REPORT

TO
PAYNTER DIXON CONSTRUCTIONS PTY LTD

ON
'DUE DILIGENCE' GEOTECHNICAL INVESTIGATION

FOR
SITE A: PROPOSED OUT DOOR SPORTS FACILITIES – 221 WALTERS ROAD, ARNDELL PARK.

SITE B: RESIDENTIAL AGE CARE FACILITY AND CHILDCARE CENTRE – 170 RESERVOIR ROAD, ARNDELL PARK

AT
BLACKTOWN WORKERS SPORTS CLUB

21 December 2015
Ref: 28870ZArpt Rev 1

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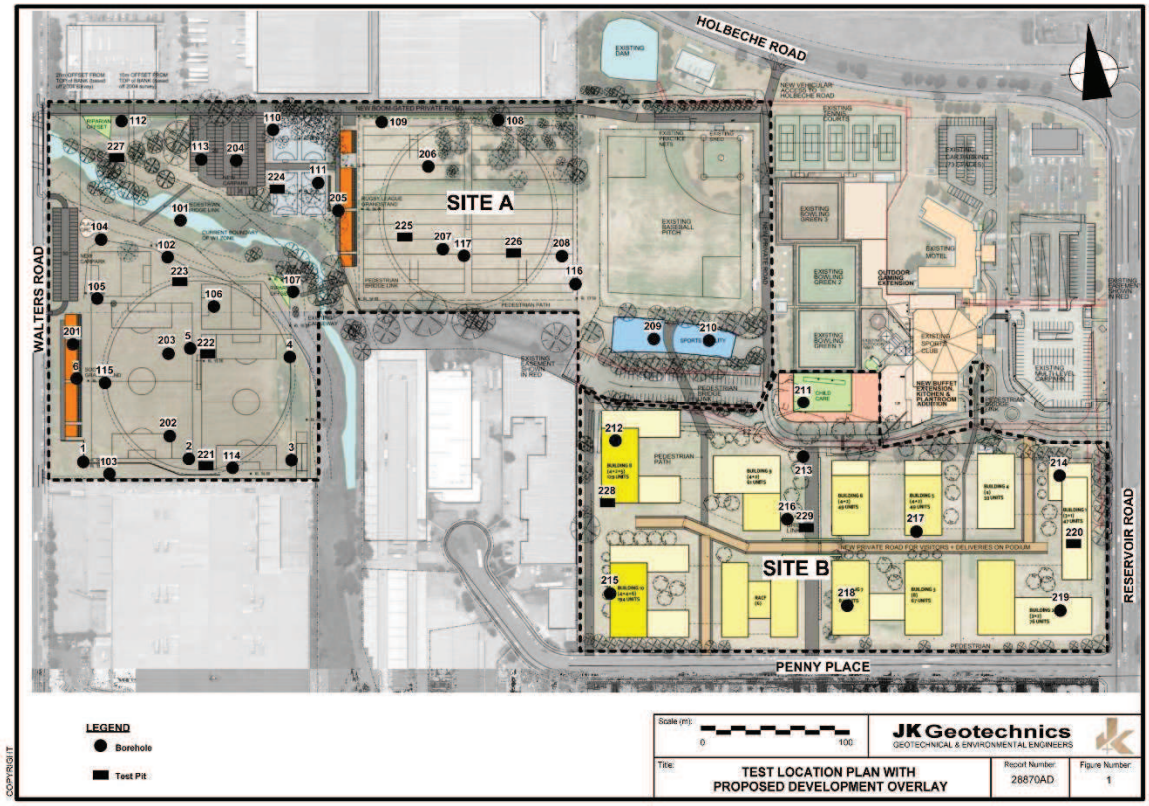

This report has been prepared to present the results of a 'due diligence' geotechnical investigation to support the master plan of the Blacktown Workers Sports Club. Given the integrated nature of the master plan this report has been prepared for all three components needed to facilitate the development:

- Planning Proposal to include 'recreation facility (outdoor)' on Lot 14 Sec 4 DP6796 and Lot 10 DP818679.
- Development Application for the outdoor sports facilities on Lot 14 Sec 4 DP6796 and Lot 10 DP818679.
- Site Compatibility Certificate for residential aged care facilities on Lot 201 DP880404.

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1 INTRODUCTION

This report presents the results of a 'due diligence' geotechnical investigation for the proposed sports facilities, residential age care facility and childcare centre at Blacktown Workers Sports Club, Reservoir Road, Arndell Park NSW. The investigation was commissioned by Mr Barry Virgilii of Paynter Dixon Constructions Pty Ltd (PDC) by email on 23 October 2015, which referenced Consultancy Services Agreement No. AA10690. The commission was on the basis of our fee proposals including:

- Ref. 'P41152AC Rev1' dated 22 September 2015;
- Ref. 'P41152AC2' dated 21 October 2015;
- Ref. 'P41152AC3' dated 21 October 2015.

1.1 Supplied Information

We have been supplied with the following information:

- An emailed geotechnical brief prepared by Mr John Jamieson of PDC dated 7 September 2015;
- 'Updated Development Brief' prepared by PDC (Job No. BWC 2/25, dated 21 October 2015);
- Architectural 'Site Plan' drawing prepared by Allen Jack & Cottier Architects (Drawing No. SK1000, Issue 01, undated);
- Architectural masterplan drawings prepared by Allen Jack & Cottier Architects (Job No. 15029, Drawing Nos. SK890 to SK893, dated 11 November 2015);
- Architectural masterplan sketch drawings prepared by Allen Jack & Cottier Architects (Job No. 15029) titled 'Grandstand Option 02', 'Sports Centre of Excellence – Parking Plan' and 'Sports Centre of Excellence – Ground Floor', which were supplied by Mr Virgilii by email on 30 November 2015;
- Unreferenced site sections for the 'Sports Centre of Excellence', 'Rugby Field', 'Soccer Field' and 'Residential Age Care Facility', which were supplied by Mr Virgilii by email on 30 November 2015;
- Unreferenced childcare centre plan sketches for the ground, first and second floors, which were supplied by Mr Virgilii by email on 30 November 2015;
- Preliminary 'Stormwater Management Concept Plan' drawing prepared by Wood & Grieve Engineers (Project No. 28811-SYD, Drawing No. SKC-002, Revision 1, dated 7 December 2015);
- Preliminary survey plans prepared by Landpartners (Plan No. SY073782.000, 4 sheets, dated 29 October 2015);

- A previous geotechnical investigation report prepared by Brink & Associates (Ref. S06160-A TV:MC, dated 1 February 2007);
- Several environmental reports by others.

The development areas have been identified by PDC as 'Site A' and 'Site B'. A test location plan showing the proposed development overlay is presented as Figure 1. Detailed architectural and civil designs have not yet been completed.

1.2 Proposed Site A Development

Based on the supplied information, we understand that the proposed Site A development will comprise construction of:

- Two natural grass rugby league fields incorporating a cricket pitch for seasonal flexibility;
- Two natural grass soccer fields incorporating a cricket pitch for seasonal flexibility;
- Synthetic surfaced futsal/netball courts;
- Practice cricket nets;
- Outdoor children's play area;
- Flood lighting around all sporting facilities;
- Grandstand structures, including amenities, on the western side of the rugby league and soccer fields;
- On-grade car parking areas and access roads;
- A single storey sports facility (Sports Centre of Excellence) at the eastern end of Site A;
- Three pedestrian bridges across Bungarribee Creek and its tributary to the east.

Based on the sloping nature and the landforms within Site A, substantial cut and fill earthworks are envisaged for the construction of the proposed playing fields. Permanent batter slopes around the playing fields have been nominated at 1 Vertical (V) on 4 Horizontal (H).

We were advised by Mr Virgilii by email on 27 November 2015 that the proposed new single storey sports facility will not include a basement level (ie. contrary to what is shown on the supplied architectural drawings). The proposed sports facility will include however, an 8m x 8m in-ground hydro-therapy pool and a 15m x 8m in-ground swimming pool.

Structural loads typical of this type of development have been assumed.

1.3 Proposed Site B Development

We understand that the proposed Site B development will comprise construction of:

- A residential age care facility comprising eleven towers, ranging from one to eight stories high, overlying two common basement car parking levels;
- A three storey childcare centre;
- One pedestrian bridge across the Bungarribee Creek tributary.

Based on the existing landform, we have assumed that the proposed basements will require excavation to depths between approximately 6m (western end) and 7.5m (eastern end) below existing grade.

Structural loads typical of this type of development have been assumed.

1.4 Purpose of Investigation

The purpose of the 'due diligence' investigation was to assess the subsurface conditions at nineteen nominated borehole locations and at ten nominated test pit locations. Based on the information obtained, we present our preliminary comments and recommendations on earthworks, excavation conditions, seepage, retention, footings, basement floor slab, external pavements and additional investigations.

Our environmental consulting division, EIS, was commissioned to carry out a Stage 1 environmental site assessment (report Ref. E28870KBrpt), which was carried out concurrently with the geotechnical investigation. This geotechnical investigation report must be read in conjunction with the EIS report.

2 INVESTIGATION PROCEDURE

2.1 Walkover Inspection & Desktop Study

On 26 October 2015, our Senior Geotechnical Engineer (David Schwarzer) carried out a walkover inspection of the topographic, surface drainage and geological conditions of the site and its immediate environs. A summary of the observations made during the walkover inspection is presented in Section 3.1.

During this inspection, the nominated borehole and test pit locations were set out. Some of the locations were slightly modified to suit site conditions. A specialist sub-consultant electro-magnetically scanned the borehole and test pit locations for buried services.

A desktop study of the supplied geotechnical and environmental reports (by others) and also of our archived previous investigations was also carried out. Two previous investigations, located within Site A, were considered to be relevant.

2.2 Borehole and Test Pit Investigation

The fieldwork for the investigation was carried out between 2 and 6 November 2015 and comprised the scope of work outlined below. The test locations within Site A and Site B are presented on the attached Figures 2 and 3, respectively.

- Nineteen boreholes (BH201 to BH219) were drilled to depths between 2.0m and 10.5m below existing grade. The boreholes were auger drilled using our truck mounted JK500 drill rig, which is equipped for site investigation purposes. The relative compaction/strength of the subsoil profile was assessed from the Standard Penetration Test (SPT) 'N' values, together with hand penetrometer readings on clayey soils recovered in the SPT split-spoon sampler and from the auger, and by tactile examination. The strength of the underlying bedrock was assessed by observation of auger penetration resistance when using a twin-pronged tungsten carbide (TC) bit, together with examination of recovered auger cuttings and correlations with subsequent laboratory moisture content test results. Groundwater observations were also made in the boreholes. On completion, each borehole was backfilled using the drill spoil and surface sealed with a concrete plug.

- Ten test pits (TP220 to TP229) were excavated to depths between 1.0m and 1.7m below existing grade using a backhoe with a 0.45m wide 'digging' bucket. Hand penetrometer readings were completed in the sides of the test pits and on recovered lump samples to assess

the strength of the natural clay soils. The strength of the underlying bedrock, where encountered, was assessed by tactile examination of the excavated spoil. Groundwater observations were also made in the test pits. On completion, each test pit was backfilled using the excavated spoil and compacted in layers by tamping with the bucket. Excess spoil was mounded above the backfill and compacted by rolling with the backhoe.

The borehole and test pit locations were set out using a combination of tape measurements from existing surface features and a hand held GPS. We expect that the positional accuracy of the test locations is within 4m. The surface reduced levels (RL) indicated on the attached borehole and test pit logs were interpolated between spot level heights and ground contour lines shown on the supplied preliminary survey plans, and are therefore only approximate. The survey datum is the Australian Height Datum (AHD).

Further details of the methods and procedures employed in the investigation are presented in the attached Report Explanation Notes.

Our engineering geologist (Lachlan May) was present full-time during the fieldwork to nominate testing and sampling, and to prepare the attached borehole and test pit logs. The Report Explanation Notes define the logging terms and symbols used. The (deep) borehole logs and (shallow) test pit logs have been presented at different vertical scales.

Selected soil and rock cutting samples were returned to a NATA registered laboratory, Soil Test Services Pty Ltd (STS), for moisture content, Atterberg Limits and linear shrinkage testing. The results are summarised in the attached STS Table A.

3 RESULTS OF THE INVESTIGATION

3.1 Site Description

3.1.1 Site A

Site A is the western half of the proposed development area. The Blacktown Workers Sports Club bounds Site A to the east. Walters Road bounds Site A to the west. Holbeche Road is located to the north-east of Site A.

The site is located in undulating topography, across the base of a relatively shallow gully and extends across Bungarribee Creek, which is oriented south-east to north-west; refer to Figure 1. The creek banks were relatively flat. On the north-eastern side of the creek was a relatively low lying alluvial flood plain. A small, east-west oriented tributary discharged into the creek on its eastern side. This tributary meandered either side of the southern site boundary. A culvert discharged into the tributary at the eastern end of the Site A southern boundary.

At the north-western corner of site, was a second tributary which was oriented north-east to south-west. This tributary appeared to be fed from stormwater discharge from the neighbouring commercial properties to the north. Small to medium size trees lined the banks of the creek and tributaries.

At the time of our inspection, the site was characterised by three separate landforms, including:

South-West of Bungarribee Creek

Here, the site generally graded down to the north-east towards Bungarribee Creek at about 3° to 4°. This portion of the site was grass covered.

North-East of Bungarribee Creek (Low Lying)

The alluvial flood plain was gently undulating, grass covered and contained scattered small to large size trees. Mid-length along the northern site boundary was an approximately 65m x 30m area which contained loosely placed clayey gravel fill. At the eastern end of this fill area was a large pool of water which was no more than about 0.4m deep.

North-East of Bungarribee Creek (Higher Lying Fill Platform)

Rising above the flood plain was a fill embankment which projected as a spur in a westerly direction; refer to Figure 2. The fill embankment was generally about 3m high and the fill batter slope typically graded at about 32°. The surface of the fill embankment was grass

covered and generally graded down to the west at about 1°. The main east-west tributary was located on the southern side of the spur, beyond the toe of the fill batter slope.

To the east of the spur (ie. eastern end of Site A) was an existing grass covered baseball field. Two asphaltic concrete (AC) surfaced car parks were located to the south of the baseball field. The surface levels of the car parks stepped down in a southerly direction, and the southern (lower) car parking area overlay the above mentioned culvert. The southern side of the baseball field and each car parking area were separated by batter slopes which were up to 2m high, and grading typically at about 20°.

To the north of the site were three concrete block warehouse buildings with concrete hardstand surrounds. The neighbouring buildings abutted the northern site boundary. The neighbouring buildings and hardstands appeared to be in good condition when viewed from within the subject site. Surface levels across the northern site boundary were similar.

The neighbouring property located off the western end of the southern site boundary was occupied by a precast concrete panel warehouse building with concrete hardstand surrounds. The neighbouring building was set back approximately 15m from the common boundary, and appeared to be in good condition when viewed from within the subject site. A concrete segmental block wall supported the neighbouring property to the south. From its western end, adjacent to Walters Road, the segmental block wall gradually increased in height to about 6.5m at its eastern end, where it returned in a southerly direction. The retaining wall appeared to be in good condition based on a cursory inspection.

The neighbouring properties located beyond the central portion of the southern site boundary were occupied by two precast concrete panel warehouse buildings, which abutted the east-west oriented tributary. The neighbouring warehouse buildings were slightly elevated above the tributary and appeared to be in good condition based on a cursory inspection from within the subject site.

3.1.2 Site B

Site B is the eastern half of the proposed development area. The Blacktown Workers Sports Club bounds Site B to the north. Reservoir Road and Penny Place bound Site B to the east and south, respectively. An internal AC surfaced access road ran along the northern boundary of Site B.

At the time of our inspection, the site was occupied by two grass covered, terraced playing fields which had been formed by cut and fill earthworks, but predominantly by filling. The higher lying

eastern field and the lower lying western field were separated by an approximately 1.5m high grass covered batter slope, which graded at about 27°. A stormwater inlet pit was located centrally along the eastern side of the upper field.

Along the northern two-thirds of the eastern site boundary was a sandstone block retaining wall, which supported the Reservoir Road footpath to a maximum height of 0.8m. The sandstone block wall appeared to be in good condition based on a cursory inspection. Beyond the southern end of the wall, the south eastern corner of the site graded at a maximum of 9° between the road boundaries and the lower playing field surface.

For the remainder of the southern boundary (ie. western three-quarters), the playing field surfaces were higher in elevation than the Penny Place boundary. Here, the southern fill slope was up to 2m high and graded at about 27° down to the south. Along the western side of the playing fields, the fill batter slope was also up to 2m high and graded at about 32° down to the west.

Along the northern side, the fill batter slope was up to 1.5m high and graded to a maximum of about 20° down to the north. Beyond the toe of the northern fill batter slope was the AC surfaced internal access road, discussed above. Towards the western end of the northern fill batter slope was an AC surfaced car park located behind the crest of the slope, at a similar level to the lower playing field surface. The northern AC access road extended up the fill batter slope, either side of the car park.

To the west of the site were two precast concrete panel warehouse buildings, which abutted the western site boundary. The neighbouring buildings appeared to be in good condition when viewed from within the subject site. The neighbouring surface levels were similar to the toe level of the western fill batter slope.

3.2 Desktop Study

Relevant to proposed development were two previous geotechnical investigation reports, including:

- The supplied geotechnical investigation report prepared by Brink & Associates (Ref. S06160-A TV:MC, dated 1 February 2007);
- Archived preliminary geotechnical investigation report prepared by Jeffery and Katauskas Pty Ltd [now trading as JK Geotechnics] (Ref. 25295ZRrpt, dated 7 November 2011).

Both these reports are relevant to Site A. We have not relied on any of the provided environmental reports for geotechnical information, as the soil and rock logging has a different emphasis.

The 2007 Brink & Associates investigation comprised the following scope of work:

- Auger drilling of seventeen boreholes (BH101 to BH117) to depths between 1.0m and 11.7m below original grade. Nine of the seventeen boreholes (BH104 to BH112) were drilled to 1.0m depth for sampling purposes only. The remaining deeper boreholes included SPT's.
- Eleven soaked CBR tests were carried out. Only a summary of the test results, not the actually laboratory test reports in Appendix B of the report were provided.
- A geotechnical report with advice tailored for a development comprising two warehouse buildings, car park and driveway pavements, and a pedestrian bridge over Bungarribee Creek.

The borehole location plan and borehole logs from the 2007 Brink & Associates report are presented in Appendix A.

The 2011 Jeffery and Katauskas Pty Ltd investigation comprised the following scope of work:

- Auger drilling of six boreholes (BH1 to BH6) to depths between 4.5m and 7.0m below original grade. All boreholes included SPT's.
- Laboratory testing comprised seven moisture content tests, two Atterberg Limits and linear shrinkage tests, and two Standard compaction and four day soaked CBR tests.
- A geotechnical report with advice tailored for a development comprising a warehouse building and surrounding pavements.

The borehole location plan, borehole logs and laboratory test results from the 2011 Jeffery and Katauskas Pty Ltd report are presented in Appendix B.

The pertinent results of both previous investigations are discussed in Sections 3.3 & 3.4 below.

3.3 Subsurface Conditions

The 1:100,000 series geological map of Penrith (Geological Survey of NSW, Geological Series Sheet 9030) indicates the site to be underlain by Bringelly Shale of the Wianamatta Group. Generally, the boreholes and test pits encountered fill to variable depths, overlying natural clay, then shale and/or sandstone bedrock at generally shallow to moderate depths. Reference should be made to the attached borehole and test pit logs for details at each specific location. Graphical borehole summaries are presented as Figures 4 to 9. A summary of the subsurface characteristics encountered in the current boreholes and test pits is provided below for each site.

3.3.1 Site A

Based on the existing landforms, Site A has been subdivided into three sub-areas, including 'South-West of Bungarribee Creek', 'North-East of Bungarribee Creek (Low Lying)' and 'North-East of Bungarribee Creek (Higher Lying Fill Platform)'.

South-West of Bungarribee Creek'

The relevant boreholes and test pits include BH201, BH202, BH203, TP221, TP222 and TP223.

- **Fill**: Clayey fill was encountered in all three boreholes and all three test pits to depths of either 0.3m or 0.4m below existing grade. Inclusions of igneous gravel, ash, roots and root fibres were found in the fill. At all test locations the fill was grass covered.
- **Natural Silty Clay**: Natural silty clay of predominantly high plasticity and of very stiff to hard strength was encountered below the fill in the boreholes and test pits. TP221 and TP223 were terminated within the natural silty clay profile at depths of 1.1m and 1.0m, respectively.
- **Bedrock**: Shale or sandstone bedrock was encountered in BH201, BH202, BH203 and TP222 at depths between 0.9m (TP222) and 2.2m (BH202). The upper bedrock profile in BH201, BH203 and TP222 was generally extremely to distinctly weathered and of extremely low and very low strength. This 'weak' profile was 0.3m thick in BH201, 1.9m thick in BH203, and at least 0.1m thick in TP222. The underlying bedrock in BH201 and BH203, and the entire bedrock profile in BH202 was generally distinctly weathered and of low, medium and high strength. In all boreholes, auger refusal occurred in high strength bedrock.
- **Groundwater**: The boreholes and test pits were 'dry' during and on completion of drilling/excavation. We note that the groundwater levels may not have stabilised within the limited observation period. No long-term groundwater level monitoring was carried out.

Our previous boreholes (BH1 to BH6) from geotechnical investigation report, Ref. '25295ZRrpt' dated 7 November 2011, encountered weathered shale bedrock at depths between 0.8m (BH5) and 2.8m (BH4 & BH6), which are consistent with the current boreholes.

The relevant boreholes from the previous Brink & Associates geotechnical report include BH102 to BH107, and BH114 and BH115. Only BH102, BH103, BH114 and BH115 proved bedrock. In these four boreholes, shale bedrock was encountered at depths between 1.4m (BH102 & BH115) and 3.0m (BH103), which are consistent with the current boreholes.

North-East of Bungarribee Creek (Low Lying)

The relevant boreholes and test pits include BH204, BH205, BH206, TP224 and TP227.

