REPORT

TO
SANDRICK

ON
GEOTECHNICAL INVESTIGATION

FOR
PROPOSED ALTERATIONS AND ADDITIONS

AT
ST CATHERINE'S SCHOOL
ALBION STREET, WAVERLEY, NSW

8 November 2013
Ref: 26904ZRrpt

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1 INTRODUCTION

This report presents the results of our geotechnical investigation for the proposed alterations and additions at St Catherine’s School, Albion Street, Waverley, NSW. The proposed alterations and additions will form the new R.P.A.C. project. The investigation was commissioned on behalf of St Catherine’s School by Mr Adam Martinez of Sandrick in an email dated 20 September 2013). The commission was on the basis of our fee proposal (Ref. P37657ZR) dated 20 September 2013.

We have been provided with the following information:

- Architectural drawings of the existing Jo Karaolis Sports Centre (Drawing Numbers A9704-00 Issue D, dated 16 February 2001, A9704-01 Issue F, dated 9 November 2001, A9704-02 and A0704-3 Issue E, dated 11 May 2001) prepared by Alexander Tzannes Associates Pty Ltd.
- Architectural drawings for the proposed aquatic centre and research centre (Drawing Numbers A.090, A.090/B, A.100, A.101, A.102, A.103, A.104, A.105, A.160 and A.161 Issue SK5, dated 1 October 2013) prepared by PD Mayoh Pty Ltd.
- A site survey plan (Drawing Number A.0002 Issue A, dated 6 September 2013) prepared by PD Mayoh Pty Ltd which was annotated with proposed borehole locations and notes (dated 10 September 2013.
- A site survey plan (Drawing Number D 10167-5, dated May 2012) prepared by Chase Burke Harvey.
- Annotated undated extracts of the architectural drawings attached to an email dated 21 October 2013, prepared by Cardno, outlining preliminary excavation support options.

Based on the provided information, we understand that following demolition of selected buildings and structures, the new development (R.P.A.C. Project) will comprise:

A basement level to accommodate mechanical and aquatic plant and equipment with a proposed finished floor reduced level (RL) at RL74m, a new aquatic centre directly above the basement level with a proposed pool deck at RL77.9m, a performing arts theatre immediately above the aquatic centre and an adjoining multi-purpose hall with a proposed finished floor level at RL85.9m. Consideration is also being given to an option to construct a basement car parking level below a portion of the main pool area within the aquatic centre; the car park would have a finished floor level at RL73.2m. Bulk excavations are therefore expected to extend to a maximum depth of about 8.8m.

The proposed foyer within the new aquatic centre (floor level at RL77.9m) will connect to the existing Dame Joan Sutherland Centre to the west (floor level at RL79.6m) via a stepped walkway. An extension to the north-western end of the aquatic centre (floor level at RL77.9m) will connect to the existing Jo Karaolis Sports Centre to the north-west with a stepped and ramped walkway extending up to the lower floor level of the sports centre (floor level at RL82.3m).

The new research centre will be constructed over the existing Jo Karaolis Sports Centre (current roof level at about RL91.7m) with a proposed finished floor level at RL91.9m. From the sports centre, the research centre will extend to the south-east over an ‘undercroft’ walkway access (finished floor level at RL85.9m) leading to the multipurpose hall, and extend east to the Leichhardt Lane frontage. The research centre will be supported by a combination of the existing sports centre footings and new footings.

The proposed excavation support systems comprise a combination of anchored secant piled walls, possibly internally supported secant pile walls (where anchors would otherwise extend below an existing sub-station and Leichhardt Lane) and battered excavations through the soil and bedrock profile.

We understand that the preliminary design of the footing system has been based on an allowable bearing pressure of 3,500kPa for the bedrock.

We note that we have prepared a number of reports for various developments within the school grounds, including:

- Geotechnical reports for the Dame Joan Sutherland Building (Ref. 7894J and 7894JH, dated 5 February 1991 and 9 December 1992, respectively) together with attending site inspections and preparing site reports during construction.
- A geotechnical report for the proposed extension to the junior school and gymnasium building (Ref. 12697Srpt, dated 23 July 1997). We note that several investigation locations were around the existing in-ground pool area of the south-eastern corner of the school grounds.
- Geotechnical reports for the Jo Karaolis Sports Centre (Ref. 13027Srpt and 13027S2rpt, dated 2 April 2008 and dated 1 June 1999, respectively) together with attending site inspections and preparing site reports during construction.

The purpose of the investigation was to obtain geotechnical information on subsurface conditions and review the contents of our previous geotechnical reports and site inspection reports during previous construction works, as a basis for comments and recommendations on excavation, retention, footings, soil aggression, on-grade floor slabs, external paved areas and drainage.

2 INVESTIGATION PROCEDURE

The fieldwork for the investigation was completed using portable hand held equipment on 30 September, 1 and 2 October 2013 and comprised the following:

- Hand auger drilling of five boreholes (BH201 to BH205) to refusal depths ranging between 1.2m and 2.9m below existing surface level. BH201 and BH205 were extended by rotary wash boring techniques from the base of the hand auger portion of the boreholes to final depths of 4.2m and 3.86m, respectively. All boreholes were extended by diamond core drilling using NMLC coring techniques to final depths ranging between 7.79m and of 10.08m.
- Completing five Dynamic Cone Penetration (DCP) tests (DCP201 to DCP205) adjacent to the boreholes. The DCP tests were extended to refusal depths ranging between about 2.3m and 4.2m.

Prior to commencement of the fieldwork, the investigation locations were scanned for the presence of buried services by a specialist sub-contractor.

The test locations, as indicated on the attached Figure 1, were set out by tape measurements from existing surface features. The approximate surface reduced levels (RLs) shown on the attached borehole logs and DCP test results sheets were estimated by interpolation between spot levels and contours shown on the provided survey plans. The survey datum is the Australian Height Datum (AHD).

The state of compaction of the fill and the relative density of the natural sands were assessed from the DCP test results. The strength of the bedrock within the cored portions of the boreholes was assessed by examination of the recovered rock core and correlation with subsequent Point Load Strength Index tests.

Groundwater observations were made in the boreholes during and on completion of hand auger drilling, wash boring and coring. We note that water is used as part of the wash boring and coring processes, and therefore water levels at the completion of the boreholes may not have stabilised in the short time period after drilling. No longer term groundwater monitoring has been carried out.

For more details of the investigation procedures, reference should be made to the attached Report Explanation Notes.

The fieldwork was carried out under the full time direction of our geotechnical engineer (Robert Cater), who set out the test locations, directed the electro-magnetic scan for buried services, logged the encountered subsurface profile and nominated in-situ testing and sampling. The borehole logs (which also include field test results, Point Load Strength Index test results and groundwater observations) are attached, together with a glossary of logging terms and symbols used.

The recovered rock core was returned to the Soil Test Services (STS) NATA registered laboratory where it was photographed and Point Load Strength Index Tests completed. A summary of the Point Load Strength Index tests and estimated Unconfined Compressive Strengths are attached in Table A. The core photographs are included opposite the relevant cored borehole logs.

Selected soil samples were also submitted under chain of custody to an alternate NATA registered laboratory (EnviroLab Services Pty Ltd) for soil pH, chloride and sulphate content testing. The test results are also presented in the attached Appendix A.

The relevant borehole logs from our previous reports are presented in the attached Appendix B.

A contamination screen of site soils and groundwater was outside the agreed scope of the current investigation.

3 RESULTS OF INVESTIGATION

3.1 Site Description

The site is located towards the crest of a hillside within undulating topography. The hillside generally slopes down towards the south and south-east. The site itself is located over the eastern end of the grounds of St Catherine’s School.

The site has a southern frontage onto Macpherson Street and Leichhardt Lane lines the central portion of the eastern site boundary.

At the time of the fieldwork the northern, central and south-western portions of the subject site were occupied by multi level brick and concrete frame school buildings and similar buildings extended to the north and west beyond the subject portion of the school grounds. A timber clad ‘demountable’ building (supported on brick piers) and a brick electricity sub-station building were located over the eastern side of the site.

The south-eastern corner of the site was occupied by a concrete pool with rendered and concrete block amenities buildings. The northern and southern sections of the pool were in-ground and above-ground, respectively. The above-ground section of the pool appeared to be supported by concrete block footings. Limited access was feasible immediately to the north of the pool and appeared to indicate the presence of a sub-vertical sandstone bedrock face estimated to be between about 0.5m and 1m high; poor visibility prevented further observation of the height or lateral extent of the bedrock face. The sandstone was assessed to be distinctly weathered and of at least low strength.

The surrounds to the school buildings comprised concrete paved walkways and yard areas, occasional brick paved walkways, grass and synthetic grass surfaced areas. Landscaped areas over the southern end of the subject site contained medium to large size trees. Two storm water pits (3.2m and 3.6m deep) connecting to on site detention bladders were located over the eastern end of the central grassed area immediately to the south of the Jo Karaolis sports centre.

The surface levels over the subject site generally stepped or sloped down to the south. The steps in surface levels were supported by sandstone masonry retaining walls which ranged between about 0.6m and 4m height.

The eastern section of the southern site boundary was lined by sandstone masonry and brick retaining walls (1.1m to 1.9m high) which supported a landscaped area immediately to the south of the above described pool. The adjacent section of the site boundary to the west was lined by the Dame Joan Sutherland building.

The neighbouring four storey brick apartment building with concrete paved yard areas to the east (4 Macpherson Street) was off-set at least 2.8m from the eastern site boundary. Site surface levels stepped down to the east across the site boundary and the subject site was supported by a brick retaining wall (maximum height about 3m). Sandstone bedrock was exposed in one area at the base of the brick retaining wall and was assessed to be distinctly weathered and of at least low strength. The northern end of the neighbouring yard area was lined by a concrete wall (about

3.5m high) which supported Leichhardt Lane to the north. Occasional vertical cracks were recorded over the brick apartment building and some loss of mortar was also evident along the brick retaining wall face. Site surface levels were similar across the central portion of the site boundary lined by Leichhardt Lane.

Based on a cursory inspection from within the site, the buildings and structures within and neighbouring the site were generally assessed to be in good external condition, unless otherwise described above.

3.2 Subsurface Conditions

The 1:100,000 geological map of Sydney indicates that the site is underlain by Quaternary age 'marine' sands with podsols overlying Hawkesbury Sandstone. In addition, an igneous dyke intrusion (trending approximately west-north-west to east-south-east) is indicated to be located close to the southern site boundary. The boreholes disclosed a subsurface profile comprising sandy fill and natural sands overlying weathered sandstone bedrock which was encountered at moderate depth. Groundwater was not encountered over the depth of the investigation. For detailed subsurface conditions at the borehole locations, reference should be made to the attached borehole logs. Figure 2 presents a graphical borehole summary. A summary of some of the more pertinent subsurface issues or considerations indicated by the results of this current investigation and our previous investigations are outlined below:

Fill

Sandy fill was encountered from surface level in all boreholes and extended to depths ranging between about 0.3m (BH205) and 1.1m (BH202). Based on the DCP test results, the fill was assessed to be poorly (occasionally moderately) compacted. Similar fill was encountered in our previous investigations to the west and north.

Natural Sands

Natural sands were encountered beneath the fill in all the boreholes and extended to the top surface of the weathered sandstone bedrock. Based on the DCP test results, the natural sands were generally assessed to be loose (occasionally very loose or medium dense) on first contact and were consistently assessed to be at least medium dense below depths of about 2m (BH201), 2.6m (BH202), 2.2m (BH203), 1.6m (BH204) and 1.1m (BH205).

Weathered Sandstone Bedrock

Weathered sandstone bedrock was encountered in all the boreholes beneath the natural sands at depths of between about 2.4m (BH204) and 5.2m (BH201). The relevant boreholes from our previous investigations encountered bedrock at depths ranging between 0.6m and 6.4m. The bedrock surface steps down to the south from about RL87.7m (JK4) to RL74.1m (BH202) and was confirmed by our site observations during construction of the Jo Karaolis Sports Centre.

On first contact, the sandstone was assessed to be extremely weathered (occasionally distinctly weathered) and of extremely low to very low (occasionally very low to low) strength.

In BH201 and BH202 the sandstone marginally improved to extremely to distinctly weathered or distinctly weathered and of very low to low strength over the depth of the boreholes. A 0.15m thick band of similar poor quality interbedded sandstone and shale was encountered at the base of BH202.

In BH203 a 2.1m thick band of interbedded shale, silty clay and sandstone was encountered at 4.6m depth.

Below depths of 6.7m (BH203), 2.7m (BH204) and 7.95m (BH205) the sandstone improved to distinctly weathered and generally of medium (occasionally low) strength. In BH204, an approximately 1.3m thick band of slightly weathered high strength sandstone was encountered below 6.5m depth.

The recovered rock core indicated that the bedrock generally contained a significant number of defects which comprised:

- A number of sub-horizontal horizontal extremely weathered seams (XWS) and clay seams (0^o to 12^o) ranging between about 1mm and 195mm thickness.
- A 140mm thick moderately sloping XWS (20^o) encountered in BH205.
- Occasional bedding partings sloping at 20^o.
- A number of planar (occasionally undulating) defects dipping at between 47^o and 90^o. Some of the defects had residual clay, sand or extremely weathered infill ranging between 10mm and 45mm thick.

In addition, the following core loss zones were encountered:

- In BH201 at 4.2m and 6.85m depth; the core loss zones were 690mm and 200mm thick, respectively. The upper core loss zone was encountered within the sandy soil profile.
- In BH202 at 4.5m and 7.5m depth; the core loss zones were 20mm and 200mm thick, respectively.
- In BH203 at 2.4m depth; the core loss zone was 200mm thick, respectively.
- In BH204 at 1.75m, 4.6m and 6.5m depth; the core loss zones were 380mm, 140mm and 30mm thick, respectively. The upper core loss zone was encountered within the sandy soil profile.
- In BH205 at 3.86m, 6.65m and 7.3m depth; the core loss zones were 140mm, 30mm and 660mm thick, respectively. The upper core loss zone was encountered within the sandy soil profile.

With the exception of the core loss zones within the sandy soil profile above bedrock, the core loss zone may be interpreted to represent XWS, clay seams and/or fractured bands of bedrock.

In accordance with Table 1a of the “Engineering Classification of Shales and Sandstones in the Sydney Region”, as revised by Pells et al 1998 a preliminary engineering classification of the bedrock has been carried out based on the boreholes and the laboratory test results as tabulated below. We note that the engineering classification has not taken into account specific footing sizes, pile types, pile diameters and founding levels and is therefore only indicative. Further comments are provided in Section 4.4, below.

Borehole	Depth To Sandstone Class (Reduced Level (RL))			Comments
	V	IV	III	
1	3.6m* 7.5m	6.5m*	8.6m	No surface RL information available. Boreholes drilled Nov. 1997.
2	3m*	7.1m*	8.3m	
3		2.2m*		
4	0.6m*	3.2m* 6.7m	4.5m	
5	2.6m* (82.7m)	3.7m* (81.6m)	5.3m (80.3m)	Borehole drilled Nov. 1997.
101	0.7m* (86.5m) 4.6m (82.6m)	2.4m* (84.8m)	5.7m (81.5m)	Borehole drilled 1999.
102	4.4m (86.2m)			Borehole terminated at 8m depth. No surface RL information available. Borehole drilled 1999.
JK4	2m* (87.7m)	4.1m* (85.6m)		No surface RL information available. Borehole drilled May 1997.
JK1	6.4			Borehole terminated at 11.7m depth. No surface RL information available. Borehole drilled 1990.
JK5	5.2m*	7m*		No surface RL information available. Borehole drilled 1990.
JK23		4.5*		Borehole terminated at 7.5m depth. Borehole drilled 1990.
JK24	N/A			Residual silty clay (very stiff) associated with igneous dyke (1m to 5m wide), encountered at 5.3m; borehole terminated at 8.5m depth. Over western side of building clay extended to 25m depth. No surface RL information available. Borehole drilled 1990
JK104	0.3m	1.8m		No surface RL information available. Borehole terminated at 5m depth Borehole drilled 1992
201	5.2m (75.2m)	7.7m (72.7m)		
202	3.2m (74.1m) 7.3m (70m)	4m (73.3m)		
203	2.6m (81.5m)		6.7m (77.4m)	
204	2.4m (79.4m)	9.4m (72.4m)	3.3m (78.5m)	
205	4.2m (76.4m)	4.9m (75.7m)	9m (71.6m)	

*: Sandstone class tentative, based on augered borehole.

Weathered Igneous Dyke

An igneous dyke intrusion within the host sandstone bedrock (trending approximately west-north-west to east-south-east) was encountered in boreholes drilled as part of the geotechnical investigation for the Dame Joan Sutherland Building. Borehole JK24 encountered residual silty clay at 5.3m depth. The residual silty clay is derived from weathering of dolerite/basalt bedrock which forms the igneous dyke. The dyke was also encountered within the excavation during construction of the Dame Joan Sutherland Building and the trend of the igneous dyke has been projected over the southern end of the proposed R.P.A.C. development on the attached Figure 1. In this regard we note that the dyke was not encountered in BH201, BH202 or BH205.

Based on available geological information, the dyke may represent the Great Sydney Dyke and the width could range between about 1m and 5m.

Dykes typically form sub-vertical features and, as observed over the Dame Joan Sutherland Building development site, comprise a deeply weathered dolerite bedrock profile comprising clayey soils and extremely weathered rock with higher strength bands.

Groundwater

No discernible groundwater seepage was encountered during hand auger drilling, wash boring or core drilling of the boreholes. Standing water flush levels were recorded at depths of 4.8m and 4.3m in BH201 and BH204, respectively. In BH204, the water flush level dropped to 5.4m depth approximately 42 hours after borehole completion and probably represent draining of the water flush through an open defect within the rock mass. Generally full water flush returns were recorded which indicates a relatively impermeable rock mass. In BH201, 70% water flush returns were recorded and probably represent water loss through the upper sandy soil profile. No longer term groundwater monitoring has been carried out.

We note that the base of the bedrock face below the northern end of the existing pool was damp and was probably associated with seepage through the soil profile at the bedrock interface over the bedrock face.

In the previous geotechnical investigations, occasional groundwater seepage was recorded within the augered portions of boreholes within the sandstone bedrock at between about 4m and 7m depth. In borehole JK24 a standing water level was recorded at 4m depth on completion of the borehole which may be associated with seepage within the sands or the weathered dyke material (residual silty clay).

