tuff, breccia



Porphyry

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 16.2 mAHd*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 75799.00
DATE: 8/9/2014
SHEET 1 OF 2

[illegible]

Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 16.2 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 75799.00
DATE: 8/9/2014
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing				
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
6		SANDSTONE: Medium strength, fresh stained, slightly fractured, light grey, medium grained sandstone (continued)																C	100	100	PL(A) = 1.31
10.62		SILTSTONE: Medium strength, moderately weathered, fractured, light grey siltstone															10.59m: J5°,pl,ro,fe 10.62m: J5°,pl,ro,fe 10.7m: J5°,pl,ro,fe 10.72m: J5°,pl,ro,fe 10.75m: J5°,pl,ro,fe 11.27m: J5°,pl,sm,inf clay10mm				PL(A) = 0.69
11																					
11.3		SANDSTONE: High strength, fresh, unbroken, light grey medium grained sandstone																			
12																	11.8m: J5°,ir,ro,cln	C	100	95	PL(A) = 1.77
13																					PL(A) = 1.75
13.3		Bore discontinued at 13.3m . Limit of investigation																			
14																					
15																					
16																					
17																					
18																					
19																					

RIG: Scout 2

DRILLER: L Cooper

LOGGED: M Hickman

CASING: 3m PQ

TYPE OF BORING: SFA to 3.1m then NMLC coring to 13.3m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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

DOUGLAS PARTNERS PTY LTD
PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 1 8/9/14



3.1 - 11.3m



Rock Core Photograph
Geotechnical Investigation
Holden Street, Gosford

CLIENT: Health Infrastructure

PROJECT: 75799.00

PLATE No: 1

REV: A

DATE: 21/11/2014

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 18.1 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 75799.00
DATE: 2/9/2014
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				
			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 S - Shear	J - Joint F - Fault	Type
18	0.05	ASPHALTIC CONCRETE																				E			PID = 0.8 ppm
	0.2	FILLING: Dark grey sandy gravel, moist (roadbase) CLAY: Very stiff, orange brown sandy clay, M=Wp																				E			PID= 0.5 ppm
17	1																					S/E			4,6,6 N = 12 PID= 1.1 ppm
	2																								
16	2.1	SILTSTONE: Very low strength, extremely weathered, light grey siltstone with soil like properties. Some very low strength sandstone bands																							
15	3																					C	100		PL(A) = 0.04
																									PL(A) = 0.06
14	4																					C	92		
13	4.7 4.82	CORE LOSS																							
	5	SILTSTONE: Extremely low strength, highly weathered light grey siltstone with soil like properties with some very low to low strength, highly weathered sandstone inclusions																							
																									PL(A) = 2.52
12	6	- very low strength from 6m																							
																									PL(A) = 0.06
11	7	SANDSTONE: Medium to high strength, moderately weathered, unbroken, light grey and light brown, medium grained sandstone																							
	7.0																								PL(A) = 0.04
	7.27 7.38	CORE LOSS																							
	7.8	SILTSTONE: Very low strength, highly weathered, light grey siltstone																							
		SANDSTONE: Medium strength, slightly weathered, unbroken, light brown and light grey, medium grained sandstone																							
10	8																								PL(A) = 0.04
																									PL(A) = 0.96
9	9																								
																									PL(A) = 0.73

RIG: Scout 2

DRILLER: L Cooper

LOGGED: M Hickman

CASING: 2.5m PQ

TYPE OF BORING: SFA to 2.13m then NMLC coring to 12.2m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 18.1 mAHd*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 75799.00
DATE: 2/9/2014
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering				Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing						
			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 S - Shear	J - Joint F - Fault	Type	Core Rec. %
8	10.2	SANDSTONE: Medium to high strength, fresh, unbroken, light grey, medium grained sandstone																								PL(A) = 0.9
11	7																						C	100	100	PL(A) = 1.54
12	6																									PL(A) = 1.29
12.2		Bore discontinued at 12.2m . Limit of investigation																								
13	5																									
14	4																									
15	3																									
16	2																									
17	1																									
18	0																									
19	-1																									

RIG: Scout 2

DRILLER: L Cooper

LOGGED: M Hickman

CASING: 2.5m PQ

TYPE OF BORING: SFA to 2.13m then NMLC coring to 12.2m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

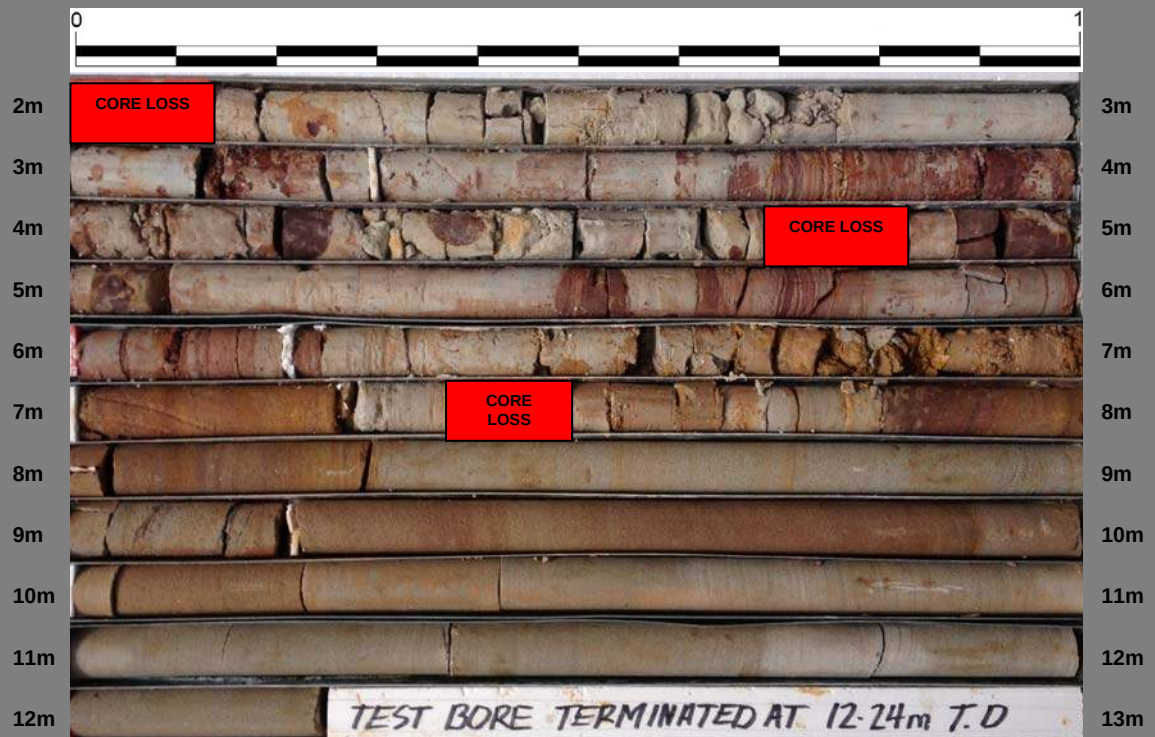
SAMPLING & IN SITU TESTING LEGEND

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

DOUGLAS PARTNERS PTY LTD
PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 2

2/9/14



2.0 - 12.24m



Rock Core Photograph
Geotechnical Investigation
Holden Street, Gosford

CLIENT: Health Infrastructure

PROJECT: 75799.00

PLATE No: 2

REV: A

DATE: 21/11/2014

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 19.4 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 75799.00
DATE: 9/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering				Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing				
			EW	HW	MW	SW		FS	FR	Ex Low	Very Low	Low			Medium	High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
19 1 18	0.05	ASPHALTIC CONCRETE																E			PID = 0.6 ppm
		FILLING: Dark grey sandy gravel, moist (roadbase)																E(QA2)			PID= 1.2 ppm
	0.6	SILTY SANDY CLAY: Stiff, grey brown silty sandy clay, M>Wp																			2,4,7 N = 11 PID= 0.8 ppm
	0.8	CLAY: Stiff, orange brown clay, M>Wp																U ₅₀ S/E			
	1.8	SILTY CLAY: Very stiff, light grey silty clay with some red brown ironstone bands, M=Wp																E			PID= 0.7 ppm
2 17 3																		S/E			8,11,12 N = 23 PID= 1.1 ppm
	3.1																				
		SILTSTONE: Extremely low strength, extremely weathered, light grey siltstone (with soil like properties)																			PL(A) = 0.01
		- with high strength sandstone bands between 3.5m and 4.3m																C	100		PL(A) = 3.59
																					PL(A) = 0.08
4 15 5																					
6 14 6	5.32	SANDSTONE: Medium strength, highly weathered , slightly fractured, red brown, medium grained sandstone																			PL(A) = 0.61
7 13 7	6.35	SILTSTONE: Extremely low to very low strength, highly weathered, light grey siltstone																			PL(A) = 0.05
12 8 11 9	7.23	CORE LOSS																			
	7.4	SILTSTONE: Extremely low to very low strength, extremely weathered, light grey siltstone																			PL(A) = 0.05
		- becoming very low strength from 8.0m																			PL(A) = 0.1
	8.42	SANDSTONE: Low strength, highly weathered, fractured, light brown, medium grained sandstone																			PL(A) = 0.04
	8.75	SILTSTONE: Extremely low to very low strength, extremely weathered, light grey siltstone Bore discontinued at 8.75m . Limit of investigation																			

