REPORT

TO
LORETO NORMANHURST

ON
GEOTECHNICAL INVESTIGATION

FOR
PROPOSED EARLY LEARNING CENTRE, BOARDING HOUSE AND MARY WARD WING

AT
LORETO NORMANHURST
91-93 PENNANT HILLS ROAD, NORMANHURST, NSW

7 January 2019
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1 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed new school buildings at Loreto Normanhurst, 91-93 Pennant Hills Road, Normanhurst, NSW. The site location is shown on the attached Figure 1. The investigation was commissioned by Ms Barbara Watkins, (Principal of Loreto Normanhurst) by signed 'Acceptance of Proposal' dated 23 August 2018. The investigation was carried out in accordance with our fee proposal, (Reference P47402L, dated 21 June 2018).

We have been provided with a brief by TTW (dated 14 June 2018) and the architectural drawings prepared by Allen, Jack & Cottier Architects (Job No. 18009 Drawing Nos. SK2000 to SK2007 and SK3201 dated 16/10/2018). This report was prepared initially as part of a State Significant Development which included the construction of two separate buildings nominated as the Boarding House Building and the Early Learning Centre Building. The Early Learning Centre Building is now to be determined as a Development Application lodged with The Hills Shire Council. Therefore any reference to the Early Learning Centre Building should not be considered as part of this subject application. A description of the development details is attached in Appendix A of this report.

The Boarding House Building will be a concrete structure with seven levels, including three basement levels excavated into the existing sloping site. The lowest basement level will have a Finished Floor Level at RL179m, and excavation to achieve the lowest Basement 2 will be to a maximum depth of about 10m in the north-eastern corner, with other localised excavations to depths of about 3m to 4m to accommodate the lower ground floor level. Column loads are expected to be in the order of 2500kN to 3000kN (unfactored).

The Early Learning Centre will be a single level structure with steel framed roof constructed at existing grade. It is possible that the structure may have a turfed concrete roof. Column loads in the order of 1750kN (unfactored) would apply where the turfed concrete roof option is adopted.

A further development at the site is also proposed and this will be in the area of the Mary Ward Building. The development in that area will comprise demolition of some small buildings and minor landscaping only. Due to the minor nature of works in that area, no specific subsurface investigations have been carried out in the area of the Mary Ward building, however we anticipate that subsurface conditions will likely be similar to those encountered within the areas of the Boarding House and Early Learning Centre buildings. No specific recommendations have been provided for the proposed landscaping works in the area of the Mary Ward Building.

The purpose of the investigation was to obtain geotechnical information on subsurface conditions as a basis for comments and recommendations on earthworks, shoring, basement slabs, footings and pavements.

2 INVESTIGATION PROCEDURE

The fieldwork for the investigation was completed between 31 August 2018 and 7 September 2018 and comprised the drilling of ten boreholes (BH1 to BH10) using our track mounted JK308 drill rig.

BH1 to BH6 inclusive were drilled within the footprint of the proposed Boarding House Building and these boreholes were taken to depths ranging from 7.9m to 14.00m below existing surface levels. BH7 to BH10 inclusive were drilled within the footprint of the Early Learning Centre Building and these boreholes were taken to depths ranging from 8.01m to 9.89m below existing surface levels.

The borehole locations are shown on the attached Figure 2 and they were set out by taped measurements from existing site features shown on the unreferenced survey plan provided to us by Mr Mark Louw of Allen Jack and Cottier. The surface reduced levels indicated on the attached borehole logs were interpolated from spot levels and contours shown on the survey plan and are therefore approximate only. We understand that the survey datum is Australian Height Datum (AHD).

All boreholes were initially auger drilled using spiral auger techniques through the soils and some of the upper more weathered and lower strength rock. The rock was then core drilled to the borehole termination depth using rotary diamond coring techniques and an NMLC triple tube core barrel with water flush.

The apparent compaction of the fill and strength of the subsurface soils were assessed from the Standard Penetration Test (SPT) ‘N’ values, augmented with the results of hand penetrometer tests on cohesive samples obtained from the SPT split tube sampler. Assessment of the rock strength in the augered portion of the boreholes was from observation of the drilling resistance when using a Tungsten Carbide (TC) bit on the augers, and inspection of the recovered rock cuttings, together with later correlation with the results of moisture content tests completed on rock chip samples. It should be noted that rock strengths assessed in this way are approximate, and variations of about one order of strength should not be unexpected.

Where the rock was core drilled, the recovered rock core was placed in steel boxes and returned to our NATA registered laboratory (Soil Test Services) where it was photographed and Point Load Strength Index (Is_{50}) testing was carried out. Using established correlations, the unconfined compressive strength (UCS) of the bedrock was estimated from the Is_{50} results. The Point Load Strength test results are summarised in the attached Soil Test Services (STS) Table C.

Groundwater observations were made in the boreholes during and on completion of auger drilling. Groundwater levels at completion of coring have not been presented as water is used during the coring process and the water level in the borehole is likely to be artificially high. PVC groundwater monitoring standpipes with gatic covers were installed in two boreholes (BH3 and BH6) to allow for longer-term groundwater monitoring. Our geotechnical engineer returned to site on 9 October 2018 to measure the groundwater levels in these two boreholes.

The fieldwork was completed in the full-time presence of our geotechnical engineer (Mr Arthur Billingham) who set out the borehole locations, nominated the sampling and testing, and prepared the borehole logs. The borehole logs are attached with this report, together with a set of explanatory notes which provide further details of the investigation techniques adopted, their limitations and the logging terms and symbols used.

Selected soil and weathered rock samples were returned to STS, for testing to determine moisture content, Atterberg limits, linear shrinkage, standard compaction and four-day soaked California Bearing Ratio (CBR). The results of these tests are summarised in the attached Tables A and B. Copies of the photographs are provided with the borehole logs, and the Point Load Strength Index test results are summarised on the borehole logs and in Table C.

Additional samples of the soil and weathered siltstone were delivered to Envirolab Services Pty Ltd for testing of soil pH, sulphate, chloride contents and soil resistivity. The results of these tests are provided in the Envirolab Services Certificate of Analysis 200408.

In conjunction with the geotechnical investigation, a contamination investigation was also carried out by Environmental Investigation Services (EIS). Reference should be made to the EIS report (Reference E31772KL, dated October 2018) for further details.

3 RESULTS OF INVESTIGATION

3.1 Site Description

This report primarily covers two separate areas within the grounds of Loreto Normanhurst, these have been designated as Site A (Boarding House) and Site D (Early Learning Centre) within the supplied masterplan drawings. Loreto Normanhurst is located within ridge and gully topography on a spur that extends southwards from the main east-west ridgeline proximately followed by Pennant Hills Road. Pennant Hills Road forms the northern boundary of the school. Surface levels across the school largely follow the undulations along the spur with a hillcrest situated roughly within the existing primary school carpark. From this point the hill slopes down towards the south at about 3°. Both sites have an eastern frontage with Mount Pleasant Avenue which undulates along the frontage with the school. Between the road and the school is a grassed verge which is occupied by a row of medium to large trees.

Site A - Boarding House

The site of the proposed Boarding House is located adjacent to the north-eastern corner of the main playing fields, which form part of the footprint of the site. Surface levels across the playing fields are relatively level and within the area of the site it appears like there has been some cut into the hillside to create the level field. A single-storey demountable building is located in the north-east corner of the playing fields. Behind the demountable is a mass concrete block retaining wall about 0.5m high with exposed siltstone bedrock at the top of the wall. Most of the exposed siltstone behind the retaining wall was covered with a shade cloth held down by pins anchored in the rock. The exposed siltstone was heavily jointed and contained seams and was assessed as highly weathered and of very low to low strength. The siltstone was bedded either sub-horizontally or dipped at 20° to 30° to the west.