3.3 Laboratory Test Results

The point load index test results indicated that the rock within the cored portions of the boreholes was of extremely low to high strength with estimated Unconfined Compressive Strengths (UCS) ranging between <1MPa and 30MPa. However, the majority of the bedrock cored was of low and medium strength

A summary of the laboratory chemical test results is provided in the table below.

Borehole Number	**Sample Depth (m)**	**Description**	**pH Units**	**Sulphate (mg/kg)**	**Chloride (mg/kg)**
201	1.8 – 2.0	SAND	6.3	9	4
202	2.4 – 2.5	Silty SAND	6.7	17	21
203	0.2 – 0.4	FILL: silty sand	6.3	6	4

4 COMMENTS AND RECOMMENDATIONS

4.1 Geotechnical Issues and Constraints

The principal geotechnical issues/constraints associated with the proposed development at the subject site are the following:

1. The potential presence of an igneous dyke over the south-eastern corner of the site which could impact the design of selected footings and shoring piles.
2. The proposed relatively deep excavations adjacent to the southern portion of the eastern site boundary which have the potential to detrimentally impact adjacent buildings and structures within and neighbouring the site.
3. The close proximity of existing school buildings, an electricity sub-station and an existing magnolia tree within the site that will remain, the existing retaining wall lining the southern portion of the eastern site boundary and the adjacent Leichhardt Lane to the east which will require to be supported/protected both during construction and over the long term.

With regard to item 3, we note that Cardno have proposed a range of temporary and permanent excavation support measures in an email dated 21 October 2013.

The above issues/constraints and their effects on the design and construction activities are discussed in more detail below together with our comments on the proposed Cardno excavation support measures.

4.2 Demolition and Excavation

4.2.1 General

The footprint of the proposed excavations and the extent of the proposed research centre which comprise the R.P.A.C. development are indicated on the attached Figure 1.

We understand that site access during construction will be via the Macpherson Street frontage and so the existing retaining wall lining the eastern portion of the southern site boundary will be removed.

We further note that the existing stormwater detention bladders installed below the central grass surfaced area will need to be removed and appropriate temporary modifications to the stormwater system will need to be provided.

During demolition and excavation there is the potential to damage or de-stabilise the retaining wall lining the southern portion of the eastern site boundary which supports site surface levels. We recommend that a structural engineer inspect the retaining wall to assess its stability and provide any details regarding appropriate propping. In addition, the rear of the base of the wall will be revealed during bulk excavations. We recommend that at the commencement of the works, ‘slots’ (at least 1m wide orientated perpendicular to the retaining wall) should be excavated, at say 5m lateral spacings, in order to expose the footings. The exposed footings will need to be inspected by the geotechnical and structural engineers and the need for any further propping and/or underpinning assessed. Any underpins supporting the soil profile behind would need to be designed to withstand any such lateral earth pressures (see Section 4.3.4, below).

We reiterate the close proximity of the Jo Karaolis sports centre, the Dame Joan Sutherland Building, the electricity sub-station (and the adjacent Leichhardt Lane to the east) and an existing magnolia tree located to the north-east of the Dame Joan Sutherland Building. Particular care is therefore required during demolition and excavation. This work will need to be completed using suitably experienced (and insured) contractors. Further comments on the proposed excavation support measures adjacent to these features are presented in Section 4.3, below.

The removal of the existing retaining wall lining the eastern end of the southern site boundary will need to be carefully completed so as not to damage the southern end of the retaining wall immediately to the east and the adjoining section of sandstone masonry retaining wall to the west. Some temporary propping of the sandstone masonry retaining wall may be required based on assessment by the structural engineer.

With regard to the above, we recommend that the contractor prepare a Construction Methodology Plan (CMP) prior to demolition or bulk excavation commencing which should be completed with due regard to the geotechnical advice provided in this report. The CMP must include, but not be limited to, proposed demolition and excavation techniques, the proposed demolition and excavation equipment, demolition and excavation sequencing, geotechnical inspection intervals or hold points, and any vibration monitoring procedures etc, if required. The geotechnical and structural engineers should review and approve the CMP.

4.2.2 Demolition and Excavation Methods

Excavation recommendations provided below should be complemented by reference to the Code of Practice ‘Excavation Work’ prepared by Safe Work Australia July 2012.

Excavations for the proposed R.P.A.C. will extend down to maximum depths of about 8.8m. On the basis of the investigation results, following demolition, the proposed excavations will encounter the soil profile, weathered sandstone bedrock and possibly an igneous dyke over the southern end of the excavations.

We expect the demolition and excavation to be completed using at least medium sized tracked excavators. A bucket attachment to the excavator will be required to excavate the soil profile. In addition, rock breakers (attached to the excavator) may be required for demolition of existing concrete paved surfaces, footings and floor slabs. Excavation of low or higher strength sandstone bedrock may be achieved using rock breakers, rock grinders and ripping attachments to the tracked excavators. Grid saw techniques may also be used in conjunction with rock breakers and/or ripping tynes.

Care will be required to control ground vibrations associated with the use of rock breakers, and further advice is provided in Section 4.2.3, below.

4.2.3 Potential Vibration Risks

The assessed poorly compacted surficial sandy fill and underlying natural very loose and loose sands encountered in the investigation may be expected to extend beyond the site boundaries. We therefore advise that sudden stop/start movements of tracked equipment should be avoided in order to reduce transmission of ground vibrations to adjoining buildings and structures.

Care should be taken where rock breakers are used during demolition and/or during bedrock excavation so that ground vibrations do not adversely affect nearby surrounding buildings, structures and paved surfaces within and neighbouring the site. If there is any cause for concern then demolition and/or excavation should cease and further geotechnical advice sought.

Consequently, continuous vibration monitoring of the neighbouring buildings and structures to the east (4 Macpherson Street) and the adjoining school buildings will be required while the rock breakers are being used to confirm that peak particle velocities (PPV) fall within acceptable limits. Subject to the results of the dilapidation reports (see Section 4.2.4, below), we would recommend that the PPV along the eastern site boundary does not exceed 5mm/sec during bedrock excavation using rock breakers. For the adjoining school buildings to the west and north, we would recommend that the PPV do not exceed 10mm/sec during bedrock excavation using rock breakers. We note that these vibration limits will reduce the risk of vibration damage to the neighbouring building and structures and adjoining school buildings. However, these vibrations may still result in discomfort to occupants of the buildings. If excessive vibrations are occurring, it will be necessary to use lower energy equipment such as smaller rock breakers and/or use rock saw cuts with the base of the slot maintained below the level at which the rock breaker is being used.

Where rock breakers are used, to reduce vibrations we recommend that saw cuts be provided (as described above) and, the rock breakers be continually orientated towards the face, be operated one at a time and in short bursts only to reduce amplification of vibrations. When using the rock breakers the resulting dust should be suppressed by spraying with water.

We note that vibrations may be generated by drilling of shoring piles through sandstone bedrock to form sockets (see Section 4.3.2, below). We recommend that periodic vibration monitoring be undertaken during drilling of shoring piles to check vibration levels do not exceed the above limits. If there are exceedances then modification of the drilling of the shoring piles may be required, such as alteration of crown pressures and/or drill bit rotation speeds. Further advice from piling contractors should be sought in this regard.

4.2.4 Dilapidation Surveys

Prior to demolition and excavation commencing, detailed dilapidation reports should be compiled on the neighbouring building and structures to the east (4 MacPherson Street) and the adjoining school buildings. In addition, Council may also require that a dilapidation survey report be completed on their assets lining the street frontages, i.e. the paved footpath, the roadway and kerb and gutter. The property owners should be asked to confirm that the reports present a fair record of existing conditions as the reports may assist the client in defending themselves from unfair damage claims due to vibrations and/or ground surface movements.

4.2.5 Groundwater

Groundwater inflow may be expected within the excavation at or below the contact between the soil profile and the sandstone bedrock below, particularly after periods of heavy rain. However, concentrated flows along the surface or discrete defect planes within the sandstone bedrock may also occur.

We expect the inflows could be controlled by conventional sump and pump techniques and gravity drainage. Inspection and monitoring of groundwater seepage during bulk excavation is recommended, so that any unexpected conditions, which may be revealed (such as concentrated flows along defect planes) can be incorporated into the drainage design.

4.3 Temporary excavation Support and retention

4.3.1 Proposed Excavation Support Methods

Cardno have proposed a range of temporary and permanent excavation support measures in an email dated 21 October 2013 which are summarised below together with our brief comments.

1. An anchored secant pile wall socketted into bedrock to support the excavation adjacent to the north-eastern corner of the Dame Joan Sutherland Building. The shoring is required to support the magnolia tree outside the excavation and should be designed in accordance with the advice provided in Sections 4.3.2 and 4.3.4, below.
2. Over the eastern portion of the northern side of the aquatic centre excavation, a secant pile wall retention system (socketted into bedrock) is proposed. The existing sub-station and Leichhardt Lane line this portion of the excavation and anchoring beneath the substation and

laneway is not preferred. Currently it is proposed to construct a temporary mass concrete wall to provide support until the structure can provide permanent support at which point the mass concrete wall can be removed. Further advice is provided in Section 4.3.2, below.

3. Over the southern end of the aquatic centre, the soil profile would be excavated down to bulk excavation level which will locally expose bedrock which will comprise sandstone and possibly the igneous dyke. The bulk excavation level is approximately equivalent to the adjacent footpath surface levels and so a shoring system is not expected to be required. Localised underpinning or temporary propping of the footpath may be required where bulk excavation levels extend below the base of the paved surface.
4. Over the eastern side of the aquatic centre, excavate the sand to bedrock from behind the retaining wall lining this portion of the site boundary; comments have been provided in Section 4.2.1, above regarding measures to protect the integrity of the retaining wall during the works.
5. The excavation to form the extension from the north-western end of the aquatic centre to the Jo Karaolis Sports Centre will be temporarily battered back through the soil profile. Bedrock is expected to stand vertically unsupported. Further advice is provided in Sections 4.3.2 and 4.3.3, below.

4.3.2 Temporary Batters and Retention

Temporary batter slopes no steeper than 1 Vertical (V) in 1.5 Horizontal (H) in the sandy soils and 1V in 1H through residual clayey soils and extremely weathered (Class V) bedrock are considered to be appropriate. Such batter slopes will only be achievable over restricted portions of the excavation and such considerations have been addressed by the proposed Cardno excavation support measures. We note that some instability may occur at the soil-bedrock interface, especially after rain periods and sand bagging may be required to stabilise the toe of batter slopes through the soils.

Where battering can be accommodated, a conventional retaining wall may be constructed at the base of the batter and subsequently backfilled. Selected retaining walls supporting a soil profile may be founded on sandstone bedrock at the crest of excavation faces, subject to geotechnical inspection. Lateral restraint may be provided by starter bars drilled and grouted into the sandstone bedrock; further advice is provided in Section 4.3.3, below.

Where battering cannot be accommodated within the site geometry, or is not preferred, a full depth engineered retention system will need to be installed prior to excavation commencing. In this regard we note that an anchored or propped secant piled wall is proposed. We consider that a piled wall is a suitable retention system and we understand that a secant piled wall has been proposed in order to reduce loss of soil through gaps between the shoring piles and consequent inducement of adjacent ground surface movements. These are valid concerns and although a contiguous piled wall would also be suitable, allowance must be made for making good gaps between contiguous piles in order to reduce the loss of retained soils. In this regard, consideration may be given to providing a shotcrete face to the contiguous pile wall. The shotcrete facing would need to be applied in 'lifts' of maximum 1.5m vertical height and must be applied on the same day as completion of excavation in front of the contiguous pile wall.

Due to the potentially collapsible nature of the sandy soil profile and the need to control potential movement of neighbouring ground surfaces, buildings and structures, we consider that bored piles are not suited to this site. Our preference, therefore, is for a grout injected (cfa) piles to be used to form the secant or contiguous piled wall.

Due to the need to protect the nearby buildings and structures, construction of the retention system and anchors should be of high quality.

The toe of the pile walls should be embedded below bulk excavation level to sufficient depth to satisfy stability and founding considerations. In this regard the retention piles will intersect bedrock. The pile walls may be incorporated into the footing system and further comments regarding the load carrying capacity of the piled walls are provided in Section 4.4, below.

The piled walls will require temporary propping and we assume that permanent propping of the retention system will be provided by the floor slabs.

Temporary propping may be achieved by using ground anchors which has been adopted over some sections of the proposed shoring system. Permission from the neighbours would need to be sought where any temporary anchors extend below neighbouring properties.

Piling rigs of sufficient capacity will need to be used at this site as rock sockets will need to be formed in the shoring piles; medium and high strength sandstone will be encountered. We note that care will be required whilst drilling the piles into the bedrock so as not to cause excessive sand draw down and possibly induce ground surface movements within neighbouring properties. In addition, site staff should continuously monitor adjacent ground surface levels whilst drilling cfa piles and if settlement occurs then piling operations should immediately cease and further geotechnical advice sought. In this regard we recommend that only competent piling contractors be used. The piling contractor should be provided with a copy of the geotechnical report in order that appropriate piling rigs and equipment are brought to site.

Furthermore, drilling rock sockets in the shoring piles may generate ground vibrations and periodic vibration monitoring as outlined in Section 4.1.3, above may be required.

Where shoring piles are detailed to be terminated above bulk excavation level, lateral toe restraint for the pile bases would have to be provided by rock bolts or anchors installed prior to excavation in front of the toe of the wall. Similar support of pile toes would be required where the piling rig refuses in the moderate to high strength sandstone bedrock and the piles are terminated above bulk excavation level. Unless the floor slabs provide permanent support, the rock bolts or anchors would need to be designed as permanent. The sandstone cut face below the pile bases would need to be continually inspected as outlined in Section 4.3.3 below, to assess whether rock stabilisation works are required below the pile toe.

Where secant or contiguous piles penetrate bedrock below bulk excavation level, then every fourth pile should be terminated about 0.5m, above the bedrock surface to allow ‘through-flow’ of groundwater.

With regard to item ‘2’ of the proposed excavation support measures outlined in Section 4.3.1 above, anchoring below the existing sub-station and Leichhardt Lane is not preferred. Currently it is proposed to construct a temporary mass concrete wall to provide support to the shoring system until the structure can provide permanent support at which point the mass concrete wall can be removed. We assume the concrete wall would be founded on bedrock. If this system is adopted then the mass concrete wall would need to be constructed in ‘panels’ in an underpinning style sequence. However, excavation through the sandy soils would need to be appropriately battered back and considerable additional volumes of sand would be removed which would further reduce support for the shoring system. We consider that this system would increase the potential for increased deflections of the shoring system. Furthermore, the removal of the concrete wall would be time consuming and require additional use of rock breakers. In addition, lateral toe restraint for the pile bases would need to be provided by rock bolts or anchors installed prior to removal of the concrete from in front of the toe of the wall and the bedrock below.

Our preference would be for a temporary shoring option comprising temporary cross bracing to support the top of the shoring piles and a ‘top down’ style construction sequence adopted with the floor slab at RL83m used to support the central section of the shoring wall. Temporary lateral toe restraint for the pile bases would need to be provided by rock bolts or anchors installed prior to excavation in front of the toe of the wall.

The sandstone bedrock cut faces would need to be inspected by a geotechnical engineer in accordance with the advice presented in Section 4.3.3, below.

For the above options, permanent toe restraint may be provided by an up-turn to the floor slab at RL77.9m or the rock bolts or anchors designed as permanent; see Section 4.3.4, below.

4.3.3 Sandstone Cut Face Stability

The majority of the proposed excavations will encounter sandstone bedrock. Competent sandstone bedrock of low or higher strength may be cut vertically, subject to geotechnical inspection. Geotechnical inspections should be completed by an experienced geotechnical engineer or engineering geologist at regular intervals at no more than 1.5m vertical excavation 'lifts'.

It is feasible that selected retaining walls supporting a soil profile may be founded on sandstone bedrock at the crest of excavation faces (say over the extension from the north-western end of the aquatic centre to the Jo Karaolis Sports Centre), subject to geotechnical inspection. Lateral restraint may be provided by starter bars drilled and grouted to a depth of at least 0.5m into the sandstone bedrock. The starter bars should be installed at a downward angle into the rock face and be provided with a vertical cogged length. If cross bedded units within the sandstone bedrock are identified during geotechnical inspections and slope down into the excavation, then the starter bars may have to be extended to stabilise the potentially unstable cross bedded units.

The presence of potentially unstable wedges, clay seams and extremely weathered seams within the sandstone bedrock may adversely affect the stability of the cut rock faces and/or pile bases close to the crests of the cut faces. Such features may require shotcreting and rock bolting. Provision should be made in the contract documents (budget and programme) for such inspection and stabilisation measures.

4.3.4 Retention Design Parameters

The major consideration in the selection of earth pressures for the design of retaining walls is the need to limit deformations occurring outside the excavation. The following characteristic earth pressure coefficients and subsoil parameters may be adopted for the design of temporary or permanent systems to retain the site soils and extremely weathered (Class V) sandstone bedrock:

- For progressively anchored or propped walls where minor movements can be tolerated, we recommend the use of a uniform rectangular earth pressure distribution of 6H kPa for soil profile and extremely weathered (Class V) sandstone bedrock, where ‘H’ is the retained height in metres.
- For progressively anchored or propped walls which support areas which are highly sensitive to lateral movement, a uniform rectangular earth pressure distribution of 8H kPa should be adopted for the soil profile and extremely weathered (Class V) sandstone bedrock, where ‘H’ is the retained height in metres.
- A bulk unit weight of 20kN/m^3 should be adopted for the soil profile and extremely weathered (Class V) sandstone bedrock.
- Any surcharge affecting the walls (such as high level footings, construction loads, traffic, sloping retained surfaces, etc) should be allowed in the design.
- The retaining walls should be designed as drained and measures taken to provide permanent and effective drainage of the ground behind the walls. Subsurface drains should comprise PVC pipes which are installed into gaps or holes between piles at approximately 1.2m horizontal centres along the basement level and along the bedrock surface level. The embedded end of the pipes should be wrapped in a non-woven geotextile fabric (such as Bidim A34) to act as a filter against subsoil erosion.
- For ‘passive’ toe resistance, the piled walls should be suitably socketted into the bedrock below bulk excavation level. An allowable lateral stress of 200kPa may be adopted for socket depth design within the bedrock. The lateral resistance of the upper 0.3m below bulk excavation level should be ignored in the above analyses in order to take disturbance and excavation tolerance issues into account. Any localised excavations in front of the walls (such as for buried services, services, footings, lift pits, etc) must also be taken into account in the wall design.
- Lateral toe restraint of shoring piles embedded into the igneous dyke will be provided by the residual clayey soils. The toe restraint may be designed using a triangular lateral earth pressure distribution and a ‘passive’ earth pressure coefficient, K_p, of 3, provided a Factor of Safety of 2 is used in order to reduce deflections. The upper 0.3m below subgrade level together with any localised excavations for buried services etc should be taken into account in the design.
- Soil anchors bonded into medium dense or denser sands should be designed for an effective angle of internal friction (ϕ') of 33°. Alternatively, anchors bonded into sandstone bedrock of

at least low strength should be designed for an allowable bond stress of 200kPa. All anchors should be proof-tested to 1.3 times the working load under the direction of an experienced engineer or construction superintendent, independent of the anchor contractor. We recommend that only experienced contractors be considered for anchor installation. We have assumed that permanent lateral support of the perimeter pile walls will be provided by the new structure. If not, permanent anchors will be required which should be designed for corrosion resistance and for long term durability.