RIG: Scout 2

DRILLER: L Cooper

LOGGED: M Hickman

CASING: 3m PQ

TYPE OF BORING: SFA to 3.1m then NMLC coring to 8.75m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

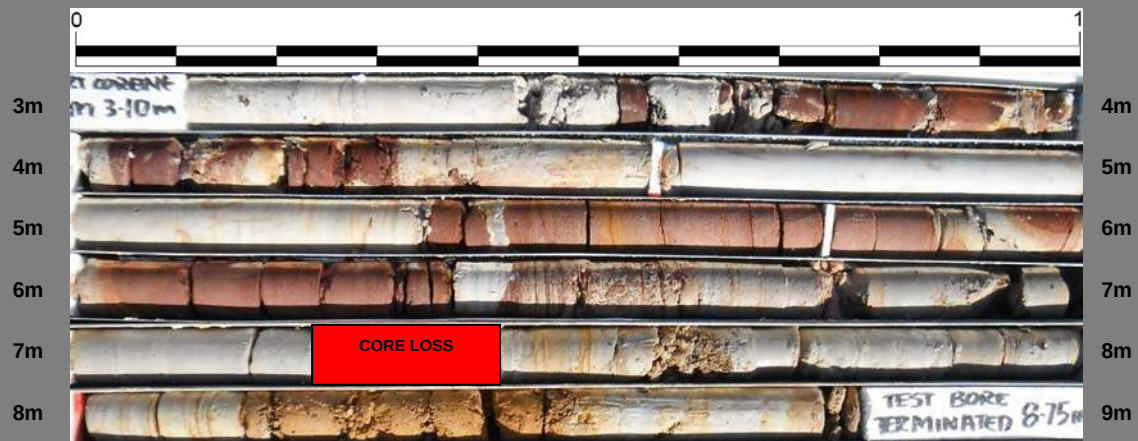
REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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

DOUGLAS PARTNERS PTY LTD
PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 3 9/9/14



3.1 – 8.75m



Rock Core Photograph
Geotechnical Investigation
Holden Street, Gosford

CLIENT: Health Infrastructure

PROJECT: 75799.00

PLATE No: 3

REV: A

DATE: 21/11/2014

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 16.8 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 75799.00
DATE: 5/9/2014
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								
			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 S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %
16 1 15 2 14 3 13 4 12 5 11 6 10 7 9 8 8 9 7	0.03	2 COAT SEAL																								PID = 0.0 ppm	
	0.25	FILLING: Dark grey sandy gravel, moist (roadbase)																									PID= 1.0 ppm
	0.6	SILTY SAND: Medium dense, brown silty sand, moist/wet																									2,4,5 N = 9 PID= 0.8 ppm
		SANDY CLAY: Stiff, orange brown sandy clay, moist/M=Wp																									
		2.2	SILTY CLAY: Hard, light grey silty clay with some red brown ironstone gravel bands, moist/M=Wp																								PID= 0.6 ppm
		3.0	CORE LOSS																								6,13,18 N = 31
		3.32	SILTSTONE: Extremely low strength, highly weathered, light grey and red brown siltstone with high strength ferruginous bands																								

RIG: Scout 2

DRILLER: L Cooper

LOGGED: M Hickman

CASING: 3m PQ

TYPE OF BORING: SFA to 3.0m then NMLC coring to 13.6m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 16.8 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 75799.00
DATE: 5/9/2014
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing					
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %
	6	SANDSTONE: Medium strength, moderately weathered, slightly fractured, light grey medium grained sandstone <i>(continued)</i>																				PL(A) = 0.9	
	11																						PL(A) = 0.85
	11.88																						PL(A) = 0.49
	12	SILTSTONE: Medium strength, fresh, slightly fractured, grey siltstone																					
	12.8	SANDSTONE: High strength, fresh, slightly fractured, grey, medium grained sandstone																					PL(A) = 1.28
	13																						PL(A) = 0.93
	13.3	SILTSTONE: Medium strength, fresh, slightly fractured, grey siltstone																					
	13.6	Bore discontinued at 13.6m . Limit of investigation																					
	14																						
	15																						
	16																						
	17																						
	18																						
	19																						

RIG: Scout 2

DRILLER: L Cooper

LOGGED: M Hickman

CASING: 3m PQ

TYPE OF BORING: SFA to 3.0m then NMLC coring to 13.6m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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

DOUGLAS PARTNERS PTY LTD
PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 4

5/9/14



3.0 – 13.6m



Rock Core Photograph
Geotechnical Investigation
Holden Street, Gosford

CLIENT: Health Infrastructure

PROJECT: 75799.00

PLATE No: 4

REV: A

DATE: 21/11/2014

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 18.7 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 75799.00
DATE: 9/9/2014
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
	0.03	2 COAT SEAL							E			PID = 0.3 ppm
	0.2	FILLING: Dark grey sandy gravel (roadbase)							E			PID= 0.6 ppm
	0.6	FILLING: Brown gravelly clayey silty sand filling							E			PID= 0.7 ppm
	1	CLAY: Stiff, orange brown clay with a trace of sand							U ₅₀			12,12,16 N = 28 PID= 0.2 ppm
	1.4	SILTY CLAY: Very stiff, light grey silty clay with a trace of red ironstained weathered rock inclusions							S/E			12,18,25/100 refusal PID= 0.5 ppm
	2							Generally unable to detect discontinuities due to degree of weathering				
	3	CORE LOSS						START CORING AT 3.0m	S/E			
	3.2	SILTSTONE: Extremely low strength, extremely to highly weathered, light grey siltstone (with soil like properties) with some low strength sandstone bands						3m: CORE LOSS: 200mm	C	83		PL(A) = 0.01
	4											PL(A) = 0.06
	4.2	CORE LOSS						4.2m: CORE LOSS: 500mm				
	4.7	SILTSTONE: Extremely low to very low strength, extremely to highly weathered, light grey siltstone (with soil like properties) with some medium strength ferruginous bands							C	75		PL(A) = 0.03
	5							5.71m: J5°,ir,ro,cln 5.76m: J10°,ir,ro,cln				PL(A) = 0.6
	6							6.1m: J10°,ir,ro,fe 6.15m: J10°,ir,ti,cln 6.24m: J20°,ir,ro,inf cly 10mm 6.35m: J80°,ir,ro,cln 6.6m: Clay seam 30mm				PL(A) = 0.08
	6.6	SILTSTONE: Very low strength, highly weathered, light grey siltstone with soil like properties							C	81		PL(A) = 0.05
	7											
	7.85	CORE LOSS						7.85m: CORE LOSS: 400mm				
	8											
	8.25	Bore discontinued at 8.25m . Limit of investigation										
	9											
	9											

RIG: Scout 2

DRILLER: L Cooper

LOGGED: M Hickman

CASING:

TYPE OF BORING: SFA to 3.0m then NMLC coring to 8.25m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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

DOUGLAS PARTNERS PTY LTD
 PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 5 9/9/14