Along the eastern boundary of the playing fields an access road traverses the inferred natural slope terminating at the southern boundary of No. 24 Mount Pleasant Avenue. Medium to large trees are located along the crest of the natural slope and the adjacent verge along Mount Pleasant Avenue.

Access to the playing fields from the main school area is via an asphaltic concrete driveway, abutting the adjoining brick Aquatic Centre. The Aquatic Centre which is located immediately west of the site contained a fully-enclosed 25m in-ground swimming pool and a smaller pool. Along the eastern edge of the driveway is a concrete block retaining wall ranging from 0.5m to 3m high. Behind the retaining wall and at the top of the slope are two brick residences (No. 24 Mount Pleasant Avenue). The residences were predominantly surrounded by lawns and gardens though there is a paved area at the rear of the southern of the two residences. The paved area appeared to be undulating and separation was noted in the concrete stairs and footpaths around the rear of the building. At the northern end of the driveway is an asphalt carpark.

The site is surrounded on all sides (except the frontage with Mount Pleasant Avenue) by school grounds and buildings. .

Site D – Early Learning Centre

The site of the proposed Early Learning Centre comprises a relatively level grassed oval which has a grassed ‘amphitheatre’ around the northern and western edges. The amphitheatre is vegetated and contains a number of small height timber retaining walls. Along the eastern boundary surface levels slope down towards Mount Pleasant Avenue and a mass concrete retaining wall steps down between 1m and 1.5m along the school boundary. Along the southern edge of the oval is a brick retaining wall ranging from 1m to about 1.9m high which supports a concrete footpath and three sports courts.

The northern portion of the site comprises a rectangular lot that slopes down to the east at approximately 5° to 10°. A single-storey brick house (No. 6 Mount Pleasant Avenue) was located centrally towards the eastern end of this property. The building appeared to be in good condition upon cursory external observation. The remainder of the property contained primarily lawns with some garden beds and small trees. An approximately 1m high brick retaining wall extends along most of the eastern boundary of this property.

North of the site is a single-storey brick house (No. 4 Mount Pleasant Avenue) which is set back approximately 5m from the boundary.

3.2 Subsurface Conditions

The 1:100,000 Geological Series Sheet 9130 ‘Sydney’ indicates that the site is underlain by Ashfield Shale comprising *“black to dark grey shale and laminite”*. Previous investigations completed by JK Geotechnics at the site in 1991 and 1993 encountered a profile of fill underlain by residual silty clay transitioning to weathered siltstone bedrock from depths ranging from about 1m to 3.5m. The current investigation encountered a similar profile.

A summary of the strata encountered for each new building is provided below, however for a detailed description at each location reference should be made to the attached borehole logs.

Boarding House (BH1 to BH6)

Fill

Fill was encountered in each borehole with the exception of BH4 and BH5. The fill was generally quite shallow (0.2m to 0.35m), however in BH2 the fill extended to 1.2m depth. The fill was quite variable and comprised either silty clay, silty sandy clay, silty gravelly sand, or gravelly sand. In BH2 the fill appeared moderately compacted. In BH5 there was a 0.2m thick layer of silty clay topsoil.

Residual Silty Clay

Residual silty clay was encountered below the fill or at the surface in all boreholes except BH1. The silty clay was assessed as high plasticity and of very stiff to hard strength with inclusions of ironstone gravel. No residual soils were encountered in BH1 as the fill directly overlies the weathered siltstone.

Weathered Siltstone Bedrock

Weathered siltstone bedrock was encountered at depths ranging from 0.2m (BH1) to 1.9m (BH2) below existing surface levels. The bedrock was initially extremely weathered and there was a general trend of increasing rock strength and rock quality with depth. The exception being BH1, where poor quality siltstone continued to a depth of 5.7m, and in BH3 where the rock quality was poorer toward the base of the borehole. Some of the upper very low and low strength siltstone contained a significant proportion of defects, including numerous joints, clay seams and extremely weathered seams.

Sandstone Bedrock

In the two southern most boreholes (BH1 and BH4), sandstone bedrock was encountered at depths of 5.70m (RL175.5m) and 9.29m (RL176.7m) respectively. The sandstone was assessed as slightly weathered to fresh and medium and high strength. The sandstone is likely to be part of the Hawkesbury Sandstone geological unit which underlies the Ashfield Shale.

Groundwater

No groundwater seepage was encountered during auger drilling of the boreholes and prior to commencement of coring. Groundwater monitoring standpipes were installed in BH3 and BH6 to allow future monitoring of the groundwater levels. The groundwater levels were measured during a return visit to site on 9 October 2018, at 7.2m (RL182.4m) and 6.6m (RL184.40m) in BH3 and BH6 respectively. No longer term groundwater monitoring has been carried out.

Early Learning Centre (BH7 to BH9)

Fill

Silty clay fill was encountered in each borehole and was typically less than 0.3m thick. However in BH9 the fill was 2.4m deep. BH9 was drilled at the eastern end of the oval neighbouring No. 6 Mount Pleasant Avenue which appears to have been filled to create a relatively level playing surface, whereas the western end appears to have been cut into the hillside. The fill in BH9 was assessed to be moderately compacted.

Residual Silty Clays

Residual silty clay was encountered below the fill. The silty clay was assessed as medium or high plasticity and of very stiff to hard strength with inclusions of ironstone gravel.

Weathered Siltstone Bedrock

The upper weathered siltstone in each borehole was only extremely weathered, although in BH8 this was only a very thin layer of 0.1m thickness. Below the upper extremely weathered siltstone, the bedrock was typically of low strength increasing to medium strength with depth. The upper low strength siltstone bedrock contained numerous defects including joints, clay seams and extremely weathered seams.

Groundwater

All boreholes in the Early Learning Centre site were dry on completion of augering. No longer-term groundwater monitoring has been carried out.

Mary Ward Wing

Based on a review of boreholes from our previous investigations within the Loreto School (which are attached as Appendix B and Figure B1), and the current investigation, it appears likely that subsurface conditions within the vicinity of the Mary Ward Wing will be similar to those encountered at these locations. Therefore the subsurface profile will likely comprise fill and residual clays overlying weathered siltstone bedrock at moderate depths. We do not anticipate that groundwater would be encountered within the upper 1.5m.

3.3 Laboratory Test Results

The moisture content test results correlated well with our field assessment of rock strength within the augered portion of the boreholes. The Atterberg Limit and linear shrinkage test results indicate that the soils are moderately to highly reactive and therefore have a moderate to high potential for shrink/swell movement with changes in moisture content.

Disturbed soil samples were sent to Envirolab for soil pH, soil sulphate, soil chloride content and resistivity testing. The following table summarises the results, but for specific details reference should be made to the attached Envirolab Certificate of Analysis 200408.

Sample Location	Depth (m)	Soil Description	Soil pH	Chloride (mg/kg)	Sulphate (mg/kg)	Resistivity (ohm cm)
BH2	1.5-1.95	Silty Clay	5.4	<10	10	52,000
BH4	0.5-0.9	Silty Clay	4.7	20	60	18,000
BH6	0.6-0.95	XW Siltstone	4.9	<10	27	44,000
BH8	0.5-0.7	Silty Clay	5.4	87	71	14,000
BH9	1.5-1.95	Silty Clay Fill	5.2	21	69	22,000
BH10	1.7-1.95	XW Siltstone	4.9	<10	25	46,000

Based on the above table of results, we consider that the soils and weathered siltstone would have an exposure classification of ‘Mild’ for concrete structural elements and ‘Non Aggressive’ for steel in accordance with Table 6.4.2(C) and Table 6.5.2(C) of AS2159-2009 ‘Piling-Design and Installation’.

The standard compaction and four-day soaked CBR values for samples of residual silty clay from BH4 and silty clay fill from BH9 returned values of 2.5% and 4.5% respectively when surcharged with a 9kg surcharge load.