4.4 Footing Design

4.4.1 General

We expect that sandstone bedrock will be revealed at bulk excavation level over the majority of the site. Sandstone bedrock is expected to be encountered within about 2m depth below bulk excavation level over the southern end of the site where it is possible that the igneous dyke may also be encountered.

A variation of the table of bedrock classifications presented in Section 3.2, above is produced below with the boreholes grouped to cover areas of the proposed R.P.A.C. development. The table was prepared in accordance with Table 1a of the “Engineering Classification of Shales and Sandstones in the Sydney Region”, as revised by Pells et al 1998. We note that the engineering classification has not taken into account specific footing sizes, pile types, pile diameters and founding levels and are therefore only indicative. These preliminary classifications should be reviewed once footing sizes/pile types, pile diameters and founding levels have been selected to confirm applicability within the zone of influence of such footings/piles.

Borehole	Depth To Sandstone Class (Reduced Level (RL))			Area of R.P.A.C. Development and/or Adjacent School Buildings
	V	IV	III	
1	3.6m* 7.5m	6.5m*	8.6m	Proposed Research Centre over and adjacent to the existing Jo Karaolis Sports Centre. Combination of existing footings and new footings to support additional loads
2	3m*	7.1m*	8.3m	
3		2.2m*		
101	0.7m* (86.5m) 4.6m (82.6m)	2.4m* (84.8m)	5.7m (81.5m)	
102	4.4m (86.2m)			
JK4	2m* (87.7m)	4.1m* (85.6m)		
JK1	6.4			Eastern end of Dame Joan Sutherland Centre at connection with foyer within the new aquatic centre. Maximum bulk excavation level at RL77.7m
JK23		4.5*		
JK24	N/A: Borehole encountered igneous dyke (4m to 5m wide), at 5.3m. Over western side of Dame Joan Sutherland Centre clay extended to 25m depth.			
JK104	0.3m	1.8m		
201	5.2m (75.2m)	7.7m (72.7m)		Proposed Aquatic Centre. Maximum bulk excavation level about RL73.8m or RL73m (if additional basement option selected).
202	3.2m (74.1m) 7.3m (70m)	4m (73.3m)		
203	2.6m (81.5m)		6.7m (77.4m)	
204	2.4m (79.4m)	9.4m (72.4m)	3.3m (78.5m)	
205	4.2m (76.4m)	4.9m (75.7m)	9m (71.6m)	
4	0.6m*	3.2m* 6.7m	4.5m	Between Dame Joan Sutherland Centre and Jo Karaolis Sports Centre
5	2.6m* (82.7m)	3.7m* (81.6m)	5.3m (80.3m)	

*: Sandstone class tentative, based on augered borehole.

Surface RLs quoted where survey information was available.

The allowable bearing pressures for the various classes of sandstones are outlined below.

Class V Sandstone:	800kPa.
Class IV Sandstone:	1,500kPa.
Class III Sandstone:	3,500kPa.

Internal pad or strip footings should be designed on the basis of the above allowable bearing pressures and with regard to the advice provided below.

For the design of pile rock sockets, allowable adhesion values in compression and tension should be based on 10% and 5% of the above allowable bearing pressures respectively, for each sandstone class.

Perimeter piles and/or pad or strip footings founded in Class IV or better quality sandstone bedrock at the crest of vertical cuts should be designed for a reduced maximum allowable bearing pressure of 1,000kPa, provided the rock immediately below the pile toe and/or shallow footing base is inspected by a geotechnical engineer to identify possible adverse defects and to assess the long term durability of the bedrock. We strongly recommend that the vertical loads on footings founded close to the crests of rock cut faces be reduced as much as possible, with the majority of the structural loads being carried down to the footings/shoring piles founded below bulk excavation level.

For the above recommended allowable bearing pressures the bases of all shallow footings must be visually inspected by a geotechnical engineer.

We note that little spoil recovery is obtained from cfa pile holes and so determination of bedrock depths and strength would be based witnessing drilling of cfa piles by a geotechnical engineer together with reference to the borehole logs and torque readings provided by the piling rig operator.

The above maximum allowable bearing pressures are based on serviceability which results in settlement of less than 1% of the minimum footing dimension.

4.4.2 Recommended Design Allowable Bearing Pressures

Based on the advice provided in Section 4.2.1 above, and with regard to our previous involvement during construction of nearby buildings, we note the following:

Over the northern and central portions of the proposed aquatic centre, generally Class III sandstone is expected to be encountered at, or within a maximum of about 2.2m below bulk excavation level (about RL73.8m and possibly RL73m, depending on final basement option selected). However, over the north-eastern corner of the aquatic centre Class IV sandstone is expected to be encountered below the Class III sandstone within the zone of influence of shallow footings and within, or below, the socket length of load bearing shoring piles below bulk excavation level. Over the southern portion of the aquatic centre, Class IV sandstone will be exposed at bulk excavation level and possibly the igneous dyke. Close to the igneous dyke Class

V sandstone may be exposed and an appropriate contingency for large sized footings will need to be made. Further advice on the footing design considerations in relation to the igneous dyke are presented in Section 4.4.3, below.

Over the footprint of the proposed foyer within the new aquatic centre which will connect to the existing Dame Joan Sutherland Centre to the west, Class V and IV sandstone is expected to be exposed at bulk excavation level (about RL77.7m) and possibly the igneous dyke. The comments provided in the preceding paragraph and Section 4.4.2 below, apply.

The soldier piles (0.4m and 0.6m diameter) installed around the perimeter of the Jo Karaolis Sports Centre were extended to at least the required embedment depth of 0.6m below bulk excavation (RL81.3m) and installed into Class III sandstone (based on inspection of bored pile rock auger cutting samples and reference to our previous borehole logs). The original allowable bearing pressure for the Class III sandstone was 3,500kPa. The internal pad and strip footings were also designed for a similar bearing pressure. However, based on our site inspections during construction of the Jo Karaolis Sports Centre, the Class III sandstone contained a significant number of defects and the allowable bearing pressure was downgraded to 2,000kPa. The pad footing dimensions were revised by the structural engineer and plan dimensions of 1.8m x 1m with a 0.6m embedment were adopted.

We therefore recommend that the lower allowable bearing pressure for the Class III sandstone be adopted for assessment of the additional load carrying capacity of existing footings. If there are concerns with regard to the load carrying capacity of existing pad or strip footings then consideration could be given to excavating test pits to expose existing footings and core drilling the sandstone below the base of the footings to confirm the sandstone quality and the appropriate allowable bearing pressure. Alternatively, the plan dimensions of the existing footings could be increased to accommodate the additional loads.

For new pile footings, a target depth equivalent to RL80.5m should be adopted for Class III sandstone suitable for an allowable bearing pressure of 3,500kPa and will need to be confirmed by geotechnical inspections.

Over the footprint of the proposed extension of the aquatic centre which will which connect to the existing Jo Karaolis Sports Centre to the north-west, Class III sandstone is expected to be exposed at or within about 0.3m of bulk excavation level (about RL77.7m). However, based on our site inspections during construction of the Jo Karaolis Sports Centre, as noted above, the

Class III sandstone contained a significant number of defects and the allowable bearing pressure was downgraded to 2,000kPa. This downgraded allowable bearing pressure may be adopted for design or, if an allowable bearing pressure of 3,500kPa is adopted, a contingency made for increasing the footprint of shallow footings should geotechnical inspections indicate poorer quality sandstone. The geotechnical inspections would need to include for spoon testing of at least 30% of pad or strip footing bases to confirm the quality of the sandstone bedrock.

4.4.2 Impact Of Igneous Dyke On Footing Design

If the igneous dyke is encountered over the southern end of the proposed aquatic centre it is likely to form a sub-vertical feature up to about 5m wide and comprising residual clayey soils possibly with bands of extremely or distinctly weathered dolerite of extremely low to low (or higher) strength. Based on our previous investigations for the Dame Joan Sutherland centre, the clays are expected to extend to 25m depth.

Where the dyke is encountered in the retention pile holes or the pile footing holes, we recommend that there be a contingency within the footing design should such materials be encountered. As a guide, the residual clayey dyke materials would be of very stiff or hard strength and an allowable bearing pressure of 300kPa may be assumed for design purposes. Alternatively, selected footings may be designed to bridge over the area of the dyke, if it is encountered. In addition, we note the reduction in lateral toe restraint and the guidance provided in Section 4.3.4.

4.5 Subgrade Preparation and Engineered Fill

4.5.1 Subgrade Preparation

Earthworks recommendations presented below should be complemented by reference to AS3798-2007.

Over any areas of soil subgrade where on-grade floor slabs and external paved areas are to be constructed, subgrade preparation should consist of the following:

- Any areas of soil subgrade (including extremely weathered sandstone and/or the clayey igneous dyke) should be proof rolled with a minimum with a 2 tonne deadweight smooth drum vibratory roller. Where access is restricted, a hand held vibrating plate compactor (wacker packer) may need to be used. Areas of sandy subgrade will need to be thoroughly moistened

The main objective of the proof rolling is to assist in detection of any soft or heaving areas and to improve the state of compaction of the near surface fill materials.

- Proof rolling should be closely monitored by the site supervisor to detect soft or unstable areas which should be removed and replaced with engineered fill (as outlined in Section 4.5.2 below).
- Areas of clay subgrade that contain shrinkage cracks should be watered and rolled until the shrinkage cracks disappear.
- Care should also be taken when using vibrating equipment not to cause damage to adjacent existing structures. If there is any cause for concern then proof rolling should cease and further geotechnical advice sought. Alternatively, where appropriate, the static (non-vibration) mode may be used.

Any areas where suspended floor slabs are proposed subgrade preparation will not be required.

4.5.2 Engineered Fill

Engineered fill should be free from organic materials, other contaminants and deleterious substances and have a maximum particle size not exceeding 40mm. We expect the excavated soils and weathered sandstone bedrock may be used as engineered fill. Engineered fill should be placed in layers of maximum 100mm loose thickness and compacted with the above mentioned roller to achieve a minimum I_D of 70% for the sandy soils. However, the I_D may be reduced to 65% in landscaped areas. For clayey materials (including weathered sandstone bedrock) engineered fill should be compacted to at least 98% of Standard Maximum Dry Density (SMDD) and reduced to 95% of SMDD in landscaped areas.

Backfill to conventional retaining walls should also comprise engineered fill. Well graded granular materials such as ripped or crushed sandstone and demolition rubble would be suitable for this purpose. Such fill should be compacted in horizontal layers as above using a hand held plate compactor. Care will be required to ensure excessive compaction stresses are not transferred to the retaining walls.

Density tests should be carried out at a frequency of one test per layer per 500m^2 or three tests per visit, whichever requires the most tests, to confirm the above specification has been achieved. For backfilling of localised excavations, such as service trenches or localised soft spots, testing should consist of one test per two layers per 50m^2. At least Level 2 testing of earthworks should be carried out in accordance with AS3798. Any areas of insufficient compaction will require reworking.

We note that if single sized granular material (or ‘no fines’ gravel) is used as backfill to retaining walls then only nominal compaction (with no compaction testing) will be required and would also act as the behind wall drainage. The behind wall drainage should be wrapped by a non woven geotextile fabric (e.g. Bidim A34) to act as a filter against subsoil erosion. Further, retaining wall backfill should be provided with a clay plug at surface level to reduce the likelihood of stormwater surcharging the retaining wall.

4.6 On Grade Floor Slabs and Drainage

Bedrock subgrades are generally expected over the aquatic centre and connecting areas to existing buildings although localised clayey soils associated with the igneous dyke may be encountered. Areas of the research centre floor slabs will overlie a sand subgrade.

Slab-on-grade construction for the proposed floor slabs is considered feasible provided the areas of soil subgrade are prepared as discussed above in Section 4.5.1.

The concrete on-grade floor slabs should be separated from all walls, columns, footings, etc, to permit relative movement. Slab joints should be designed to resist shear forces but not bending moments by providing dowelled or keyed joints. The floor slabs 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, 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 proposed basements. Outlets into the stormwater system will require Council approval.

4.7 Soil Aggression

Based on the advice provided in Table 4.8.1 of AS3600-2009 “Concrete Structures” the laboratory chemical test results have indicated that an A1 Exposure Classification applies.

For pile footings, based on the advice provided in AS2159-2009 “Piling Design and Installation” for corrosion protection and durability a ‘Non-aggressive’ Exposure Classification would apply (based on Table 6.4.2(C) of AS2159).

4.8 Further Geotechnical Input

Provided below is a summary of additional geotechnical input outlined in the preceding sections of this report:

- Expose existing footings in the Jo Karaolis Sports Centre and core drill bedrock to confirm allowable bearing pressure of the sandstone.
- Review the Contractors CMP.
- Review of allowable bearing pressures once footing sizes determined.
- Inspection of excavations exposing retaining wall footings along the eastern site boundary.
- Continuous vibration monitoring during rock excavations.
- Proof-rolling inspections.
- Density testing of all engineered fill.
- Pad and strip footing inspections and witnessing installation of CFA piles.
- Witnessing installation of ground anchors.

5 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. 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 and below the completed boreholes 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 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 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.

A waste classification will need to be assigned to any soil excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), General Solid, Restricted Solid or Hazardous Waste. If the natural soil has been stockpiled, classification of this soil as Excavated Natural Material (ENM) can also be undertaken, if requested. However, the criteria for ENM are more stringent and the cost associated with attempting to meet these criteria may be significant. Analysis takes seven to 10 working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing (and associated delays) should be expected. We strongly recommend that this issue is addressed prior to the commencement of excavation on site.

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
POINT LOAD STRENGTH INDEX TEST REPORT

Client: JK Geotechnics
Project: Proposed Alterations and Additions
Location: St Catherine's School, Waverley, NSW
Ref No: 26904ZR
Report: A
Report Date: 9/10/2013
Page 1 of 3

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
201	5.24-5.28	0.01	<1
	5.54-5.57	0.01	<1
	5.96-5.99	0.02	<1
	6.06-6.11	0.01	<1
	6.49-6.53	0.02	<1
	7.34-7.36	0.01	<1
	7.79-7.83	0.2	3
	8.00-8.04	0.07	1
202	3.31-3.34	0.06	1
	3.61-3.66	0.04	<1
	4.14-4.17	0.2	5
	4.71-4.75	0.2	4
	5.00-5.02	0.07	1
	5.29-5.33	0.2	5
	5.68-5.71	0.2	4
	6.28-6.32	0.3	7
	6.81-6.85	0.2	4
	7.00-7.04	0.2	5
	7.36-7.39	0.08	2
203	2.85-2.90	0.05	<1
	3.11-3.15	0.07	1
	3.41-3.44	0.03	<1
	3.74-3.77	0.1	2
	4.24-4.28	0.08	2
	4.53-4.56	0.04	<1

NOTES: See Page 3 of 3

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TABLE A
POINT LOAD STRENGTH INDEX TEST REPORT

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Project:	Proposed Alterations and Additions	**Report:**	A
Location:	St Catherine's School, Waverley, NSW	**Report Date:**	9/10/2013
		Page 2 of 3	

BOREHOLE NUMBER	DEPTH m	$I_{S\,(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
203	4.83-4.86	0.03	<1
	5.17-5.21	0.1	2
	5.40-5.43	0.06	1
	6.43-6.47	0.04	<1
	6.82-6.85	0.6	13
	7.00-7.04	0.7	14
	7.76-7.79	0.3	6
	8.22-8.26	0.4	8
	8.66-8.70	0.4	8
	9.23-9.27	0.4	9
204	2.85-2.89	0.2	4
	3.29-3.32	0.4	8
	3.50-3.53	0.7	13
	3.92-3.94	0.3	6
	4.34-4.37	0.6	11
	5.18-5.20	0.4	8
	5.79-2.82	0.6	11
	6.12-6.16	0.6	12
	6.72-6.75	0.6	12
	7.28-7.32	1.5	30
	7.73-7.77	0.5	9
	8.11-8.15	0.5	11
	8.82-8.86	0.7	14
	9.37-9.42	0.3	6

NOTES: See Page 3 of 3

115 Wicks Road
Macquarie Park, NSW 2113
PO Box 976
North Ryde, BC 1670
Telephone: 02 9888 5000
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SOIL TEST SERVICES
ABN 43 002 145 173

TABLE A
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	**Ref No:**	26904ZR
Project:	Proposed Alterations and Additions	**Report:**	A
Location:	St Catherine's School, Waverley, NSW	**Report Date:**	9/10/2013
		Page 3 of 3	

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
204	9.76-9.79	0.3	6
205	4.27-4.30	0.04	<1
	4.62-4.67	0.03	<1
	4.85-4.88	0.1	3
	5.24-5.27	0.2	3
	5.81-5.86	0.04	<1
	6.19-6.24	0.2	4
	6.80-6.84	0.1	3
	7.19-7.22	0.07	1
	8.06-8.11	0.2	4
	8.69-8.72	0.4	7
	9.09-9.13	0.5	9
	9.92-9.96	0.4	8

NOTES:

1. In the above table testing was completed in the Axial direction.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RMS T223.
4. For reporting purposes, the $I_{S(50)}$ has been rounded to the nearest 0.1 MPa
5. The Estimated Unconfined Compressive Strength was calculated from the point load Strength Index by the following approximate relationship and rounded off to the nearest whole number :
   U.C.S. = 20 $I_{S(50)}$