- **Fill**: Clayey fill was generally encountered in the boreholes and test pits to depths between 0.3m and 0.5m below existing grade. However in BH206 (loosely placed fill area), the fill was 2.5m deep. Inclusions of shale, sandstone and igneous gravel, ash, fibro cement fragments, plastic, glass, roots and root fibres were found in the fill. At all locations except for BH206, the fill was grass covered. Based on the SPT results and the limited hand penetrometer readings, the deeper fill in BH206 was initially assessed to be poorly compacted, but improved with depth to well compacted.
- **Natural Silty Clay**: Natural silty clay of either medium or high plasticity and of generally stiff to very stiff strength was encountered below the fill in all boreholes and test pits, except for BH206. Natural silty clay of firm strength was encountered in the basal profile of BH204. TP224 and TP227 were terminated within the natural silty clay profile at 1.0m depth.
- **Bedrock**: Shale bedrock was encountered in BH204, BH205 and BH206 at depths between 2.5m (BH206) and 4.1m (BH205). The shale was generally distinctly to slightly weathered, and of very low, low and medium strength. In BH205, high strength shale was encountered at 6.6m depth with auger refusal occurring at 7.1m depth.
- **Groundwater**: On completion of drilling, groundwater was encountered in BH204, BH205 and BH206 at depths of 2.9m, 6.5m and 8.2m, respectively. All three boreholes were left open for 1 day and the groundwater levels rose to depths of 0.6m in BH204, 0.3m in BH205, and 2.4m in BH206. The test pits were 'dry' during and on completion of excavation. We note that the groundwater levels may not have stabilised within the limited observation period. No long-term groundwater level monitoring was carried out.

The relevant boreholes from the previous Brink & Associates geotechnical report include BH101, and BH108 to BH113. Only BH101 and BH113 proved bedrock. In these two boreholes, weathered

shale bedrock was encountered at depths of 3.2m (BH101) and 3.5m (BH113), which are consistent with the current boreholes.

North-East of Bungarribee Creek (Higher Lying Fill Platform)

The relevant boreholes and test pits include BH207 to BH210, TP225 and TP226.

- **Pavement**: A 100mm thick AC surfacing was encountered in BH209 and BH210. No basecourse or sub-base layers were found below the AC surfacing.
- **Fill**: Fill, predominantly comprising clayey soils and to a lesser extent sandy soils, was encountered below the AC surfacing in BH209 and BH210, and from the surface in the remaining boreholes and test pits to depths from at least 1.5m (TP225 & TP226) to 5.8m (BH208). Inclusions of shale, sandstone and igneous gravel, cobbles, tile, brick, concrete, plastic, ash, slag, roots and root fibres were found in the fill. In BH210, the basal fill profile comprised sandstone cobbles and boulders. The fill at BH207, BH208, TP225 and TP226 was grass covered. Based on the SPT results and the limited hand penetrometer readings, the fill was assessed to be variably compacted, with poor compaction indicated in the upper profile of BH208 and in the lower profile of BH209. TP225 and TP226 were terminated within the fill profile at 1.5m depth.
- **Natural Silty Clay**: Natural silty clay of high plasticity and of very stiff strength was encountered below the fill in all four boreholes.
- **Bedrock**: Shale bedrock was encountered in BH207 to BH210 at depths between 3.0m (BH210) and 8.5m (BH207). The bedrock profile in BH207, BH208 and BH209 was generally distinctly weathered and of low, medium and high strength. In BH209 and BH210, the bedrock was capped with an extremely to distinctly weathered shale layer of extremely low to very low strength. This 'weak' profile was 0.4m thick. In BH209 and BH210, auger refusal occurred in high strength bedrock.
- **Groundwater**: On completion of drilling, groundwater was encountered in BH207 and BH209 at depths of 6.8m and 3.6m, respectively. BH208 and BH210 were 'dry' during and on completion of drilling. BH207 and BH208 were left open for 1 day and the groundwater levels rose to depths of 4.3m in BH207 and 5.3m in BH208. The test pits were 'dry' during and on completion of excavation. We note that the groundwater levels may not have stabilised within the limited observation period. No long-term groundwater level monitoring was carried out.

The relevant boreholes from the previous Brink & Associates geotechnical report include BH116 and BH117, which both proved bedrock. In these two boreholes, shale bedrock was encountered at depths of 5.8m (BH116) and 9.8m (BH117), which are generally consistent with the current

boreholes. BH117 was drilled approximately 15m to the south-east of current BH207, which encountered shale bedrock at 8.5m depth. The difference in bedrock depths over a relatively short distance is unknown; possibly an error by Brink & Associates in the plotting of BH117.

3.3.2 Site B

The relevant boreholes and test pits include BH211 to BH219, and TP220, TP228 and TP229.

- **Fill**: Clayey fill was encountered in all nine boreholes and three test pits to depths between 0.4m (BH219) and 3.0m (BH212 & BH215). Inclusions of shale, sandstone and igneous gravel, shale cobbles, ash, brick, slag, roots and root fibres were found in the fill. The fill at all boreholes and test pits was grass covered. Based on the SPT results and the limited hand penetrometer readings, the fill was generally assessed to be moderately to well compacted. TP220, TP228 and TP229 were terminated within the fill profile at depths of either 1.3m or 1.7m.
- **Natural Silty Clay**: Natural silty clay of predominantly high plasticity and of stiff to hard strength was encountered below the fill in all boreholes.
- **Bedrock**: Shale or sandstone bedrock was encountered in all boreholes at the depths and RL's tabulated below:

Borehole	Depth to Bedrock (m)	Approximate RL of Bedrock Surface (mAHD)
BH211	1.7	56.3
BH212	4.5	54.7
BH213	3.6	56.2
BH214	3.0	60.0
BH215	5.2	54.0
BH216	2.3	57.5
BH217	2.4	59.9
BH218	3.5	58.5
BH219	1.8	61.6

The bedrock surface levels generally deepened in a westerly to north-westerly direction. In BH211, BH213, BH216 and BH217, the bedrock comprised sandstone. The sandstone was distinctly weathered and of low, medium and high strength. In all four boreholes, auger refusal occurred in high strength sandstone bedrock. The sandstone was only proven for a penetration length between 0.3m (BH211) and 1.6m (BH217). In the remaining boreholes, the bedrock comprised shale. The shale was generally distinctly to slightly weathered and of low, medium and high strength. The upper bedrock profile in BH212, BH214 and BH215 was generally extremely to distinctly weathered and of extremely low and very low strength. This 'weak' profile was 0.5m thick in BH212, 0.4m thick in BH214, and 1.8m thick in BH215. In

BH212, BH214, BH215, BH218 and BH219, auger refusal occurred in high strength shale bedrock.

- **Groundwater**: On completion of drilling, groundwater was encountered in BH212 at 6.3m depth. All remaining boreholes were 'dry' during and on completion of drilling. Groundwater seepage was encountered in TP229 at 1.0m depth; presumably 'perched' groundwater within the fill profile. TP220 and TP228 were 'dry' during and on completion of excavation. We note that the groundwater levels may not have stabilised within the limited observation period. No long-term groundwater level monitoring was carried out.

3.4 Laboratory Test Results

3.4.1 Current Test Results

The moisture content and Atterberg Limits test results confirmed our field classification of the site soils. The Atterberg Limits and linear shrinkage test results generally indicated the sampled natural silty clay of medium or high plasticity to have a moderate to high potential for shrink-swell reactivity with changes in moisture content.

The results of the moisture content tests carried out on recovered rock chip samples generally correlated poorly with our field assessment of bedrock strength. As such, our assessment of rock strength was based on observation of auger penetration resistance and examination of recovered auger cuttings. We note that there are limitations in assessing rock strength based on a combination of auger penetration resistance and tactile examination of recovered auger cuttings, and in some instances the assessed strength may vary from the actual strength by one order of rock strength.

3.4.2 Previous Test Results

2011 Jeffery and Katauskas Pty Ltd Investigation

For our previous 2011 investigation in Site A, the laboratory testing included two Atterberg Limits and linear shrinkage tests, and two Standard compaction and four day soaked CBR tests. The Atterberg Limits and linear shrinkage test results generally indicated the sampled natural silty clay of high plasticity from BH2 and BH6 to have a high potential for shrink-swell reactivity with changes in moisture content.

The four day soaked CBR tests carried out on natural silty clay samples from BH1 and BH4 resulted in a value of 3.0% when compacted to 98% of Standard Maximum Dry Density (SMDD) and

surcharged with 9kg. The clayey samples were compacted prior to CBR testing at close to their Standard Optimum Moisture Contents (SOMC), which were up to 4.5% 'dry' of their respective insitu moisture contents. A swell of 1.5% was measured on both clayey samples during the four day soaking period.

2007 Brink & Associates Investigation

A summary of the four day soaked CBR test results is tabulated below. The detailed laboratory test reports (Appendix B of the Brink & Associates report) were not supplied.

Borehole	Depth (m)	Material Description (as per Brink & Associates borehole logs)	CBR Value (%)
BH102	0.3-1.0	Natural Clay	3.5
BH104	0.3-1.0	Natural Clay	3.0
BH105	0.2-1.0	Natural Clay	2.0
BH106	0.4-1.0	Natural Silty Clay	3.0
BH107	0.3-1.0	Natural Clay	2.5
BH108	0.2-1.0	Natural Clay	1.5
BH109	0.3-1.0	Natural Clay	2.0
BH110	0.4-1.0	Natural Clay	3.5
BH111	0.3-1.0	Natural Silty Clay	3.5
BH112	0.3-1.0	Gravelly Clay Fill	4.5
BH113	0.3-1.0	Natural Silty Clay	4.0

4 SITE A PRELIMINARY COMMENTS AND RECOMMENDATIONS

The comments and recommendations provided below are generalised and are of a preliminary nature, and will need to be reviewed and most likely supplemented once the architectural and civil designs have been finalised.

4.1 Geotechnical Issues

We consider the following to be the primary geotechnical issues for the proposed Site A development:

- Stability of the segmental block retaining wall along the western end of the southern site boundary due to any proposed cuts for the creation of the new soccer fields.
- Removal of trees which could result in an increase in swell movements in the vicinity of the trees and potentially cause damage to the abutting warehouse buildings and hardstands in the neighbouring properties to the north.
- Relatively shallow groundwater within the low lying alluvial flood plain on the north-eastern side of Bungarribee Creek.
- Presence of clay soils with a moderate to high potential for shrink-swell movements with changes in moisture content.
- Presence of medium and high strength shale and sandstone for excavation and pile drilling.
- Low CBR values for the clay subgrade.

The effects of the above geotechnical issues on design and construction are detailed in the sections which follow.

4.2 Southern Boundary Segmental Block Retaining Wall

The civil design for the proposed soccer fields and surrounding structures must take into account the toe level and the stability of the boundary segmental block retaining wall. The investigation of the boundary wall should include review of the design drawings (if available) and test pits along the base to confirm the footing details and foundation material. If proposed excavations are to extend below the base of the wall, then a cast-insitu retention system (eg. a contiguous pile wall or soldier pile wall with concrete infill panels) will be required to support the segmental block retaining wall, its backfill and its pavement surcharge load. If deep excavations are proposed, then permanent rock anchors will most likely be required along the cast-insitu retention system to control deflections.

Once the civil design has been finalised, we can complete the test pit investigation (and cored boreholes if anchoring is envisaged) and provide appropriate retention design advice, if commissioned to do so.

4.3 Removal of Existing Trees

The proposed development will require the removal of numerous trees. We note that the existing trees have likely caused localised 'drying out' of the surrounding clay soils. Removal of the trees will therefore lead to the recovery of the soil moisture content, resulting in differential swell movements in the vicinity of the trees and their root systems (which can extend for a significant distance from the trunk). The swell movements generated by the removal of the trees are in addition to the shrink-swell movements which can occur in the clay soils due to weather related natural moisture changes and by the reduction in surface evaporation subsequent to covering the site with the proposed pavements, courts and grandstands. Both mechanisms of shrink/swell movement are outlined in AS2870-2011 'Residential Slabs and Footings'.

Removal of boundary trees may result in damage to neighbouring warehouse buildings and hardstands which abut the site (eg. along the northern site boundary). Precautions will be required when removing trees from along the site boundaries. In this event, further advice from JK Geotechnics should be sought.

It is likely that moisture equilibrium in the clay soils, following removal of the tree stumps and roots, could take one to two years to develop. In order to reduce the effects that removal of the trees will have on the proposed development, we strongly recommend they be removed as early as possible ahead of construction.

4.4 Earthworks

All earthworks recommendations provided below should be complemented by reference to AS3798-2007 'Guidelines on Earthworks for Commercial and Residential Developments'.

4.4.1 Site Drainage

The clay subgrade at the site is expected to undergo substantial loss in strength when wet as evident from the low CBR values from the previous investigations. Furthermore, the clay subgrade is expected to have a moderate to high shrink-swell reactive potential. Therefore, it is important to provide good and effective site drainage both during construction and for long-term site

maintenance. The principle aim of the drainage is to promote run-off and reduce ponding. A poorly drained clay subgrade may become untraffickable when wet. The earthworks should be carefully planned and scheduled to maintain good cross-falls during construction.

4.4.2 Site Preparation

Following removal of the trees (including their root balls) and demolition of the AC surfacing in the vicinity of BH209 and BH210, all grass, topsoil, root affected soils and any deleterious fill or contaminated soil should be stripped. Based on the results of the investigation, root affected soil should be stripped to a nominal depth of about 0.1m. We note that it is difficult to accurately assess the depth of topsoil and root affected soils in 100mm diameter boreholes and a limited number of test pits. If considered to be an important contractual issue, we recommend that a number of shallow test pits be excavated across the site to more accurately confirm the root affected soil stripping depth or alternatively a geotechnical inspection could be carried out after initial stripping to confirm the depth.

Deep topsoil profiles can often be separated into an upper root/organic rich zone and a lower less organic zone. On many projects now, JK Geotechnics have successfully designed a material blend so that the lower less organic zone can be reused as engineered fill. The design of the blend would be assessed during the test pit investigation.

Stripped (unsuitable) topsoil and root affected soils should be stockpiled separately as they are considered unsuitable for reuse as engineered fill. They may however be reused for landscaping purposes, subject to approval by EIS. Reference should be made to the EIS report for guidance on the offsite disposal of soil.

The loosely placed clayey gravel fill within the approximately 65m x 30m area located mid-length along the northern side of Site A should be stripped, stockpiled and inspected by JK Geotechnics for possible reuse as engineered fill.

Care must be taken not to undermine or remove support from the site boundaries during stripping and subsequent bulk excavation works.

4.4.3 Excavation & Seepage

Prior to any excavation commencing we recommend that reference be made to the Safe Work Australia 'Excavation Work Code of Practice' dated July 2015.

Excavation of the soils and extremely low to very low strength bedrock can be completed using large hydraulic excavators and dozers. Notwithstanding, for such a large earthworks project, we expect that dozers will be mostly used for excavation. Hard ripping or 'hard rock' excavation conditions should be expected if the proposed excavations on the south-western side of Bungarribee Creek extend into medium and high strength bedrock (in which auger refusal occurred when using our large truck mounted JK500 drill rig). Ripping may only just be possible with a Caterpillar D10 dozer and a very generous allowance would need to be made for hydraulic rock hammer assistance to the ripping. Notwithstanding, rock hammers may need to be used for effective removal of low strength or stronger bedrock, particularly for detailed footing and trench excavations.

Once the civil design has been finalised, we recommend that cored boreholes be completed if deep cuts are proposed, so that a more detailed assessment of rock excavation can be made. We can complete the cored boreholes and provide the advice on rock excavation, if commissioned to do so.

All cuts less than 1m deep can be tentatively cut vertically, on condition that they are set well back from the site boundaries (particularly the southern boundary segmental block retaining wall) and subject to geotechnical inspection. All cuts greater than 1m deep should be temporarily battered back at no steeper than 1V on 1H for stability considerations and to facilitate compaction of engineered fill up against the cut faces. If the above recommended batter slope cannot be accommodated, then further geotechnical advice should be sought from JK Geotechnics.

Groundwater inflows into the proposed excavation may occur as local seepage flows through the existing fill, at the fill/natural clay interface, through relic joints/fissures and gravel bands in the natural clay, at the natural clay/ bedrock interface, and through joints and bedding partings within the bedrock profile, particularly after heavy rain. Seepage volumes emanating from the proposed cuts are expected to be controllable by sump and pump methods and/or gravity drainage methods.

4.4.4 Subgrade Preparation

Following stripping and bulk excavation, the clay subgrade should be proof rolled with at least six passes of a static (non-vibratory) smooth drum roller of at least 12 tonnes deadweight. The final pass of proof rolling should be carried out under the direction of an experienced geotechnical engineer for the detection of unstable or soft areas.

Subgrade heaving during proof-rolling may occur in areas where the clays have become 'saturated', where deep under-compacted existing fill exists and/or where natural clay of limited bearing capacity exists. Small areas can typically be improved by locally removing the heaving/soft material to a stable base and replaced with engineered fill, as outlined below. Alternatively, bridging layer support using high tensile geogrids and appropriately sized well graded durable crushed rock could be considered to support the new fill.

If the area requiring subgrade improvement is large (for example in the low lying portion on the north-eastern side of the creek, where groundwater is shallow and susceptible to pumping during the earthworks), then a minimum 300mm thick bridging layer comprising coarse grained durable crushed rock or crushed concrete, of nominal 40-150mm size, with a dense grade non-woven geotextile filter fabric placed on the surface of the bridging layer to control subsoil erosion, may be required. We forewarn that if crushed concrete is used, then it must contain less than 10% brick and tile fragments. Brick and tile fragments break down during compaction of the bridging layer, and have the propensity to absorb moisture, thus potentially negating the performance of the layer. Options and detailed design of subgrade improvement works must be provided by the geotechnical engineer following the proof rolling inspection.

If soil softening occurs after rainfall periods, then the clay subgrade should be over-excavated to below the depth of moisture softening and replaced with engineered fill. If the clay subgrade exhibits shrinkage cracking, then the surface must be moistened with a water cart and rolled until the shrinkage cracks are no longer evident. Care must be taken not to over-water the subgrade as this will result in softening.

4.4.5 Engineered Fill

General

From a geotechnical perspective, the excavated clayey fill, sandy fill, natural silty clay and shale and sandstone bedrock are considered suitable for reuse as engineered fill on condition that they

are ‘clean’, free of organic matter and contain a maximum particle size of 150mm. All excavated sandy fill should be blended with the clayey soils to improve the workability of the latter soil type.

Excavated low strength or stronger bedrock (including from the Site B basement excavation), and any boulders within the fill profile, will most likely need to be crushed in order to meet the maximum particle size specification. It is common place for earthworks contractors to attempt to break down over-size particles with numerous passes of large pad-foot rollers. However, this only results in over-compaction and failure of the compaction specification provided below.

Engineered fill comprising the above mentioned material should be compacted in maximum 300mm thick loose layers using a large static pad-foot roller (say, at least 17 tonnes deadweight) to a minimum density ratio of 95% of SMDD and at a moisture content within 3% of SOMC. We note that Section 6.2.2 if AS3798-2007 states “*the maximum particle size of any rocks or other lumps within the layer, after compaction, generally should not exceed two-thirds of the compacted layer thickness*.” For such a large earthworks project, moisture conditioning (ie. ‘drying out’ or ‘wetting up’) of the clay soils should be expected.

In areas of proposed structures and pavements, we recommend that each placed engineered fill layer be compacted to a minimum density ratio of 98% of SMDD and at a moisture content within 2% of SOMC.

Our preference is for static (non-vibratory) rolling for fill compaction so as limit the potential for ground borne vibration damage to the adjacent neighbouring buildings and the southern boundary retaining wall. If the earthworks contractor wishes to employ vibratory rolling, then trials would need to be carried out at the commencement of works using vibration monitors affixed onto the neighbouring buildings and retaining wall to assess the exclusion zone widths (which would include a nominal buffer zone, say, an additional 10-15m) where static rolling would need to be completed. If the contractor wishes to reduce the buffer zone width, then dilapidation surveys would need to be completed on all adjacent neighbouring buildings and retaining wall. We expect that dilapidation surveys to this scale will be uneconomical.

Edge Compaction

In order to achieve adequate edge compaction where fill platforms are proposed, we recommend that the outer edge of each fill layer extend a horizontal distance of at least 1m beyond the design geometry. The roller must extend over the edge of each placed layer in order to seal the batter

surface. On completion of filling, the excess under-compacted edge fill should be trimmed back to the design geometry.

The 'tying in' of engineered fill to temporary cut batter slopes can be achieved by locally benching the cut slopes in no greater than 0.4m high steps. This can be carried out progressively as the height of engineered fill increases.

Service Trenches

Backfilling of service trenches must be carried out using engineered fill in order to reduce post-construction settlements. Due to the reduced energy output of the rollers that can be placed in trenches, backfilling should be carried out in maximum 150mm thick loose layers and compacted using a trench roller, a pad foot roller attachment fitted to an excavator, and/or a vertical rammer compactor (also known as a 'Wacker Packer'). Due to the reduced loose layer thickness, the maximum particle size of the backfill material should also reduce to 75mm. The compaction specifications provided above is applicable.

Earthworks Inspection and Testing

Density tests should be regularly carried out on the engineered fill to confirm the above specifications are achieved, as outlined below:

- The frequency of density testing for general engineered fill should be at least one test per layer per 2500m^2 or one test per 500m^3 distributed reasonably evenly throughout the full depth and area, or 3 tests per lot (as defined in Clause 1.2.8 of AS3798-2007), whichever requires the most tests (assumes maximum 300mm thick loose layers).
- The frequency of density testing for trench backfill should be at least one test per two layers per 40 linear metres (assumes maximum 150mm thick loose layers).

Based on the large scale nature of the proposed earthworks, we recommend that Level 1 control of fill placement and compaction in accordance with AS3798-2007 be carried out, including for the trench backfill. Due to a potential conflict of interest, the GITA should be directly engaged by PDC, and not by the earthworks contractor or sub-contractors.

4.4.6 Permanent Batter Slopes

We consider that the nominated permanent batter slope grade of 1V on 4H to be suitable from a stability perspective, assuming that the vertical height of the batter slope is no more than 3m. Surface erosion protection, for example, quick establishing grass or proprietary systems (such as

those provided by Geofabrics Australasia or Global Synthetics) should be provided to the permanent batter slopes. Dish drains or swales should also be provided along the crest of all permanent batter slopes to intercept surface water run-off. Discharge should be piped to the stormwater system.

4.4.7 Warning

The long term successful performance of the proposed structures, pavements and playing surfaces is dependent on the satisfactory completion of the earthworks. In order to achieve this, the quality assurance program should not be limited to routine compaction density testing only. Other critical factors associated with the earthworks may include subgrade preparation, selection of fill materials, control of moisture content and drainage, etc. The satisfactory control and assessment of these items may require judgment from an experienced engineer. Such judgment often cannot be made by a technician who may not have formal engineering qualifications and experience.