3.4 Bedrock Classification

Based on the Pells et al 1998 system, bedrock classifications have been applied to the weathered siltstone and sandstone encountered in the boreholes. We note that the bedrock classification can vary depending on the size of footing and its zone of influence. Therefore these classifications should be treated as a guide only. When footing types, sizes and founding depths are determined these classifications should be reviewed to confirm that they are suitable for the specific footing details. Some engineering judgement has been applied to the augered portions of the boreholes and those portions are approximate only. The attached geotechnical sections (Figures 3, 4, 5 and 6) show indicatively the rock classifications. Linear interpolation has been adopted between the known borehole locations.

Bedrock Classification – Early Learning Centre Building

Borehole No. Surface RL (mAHD	Depth (m) and RL (mAHD) to Top of Assessed Rock Class			
	Class 5	Class 4	Class 3	Class 2 or better
BH7 (RL187.1m)	2.0m (RL185.1m)	3.9m (RL183.2m)	5.5m RL181.6m)	Not Encountered
BH8 (RL 186.7m)	2.0m (RL184.7m)	3.1m (RL183.3m)	5.6m (RL181.1m)	Not Encountered
BH9 (RL185.5m)	Not Encountered	4.9m (RL180.9m)	7.0m (RL178.8m)	Not Encountered
BH10 (RL184.2m)	1.7m (RL182.5m)	3.4m (RL180.8m)	5.4m (RL178.8m)	Not Encountered

Bedrock Classification – Boarding House Building

Borehole No. Surface RL (mAHD)	Depth (m) and RL (mAHD) to Top of Assessed Rock Class			
	Class 5	Class 4	Class 3	Class 2 or better
BH1 (RL181.2m)	0.2m (RL181.0m)	Not Encountered	Not Encountered	5.7m (RL175.5m)
BH2 (RL183.8m)	1.9m (RL181.9m)	6.8m (RL177.0m)	Not Encountered	8.5m (RL175.3m)
BH3 (RL189.6m)	0.9m (RL188.7m)	11.0m (RL178.6m)	7.5m (RL182.1m)	Not Encountered
BH4 RL186.0m)	0.9m (RL185.1m)	Not Encountered	Not Encountered	9.3m (RL176.7m)
BH5 (RL188.4m)	0.6m (RL187.8m)	Not Encountered	1.6m (RL186.8m)	8.0m (RL180.4m)
BH6 (RL 191.0m)	0.6m (RL190.4m)	3.7m (RL187.3m)	Not Encountered	7.9m (RL183.1m)

NOTE 1 Class 3 rock classification for the upper portion of BH5 is based on the augered portion of the borehole and therefore should be treated as approximate only.

4 COMMENTS AND RECOMMENDATIONS

4.1 Geotechnical Issues

We consider that the main geotechnical issues for this project are as follows. More specific comments and recommendations are provided for each of these issues in the relevant sections of this report below.

- Construction of the Boarding House Building will require significant excavations, up to a maximum of about 10m deep. The majority of the excavations will be through Class 5 and Class 4 siltstone which is quite fractured and jointed. However the lower portion of the main excavation will likely encounter high strength siltstone which will produce ‘hard rock’ excavation conditions.

- The Boarding House Basement 2 excavation will extend relatively close to the adjoining Aquatic Centre and therefore any shoring system will need to be designed to reduce movements and damage to that adjoining structure. An assessment of its footing system prior to bulk excavation and shoring works is recommended.

- Groundwater was encountered at about 5m above the Boarding House Basement 2 level. Therefore groundwater seepage will need to be managed and controlled in both the short term (during excavation) and in the long term. Further groundwater monitoring is recommended to assess groundwater levels with time.

- BH9 in the Early Learning Centre site encountered 2.4m of fill which without any confirmation of compaction, would need to be assessed as uncontrolled. This will have an impact on the design of ground floor slabs if ground floor slabs are not designed as suspended.

- The alignment of the NorthConnex tunnels appears to traverse under Loreto Normanhurst School, and the impact of the proposed development on the tunnels will need to be assessed once further information is made available on the location and depth of the tunnels with respect to the proposed development works.

4.2 Excavation

The following recommendations should be read in conjunction with the ‘Excavation Work – Code of practise’ by Safe Work Australia (July 2015).

Boarding House

Excavation for the proposed boarding house will extend to maximum depths up to about 10m below the existing surface levels in the north-eastern corner of Basement 2 and these depths will grade down to approximately 2m of excavation in the south-western corner. As the footprint of the building is staggered over the hillside, excavations for floor levels above the lower three basements will be required generally to depths ranging from about 1m to 4m below existing surface levels.

Excavation will occur through fill, residual clays and weathered siltstone bedrock. Excavation through the fill, residual soils and extremely weathered siltstone should be readily excavated using conventional earthmoving equipment such as buckets on tracked excavators. Ironstone bands and siltstone bands of low or greater strength within the extremely weathered siltstone may require ripping with tynes on tracked excavators.

Excavation through siltstone of low or higher strength will require the use of rock excavation techniques such as dozers with ripping tynes, hydraulic impact hammers, rock saws or rock grinders. Where hydraulic impact hammers are adopted there is the risk that transmitted vibrations may damage nearby movement sensitive structures (such as the Aquatic Centre) or services. Where siltstone of high strength is encountered then these conditions will present ‘hard’ rock excavation conditions. Such material may be effectively ‘unrippable’ and hydraulic impact hammers in association with rock sawing may be required.

During at least the initial stages of excavation using hydraulic impact hammers, quantitative vibration monitoring must be completed by the geotechnical engineers. Quantitative vibration monitoring should be carried out at the commencement of the use of hydraulic impact hammers, and then depending on the results, at the discretion and frequency as recommended by the geotechnical engineers. Vibration monitoring should be set up on structures in close proximity to the area of excavation (i.e. the Aquatic Centre). Vibration monitoring should measure Peak Particle Velocities (PPV) and vibration frequency. If during excavation with the hydraulic impact hammers, vibrations are found to be excessive or there is concern, then alternative lower vibration emitting equipment, such as rock saws, rock grinders or smaller hammers may need to be used. The use of a rotary grinder or rock sawing in conjunction with ripping or hydraulic hammers presents an alternative lower vibration excavation technique, however, productivity is likely to be slower. When using a rock saw or rotary grinder, the resulting dust must be suppressed by spraying with water.

The attached vibration emission guidelines provide some advice on acceptable vibrations in this regard.

We recommend that only excavation contractors with appropriate insurances and experience on similar projects be used. Excavation contractors should be provided with a copy of this geotechnical report, including the borehole logs and point load strength test results, so that they can make their own assessment of suitable excavation equipment.

Based on the current groundwater monitoring, we expect groundwater levels will be above the lowest Basement 2 level. Groundwater seepage will likely occur through joints and defects within the rock and are likely to be more prevalent during or immediately following periods of wet weather. Considering the relatively low permeability of the underlying siltstone bedrock, we expect that any groundwater seepage will be able to be controlled by conventional sump and pump techniques. Additional groundwater monitoring is recommended prior to any detailed design to assess groundwater levels further. At that time it would also be prudent to undertake some pump out tests to make an assessment of the rock permeability.

Early Learning Centre

We have assumed that the Early Learning Centre will be constructed close to existing surface levels and therefore excavation will be minimal across most of the footprint. Excavation up to 3m deep may be required at the western end of the proposed building where the existing surface levels rise up through the embankment. If excavation is required in this area it will predominantly extend through fill, residual clay and extremely weathered siltstone. Excavation through the fill, residual soils and extremely weathered siltstone should be readily excavated using conventional earthmoving equipment such as buckets on tracked excavators.

Groundwater is unlikely to be encountered during excavation for the Early Learning Centre except where excavation extends below the soil/rock interface into the extremely weathered siltstone, where seepage may occur along the soil/rock interface during and immediately following rainfall periods. We expect this seepage would be manageable using gravity drainage techniques.