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
201
1/2

Client: SANDRICK
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR
Date: 1-10-13
Method: HAND AUGER / WASHBORE
R.L. Surface: ≈ 80.4m
Datum: AHD
Logged/Checked by: R.C./

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■				REFER TO DCP TEST RESULTS	0			FILL: Silty sand, fine to medium grained, dark grey, trace of fine to coarse grained sandstone gravel and roots.	M			APPEARS POORLY COMPACTED
	■			■				SP	SAND: fine to medium grained, grey, with silt, trace of ash.	M	(L)		POSSIBLY FILL
	■			■		1			SAND: fine to medium grained, light grey, with silt.				
				■					as above, but orange brown.				
						2					(MD)		COMMENCE WASH BORE DRILLING
						3			as above, but orange brown and dark brown.				
											(D)		
						4					(VD)		
						5 6 7			REFER TO CORED BOREHOLE LOG				

Client: Sandrick

Project: Proposed Alterations and Additions

Location: St Catherine’s School, Waverley, NSW

CORED BOREHOLE LOG

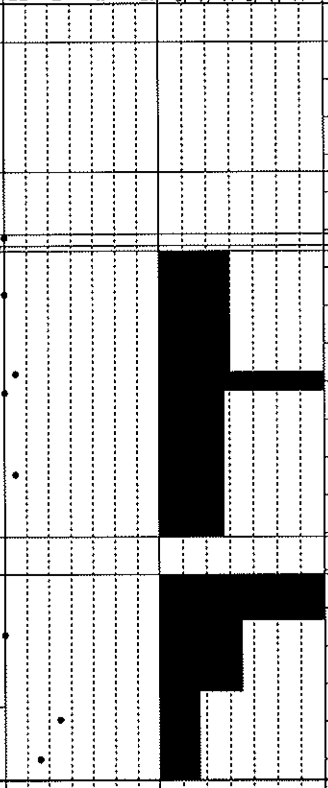
Borehole No.
201
2/2

Client: SANDRICK
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR
Date: 1-10-13
Drill Type: MELVELLE

Core Size: NMLC
Inclination: VERTICAL
Bearing: -

R.L. Surface: ≈ 80.4m
Datum: AHD
Logged/Checked by: R.C./



Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		4		START CORING AT 4.20m						
				CORE LOSS 0.69m						
▼ ON COMPLETION OF CORING & WASH BORING		5		SAND: fine to medium grained brown, with silt.	N/A	N/A				
				SANDSTONE: fine to coarse grained, light grey.	XW	EL-L				
				CORE LOSS 0.09m	XW-DW	EL-VL				
70% RETURN		6		SANDSTONE: fine to coarse grained, light grey, with orange brown staining.					- XWS, 0°, 20mm.t - XWS, 0°, 3mm.t - XWS, 0°, 65mm.t - XWS, 0°, 50mm.t - XWS, 0°, 200mm.t - XWS, 0°, 60mm.t - J, 58°, P, R, IS - J, 58°, XW INFILL 35mm.t	
				CORE LOSS 0.20m						
		7		SANDSTONE: fine to coarse grained, light grey, with orange brown staining, and fine to medium grained gravel sized sub rounded quartz inclusions	XW-DW	EL-VL			- XWS, 0°, 180mm.t - XWS, 5°, 9mm.t - XWS, 11°, 6mm.t - XWS, 11°, 2mm.t - XWS, 0°, 4mm.t - 2x J, 60° & 65°, P, S, IS	
		8		SANDSTONE: fine to medium grained, light grey.	DW	VL-L			- XWS, 0°, 27mm.t - J, 55°, P, S, IS	
				END OF BOREHOLE AT 8.11m						
		9								
		10								

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

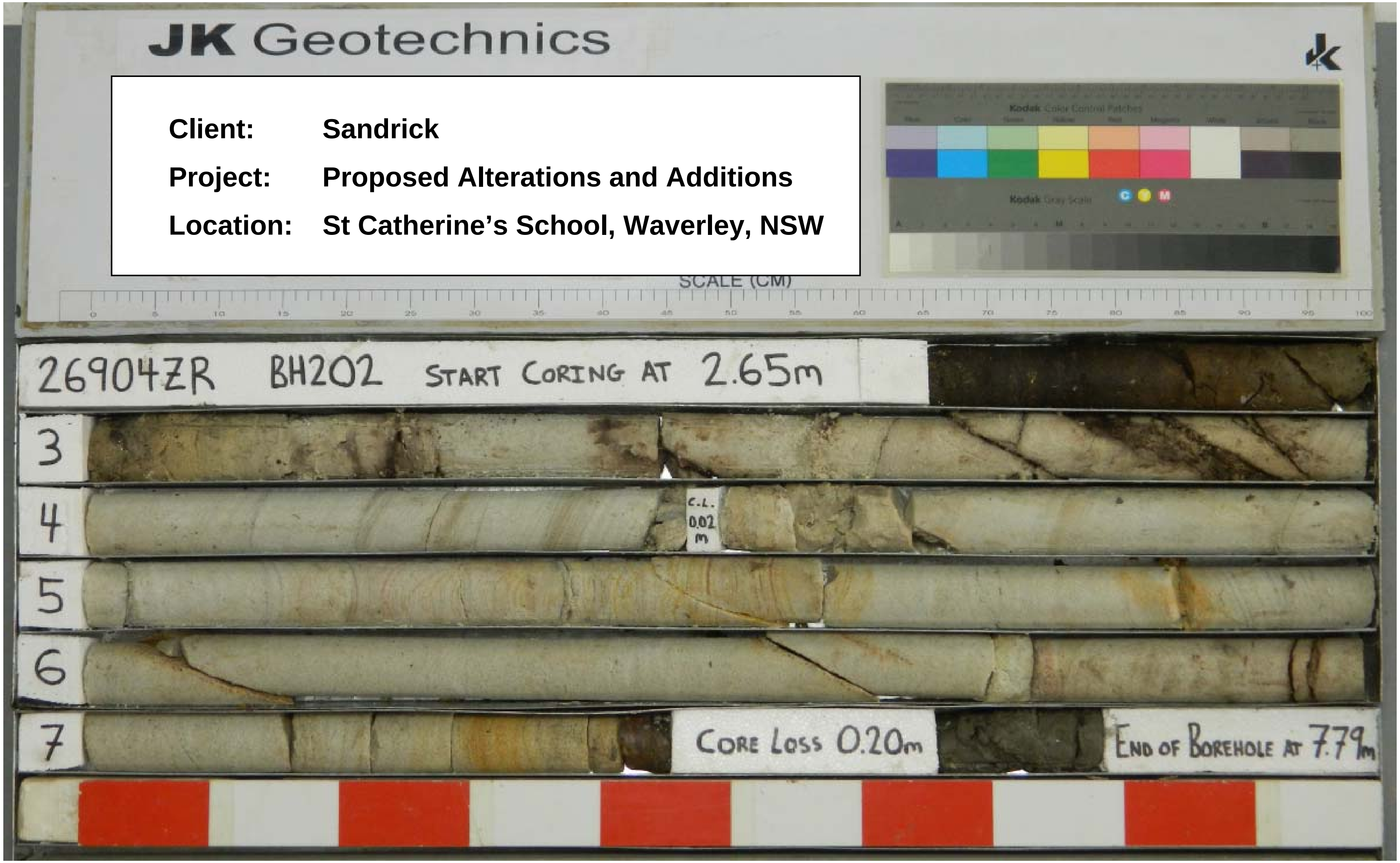
Borehole No.
202
1/2

Client: SANDRICK
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR
Method: HAND AUGER
R.L. Surface: ≈ 77.3m
Date: 2-10-13
Datum: AHD
Logged/Checked by: R.C./

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION OF AUGERING	■			■		0	▨		FILL: Silty sand, fine to medium grained, grey, trace of roots.	D			APPEARS POORLY COMPACTED
	■			■		1	▨		FILL: Silty sand, fine to medium grained, brown, with fine to medium grained sandstone gravel.	M			APPEARS MODERATELY COMPACTED
	■			■			░	SP	SAND: fine to medium grained, grey, with silt.	M	(MD) (L)		
				■		2	░		as above, but light grey.				
				■			░	SM	SILTY SAND: fine to medium grained, dark brown.		MD		
						3 4 5 6 7			REFER TO CORED BOREHOLE LOG				

Ref: 26904ZR Borehole BH202



Client: Sandrick

Project: Proposed Alterations and Additions

Location: St Catherine's School, Waverley, NSW

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

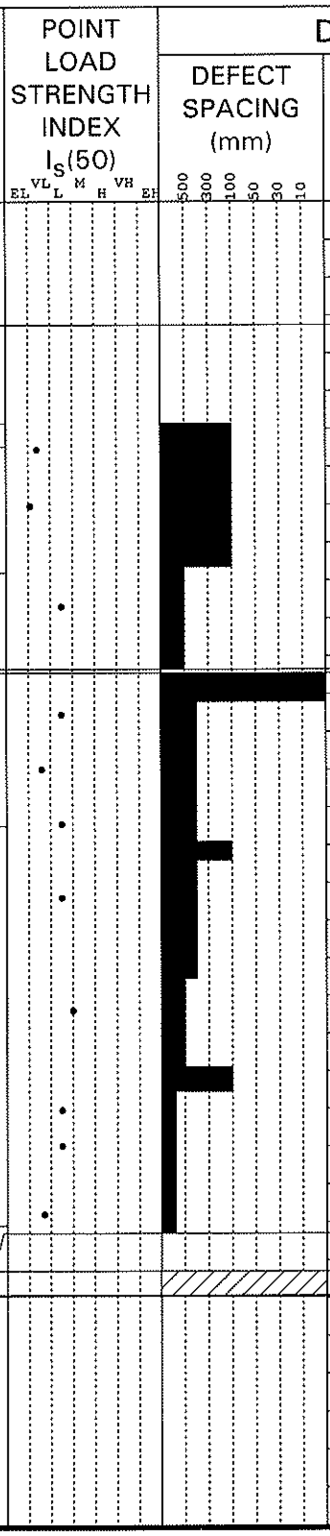
CORED BOREHOLE LOG

Borehole No.
202
2/2

Client: SANDRICK
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR
Date: 2-10-13
Drill Type: MELVELLE
Core Size: NMLC
Inclination: VERTICAL
Bearing: -
R.L. Surface: ≈ 77.3m
Datum: AHD
Logged/Checked by: R.C./

Water Loss/Level	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
	START CORING AT 2.65m				
FULL RETURN	SILTY SAND: fine to medium grained, dark brown.	N/A	(MD)	REFER TO DCP TEST RESULTS SHEET	
	SANDSTONE: fine to medium grained, light grey, with occasional dark grey laminae.	XW DW	EL VL L	- J, 60°, P, R, IS - XWS, 20°, 15mm.t - J, 52°, P, S - J, 70°, P, S, SAND INFILL 18mm.t - J, 50°, P, R, IS - XWS, 0°, 30mm.t	
	CORE LOSS 0.02m			- XWS, 0°, 145mm.t	
	SANDSTONE: fine to medium grained, light grey, with occasional orange brown staining.	DW	VL-L L	- J, 50°, P, S - XWS, 10°, 4mm.t - XWS, 5°, 5mm.t - J, 58°, P, R, IS - XWS, 0-18°, 15mm.t - J, 66°, P, S, IS - J, 58°, P, R, IS - XWS, 0°, 31mm.t	
	SANDSTONE: fine to medium grained, red brown, with fine to medium grained gravel sized sub rounded quartz inclusions.		VL		
	CORE LOSS 0.20m				
	INTERBEDDED SANDSTONE: fine grained, grey, and SHALE: grey.	XW	EL		
	END OF BOREHOLE AT 7.79m				



Barrel Lift | Depth (m) | Graphic Log
2
3
4
5
6
7
8
9

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BOREHOLE LOG

Borehole No.
203
1/3

Client: SANDRICK
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR
Method: HAND AUGER
R.L. Surface: ≈ 84.1m
Date: 30-9-13
Datum: AHD
Logged/Checked by: R.C./

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
DRY ON COMPLETION OF AUGERING	■			■		0			FILL: Silty sand, fine to medium grained, grey, trace of fine to medium grained sandstone gravel and slag.	M			GRASS COVER APPEARS POORLY COMPACTED
	■			■		1		SM	SILTY SAND: fine to medium grained, dark grey, trace of root fibres.	M	(VL)		
									as above, but grey.				
				■		2		SP	SAND: fine to medium grained, light grey, trace of silt.		(L) (MD)		
						3 4 5 6 7			REFER TO CORED BOREHOLE LOG				

Ref: 26904ZR Borehole BH203

Client: Sandrick

Project: Proposed Alterations and Additions

Location: St Catherine's School, Waverley, NSW

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No.
203
2/3

Client: SANDRICK

Project: PROPOSED ALTERATIONS AND ADDITIONS

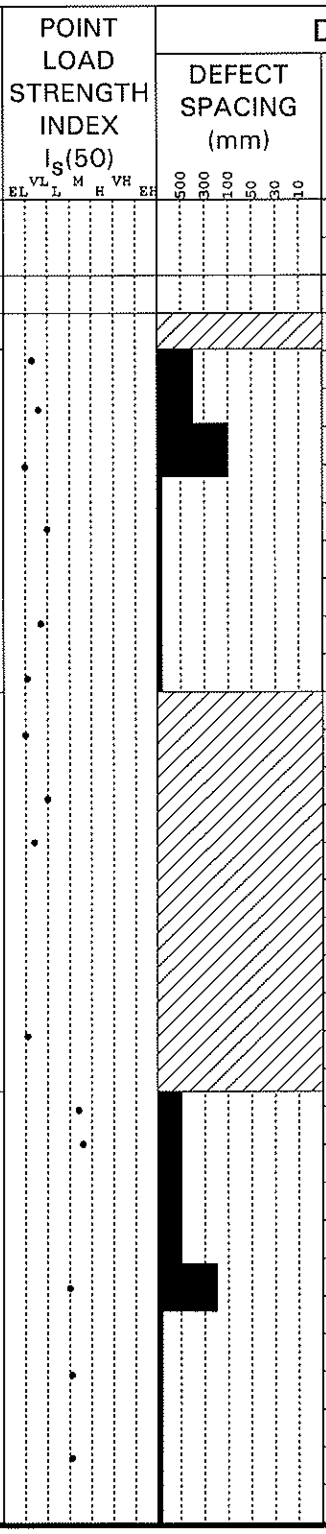
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR
Core Size: NMLC
R.L. Surface: ≈ 84.1m

Date: 30-9-13
Inclination: VERTICAL
Datum: AHD

Drill Type: MELVELLE
Bearing: -
Logged/Checked by: R.C./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		2		START CORING AT 2.40m				
				CORE LOSS 0.20m				
		3		SANDSTONE: fine to coarse grained, orange brown.	XW DW	EL VL	- XWS, 0°, 23mm.t - XWS, 0°, 140mm.t	
		4		as above, but light grey.			- J, 70°, P, R	
FULL RET -URN		5 6		INTERBEDDED SHALE: light grey and dark grey banded and SILTY CLAY: high plasticity, light grey and dark bands, with thin DW, VL strength bands, trace of fine grained sand.	RS-XW	(H)-EL	- J, 68°, P, S, IS	
		7		SANDSTONE: fine to medium grained, light grey, with grey and orange brown laminae, bedded at 0-5°.	DW	M	- Be, 20°, P, S - XWS, 8°, 3mm.t - XWS, 0-10°, 60mm.t - XWS, 12°, 3mm.t	
		8 9		as above, but light grey, with occasional orange brown staining.				