In order to identify potential problems, we recommend that a pre-construction meeting be held so that all parties involved understand the earthworks requirements and potential difficulties. This meeting should clearly define the lines of communication and responsibility. This should be detailed in the tender documents.

We also recommend that the GITA be requested to provide a summary of test results, including a test location plan, and daily site reports on a fortnightly basis for review by the Project Superintendent and/or JK Geotechnics. On completion of the earthworks, the GITA should be requested to provide a Level 1 'sign off' report for our review.

4.5 Footings

The proposed structures in Site A that will require substantial footings include:

- The two grandstands;
- The three pedestrian bridges;
- The single storey sports facility (Sports Centre of Excellence);
- The lighting towers around all sporting facilities.

For uniform bearing conditions, we recommend that the proposed grandstands, pedestrian bridges, lighting towers and sports facility be supported on piled footings socketed into bedrock.

4.5.1 Soccer Field Grandstand

Based on BH201 and BH6, we recommend that the proposed grandstand be supported on conventional bored piles socketed at least 0.3m into low strength or stronger shale bedrock and designed for a maximum allowable end bearing pressure of 1000kPa. Sockets formed below the minimum 0.3m length requirement may be designed for maximum allowable shaft adhesion values of 100kPa (compression) and 50kPa (tension) on condition that the pile shaft is suitably roughened using a grooving tool fitted to the side of the auger. The provided design pressures are based upon serviceability criteria of deflections at the pile toe of less than 1% of the pile diameter.

4.5.2 Rugby League Field Grandstand

Based on BH205, we recommend the use of continuous flight auger (CFA) piles to support the proposed rugby league field grandstand due to the relatively shallow groundwater. CFA piles socketed at least 0.3m into low strength or stronger shale bedrock may be designed for a maximum allowable end bearing pressure of 1000kPa. Sockets formed below the minimum 0.3m length requirement may be designed for maximum allowable shaft adhesion values of 100kPa (compression) and 50kPa (tension). The provided design pressures are based upon serviceability criteria of deflections at the pile toe of less than 1% of the pile diameter.

4.5.3 Pedestrian Bridges

Only BH209 and BH101 are relevant for the proposed bridges. Notwithstanding, based on the proximity of the bridge footings to the creek and tributary, we recommend that the pile design initially include CFA piles. For the proposed bridge adjacent to the sports facility, conventional bored piles may be justified subject to trials.

CFA piles socketed at least 0.3m into low strength or stronger bedrock may be designed for a maximum allowable end bearing pressure of 1000kPa. Sockets formed below the minimum 0.3m length requirement may be designed for maximum allowable shaft adhesion values of 100kPa (compression) and 50kPa (tension). The provided design pressures are based upon serviceability criteria of deflections at the pile toe of less than 1% of the pile diameter.

4.5.4 Sports Facility (Sports Centre of Excellence)

Based on BH209 and BH210, we recommend that the proposed single storey sports facility be supported on CFA piles due to the presence of collapsible, deep poorly compacted sandy fill and

groundwater in BH209. The sandstone cobbles and boulders encountered in BH210 may need to be dug out prior to piling so as not to cause installation difficulties.

CFA piles socketed at least 0.3m into low strength or stronger shale bedrock may be designed for a maximum allowable end bearing pressure of 1000kPa. Sockets formed below the minimum 0.3m length requirement may be designed for maximum allowable shaft adhesion values of 100kPa (compression) and 50kPa (tension). The provided design pressures are based upon serviceability criteria of deflections at the pile toe of less than 1% of the pile diameter.

The design of the proposed swimming pool walls should adopt a triangular lateral earth pressure distribution and an 'active' earth pressure coefficient (K_a) of 0.35 for the soil profile. The use of K_a is on condition that the design requirements outlined in Clause 7.4.1 of AS2783-1992 ('Use of Reinforced Concrete for Small Swimming Pools') are met.

A bulk unit weight of 20kN/m^3 should be adopted for the soil profile. Any surcharge affecting the walls (eg. slab loads, compaction stresses during backfilling, etc.) should be allowed in the design using the K_a value from above. We recommend that at least two groundwater monitoring wells be installed to assess whether the pool shell will be subjected to hydrostatic pressures. Notwithstanding, hydrostatic pressure relief valves should be provided at the deep end of each proposed pool to avoid potential buoyancy.

4.5.5 Lighting Towers

The design of the lighting tower footings will be dependent on the height of the towers, as well as the subsurface conditions and groundwater levels. As substantial earthworks are proposed, we recommend that a borehole be drilled at every lighting tower location on completion of the earthworks so that appropriate subsoil parameters can be provided to the designer.

4.5.6 General

For limit state design, an ultimate bearing capacity of 3000kPa and ultimate pile shaft adhesion values of 150kPa and 75kPa in compression and tension, respectively, could be tentatively adopted for the low strength or stronger bedrock. Settlement limitations to the structures will still need to be satisfied and can be estimated using an Elastic Modulus value of 200MPa for low strength or stronger bedrock. It should be noted that the ultimate bearing pressures must be used in conjunction with an appropriate "*Basic Geotechnical Strength Reduction Factor*" (ϕ_{gb}), as defined in Clause 4.3.2 of AS2159-2009 ('Piling – Design and Installation'). A specific assessment of the

ϕ_{gb} value must be made in accordance with the procedure set out in AS2159-2009. Provided there is good workmanship, quality control and performance monitoring in the piling process, the expectation of the ϕ_{gb} value for end bearing and shaft adhesion is approximately 0.5.

At this stage, we have insufficient borehole information for the proposed structures, particularly if higher bearing pressures are required. Furthermore, the presence of high strength bedrock may cause installation difficulties (ie. slow penetration rates, high bit wear and possibly refusal) for piles designed with long rock sockets.

Once the architectural, civil and lighting tower designs, and the structural loads have been finalised, we strongly recommend that additional boreholes be completed to further assess the subsurface conditions below the proposed structures. Where higher bearing pressures and/or higher limit state design parameters are required by the structural engineer, then we recommend that the boreholes include rock coring.

As a guide, we recommend the following additional investigations:

- Grandstands - at least two additional boreholes for each of the two grandstands.
- Three pedestrian bridges – a borehole at each footing location.
- Sports facility (Sports Centre of Excellence) – at least two additional boreholes and groundwater monitoring wells.
- Lighting towers – a borehole at each tower location.

We can complete the boreholes and provide the appropriate design advice, if commissioned to do so. The boreholes for the proposed lighting towers would need to be drilled on completion of bulk earthworks.

We are not in favour of steel (helix) screw piles as they may encounter difficulties penetrating the fill profile (including potentially damaging the helix). Furthermore, if competent bedrock is encountered on first contact, it is likely that the leader at the base of the screw pile will refuse on the bedrock surface with the helix ‘hung up’ in the soil profile.

Conventional bored piles should be cleaned-out, inspected and poured on the same day as drilling. For a design bearing pressure of 1000kPa, conventional bored piling should be inspected by a geotechnical engineer during the initial stages and then periodically during the works to confirm that a satisfactory bearing stratum has been achieved.

For a design bearing pressure of 1000kPa, CFA piling should be witnessed at the commencement of the work and then periodically throughout, and compared to the borehole information by a geotechnical engineer to confirm that a satisfactory bearing stratum has been achieved. Notwithstanding, all CFA piles must be certified by the piling contractor.

Due to the shrink-swell nature of the clay soils, we strongly recommend that any ground beams between pile heads and any suspended floor slabs be poured over void formers which can accommodate the expected heave movements. The thickness of the void former will be dependent on the earthworks levels. For preliminary design purposes, a void former which can accommodate heave movements of 50mm should be incorporated into the design. Further geotechnical advice should be sought in this regard once the architectural and civil designs have been finalised.

4.6 External Pavements

4.6.1 Design

Based on the previous laboratory test results, we recommend that the proposed new external pavements be tentatively designed for a CBR value of 2% or a short-term Young's modulus of 16MPa for the compacted clay subgrade.

4.6.2 Concrete Pavements

If concrete pavements are to be supported on an unbound granular sub-base, then it should be at least 100mm thick and comprise good quality fine crushed rock such as DGB20 (RMS QA Specification 3051 unbound granular material) and compacted to a minimum density ratio of 98% of Modified Maximum Dry Density (MMDD). Adequate moisture conditioning to within 2% of Modified Optimum Moisture Contents (MOMC) should be provided during placement so as to reduce the potential for material breakdown during compaction. The sub-base material would provide more uniform slab support and would reduce 'pumping' of subgrade 'fines' at joints due to vehicular movements. Slab joints should be designed to resist shear forces but not bending moments by providing dowelled or keyed joints.

4.6.3 Flexible Pavements

We recommend that all base course materials comprise DGB20 (RMS QA Specification 3051). The base course material should be compacted in maximum 200mm thick loose layers using a large static smooth drum roller to at least 98% of MMDD. Adequate moisture conditioning to within 2% of MOMC should be provided during placement.

We further recommend that all sub-base materials comprise DGS20 or DGS40 (RMS QA Specification 3051). The sub-base material should be compacted in maximum 200mm thick loose layers using a large static smooth drum roller to at least 95% of MMDD. Again, adequate moisture conditioning to within 2% of MOMC should be provided during placement.

4.6.4 Density Testing

Density tests should be regularly carried out on the granular pavement materials to confirm the above specifications are achieved. The frequency of density testing should be at least one test per layer per 1000m^2, or three tests per layer, or three tests per visit, whichever requires the most tests. Level 2 testing of fill compaction is the minimum permissible in AS3798-2007. The geotechnical testing authority (GTA) should be directly engaged by PDC.

4.6.5 Subsoil Drains

In order to protect the pavement edge, subsoil drains should be provided along the perimeter of all proposed new external pavement areas, with invert levels of at least 200mm below subgrade level. The drainage trenches should be excavated with a uniform longitudinal fall to appropriate discharge points so as to reduce the risk of water ponding. The subgrade should be graded to promote water flow towards the subsoil drains. Discharge from the subsoil drains should be piped to the stormwater system.

4.7 Additional Geotechnical Input

We summarise below the previously recommended additional work that needs to be carried out:

1 Test pit and cored borehole investigation for the design of the retention system to support the southern boundary segmental block wall, if required.

2 Additional geotechnical investigations for the proposed grandstands, pedestrian bridges, sports facility and lighting towers.

3 Pre-construction meeting to discuss the earthworks. PDC, the earthworks contractor, the GITA and a representative from JK Geotechnics should attend the meeting.

4 Test pit investigation, or geotechnical inspection during initial stripping, to confirm topsoil depths and topsoil/'clean' fill blend design.

5 Inspection of cut faces.

6 Proof-rolling inspections.

7 Vibratory rolling trials, if required.

8 Inspection and testing of all engineered fill to Level 1 control by a GITA.

9 Review of the Level 1 inspection and testing report.

10 Footing inspections.

11 Density testing of all granular pavement materials to at least Level 2 control by a GTA.

5 SITE B PRELIMINARY COMMENTS AND RECOMMENDATIONS

The comments and recommendations provided below are generalised and are of a preliminary nature, and will need to be reviewed and most likely supplemented once the architectural and civil designs have been finalised.

5.1 Geotechnical Issues

We consider the following to be the primary geotechnical issues for the proposed Site B development:

- Basement excavation adjacent to Reservoir Road, which may be RMS Infrastructure and therefore their requirements will need to be satisfied.
- Potential groundwater seepage into the basement excavation, and satisfying DPI Water requirements.
- Presence of medium and high strength shale and sandstone bedrock for basement excavation and retention pile installation.
- Presence of clay soils with a moderate to high potential for shrink-swell movements with changes in moisture content.

The effects of the above geotechnical issues on design and construction are detailed in the sections which follow.

If Reservoir Road is RMS infrastructure, then we strongly recommend that the RMS 'Technical Direction: Geotechnology - Excavation Adjacent to RMS Infrastructure' (Ref. GTD 2012/001 dated 27 April 2012) be reviewed to determine their specific requirements in relation to design and construction, including instrumentation and monitoring. This RMS Technical Direction should be read in conjunction with this geotechnical report.

5.2 Residential Age Care Facility

The proposed residential age care facility will comprise eleven towers, ranging from one to eight stories high, overlying two common basement car parking levels. We have assumed that the proposed basements will require excavation to depths between approximately 6m (western end) and 7.5m (eastern end) below existing grade, and will extend to the eastern, southern and western site boundaries.

5.2.1 Site Preparation

Site preparation will include demolition of the AC surfaced car park, and stripping of all grass, topsoil, root affected soils and any deleterious fill or contaminated soil. Based on the results of the investigation, root affected soil should be stripped to a nominal depth of about 0.1m. We note that it is difficult to accurately assess the depth of topsoil and root affected soils in 100mm diameter boreholes and a limited number of test pits. If considered to be an important contractual issue, we recommend that a number of shallow test pits be excavated across the site to more accurately confirm the root affected soil stripping depth or alternatively a geotechnical inspection could be carried out after initial stripping to confirm the depth. Stripped topsoil and root affected soils should be stockpiled separately as they are considered unsuitable for reuse as engineered fill. They may however be reused for landscaping purposes, subject to approval by EIS. Reference should be made to the EIS report for guidance on the offsite disposal of soil.

Care must be taken not to undermine or remove support from the site boundaries during stripping and subsequent bulk excavation works.

5.2.2 Excavation Retention

Design Approach

Given the size of the proposed basement excavation, groundwater seepage should be expected. Discharge from the drainage system could be significant and therefore a dewatering license may need to be obtained from the relevant authorities such as Council and DPI Water (formerly NSW Office of Water) to allow temporary dewatering and discharge. These authorities impose limits on the amount of discharge allowed and analysis of the likely discharge may be required as part of the approval process. This would require the installation of standpipes to monitor groundwater levels and testing to assess the permeability of the soils and rock. Based on those results the groundwater inflow into the basement may be estimated. Depending on the groundwater inflow rates a tanked basement may be required, such that the basement walls and possibly the lower basement floor slab are designed to resist hydrostatic uplift forces.

We strongly recommend that a groundwater investigation and seepage analysis be carried out as soon as possible. We could carry out this work, if commissioned to do so.

The comments and recommendations provided below are tentative and assume that a drained basement will be feasible. Following the results of the groundwater investigation and seepage analysis, the advice provided below will need to be reviewed and updated if appropriate.

Furthermore, we also recommend that all buried services located immediately outside the basement walls be accurately located in both alignment and depth. This information should be plotted on the survey drawings for ease of reference. The locations of these services will need to be taken into account in the design of the basement walls.

Retention Systems

We recommend that the proposed vertical cuts in the soil, and shale and sandstone bedrock be supported by contiguous pile walls (in areas which are highly sensitive to lateral movement, such as adjacent to the neighbouring buildings to the west which are presumably supported on high level footings) and soldier pile walls with shotcrete infill panels elsewhere. The piles must be installed prior to excavation commencing and must be progressively shotcreted (soldier pile walls only) and anchored, or internally propped, as the excavation proceeds (ie. once the restraining point has been uncovered).

The piles can be used as load bearing piles for the proposed new building if taken down to the appropriate founding depths; that is, they will need to be embedded below bulk excavation level (including nearby footings, service trenches and pits) at suitable depths to satisfy founding and stability considerations.

For approximately the eastern two-thirds of the proposed basement excavation, medium and high strength bedrock (in which auger refusal occurred when using our large truck mounted JK500 drill rig) will be encountered within the bulk excavation depth. Socketing of piles into medium strength or stronger bedrock below bulk excavation level will most likely be time consuming and may not be economical. Consideration could therefore be given to nominally socketing the piles into medium and high strength sandstone above bulk excavation level, and restraining the toe of the piles from 'kicking out' by the provision of rock bolts or by another row of anchors. Such a decision must take into account the possible need for a tanked basement.

Due to the presence of medium and high strength bedrock, only high torque drilling rigs equipped with rock augers and/or coring buckets should be brought to site. All conventional bored pile holes should be cleaned out using a cleaning bucket (for all pile diameters) for effective removal of the expected sludge at the base of the open pile holes. Piles should only be cleaned out when concrete is ready to be poured. All conventional bored piles must be tremie poured due to the expected depths of the pile holes and groundwater seepage inflows. The prospective piling contractors should be provided with a full copy of this, and any future geotechnical reports so that appropriate drilling rigs and equipment are brought to site.

Construction of the piled walls must be of high quality. For soldier pile walls, the shotcrete infill panels must be completed without delay to reduce the shrinkage of clay soils immediately outside the excavation. Such shrinkage could result in ground subsidence behind the wall. The construction sequence should be fully specified and carefully controlled to reduce potential movements.

Retention Design Parameters

The major consideration in the selection of earth pressures for the design of the retention system is the need to limit deformations occurring outside the excavation. The characteristic earth pressure coefficients and subsoil parameters provided below may be tentatively adopted for the static design of the retention systems. Where 'weathered bedrock' is referred to below, it means all extremely low and very low strength shale and sandstone bedrock.

- For progressively anchored or propped walls, where only minor movements can be tolerated [possibly the northern basement wall and southern (Penny Place) basement wall, provided there are no movement sensitive buried services], we recommend the use of a trapezoidal earth pressure distribution and a lateral earth pressure of 6H (kPa) for the soil and weathered bedrock profiles, where H is the retained height in metres (ie. between surface level and the top level of low strength or stronger bedrock or bulk excavation level, including nearby footings, service trenches and lift pits, whichever the shallower). These pressures should be assumed to be uniform over the central 50% of the support system. For the shotcrete infill panel design, a trapezoidal earth pressure distribution and a lateral earth pressure of 4H (kPa) can be adopted for the soil and weathered bedrock profiles.

- For progressively anchored or propped walls which are highly sensitive to lateral movement (possibly the eastern and western basement walls), we recommend the use of a trapezoidal earth pressure distribution and a lateral earth pressure of 8H (kPa) for the soil and weathered

bedrock profiles, where H is the retained height in metres (ie. between surface level and the top level of low strength or stronger bedrock or bulk excavation level, including nearby footings, service trenches and lift pits, whichever the shallower). These pressures should be assumed to be uniform over the central 50% of the support system. For the shotcrete infill panel design, a trapezoidal earth pressure distribution and a lateral earth pressure of 6H (kPa) can be adopted for the soil and weathered bedrock profiles.

- For either of the above cases where the retention system supports the entire cut face, we recommend that an allowance be made for jointing in the underlying low, medium and high strength (competent) bedrock necessitating some support. Under ultimate load conditions, the design should be also checked for the presence of a 45° inclined joint within the competent bedrock which daylights at or just above bulk excavation level. The joint should be assumed to be clay coated and smooth with a friction angle of 25°. Nevertheless, it is essential that the rock faces between soldier piles are progressively inspected by an experienced geotechnical engineer as the excavation proceeds at no more than 1.5m depth intervals, in order that any wedges that could detach are identified and appropriate support measures implemented (eg. dowels and/or rock bolts).

- Any surcharge affecting the walls (eg. traffic loading, nearby footings, etc.) should be allowed in the design using an 'at rest' earth pressure coefficient (K_0) of 0.55 for the soil and weathered bedrock profiles, assuming a horizontal backfill surface. An average bulk unit weight of 21kN/m^3 should be adopted for the soil and weathered bedrock profiles.

- At this stage, the piled walls should be designed to withstand some lateral hydrostatic pressures, say, for a head of water at 0.3m above the bedrock surface. Notwithstanding, the retaining walls should be tentatively designed as a drained system with measures undertaken to induce complete and permanent drainage of the ground behind the walls. Weep hole outlets (also known as spitter pipes) should be provided between contiguous piles at a horizontal spacing no greater than 1.35m and should incorporate a non-woven geotextile filter fabric (at the inserted end) to reduce subsoil erosion. Between soldier piles, at least two equally spaced strip drains (with weep hole outlets) should be provided. All drainage water should be piped to the stormwater system.

- If Reservoir Road is an RMS asset, we expect that RMS will require that the design of the eastern basement retaining wall be checked for a burst water pipe scenario under ultimate

load conditions. For this scenario, the location, orientation and depth of all water mains in Reservoir Road will need to be confirmed.

- For perimeter piles embedded at least 0.5m into medium and high strength bedrock below bulk excavation level (including below nearby internal footing excavations, service trenches and lift pits), an allowable lateral toe resistance of 500kPa may be tentatively adopted. The above design value assumes excavation is not carried out within the zone of influence of the wall toe. The upper 0.2m depth of the socket should not be taken into account to allow for disturbance and tolerance effects during excavation. The quality of the toe restraint rock should be progressively inspected at bulk excavation level by an experienced geotechnical engineer to confirm that unexpected conditions do not exist. If the piles are inadequately socketed, then it will most likely be necessary to install an additional rock anchor or rock bolt at the base of the piles.

- For rock anchors, permission must be sought from the neighbouring property owners, Council and RMS (if appropriate) prior to installation. Rock anchors bonded at least 3m into medium strength or stronger bedrock, beyond a 45° line inclined up from bulk excavation level (including nearby footings and service trenches) may be tentatively designed for a maximum allowable bond stress of 300kPa. All anchors should be proof tested to 1.3 times the working load under the supervision of an experienced engineer independent of the anchor contractor. If applicable, we expect that there will be additional RMS requirements for design and proof testing of anchors which extend below Reservoir Road (ie. in accordance with AS5100). The testing may allow an upgrading of the above bond stress. We recommend that only experienced contractors be considered for the anchor installations. We have assumed that permanent lateral support of the piled walls will be provided by the proposed structure, after which time the rock anchors can be de-stressed.

If Reservoir Road is an RMS asset, then we expect that the prediction of deflection will be an RMS requirement for the proposed eastern basement retaining wall. As such, we recommend that the retention system design be assessed using a finite element (FE) computer program, such as 'Plaxis' or similar. RMS may also require a geotechnical monitoring and contingency plan be prepared for implementation during the proposed basement excavation and shoring along Reservoir Road. So that ground movements induced by the excavation and retention can be monitored during construction, installation of inclinometers along the crest of the shoring wall may be part of the RMS requirements. We could carry out the FE analyses, prepare the monitoring and contingency plan, and install and monitor the inclinometers if commissioned to do so.

5.2.3 Excavation Conditions

Prior to any excavation commencing, reference should be made to the Safe Work Australia 'Excavation Work Code of Practice' dated July 2015.