4.2.1 Temporary Batters

Temporary excavation batters may be feasible in some areas of the site where they can fit within the site boundaries or other site constraints. We provide the following general recommendations for temporary batters at this site.

- Temporary batters through the upper soils and extremely weathered and very low strength siltstone may be battered at not steeper than 1 Vertical (H) in 1.5 Horizontal (H).
- Temporary batters through the underlying low and medium strength siltstone should be battered at not steeper than 1V in 1H. This batter slope is due to the numerous joints and defects within the siltstone.

- Steeper batters may be suitable through any high strength siltstone if it is encountered toward the base of any of the excavations. The geotechnical engineers would be able to provide specific advice as and when it is exposed, as the batter slope will be governed primarily by the nature of any defects within the rock.
- We recommend that a horizontal berm of at least 1.5m width be formed for every 3m vertical height of batter.
- Surcharge loads should be kept well clear of the crest of batter slopes (at least 2H from the crest, where H is the vertical height of the batter in metres).
- Stormwater runoff should not be allowed to flow over the crest of temporary batters and should be directed and discharged in a manner which avoids concentrated flows and erosion within the batter slopes.
- Geotechnical inspections should be undertaken at not greater than 1.5m depth intervals to check for any adverse defects within the temporary batter slopes. If adverse defects are encountered, then temporary batters may need to be flattened or some stabilisation, such as rock bolts and shotcrete may be required.

Where temporary batters are formed, consideration needs to be given to the type of backfill to be used against the permanent basement walls. Uncompacted backfill placed up against basement walls will result in large settlements which can have adverse effects on structures, paving or landscaping supported above. The backfill placed against the permanent basement retaining walls should preferably comprise a uniform sized durable granular material which is surrounded in a geotextile fabric. A capping layer of at least 0.5m thickness of clayey site won material should be placed above the geofabric, to reduce water infiltration. A subsoil ‘agg’ drain surrounded by a geofabric filter sock should also be placed at the base and rear of the basement wall to collect seepage and discharge it to the stormwater system. This type of backfill has the advantage that only nominal compaction is required (such as by the use of a plate attached to the excavator). The alternative (although less preferred) is to use the site won material as backfill, however it will require careful control of moisture content, placement and compaction of material in thin layers, and density testing of each layer to ensure it is placed in a controlled manner as an engineered fill material. Placement and compaction of site won material at the rear of basement walls is difficult and time consuming due to the space limitations. Care should also be taken when compacting fill behind retaining walls, to ensure that compaction stresses do not exceed the design earth pressures. Advice during construction is recommended when the type of equipment proposed is known.

There are also cost implications of excavating and disposing of the additional soil and weathered siltstone from the batters, and importing large amounts of drainage material to backfill the permanent basement walls. The space required to form the temporary batters may also be problematic due to limited storage and construction space. Therefore it may be preferable to install a shoring system to avoid the excavation of the material in the batters and replacement with high quality material.

4.2.2 Permanent Batters

If permanent batters are proposed, then specific advice will be required from the geotechnical engineers following inspection of the temporary batters, however as a guide we consider that the following may be adopted for initial planning purposes.

- Permanent batters through the soils and extremely weathered and very low strength siltstone should be battered at not steeper than 1V in 2.5H.
- Permanent batters through the underlying low and medium strength siltstone should be battered at not steeper than 1V in 1.5H.
- Permanent batters will need to be protected by approved erosion protection, such as shotcrete facing. If flatter batters (say 1V in 3H) within the upper soils are adopted then erosion control may include revegetation.

4.3 Shoring Systems

Where temporary batter slopes are not preferred or cannot fit within the boundary constraints, we recommend that properly designed insitu shoring systems be constructed and installed prior to commencement of excavation.

Given the subsurface conditions encountered, we consider that anchored soldier pile walls with shotcrete infill panels are suitable for this site, although immediately adjacent to the Aquatic Centre we recommend an anchored contiguous piled wall be adopted to provide a stiffer shoring system. During the detailed design stage of the works and prior to commencement of shoring wall construction and excavation, we recommend that a few test pits be excavated next to the adjoining Aquatic Centre to assess its footing type and depth. These details will need to be taken into account in the design.

Bored piles will be suitable for the piles, however some seepage will likely occur into bored piles if they are left open for any extended periods of time and this will require pumping of water and thorough cleaning of the base (including removal of any softened material) prior to pouring or more likely the need to pour using tremie techniques.

Piles for the shoring system should be socketed at least 1.0m below the bulk excavation level, including allowances for nearby lift pits, footing and services excavations. Greater embedment may be required for lateral stability of the shoring system. Deeper shoring systems may need to penetrate high strength siltstone bedrock which will require the use of large capacity piling rigs. Even with large capacity piling rigs, productivity may be very slow. We recommend that further advice from piling contractors be obtained on the suitability of their equipment to cost effectively penetrate through the required strength of rock.

Temporary lateral support of the shoring system will need to be provided by anchors or internal propping. During excavation, reinforced shotcrete panels should be sprayed progressively with the excavation to support the soil and weathered rock between the piles, such that there is no more than 1.5m of vertical face of material exposed at any one time. It will be necessary to install strip drains with a non-woven geotextile filter fabric behind each panel of shotcrete to dissipate the pore pressures behind the shotcrete. We recommend strip drain be placed at minimum 1.5m centres. Where contiguous piled walls are adopted, we recommend that weep holes be placed through the walls at horizontal and vertical spacing's of not greater than 1.5m. The weep holes should include 30mm diameter PVC pipes with a non-woven geotextile filter fabric on the end. We have assumed that the permanent support of the shoring system will be provided by bracing or propping from the floor slabs in the long term.

Where temporary batter slopes are adopted, conventional concrete block retaining walls can be constructed.

An alternative shoring option may be the use of soil nailed walls. While further specific design and construction staging would need to be provided once details are known, soil nail walls are likely to include soil nails drilled at 1.5m horizontal and vertical spacings, with the soil nails installed to a similar length to the height of the excavation. However a specific soil nail design would be required.

4.3.1 Insitu Shoring Systems – Design Parameters

The following characteristic parameters may be adopted for shoring wall design. Where soldier pile walls are constructed, inspection of the rock face between soldier piles should be completed by a geotechnical engineer at not greater than 1.5m depth intervals to check for significant adverse defects.

- Where minor movements of the shoring wall are tolerable, we recommend a trapezoidal lateral earth pressure distribution of 6H (where H is the depth of excavation in metres). The 6H should apply over the central 75% of the distribution with the earth pressure tapering to zero at the crest and bulk excavation level
- Where adjoining structures or movement sensitive services are within a horizontal distance of 2H from the shoring wall we recommend that the magnitude of the trapezoidal lateral earth pressure be increased to 8H to reduce the risk of adverse deflections.
- Within siltstones there is always a risk that large continuous defects will be encountered. Therefore although geotechnical inspections at 1.5m depth intervals are recommended, in addition, we also recommend that the structural shoring design be checked for the presence of a 45° sliding wedge of rock with a friction angle of 25° and with soil surcharge above. If such defects are encountered during geotechnical inspections, then additional and or higher capacity anchors may need to be installed.
- Measures should be taken to provide permanent and effective drainage of the ground immediately behind the shoring walls. As discussed above, strip drain protected by non-woven geotextile filter fabric should be used behind the shotcrete panels of soldier pile walls. PVC weep holes should be adopted through contiguous piled walls. The drainage should be connected into the basement drainage. Although the shoring walls will be provided with rear drainage in the form of strip drains or weep holes, this drainage will essentially only be effective in reducing water pressures from immediately behind the shotcrete facing. Hydrostatic pressures can build up behind wedges of rock some distance back from the wall. Therefore we recommend that hydrostatic pressures based on the groundwater level should still be assumed to apply to the shoring wall design. These hydrostatic pressures are additional to the earth pressure recommendations above. Out of balance hydrostatic pressures will occur during construction and these need to be considered as part of the shoring wall design.
- All surcharge loads affecting the walls (e.g. nearby footings, construction loads and traffic etc) are additional to the earth pressure recommendations above and should be included in the design.
- Anchors should be bonded a minimum of 3m into siltstone of at least low strength or siltstone of at least medium strength for which we consider that a maximum allowable bond stress of 150kPa or 250kPa may be adopted respectively. The anchor bond length should commence beyond a line drawn up at 45° from the bulk excavation level.