3.0 – 8.25m



Rock Core Photograph
Geotechnical Investigation
Holden Street, Gosford

CLIENT: Health Infrastructure

PROJECT: 75799.00

PLATE No: 5

REV: A

DATE: 21/11/2014

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 20.2 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 75799.00
DATE: 4/9/2014
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
20.04	0.04	ASPHALT CONCRETE							E			PID = 1.0 ppm
	0.3	FILLING: Brown sandy gravel filling, moist (roadbase) CLAY: Very stiff, orange brown clay, M=Wp							E			PID= 1.3 ppm
	1							Generally unable to detect discontinuities from 2m - 5m due to degree of weathering	E			PID= 1.7 ppm 5,7,9 N = 16
	2							START CORING AT 2.0m	S			
	2.0	SANDSTONE: Extremely low to very low strength, extremely to highly weathered light grey sandstone with some medium strength ferruginous bands							E			PID= 2.1 ppm
	3								C	90		
	3.28	CORE LOSS						3.28m: CORE LOSS: 340mm				
	3.62	SANDSTONE: Extremely low to very low strength, extremely to highly weathered light grey sandstone with some medium strength ferruginous bands						4m: J40°,ir,ro,fe	C	87		
	4							4.9m: J70°,ir,ro,cln				
	5							6.44m: fg 20mm				
	5.25	SILTSTONE: Very low strength, moderately weathered, light grey and orange brown siltstone						6.8m: J70°,ir,ro,fe 6.85m: CORE LOSS: 350mm	C	84		PL(A) = 0.09
	6							7.3m: J85°,ir,ro,fe 7.5m: J85°,ir,ro,fe 7.8m: 200mm fg				
	6.85	CORE LOSS						8.7m: J5°,ir,ro,fe	C	90		PL(A) = 0.01
	7.2	SILTSTONE: Very low strength, moderately weathered, light grey and orange brown siltstone						9m: CORE LOSS: 200mm 9.25m: J10°,ir,ro,fe 9.44m: J80°,ir,ro,fe 9.7m: J60°,ir,ro,fe				PL(A) = 0.74
	8	- extremely low strength from 8m							C	80		
	9.0	CORE LOSS										
	9.2	SILTSTONE: Low strength, moderately weathered, light grey and orange brown siltstone										

RIG: Scout 2

DRILLER: L Cooper

LOGGED: M Hickman

CASING:

TYPE OF BORING: SFA to 2.0m then NMLC coring to 14.9m

WATER OBSERVATIONS: Free Groundwater Observed at 2.4m on 19.09.2014

REMARKS: * Surface level interpolated from survey plan. Standpipe piezometer installed to 5.7m depth

SAMPLING & IN SITU TESTING LEGEND

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



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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 20.2 mAHD*

BORE No: 6

EASTING:

PROJECT No: 75799.00

NORTHING:

DATE: 4/9/2014

DIP/AZIMUTH: 90°/--

SHEET 2 OF 2

[illegible]

RIG: Scout 2

DRILLER: L Cooper

LOGGED: M Hickman

CASING:

TYPE OF BORING: SFA to 2.0m then NMLC coring to 14.9m

WATER OBSERVATIONS: Free Groundwater Observed at 2.4m on 19.09.2014

REMARKS: * Surface level interpolated from survey plan. Standpipe piezometer installed to 5.7m depth

SAMPLING & IN SITU TESTING LEGEND

SAMPLING AND INSTRUMENT 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 (s(50) (MPa)
BLK	Block sample	U _t	Tube sample (x mm dia.)	PL(D)	Point load diametral test (s(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 6

4/9/14



2.0 – 14.9m



Rock Core Photograph
Geotechnical Investigation
Holden Street, Gosford

CLIENT: Health Infrastructure

PROJECT: 75799.00

PLATE No: 6

REV: A

DATE: 21/11/2014

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 21.1 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 75799.00
DATE: 12/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering				Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing				
			EW	HW	MW	SW		FS	FR	Ex Low	Very Low	Low			Medium	High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
21	0.03	2 COAT SEAL																E			PID = 0.9 ppm
	0.3	FILLING: Brown gravelly sand, moist (roadbase)																E			PID= 1.2 ppm
	0.8	CLAY: Stiff to very stiff, brown clay, M=Wp																			
20	1	SILTY CLAY: Hard, light grey silty clay																S/E			5,19,25/70 refusal
	1.3	SILTSTONE: Extremely low strength, extremely to highly weathered light grey and red brown siltstone with some high strength ferruginous bands																			PID= 0.8 ppm
	2																	C	100	0	PL(A) = 0.04 PL(A) = 0.01
	3																	C	100		PL(A) = 1.14
	4																	C	96		PL(A) = 0.02 PL(A) = 1.35
	4.85	CORE LOSS																			
	4.89	SANDSTONE: Low to medium strength, moderately weathered, fractured, red brown, medium grained sandstone with occasional bands of very low strength siltstone																C	96		
	6	CORE LOSS																			
	6.0	SILTSTONE: Very low strength, slightly weathered, light grey siltstone																C	100		PL(A) = 0.07
	7	SANDSTONE: Low strength, moderately weathered, fractured, light brown, medium grained sandstone																			PL(A) = 0.25
	7.36	Bore discontinued at 7.36m . Limit of investigation																			
	8																				
	9																				
	10																				

RIG: Bobcat

DRILLER: L Cooper

LOGGED: M Hickman

CASING: PQ 1.5m

TYPE OF BORING: SFA to 1.3m then NMLC coring to 7.36m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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

DOUGLAS PARTNERS PTY LTD
 PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 7 12/9/14



1.3 - 7.36m

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 21.5 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 75799.00
DATE: 12/9/2014
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				
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %
21 1 20 2 19 3 18 4 17 5 16 6 15 7 14 8 13 9 12	0.04	2 COAT SEAL															E(QA4)			PID = 0.9 ppm		
	0.25	FILLING: Brown gravelly clayey sand (roadbase)																E			PID= 0.3 ppm	
		SILTY CLAY: Very stiff, light grey and red brown ironstained silty clay																B				
		- grading into weathered rock from 1.25m																E			PID= 0.6 ppm 5,15,17 N = 32	
	1.45	SANDSTONE: Extremely low strength, extremely to highly weathered, red brown and light grey sandstone with some medium strength ferruginous bands																C	100		PL(A) = 0.05	
	2.5	CORE LOSS																				
																		C	6			
	3.6	SILTSTONE: Very low then low strength, highly weathered, red brown and light grey siltstone																			PL(A) = 0.09	
		- 150mm medium strength sandstone band 4.1m																				
																					PL(A) = 0.2	
	5.3	SANDSTONE: Medium to high strength, moderately weathered, fractured, red brown, medium grained sandstone																			PL(A) = 1.31	
	5.89	SILTSTONE: Extremely low to very low strength, highly weathered, light grey siltstone																	C	82		
	6.32	CORE LOSS																				
	6.45	SILTSTONE: Extremely low to very low strength, highly weathered, light grey siltstone																			PL(A) = 0.07	
																			C	100		
	7.58	SANDSTONE: Medium strength, moderately weathered, fractured, orange brown, medium grained sandstone																			PL(A) = 0.46	
	- very low and low strength from 8.3m																	C	92		PL(A) = 0.04	
8.95	CORE LOSS																					
9.05	SANDSTONE: Low strength, moderately weathered, fractured, orange brown, medium grained sandstone																			PL(A) = 0.05		
																		C	100			

RIG: Bobcat

DRILLER: L Cooper

LOGGED: M Hickman

CASING: 2m PQ

TYPE OF BORING: SFA to 1.475m then NMLC coring to 14.88m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

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 1s(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test 1s(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	sp	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 21.5 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 75799.00
DATE: 12/9/2014
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
	10.35	SILTSTONE: Extremely low to very low strength, highly weathered grey siltstone with soil like properties (continued)						9.9m: J85°,ir,ro,fe,cln	C	100		PL(A) = 1.56
	10.89	SANDSTONE: High strength, moderately weathered, grey brown, medium grained sandstone						10.4m: J80°,he,ir,fe,cln	C	100		
	11.2	SILTSTONE: Very low strength, highly weathered grey siltstone										PL(A) = 0.99
		SANDSTONE: High strength, fresh, unbroken, medium grained sandstone										
	12											PL(A) = 1.72
	13											
	14											PL(A) = 1.8
	14.88	Bore discontinued at 14.88m . Limit of investigation										
	15											PL(A) = 1.76
	16											
	17											
	18											
	19											

RIG: Bobcat

DRILLER: L Cooper

LOGGED: M Hickman

CASING: 2m PQ

TYPE OF BORING: SFA to 1.475m then NMLC coring to 14.88m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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

DOUGLAS PARTNERS PTY LTD
 PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 8 12/9/14