Prior to the commencement of excavation, we recommend that detailed dilapidation surveys be compiled on the neighbouring buildings to the west. The dilapidation reports can be used as a benchmark against which to set vibration limits for rock excavation and for assessing possible future claims for damage arising from the works. The respective owners should confirm (by signing a copy of the report) that the dilapidation surveys are a fair representation of existing conditions. We forewarn that RMS and Council may also require dilapidation surveys on the abutting roadways and footpaths. We could carry out the dilapidation surveys if commissioned to do so.

Excavation of the soils and extremely low to very low strength bedrock can be completed using large hydraulic excavators and dozers. Notwithstanding, for such a large excavation, we expect that dozers will be mostly used. Hard ripping or 'hard rock' excavation conditions should be expected for the medium and high strength bedrock. Ripping may only just be possible with a Caterpillar D10 dozer and a very generous allowance would need to be made for hydraulic rock hammer assistance to the ripping. Notwithstanding, rock hammers may need to be used for effective removal of low strength or stronger bedrock, particularly for detailed footing and trench excavations.

Rock excavations using hydraulic rock hammers will need to be strictly controlled as there may be direct transmission of ground vibrations to the neighbouring buildings. We recommend that quantitative vibration monitoring be carried out on the neighbouring warehouse buildings to the west at the commencement, and then periodically during rock excavation as a safeguard against possible vibration induced damage. The vibrations on the neighbouring warehouse buildings should be tentatively limited to a peak particle velocity of 20mm/s, subject to review of the dilapidation survey reports. If higher vibrations are measured, then they should be measured against the attached Vibration Emission Design Goals as higher vibrations may be acceptable depending on the associated vibration frequency. If the vibration monitoring confirms that transmitted vibrations are excessive, then it would be necessary to change to alternative rock excavation methods such as a rock sawing and/or a smaller rock hammer.

The following procedures are recommended to reduce vibrations if rock hammers are used:

- Rock saw the western cut face. This will dampen ground borne vibrations on the neighbouring buildings. The base of the rock saw slot should be maintained at a lower level than the adjacent excavation at all times.
- Maintain rock hammer oriented towards the face and enlarge excavation by breaking small wedges off face. Grid sawing the base would facilitate removal.
- Operate hammer in short burst only, to reduce amplification of vibrations.
- Use excavation contractors with appropriate experience and a competent supervisor who is aware of vibration damage risks, etc. The contractor should have all appropriate statutory and public liability insurances and should be provided with a full copy of this report.

Once the architectural design has been finalised, we recommend that at least eight cored boreholes be completed so that a more detailed assessment of rock excavation (particularly below the auger refusal depths) can be made. We can complete the cored boreholes and provide the advice on rock excavation, if commissioned to do so.

5.2.4 Seepage

Groundwater inflows into the excavation are expected to occur as local seepage flows from the fill profile, at the fill/natural silty clay interface, through gravel bands or relic joints/fissures within the natural silty clay, at the soil/rock interface, and through joints and bedding partings within the bedrock profile, particularly after heavy rain. Seepage volumes into the excavation are expected to be controllable by conventional sump and pump discharge systems.

5.2.5 Footings

Based on the results of the 'due diligence' investigation, we expect that the proposed basement excavation will expose shale and sandstone bedrock. Pad and strip footings founded in low strength or stronger shale and sandstone bedrock may be designed for a maximum allowable bearing pressure of 1000kPa.

Conventional bored piles used in the construction of the perimeter walls and founded in low strength or stronger shale and sandstone bedrock below bulk excavation level may also be designed for a maximum allowable end bearing pressure of 1000kPa. From 0.5m depth below bulk excavation level (including adjacent footing excavations, pits and service trenches), the rock socket for soldier

piles may be designed for a maximum allowable shaft adhesion value of 100kPa (compression) on condition that the pile shaft is suitably roughened.

The provided design pressures are based upon serviceability criteria of deflections at the footing base of less than 1% of the minimum footing dimension/pile diameter. We note that these footing settlements will be of an elastic nature and are expected to occur as construction proceeds.

For limit state design, an ultimate bearing capacity of 3000kPa and ultimate pile shaft adhesion value of 150kPa in compression could be tentatively adopted for the low strength or stronger bedrock. Settlement limitations to the structures will still need to be satisfied and can be estimated using an Elastic Modulus value of 200MPa for low strength or stronger bedrock. It should be noted that the ultimate bearing pressures must be used in conjunction with an appropriate "*Basic Geotechnical Strength Reduction Factor*" (ϕ_{gb}), as defined in Clause 4.3.2 of AS2159-2009, as discussed in Section 4.5.6.

The medium and high strength bedrock is more than likely suitable for a higher bearing pressure, most likely in the order of 3500kPa (serviceability) and 15-30MPa (ultimate limit state), but is dependent on the amount of rock proving. In conjunction with the additional investigation recommended in Section 5.2.3 to further assess the excavability of the bedrock, the cored boreholes could also be used to attempt to optimise the bearing pressures for footing design.

All pad and strip footings should be cleaned out, inspected by a geotechnical engineer (prior to the installation of reinforcement cages) and poured on the same day as excavation. If delays in pouring are envisaged, then we recommend that a concrete blinding layer be provided over the bases to reduce deterioration due to weathering.

Conventional bored piles should be cleaned out, inspected and poured on the same day as drilling. All pile holes should be cleaned out using a cleaning bucket (for all pile diameters) for effective removal of sludge and loose material. Due to the expected groundwater seepage, the piles should only be cleaned out when concrete is ready to be tremie poured. For a design bearing pressure of 1000kPa, we recommend that the bored pile drilling be inspected by a geotechnical engineer during the initial stages and then periodically during the works.

5.2.6 Lower Basement Floor Slab

The advice provided below is tentative, assuming that a drained basement will be permitted.

The surface of the bedrock at bulk excavation level will need to be graded and/or trenched to provide good and effective drainage both during construction and in the long-term. The principal aim of the drainage is to promote run-off towards designated sumps by cross-falls and to reduce ponding. Any softened material must be scraped off prior to the placement of the sub-floor drainage layer.

The proposed lower basement floor slab should be separated from all walls, footings, etc. (ie. designed as 'floating') to permit relative movement. Slab joints should be capable of resisting shear forces but not bending moments by providing dowels or keys.

The basement floor slab should be provided with at least a 100mm thick sub-base of good quality, durable, single size, crushed rock (free of fines) such as 'Blue Metal' gravel or crushed concrete aggregate, which will also act as underfloor drainage.

The underfloor drainage should include a sump and pump dewatering system. The retaining wall drains should be connected into the underfloor drainage system. Groundwater seepage monitoring should be carried out during basement excavation prior to finalising the design of the pump out facility. The sump(s) should have an automatic level control pump to avoid flooding of the basement level. Outlets into the stormwater system will require Council approval.

Appropriate damp proofing is recommended for external walls close to, or in contact with, the excavated areas.

5.3 Childcare Centre

Based on BH211, we recommend that the proposed three storey childcare centre be supported on conventional bored piles socketed at least 0.3m into low strength or stronger sandstone bedrock and designed for a maximum allowable end bearing pressure of 1000kPa. Sockets formed below the minimum 0.3m length requirement may be designed for a maximum allowable shaft adhesion value of 100kPa (compression) on condition that the pile shaft is suitably roughened using a grooving tool fitted to the side of the auger. The provided design pressures are based upon serviceability criteria of deflections at the pile toe of less than 1% of the pile diameter.

For limit state design, an ultimate bearing capacity of 3000kPa and ultimate pile shaft adhesion value of 150kPa in compression could be tentatively adopted for the low strength or stronger bedrock. Settlement limitations to the structures will still need to be satisfied and can be estimated using an Elastic Modulus value of 200MPa for low strength or stronger bedrock. It should be noted that the ultimate bearing pressures must be used in conjunction with an appropriate "*Basic Geotechnical Strength Reduction Factor*" (ϕ_{gb}), as defined in Clause 4.3.2 of AS2159-2009, as discussed in Section 4.5.6.

Due to the presence of high strength sandstone bedrock, only high torque drilling rigs equipped with rock augers and/or coring buckets should be brought to site. Notwithstanding, slow penetration rates and high bit wear should be expected whilst drilling through high strength sandstone.

In order to confirm the subsurface conditions across the proposed building footprint, we recommend that at least two additional boreholes be completed for adequate coverage. If higher bearing pressures are required to reduce pile diameters and/or rock socket lengths, then we recommend that the bedrock in the boreholes be core drilled. If required, we would be happy to provide a fee proposal for this additional work.

Conventional bored piles should be cleaned out, inspected and poured on the same day as drilling. For a design bearing pressure of 1000kPa, conventional bored piling should be inspected by a geotechnical engineer during the initial stages and then periodically during the works to confirm that a satisfactory bearing stratum has been achieved.

Due to the shrink-swell nature of the clay soils, we strongly recommend that any ground beams between pile heads and any suspended floor slabs be poured over void formers which can accommodate the expected heave movements. The thickness of the void former will be dependent on earthworks levels and nature of the clay soils in the recommended additional boreholes. For preliminary design purposes, a void former which can accommodate heave movements of 50mm should be incorporated into design. Further geotechnical advice should be sought in this regard once the architectural design has been completed.

5.4 Pedestrian Bridge

The advice provided in Sections 4.5.3 & 4.5.6 is applicable for the design of the proposed easternmost pedestrian bridge. As no boreholes were completed at this bridge location, we recommend that a cored borehole be complete at each footing location once the architectural design has been finalised. We can complete the boreholes and provide the appropriate design advice, if commissioned to do so.

5.5 Additional Geotechnical Input

We summarise below the previously recommended additional work that needs to be carried out:

1. Assessment of RMS requirements, if appropriate.
2. Installation of groundwater monitoring wells for the proposed basement excavation. Testing should be completed in the well holes to assess the permeability of the soil and rock profiles. Seepage analyses should then be carried out to assess the expected groundwater inflow.
3. Additional geotechnical investigations for the proposed residential age care facility, childcare centre and pedestrian bridge once the architectural designs are finalised.
4. Additional work to satisfy RMS, as required.
5. Test pit investigation, or geotechnical inspection during initial stripping, to confirm topsoil depths.
6. Dilapidation survey reports.
7. Vibration monitoring when using hydraulic rock hammers.
8. Proof testing of anchors.
9. Progressive rock face inspections (between soldier piles) as the excavation proceeds.
10. Footing inspections.
11. Groundwater monitoring of seepage volumes in basement excavation.

6 GENERAL COMMENTS

The preliminary recommendations presented in this report include specific issues to be addressed during the construction phase of the project. As an example, special treatment of soft spots may be required as a result of their discovery during proof-rolling, etc. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and JK Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

Occasionally, the subsurface conditions between the completed boreholes and test pits may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides preliminary advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our 'due diligence' geotechnical report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of JK Geotechnics. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE A
MOISTURE CONTENT, ATTERBERG LIMITS AND LINEAR SHRINKAGE TEST REPORT

Client: JK Geotechnics
Project: Proposed Sports Facilities , Residential Age Care Facility and Childcare Centre
Location: Reservoir Road, Arndell Park, NSW

Ref No: 28870AD
Report: A
Report Date: 18/11/2015

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	LINEAR SHRINKAGE %
201	0.50-0.95	27.6	61	20	41	15.0
201	2.50-3.00	9.4				
201	3.50-4.00	12.6				
202	0.50-0.95	24.6	67	25	42	16.0
202	2.50-3.00	7.2				
202	3.00-3.60	13.9				
203	0.50-0.95	14.3	48	18	30	13.5
203	2.50-3.00	7.3				
203	4.00-4.50	10.4				
204	0.50-0.95	23.2	54	19	35	15.0
204	3.60-4.00	13.3				
204	5.50-6.00	15.7				
204	7.00-7.50	8.1				
205	0.50-0.95	22.1	41	16	25	11.0
205	4.10-4.50	14.4				
205	6.70-7.10	6.1				
206	4.00-4.50	7.4				
206	7.00-7.50	8.3				
207	10.00-10.50	14.7				
208	6.00-6.45	21.8	74	25	49	16.5
208	7.00-7.50	5.3				
208	8.50-9.00	7.9				
209	7.00-7.50	8.6				
209	7.60-7.80	10.5				

Notes: See Page 2 of 2

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TABLE A
MOISTURE CONTENT, ATTERBERG LIMITS AND LINEAR SHRINKAGE TEST REPORT

Client: JK Geotechnics
Project: Proposed Sports Facilities , Residential Age Care Facility and Childcare Centre
Location: Reservoir Road, Arndell Park, NSW

Ref No: 28870AD
Report: A
Report Date: 18/11/2015

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	LINEAR SHRINKAGE %
210	0.50-0.95	11.8	33	16	17	7.0
210	1.60-2.00	5.7				
210	3.00-3.40	8.6				
210	3.40-3.60	11.8				
211	0.50-0.95	12.7	32	15	17	7.0
211	1.70-1.80	9.8				
212	3.00-3.45	17.9	36	14	22	7.5
212	4.50-4.60	10.8				
212	5.50-6.00	6.4				
212	7.20-7.70	6.9				
213	0.50-0.95	11.8	42	18	24	10.0
213	4.00-4.30	6.9				
214	1.50-1.95	20.3	64	23	41	16.0
214	4.00-4.30	9.1				
215	5.50-6.00	10.4				
215	7.00-7.50	7.8				
215	8.00-8.30	6.0				
216	1.50-1.95	24.1	60	22	38	15.5
217	2.80-3.00	4.9				
217	3.60-4.00	7.9				
219	0.50-0.95	15.9	54	20	34	14.5
219	2.50-3.00	7.0				
219	4.00-4.30	9.9				

Notes:

- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 11/11/2015

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BOREHOLE LOG

Borehole No. **201** 1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 57.0m

Date: 6-11-15 **Datum:** AHD

Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0			FILL: Silty clay, medium plasticity, dark orange brown and dark brown, trace of ash and root fibres.	MC>PL			GRASS COVER
				■	N = 10 3,5,5			CH	SILTY CLAY: high plasticity, dark orange brown mottled grey, trace of ash.	MC>PL	H	550 500 520	
	■					1							
								-	SHALE: brown.	XW-DW	EL-VL		VERY LOW 'TC' BIT RESISTANCE
									SHALE: brown and grey.	DW	L		LOW RESISTANCE
				■		2							
						3							
				■		4					M		LOW TO MODERATE RESISTANCE
									END OF BOREHOLE AT 4.1m				'TC' BIT REFUSAL
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No. **202** 1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 6-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 58.2m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay, high plasticity, dark brown and orange brown, with roots and root fibres, fine to coarse grained igneous gravel, trace of ash.	MC>PL			GRASS COVER
					N = 7 4,5,2			CH	SILTY CLAY: high plasticity, light orange brown and light grey, trace of fine to coarse grained ironstone gravel, ash and root fibres.	MC≈PL	H	>600 >600 >600	
					N = 18 3,7,11	1			as above, but light grey.			>600 >600 >600	
						2		-	SHALE: brown, with M strength iron indurated bands.	DW	L		LOW 'TC' BIT RESISTANCE
						3					H		MODERATE TO HIGH RESISTANCE
									END OF BOREHOLE AT 3.6m				'TC' BIT REFUSAL
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No. **203** 1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 56.4m

Date: 6-11-15 **Datum:** AHD

Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0			FILL: Silty clay, medium plasticity, dark brown, with roots and root fibres, trace of ash.	MC≈PL			GRASS COVER
				■	N = 16 3,5,11			CL	SILTY CLAY: medium plasticity, light orange brown, with fine to coarse grained ironstone gravel, trace of ash.	MC<PL	H	450 420 420	
	■					1							
				■	SPT 6/50mm REFUSAL			-	SHALE: brown.	XW-DW	EL-VL		VERY LOW 'TC' BIT RESISTANCE
						2							
				■		3			SHALE: grey.	DW	L		LOW RESISTANCE
				■		4							
						5				SW	H		MODERATE RESISTANCE
						6			END OF BOREHOLE AT 5.8m				'TC' BIT REFUSAL
						7							

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. **204** 1/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 2-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 52.3m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty clay, medium plasticity, dark brown, with roots and root fibres.	MC<PL			GRASS COVER
▼ AFTER 24 HRS					N = 8 3,3,5	1		CH	SILTY CLAY: high plasticity, light grey mottled light orange brown.	MC>PL	St-VSt	200 220 200	
					N = 7 3,3,4	2						200 220 220	
▼ ON COMPLET-ION					N = 5 2,2,3	3					F	50 75 50	
						4		-	SHALE: light brown.	DW	VL-L		VERY LOW TO LOW 'TC' BIT RESISTANCE
						5			SHALE: grey.	DW-SW	L-M		LOW RESISTANCE WITH MODERATE BANDS
						6							
						7							

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 204
2/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 2-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 52.3m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
				■		8			SHALE: grey.	SW	M		MODERATE RESISTANCE
				■		9			END OF BOREHOLE AT 9.0m				
						10							
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No. **205** 1/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 52.7m

Date: 2-11-15 **Datum:** AHD

Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty clay, high plasticity, dark brown, with fine to coarse grained igneous gravel, trace of ash, roots and root fibres.	MC>PL			GRASS COVER
▼ AFTER 24 HRS					N = 5 1,2,3	1		CL	SILTY CLAY: medium plasticity, light grey mottled orange brown.	MC>PL	St		
					N = 10 3,4,6	2					VSt	250 250 250	
											St		
					N = 18 4,9,9	3			as above, but with fine to coarse grained ironstone gravel.			150 180 150	
						4		-	SHALE: grey, with M-H strength iron indurated bands.	DW	VL-L		VERY LOW TO LOW 'TC' BIT RESISTANCE
						5					M		LOW TO MODERATE RESISTANCE
▼ ON COMPLET-ION						6							
						7					H		HIGH RESISTANCE

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BOREHOLE LOG

Borehole No. **205** 2/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD

Date: 2-11-15

Method: SPIRAL AUGER
JK500

Logged/Checked by: L.M./D.S.

R.L. Surface: ≈ 52.7m

Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
				■					SHALE: grey, with iron indurated bands.	DW	H		'TC' BIT REFUSAL
									END OF BOREHOLE AT 7.1m				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No. **206** 1/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 2-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 56.2m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty clay, medium plasticity, dark orange brown, trace of fine to coarse grained shale gravel, shale cobbles, fine grained sandstone and igneous gravel, tile and brick fragments.	MC>PL			APPEARS POORLY COMPACTED
					N = 4 2,2,2	1							
													APPEARS WELL COMPACTED
					N = 11 4,5,6							580 550 580	
▼ AFTER 24 HRS						2							
						3		-	SHALE: grey and brown.	DW	L		LOW 'TC' BIT RESISTANCE
						4			SHALE: grey.				
						5							
										SW	M		LOW TO MODERATE RESISTANCE
						6							
						7							

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 206
2/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 2-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 56.2m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
▼ ON COMPLET-ION				■		8			SHALE: grey.	SW	M		MODERATE RESISTANCE
				■		9			END OF BOREHOLE AT 9.0m				
						10							
						11							
						12							
						13							
						14							

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. **207** 1/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 59.5m

Date: 2-11-15 **Datum:** AHD

Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty clay, medium plasticity, light brown, with fine to coarse grained sandstone and igneous gravel, trace of tile and brick fragments and root fibres.	MC<PL			GRASS COVER APPEARS WELL COMPACTED
					N = 14 4,7,7					MC>PL		580 580 550	
						1			FILL: Silty clay, medium plasticity, dark orange brown, with fine to coarse grained sandstone gravel and sandstone cobbles, trace of roots and root fibres.				
					N > 18 3,8,10/ 100mm							520 500 550	
					REFUSAL	2							
									FILL: Silty clay, high plasticity, dark grey, with fine to medium grained shale gravel.				
					N = 8 2,3,5	3						250 220 240	APPEARS MODERATELY COMPACTED
▼ AFTER 24 HRS						4			FILL: Silty clay, high plasticity, grey.				
					N = 8 1,2,6							120 150 150	
						5							
								CH	SILTY CLAY: high plasticity, dark orange brown mottled grey.	MC>PL	VSt		
					N = 12 3,4,8	6						350 400 320	
▼ ON COMPLET-ION						7							

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BOREHOLE LOG

Borehole No. **207** 2/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 2-11-15

Method: SPIRAL AUGER
JK500

Logged/Checked by: L.M./D.S.

R.L. Surface: ≈ 59.5m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
								CH	SILTY CLAY: high plasticity, dark orange brown mottled grey.	MC>PL	VSt		
				■	N = 8 2,3,5	8						250 250 240	
						9		-	SHALE: brown and grey.	DW	L		LOW 'TC' BIT RESISTANCE
				■		10							
									END OF BOREHOLE AT 10.5m				
						11							
						12							
						13							
						14							

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 208 1/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 60.7m

Date: 2-11-15 **Datum:** AHD

Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Gravelly silty sand, fine to coarse grained, light brown, fine to coarse grained igneous and sandstone gravel, trace of root fibres.	D			GRASS COVER APPEARS MODERATELY COMPACTED
					N = 13 10,8,5	1							
									FLL: Silty clay, medium plasticity, dark orange brown, with fine to coarse grained sandstone and igneous gravel, trace of ash.	MC≈PL			APPEARS POORLY COMPACTED
					N = 5 3,2,3	2							
													APPEARS MODERATELY COMPACTED
					N = 7 4,3,4	3			FILL: Silty clay, high plasticity, dark orange brown and dark grey, trace of ash.	MC>PL		250 250 250	
						4							
					N = 13 3,7,6							250 220 200	
▼ AFTER 24 HRS						5							
					N = 18 4,8,10	6		CH	SILTY CLAY: high plasticity, orange brown mottled grey, trace of fine grained ironstone gravel.	MC<PL	VSt	350 350 350	
						7		-	SHALE: grey and light brown.	DW	L		

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BOREHOLE LOG

Borehole No. **208** 2/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 2-11-15

Method: SPIRAL AUGER
JK500

Logged/Checked by: L.M./D.S.