- All anchors should be proof loaded to 1.3 times their design working load and then locked off at about 85% of the working load under the direction of an experienced engineer or construction superintendent, independent of the anchor contractor. Lift off tests should be completed on all anchors about 4 days after lock off to confirm that anchors are holding their load.
- Piles embedded below bulk excavation level into weathered siltstone of very low strength or low strength may be designed for a uniform passive resistance of 150kPa and 250kPa respectively. The upper 0.5m of the rock socket should be ignored in the passive resistance calculations to account for some disturbance and jointing within the upper siltstone from the excavation processes.
- Shoring wall designs should include an assessment of wall movements during all stages of the excavation and anchoring construction stages. The wall designer should review the wall movements and assess whether such movements will adversely affect any nearby adjoining structures and services. If movements are assessed to be adverse to adjoining structures then consideration will need to be given to underpinning.

4.3.2 In situ Shoring Wall Parameters for Detailed Computer Based Design

Where detailed computer based shoring wall designs are to be undertaken, we provide the following table of parameters. Such designs should be undertaken by engineers familiar with the geology and the implication of jointing and defects within the underlying bedrock. The following table provides our parameters for the rock mass (i.e. it takes into account some strata bound jointing only). All designs must also be checked for the possibility of large continuous defects within the siltstone. Designs must check all stages of excavation, and anchoring to confirm that the shoring wall has adequate factors of safety during all stages of its construction.

Material Type	Unit Weight (kN/m^3)	Effective Friction Angle (°)	Effective Cohesion (kPa)	Elastic Modulus (MPa)
Fill	19	26	2	5
Residual Very Stiff or Hard Silty Clays	20	30	2	20
XW Siltstone (Class 5)	21	30	5	50
Class 4 Siltstone	23	30	15	300
Class 3 Siltstone	24	35	50	500

Material Type	Unit Weight (kN/m^3)	Effective Friction Angle (°)	Effective Cohesion (kPa)	Elastic Modulus (MPa)
Class 2 Siltstone	24	35	100	1000
Class 2 Sandstone	24	35	200	1200

As discussed above, the shoring designs should also be checked for the potential of 45° sliding wedge of rock with a friction angle of 25°, daylighting from the excavated rock face just above each stage of excavation and above the final bulk excavation level.

4.3.3 Permanent Basement Walls and Landscaping Walls

Where temporary batter slopes are adopted and permanent basement walls constructed within the excavation, we recommend that the following characteristic parameters may be adopted for shoring wall design. The following parameters are on the basis of either a properly placed and compacted engineered backfill or backfill comprising a uniform sized durable granular material which is surrounded in a geotextile fabric as discussed in Section 5.2.1 above.

- For cantilever walls where some movement can be tolerated we recommend a triangular lateral earth pressure distribution using an ‘active’ earth pressure coefficient (Ka) of 0.35.
- For cantilever walls which will be propped by floor slabs or where movements are to be reduced, we recommend a triangular lateral earth pressure distribution using an ‘at rest’ earth pressure coefficient (Ko) of 0.6.
- A bulk unit weight of $20kN/m^3$ may be used for the backfill.
- All surcharge loads affecting the walls (e.g. nearby footings, construction loads and traffic etc) are additional to the earth pressure recommendations above and should be included in the design.
- Measures must be taken to provide permanent and effective drainage of the ground immediately behind the basement walls. We recommend the use of a free draining durable aggregate (such as 20mm size blue metal) with ‘agg’ pipe surrounded by a geotextile at the base and connected to the stormwater drainage system.

4.4 Earthworks

For the Boarding House Building we expect that following bulk excavation weathered siltstone will be exposed at subgrade level. Therefore we do not expect any significant subgrade preparation will be required. For the Early Learning Centre Building, some earthworks may be required if the building is to be constructed as a slab on grade. The following provides our earthworks recommendations.

4.4.1 Subgrade Preparation – Early Learning Centre

At this stage we do not know the proposed ground floor level for the proposed Early Learning Centre. Therefore the following recommendations should be reviewed and amplified prior to construction and once floor levels have been provided to us.

For all building areas subgrade preparation should initially comprise the stripping of all topsoil, root affected soils and uncontrolled fill. The topsoils and root affected soils are unsuitable for re-use as engineered fill but may be used for landscaping purposes. If topsoil/root affected soils are not to be re-used these should be stockpiled separately for disposal.

The uncontrolled fill was assessed as moderately compacted however it is likely that there are no records indicating that the fill has been placed as engineered fill and consequentially it would be considered uncontrolled fill and should also be stripped. The fill may be able to be re-used as an engineered fill provided it does not contain any obvious deleterious materials or particles greater than a nominal 70mm diameter.

Following stripping, the exposed subgrade should be proof rolled with 8 passes of a minimum 10 tonne smooth drum roller to detect any soft or heaving areas. The proof rolling should be carried out in the presence of a geotechnical engineer or experienced earthworks technician. The boreholes have generally indicated that the residual silty clays are of very stiff or hard strength, although the moisture content of the residual soils is often close to or greater than the plastic limit and therefore some areas of heaving subgrade may occur during proof rolling. Where heaving subgrade occurs it should be locally removed to a competent base and replaced with engineered fill. If there is a significant thickness of heaving subgrade then further advice should be obtained from the geotechnical engineers, however it is likely that a bridging layer and geogrid reinforcement may be required. The subgrade should be well graded to promote runoff and reduce the risk of water ponding on the surface. If the subgrade becomes wet it may become untrafficable.

Preferably engineered fill should comprise a good quality granular material, such as crushed siltstone or sandstone. All engineered fill should be compacted in horizontal layers with a maximum 200mm loose thickness to at least 98% of Standard Maximum Dry Density (SMDD).

While not preferred, the existing residual clays and the excavated and approved existing site won fill materials may also be used as engineered fill, provided they are compacted to between 98% and 102% of Standard Maximum Dry Density (SMDD) and to within ±2% of Standard Optimum Moisture Content (SOMC). If the clayey soils are to be adopted for use as an engineered fill the following needs to be carefully considered.

(i) Some of the clays have moisture contents greater than the plastic limit and therefore they may require drying out prior to their use as engineered fill, and

(ii) Where reactive silty clays are used as an engineered fill, they will undergo greater shrink swell movements with changes in moisture content than the insitu reactive clays. Therefore consideration needs to be given to the affect that greater shrink-swell movements will have on the performance of structures founded above.

Density testing should be regularly carried out on any engineered fill. Regular density testing in accordance with Level 1 requirements of AS3798-2007 ‘Guidelines on Earthworks for Commercial and Residential Developments’ are recommended. Any of the existing weathered rock excavated from the site would be suitable for use as an engineered fill. However the weathered siltstones will likely degrade during fill placement and compaction and may well become closer to a silty clay when placed and compacted. Therefore these materials would also then have a relatively low soaked CBR value for pavement design purposes.

Soil may need to be removed from site during earthworks operations or pile drilling. A contamination assessment has been carried out by Environmental Investigation Services (EIS). Reference should be made to their report (Reference E29845KP dated February 2017) for further advice.

4.5 <u>Footing Design</u>

Based on the rock classifications provided in Section 3.4 above, the following table presents our recommendations on maximum allowable end bearing pressures, ultimate end bearing pressures, maximum allowable skin friction values and ultimate skin friction values for the various classes of rock. The skin friction values are for compressive loads. For tension loads the skin friction values should be halved.