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CORED BOREHOLE LOG

Borehole No.
203
3/3

Client: SANDRICK
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR
Date: 30-9-13
Drill Type: MELVELLE
Core Size: NMLC
Inclination: VERTICAL
Bearing: -
R.L. Surface: ≈ 84.1m
Datum: AHD
Logged/Checked by: R.C./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
FULL RET-URN				SANDSTONE: fine to medium grained, light grey, with occasional orange brown staining.	DW	M	●		- XWS, 18°, 1mm.t - J, 47°, P, S	
		10		END OF BOREHOLE AT 9.97m						
		11								
		12								
		13								
		14								
		15								

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
204
1/3

Client: SANDRICK
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR
Method: HAND AUGER
R.L. Surface: ≈ 81.8m
Date: 30-9-13
Datum: AHD
Logged/Checked by: R.C./

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
DRY ON COMPLETION OF AUGERING	■ ■			■	REFER TO DCP TEST RESULTS	0	▨		FILL: Silty sand, fine to medium grained, grey, trace of root fibres.	D			APPEARS POORLY COMPACTED
	■			■		1	░	SP	SAND: fine to medium grained, light grey, with silt.	D-M	(VL)		
						2 3 4 5 6 7			REFER TO CORED BOREHOLE LOG				

Ref: 26904ZR Borehole BH204

Client: Sandrick

Project: Proposed Alterations and Additions

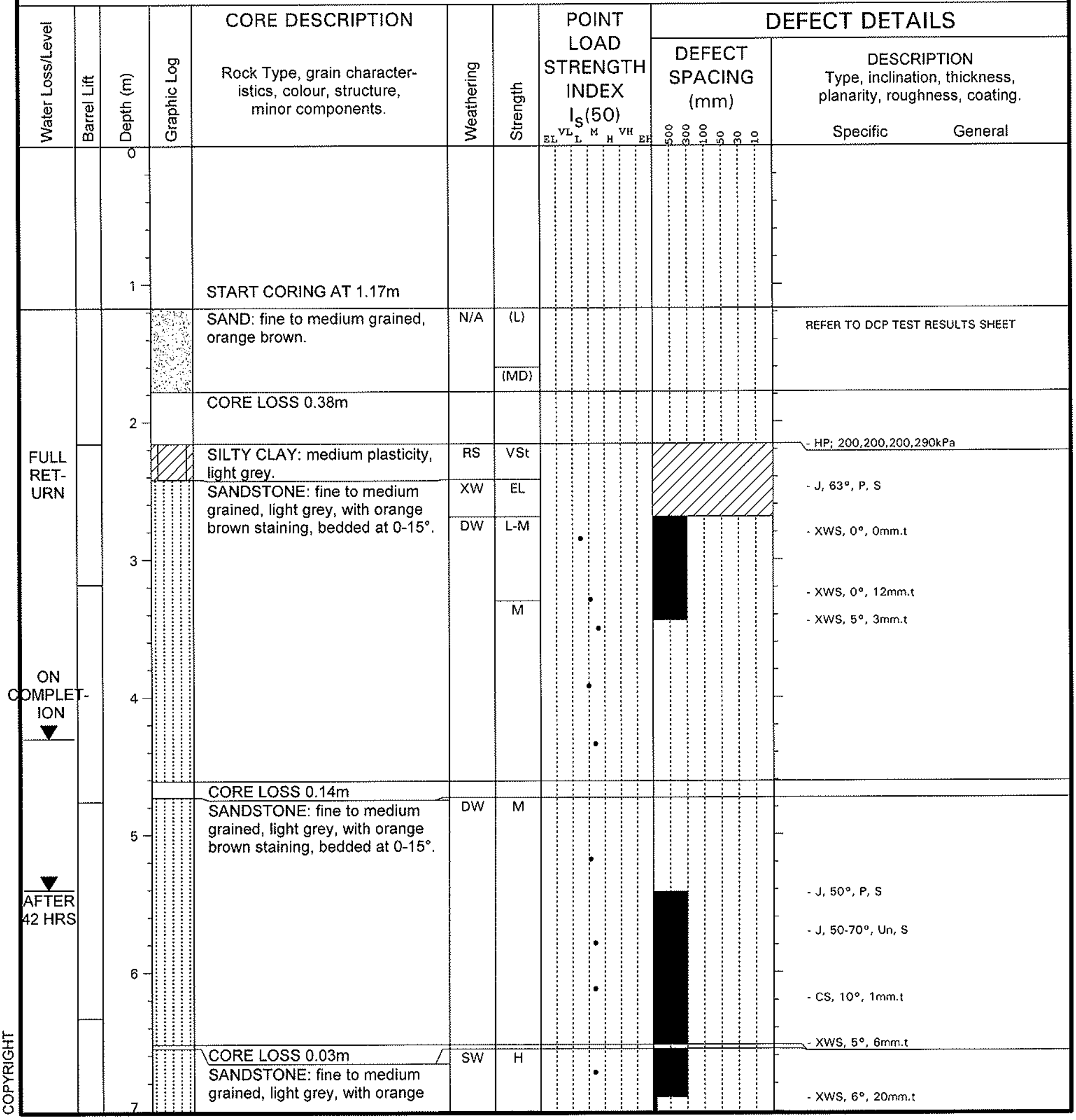
Location: St Catherine's School, Waverley, NSW

CORED BOREHOLE LOG

Borehole No.
204
2/3

Client: SANDRICK
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR
Date: 1-10-13
Drill Type: MELVELLE
Core Size: NMLC
Inclination: VERTICAL
Bearing: -
R.L. Surface: ≈ 81.8m
Datum: AHD
Logged/Checked by: R.C./



Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT SPACING (mm)	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		0								
		1		START CORING AT 1.17m						
				SAND: fine to medium grained, orange brown.	N/A	(L) (MD)			REFER TO DCP TEST RESULTS SHEET	
		2		CORE LOSS 0.38m					- HP; 200,200,200,290kPa	
FULL RET-URN				SILTY CLAY: medium plasticity, light grey.	RS	VSt				
				SANDSTONE: fine to medium grained, light grey, with orange brown staining, bedded at 0-15°.	XW	EL			- J, 63°, P, S	
		3			DW	L-M M			- XWS, 0°, 0mm.t - XWS, 0°, 12mm.t - XWS, 5°, 3mm.t	
ON COMPLETION		4								
				CORE LOSS 0.14m						
AFTER 42 HRS		5		SANDSTONE: fine to medium grained, light grey, with orange brown staining, bedded at 0-15°.	DW	M			- J, 50°, P, S - J, 50-70°, Un, S	
		6							- CS, 10°, 1mm.t - XWS, 5°, 6mm.t	
				CORE LOSS 0.03m						
		7		SANDSTONE: fine to medium grained, light grey, with orange	SW	H			- XWS, 6°, 20mm.t	

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

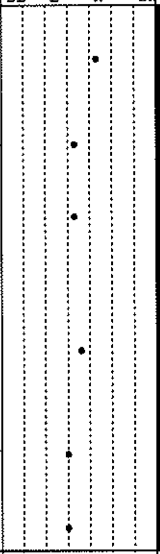
CORED BOREHOLE LOG

Borehole No.
204
3/3

Client: SANDRICK
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR
Core Size: NMLC
R.L. Surface: ≈ 81.8m
Date: 1-10-13
Inclination: VERTICAL
Datum: AHD
Drill Type: MELVELLE
Bearing: -
Logged/Checked by: R.C./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
				brown staining.	SW	H				
				SANDSTONE: fine to medium grained, light grey, with grey and dark grey laminae, bedded at 5-15°.						
					DW	M			- XWS, 5°, 17mm.t	
		8								
		9								
				SANDSTONE:fine to medium grained, light grey, with orange brown staining and fine to medium grained gravel sized, sub rounded quartz inclusions.		L-M			- XWS, 5-10°, 40mm.t	
		10		END OF BOREHOLE AT 9.88m						
		11								
		12								
		13								
		14								



JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

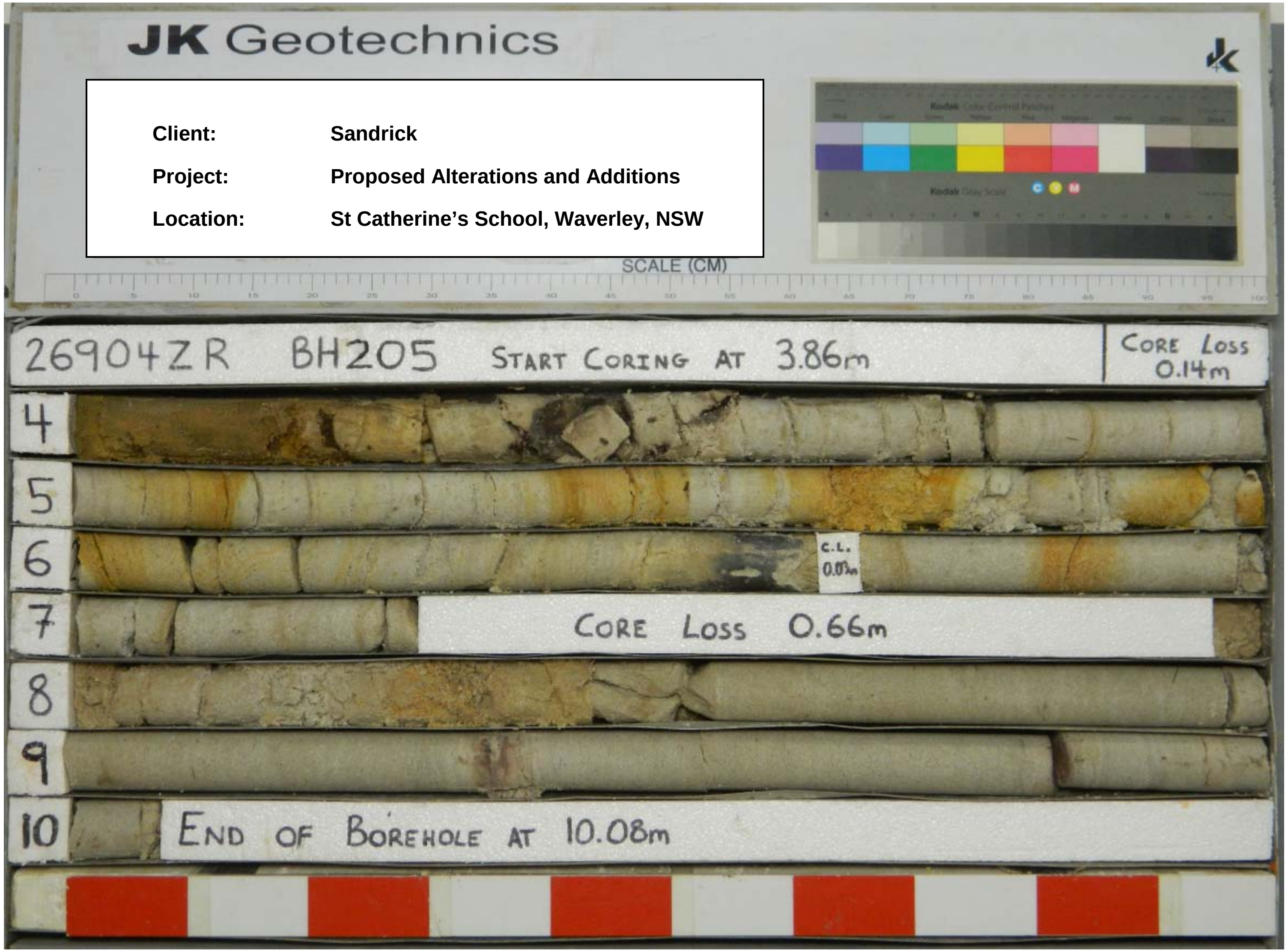
BOREHOLE LOG

Borehole No.
205
1/3

Client: SANDRICK
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR
Date: 2-10-13
Method: HAND AUGER/ WASHBORE
Logged/Checked by: R.C./
R.L. Surface: ≈ 80.6m
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 OF AUGERING				■	REFER TO DCP TEST RESULTS	0	▨		FILL: Silty sand, fine to medium grained, grey, trace of root fibres.	M			GRASS COVER APPEARS POORLY COMPACTED
				■			░	SP	SAND: fine to medium grained, light grey, with silt.	M	(L)		
							░		as above, but orange brown.				
						1	░				(MD)		
				■			░						
						2	░						
						3	░						COMMENCE WASHBORE DRILLING WITH NO SAMPLING
						4			REFER TO CORED BOREHOLE LOG				
						5							
						6							
						7							

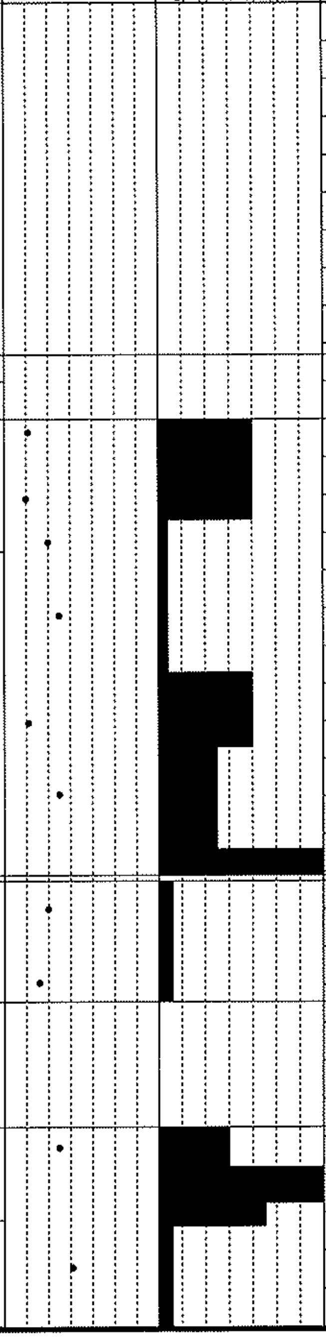

JK Geotechnics
Client: Sandrick
Project: Proposed Alterations and Additions
Location: St Catherine's School, Waverley, NSW
SCALE (CM)
26904ZR BH205 START CORING AT 3.86m
CORE LOSS 0.14m
4
5
6
C.L. 0.03m
7
CORE LOSS 0.66m
8
9
10
END OF BOREHOLE AT 10.08m

CORED BOREHOLE LOG

Borehole No.
205
2/3

Client: SANDRICK
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR
Date: 3-10-13
Drill Type: MELVELLE
Core Size: NMLC
Inclination: VERTICAL
Bearing: -
R.L. Surface: ≈ 80.6m
Datum: AHD
Logged/Checked by: R.C./



Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	DEFECT DETAILS – DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		2						
		3		START CORING AT 3.86m				
				CORE LOSS 0.14m				
		4		SAND: fine to medium grained, orange brown, with silt.	N/A	(MD)	REFER TO DCP TEST RESULTS SHEET	
				SANDSTONE: fine to medium grained, light grey, with orange brown and dark brown staining, bedded at 0-20°.	DW	VL	- J, 60°, P, S, SAND INFILL 10mm.t - J, 56°, P, S, IS, XW INFILL 30mm.t - XWS, 10°, 3mm.t - XWS, 10°, 2mm.t - XWS, 7°, 2mm.t - XWS, 6°, 2mm.t - XWS, 6°, 2mm.t	
		5				VL-L	- XWS, 5°, 8mm.t - XWS, 5°, 3mm.t - XWS, 0°, 60mm.t - J, Un, S, MAX. 50°, XW INFILL 45mm.t	
		6					- XWS, 7°, 2mm.t - J, 50°, P, R - XWS, 20°, 140mm.t	
				CORE LOSS 0.03m				
FULL RET-URN		7		SANDSTONE: fine to medium grained, light grey.	DW	VL-L		
				CORE LOSS 0.66m			- XWS, 0°, 47mm.t	
		8		SANDSTONE: fine to coarse grained, light grey, with fine to medium grained gravel sized quartz.	DW	L	- XWS, 0°, 195mm.t - XWS, 0°, 30mm.t - J, 70-90°, Un, R	
				SANDSTONE: fine to medium grained, light grey.		M		
		9						

JK Geotechnics

GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No.
205
3/3

Client: SANDRICK
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR
Date: 3-10-13
Drill Type: MELVELLE
Core Size: NMLC
Inclination: VERTICAL
Bearing: -
R.L. Surface: ≈ 80.6m
Datum: AHD
Logged/Checked by: R.C./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH	DEFECT DETAILS: DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS: DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
				SANDSTONE: fine to medium grained, light grey.	DW	M			- XWS, 0°, 70mm.t	
		10							- XWS, 0°, 17mm.t	
				END OF BOREHOLE AT 10.08m						
		11								
		12								
		13								
		14								
		15								

DYNAMIC CONE PENETRATION TEST RESULTS

Client: SANDRICK

Project: PROPOSED ALTERATIONS AND ADDITIONS

Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

Job No. 26904ZR

Date: 1-10-13

Tested By: R.C.

Hammer Weight & Drop: 9kg/510mm

Rod Diameter: 16mm

Point Diameter: 20mm

Number of Blows per 100mm Penetration							
Test Location	RL ~80.4m	RL ~77.3m	RL ~84.1m	Test Location			
Depth (mm)	**201**	**202**	**203**	Depth (mm)	**201**	**202**	
0 - 100	SUNK	SUNK	3	3000-3100	9	6	
100 - 200	↓	1	1	3100-3200	9	15	
200 - 300	1	1	2	3200-3300	10	12/20mm	
300 - 400	1	1	2	3300-3400	13	REFUSAL	
400 - 500	2	4	2	3400-3500	12		
500 - 600	2	4	1	3500-3600	14		
600 - 700	4	5	1	3600-3700	15		
700 - 800	2	7	2	3700-3800	13		
800 - 900	2	9	1	3800-3900	15		
900 - 1000	2	8	1	3900-4000	21		
1000 - 1100	3	10	1	4000-4100	22		
1100 - 1200	4	8	2	4100-4200	8/20mm		
1200 - 1300	3	5	2	4200-4300	REFUSAL		
1300 - 1400	3	3	1	4300-4400			
1400 - 1500	3	4	1	4400-4500			
1500 - 1600	3	4	1	4500-4600			
1600 - 1700	4	4	1	4600-4700			
1700 - 1800	4	3	2	4700-4800			
1800 - 1900	3	3	1	4800-4900			
1900 - 2000	3	2	2	4900-5000			
2000 - 2100	5	2	3	5000-5100			
2100 - 2200	5	2	3	5100-5200			
2200 - 2300	7	3	4	5200-5300			
2300 - 2400	7	3	4	5300-5400			
2400 - 2500	10	3	5	5400-5500			
2500 - 2600	9	4	7	5500-5600			
2600 - 2700	10	4	6	5600-5700			
2700 - 2800	10	9	5	5700-5800			
2800 - 2900	10	5	5/80mm	5800-5900			
2900 - 3000	10	4	REFUSAL	5900-6000			

Remarks:
1. The procedure used for this test is similar to that described in AS1289.6.3.2-1997, Method 6.3.2.
2. Usually 8 blows per 20mm is taken as refusal
3. Site survey datum is AHD.