R.L. Surface: ≈ 60.7m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
				■					SHALE: grey and light brown	DW	L		LOW 'TC' BIT RESISTANCE
						8					M		MODERATE RESISTANCE
				■		9			END OF BOREHOLE AT 9.0m				
						10							
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No. **209** 1/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 6-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 60.2m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			ASPHALTIC CONCRETE: 100mm.t				
					N = 19 7,10,9			-	FILL: Silty sand, fine to coarse grained, light brown, with fine to coarse grained igneous and sandstone gravel, trace of ash.	M			APPEARS WELL COMPACTED
					N = 7 3,4,3	1							APPEARS POORLY COMPACTED
					N = 6 3,3,3	2							
▼ ON COMPLETION						3			FILL: Silty clay, high plasticity, brown, with fine to coarse grained igneous and sandstone gravel, trace of ash.	MC>PL		350 300 300	HP READINGS ON REMOULDED SAMPLE
					N = 9 3,4,5	4		CH	SILTY CLAY: high plasticity, light orange brown, with fine to coarse grained ironstone gravel, trace of ash.	MC>PL	VSt	350 350 380	APPEARS MODERATELY COMPACTED
						5							
						6		-	SHALE: brown.	XW-DW	EL-VL		VERY LOW 'TC' BIT RESISTANCE
									SHALE: grey.	DW-SW	L-M		LOW TO MODERATE RESISTANCE
						7							

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. **209** 2/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 6-11-15

Method: SPIRAL AUGER
JK500

Logged/Checked by: L.M./D.S.

R.L. Surface: ≈ 60.2m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
				■					SHALE:grey.	DW-SW	L-M		
				■						SW	H		MODERATE TO HIGH RESISTANCE
						8			END OF BOREHOLE AT 7.8m				'TC' BIT REFUSAL
						9							
						10							
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No. 210
1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 4-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 60.7m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			ASPHALTIC CONCRETE: 100mm.t				
								-	FILL: Silty clay, low plasticity, dark brown, with fine to coarse grained igneous gravel, ash and slag.	MC<PL			APPEARS WELL COMPACTED
					N = 18 8,10,8							350 400 380	
						1			FILL: Sandstone cobbles and boulders. brown.	M			
						2		CH	SILTY CLAY: high plasticity, orange red brown.	MC>PL	VSt	350 320 300	HP TESTING ON REMOULDED SAMPLE
					N > 25 5,15, 10/100mm	3		-	SHALE: brown, with iron indurated bands.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
					REFUSAL					DW	H		MODERATE TO HIGH RESISTANCE
									END OF BOREHOLE AT 3.6m				'TC' BIT REFUSAL
						4							
						5							
						6							
						7							

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 211
1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 3-11-15

Method: SPIRAL AUGER
JK500

Logged/Checked by: L.M./D.S.

R.L. Surface: ≈ 58.0m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0			FILL: Silty clay, low plasticity, dark red brown, with roots and root fibres.	MC<PL			GRASS COVER APPEARS MODERATELY COMPACTED
				■	N = 7 5,4,3	1							
	■								FILL: Silty clay, low plasticity, brown, trace of ash.				
	■			■	N > 12 3,12/ 150mm			CH	SILTY CLAY: high plasticity, orange brown, trace of roots.	MC>PL	VSt		
				■	REFUSAL			-	SANDSTONE: fine to medium grained, brown.	DW	H		MODERATE TO HIGH 'TC' BIT RESISTANCE
						2			END OF BOREHOLE AT 2.0m				'TC' BIT REFUSAL
						3							
						4							
						5							
						6							
						7							

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 212
1/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 3-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 59.2m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty clay, medium palsticity, dark brown, with roots and root fibres, trace of fine to medium grained sand and ash.	MC<PL			GRASS COVER
					N = 8 3,3,5				FILL: Silty clay, medium plasticity, red brown, with fine to coarse grained sandstone and igneous gravel, trace of ash.	MC>PL		550 500 500	APPEARS WELL COMPACTED
					N = 15 2,8,7	1						350 380 400	
					N = 15 5,7,8	2							
						3		CL	SILTY CLAY: medium plasticity, red brown and brown, trace of coarse grained ironstone gravel.	MC>PL	H	500 450 480	
					N = SPT 16/100mm REFUSAL	4		-	SHALE: brown	XW-DW	EL-VL		VERY LOW 'TC' BIT RESISTANCE
						5			SHALE: brown and grey.	DW	M		MODERATE RESISTANCE
▼ ON COMPLET-ION & AFTER 30 MINS						6							
						7							

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 212
2/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 3-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 59.2m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
				■					SHALE: grey.	SW	H		MODERATE TO HIGH RESISTANCE
									END OF BOREHOLE AT 7.4m				'TC' BIT REFUSAL
						8							
						9							
						10							
						11							
						12							
						13							
						14							

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 213
1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 3-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 59.8m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0			FILL: Silty clay, medium plasticity, light brown, with roots and root fibres.	MC<PL			GRASS COVER
				■	N = 14 5,7,7	1			FILL: Silty clay, medium plasticity, light brown, with shale gravel, trace of root fibres and ash.			>600 >600 >600	APPEARS WELL COMPACTED
				■	N = 11 2,5,6	2			FILL; Silty clay, high plasticity, brown.	MC>PL		150 150 150	APPEARS MODERATELY COMPACTED
	■					3		CH	SILTY CLAY: high plasticity, red brown, with fine to coarse grained ironstone gravel.	MC>PL	VSt	220 250 250	
				■	N = 16 4,8,8	4		-	SANDSTONE: fine to coarse grained, brown.	DW	L-M H		LOW TO MODERATE 'TC' BIT RESISTANCE MODERATE TO HIGH RESISTANCE
						5			END OF BOREHOLE AT 4.3m				'TC' BIT REFUSAL
						6							
						7							

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 214
1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 4-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 63.0m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0			FILL: Silty clay, low plasticity, dark brown, with root fibres.	MC<PL			GRASS COVER
				■	N = 8 4,4,4	1			FILL: Silty clay, medium plasticity, dark brown, with fine to medium grained shale gravel, trace of ash and root fibres.				APPEARS MODERATELY COMPACTED
	■			■	N = 13 4,5,8	2		CH	SILTY CLAY: high plasticity, red and orange brown, trace of root fibres.	MC<PL	H	450 450 480	
	■			■	N = SPT 12/150mm REFUSAL	3		-	SHALE: brown.	XW-DW	EL-VL		VERY LOW 'TC' BIT RESISTANCE
						4				DW	M		LOW TO MODERATE RESISTANCE
									END OF BOREHOLE AT 4.3m				'TC' BIT REFUSAL
						5							
						6							
						7							

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 215
1/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 3-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 59.2m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay, medium plasticity, light brown, with roots, root fibres and fine grained sand, trace of fine to coarse grained igneous gravel and ash.	MC<PL			GRASS COVER APPEARS MODERATELY COMPACTED
					N = 9 4,4,5	1							
					N = 6 2,3,3				FILL: Silty clay, medium plasticity, red brown and dark brown, trace of ash.	MC>PL		250 250 250	
						2			FILL: Silty clay, high plasticity, red brown and dark brown, trace of ash.				
					N = 8 3,4,4	3		CH	SILTY CLAY: high plasticity, orange brown mottled grey.	MC>PL	VSt	250 220 220	
						4							
					N = 18 3,6,12	5						400 250 350	
								-	SHALE: brown and grey.	DW	VL		VERY LOW 'TC' BIT RESISTANCE
						6							
						7							

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 215
2/2

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 3-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 59.2m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
				■					SHALE: grey.	DW-SW	L-M		LOW TO MODERATE RESISTANCE
						8				SW	M		
									END OF BOREHOLE AT 8.3m				'TC' BIT REFUSAL
						9							
						10							
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No. **216** 1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 59.8m

Date: 3-11-15 **Datum:** AHD

Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0			FILL: Silty clay, low plasticity, light brown, with roots and root fibres.	MC<PL			GRASS COVER
				■	N = 9 4,4,5				FILL: Silty clay, high plasticity, brown, with fine to coarse grained ironstone gravel, trace of ash, roots and root fibres.	MC>PL		350 350 300	APPEARS WELL COMPACTED
	■					1							
				■	N = 9 2,4,5			CH	SILTY CLAY: high plasticity, red brown, trace of root fibres.	MC>PL	VSt	300 320 300	
	■					2		-	SANDSTONE: fine to coarse grained, light brown.	DW	M-H		MODERATE TO HIGH 'TC' BIT RESISTANCE
									END OF BOREHOLE AT 2.7m				'TC' BIT REFUSAL
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No. 217
1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 4-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 62.3m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0			FILL: Silty clay, medium plasticity, dark brown, with roots and root fibres.	MC<PL			GRASS COVER
				■	N = 8 5,5,3				FILL: Silty clay, medium plasticity, dark red brown, with fine to coarse grained sandstone gravel, trace of ash.	MC≈PL		600 580 570	APPEARS WELL COMPACTED
	■					1		CH	SILTY CLAY: high plasticity, orange brown mottled grey, trace of root fibres.	MC>PL	St		
				■	N = 6 2,3,3							200 150 180	
	■					2							
				■				-	SANDSTONE: fine to medium grained, brown.	DW	L-M		LOW TO MODERATE 'TC' BIT RESISTANCE
				■		3							
				■		4			END OF BOREHOLE AT 4.0m				'TC' BIT REFUSAL
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No. **218** 1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 62.0m

Date: 4-11-15 **Datum:** AHD

Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay, medium plasticity, dark brown, with root fibres.	MC<PL			GRASS COVER
					N = 8 3,4,4	1			FILL: Silty clay, medium plasticity, dark brown, with fine to medium grained ironstone gravel, trace of ash.	MC>PL		350 350 350	APPEARS MODERATELY COMPACTED
					N = 11 5,4,7	2			FILL: Silty clay, high plasticity, red brown, trace of ash.			>600 >600 >600	APPEARS WELL COMPACTED
								CL	SILTY CLAY: medium plasticity, red brown mottled grey, trace of fine to medium grained ironstone gravel.	MC>PL	VSt -H		
					N = 18 5,7,11	3						450 450 400	
						4		-	SHALE: grey, with iron indurated bands.	DW	L-M		LOW 'TC' BIT RESISTANCE
									END OF BOREHOLE AT 4.0m				'TC' BIT REFUSAL
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No. 219
1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD
Date: 4-11-15
Method: SPIRAL AUGER JK500
Logged/Checked by: L.M./D.S.
R.L. Surface: ≈ 63.4m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0			FILL: Silty clay, medium plasticity, dark brown, with roots and root fibres.	MC<PL			GRASS COVER
				■	N = 12 3,5,7			CH	SILTY CLAY: high plasticity, orange brown.	MC<PL	H	500 520 480	
	■					1							
				■	N > 8 5,8/100mm							450 550	
					REFUSAL			-	SHALE: brown and grey.	DW	L	550	LOW 'TC' BIT RESISTANCE
						2							
				■		3							
				■					SHALE: grey.	SW	M		LOW TO MODERATE RESISTANCE
				■		4							
									END OF BOREHOLE AT 4.3m				'TC' BIT REFUSAL
						5							
						6							
						7							

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TEST PIT LOG

Test Pit No.
220
1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** BACKHOE **R.L. Surface:** ≈ 63.4m
Date: 5-11-15 **Datum:** AHD
Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■			■		0			FILL: Silty clay, low plasticity, dark brown, with roots and root fibres, trace of ash.	MC<PL			GRASS COVER
	■			■					FILL: Silty clay, low plasticity, light brown, with fine to medium grained shale gravel, trace of root fibres.				
	■			■		0.5			FILL: Silty clay, high plasticity, light grey and orange brown, with root fibres, trace of ash.	MC>PL			
	■			■					FILL: Silty clay, high plasticity, dark orange brown, trace of fine to medium grained ironstone gravel and ash.				
	■			■		1							
	■					1.5							
									END OF TEST PIT AT 1.7m				
						2							
						2.5							
						3							
						3.5							

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TEST PIT LOG

Test Pit No. **221** 1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** BACKHOE **R.L. Surface:** ≈ 57.5m
Date: 5-11-15 **Datum:** AHD
Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■			■		0			FILL: Silty clay, medium plasticity, dark brown, with roots and root fibres, fine to coarse grained igneous gravel, trace of ash.	MC≈PL			GRASS COVER
	■			■		0.5		CH	SILTY CLAY: high plasticity, light orange brown, trace of root fibres and ash.	MC>PL	H	500 480 510	
				■		1			as above, but light grey mottled orange brown.		VSt	350 320 300	
									END OF TEST PIT AT 1.1m				
						1.5							
						2							
						2.5							
						3							
						3.5							

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TEST PIT LOG

Test Pit No. **222** **1/1**

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** BACKHOE **R.L. Surface:** ≈ 55.3m

Date: 5-11-15 **Datum:** AHD

Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■			■		0			FILL: Silty clay, medium plasticity, dark brown, with roots and root fibres, trace of ash.	MC≈PL			GRASS COVER
	■					0.5		CH	SILTY CLAY: high plasticity, dark orange brown mottled grey, trace of roots and ash.	MC>PL	H	>600 >600	
									as above, but light brown.		VSt	350 320 300	
				■		1		-	SANDSTONE: fine to medium grained, brown.	DW	VL		
									END OF TEST PIT AT 1.0m				
						1.5							
						2							
						2.5							
						3							
						3.5							

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TEST PIT LOG

Test Pit No.
223
1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** BACKHOE **R.L. Surface:** ≈ 53.5m
Date: 5-11-15 **Datum:** AHD
Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■			■		0			FILL: Silty clay, medium plasticity, dark brown, with roots and root fibres, trace of ash.	MC>PL			GRASS COVER
	■			■		0.5		CH	SILTY CLAY: high plasticity, light orange brown, trace of ash.	MC>PL	H	400 420 450	
						1					VSt	350 350 350	
									END OF TEST PIT AT 1.0m				
						1.5							
						2							
						2.5							
						3							
						3.5							

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TEST PIT LOG

Test Pit No.
224
1/1

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** BACKHOE **R.L. Surface:** ≈ 52.6m
Date: 5-11-15 **Datum:** AHD
Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■			■		0			FILL: Silty clay, low plasticity, dark brown, with roots and root fibres.	MC<PL			GRASS COVER
	■			■		0.5		CH	SILTY CLAY: high plasticity, dark orange brown, trace of root fibres and ash.	MC>PL	VSt	250 300 300 250 300 250	
						1			END OF TEST PIT AT 1.0m				
						1.5							
						2							
						2.5							
						3							
						3.5							

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TEST PIT LOG

Test Pit No. **225** **1/1**

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** BACKHOE **R.L. Surface:** ≈ 58.7m
Date: 5-11-15 **Datum:** AHD
Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■			■		0			FILL: Silty clay, medium plasticity, dark orange brown, with fine to medium grained igneous and shale gravel, trace of ash and slag.	MC>PL			GRASS COVER
	■			■		0.5			FILL: Silty clay, medium plasticity, light brown, with fine to medium grained shale and sandstone gravel, trace of ash and slag.	MC<PL			
	■								FILL: Silty clay, high plasticity, dark brown, with fine to coarse grained sandstone, shale and igneous gravel and cobbles, trace of ash and slag.	MC>PL			
	■			■		1							
						1.5			END OF TEST PIT AT 1.5m				
						2							
						2.5							
						3							
						3.5							

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TEST PIT LOG

Test Pit No. **226** **1/1**

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** BACKHOE **R.L. Surface:** ≈ 60.2m
Date: 5-11-15 **Datum:** AHD
Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay, low plasticity, dark brown, trace of roots and root fibres and ash.	MC<PL			GRASS COVER
									FILL: Silty clay, low plasticity, dark brown, with fine to coarse grained sandstone and shale gravel, trace of ash, root fibres and fibro cement fragments.				
						0.5			FILL: Silty clay, low plasticity, dark brown, with fine to coarse grained igneous, sandstone and shale gravel, trace of ash, slag, tile, plastic and concrete fragments.				
									as above, but high plasticity.	MC>PL			
						1							
						1.5			END OF TEST PIT AT 1.5m				
						2							
						2.5							
						3							
						3.5							

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TEST PIT LOG

Test Pit No. **227** **1/1**

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD

Project: PROPOSED DEVELOPMENT

Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** BACKHOE **R.L. Surface:** ≈ 61.4m

Date: 5-11-15 **Datum:** AHD

Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■			■		0			FILL: Silty clay, high plasticity, dark brown, with roots and root fibres, trace of glass, fibro cement fragments, ash, slag and plastic fragments.	MC>PL			GRASS COVER
	■			■		0.5		CL	SILTY CLAY: medium plasticity, light brown, trace of root fibres and ash.	MC>PL	St	100 120 120	
						1			END OF TEST PIT AT 1.0m				
						1.5							
						2							
						2.5							
						3							
						3.5							

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TEST PIT LOG

Test Pit No. **228** **1/1**

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** BACKHOE **R.L. Surface:** ≈ 59.1m
Date: 5-11-15 **Datum:** AHD
Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■			■		0			FILL: Silty clay, low plasticity, dark brown, with roots and root fibres, trace of ash.	MC<PL			GRASS COVER
	■			■					FILL: Silty clay, low plasticity, light brown, with fine to medium grained shale gravel, trace of ash, slag and brick fragments.				
	■			■		0.5							
	■												
	■			■		1			FILL: Silty clay, high plasticity, light grey and red.	MC>PL			
									END OF TEST PIT AT 1.3m				
						1.5							
						2							
						2.5							
						3							
						3.5							

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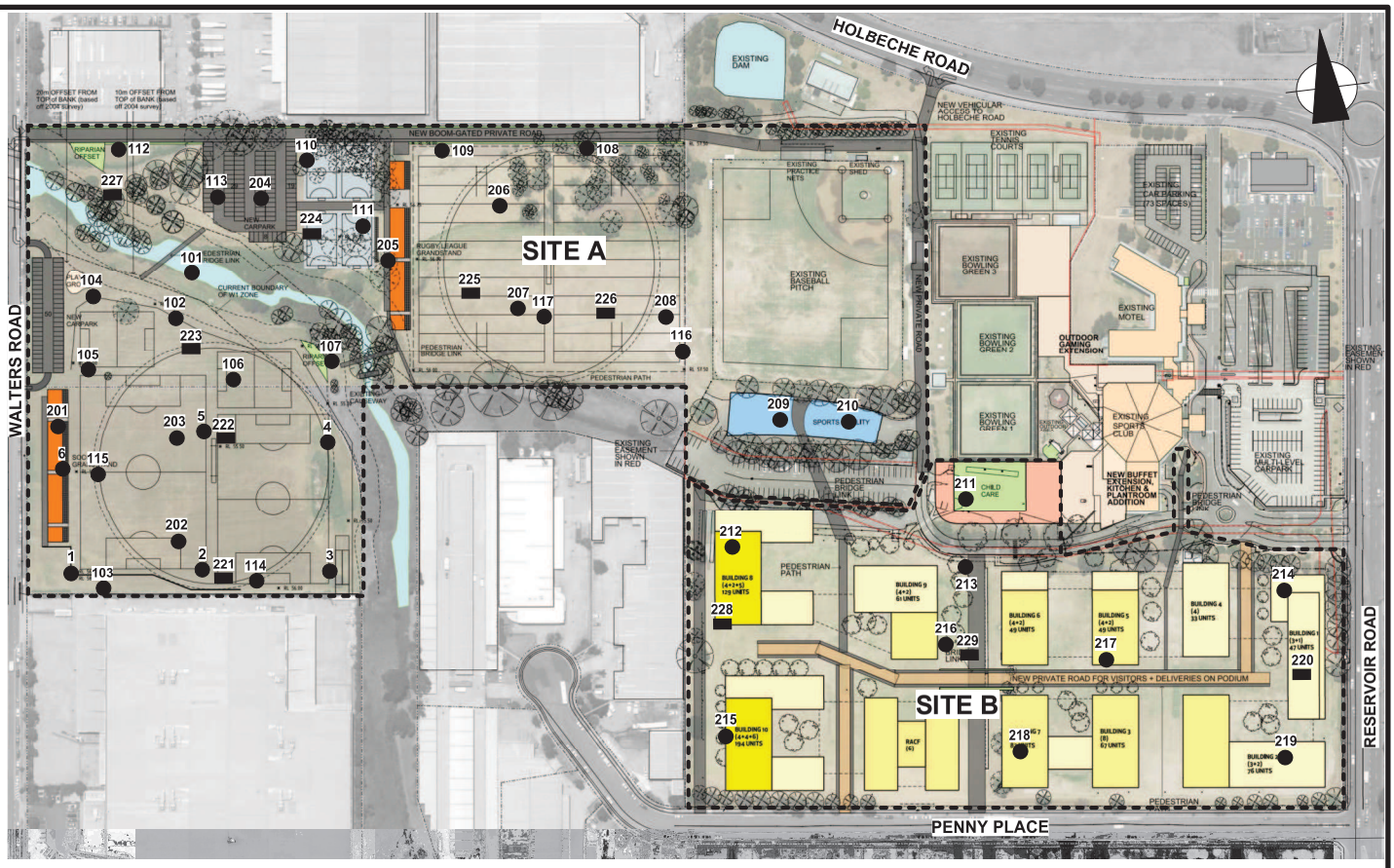
TEST PIT LOG

Test Pit No. **229** **1/1**

Client: PAYNTER DIXON CONSTRUCTIONS PTY LTD
Project: PROPOSED DEVELOPMENT
Location: RESERVOIR ROAD, ARNDELL PARK, NSW

Job No. 28870AD **Method:** BACKHOE **R.L. Surface:** ≈ 59.8m
Date: 5-11-15 **Datum:** AHD
Logged/Checked by: L.M./D.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty clay, low plasticity, dark brown, with fine grained sand, roots and root fibres, trace of ash.	MC<PL MC>PL			GRASS COVER
									FILL: Silty clay, high plasticity, light brown, trace of ash.				
						0.5			FILL: Silty clay, high plasticity, light grey and orange brown, with fine to medium grained shale gravel and cobbles, trace of ash.				
▶						1			FILL: Silty clay, medium plasticity, dark brown, trace of ash and organic matter.				
						1.5			END OF TEST PIT AT 1.3m				
						2							
						2.5							
						3							
						3.5							