Summary Table of Maximum Allowable and Ultimate End Bearing Pressures and Skin Friction Values

Rock Class	Maximum Allowable End Bearing Pressure (kPa)	Ultimate End Bearing Pressure (kPa)	Maximum Allowable Skin Friction (kPa)	Ultimate Skin Friction (kPa)
Class V Siltstone	700	1,500	40	70
Class IV Siltstone	1,000	3,000	75	150
Class III Siltstone	2,000	10,000	150	350
Class II Siltstone	4,000	30,000	350	700
Class II Sandstone	6,000	60,000	600	1,500

4.5.1 Boarding House Building

Following bulk excavation for the Boarding House Building, variable subgrade conditions will be exposed. We expect that weathered siltstone will be exposed across the base of all basement excavations and considering the column loads we recommend that all footings be uniformly founded on the underlying weathered siltstone bedrock. The borehole results indicate that the exposed bedrock at bulk excavation levels could range from Class 5 through to Class 2, as such a combination of pad footings and piled footings may be required in order to support the required column loads.

Pad Footing Recommendations

Where bulk excavations expose weathered siltstone, shallow pad/strip footings founded on weathered siltstone would be feasible. Pad/strip footings may be designed on the basis of the recommended end bearing pressures outlined in Section 4.5 above provided they are founded on and with a minimum embedment of at least 0.3m into the appropriate class of rock.

Water should be prevented from ponding in the base of footing excavations as this will lead to softening of the base. Any water softened founding material as well as any ‘fall in’ must be removed from the base of footings prior to pouring concrete.

Footing excavations should be inspected and tested by the geotechnical engineer to confirm that a suitable founding stratum is being achieved. The inspection and testing requirements for the various classes of rock founding material are outlined below.

- Where Class 4 and Class 5 founding materials are adopted, footing inspections should include a visual appraisal of all footings by the geotechnical engineers.
- Where Class 3 siltstone is to be adopted as a founding material, then pad footing inspections should include a visual appraisal of all footings and spoon testing of at least one third of all footings.
- Where Class 2 siltstone is to be adopted then pad footing inspections should include a visual appraisal of all footings and spoon testing of at least one half of all footings.

Pile Footing Recommendations

We recommend that all piles be founded on and with a minimum embedment of 0.3m into the appropriate quality of rock. In addition to the maximum allowable and ultimate end bearing pressures, piles can also be designed for skin friction.

Where ultimate end bearing and skin friction values are adopted, then the ultimate values recommended in the table above must be reduced by an appropriate geotechnical reduction factor. The geotechnical reduction factor should be based on the risk assessment procedure set out in Table 4.3.2 (A) of AS2159-2009, but should not be greater than 0.5, unless the risk factors producing a higher geotechnical reduction factor can be fully justified. Consideration should also be given to the pile testing requirements when determining a suitable geotechnical strength reduction factor.

In order to achieve the recommended skin friction values nominated in the table above, it is essential that the rock sockets be cleaned of any clay smear and suitably roughened using a side wall grooving tool, and that they be at least as rough as Roughness Class R2. We note that an R2 roughness is equivalent to grooves 1mm to 4mm deep and grooves 2mm wide, which are spaced at 50mm to 200mm down the socket length. It will be the responsibility of the piling contractor to ensure that he has the appropriate equipment and methodology to satisfy this roughness criteria.

Where allowable bearing pressures and skin friction values are adopted, settlement of piles will typically be less than 1% of the pile diameter at the toe of the pile. However where ultimate end bearing and skin friction values are adopted, settlements will be greater and therefore once column loads are known, some detailed settlement analysis of piles is recommended to check that predicted settlements are within acceptable limits.

We recommend that the geotechnical engineers inspect piles during drilling to confirm the above recommended bearing pressures and skin frictions are being achieved. Where the lower quality rock (equivalent to Class 4 or 5 siltstone) is adopted as the founding material, we consider that only a selection of piles will need to be inspected by the geotechnical engineers. However if higher quality rock (equivalent to Class 2 or 3) is adopted for a founding material then all piles should be inspected by the geotechnical engineers. Inspection of piles will require the geotechnical engineer to be on site during the drilling process so that they can inspect both the material being drilled and check it’s consistency with nearby borehole logs. It is important to note that the geotechnical engineers can only ‘sign off’ on piles which they have inspected. We note that Class 2 siltstone was not proven in BH3, although it may just have been encountered at the end of the borehole. Therefore if Class 2 rock is adopted as the founding stratum for piled footings, we recommend some additional boreholes be drilled to define this layer more definitively across the site.

Prior to pouring concrete, piles will need to be dewatered, cleaned of all loose debris from the base, inspected and approved by the geotechnical engineers. Piles will need to be poured as soon as possible after drilling, but at least on the day of drilling. If piles are left open overnight they must be redrilled prior to pouring concrete to remove any softened or other debris from the base of the pile.

4.5.2 Early Learning Centre

We understand that the options for support of the single storey Early Learning Centre Building are to support the ground floor slab at existing grade or to provide a fully suspended slab.

Shallow Footing Systems at Grade

Where the Early Learning Centre is supported on the existing grade, the subgrade must be properly prepared in accordance with the requirements and recommendations outlined in Section 4.4.1. The nature of the structure is such that it is unlikely to be within the scope set out in AS2870-2011 ‘Residential Slabs and Footings’ and therefore the footing system will need to be designed on the basis of engineering principles. Nevertheless we expect that due to the underlying reactive soils, footings can be designed for shrink-swell movements typical of a Class H1 site. However as discussed above, if clayey engineered fill is used, the subgrade soils will exhibit a higher potential for shrink-swell movements and therefore specific assessment of the likely shrink-swell movements by the geotechnical engineers is recommended.

Where shallow footings are founded on the residual silty clays of at least very stiff strength, or engineered fill placed and compacted under Level 1 earthworks control, we consider that a maximum allowable bearing pressure of 150kPa would be applicable. The settlement of shallow pad/strip footings will be dependent on the size of the footing, the strength of the founding material and the depth to any underlying rigid material (such as rock). As a guide, settlements in the order of 1% of the footing width can be assumed to apply, however shrink-swell movements as a result of the reactive clays are likely to be most critical to the design of shallow footings.

If adopting shallow footings founded on the residual silty clays, consideration will need to be given to the potential for differential movements between other structural elements that may be founded on the underlying bedrock. We strongly recommend that these structures include good articulation to allow relative movements to occur. Reference should also be made to Appendix B of AS2870-2011 which provides further guidance on foundation performance and maintenance for structures on reactive silty clay soils.

Footing excavations should be inspected by the geotechnical engineer to confirm that a suitable founding stratum is being achieved. Water should be prevented from ponding in the base of footing excavations as this will lead to softening of the base. Any water softened founding material as well as any ‘fall in’ must be removed from the base of footings prior to pouring concrete.

Piled Footing Systems

We consider that the most likely footing system to support the column loads for the Early Learning Centre Building will be piled footings founded down on the underlying Class 3 or Class 4 siltstone. The pile footing bearing pressures and recommendations outlined in Section 4.5.1 above for the Boarding House Building are also appropriate for the pile footings for the Early Learning Centre and reference should be made to that section for further details.

In addition, if the Early Learning Centre Building is designed as a fully suspended slab, the slab and footing beams should be underlain by void formers of at least 100mm thickness to allow for swelling of the reactive clay soils and to reduce the risk that swelling pressures will ‘jack’ the slab off the piles.

4.6 Basement Slabs

We expect that the basement slabs for the Boarding House Building will be supported on weathered siltstone, in which case no specific subgrade improvement will be required. However we recommend that an inspection of the exposed subgrade be carried out by a geotechnical engineer following bulk excavation to confirm the exposed conditions.