1.47 - 14.88 m



Rock Core Photograph
 Geotechnical Investigation
 Holden Street, Gosford

CLIENT: Health Infrastructure

PROJECT: 75799.00

PLATE No: 8

REV: A

DATE: 21/11/2014

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 32.0 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 9
PROJECT No: 75799.00
DATE: 8/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
32	0.05	ASPHALTIC CONCRETE																E			PID = 0.6 ppm
	0.3	FILLING: Dark grey sandy gravel, dry (roadbase)																E			PID= 0.3 ppm
	0.6	FILLING: Brown gravelly silty sand filling, moist																S			25/50
	0.75	CORE LOSS																			refusal
31	1	SILTSTONE: Low to medium strength, moderately weathered, fractured, grey siltstone																C	89		PL(A) = 0.54
	1.9	SANDSTONE: Medium and high strength, moderately weathered, highly fractured, orange brown and light grey, fine to medium grained sandstone with some medium strength ferruginous bands - band of conglomerate from 2.8-3.1m																			PL(A) = 0.48
30	2																				PL(A) = 2.08
	3																	C	100		PL(A) = 0.6
29	3																				PL(A) = 0.41
	4	- band of conglomerate from 3.9-4.0m																			PL(A) = 2.28
	4.18	Bore discontinued at 4.18m . Limit of investigation																			PL(A) = 0.54
28																					
27	5																				
26	6																				
25	7																				
24	8																				
23	9																				

RIG: Scout 2

DRILLER: L Cooper

LOGGED: M Hickman

CASING: 0.7m PQ

TYPE OF BORING: SFA to 0.6m then NMLC coring to 4.18m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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



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DOUGLAS PARTNERS PTY LTD
 PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 9 8/9/14



0.6 - 4.18m



Rock Core Photograph
Geotechnical Investigation
Holden Street, Gosford

CLIENT: Health Infrastructure

PROJECT: 75799.00

PLATE No: 9

REV: A

DATE: 21/11/2014

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 25.0 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 75799.00
DATE: 9/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint D - Drill Break	Type
25	0.1	FILLING: Dark brown sandy clay topsoil filling with some gravel and rootlets, M<Wp																E/D			pp = 280-340 2,4,8 N = 12
		FILLING: Dark brown clay and sand filling with some gravel, M>Wp/moist																E/D			
24	1.1	- pockets of orange brown clay at 1.0m																E/D			
		CLAY: Stiff, orange brown mottled yellow brown clay with a trace of sand, M=Wp																S			
	1.7																	E/D			
	2	SANDSTONE: Very low strength, highly weathered, fractured, red brown and light grey, fine to medium grained sandstone																			PL(A) = 0.04
	2	- very low to low strength from 2.3-2.8m																			PL(A) = 0.18
	3	- extremely low strength from 2.8m																			PL(A) = 0.01
	4																				
	4	- extremely low strength, extremely weathered from 4.30m																			PL(A) = 0
20	5.0	Bore discontinued at 5.0m . Limit of investigation																			
	6																				
	7																				
	8																				
	9																				

RIG: Tightsite

DRILLER: I Drever

LOGGED: T Warriner

CASING:

TYPE OF BORING: SFA to 1.7m then NMLC coring to 5.0m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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

DOUGLAS PARTNERS PTY LTD
PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
Holden Street, Gosford

BORE 101 9/9/14



1.7 – 5.0 m



Rock Core Photograph
Geotechnical Investigation
Holden Street, Gosford

CLIENT: Health Infrastructure

PROJECT: 75799.00

PLATE No: 10

REV: A

DATE: 21/11/2014

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 24.0 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 75799.00
DATE: 11/9/2014
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			
			EW	HW	MW	SW	FS	FR	Ex Low	Very Low	Low	Medium	High	Ex High			Type	Core Rec. %	RQD %	Test Results & Comments
24	0.15	CONCRETE																		
	0.2	FILLING: Dark grey sandy gravel, moist															E			
	0.7	CLAY: Very stiff, orange brown clay with a trace of sand, M>Wp															S			8,30/50 refusal
	1	SANDSTONE: Very low strength, moderately weathered, slightly fractured, light brown and light grey, medium grained sandstone															C	69	0	PL(A) = 0.21
	1.45	SILTSTONE: Very low strength, extremely to highly weathered, light grey siltstone																		PL(A) = 0.09
	1.67	CORE LOSS																		
	2.1	SILTSTONE: Very low strength, extremely to highly weathered, light grey siltstone																		PL(A) = 0.07
	2.6	very low strength from 2.6m																		
	3.09	CORE LOSS																		
	3.3	SILTSTONE: Very low strength, extremely to highly weathered, light grey siltstone																		PL(A) = 0.04
	3.9																			
	4.83	CORE LOSS																		
	4.88	SILTSTONE: Very low strength, extremely to highly weathered, light grey siltstone																		
	5.23																			
	5.27																			
	5.78																			
	5.92	SANDSTONE: High strength, moderately weathered, light grey and brown sandstone																		
	6.05	CORE LOSS																		
	6.2																			
	6.61	SANDSTONE: High strength, moderately weathered, light grey and brown sandstone																		
	6.71	SILTSTONE: Very low strength, highly weathered, fractured, light brown and grey siltstone																		
	7.9	SANDSTONE: Medium strength, moderately weathered, fractured, light brown, medium grained sandstone																		
	8.46	SANDSTONE: Medium to high strength, fresh stained, fractured, light grey, medium grained sandstone																		
	8.81																			
	9.14																			
	9.22																			
	9.3																			

RIG: Scout 2

DRILLER: L Cooper

LOGGED: M Hickman

CASING:

TYPE OF BORING: SFA to 0.7m then NMLC coring to 12.1m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

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 1s(50) (MPa)
BLK Block sample	U Tube sample (x mm dia.)	PL(D) Point load diametral test 1s(50) (MPa)
C Core drilling	W Water sample	pp Pocket penetrometer (kPa)
D Disturbed sample	> Water seep	sp Standard penetration test
E Environmental sample	≡ Water level	V Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 24.0 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 75799.00
DATE: 11/9/2014
SHEET 2 OF 2

[illegible]

RIG: Scout 2

DRILLER: L Cooper

LOGGED: M Hickman

CASING:

TYPE OF BORING: SFA to 0.7m then NMLC coring to 12.1m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

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



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 PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 102

11/9/14



0.7 - 12.1m

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 17.9 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 75799.00
DATE: 13/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering				Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing						
			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 S - Shear	J - Joint D - Drill Break	Type	Core Rec. %
17 1	0.25	FILLING/TOPSOIL: Dark brown clayey silty sand with a trace of gravel																								1,2,2 N = 4
	0.6																									
	2.3	SILT CLAY: Very stiff, light grey, red ironstained silty clay																							4,7,13 N = 20	
16 2																										
15 3																										
14 4																										
13 5																										
12 6																										
11 7																										
10 8																										
9 9																										
8																										

RIG: Bobcat

DRILLER: L Cooper

LOGGED: M Hickman

CASING: PQ 3m

TYPE OF BORING: SFA to 3.5m then NMLC coring to 7.0m

WATER OBSERVATIONS: Free Groundwater Observed at 2.7m on 19.11.2014

REMARKS: * Surface level interpolated from survey plan. Standpipe piezometer installed to 7m depth

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 1s(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test 1s(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 103

13/9/14



3.5 – 7.0m

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 18.8 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 104
PROJECT No: 75799.00
DATE: 19/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering				Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing								
			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		Type	Core Rec. %	RQD %	Test Results & Comments
																							S - Shear	D - Drill Break				
18	0.25	TOPSOIL: Brown silty sand, moist																				E			PID = 0.5 ppm			
1		CLAY: Stiff, orange brown clay with a trace of sand, moist/M>Wp																				E/S			2,4,4 N = 8 PID= 0.6 ppm			
17	1.2	SILTY CLAY: Stiff, light grey, red ironstained silty clay, moist/M=Wp																				E			PID= 0.8 ppm			
2		- very stiff from 2.4m																				E/S			5,6,11 N = 17 PID= 0.6 ppm			
16																												
3																												
15	3.62	SILTSTONE: Extremely low to very low strength, extremely to highly weathered, slightly fractured, light grey siltstone with some medium and high strength ferruginous bands																							7,12/100 refusal			
4																									PID= 0.5 ppm PL(A) = 0.03			
14																						C E/S	100	25	PL(A) = 3.81			
5																									PL(A) = 0.03			
13																									PL(A) = 1.38			
6																						C	100	75				
12	6.2	SILTSTONE: Low strength, mderately weathered, fractured, light brown and grey siltstone																							PL(A) = 0.29			
7	6.55	Bore discontinued at 6.55m . Limit of investigation																										
11																												
8																												
10																												
9																												

RIG: Tightsite

DRILLER: I Drever

LOGGED: M Hickman

CASING:

TYPE OF BORING: SFA to 3.61 then NMLC coring to 6.55m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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

DOUGLAS PARTNERS PTY LTD
 PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 104

19/9/14



3.62 – 6.55m

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 10.3 mAHD*

BORE No: 105

EASTING:

PROJECT No: 75799.00

NORTHING:

DATE: 13/9/2014

DIP/AZIMUTH: 90°/--

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				
			EW	HW	MW	SW	FR		Ex Low	Very Low	Low	Medium	High		Very High	Ex High	0.01	0.05	0.10	0.50	1.00	B - Bedding S - Shear	J - Joint D - Drill Break	Type	Core Rec. %
10	0.2	TOPSOIL: Brown clayey silty sand, wet																			E(QA5)				
	0.7	SANDY SILTY CLAY: Firm, light grey sandy silty clay, M>Wp																			E				
1		CLAY: Firm, light brown clay with some silt and sand, M>Wp																			E				
9		= stiff from 1.0m																			S			4,7,10 N = 17	
2																					E				
8																									
2.5		SANDY CLAY: Very stiff to hard, light grey mottled red brown sandy clay with some silt, M>Wp																			S			8,12,16 N = 28	
3																									
7																									
4																									
6																					S			4,10,15 N = 25	
5																									
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RIG: Bobcat

DRILLER: L Cooper

LOGGED: M Hickman

CASING:

TYPE OF BORING: SFA to 10.1m then NMLC coring to 13.78m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

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



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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 10.3 mAHd*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 105
PROJECT No: 75799.00
DATE: 13/9/2014
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing						
			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 S - Shear	J - Joint D - Drill Break	Type	Core Rec. %	RQD %
0	10.1	SANDSTONE: Very low strength, extremely to highly weathered, fractured, red brown and grey medium grained sandstone with some medium strength ferruginous bands																									PL(A) = 0.69
11	11.15	SILTSTONE: Very low strength, extremely to highly weathered, slightly fractured, light grey and red brown siltstone																				C	100				PL(A) = 0.09
12																											
13																						C	100				PL(A) = 0.3 PL(A) = 0.07 PL(A) = 0.15
13.78		Bore discontinued at 13.78m . Limit of investigation																									
14																											
15																											
16																											
17																											
18																											
19																											

RIG: Bobcat

DRILLER: L Cooper

LOGGED: M Hickman

CASING:

TYPE OF BORING: SFA to 10.1m then NMLC coring to 13.78m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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

DOUGLAS PARTNERS PTY LTD
PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
Holden Street, Gosford

BORE 105 13/9/14



10.1 – 13.78 m



Rock Core Photograph
Geotechnical Investigation
Holden Street, Gosford

CLIENT: Health Infrastructure

PROJECT: 75799.00

PLATE No: 14

REV: A

DATE: 21/11/2014

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 18.7 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 106
PROJECT No: 75799.00
DATE: 10/9/2014
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						
			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 S - Shear	J - Joint D - Drill Break	Type	Core Rec. %	RQD %
18 1 17 2 16 3 15 4 14 5 13 6 12 7 11 8 10 9 9.28 9.55 9.95	0.08	PAVERS																									
	0.15	FILLING: Dark grey sandy gravel																					E				
		FILLING: Red brown clay filling with a trace of sand, M=Wp																					E (QA3) B				
	0.8	SANDY CLAY: Stiff, orange brown sandy clay, M=Wp																					S			2,4,6 N = 10	
	2.0	CLAY: Very stiff, brown grey clay, M=Wp																					E			5,11,12 N = 23	
	3.5	SANDY CLAY: Very stiff, grey mottled red sandy clay, M=Wp																					S			4,8,12 N = 20	
	5.5	SILTY CLAY: Very stiff, light grey silty clay with a trace of red ironstained weathered rock inclusions																					S			5,12,17 N = 29	
	7.0	SILTSTONE: Very low strength, extremely to highly weathered, light grey and red brown siltstone with some medium strength ferruginous bands																								PL(A) = 0.04	
	8.04																									PL(A) = 3.17	
	9.14																									PL(A) = 1.11	
	9.33																									PL(A) = 0.09	
	9.45																										
	9.52																										
	9.95	SANDSTONE: Medium strength, moderately weathered, slightly fractured, red brown medium grained sandstone																									

RIG: Scout 2 **DRILLER:** L Cooper **LOGGED:** M Hickman **CASING:** 3m PQ
TYPE OF BORING: SFA to 2.5m, Rotary to 7.0m and then NMLC coring to 18.07m
WATER OBSERVATIONS: No Free Groundwater Observed whilst augering
REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 18.7 mAHd*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 106
PROJECT No: 75799.00
DATE: 10/9/2014
SHEET 2 OF 2

[illegible]

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DOUGLAS PARTNERS PTY LTD
PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 106

10/9/14



7.0 - 18.07m



Rock Core Photograph
Geotechnical Investigation
Holden Street, Gosford

CLIENT: Health Infrastructure

PROJECT: 75799.00

PLATE No: 15

REV: A

DATE: 21/11/2014

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 25.4 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 107
PROJECT No: 75799.00
DATE: 11/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering				Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing							
			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 S - Shear	J - Joint D - Drill Break	Type	Core Rec. %	RQD %
25	0.03	ASPHALTIC CONCRETE																									
	0.3	FILLING: Dark grey sandy gravel, moist (roadbase)																					E				
1	0.4	SILTY SAND: Medium dense, dark grey silty sand, moist																					E				
		CLAY: Stiff, orange brown clay with a trace of sand, M>Wp																					E(QA4)				
24																							U ₅₀				
	1.5	SILTY CLAY: Very stiff, light grey red ironstained silty clay, M=Wp																									
2																							S				7,8,8 N = 16
23																											
	2.75	SILTSTONE: Very low strength, extremely to highly weathered, light grey siltstone with some medium strength ferruginous bands																									
3																											
	3.34	CORE LOSS																									
22																											
	3.63	SILTSTONE: Very low strength, extremely to highly weathered, light grey siltstone with some medium strength ferruginous bands																									
4																											
	4.45	CORE LOSS																									
21																											
	4.66	SILTSTONE: Low strength, highly weathered, highly fractured, red brown siltstone with some ferruginous bands																									
5		orange brown and light grey from 5m																									
	5.47	SANDSTONE: Medium strength, moderately weathered, fractured, orange brown, medium grained sandstone																									
20																											
	5.85	Bore discontinued at 5.85m . Limit of investigation																									
6																											
19																											
7																											
18																											
8																											
17																											
9																											
16																											

RIG: Scout 2

DRILLER: L Cooper

LOGGED: M Hickman

CASING: PQ 2.5m

TYPE OF BORING: SFA to 2.75m then NMLC coring to 5.85m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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



BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 29.3 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 108
PROJECT No: 75799.00
DATE: 9/9/2014
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				
			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 S - Shear	J - Joint D - Drill Break	Type
29	0.2	FILLING: Dark brown sand and gravel topsoil filling with some rootlets, moist																				D/E			
	0.6	SANDY CLAY: Firm, grey brown sandy clay, M>Wp																				D/E			
1	1.0	CLAY: Stiff, orange brown clay with some gravel																				D/E S			20/50 refusal
28		SANDSTONE: Medium strength, moderately weathered, light brown and light grey sandstone																							PL(A) = 0.51
2		- high strength from 2.1m																				C	100	97	PL(A) = 1.03
27																									
3																						C	100	100	PL(A) = 1.27
26																									
4		- very low strength, highly weathered from 4.1-4.8m																							PL(A) = 0.08
25		- low strength from 4.8m																				C	100		
5																									PL(A) = 0.17
24																									
5.8		INTERBEDDED SANDSTONE & SILTSTONE: Low strength, slightly weathered, light brown, light grey and dark grey interbedded sandstone and siltstone																				C	100		PL(A) = 0.23
6																									
23																						C	97		
7																									PL(A) = 0.92
22																									
7.9		SILTSTONE: High strength, fresh, grey siltstone with thin bands of sandstone																				C	100		PL(A) = 0.15
8																									
21																									PL(A) = 1.42
9																						C	100		
20																									

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 29.3 mAHd*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 108
PROJECT No: 75799.00
DATE: 9/9/2014
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering				Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing				
			EW	HW	MW	SW		FS	FR	Ex Low	Very Low	Low			Medium	High	Very High	Ex High	B - Bedding S - Shear	J - Joint D - Drill Break	Type
19		SILTSTONE: High strength, fresh, grey siltstone with thin bands of sandstone <i>(continued)</i>						—	—	—	—	—	—	—				C	100		PL(A) = 1.06
11								—	—	—	—	—	—	—				C	100		
11.2								—	—	—	—	—	—	—							
18	11.2	Bore discontinued at 11.2m . Limit of investigation																			PL(A) = 1.22
12																					
17																					
13																					
16																					
14																					
15																					
15																					
14																					
16																					
13																					
17																					
12																					
18																					
11																					
19																					
10																					