LEGEND

- Borehole
- Test Pit

Scale (m): 0 — 100

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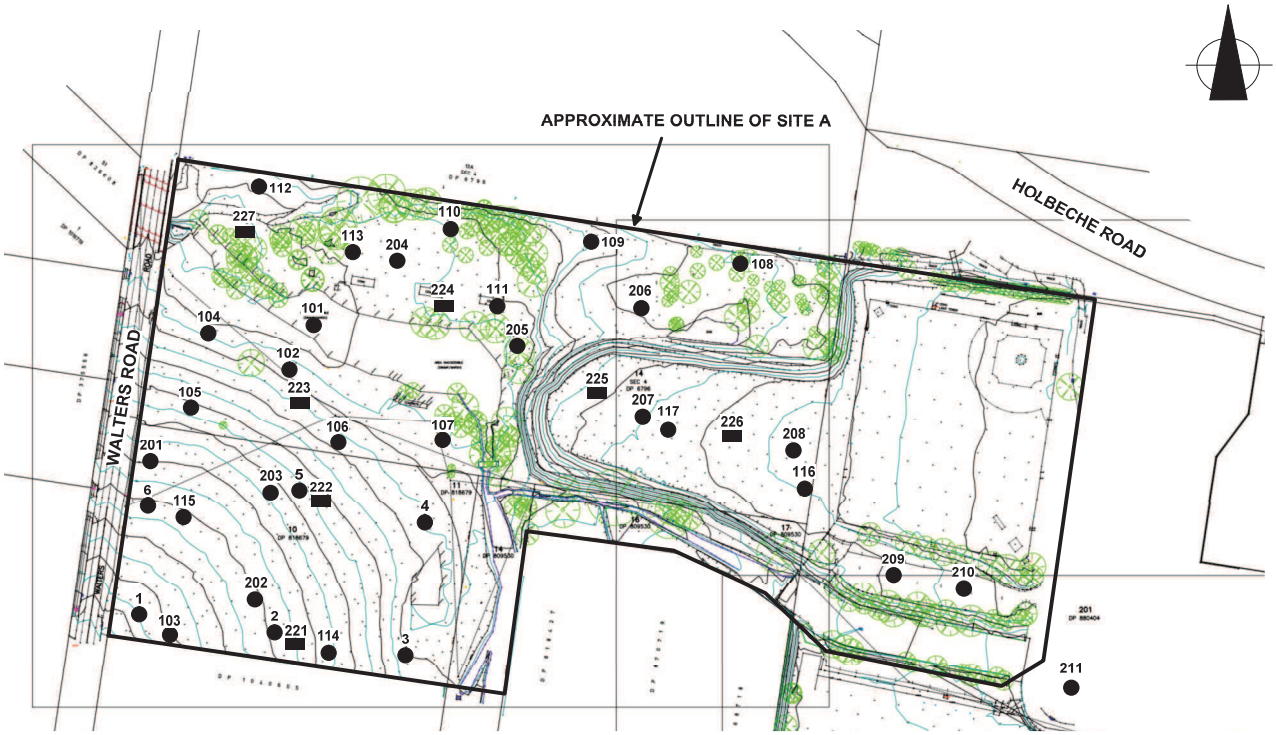
Title: **TEST LOCATION PLAN WITH PROPOSED DEVELOPMENT OVERLAY**

Report Number: 28870AD

Figure Number: 1



LEGEND

- Boreholes 201 - 211 are from the current geotechnical investigation
- Test Pits 221 - 227 are from the current geotechnical investigation
- Boreholes 1 - 6 are from our previous preliminary geotechnical investigation report (Ref: 25295ZRrpt) dated 7 November 2011
- Boreholes 101 - 117 are from the supplied previous geotechnical investigation report prepared by Brink & Associates (Ref: S06160-A TV:MC) dated 1 February 2007

Scale (m): 0 100

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Title: SITE A - TEST LOCATION PLAN

Report Number: 28870AD

Figure Number: 2

LEGEND

- Borehole
- Test Pit

Scale (m): 0 100

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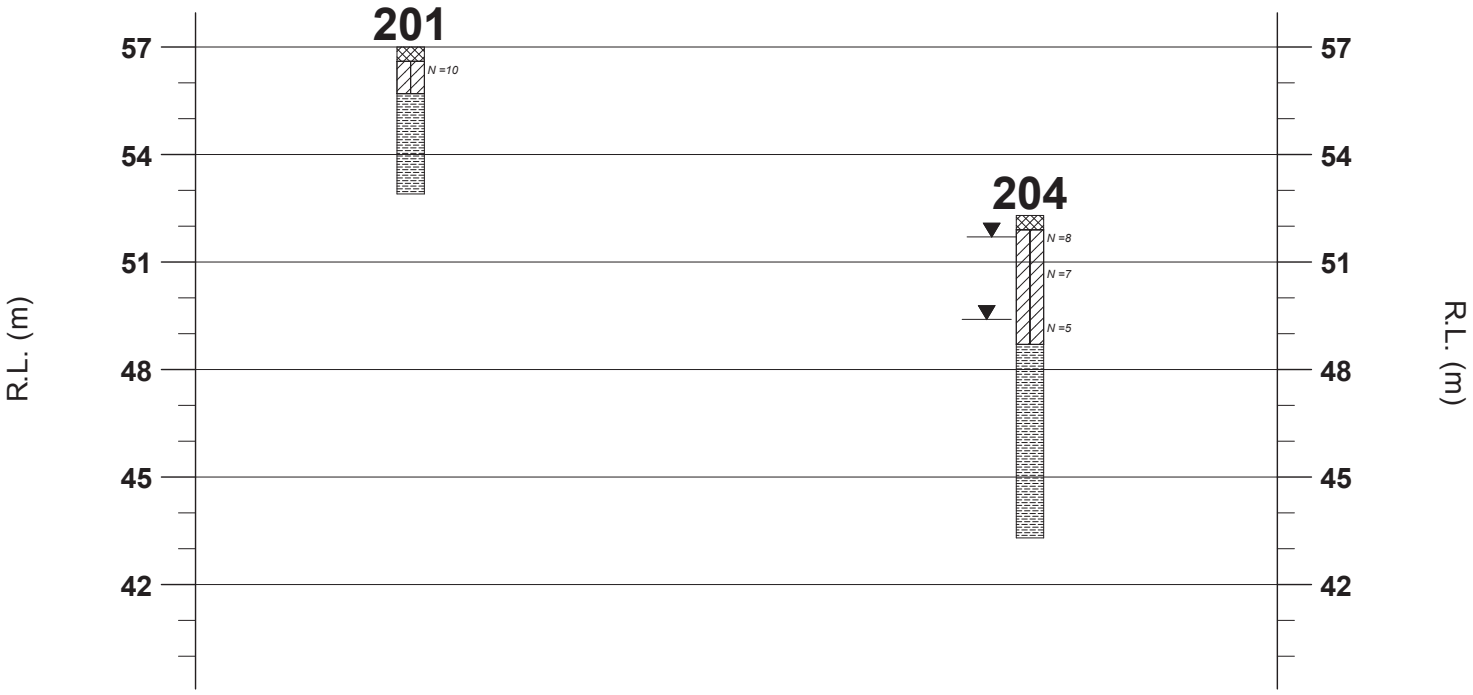
Title: SITE B - TEST LOCATION PLAN

Report Number: 28870AD

Figure Number: 3

GRAPHICAL BOREHOLE SUMMARY



Fill		Observed water level
Silty Clay	N	SPT "N" VALUE
Shale	Nc	SOLID CONE BLOW COUNTS PER 150mm

NOTE: REFER TO BOREHOLE LOGS

Scale: 1 : 150 (vert) ; NTS (horiz)

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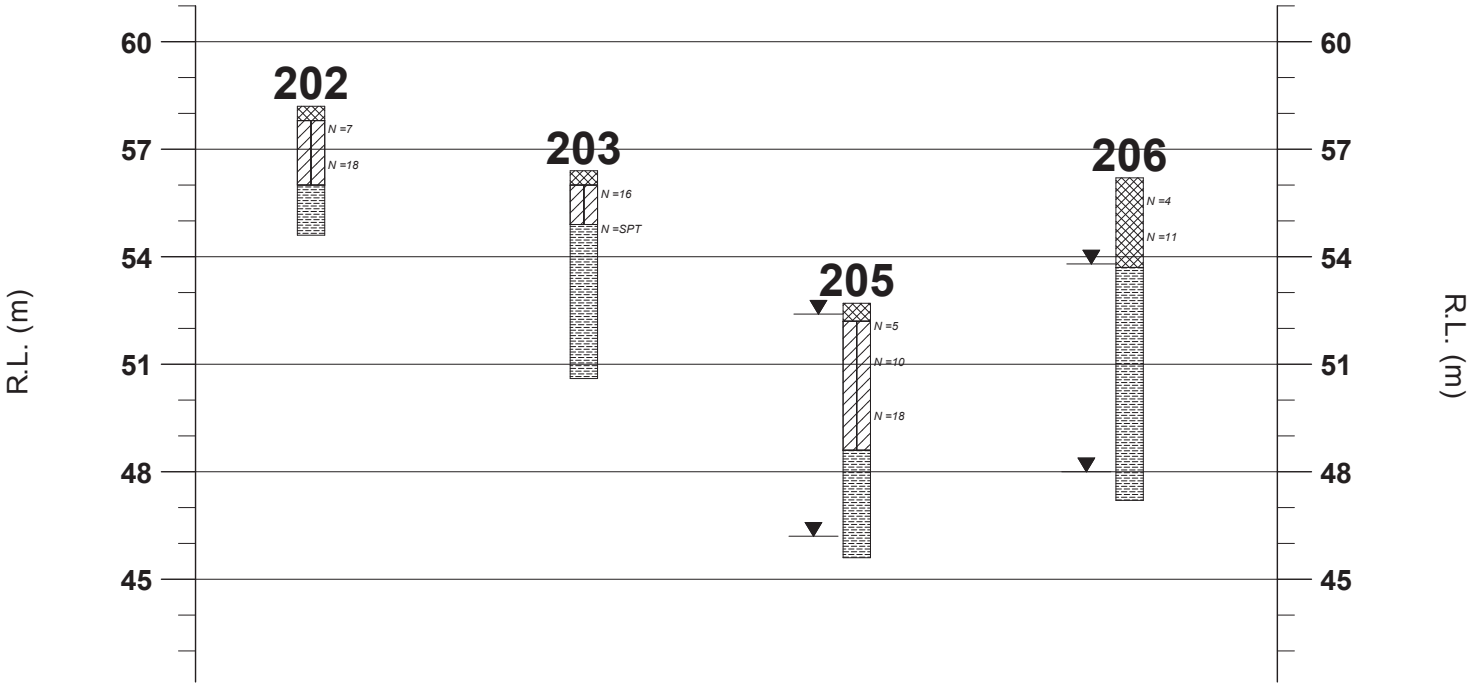
Job No.: 28870AD

Figure No.: 4

GRAPHICAL BOREHOLE SUMMARY



Fill
Silty Clay
Shale

Observed water level

N — SPT "N" VALUE

Nc — SOLID CONE BLOW COUNTS PER 150mm

NOTE: REFER TO BOREHOLE LOGS

Scale: 1 : 150 (vert) ; NTS (horiz)

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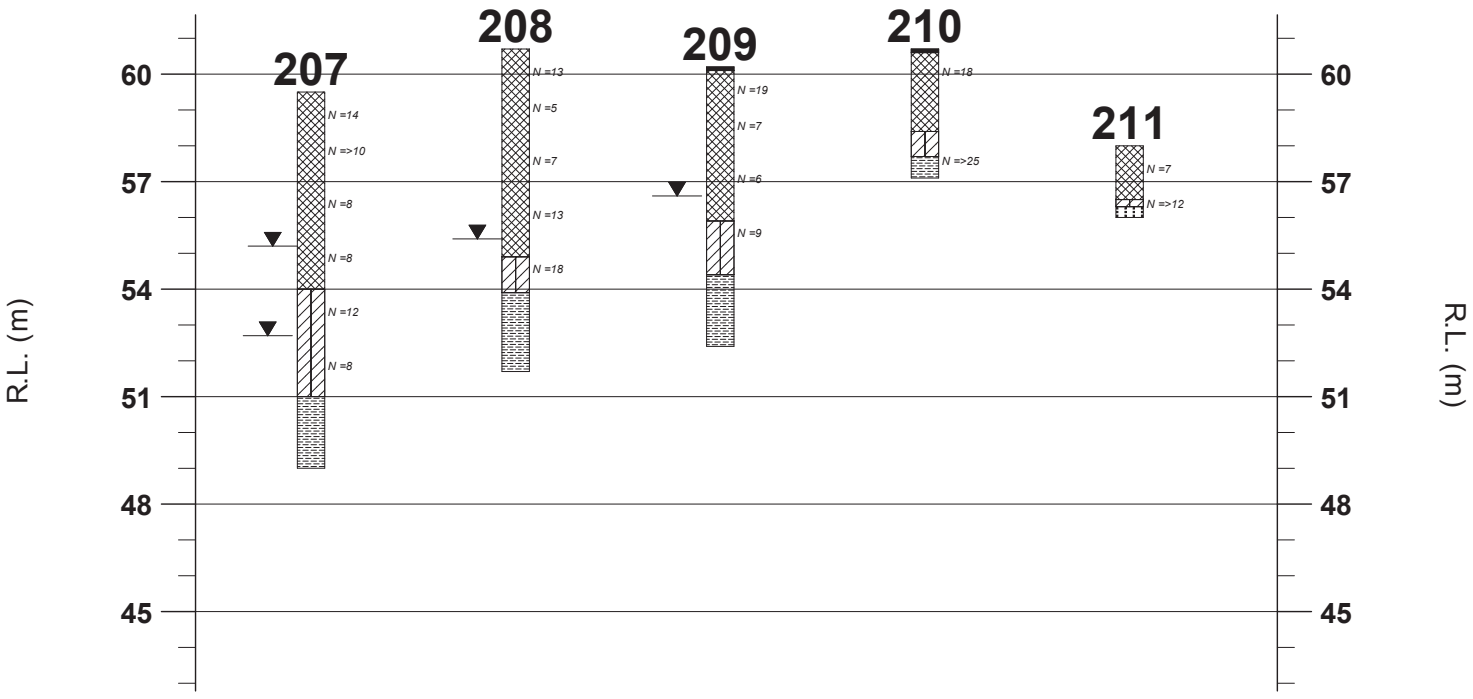
Job No.: 28870AD

Figure No.: 5

GRAPHICAL BOREHOLE SUMMARY



Fill
Silty Clay
Shale
Asphaltic/ Bituminous Paving or Coal
Sandstone/ Greywacke
Observed water level
N SPT "N" VALUE
Nc SOLID CONE BLOW COUNTS PER 150mm

NOTE: REFER TO BOREHOLE LOGS

Scale: 1 : 150 (vert) ; NTS (horiz)

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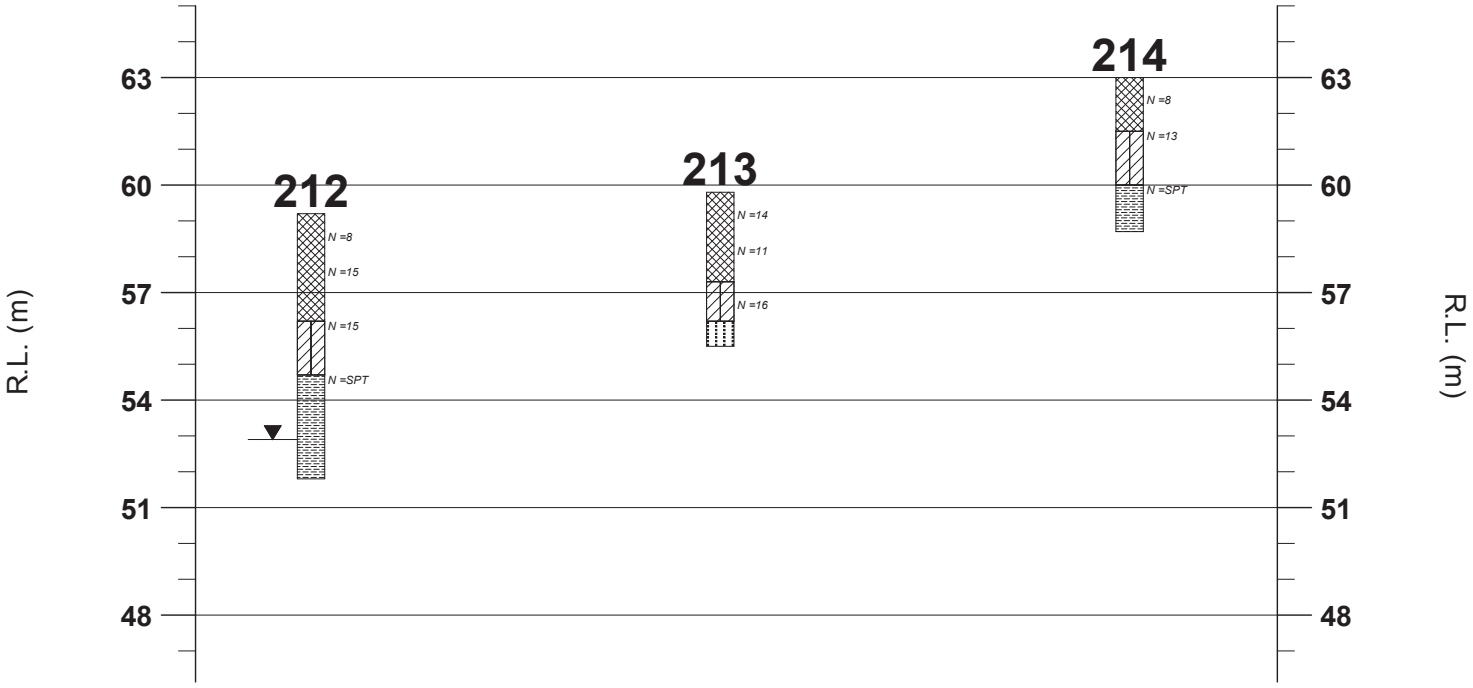
Job No.: 28870AD

Figure No.: 6

GRAPHICAL BOREHOLE SUMMARY



Fill
Silty Clay
Shale
Sandstone/ Greywacke
Observed water level
N SPT "N" VALUE
Nc SOLID CONE BLOW COUNTS PER 150mm

NOTE: REFER TO BOREHOLE LOGS

Scale: 1 : 150 (vert) ; NTS (horiz)

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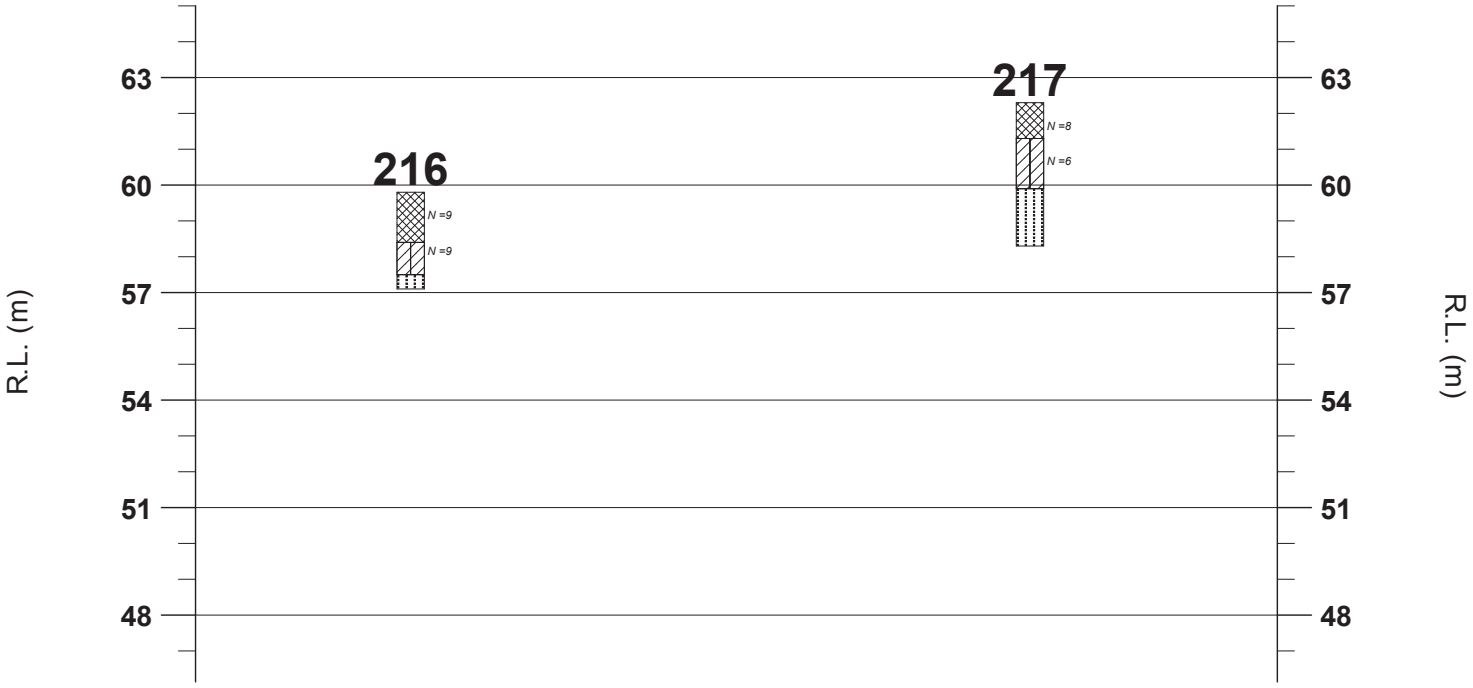
Job No.: 28870AD Figure No.: 7

GRAPHICAL BOREHOLE SUMMARY



Fill
Silty Clay
Sandstone/ Greywacke

N SPT "N" VALUE

Nc SOLID CONE BLOW COUNTS PER 150mm

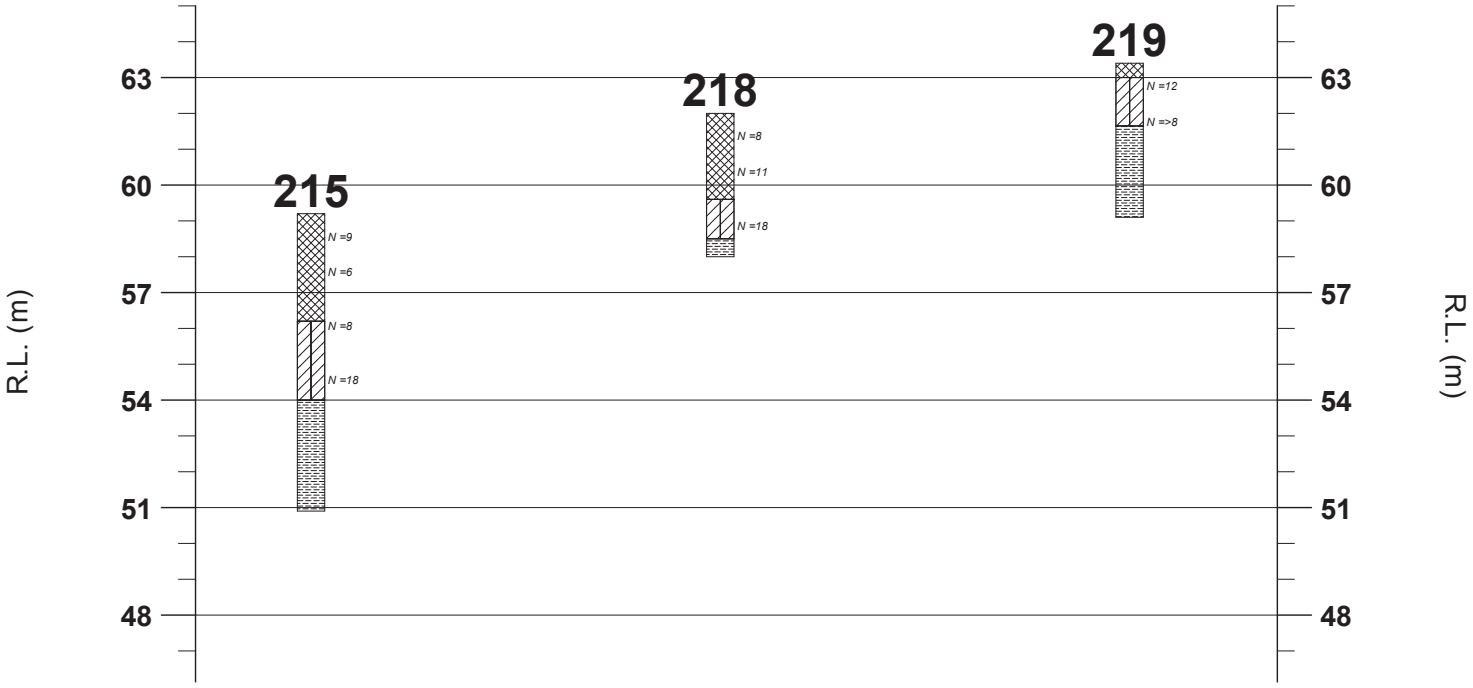
NOTE: REFER TO BOREHOLE LOGS

Scale: 1 : 150 (vert) ; NTS (horiz)

JK Geotechnics

Job No.: 28870AD Figure No.: 8

GRAPHICAL BOREHOLE SUMMARY



Fill
Silty Clay
Shale

N SPT "N" VALUE

Nc SOLID CONE BLOW COUNTS PER 150mm

NOTE: REFER TO BOREHOLE LOGS

Scale: 1 : 150 (vert) ; NTS (horiz)

JK Geotechnics

Job No.: 28870AD

Figure No.: 9

VIBRATION EMISSION DESIGN GOALS

German Standard DIN 4150 – Part 3: 1999 provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally recognised to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, OR, maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor), are summarised in Table 1 below.