Where the basement subgrade comprises a weathered siltstone, we consider that it should be underlain by a subbase layer of DGB20, compacted to at least 100% of Standard Maximum Dry Density or other approved durable granular sub-base material. This material will act as a separation/debonding layer from the rock subgrade below.

Drainage will also need to be incorporated into the subbase layer. Drainage will need to be provided below the basement slab either as a grid of subsoil drains or a gravel blanket. The drainage will need to be connected to a permanent fail safe pump out system which is fitted with automatic level control pumps to avoid flooding, or alternatively drainage may be able to be discharged using gravity means.

The extent of basement drainage will depend on the seepage volumes. As a guide the weathered siltstone may have a horizontal permeability in the order of $1x10^{-7}$m/sec, however we recommend that some further assessment of groundwater levels (including some pump out tests) be carried out to provide further assessment of seepage inflows. Assuming seepage volumes are within the acceptable authority limits, the basement will be able to be designed as a permanently drained structure.

4.7 Pavements

Following satisfactory preparation of the subgrade (as detailed in Section 4.4.1 above), new pavements will need to be designed on the basis of the specific subgrade material. Where pavements are supported on the underlying residual silty clays then they may be able to be designed on the basis of a soaked CBR of 2.5%.

Flexible pavements should be underlain by a good quality base-course layer comprising crushed rock to RTA QA specification 3051 (2010) unbound base material, or equivalent good quality and durable fine crushed rock compacted to at least 100% of Standard Maximum Dry Density (SMDD).

Concrete pavements should also be underlain by a subbase layer of at least 100mm thickness comprising DGB20 compacted to at least 100% of SMDD. This will reduce the risk of pumping of fines where clayey subgrades are encountered. Concrete pavements should be isolated from the structural columns to allow relative movement.

Consideration could be given to the use of subsoil drains along the high side of pavements. The subsoil drains should extend to a depth of at least 0.3m below the subgrade level and the drains should have adequate falls to reduce ponding in the drains.

4.8 Earthquake Classification

The following parameters can be adopted for earthquake design in accordance with AS1170.4-2007 ‘Structural Design Actions, Part 4: Earthquake Actions in Australia’:

- Hazard factor (Z) = 0.08
- Site Subsoil Class = Class Ce

4.9 Further Geotechnical Input

The following is a summary of the further geotechnical input which is required and which has been detailed in the preceding sections of this report:

- Further groundwater monitoring to assess groundwater levels, including some pump out tests to assess likely groundwater inflow rates.
- Further boreholes to assess the consistency and uniformity of the Class 2 rock if it is to be adopted as a founding stratum for piles.
- Excavation of some test pits to expose the footings of the adjoining Aquatic Centre.
- Vibration Monitoring during use of hydraulic impact hammers.
- Proof rolling of the subgrade during earthworks operations.
- Inspection of the basement bulk excavation conditions to confirm suitable subgrade conditions for support of basement slabs.
- Footing inspections.
- Proof load testing of 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.

The long term successful performance of floor slabs and pavements is dependent on the satisfactory completion of the earthworks. In order to achieve this, the quality assurance program should not be limited to routine compaction density testing only. Other critical factors associated with the earthworks may include subgrade preparation, selection of fill materials, control of moisture content and drainage, etc. The satisfactory control and assessment of these items may require judgment from an experienced engineer. Such judgment often cannot be made by a technician who may not have formal engineering qualifications and experience. In order to identify potential problems, we recommend that a pre-construction meeting be held so that all parties involved understand the earthworks requirements and potential difficulties. This meeting should clearly define the lines of communication and responsibility.

Occasionally, the subsurface conditions between 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. 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
MOISTURE CONTENT, ATTERBERG LIMITS AND LINEAR SHRINKAGE TEST REPORT

Client: JK Geotechnics
Project: Proposed New School Buildings
Location: Loreto Normanhurst Girls School, Normanhurst, NSW

Ref No: 31772L
Report: A
Report Date: 20/09/2018
Page 1 of 1

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	**DEPTH m**	**MOISTURE CONTENT %**	**LIQUID LIMIT %**	**PLASTIC LIMIT %**	**PLASTICITY INDEX %**	**LINEAR SHRINKAGE %**
1	0.20-0.50	8.3				
2	2.60-2.80	9.4				
3	2.50-2.70	7.4				
4	0.30-0.70	15.7	51	20	31	15.0
4	2.50-2.70	11.1				
5	2.20-2.60	4.4				
6	2.50-2.70	6.1				
7	0.50-0.95	17.5	46	18	28	12.0
8	2.80-3.00	11.5				
9	0.40-1.20	24.4	52	24	28	15.0
9	4.90-5.10	8.5				
10	0.50-0.95	30.8	58	26	32	15.5
10	3.00-3.10	6.8				

Notes:

- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 12/9/18

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SOIL TEST SERVICES
ABN 43 002 145 173

TABLE B
FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client: JK Geotechnics
Project: Proposed New School Buildings
Location: Loreto Normanhurst Girls School, Normanhurst, NSW

Ref No: 31772L
Report: B
Report Date: 20/09/2018
Page 1 of 1

BOREHOLE NUMBER	4	9
DEPTH (m)	0.30 - 0.70	0.40 - 1.20
Surcharge (kg)	9.0	9.0
Maximum Dry Density (t/m^3)	1.63 STD	1.52 STD
Optimum Moisture Content (%)	18.6	23.6
Moulded Dry Density (t/m^3)	1.60	1.49
Sample Density Ratio (%)	98	98
Sample Moisture Ratio (%)	99	102
Moisture Contents		
Insitu (%)	15.9	24.5
Moulded (%)	18.4	24.1
After soaking and After Test, Top 30mm(%)	28.1	31.8
Remaining Depth (%)	26.2	27.8
Material Retained on 19mm Sieve (%)	0	0
Swell (%)	3.0	1.0
C.B.R. value: @5.0mm penetration	2.5	4.5

NOTES:

- Refer to appropriate Borehole logs for soil descriptions
- Test Methods :
  - (a) Soaked C.B.R. : AS 1289 6.1.1
  - (b) Standard Compaction : AS 1289 5.1.1
  - (c) Moisture Content : AS 1289 2.1.1
- Date of receipt of sample:12/9/18

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Authorised Signature / Date
(A. Tatikonda) 20/9/18

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SOIL TEST SERVICES

TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client: JK Geotechnics
Project: Proposed New School
Location: Loreto Normanhurst Girls School, Normanhurst, NSW

Ref No: 31772L
Report: C
Report Date: 12/09/2018
Page 1 of 5

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
1	3.04 - 3.07	0.2	4
	4.34 - 4.37	0.2	4
	5.77 - 5.81	0.3	6
	6.08 - 6.12	1.7	34
	6.68 - 6.72	1.3	26
	7.16 - 7.19	1.1	22
	7.80 - 7.83	1.7	34
2	4.35 - 4.38	0.1	2
	5.30 - 5.32	0.1	2
	6.25 - 6.29	0.05	1
	6.87 - 6.91	0.1	2
	7.26 - 7.29	0.3	6
	7.88 - 7.92	0.5	10
	8.62 - 8.65	0.4	8
	9.05 - 9.08	1.5	30
	9.41 - 9.44	1.8	36
	9.80 - 9.83	2.2	44
3	5.55 - 5.58	0.03	1
	5.49 - 5.51	0.3	6
	6.22 - 6.25	0.06	1
	6.73 - 6.76	0.08	2
	7.46 - 7.50	0.4	8
	7.97 - 8.00	0.5	10
	8.46 - 8.50	0.3	6
	9.15 - 9.18	0.2	4

NOTES: See Page 5 of 5

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TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	**Ref No:**	31772L
Project:	Proposed New School	**Report:**	C
Location:	Loreto Normanhurst Girls School, Normanhurst, NSW	**Report Date:**	12/09/2018
		Page 2 of 5	