JK Geotechnics

GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

DYNAMIC CONE PENETRATION TEST RESULTS

Client: SANDRICK
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: ST CATHERINE'S SCHOOL, ALBION STREET, WAVERLEY, NSW

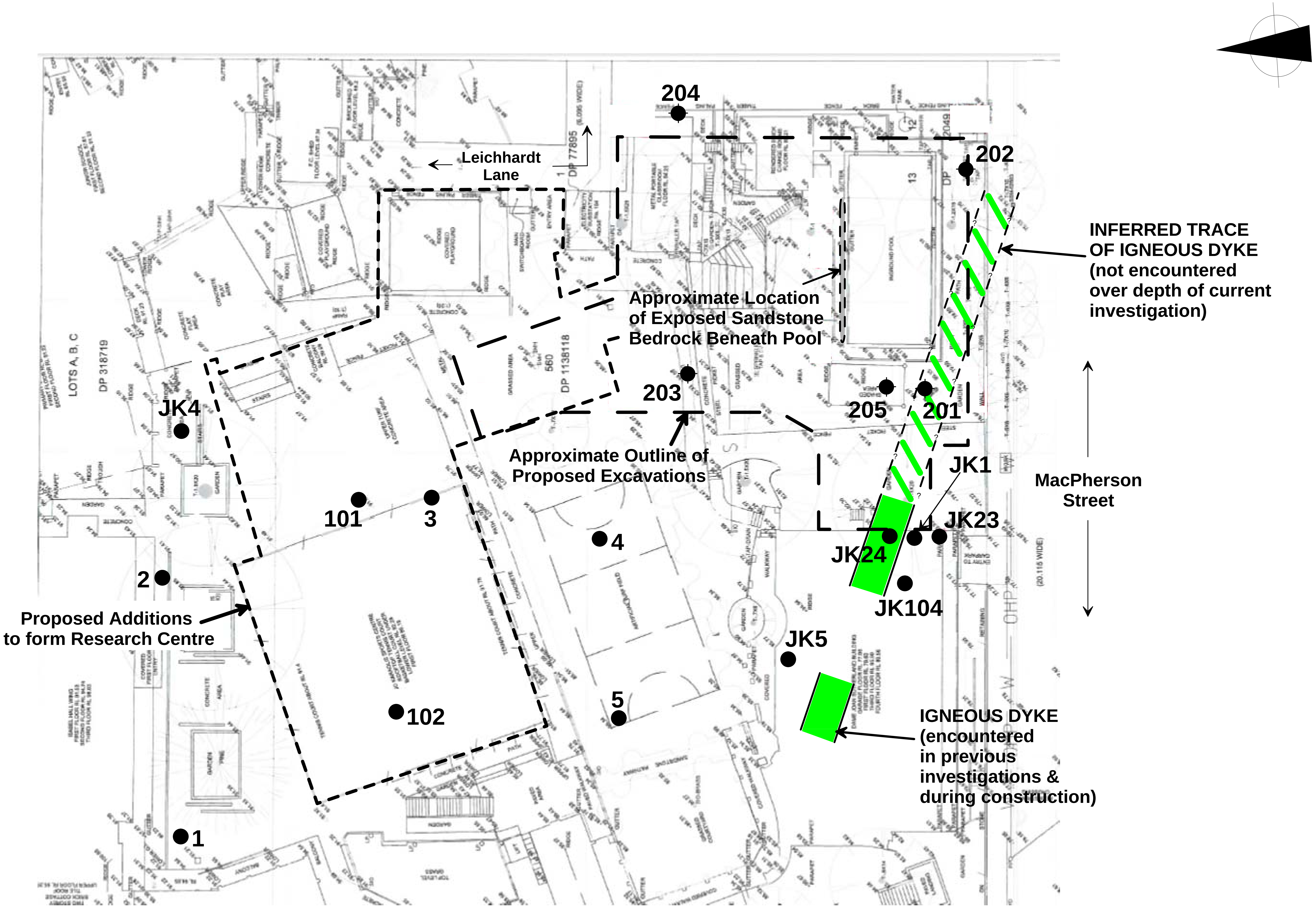
Job No. 26904ZR
Date: 1-10-13
Tested By: R.C.

Hammer Weight & Drop: 9kg/510mm
Rod Diameter: 16mm
Point Diameter: 20mm

Number of Blows per 100mm Penetration

Test Location	RL ~81.8m	RL ~80.6m		Test Location			
Depth (mm)	**204**	**205**		Depth (mm)	**205**		
0 - 100	SUNK	2		3000-3100	4		
100 - 200	↓	1		3100-3200	4		
200 - 300	1	1		3200-3300	6		
300 - 400	1	2		3300-3400	7		
400 - 500	1	1		3400-3500	7		
500 - 600	1	2		3500-3600	7		
600 - 700	1	2		3600-3700	7		
700 - 800	↓	2		3700-3800	6		
800 - 900	1	2		3800-3900	5		
900 - 1000	1	3		3900-4000	8		
1000 - 1100	1	4		4000-4100	9		
1100 - 1200	4	5		4100-4200	19/80mm		
1200 - 1300	4	3		4200-4300	REFUSAL		
1300 - 1400	3	4		4300-4400			
1400 - 1500	2	4		4400-4500			
1500 - 1600	3	6		4500-4600			
1600 - 1700	4	5		4600-4700			
1700 - 1800	4	6		4700-4800			
1800 - 1900	5	6		4800-4900			
1900 - 2000	6	4		4900-5000			
2000 - 2100	3	4		5000-5100			
2100 - 2200	5	4		5100-5200			
2200 - 2300	16	3		5200-5300			
2300 - 2400	13/40mm	4		5300-5400			
2400 - 2500	REFUSAL	5		5400-5500			
2500 - 2600		6		5500-5600			
2600 - 2700		5		5600-5700			
2700 - 2800		4		5700-5800			
2800 - 2900		4		5800-5900			
2900 - 3000		4		5900-6000			

Remarks:
1. The procedure used for this test is similar to that described in AS1289.6.3.2-1997, Method 6.3.2.
2. Usually 8 blows per 20mm is taken as refusal
3. Site survey datum is AHD.



LEGEND

● BOREHOLE

⌖ BOREHOLE AND DCP TEST

201 etc	Boreholes and DCP tests from current investigation
1, 101, JK1 etc	Boreholes from previous investigations

Scale (m):
0 25

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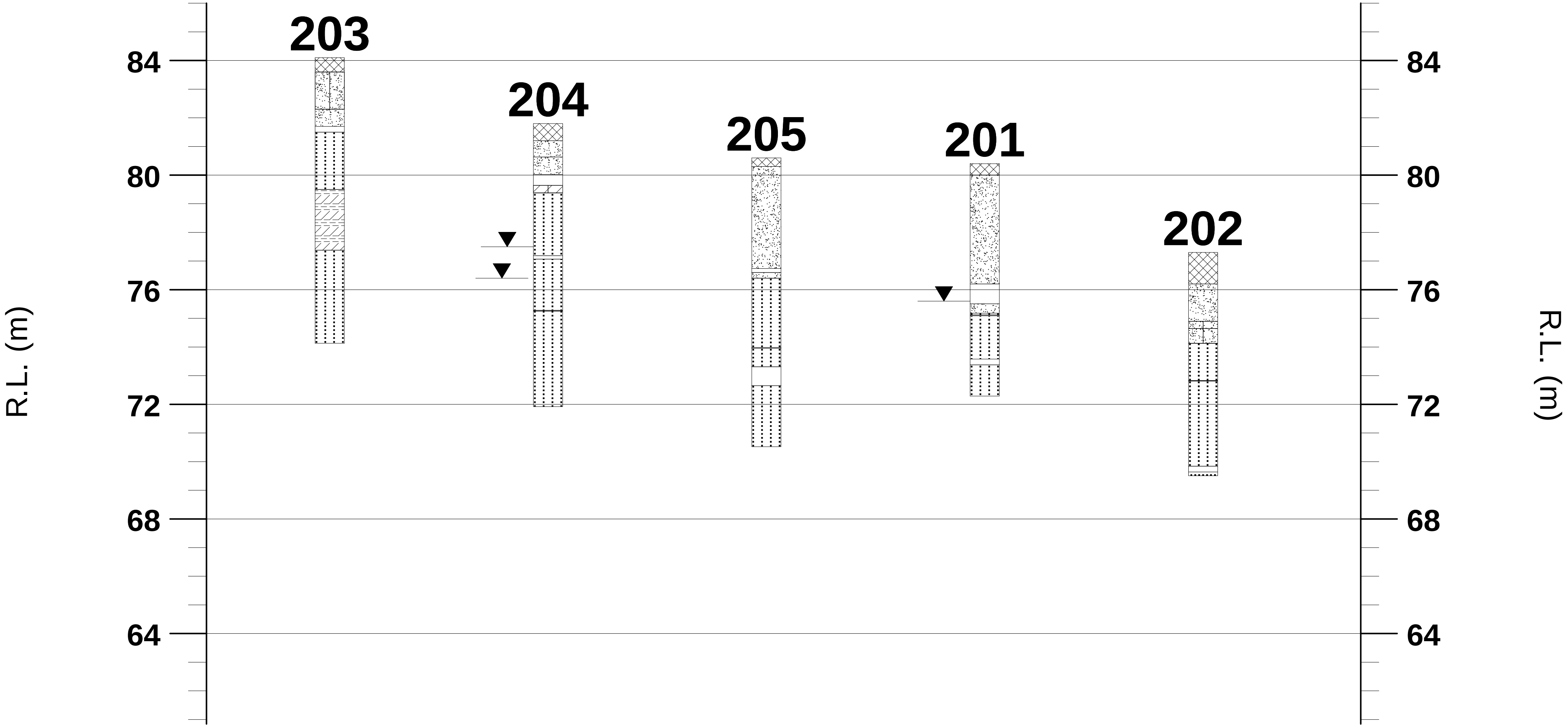
Title:
INVESTIGATION LOCATION PLAN

Report Number:
26904ZR

Figure Number:
1

GRAPHICAL BOREHOLE SUMMARY



- ▩ Fill
- ▩ Silty Sand
- ▩ Sand
- ☐ Core Loss/ Empty
- ▩ Sandstone/ Greywacke
- ▩ Interbedded Shale and Clay
- ▨ Silty Clay
- ▩ Interbedded Sandstone and shale
- ▼ Observed water level

N SPT "N" VALUE

Nc SOLID CONE BLOW COUNTS PER 150mm

NOTE: REFER TO BOREHOLE LOGS

Scale: 1 : 200 (vert) ; NTS (horiz)

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Job No.: 26904ZR

Figure No.: 2

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.

Copyright in all documents (such as drawings, borehole or test pit logs, reports and specifications) provided by the Company shall remain the property of Jeffery and Katauskas Pty Ltd. Subject to the payment of all fees due, the Client alone shall have a licence to use the documents provided for the sole purpose of completing the project to which they relate. License to use the documents may be revoked without notice if the Client is in breach of any objection to make a payment to us.

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.

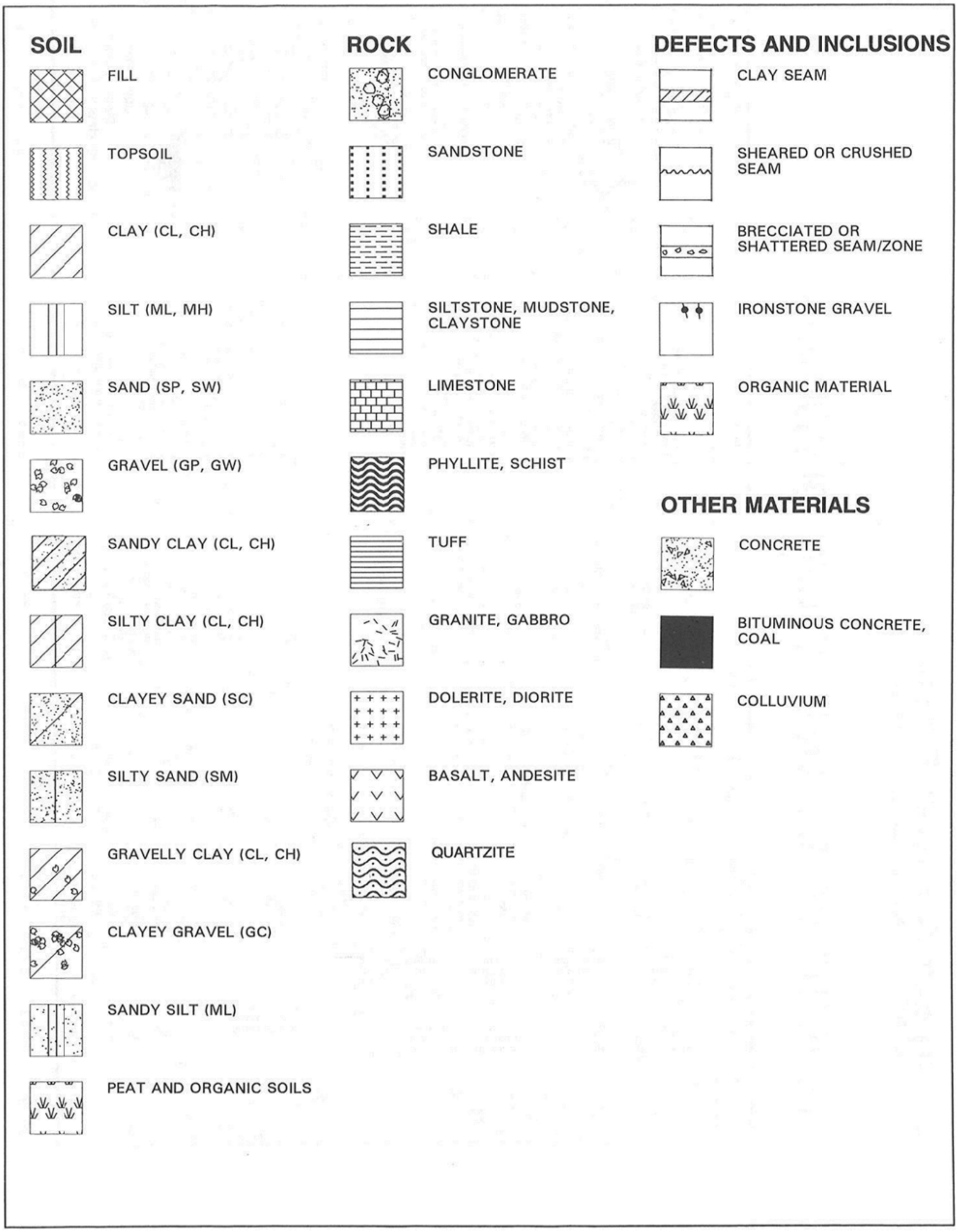
SITE INSPECTION

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

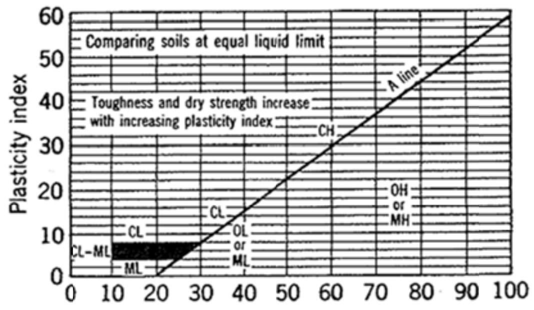
- CONGLOMERATE
- SANDSTONE
- SHALE
- SILTSTONE, MUDSTONE, CLAYSTONE
- LIMESTONE
- PHYLLITE, SCHIST
- TUFF
- GRANITE, GABBRO
- DOLERITE, DIORITE
- BASALT, ANDESITE
- QUARTZITE

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^b (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	
			Predominantly one size or a range of sizes with some intermediate sizes missing			*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines				Not meeting all gradation requirements for *GW*	
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)			*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures				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
			Plastic fines (for identification procedures, see *CL* below)			*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures				Atterberg limits above "A" line, with *PI* greater than 7	
	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	
			Predominantly one size or a range of sizes with some intermediate sizes missing			*SP*	Poorly graded sands, gravelly sands, little or no fines				Not meeting all gradation requirements for *SW*	
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)			*SM*	Silty sands, poorly graded sand-silt mixtures				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
			Plastic fines (for identification procedures, see *CL* below)			*SC*	Clayey sands, poorly graded sand-clay mixtures				Atterberg limits below "A" line with *PI* greater than 7	
Fine-grained soils More than half of material is *smaller* than 75 μm sieve size	Identification Procedures on Fraction Smaller than 380 μm Sieve Size											
			Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)							
	Silts and clays liquid limit less than 50		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*)		 Plasticity chart for laboratory classification of fine grained soils		
			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					

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

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

CERTIFICATE OF ANALYSIS 98512

Client:

JK Geotechnics
PO Box 976
North Ryde BC
NSW 1670

Attention: A Mitchell

Sample log in details:

Your Reference:	**26904ZR, Waverley**
No. of samples:	3 Soils
Date samples received / completed instructions received	04/10/2013 / 04/10/2013

Analysis Details:

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

Report Details:

Date results requested by: / Issue Date:	14/10/13 / 12/10/13
Date of Preliminary Report:	Not issued

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Jacinta Hurst
Laboratory Manager

Miscellaneous Inorg - soil Our Reference:	UNITS	98512-1	98512-2	98512-3
Your Reference	-------------	201	202	203
Depth	------------	1.8-2.0	2.4-2.5	0.2-0.4
Date Sampled		1/10/2013	2/10/2013	30/09/2013
Type of sample		Soil	Soil	Soil
Date prepared	-	09/10/2013	09/10/2013	09/10/2013
Date analysed	-	09/10/2013	09/10/2013	09/10/2013
pH 1:5 soil:water	pH Units	6.3	6.7	6.3
Chloride, Cl 1:5 soil:water	mg/kg	4	21	4
Sulphate, SO4 1:5 soil:water	mg/kg	9	17	6

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 22nd ED, 4500-H+.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 22nd ED, 4110-B.

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			09/10/2013	[NT]	[NT]	LCS-1	09/10/2013
Date analysed	-			09/10/2013	[NT]	[NT]	LCS-1	09/10/2013
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	LCS-1	99%
Chloride, Cl 1:5 soil:water	mg/kg	2	Inorg-081	<2	[NT]	[NT]	LCS-1	103%
Sulphate, SO4 1:5 soil:water	mg/kg	2	Inorg-081	<2	[NT]	[NT]	LCS-1	116%

Report Comments:

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

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

Quality Control Definitions

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

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

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

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

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

Laboratory Acceptance Criteria

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

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

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

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

APPENDIX B

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
1
1/3

Client: ST CATHERINE'S SCHOOL
Project: PROPOSED POOL AND SPORTS HALL
Location: 26 ALBION STREET, WAVERLY

Job No. 13027S
Date: 19-11-97
Method: SPIRAL AUGER BCD 350
R.L. Surface: N/A
Datum:
Logged/Checked by: K.T.N./

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		SP	BRICK PAVING: 60mm.t. SAND: fine to medium grained, brown.	M	L	–	–
				■	N = 7 2,3,4								
									as above, but yellow brown.				
						1							
				■	N = 11 3,5,6						MD		
						2							
				■	N = 14 4,7,7	3							
								–	SANDSTONE: fine to medium grained, grey, with sandy clay bands.	XW	EL	–	VERY LOW 'TC' BIT RESISTANCE
						4							
				■									
						5							
				■									
						6							
▶										DW	L–M		LOW RESISTANCE
						7							

BOREHOLE LOG

Borehole No.
1
2/3

Client: ST CATHERINE'S SCHOOL
Project: PROPOSED POOL AND SPORTS HALL
Location: 26 ALBION STREET, WAVERLY

Job No. 13027S
Date: 19-11-97
Method: SPIRAL AUGER
BCD 350
R.L. Surface: N/A
Datum:
Logged/Checked by: K.T.N./B.