RIG: Tightsite

DRILLER: I Drever

LOGGED: T Warriner

CASING:

TYPE OF BORING: SFA to 1.2m then NMLC coring to 11.2m

WATER OBSERVATIONS: Free Groundwater Observed at 3.2m on 19.11.2014

REMARKS: * Surface level interpolated from survey plan. Standpipe piezometer installed to 11m depth

SAMPLING & IN SITU TESTING LEGEND

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

DOUGLAS PARTNERS PTY LTD
PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 108 9/9/14



1.2 – 11.25m



Rock Core Photograph
Geotechnical Investigation
Holden Street, Gosford

CLIENT: Health Infrastructure

PROJECT: 75799.00

PLATE No: 17

REV: A

DATE: 21/11/2014

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 31.3 mAHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/-

BORE No: 109
PROJECT No: 75799.00
DATE: 4/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing				
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint D - Drill Break	Type	Core Rec. %
31	0.2	FILLING: Brown silty sandy gravel, moist																				
	0.6	CLAY: Stiff, orange brown clay with a trace of sand and silt, M=Wp																				
	1.0	SILTSTONE: Extremely low strength, extremely weathered light grey and red brown siltstone with soil like properties																B				3,6,8 N = 14 PID = 2.7 ppm
	1.14	CORE LOSS																S				
30		SANDSTONE: Low then high strength, highly weathered, fractured, light brown and grey sandstone with some extremely low strength bands																C	91			PL(A) = 0.01 PL(A) = 0.25 PL(A) = 1.79
29	2.44	SANDSTONE: High strength, moderately weathered, slightly fractured, medium grained, light brown sandstone																				PL(A) = 0.95
28		= pebbly sandstone band from 2.8-3.14m																C	100	95		PL(A) = 1.66
27	4.0	Bore discontinued at 4.0m . Limit of investigation																				PL(A) = 1.25
26																						
25																						
24																						
23																						
22																						

RIG: Tightsite

DRILLER: I Drever

LOGGED: M Hickman

CASING: PQ 1m

TYPE OF BORING: SFA to 1.0m then NMLC coring to 4.0m

WATER OBSERVATIONS: No Free Groundwater Observed whilst augering

REMARKS: * Surface level interpolated from survey plan

SAMPLING & IN SITU TESTING LEGEND

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



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 PROPOSED GOSFORD HOSPITAL REDEVELOPMENT
 Holden Street, Gosford

BORE 109 4/9/14



1.0 – 4.0m



Rock Core Photograph
Geotechnical Investigation
Holden Street, Gosford

CLIENT: Health Infrastructure

PROJECT: 75799.00

PLATE No: 18

REV: A

DATE: 21/11/2014

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Proposed Hospital Redevelopment
LOCATION: Gosford Hospital, Holden Street, Gosford

SURFACE LEVEL: 32.0 mAHD*

EASTING:

NORTHING:

DIP/AZIMUTH: 90°/--

BORE No: 28

PROJECT No: 75799.00

DATE: 17/9/2014

SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
32		FILLING/TOPSOIL: Brown silty sand, humid		E(QA7)	0.05		PID = 1.6 ppm		
	0.1	FILLING: Orange brown clay filling, M~Wp		E	0.3		PID = 0.5 ppm		
	0.4	CLAY: Very stiff, light brown clay, M~Wp			0.5				
				B					
	0.75	Bore discontinued at 0.75m - Refusal on rock		E	0.75		PID = 0.7 ppm		
31	1							1	
30	2							2	

RIG: Hand Tools

DRILLER: M Hickman

LOGGED: M Hickman

CASING:

TYPE OF BORING: Hand Auger

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: * Surface level interpolated from survey plan

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



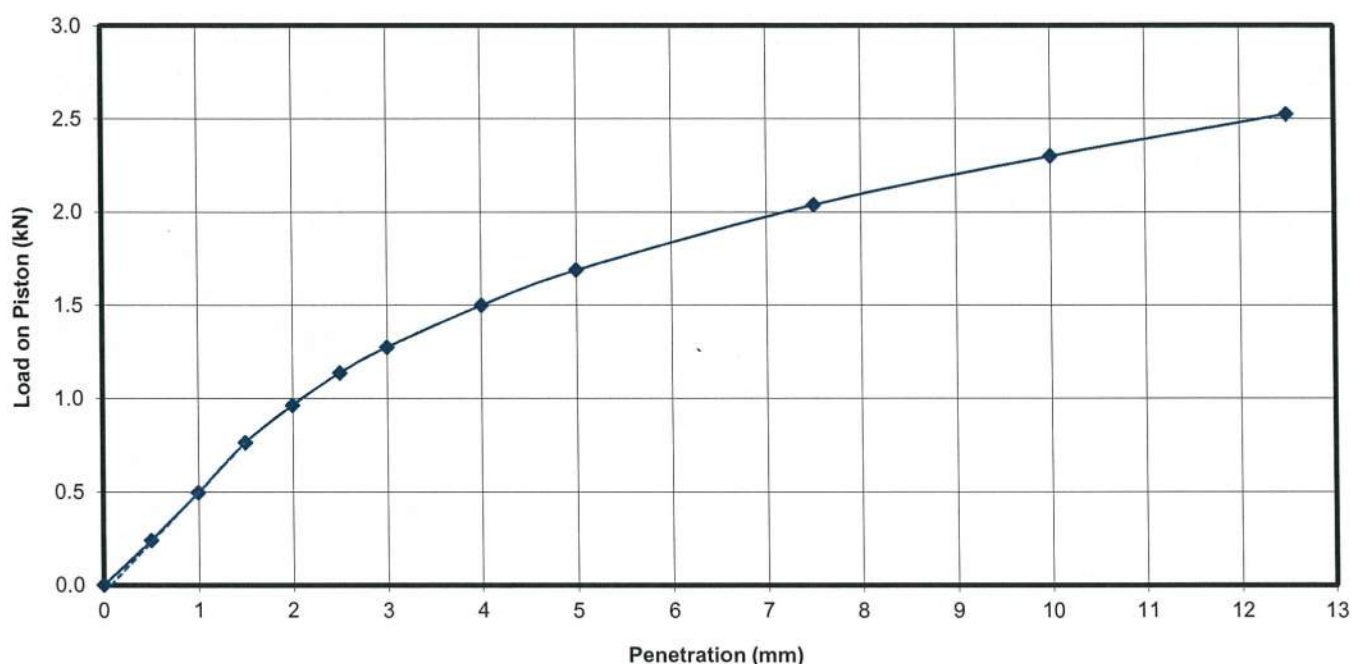
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Appendix C

Results of Laboratory Tests

Result of California Bearing Ratio Test

Client :	Health Infrastructure	Project No. :	75799
Project :	Proposed Gosford Hospital Redevelopment	Report No. :	CC14-111_1
Location :	Holden Street, Gosford	Report Date :	8.10.2014
Test Location :	Bore 1	Date Sampled :	8.9.2014
Depth / Layer :	0.6 - 0.9m	Date of Test:	30.9.2014
		Page:	1 of 1



Description: Brown sandy CLAY **Test Method(s):** AS 1289.6.1.1, AS 1289.2.1.1

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

Remarks:

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 99% of STD MDD

SURCHARGE: 4.5 kg

SWELL: 0.6%

MOISTURE RATIO: 100% of STD OMC

SOAKING PERIOD: 4 days

CONDITION	MOISTURE CONTENT %	DRY DENSITY t/m ³
At compaction	14.2	1.84
After soaking	15.3	1.83
After test		
Top 30mm of sample	17.2	-
Remainder of sample	15.5	-
Field values	17.9	-
Standard Compaction	14.2	1.85