It should be noted that peak vibration velocities higher than the minimum figures in Table 1 for low frequencies may be quite 'safe', depending on the frequency content of the vibration and the actual condition of the structures.

It should also be noted that these levels are 'safe limits', up to which no damage due to vibration effects has been observed for the particular class of building. 'Damage' is defined by DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls. Should damage be observed at vibration levels lower than the 'safe limits', then it may be attributed to other causes. DIN 4150 also states that when vibration levels higher than the 'safe limits' are present, it does not necessarily follow that damage will occur. Values given are only a broad guide.

Table 1: DIN 4150 – Structural Damage – Safe Limits for Building Vibration

Group	Type of Structure	Peak Vibration Velocity in mm/s			
		At Foundation Level at a Frequency of:			Plane of Floor of Uppermost Storey
		Less than 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use.	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 and 2 and have intrinsic value (eg. buildings that are under a preservation order).	3	3 to 8	8 to 10	8

NOTE: For frequencies above 100Hz, the higher values in the 50Hz to 100Hz column should be used.

REPORT EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, the SAA Site Investigation Code. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (e.g. sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'Shale' is used to describe thinly bedded to laminated siltstone.

SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained 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.

Details of the type and method of sampling used are given on the attached logs.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All except test pits, hand auger drilling and portable dynamic cone penetrometers require the use of a mechanical drilling rig which is commonly mounted on a truck chassis.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as hard clay, gravel or ironstone, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water 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 “feel” and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term ‘mud’ encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength 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 F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the ‘N’ value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm 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 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

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

  N>30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as "N_c" on the borehole logs, together with the number of blows per 150mm penetration.

Static Cone Penetrometer Testing and Interpretation: Cone penetrometer testing (sometimes referred to as a Dutch Cone) described in this report has been carried out using an Electronic Friction Cone Penetrometer (EFCP). The test is described in Australian Standard 1289, Test F5.1.

In the tests, a 35mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

  The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between EFCP and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of EFCP values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a sliding hammer and counting the blows for successive 100mm increments of penetration.

Two relatively similar tests are used:

- Cone penetrometer (commonly known as the Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS1289, Test F3.2). The 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.
- Perth sand penetrometer – a 16mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test F3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

LOGS

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

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than “straight line” variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

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

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it 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 and may not be the same at the time of construction.
- 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 be washed out of the hole or ‘reverted’ chemically if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after stabilising at intervals ranging from several days to 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 perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg bricks, steel etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soil for Engineering Purposes'*. Details of the test procedure used are given on the individual report forms.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg to a twenty storey building). If this happens, the company 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 aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.

If these occur, the company will be pleased to assist with investigation or advice to resolve any problems occurring.

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, the company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed that at some later stage, well after the event.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Attention is drawn to the document *'Guidelines for the Provision of Geotechnical Information in Tender Documents'*, published by the Institution of Engineers, Australia. Where information obtained from this investigation 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. The company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

REVIEW OF DESIGN

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer.

SITE INSPECTION

The company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or

iii) full time engineering presence on site.

GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS

SOIL


FILL


TOPSOIL


CLAY (CL, CH)


SILT (ML, MH)


SAND (SP, SW)


GRAVEL (GP, GW)


SANDY CLAY (CL, CH)


SILTY CLAY (CL, CH)


CLAYEY SAND (SC)


SILTY SAND (SM)


GRAVELLY CLAY (CL, CH)


CLAYEY GRAVEL (GC)


SANDY SILT (ML)


PEAT AND ORGANIC SOILS

ROCK


CONGLOMERATE


SANDSTONE


SHALE


SILTSTONE, MUDSTONE, CLAYSTONE


LIMESTONE


PHYLLITE, SCHIST


TUFF


GRANITE, GABBRO


DOLERITE, DIORITE


BASALT, ANDESITE


QUARTZITE

DEFECTS AND INCLUSIONS


CLAY SEAM


SHEARED OR CRUSHED SEAM


BRECCIATED OR SHATTERED SEAM/ZONE


IRONSTONE GRAVEL


ORGANIC MATERIAL

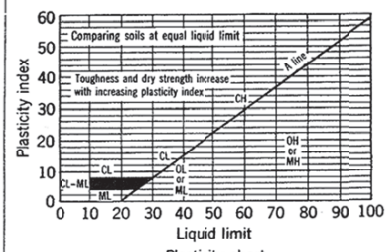
OTHER MATERIALS


CONCRETE


BITUMINOUS CONCRETE, COAL


COLLUVIUM

Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights)						Group Symbols [a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils More than half of material is larger than 75 μm sieve size[a] (The 75 μm sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	Use grain size curve in identifying the fractions as given under field identification Determine percentages of gravel and sand from grain size curve Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP* More than 12% *GM, GC, SM, SC* 5% to 12% *Borderline* cases requiring use of dual symbols $C_U = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *GW* Atterberg limits below "A" line, or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols Atterberg limits above "A" line, with *PI* greater than 7
			Predominantly one size or a range of sizes with some intermediate sizes missing			*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)			*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)			*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		
	Sands More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes			*SW*	Well graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *SW* Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols Atterberg limits below "A" line with *PI* greater than 7
			Predominantly one size or a range of sizes with some intermediate sizes missing			*SP*	Poorly graded sands, gravelly sands, little or no fines		
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)			*SM*	Silty sands, poorly graded sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)			*SC*	Clayey sands, poorly graded sand-clay mixtures		
Fine-grained soils More than half of material is *smaller* than 75 μm sieve size (The 75 μm sieve size is about the smallest particle visible to naked eye)	Identification Procedures on Fraction Smaller than 380 μm Sieve Size								
	Silts and clays liquid limit less than 50		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)				
			None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)	
			Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity		
	Silts and clays liquid limit greater than 50		Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays		
			Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity		
Highly Organic Soils			Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils		



Plasticity chart
for laboratory classification of fine grained soils

Note: 1 Soils possessing characteristics of two groups are designated by combinations of group symbols (eg. GW-GC, well graded gravel-sand mixture with clay fines).
2 Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.

LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record	▼	Standing water level. Time delay following completion of drilling may be shown.
	C	Extent of borehole collapse shortly after drilling.
	▶	Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
	ASB	Soil sample taken over depth indicated, for asbestos screening.
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.
	SAL	Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of Undrained Shear Strength.
	PID = 100	Photoionisation detector reading in ppm (Soil sample headspace test).
Moisture Condition (Cohesive Soils)	MC>PL	Moisture content estimated to be greater than plastic limit.
	MC≈PL	Moisture content estimated to be approximately equal to plastic limit.
	MC<PL	Moisture content estimated to be less than plastic limit.
(Cohesionless Soils)	D	DRY – Runs freely through fingers.
	M	MOIST – Does not run freely but no free water visible on soil surface.
	W	WET – Free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT – Unconfined compressive strength less than 25kPa
	S	SOFT – Unconfined compressive strength 25-50kPa
	F	FIRM – Unconfined compressive strength 50-100kPa
	St	STIFF – Unconfined compressive strength 100-200kPa
	VSt	VERY STIFF – Unconfined compressive strength 200-400kPa
	H	HARD – Unconfined compressive strength greater than 400kPa
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other tests.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (I_D) Range (%)** / **SPT 'N' Value Range (Blows/300mm)**
	VL	Very Loose <15 0-4
	L	Loose 15-35 4-10
	MD	Medium Dense 35-65 10-30
	D	Dense 65-85 30-50
	VD	Very Dense >85 >50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other tests.
Hand Penetrometer Readings	300 250	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise.
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Tungsten carbide wing bit.
	T 60	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.

LOG SYMBOLS continued

ROCK MATERIAL WEATHERING CLASSIFICATION

TERM	SYMBOL	DEFINITION
Residual Soil	RS	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely weathered rock	XW	Rock is weathered to such an extent that it has "soil" properties, ie it either disintegrates or can be remoulded, in water.
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh rock	FR	Rock shows no sign of decomposition or staining.

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining, Science and Geomechanics. Abstract Volume 22, No 2, 1985.

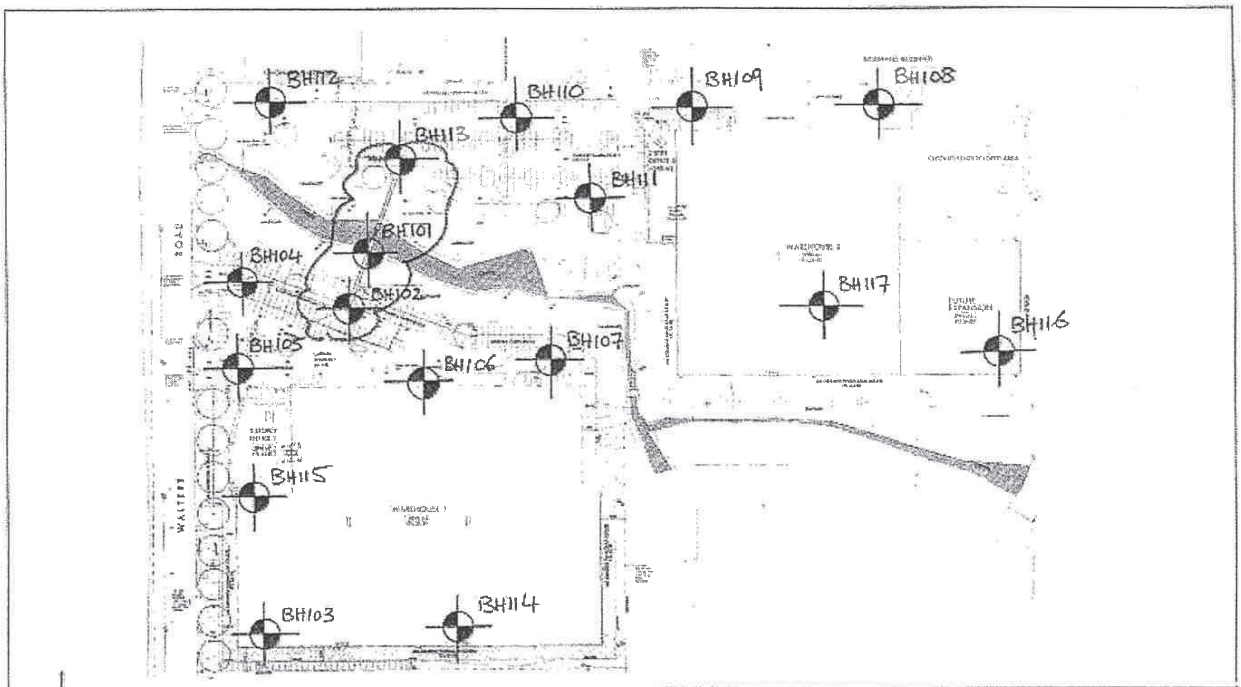
TERM	SYMBOL	Is (50) MPa	FIELD GUIDE
Extremely Low:	EL		Easily remoulded by hand to a material with soil properties.
----------	----------	0.03	
Very Low:	VL		May be crumbled in the hand. Sandstone is "sugary" and friable.
----------	----------	0.1	
Low:	L		A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
----------	----------	0.3	
Medium Strength:	M		A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
----------	----------	1	
High:	H		A piece of core 150mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
----------	----------	3	
Very High:	VH		A piece of core 150mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
----------	----------	10	
Extremely High:	EH		A piece of core 150mm long x 50mm dia. is very difficult to break with hand-held hammer. Rings when struck with a hammer.

ABBREVIATIONS USED IN DEFECT DESCRIPTION

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to the long core axis (ie relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Ironstained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	

APPENDIX A

Borehole Location Plan and
Borehole Logs 101 to 117 from
Geotechnical Investigation Report
Prepared by Brink & Associates
(Ref. S06160-A TV:MC dated 1 February 2007)



LEGEND

Approximate Borehole Location

BRINK & ASSOCIATES
Geotechnical, Geological, Environmental
Consulting Engineers and Scientists

P.O. Box 6871
WETHERILL PARK NSW 2164
Ph: (02) 9609 3800
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SCALE: N.T.S

DRAWING NO: S06160-1

PAYNTER DIXON CONSTRUCTIONS PTY LTD
PROPOSED COMMERCIAL DEVELOPMENT
BLACKTOWN WORKERS CLUB
WALTERS ROAD,
ARNDELL PARK

SITE PLAN

Brink Holdings Pty Ltd ABN 75050212710 trading as

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Geotechnical, Geological, Environmental Consultants

Job No:	S06160-A
Hole No:	BH101
Sheet	1 of 2

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:	Ref. Dwg No.S06160-1
Project:	Proposed Commercial Development	Test Method:	Truck-mounted drill rig
Project Location:	Blacktown Workers Club Walters Road, Arndell Park	Coordinates: -	Logged by: MC
		Surface level: Existing	Date: 15/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
				-	Ripped SHALE	D	-	FILL	
		0.5		CI - CH	CLAY, medium to high plasticity, yellow-brown to brown with minor silt	D-M	F-St	RESIDUAL	0.5
▽	3,3,5 N=8	1.0			grading to grey				1.0
		1.5							1.5
		2.0			Gravelly Sandy CLAY, medium plasticity, orange-borwn with ironstone gravels	M> Wp			2.0
▶	3,3,8 N=11	2.5					VSt		2.5
		3.0							3.0
		3.5		-	SHALE, very low to low strength, brown, extremely weathered grading to medium strength, dark grey-brown, distinctly weathered	-	-	BEDROCK High V-bit resistance from 3.2m. V-bit refusal at 3.5m.	3.5
					Continued on Sheet 2 of 2				

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Geotechnical, Geological, Environmental Consultants

Job No:	S06160-A
Hole No:	BH101
Sheet	2 of 2

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club Walters Road, Arndell Park	Coordinates: -	Logged by: MC
		Surface level:Existing	Date: 15/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
					Contiuned from Sheet 1 of 2				
				-	SHALE, medium strength, dark grey-brown, distinctly weathered	-	-	BEDROCK	
		4.0			BH101 terminated at 3.8m depth due to TC-bit resfusal on Shale bedrock.				4.0
		4.5							4.5
		5.0							5.0
		5.5							5.5
		6.0							6.0
		6.5							6.5
		7.0							7.0

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH102
Sheet	1 of 2

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 15/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
NIL				-	Gravelly SILT, low plasticity, brown	D	-	TOPSOIL / FILL	
		0.5		CI - CH	CLAY, medium to high plasticity, orange-brown with yellow-brown	M≥ Wp	St/ VSt	RESIDUAL	0.5
		1.0							1.0
	3,13, 23 N=36			CI	Shaley CLAY, medium plasticity, orange-brown	M< Wp	H	V-bit refusal at 1.4m.	
		1.5		-	SHALE, low strength, brown, distinctly weathered	-	-	BEDROCK	1.5
		2.0							2.0
		2.5							2.5
		3.0							3.0
		3.5							3.5
					Continued on Sheet 2 of 2				

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample	W	Wet
St	Stiff	D	Dense		(50mm diam.)	Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH102
Sheet	2 of 2

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 15/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
NIL					**Continued from Sheet 1 of 2**				
				-	SHALE, low strength, distinctly weathered, brown	-	-	BEDROCK	
		4.0			grading to grey from 4.0m			High TC-bit resistance from 4.0m.	4.0
		4.5							4.5
		5.0							5.0
		5.5							5.5
					BH102 terminated at 5.5m depth due to TC-bit refusal on Shale bedrock.				
		6.0							6.0
		6.5							6.5
		7.0							7.0

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH103
Sheet	1 of 1

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club Walters Road, Arndell Park	Coordinates: -	Logged by: MC
		Surface level:Existing	Date: 15/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
NIL				-	Gravelly SILT, low plasticity, dark brown	-	-	TOPSOIL / FILL	
				CI/ CH	CLAY, medium to high plasticity, red-brown	M≥ Wp	VSt	RESIDUAL	
		0.5							0.5
		1.0		CI	CLAY, meidum plasticity, pale grey with red ironstone bands				1.0
	8,15,11 N=26						VSt/ H		
		1.5							1.5
		2.0							2.0
		2.5							2.5
	11,25, REF							V-bit refusal at 2.8m	
		3.0							3.0
				-	SHALE, Distinctly weathered, low strength, brown grey	-	-	BEDROCK	
		3.5							3.5
					BH103 terminated at 3.9m depth due to TC-bit refusal.				

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH104
Sheet	1 of 1

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 15/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L				-	Clayey SILT, low plasticity, dark brown	M< Wp	-	TOPSOIL	
				CI	Silty CLAY, medium plasticity, orange brown	M≤ Wp	St/ VSt	RESIDUAL	
	B	0.5							0.5
		1.0							1.0
					BH104 terminated at 1.0m depth.				
		1.5							1.5
		2.0							2.0
		2.5							2.5
		3.0							3.0
		3.5							3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample	W	Wet
St	Stiff	D	Dense		(50mm diam.)	Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH105
Sheet	1 of 1

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club Walters Road, Arndell Park	Coordinates: -	Logged by: MC
		Surface level:Existing	Date: 16/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
NIL				-	Clayey SILT, low plasticity, dark brown	M< Wp	-	TOPSOIL	
				CI/ CH	CLAY, medium to high plasticity, orange brown with ironstone gravel	M≤ Wp	VSt	RESIDUAL	
	B	0.5							0.5
		1.0							1.0
					BH105 terminated at 1.0m depth.				
		1.5							1.5
		2.0							2.0
		2.5							2.5
		3.0							3.0
		3.5							3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH106
Sheet	1 of 1

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 16/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
NIL				-	Clayey SILT, low plasticity, dark brown	M< Wp	-	TOPSOIL	
				CI	Silty CLAY, medium plasticity, orange brown, with pale grey mottling	M≤ Wp	St/ VSt	RESIDUAL	
	B	0.5							0.5
		1.0							1.0
					BH106 terminated at 1.0m depth.				
		1.5							1.5
		2.0							2.0
		2.5							2.5
		3.0							3.0
		3.5							3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH107
Sheet	1 of 1

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 16/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
NIL				-	Clayey SILT, low plasticity, dark brown	M< Wp	-	TOPSOIL	
				CI/ CH	CLAY, medium to high plasticity, orange-yellow brown	M≤ Wp	VSt	RESIDUAL	
	B	0.5							0.5
		1.0							1.0
					BH107 terminated at 1.0m depth.				
		1.5							1.5
		2.0							2.0
		2.5							2.5
		3.0							3.0
		3.5							3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH108
Sheet	1 of 1

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club Walters Road, Arndell Park	Coordinates: -	Logged by: MC
		Surface level:Existing	Date: 16/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N		-		-	Clayey SILT, low plasticity, dark brown	M< Wp	-	TOPSOIL	
I									
L				CI	CLAY, medium plasticity, pale orange	M≤ Wp	VSt	RESIDUAL	
					... grading to ...				
		0.5			pale grey				0.5
	B								
		1.0							1.0
					BH108 terminated at 1.0m depth.				
		1.5							1.5
		2.0							2.0
		2.5							2.5
		3.0							3.0
		3.5							3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH109
Sheet	1 of 1

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:	Ref. Dwg No.S06160-1
Project:	Proposed Commercial Development	Test Method:	Truck-mounted drill rig
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level: Existing	Date: 16/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L				-	Clayey SILT, low plasticity, dark brown	M< Wp	-	TOPSOIL	
				Cl	CLAY, medium plasticity, red brown with orange mottling	M≥ Wp	VSt	RESIDUAL	
	B	0.5							0.5
		1.0							1.0
					BH109 terminated at 1.0m depth.				
		1.5							1.5
		2.0							2.0
		2.5							2.5
		3.0							3.0
		3.5							3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH110
Sheet	1 of 1

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 16/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L				-	Clayey SILT, low plasticity, dark brown	M< Wp	-	TOPSOIL	
				CI	CLAY, medium to high plasticity, yellow brown	M> Wp	VSt	RESIDUAL	
	B	0.5							0.5
		1.0							1.0
					BH110 terminated at 1.0m depth.				
		1.5							1.5
		2.0							2.0
		2.5							2.5
		3.0							3.0
		3.5							3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Geotechnical, Geological, Environmental Consultants