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
				■		7	⁝⁝⁝		SANDSTONE: fine to medium grained, pale grey.	DW	L-M		LOW RESISTANCE
									REFER TO CORED BOREHOLE LOG				
						8							
						9							
						10							
						11							
						12							
						13							

CORED BOREHOLE LOG

Borehole No. 1 3/3

Client: ST CATHERINE'S SCHOOL
Project: PROPOSED POOL AND SPORTS HALL
Location: 26 ALBION STREET, WAVERLY

Job No. 13027S
Date: 29-11-97
Drill Type: BCD 350
Core Size: NMLC
Inclination: VERTICAL
Bearing: –
R.L. Surface: N/A
Datum:
Logged/Checked by: K.T.N./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		7		START CORING AT 7.46m						
				SANDSTONE: fine to medium grained, grey red mottled orange bedding 0-15°.	DW	H			- Be, 15°, P, S	
				CORE LOSS 0.33m						
		8		CLAY: high plasticity, brown. HP=240,>600,500	MC<PL	VSt-H				
				CORE LOSS 0.15m						
				SANDSTONE: fine to medium grained, grey, with dark grey laminae bedding at 0-10°.	XW	VL			- Be, 5°, P, S	
		9		as above, but pale grey with grey laminae bedding 10-20°.	SW	M				
		10								
		11		as above, but pale grey with orange laminae.	DW				- Be, 20°, P, S	
				as above, but pale grey, with grey laminae.	SW				- Be, 20°, P, S	
		12							- CS, 10mm.t	
				END OF BOREHOLE AT 12.29m						
		13								
		14								

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
2
1/3

Client: ST CATHERINE'S SCHOOL
Project: PROPOSED POOL AND SPORTS HALL
Location: 26 ALBION STREET, WAVERLY

Job No. 13027S
Date: 19-11-97
Method: SPIRAL AUGER BCD 350
R.L. Surface: N/A
Datum:
Logged/Checked by: K.T.N./

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0			CONCRETE: 100mm.t				8mm DIAMETER WITH 30mm TOP COVER
					SP	SAND: fine to medium grained, pale grey brown.	D	L	–	–
		N = 5 2,2,3								
			1			as above, but orange brown.	M			HOLE COLLAPSING TO 1.0m
		N_c = 8 8 7 8 9						MD		
			2			as above, but with trace of clay fines.				
					SC	CLAYEY SAND: fine to medium grained, pale grey.				THIN IRONSTONE BAND
		N > 29 9,20/ 120mm R	3		–	SANDSTONE: fine to medium grained, pale grey, with red brown bands, with sandy clay bands.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
			4							
		N > 20 20/ 100mm				as above, but pale grey mottled red.				
			5							
			6							
			7							

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BOREHOLE LOG

Borehole No.
2
2/3

Client: ST CATHERINE'S SCHOOL
Project: PROPOSED POOL AND SPORTS HALL
Location: 26 ALBION STREET, WAVERLY

Job No. 13027S
Date: 19-11-97
Method: SPIRAL AUGER
BCD 350
R.L. Surface: N/A
Datum:
Logged/Checked by: K.T.N./B

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
						7			SANDSTONE: as above.				
				■					as above, but pale grey.	DW	L–M		LOW RESISTANCE
									REFER TO CORED BOREHOLE LOG				
						8							
						9							
						10							
						11							
						12							
						13							

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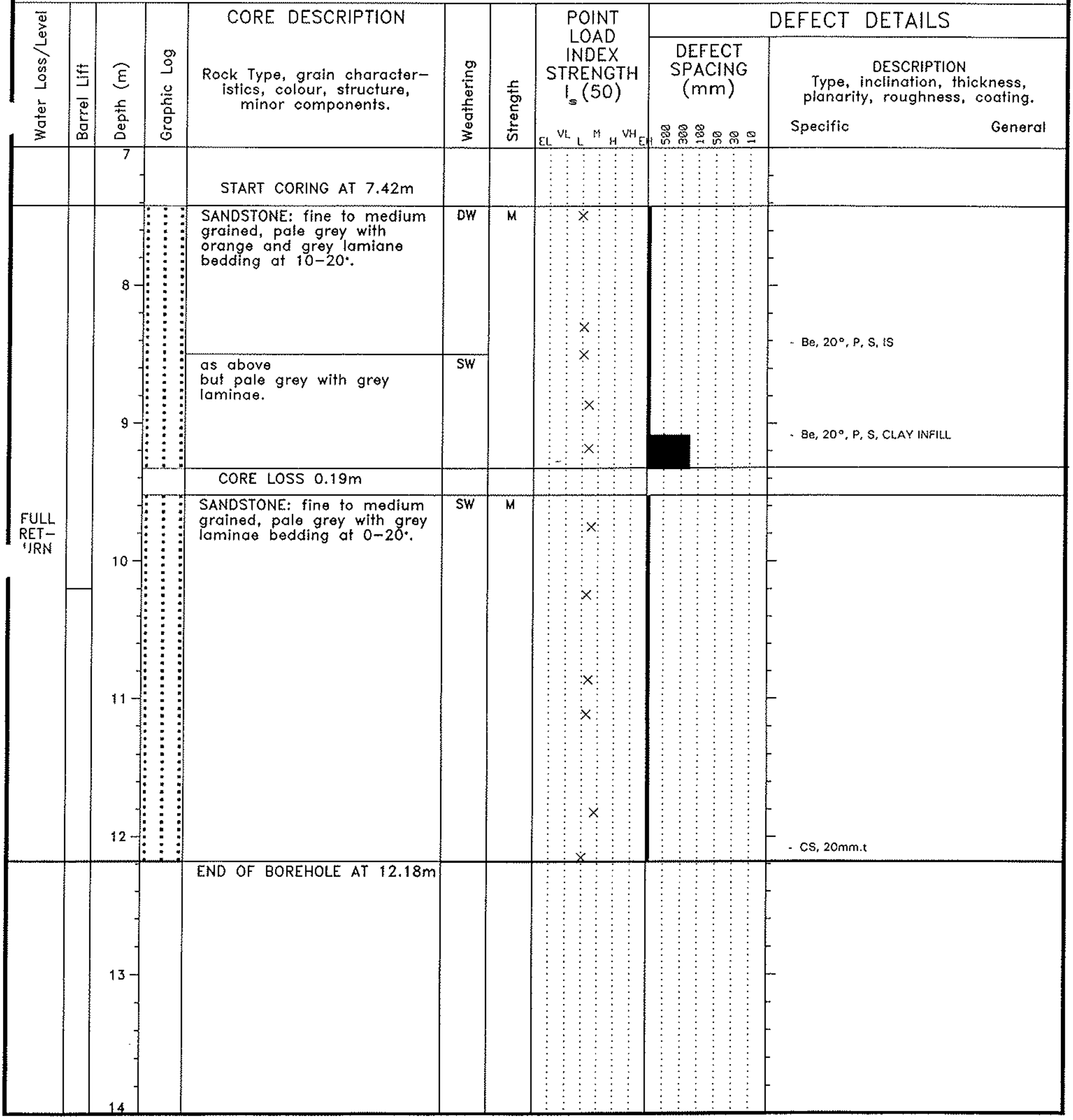
CORED BOREHOLE LOG

Borehole No. 2 3/3

Client: ST CATHERINE'S SCHOOL
Project: PROPOSED POOL AND SPORTS HALL
Location: 26 ALBION STREET, WAVERLY

Job No. 13027S
Date: 19-11-97
Drill Type: BCD 350
Core Size: NMLC
Inclination: VERTICAL
Bearing: –
R.L. Surface: N/A
Datum:
Logged/Checked by: K.T.N.



Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		7		START CORING AT 7.42m						
		8		SANDSTONE: fine to medium grained, pale grey with orange and grey lamiane bedding at 10-20°.	DW	M	× × ×		- Be, 20°, P, S, IS	
		9		as above but pale grey with grey laminae.	SW		× × ×		- Be, 20°, P, S, CLAY INFILL	
				CORE LOSS 0.19m						
FULL RET-'JRN		10 11 12		SANDSTONE: fine to medium grained, pale grey with grey laminae bedding at 0-20°.	SW	M	× × × × × ×		- CS, 20mm.t	
		13 14		END OF BOREHOLE AT 12.18m						

BOREHOLE LOG

Borehole No.
3
1/2

Client: ST CATHERINE'S SCHOOL
Project: PROPOSED POOL AND SPORTS HALL
Location: 26 ALBION STREET, WAVERLY

Job No. 13027S
Date: 20-11-97
Method: SPIRAL AUGER BCD 350
R.L. Surface: N/A
Datum:
Logged/Checked by: K.T.N./B

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			TOPSOIL/FILL: Silty sand, fine to medium grained, dark brown, with rootlets.	M			GRASS COVER
					N > 23 2,21/ 100mm			SC	CLAYEY SAND: fine to medium grained, orange brown.	M	MD		–
						1			as above, but with fine to medium grained sandstone gravel.				
					N > 31 11,11,20/ 50mm R								
						2		–	SANDSTONE: medium to coarse grained, pale grey.	DW	L		LOW RESISTANCE
						3					L–M		LOW TO MODERATE RESISTANCE
▼ AFTER 4 HRS						4					M		MODERATE RESISTANCE
						5			as above, but pale grey mottled orange.				
►						6							
						7							

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BOREHOLE LOG

Borehole No.
3
2/2

Client: ST CATHERINE'S SCHOOL
Project: PROPOSED POOL AND SPORTS HALL
Location: 26 ALBION STREET, WAVERLY

Job No. 13027S
Date: 20-11-97
Method: SPIRAL AUGER
BCD 350
R.L. Surface: N/A
Datum:
Logged/Checked by: K.T.N./

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
				■		7	⁞		SANDSTONE: medium to coarse grained, pale grey mottled orange.	DW	M		MODERATE RESISTANCE
				■		8	⁞						
						9			END OF BOREHOLE AT 9.0m				
						10							
						11							
						12							
						13							

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
4
1/2

Client: ST CATHERINE'S SCHOOL
Project: PROPOSED POOL AND SPORTS HALL
Location: 26 ALBION STREET, WAVERLY

Job No. 13027S
Date: 20-11-97
Method: SPIRAL AUGER BCD 350
R.L. Surface: N/A
Datum:
Logged/Checked by: K.T.N./

Groundwater Record	SAMPLES ES	U50	DB	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			TOPSOIL: Silty sand, fine to medium grained, dark brown.	D			GRASS COVER
								SP	SAND: fine to medium grained, pale grey.	M	MD	–	–
					N > 10 10/ 100mm R	1		–	SANDSTONE: medium to coarse grained, grey mottled orange, with clay bands.	DW	VL–L	–	VERY LOW TO LOW 'TC' BIT RESISTANCE
						3					L–M		LOW TO MODERATE RESISTANCE
						5			REFER TO CORED BOREHOLE LOG				

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

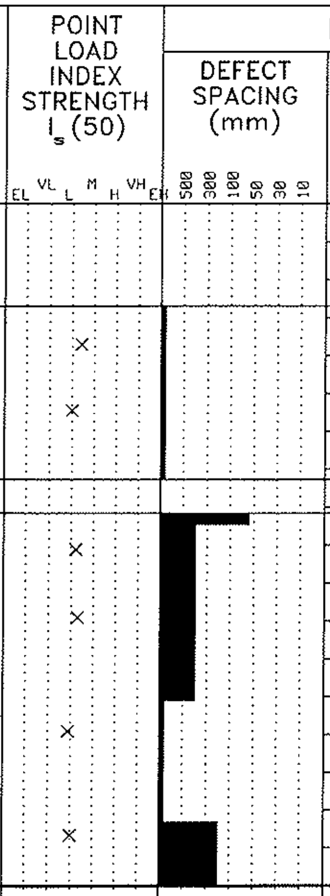
CORED BOREHOLE LOG

Borehole No.
4
2/2

Client: ST CATHERINE'S SCHOOL
Project: PROPOSED POOL AND SPORTS HALL
Location: 26 ALBION STREET, WAVERLY

Job No. 13027S
Date: 20-11-97
Drill Type: BCD 350
Core Size: NMLC
Inclination: VERTICAL
Bearing: –
R.L. Surface: N/A
Datum:
Logged/Checked by: K.T.N./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	DEFECT DETAILS – DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		4		START CORING AT 4.54m				
		5		SANDSTONE: medium to coarse grained, pale grey and orange laminae bedding at 10–20°.	DW	M		
				CORE LOSS 0.18m				
		6		as above, but bedding at 0–10°.	DW	M	- Be, 5°, P, S - Be, 10°, P, S - Be, 10°, P, S	
		7				L–M	- Be, 5°, P, S - CS, 20mm.t	
		8		END OF BOREHOLE AT 7.6m				
		9						
		10						
		11						



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BOREHOLE LOG

Borehole No.
5
1/2

Client: ST CATHERINE'S SCHOOL
Project: PROPOSED POOL AND SPORTS HALL
Location: 26 ALBION STREET, WAVERLY

Job No. 13027S
Date: 20-11-97
Method: SPIRAL AUGER
BCD 350
R.L. Surface: ~~N/A~~ ~85.3
Datum:
Logged/Checked by: K.T.N./

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			TOPSOIL/FILL: Silty sand, fine to medium grained, dark brown.	D			GRASS COVER
				■	N = 11 2,5,6	1		SP	SAND: fine to medium grained, orange brown.	M	MD	–	–
				■		2		SC	CLAYEY SAND: fine to medium grained, orange brown.				
				■	N > 15 15/ 100mm R	3		–	SANDSTONE: medium to coarse grained, pale grey orange with clay bands.	DW	VL	–	VERY LOW 'TC' BIT RESISTANCE
				■		4			as above, but pale grey mottled orange.		L		LOW RESISTANCE
						5 6 7			REFER TO CORED BOREHOLE LOG				

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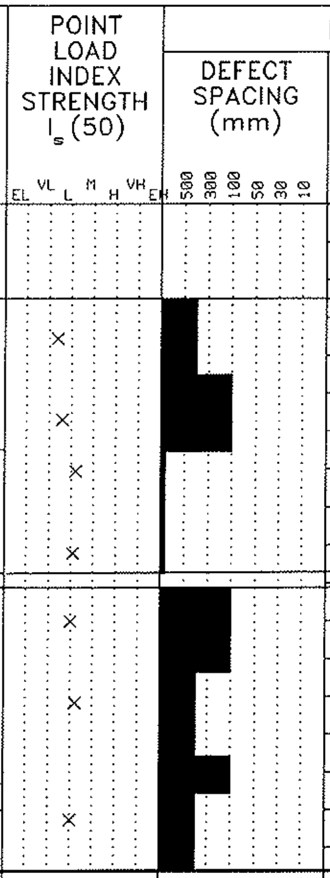
CORED BOREHOLE LOG

Borehole No.
5
2/2

Client: ST CATHERINE'S SCHOOL
Project: PROPOSED POOL AND SPORTS HALL
Location: 26 ALBION STREET, WAVERLY

Job No. 13027S
Date: 20-11-97
Drill Type: BCD350
Core Size: NMLC
Inclination: VERTICAL
Bearing: –
R.L. Surface: ~~N/A~~ 85.3
Datum:
Logged/Checked by: K.T.N./KB



Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$	DEFECT SPACING (mm)	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		4		START CORING AT 4.5m						
		5		SANDSTONE: medium to coarse grained, orange brown, bedding at 0–20°.	DW	L			- Be, 20°, P, S - J, 80°, P, S - Be, 20°, P, S - Be, 20°, P, S	
				as above, but pale grey, with orange laminae.		M				
		6		CORE LOSS 0.07m						
				SANDSTONE: medium to coarse grained, pale grey with orange laminae, bedding at 0–20°.	DW	M			- Be, 20°, P, S - XWS, 10mm.t - Be, 20°, P, S - XWS, 15mm.t	
		7				L			- XWS/CS, 20mm.t - XWS/CS, 70mm.t	
						M				
				END OF BOREHOLE AT 7.52m						
		8								
		9								
		10								
		11								

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Borehole No.
101 1/2

BOREHOLE LOG

Client: ST CATHERINE'S SCHOOL C/– ALEXANDER TZANNES ARCHITECTS PTY LTD
Project: FURTHER GEOTECHNICAL INVESTIGATION – SCHOOL SPORTS CENTRE
Location: 26 ALBION STREET, WAVERLEY, NSW

Job No. 13027S2
Date: 21-5-99
Method: SPIRAL AUGER INTERTECH 350
R.L. Surface: ~87.2m
Datum: AHD
Logged/Checked by: A.R./

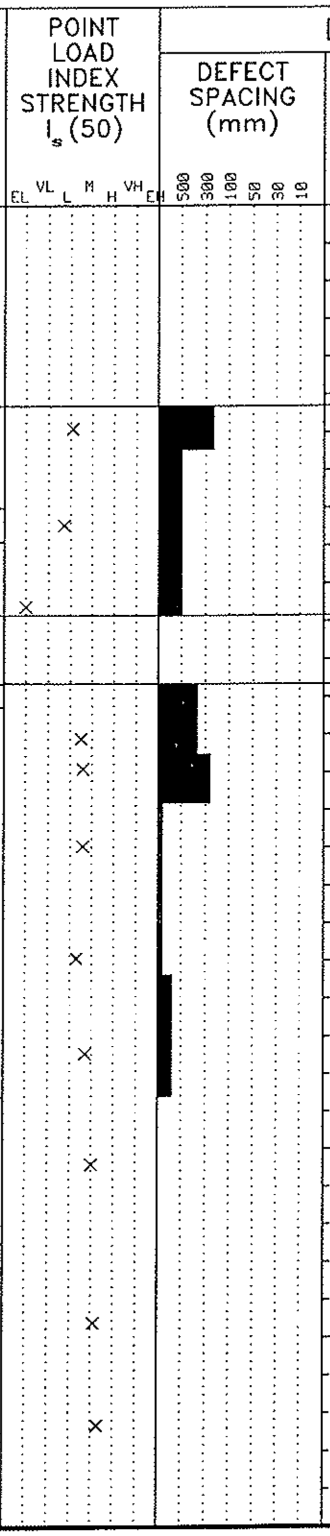
Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION OF AUGERING						0		SP	SAND: fine to medium grained, dark brown.	M			THIN GRASS COVER
				■	N = 18 4,8,10			–	SANDSTONE: fine to medium grained, pale grey with pale brown bands.	XW	EL		–
						1							
				■	N > 17 10,10, 7/80mm R				as above, but with red brown bands.				
						2							
										DW	L		LOW 'TC' BIT RESISTANCE
				■					SANDSTONE: fine to medium grained, pale grey with pale brown bands.		L–M		LOW TO MODERATE RESISTANCE
						3							
											M		MODERATE RESISTANCE
						4			REFER TO CORED BOREHOLE LOG				
						5							
						6							
						7							

CORED BOREHOLE LOG

Borehole No.
101 2/2

Client: ST CATHERINE'S SCHOOL C/– ALEXANDER TZANNES ARCHITECTS PTY LTD
Project: FUTHER GEOTECHNICAL INVESTIGATION – SCHOOL SPORTS CENTRE
Location: 26 ALBION STREET, WAVERLEY, NSW.