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5mm	9



NATA Accredited Laboratory Number: 828

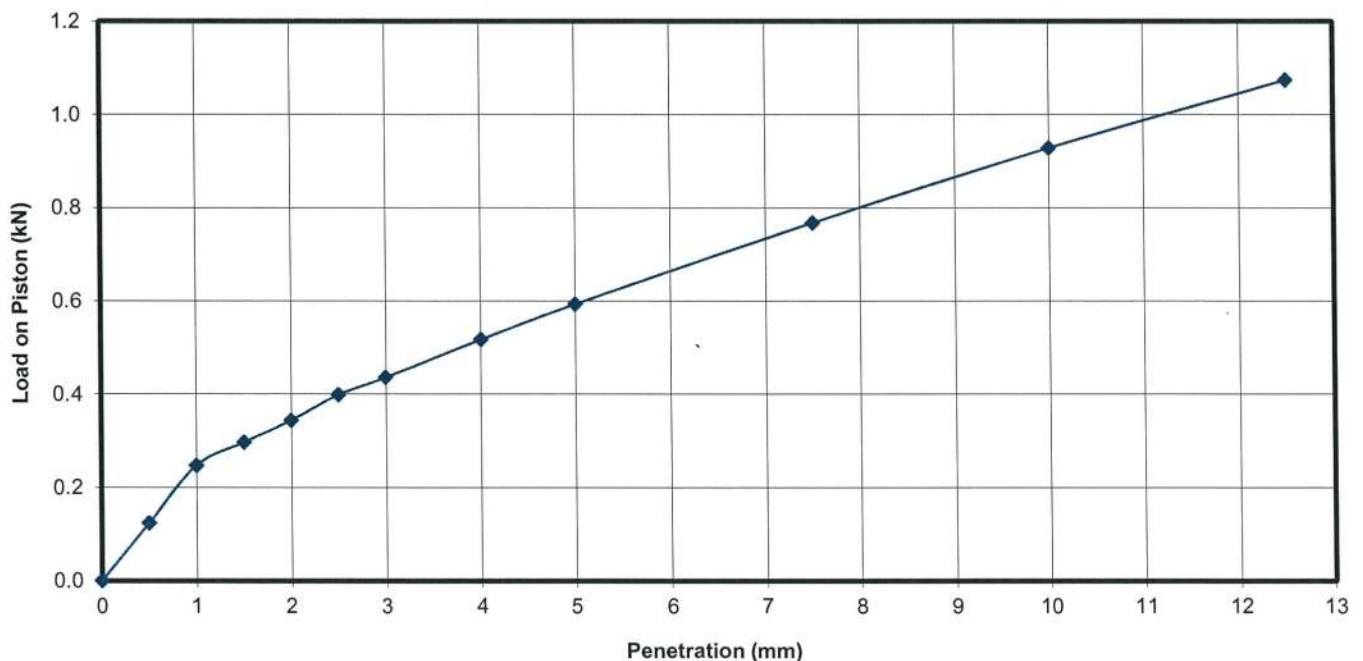
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025

Tested: BWO
Checked: DB

Dan Byrnes
Dan Byrnes
Laboratory Manager

Result of California Bearing Ratio Test

Client :	Health Infrastructure	Project No. :	75799
Project :	Proposed Gosford Hospital Redevelopment	Report No. :	CC14-111_2
Location :	Holden Street, Gosford	Report Date :	8.10.2014
Test Location :	Bore 8	Date Sampled :	12.9.2014
Depth / Layer :	0.6 - 1.0m	Date of Test:	30.9.2014
		Page:	1 of 1



Description: Grey red brown silty CLAY **Test Method(s):** AS 1289.6.1.1, AS 1289.2.1.1

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

Remarks:

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 99% of STD MDD
MOISTURE RATIO: 100% of STD OMC

SURCHARGE: 4.5 kg **SWELL:** 3.7%
SOAKING PERIOD: 4 days

CONDITION	MOISTURE CONTENT %	DRY DENSITY t/m ³
At compaction	14.1	1.88
After soaking	16.7	1.81
After test	Top 30mm of sample	-
	Remainder of sample	-
Field values	14.2	-
Standard Compaction	14.1	1.89

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5mm	3.0



NATA Accredited Laboratory Number: 828

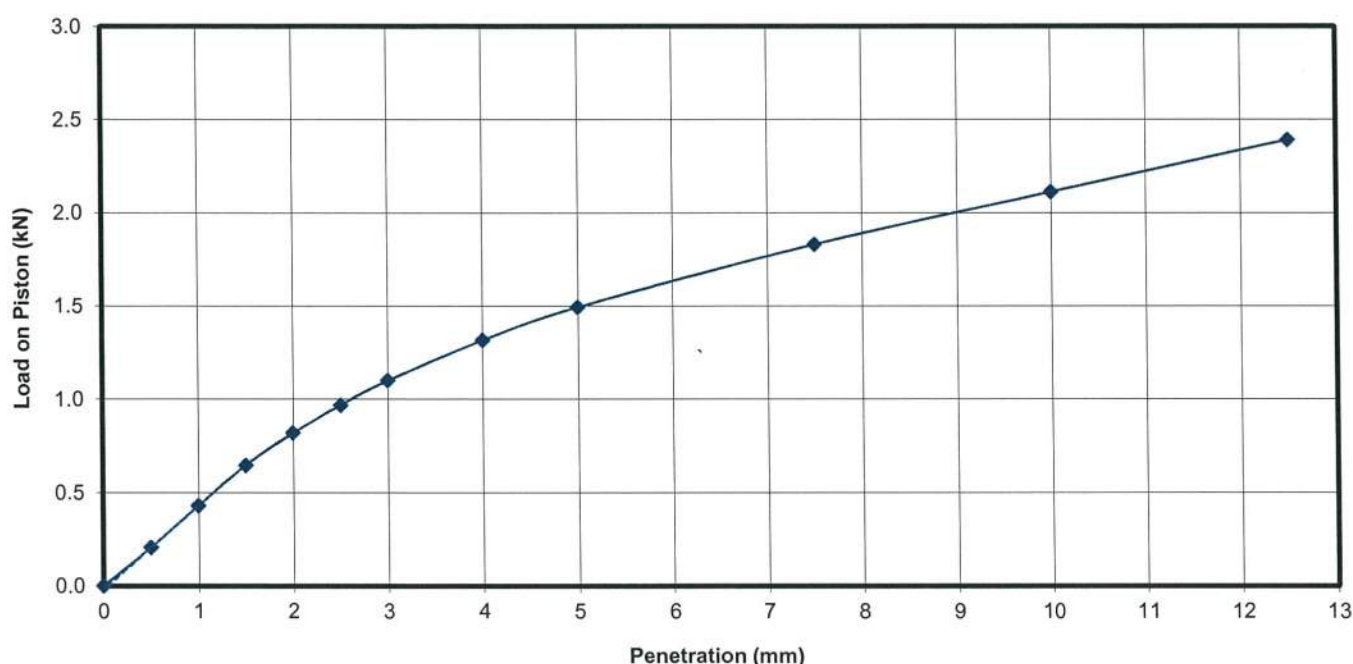
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 Accredited for compliance with ISO/IEC 17025

Tested: BWO
 Checked: DB

Dan Byrnes
 Dan Byrnes
 Laboratory Manager

Result of California Bearing Ratio Test

Client :	Health Infrastructure	Project No. :	75799
Project :	Proposed Gosford Hospital Redevelopment	Report No. :	CC14-111_3
Location :	Holden Street, Gosford	Report Date :	8.10.2014
Test Location :	Bore 28	Date Sampled :	17.9.2014
Depth / Layer :	0.5 - 0.75m	Date of Test:	30.9.2014
		Page:	1 of 1



Description: Light brown CLAY **Test Method(s):** AS 1289.6.1.1, AS 1289.2.1.1

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

Remarks:

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 101% of STD MDD

SURCHARGE: 4.5 kg

SWELL: 0.9%

MOISTURE RATIO: 94% of STD OMC

SOAKING PERIOD: 4 days

CONDITION	MOISTURE CONTENT %	DRY DENSITY t/m ³
At compaction	19.8	1.69
After soaking	22.4	1.68
After test		
Top 30mm of sample	21.7	-
Remainder of sample	21.3	-
Field values	22.0	-
Standard Compaction	21.0	1.67

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	5.0mm	8

Result of Shrink-Swell Index Determination

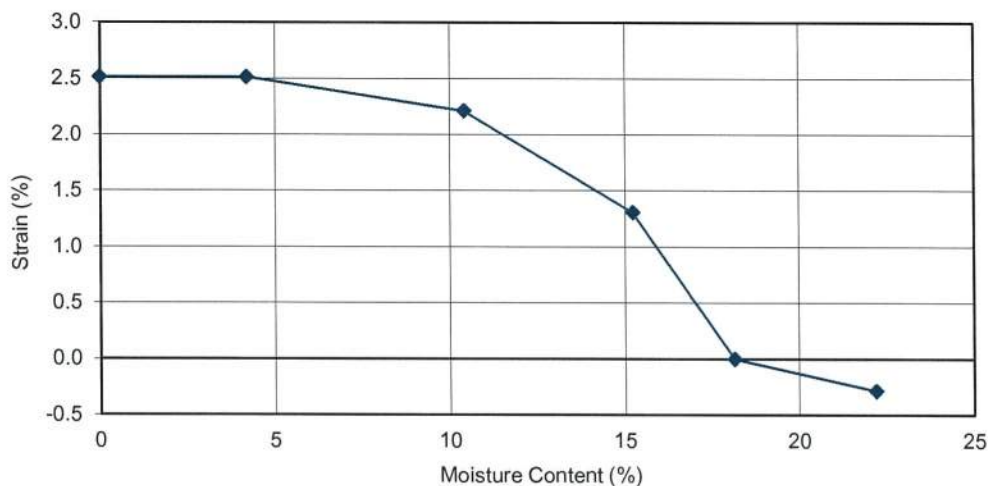
Client :	Health Infrastructure	Project No. :	75799.00
Project :	Proposed Gosford Hospital Redevelopment	Report No. :	CC14-120_1
Location :	Holden Street, Gosford	Report Date :	13.11.2014
Test Location :	Bore 3	Date Sampled :	9.9.2014
Depth / Layer :	1.0 - 1.45m	Date of Test:	29.10.2014
		Page:	1 of 1