Job No:	S06160-A
Hole No:	BH111
Sheet	1 of 1

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 16/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
NIL				-	Clayey SILT, low plasticity, dark brown	M< Wp		TOPSOIL	
				CI	Silty CLAY, medium plasticity, orange and orange grey	M≥ Wp	VSt	ALLUVIUM	
	B	0.5							0.5
		1.0							1.0
					BH111 terminated at 1.0m depth.				
		1.5							1.5
		2.0							2.0
		2.5							2.5
		3.0							3.0
		3.5							3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

Brink Holdings Pty Ltd ABN 75050212710 trading as
BRINK & Associates
Geotechnical, Geological, Environmental Consultants

Job No:	S06160-A
Hole No:	BH112
Sheet	1 of 1

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 16/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
NIL	D			-	Gravelly CLAY, medium plasticity, orange and grey with minor topsoil and shale gravel	M≤Wp	-	FILL (appears well compaced)	
	B	0.5							0.5
		1.0							1.0
					BH112 terminated at 1.0m depth.				
		1.5							1.5
		2.0							2.0
		2.5							2.5
		3.0							3.0
		3.5							3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

Brink Holdings Pty Ltd ABN 75050212710 trading as
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Job No:	S06160-A
Hole No:	BH113
Sheet	1 of 2

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 16/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
	D			-	Clayey SILT, low plastcitiy dark brown	M< Wp	-	TOPSOIL	
				CI	Silty CLAY, medium plasticity, pale orange brown	M> Wp	St/ VSt	ALLUVIAL	
	B	0.5							0.5
		1.0							1.0
	2,4,7 N=11				... grading to ... mottled pale orange and pale grey				
		1.5							1.5
▼		2.0			... grading to ... pale grey				2.0
		2.5							2.5
	2,3,6 N=9								
		3.0			Gravelly Sandy CLAY, medium plasticity, yellow-brown				3.0
		3.5			SHALE, extremely weathered, very low to low strength, brown	-	-	BEDROCK High V-bit resistance from 3.5m	3.5
					Continued on Sheet 2 of 2				

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH113
Sheet	2 of 2

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 16/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
					Continued from Sheet 1 of 2				
				-	SHALE, extremely weathered, very low to low strength, brown	-	-	BEDROCK	
		4.0			SHALE, Dinstinctly weathered, low to medium strength, dark grey			V-bit refusal at 4.0m	4.0
		4.5							4.5
		5.0							5.0
					BH113 terminated at 5.2m depth due to TC-bit refusal.				
		5.5							5.5
		6.0							6.0
		6.5							6.5
		7.0							7.0

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH114
Sheet	1 of 1

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 16/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L				-	Clayey SILT, low plasticity, dark brown	M< Wp	-	TOPSOIL	
		0.5		CI/ CH	CLAY, medium to high plasticity, orange brown	M> Wp	VSt/ H	RESIDUAL	0.5
		1.0			... grading to ... pale grey				1.0
	4,10,11 N=21	1.5							1.5
		2.0			SHALE, very low to low strength, grey brown, extremely weathered to distinctly weathered	-	-	BEDROCK High V-bit resistance from 1.6m	2.0
		2.5			SHALE, low to medium strength, grey brown, distinctly weathered			V-bit refusal at 1.8m	2.5
		3.0			BH114 terminated at 2.7m depth due to TC-bit refusal.				3.0
		3.5							3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH115
Sheet	1 of 2

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club Walters Road, Arndell Park	Coordinates: -	Logged by: MC
		Surface level:Existing	Date: 19/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L				-	Clayey SILT, low plasticity dark brown, grey	M> Wp	-	TOPSOIL	
				CI/ CH	CLAY, medium to high plasticity, red ... grading to ... pale grey	M≥ Wp	VSt/ H	RESIDUAL	
		0.5							0.5
		1.0							1.0
	3,8,21 N=29								
		1.5		-	SHALE, extremely weathered, very low to low strength, pale brown and pale grey with CLAY banding	-	-	BEDROCK V-bit refusal at 1.4m	1.5
		2.0							2.0
		2.5							2.5
		3.0			SHALE, low to medium strength, yellow brown/dark grey, distinctly weathered				3.0
		3.5							3.5
					Continued on Sheet 2 of 2				

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH115
Sheet	2 of 2

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 19/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
					Continued from Sheet 1 of 2				
NIL		4.0		-	SHALE, low to medium strength, yellow brown/dark grey, distinctly weathered	-	-	BEDROCK	4.0
		4.5						High TC-bit resistance from 4.7m	4.5
		5.0							5.0
		5.5			BH115 terminated at 5.0m depth due to TC-bit refusal.				5.5
		6.0							6.0
		6.5							6.5
		7.0							7.0

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample	W	Wet
St	Stiff	D	Dense		(50mm diam.)	Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH116
Sheet	1 of 3

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 22/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
NIL		0.5		-	Gravel Clayey SILT, low plasticity, dark brown, with shale gravel and brick fragments	-	-	TOPSOIL / FILL	0.5
		1.0							1.0
	4,2,3 N=5	1.5							1.5
		2.0							2.0
		2.5			Gravelly CLAY/Clayey GRAVEL, medium plasticity, medium grained, grey orange brown	M> Wp		FILL	2.5
	4,5,8 N=13	3.0							3.0
		3.5							3.5
					Continued on Sheet 2 of 3				

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH116
Sheet	2 of 3

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 22/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
					Continued from Sheet 1 of 3				
NIL	D	4.0		CL/ ML	Silty CLAY/Clayey SILT, low plasticity, grey brown	M> Wp	St	ALLUVIUM	4.0
	2,3,5 N=8	4.5							4.5
		5.0			Gravelly CLAY, medium plasticity, orange brown, with ironstone gravel		VSt/ H		5.0
	4,7, 15/ 100mm	5.5							5.5
		6.0	-	-	SHALE, low to medium strength, grey brown, distinctly weathered	-	-	BEDROCK V-bit refusal at 5.9m	6.0
		6.5							6.5
		7.0							7.0
					Continued on Sheet 3 of 3				

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample (50mm diam.)	W	Wet
St	Stiff	D	Dense			Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

Brink Holdings Pty Ltd ABN 75050212710 trading as
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Job No:	S06160-A
Hole No:	BH116
Sheet	3 of 3

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 22/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
					Continued from Sheet 2 of 3				
NIL				-	SHALE, low to medium strength, grey brown, distinctly weathered	-	-	BEDROCK	
		7.5							7.5
		8.0							8.0
		8.5							8.5
		9.0							9.0
		9.5							9.5
		10.0			BH116 terminated at 9.9m depth due to TC-bit refusal.				10.0
		10.5							10.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample	W	Wet
St	Stiff	D	Dense		(50mm diam.)	Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH117
Sheet	1 of 4

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 22/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
				-	Gravelly Clayey SILT, low plasticity, dark brown	M< Wp	-	TOPSOIL	
		0.5							0.5
				CI	Gravelly Sandy CLAY, medium plasticity, orange brown, with shale and ironstone gravels	M≤ Wp	VSt	FILL	
		1.0							1.0
	4,4,7 N=11								
		1.5							1.5
		2.0							2.0
		2.5							2.5
	4,6,11 N=17								
		3.0							3.0
		3.5							3.5
					Continued on Sheet 2 of 4				

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample	W	Wet
St	Stiff	D	Dense		(50mm diam.)	Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH117
Sheet	2 of 4

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 22/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
					Continued from Sheet 1 of 4				
					Gravelly Sandy CLAY, medium plasticity, orange brown, with shale and ironstone gravels	M≤ Wp		FILL	
		4.0							4.0
	7,9,9 N=18								
		4.5							4.5
					Silty CLAY, medium plasticity, orange brown	M> Wp	VSt	RESIDUAL	
		5.0							5.0
		5.5							5.5
	3,6,9 N=15								
		6.0							6.0
		6.5							6.5
		7.0							7.0
					Continued on Sheet 3 of 4				

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample	W	Wet
St	Stiff	D	Dense		(50mm diam.)	Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH117
Sheet	3 of 4

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club Walters Road, Arndell Park	Coordinates: -	Logged by: MC
		Surface level:Existing	Date: 22/1/07

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
					Continued from Sheet 2 of 4				
	5,7,11 N=18	7.5			Silty CLAY, medium plasticity, orange brown, with pale grey mottling	M> Wp	VSt	RESIDUAL	7.5
		8.0							8.0
	4,4,7 N=11	8.5							8.5
		9.0							9.0
		9.5							9.5
		10.0		-	SHALE, Distinctly weathered, low to medium strength, grey brown	-	-	BEDROCK V-bit refusal 9.8m	10.0
		10.5							10.5
					Continued on Sheet 4 of 4				

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample	W	Wet
St	Stiff	D	Dense		(50mm diam.)	Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

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Job No:	S06160-A
Hole No:	BH117
Sheet	4 of 4

ENGINEERING LOG OF BOREHOLE

Client:	Paynter Dixon Constructions Pty Ltd	Test Location:Ref. Dwg No.S06160-1	
Project:	Proposed Commercial Development	Test Method: Truck-mounted drill rig	
Project Location:	Blacktown Workers Club	Coordinates: -	Logged by: MC
	Walters Road, Arndell Park	Surface level:Existing	Date: 22/1/07

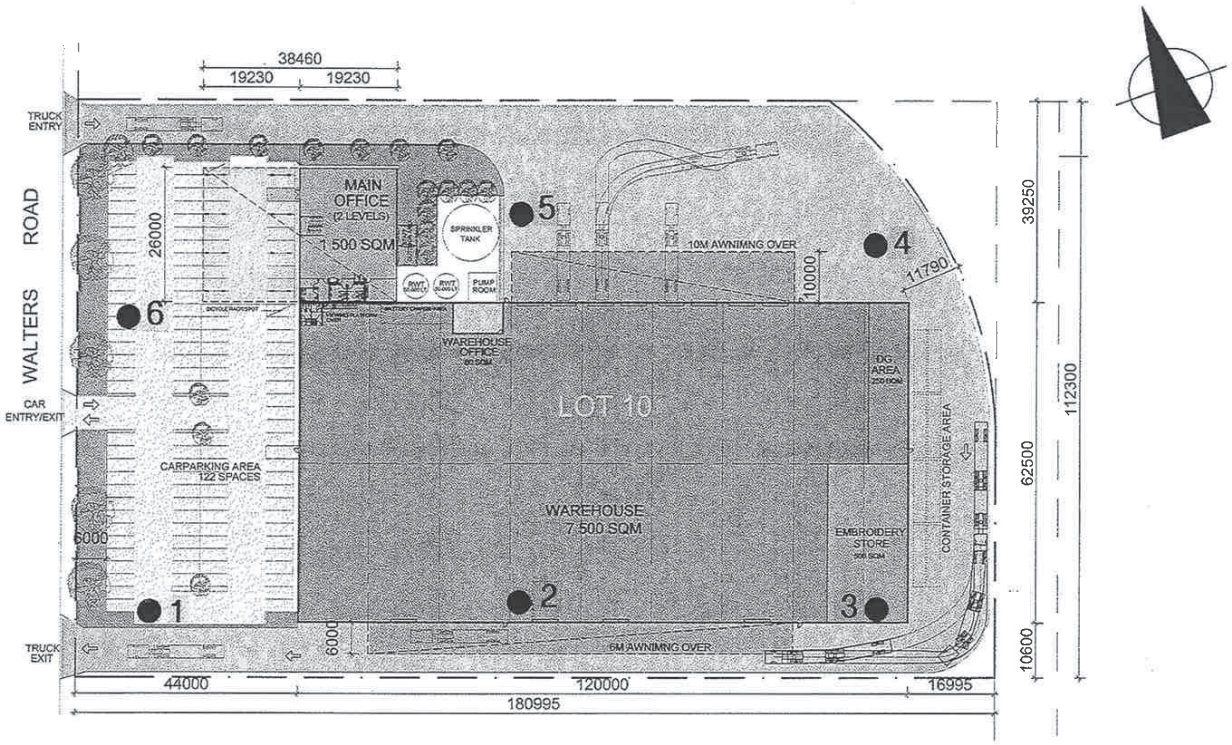
Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
					Continued from Sheet 3 of 4				
				-	SHALE, Distinctly weathered, low to medium strength, grey brown	-	-	BEDROCK	
		11.5							11.5
					BH117 terminated at 11.7m depth due to TC-bit refusal.				
		12.0							12.0
		12.5							12.5
		13.0							13.0
		13.5							13.5
		14.0							14.0
		14.5							14.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	VL	Very Loose	B	Bulk Sample	D	Dry
S	Soft	L	Loose	D	Disturbed Sample	M	Moist
F	Firm	MD	Medium Dense	U50	Undisturbed Sample	W	Wet
St	Stiff	D	Dense		(50mm diam.)	Wp	Plastic Limit
VSt	Very Stiff	VD	Very Dense	N	S.P.T. Value	Wl	Liquid Limit
H	Hard						

APPENDIX B

Borehole Location Plan, Borehole Logs 1 to 6, and Laboratory Test Results from Preliminary Geotechnical Investigation Report prepared by Jeffery and Katauskas Pty Ltd (Ref. 25295ZArpt dated 7 November 2011)



SCALE (m)

0 50

BOREHOLE LOCATION PLAN

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL & ENVIRONMENTAL ENGINEERS

Report No. 25295ZR **Figure No. 1**

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **1** 1/1

BOREHOLE LOG

Client:

Project: PROPOSED WAREHOUSE

Location: LOT 10, WALTERS ROAD, ARNDELL PARK, NSW

Job No. 25295ZR **Method:** SPIRAL AUGER JK500 **R.L. Surface:** N/A

Date: 18-10-11 **Datum:**

Logged/Checked by: M.L.T./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay, low plasticity, dark brown, with fine to medium grained igneous gravel and root fibres.	MC < PL			GRASS COVER
					N = 6 3,3,3	1		CH	SILTY CLAY: high plasticity, light brown and red brown, with root fibres and fine to medium grained ironstone gravel.	MC≈PL	VSt-H	- 350 420 450	RESIDUAL
					N = 13 5,6,7	2			as above, but light grey mottled orange brown and red brown.	MC < PL	VSt	350 350 300	
					SPT 10/50mm REFUSAL	3		-	SHALE: light brown, orange brown, grey to dark grey, with clay bands, (up to 0.5m.t).	XW-DW	EL-VL		VERY LOW 'TC' BIT RESISTANCE
						4							
						5							
						6			as above, but dark grey and dark brown.	DW	L		LOW RESISTANCE
						7			END OF BOREHOLE AT 7.0m				

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Borehole No. **2** 1/1

BOREHOLE LOG

Client:

Project: PROPOSED WAREHOUSE

Location: LOT 10, WALTERS ROAD, ARNDELL PARK, NSW

Job No. 25295ZR **Method:** SPIRAL AUGER JK500 **R.L. Surface:** N/A

Date: 18-10-11 **Datum:**

Logged/Checked by: M.L.T./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay topsoil, low plasticity, dark brown, with root fibres.	MC > PL			GRASS COVER
								CH	SILTY CLAY: high plasticity, light grey mottled orange brown and red brown, with root fibres.	MC > PL	St	-	RESIDUAL
					N = 4 1,2,2	1						150 170 140	
									as above, but light grey mottled orange brown, with fine to medium grained ironstone gravel.	MC < PL	H		
					N > 24 6,8, 16/130mm							> 600 > 600 > 600	
					REFUSAL	2		-	SHALE: grey to dark grey and dark brown, with clay bands.	XW-DW	EL-VL		VERY LOW 'TC' BIT RESISTANCE
						3							
						4		-	SANDSTONE: fine grained, dark brown and dark grey, with shale bands.	DW	M	-	MODERATE RESISTANCE WITH HIGH BANDS
						5			SANDSTONE: fine grained, light grey.	SW	M-H		
						6			END OF BOREHOLE AT 5.8m				'TC' BIT WAS REFUSED ON SANDSTONE BEDROCK
						7							

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Borehole No. 3 1/1

BOREHOLE LOG

Client:

Project: PROPOSED WAREHOUSE

Location: LOT 10, WALTERS ROAD, ARNDELL PARK, NSW

Job No. 25295ZR **Method:** SPIRAL AUGER JK500 **R.L. Surface:** N/A

Date: 18-10-11 **Datum:**

Logged/Checked by: M.L.T./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay topsoil, low plasticity, dark brown, with root fibres.	MC < PL			GRASS COVER
								CH		MC < PL	VSt	-	RESIDUAL
					N = 7 2,2,5				SILTY CLAY: high plasticity, red brown, orange brown mottled light grey, with root fibres.			250 270 270	
						1			as above, but light grey, orange brown and red brown.				
					N > 20 10,20/ 150mm REFUSAL						H	>600 550	
						2		-	SHALE: orange brown and grey to dark grey with clay bands.	XW-DW	EL-VL		VERY LOW 'TC' BIT RESISTANCE
						3							
						4							
					SPT 10/70mm REFUSAL	5							
									as above, but grey to dark grey stained orange brown, without clay bands.	DW	VL-L		VERY LOW RESISTANCE WITH LOW BANDS
						6							
▶						7			SHALE: dark grey. END OF BOREHOLE AT 7.0m		L		LOW RESISTANCE

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Borehole No. **4** 1/1

BOREHOLE LOG

Client:

Project: PROPOSED WAREHOUSE

Location: LOT 10, WALTERS ROAD, ARNDELL PARK, NSW

Job No. 25295ZR **Method:** SPIRAL AUGER JK500 **R.L. Surface:** N/A

Date: 18-10-11 **Datum:**

Logged/Checked by: M.L.T./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay topsoil, low plasticity, dark brown, with root fibres.				GRASS COVER
								CH	SILTY CLAY: high plasticity, orange brown and red brown, with fine to medium grained ironstone gravel.	MC < PL	VSt-H	-	RESIDUAL
					N = 8 2,4,4							350 420 450	
						1			as above, but medium plasticity, light grey and orange brown.	MC≈PL	VSt		
					N = 10 4,5,5							250 200 210	
						2							
					N = 23 10,11,12	3		-	SHALE: grey to dark grey and orange brown, with clay bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE
						4			as above, but without clay bands.	DW	VL-L		VERY LOW RESISTANCE WITH LOW BANDS
						5			as above, but dark grey.		L		LOW RESISTANCE
						6			END OF BOREHOLE AT 6.0m				
						7							

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Borehole No. 5 1/1

BOREHOLE LOG

Client:

Project: PROPOSED WAREHOUSE

Location: LOT 10, WALTERS ROAD, ARNDELL PARK, NSW

Job No. 25295ZR **Method:** SPIRAL AUGER JK500 **R.L. Surface:** N/A

Date: 18-10-11 **Datum:**

Logged/Checked by: M.L.T./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay topsoil, low plasticity, dark brown, with root fibres.	MC<PL			GRASS COVER
								CH	SILTY CLAY: high plasticity, orange brown and red brown.	MC<PL	VSt	-	RESIDUAL
					N = 19 3,8,11							350 300	
						1		-	SHALE: orange brown and dark grey.	XW-DW	EL-VL		VERY LOW 'TC' BIT RESISTANCE
										DW	VL		
						2			SANDSTONE: fine grained, orange brown, dark brown and grey.		L-M		LOW TO MODERATE RESISTANCE
						3							
						4			END OF BOREHOLE AT 4.5m				
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No. 6
1/1

Client:

Project: PROPOSED WAREHOUSE

Location: LOT 10, WALTERS ROAD, ARNDELL PARK, NSW

Job No. 25295ZR
Date: 18-10-11
Method: SPIRAL AUGER JK500
Logged/Checked by: M.L.T./
R.L. Surface: N/A
Datum:

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay, low plasticity, dark brown, with fine to medium grained igneous gravel and fine grained sand and root fibres.				GRASS COVER
					N = 5 3,3,2			CH	SILTY CLAY: high plasticity, light grey, red brown and orange brown, trace of fine to coarse grained ironstone gravel.	MC>PL	VSt	200 220 300	RESIDUAL
						1			as above, but with fine to medium grained ironstone gravel, without root fibres.				
					N = 9 6,4,5					MC≈PL		350 240 260	
						2			as above, but light grey and orange brown, with XW and EL strength shale bands.	MC<PL	(H)		
					N > 14 15,14/ 150mm REFUSAL	3			SHALE: grey stained orange brown and red brown.	XW-DW	EL-VL	-	VERY LOW 'TC 'BIT RESISTANCE
						4			as above, but grey to dark grey stained orange brown.	DW	VL-L		VERY LOW TO LOW RESISTANCE
						5			as above, but dark grey and dark brown.		L		LOW RESISTANCE
						6			END OF BOREHOLE AT 6.0m				
						7							

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North Ryde, Bc 1670
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Facsimile: 02 9888 5001

SOIL TEST SERVICES

ABN 43 002 145 173

Ref No: 25295ZR
Table A: Page 1 of 1

TABLE A
SUMMARY OF LABORATORY TEST RESULTS

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	LINEAR SHRINKAGE %
2	0.50-0.95	27.2	62	22	40	16.5
2	4.00-4.50	4.6				
3	5.50-6.00	9.7				
4	4.00-4.50	8.0				
5	2.50-3.00	7.2				
6	0.50-0.95	29.4	51	19	32	15.5
6	4.00-4.50	7.5				

Notes:

- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions

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TABLE B
SUMMARY OF FOUR DAY SOAKED C.B.R.TEST RESULTS

BOREHOLE NUMBER	1	4
DEPTH (m)	0.50 - 1.50	0.20 - 1.00
Surcharge (kg)	9.0	9.0
Maximum Dry Density (t/m^3)	1.701 STD	1.617 STD
Optimum Moisture Content (%)	19.1	21.9
Moulded Dry Density (t/m^3)	1.66	1.58
Sample Density Ratio (%)	98	98
Sample Moisture Ratio (%)	102	100
Moisture Contents		
Insitu (%)	23.6	22.8
Moulded (%)	19.5	22.0
After soaking and		
After Test, Top 30mm(%)	27.2	29.7
Remaining Depth (%)	24.5	26.1
Material Retained on 19mm Sieve (%)	0	0
Swell (%)	1.5	1.5
C.B.R. value: @5.0mm penetration	3.0	3.0

NOTES:

- Refer to appropriate Borehole logs for soil descriptions
- Test Methods :
  - (a) Soaked C.B.R. : AS 1289 6.1.1
  - (b) Standard Compaction : AS 1289 5.1.1
  - (c) Moisture Content : AS 1289 2.1.1

NATA Accredited Laboratory Number:1327

Approved Signatory
(A.Tatikonda)
Date: 2/11/11