Job No. 13027S2
Date: 21–5–99
Drill Type: INTERTECH 350
Core Size: NMLC
Inclination: VERTICAL
Bearing: –
R.L. Surface: ~87.2m
Datum: AHD
Logged/Checked by: A.R./



Water Loss/Level	Barrel Lift	Depth (m)	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		4	START CORING AT 4.06m				
			SANDSTONE: fine to medium grained, pale grey, trace of quartz gravel, cross bedding at 15°.	DW	M	J, 85°, P, R, TIGHT AND WELL HEALED	
			as above, but with red brown bands.		L	CS, 5mm.t	
		5	SANDSTONE: fine to medium grained, pale grey with red brown and dark grey laminae, cross bedding at 18°.	XW	EL		
			CORE LOSS 0.36m				
			SANDSTONE: as above.	XW	EL		
		6		DW	M	Be, 25°, P, S CS, 5mm.t	
FULL RET–URN		7				J, 70°, P, R CS, 15mm.t	
		8			M–H		
		9			H		
			END OF BOREHOLE AT 10.0m				

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BOREHOLE LOG

Borehole No.
102 1/2

Client: ST CATHERINE'S SCHOOL C/– ALEXANDER TZANNES ARCHITECTS PTY LTD
Project: FURTHER GEOTECHNICAL INVESTIGATION – SCHOOL SPORTS CENTRE
Location: 26 ALBION STREET, WAVERLEY, NSW

Job No. 13027S2
Method: HAND AUGER
R.L. Surface: ~90.6m
Date: 21-5-99
Datum: AHD
Logged/Checked by: A.R./

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 OF AUGERING					REFER TO DCPT SHEET	0			CONCRETE PAVEMENT: 100mm.t				1 LAYER OF REINFORCEMENT, 6mm DIAMETER, 80mm FROM TOP
								–	FILL: Sand, fine to medium grained, pale brown, some coarse grained gravel.	M	–	–	APPEARS POORLY COMPACTED
						1		SP	SAND: fine to medium grained, yellow brown.	M	L VL L	–	–
						2 3			SAND: fine to medium grained,		MD D VD		
						4		–	SANDSTONE: fine to medium grained, pale grey.	XW	EL	–	–
						5 6 7			REFER TO CORED BOREHOLE LOG				

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CORED BOREHOLE LOG

Borehole No.
102 2/2

Client: ST CATHERINE'S SCHOOL C/- ALEXANDER TZANNES ARCHITECTS PTY LTD
Project: FUTHER GEOTECHNICAL INVESTIGATION - SCHOOL SPORTS CENTRE
Location: 26 ALBION STREET, WAVERLEY, NSW.

Job No. 13027S2
Date: 21-5-99
Drill Type: MELVELLE
Core Size: NMLC
Inclination: VERTICAL
Bearing: -
R.L. Surface: ~90.6m
Datum: AHD
Logged/Checked by: A.R./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$ EL VL L M H VH EH	DEFECT DETAILS: DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS: DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific General
		4 5		START CORING AT 5.06m					
FULL RET-URN		6 7		CORE LOSS 2.17m					
			⁝⁝	SANDSTONE: fine to medium grained, pale grey with red brown bands and pale brown bands, cross bedding at 22°.	XW	EL	×		
		8 9 10 11		END OF BOREHOLE AT 8.0m					

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CONSULTING GEOTECHNICAL ENGINEERS

Borehole No.
JK / 112

BOREHOLE LOG

Client:
Project: PROPOSED PERFORMING ARTS CENTRE
Location: ST CATHERINES SCHOOL, MACPHERSON STREET, WAVERLEY

Job No. 7894 J
Method: HAND AUGER / PROLINE
R.L. Surface: ≑ 80·5m.
Date: 27 - 11 - 90
Datum: SITE

undwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
DRY ON COMPLETION OF AUGERING.		SCALA BLOWS /100mm 1 0 0 1 3 1 1 4 1 2 2 2 2 3 2 3 2 3 2 4 3 4 5 6 8 8 17 15 12 9 9 9 10 11 11 12 14 13 14 END.			SM	SILTY SAND: fine to medium grained, grey, some roots.	D			THICK UNDERGROWTH. FILL ?
	DS				SP	SAND: fine to medium grained, grey and brown. A trace to some roots.				
			1			as above but brownish	M ?	L		
	DS					as above but brown becoming yellow brown.				
			2					MD.		
						as above but yellow.				
			3					D		RL 76.6
			4			as above but white mottled yellow.				
	DS.	RECOMMENCE SCALA TEST. 40/150mm REFUSAL								
			5			REFER TO CORED BOREHOLE LOG. AFTER 4.75m.				
			6							
			7							

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Borehole No.
3K / 2/2

CORED BOREHOLE LOG

Client:
Project: PROPOSED PERFORMING ARTS CENTRE
Location: ST CATHERINES SCHOOL, MACPHERSON STREET, WAVERLEY.

Job No: 7894 J
Date Drilled: 28-11-90 & 18-12-90
Drill Type: PROLINE.
Core Size: N.M.L.C.
Inclination: VERTICAL.
Bearing: —
R. L. Surface: ≑ 80·5 m
Datum: SITE.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_S(50)$ EW VW W MS S VS ES	DEFECT DETAILS: DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS: DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific General
		4		START CORING AT 4·75m.					RL 76 m
FULL RETURN		5		CORE LOSS 1·75m.					RL 75·5 RL 75 RL 74·5 RL 74,0.
		6		SANDSTONE: medium grained, orange pale grey and red brown.	HW	W			SOIL PROPERTIES ONLY.
		7		SAND & CLAYEY SAND: fine to medium and medium grained, orange and greyish white, occasional extremely weathered seam of sandstone.					WASHBORING. RECOMMENCE CORING AT 7·9m.
FULL RETURN		8		SANDY CLAY: medium plasticity, orange brown, some fine sandstone gravel.	HW	VW W			CLAY SEAM 25mm
				as above but light grey white.					
		9		SANDSTONE: fine to medium grained, orange brown some red brown ironstained bands.	HW	W			NOTE: ALL UNLABELLED DEFECTS ARE BEDDING PARTINGS. 0°-10° PLANAR, SMOOTH, OCCASIONALLY IRONSTAINED.
				CORE LOSS 0·6m.					
1/2 RETURN		10		SANDSTONE: fine to medium grained, light grey heavily ironstained, red brown					

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Borehole No.
JK/ 2/2

CORED BOREHOLE LOG

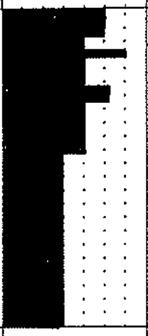
Client:
Project: PROPOSED PERFORMING ARTS CENTRE
Location: ST CATHERINES SCHOOL, MACPHERSON STREET, WAVERLEY.

Job No: 7894 J
Date Drilled: 18-12-90
Drill Type: PROLINE.

Core Size: N.M.L.C.
Inclination: VERTICAL.
Bearing: —

R. L. Surface: ≑ 80·5m
Datum: SITE.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$ EW VW W MS S VS ES	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		10		SANDSTONE: as above	HW	W				
									CLAY SEAM 10mm	
				——— as above but less ironstained		W/MS				
									CROSS BEDDING, 30°, THIN CLAY LININGS.	
		11								
									CLAY SEAM 20mm.	
				END OF BOREHOLE AT 11·7m						
		12								
		13								
		14								
		15								
		16								



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BOREHOLE LOG

Borehole No. JK4 1/1

Client:
Project: PROPOSED DEVELOPMENT, ST CATHERINE'S SCHOOL
Location: CNR. MACPHERSON AND LEICHHARDT STREETS, WAVERLEY. NSW

Job No. 12697S
Date: 26-5-97
Method: SPIRAL AUGER BCD 450
R.L. Surface: 89.7m
Datum: UNKNOWN
Logged/Checked by: J.B./

Groundwater Record	SAMPLES ES U50 DB DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	DS ■		0	▨		FILL: Silty sand, fine to medium grained, dark brown, with trace of clay and rootlets (2mm.t.) to 50mm.	M			GRASS COVER APPEARS POORLY TO MODERATELY COMPACTED
	DS ■	N = 24 4,9,15		▨	SC	CLAYEY SAND: medium grained, mottled pale orange and yellow grey.	M	MD	–	
	DS ■	N > 37 4,12,25/70	1	▨		CLAYEY SAND: medium grained, pale yellow grey, with trace of decomposed wood pieces and semi decomposed rootlets (2mm.t.)	M–W	D		
	DS ■		2		–	*SANDSTONE: fine grained, mottled pale grey, pink and pale yellow, with trace to some clay.	XW	EL		*WITH SOIL PROPERTIES
						as above, but pale grey, with trace of ironstaining.				
	DS ■	N = 44 10,17,27	3					EL–VL		
			4		–	SANDSTONE: fine to medium grained, pale grey.	(DW)	(L)	–	LOW 'TC' BIT RESISTANCE
								(L–M)		LOW TO MODERATE RESISTANCE
				▨	–	INFERRED CLAY SEAM: 400mm.t., pale yellow grey.	–	(VL)	–	VERY LOW RESISTANCE
			5		–	SANDSTONE: medium to coarse grained, pale grey.	(DW)	(L–M)	–	LOW TO MODERATE RESISTANCE
▶										
	DS ■							(M)		MODERATE RESISTANCE
			6			END OF BOREHOLE AT 6.0m				
			7							

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BOREHOLE LOG

Borehole No.
JK 5
1/2

Client:
Project: PROPOSED PERFORMING ARTS CENTRE
Location: ST. CATHERINES SCHOOL, MACPHERSON STREET, WAVERLEY.

Job No. 7894 J
Date: 28 - 11 - 90
Method: SPIRAL AUGER JACRO RIG.
R.L. Surface: ≑ 84·0m.
Datum: SITE

ndwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
		SCALA BLOWS / 100mm. 1 7 5 3 4 2 2 3 1 2 1 2 1 1 2 2 4 3 4 4 5 5 5 5 5 4 5 5 4 4 4 3 3 3 4 3 4 3 3 4 4 5 3 5 4 6 4 6 6 7 5 9 20/40mm BOUNCING.		▨		BRICK PAVERS: 75mm t over FILL: Silty Sand, fine to medium grained, grey. A trace of mortar pieces.	D.			APPEARS MODERATELY COMPACTED
			1	░	SP	SAND: fine to medium grained, greyish white.	M	VL		
				░				L		
			2	░		as above but orange brown becoming brown.		MD		
	DS			░						
			3	░				L		
			4	░		as above but brownish yellow becoming yellow.				
				░				MD		
			5	░						ESTIMATED 'V' BIT REFUSAL.
	DS		6	░		SANDSTONE, SANDY SILTY CLAY and SAND: medium grained, yellow and pale grey. Sandstone is extremely weathered and extremely weak.				LOW 'TC' BIT RESISTANCE WITH VERY LOW BANDS.
	DS		7	░		SANDSTONE and SAND: medium grained, orange brown. Sandstone is extremely weak.				VERY LOW RESISTANCE.
										LOW RESISTANCE.

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Borehole No.
JK5
2/2

BOREHOLE LOG

Client:
Project: PROPOSED PERFORMING ARTS CENTRE
Location: ST. CATHERINES SCHOOL, MACPHERSON STREET, WAVERLEY

Job No. 7894 J
Date: 28 - 11 - 90
Method: SPIRAL AUGER
JACRO RIG.
R.L. Surface: ≑ 84·0m.
Datum: SITE

undwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
				░		SANDSTONE: medium grained, orange, highly weathered and very weak.	↓76·6.			LOW TO MODERATE RESISTANCE.
▼ ON COMPLETION.	DS		8	░		— — as above but greyish white with red brown and orange iron-stained zones. Highly weathered and weak. Some extremely weathered zones.			76 75·5	MODERATE RESISTANCE ← VERY LOW 50 -100mm.
			9	░		— — as above but moderately weathered and weak to medium strong with medium strong bands.			75 74·5	MODERATE TO HIGH RESISTANCE.
			10 11 12 13			END OF BOREHOLE AT 9·6m.				

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Borehole No.
JK23
1/2

BOREHOLE LOG

Client:
Project: PROPOSED PERFORMING ARTS CENTRE
Location: ST CATHERINES SCHOOL, MACPHERSON STREET, WAVERLEY.

Job No. 7894 J
Date: 24-1-91
Method: WASH BORING
MELVILLE
R.L. Surface: ≈ 79·5m.
Datum: SITE

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
					SM	SILTY SAND: fine to medium grained, grey, some roots.	D			HAND AUGERING.
					SP	SAND: fine to medium grained, light grey to grey.				COLLAPSE WATER ADDED.
ON COMPLETION (DRILLING WATER?)			1			as above but brownish.	M			CONTINUE COLLAPSE WATER ADDED.
						as above but becoming light grey yellow brown.	W			CONTINUAL COLLAPSE INSTALL CASING TO 1·5m AND WASH BORING COMMENCED USING POLYMER "LIQUIPOL" AS DRILLING MUD.
			2							
						76.				
			3							76·0
	DS		4						75·5	LOW 'TC' BIT RESISTANCE.
					SC	CLAYEY SAND: fine to medium grained, whitish grey.				
	DS					SANDSTONE: fine to medium grained, orange red brown.			75·0	
			5						74·5	
	DS								74	MODERATE RESISTANCE.
			6							
	DS					as above but light grey brown with clay bands.				
	DS									
	DS		7							

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Borehole No.
JK 23
2/2

BOREHOLE LOG

Client:
Project: PROPOSED PERFORMING ARTS CENTRE
Location: ST CATHERINES SCHOOL, MACPHERSON STREET, WAVERLEY.

Job No. 7894 J
Date: 24 - 1 - 91
Method: WASHBORING
MELVILLE.
R.L. Surface: ≑ 79.5m.
Datum: SITE

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
	DS DS			░		SANDSTONE: fine to medium grained, light grey, orange brown with clay bands				MODERATE RESISTANCE.
						END OF BOREHOLE AT 7.5m				
			8							
			9							
			10							
			11							
			12							
			13							

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Borehole No.
JK24
1/2

BOREHOLE LOG

Client:
Project: PROPOSED PERFORMING ARTS CENTRE
Location: ST. CATHERINES SCHOOL, MACPHERSON STREET, WAVERLEY.

Job No. 7894 J
Date: 24 - 1 - 91
Method: WASH BORING
MELVILLE
R.L. Surface: ≑ 81·2m
Datum: SITE

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
					SM.	SILTY SAND: fine to medium grained, grey.	M			
					SP	SAND : fine to medium grained, grey.	M			— COLLAPSE — WATER ADDED.
						as above but light grey to grey.				—CONTINUE COLLAPSE
			1							
							W			— INSTALL CASING TO 1·5m AND WASH BORING COMMENCED USING POLYMER LIQUIPOL AS DRILLING MUD.
						as above but brownish.				
			2							
						as above but yellow brown.				
			3							
▼ ON COMPLETION (DRILLING WATER?)			4							
			5							
	DS				CL	SILTY CLAY: whitish grey yellow brown with seams of sandy clay.	(MC>PL)	(Vst)		
	DS									
	DS									
	DS		6							LOW RESISTANCE.
	DS									
	DS		7							

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Borehole No.
JK24
2/2

BOREHOLE LOG

Client:
Project: PROPOSED PERFORMING ARTS CENTRE
Location: ST CATHERINES SCHOOL, MACPHERSON STREET, WAVERLEY.

Job No. 7894 J
Date: 24 - 1 - 91
Method: WASHBORING
MELVILLE
R.L. Surface: ≑ 81·2m.
Datum: SITE

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
	DS DS DS		8		CL	SILTY CLAY: whitish grey yellow brown with seams of sandy clay. as above but with more sandy clay.	(MC>PL)	(Vst)		LOW RESISTANCE.
			9 10 11 12 13			END OF BOREHOLE AT 8·54m				

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

BOREHOLE LOG

Borehole No. JK104 1/2

Client:
Project: PROPOSED PERFORMING ARTS CENTRE
Location: ST. CATHERINES SCHOOL, WAVERLEY. N.S.W.

Job No. 7894 JH
Date: 11-11-92
Method: WASH BORE- ROLLER BIT MULTI DRILL 300
R.L. Surface: 76.3 m.
Datum: SITE

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
				▨		FILL: Sand, fine to medium grained, brown.				
						END OF WASH BORE AT 0.25m. REFER TO CORED B.H. LOG				
			1							
			2							
			3							
			4							
			5							
			6							

Borehole No.
JK104
2/2

CORED BOREHOLE LOG

Client:
Project: PROPOSED PERFORMING ARTS CENTRE
Location: ST. CATHERINES SCHOOL, WAVERLEY. N.S.W.

Job No: 7894JH
Date Drilled: 11-11-92
Drill Type: MULTI DRILL 3000
Core Size: N.M.L.C.
Inclination: 90°
Bearing: -
R. L. Surface: 76·3 m.
Datum: SITE

Water Loss/Level	Barrel Lift	Depth (m)	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_S(50)$ EW VW W MS S VS ES	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
			SANDSTONE: fine to medium grained, yellow brown.	EW HW	XW VW-W				DEFECTS NOT LABELLED ARE BEDDING PARTINGS, 0-20° PLANAR, ROUGH.
		1	CORE LOSS 0·95m.						
			SANDSTONE: yellow brown, with some red & light grey.	EW	XW XW-VW				
		2		HW	W-MS			JOINT, 35° PLANAR, ROUGH FRAGMENTED AROUND JOINT JOINT, 80° PLANAR, ROUGH	
		3	SANDY CLAY: 100mm.t.					SANDY CLAY, 100mm.	
		4	SANDSTONE: as above	HW	VW-W XW-VW			FRAGMENTATION AROUND BEDDING PARTING	
			SANDY CLAY					SANDY CLAY, 30° 100mm.	
		5	SANDSTONE: fine to medium grained, light grey	HW	W				
		6	END OF BOREHOLE AT 5·0m.