CORE SHRINKAGE TEST

Shrinkage - air dried	2.5 %
Shrinkage - oven dried	2.5 %
Significant inert inclusions	0.0 %
Extent of cracking	MC
Extent of soil crumbling	0.0 %
Moisture content of core	18.2 %

SWELL TEST

Pocket penetrometer reading at initial moisture content	240 kPa
Pocket penetrometer reading at final moisture content	220 kPa
Initial Moisture Content	21.4 %
Final Moisture Content	22.2 %
Swell under 25kPa	0.3 %



SHRINK-SWELL INDEX Iss 1.5% per Δ pF

Description: Orange brown CLAY
Test Method(s): AS 1289.7.1.1, AS 1289.2.1.1
Sampling Method(s): Sampled by Douglas Partners' Engineers
Extent of Cracking: UC - Uncracked
 SC - Slightly cracked
 MC - Moderately cracked
 HC - Highly cracked
 FR - Fractured

Remarks:

Note that NATA accreditation does not cover the performance of pocket penetrometer readings



NATA Accredited Laboratory Number: 828
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Tested: AG
 Checked: DB

Dan Byrnes
 Laboratory Manager

Result of Shrink-Swell Index Determination

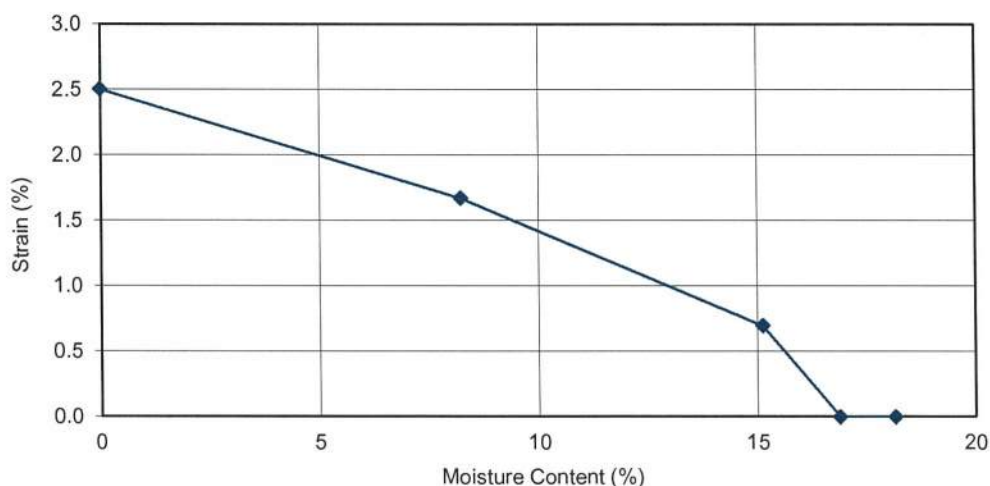
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Project :	Proposed Gosford Hospital Redevelopment	Report No. :	CC14-120_2
Location :	Holden Street, Gosford	Report Date :	13.11.2014
Test Location :	Bore 4	Date Sampled :	5.9.2014
Depth / Layer :	1.5 - 1.95m	Date of Test:	29.10.2014
		Page:	1 of 1

CORE SHRINKAGE TEST

Shrinkage - air dried	1.7 %
Shrinkage - oven dried	2.5 %
Significant inert inclusions	0.0 %
Extent of cracking	UC
Extent of soil crumbling	0.0 %
Moisture content of core	16.9 %

SWELL TEST

Pocket penetrometer reading at initial moisture content	400 kPa
Pocket penetrometer reading at final moisture content	310 kPa
Initial Moisture Content	17.5 %
Final Moisture Content	18.2 %
Swell under 25kPa	0.0 %



SHRINK-SWELL INDEX Iss 1.4% per Δ pF

Description:	Orange brown SANDY CLAY
Test Method(s):	AS 1289.7.1.1, AS 1289.2.1.1
Sampling Method(s):	Sampled by Douglas Partners' Engineers
Extent of Cracking:	UC - Uncracked SC - Slightly cracked MC - Moderately cracked

HC - Highly cracked
FR - Fractured

Remarks:

Note that NATA accreditation does not cover the performance of pocket penetrometer readings



NATA Accredited Laboratory Number: 828

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Tested:	AG
Checked:	DB

Dan Byrnes
Dan Byrnes
Laboratory Manager

Result of Shrink-Swell Index Determination

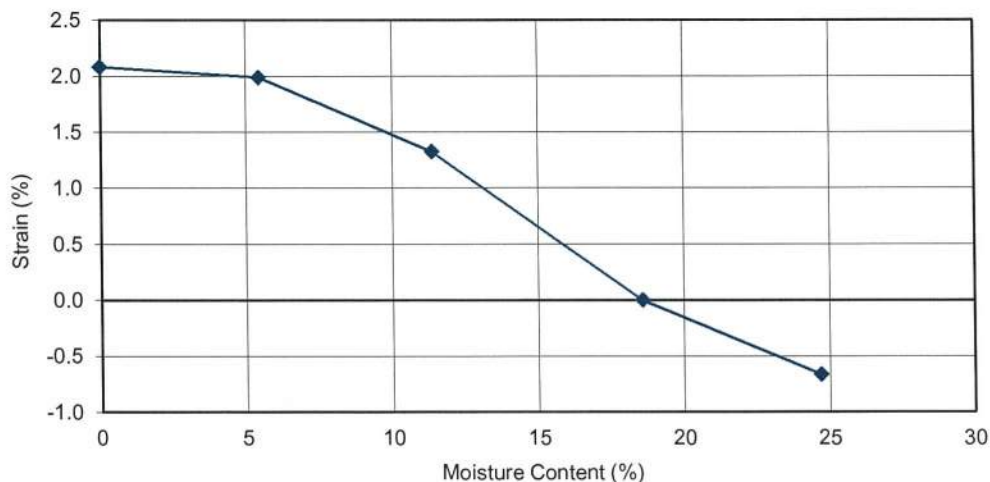
Client :	Health Infrastructure	Project No. :	75799.00
Project :	Proposed Gosford Hospital Redevelopment	Report No. :	CC14-120_3
Location :	Holden Street, Gosford	Report Date :	13.11.2014
Test Location :	Bore 5	Date Sampled :	9.9.2014
Depth / Layer :	1.0 - 1.4m	Date of Test:	29.10.2014
		Page:	1 of 1

CORE SHRINKAGE TEST

Shrinkage - air dried	2.0 %
Shrinkage - oven dried	2.1 %
Significant inert inclusions	0.0 %
Extent of cracking	UC
Extent of soil crumbling	0.0 %
Moisture content of core	18.6 %

SWELL TEST

Pocket penetrometer reading at initial moisture content	400 kPa
Pocket penetrometer reading at final moisture content	380 kPa
Initial Moisture Content	23.0 %
Final Moisture Content	24.7 %
Swell under 25kPa	0.7 %



SHRINK-SWELL INDEX Iss 1.3% per Δ pF

Description:	Orange brown CLAY
Test Method(s):	AS 1289.7.1.1, AS 1289.2.1.1
Sampling Method(s):	Sampled by Douglas Partners' Engineers
Extent of Cracking:	UC - Uncracked SC - Slightly cracked MC - Moderately cracked

HC - Highly cracked
FR - Fractured

Remarks:

Note that NATA accreditation does not cover the performance of pocket penetrometer readings



NATA Accredited Laboratory Number: 828

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025

Tested:	AG
Checked:	DB

Dan Byrnes
Dan Byrnes
Laboratory Manager