BOREHOLE NUMBER	DEPTH m	$I_{S\,(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
3	9.72 - 9.75	0.2	4
	10.39 - 10.42	0.3	6
	11.00 - 11.03	0.2	4
	11.51 - 11.54	0.2	4
	12.06 - 12.09	0.4	8
	12.62 - 12.65	1.0	20
4	3.42 - 3.44	0.07	1
	3.85 - 3.88	0.1	2
	4.12 - 4.15	0.2	4
	5.00 - 5.03	0.4	8
	5.76 - 5.80	0.2	4
	6.61 - 6.64	0.3	6
	7.44 - 7.47	0.4	8
	7.88 - 7.90	0.2	4
	8.82 - 8.85	0.6	12
	9.20 - 9.23	0.7	14
	9.43 - 9.46	0.5	10
	9.86 - 9.90	2.3	46
	10.29 - 10.32	1.8	36
	10.75 - 10.78	1.0	20
	11.25 - 11.28	1.2	24
5	2.64 - 2.66	1.3	26
	3.20 - 3.24	0.2	4
	3.63 - 3.66	0.9	18
	4.09 - 4.13	0.03	1

NOTES: See Page 5 of 5

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TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client: JK Geotechnics
Project: Proposed New School
Location: Loreto Normanhurst Girls School,
Normanhurst, NSW

Ref No: 31772L
Report: C
Report Date: 12/09/2018
Page 3 of 5

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
5	5.22 - 5.26	1.2	24
	5.69 - 5.72	0.7	14
	6.10 - 6.14	0.8	16
	6.69 - 6.72	0.2	4
	7.18 - 7.22	0.2	4
	7.59 - 7.62	0.06	1
	8.00 - 8.03	1.3	26
	8.45 - 8.48	1.2	24
	8.94 - 8.97	1.2	24
	9.45 - 9.48	1.3	26
	10.40 - 10.43	0.7	14
6	4.37 - 4.39	0.1	2
	4.98 - 5.00	0.5	10
	5.34 - 5.36	0.4	8
	5.76 - 5.79	0.4	8
	6.16 - 6.20	0.9	18
	6.55 - 6.59	0.9	18
	7.19 - 7.22	0.3	6
	7.63 - 7.66	1.1	22
	8.11 - 8.15	0.4	8
	8.55 - 8.58	2.2	44
	9.19 - 9.22	1.4	28
	9.71 - 9.75	1.2	24
	10.25 - 10.29	2.1	42
	10.87 - 10.90	4.2	84

NOTES: See Page 5 of 5

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SOIL TEST SERVICES

TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client: JK Geotechnics
Project: Proposed New School
Location: Loreto Normanhurst Girls School, Normanhurst, NSW

Ref No: 31772L
Report: C
Report Date: 12/09/2018
Page 4 of 5

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
6	11.34 - 11.38	2.4	48
	11.73 - 11.77	1.7	34
	12.16 - 12.19	1.8	36
	12.64 - 12.67	2.4	48
	13.20 - 13.24	1.2	24
	13.98 - 14.00	1.1	22
7	4.39 - 4.42	0.2	4
	4.90 - 4.94	0.3	6
	5.33 - 5.36	0.4	8
	5.60 - 5.63	0.3	6
	6.00 - 6.03	0.4	8
	6.57 - 6.60	0.7	14
	6.97 - 7.00	0.9	18
	7.35 - 7.38	1.0	20
	7.94 - 7.97	0.5	10
	8.31 - 8.34	0.4	8
	8.65 - 8.68	1.7	34
8	3.72 - 3.75	0.5	10
	4.13 - 4.15	0.4	8
	4.52 - 4.54	0.09	2
	5.00 - 5.04	0.2	4
	5.58 - 5.60	0.4	8
	6.09 - 6.13	0.3	6
	6.74 - 6.77	0.4	8
	7.28 - 7.30	1.0	20

NOTES: See Page 5 of 5

115 Wicks Road
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SOIL TEST SERVICES

TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	**Ref No:**	31772L
Project:	Proposed New School	**Report:**	C
Location:	Loreto Normanhurst Girls School, Normanhurst, NSW	**Report Date:**	12/09/2018
		Page 5 of 5	

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
8	7.68 - 7.71	0.8	16
9	5.47 - 5.50	0.1	2
	6.19 - 6.21	0.2	4
	6.74 - 6.77	0.3	6
	8.09 - 8.12	0.4	8
	8.94 - 8.98	0.6	12
	9.12 - 9.15	1.0	20
	9.83 - 9.86	0.8	16
10	3.48 - 3.50	0.4	8
	3.75 - 3.78	0.1	2
	4.11 - 4.13	0.5	10
	4.50 - 4.52	0.2	4
	5.10 - 5.13	0.5	10
	5.62 - 5.64	0.4	8
	6.12 - 6.14	0.3	6
	6.50 - 6.54	0.4	8
	7.02 - 7.04	0.6	12
	7.69 - 7.72	0.6	12

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 0.1MPa, or to one significant figure if less than 0.1MPa
5. The Estimated Unconfined Compressive Strength was calculated from

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CERTIFICATE OF ANALYSIS 200408

Client Details

Client	JK Geotechnics
Attention	Arthur Billingham
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**31772L, NORMANHURST**
Number of Samples	6 Soil
Date samples received	10/09/2018
Date completed instructions received	10/09/2018

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	17/09/2018
Date of Issue	12/09/2018

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

Results Approved By
Nick Sarlamis, Inorganics Supervisor

Authorised By
Jacinta Hurst, Laboratory Manager

Misc Inorg - Soil						
Our Reference		200408-1	200408-2	200408-3	200408-4	200408-5
Your Reference	UNITS	2	4	6	8	9
Depth		1.5-1.95	0.5-0.9	0.6-0.95	0.5-0.7	1.5-1.95
Date Sampled		05/09/2018	04/09/2018	07/09/2018	31/08/2018	03/09/2018
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	11/09/2018	11/09/2018	11/09/2018	11/09/2018	11/09/2018
Date analysed	-	11/09/2018	11/09/2018	11/09/2018	11/09/2018	11/09/2018
pH 1:5 soil:water	pH Units	5.4	4.7	4.9	5.4	5.2
Sulphate, SO4 1:5 soil:water	mg/kg	10	60	27	71	69
Chloride, Cl 1:5 soil:water	mg/kg	<10	20	<10	87	21
Resistivity	ohm m	520	180	440	140	220

Misc Inorg - Soil		
Our Reference		200408-6
Your Reference	UNITS	10
Depth		1.7-1.95
Date Sampled		31/08/2018
Type of sample		Soil
Date prepared	-	11/09/2018
Date analysed	-	11/09/2018
pH 1:5 soil:water	pH Units	4.9
Sulphate, SO4 1:5 soil:water	mg/kg	25
Chloride, Cl 1:5 soil:water	mg/kg	<10
Resistivity	ohm m	460

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	200408-2
Date prepared	-			11/09/2018	1	11/09/2018	11/09/2018		11/09/2018	11/09/2018
Date analysed	-			11/09/2018	1	11/09/2018	11/09/2018		11/09/2018	11/09/2018
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	5.4	5.2	4	102	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	10	<10	0	92	118
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	92	93
Resistivity	ohm m	1	Inorg-002	<1	1	520	590	13	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

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.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

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: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics 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.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

MISC_INORG_DRY

Spike recovery failed due to matrix interferences. However, an acceptable recovery was obtained for the LCS.

JK Geotechnics

GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
1
1 / 2

BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L **Method:** SPIRAL AUGER **R.L. Surface:** ~181.2 m
Date: 5/9/18 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.B./L.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	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	■							▨		FILL: Silty clay, low plasticity, dark brown, trace of roots.				GRASS COVER
				■		181		‖	-	Extremely Weathered siltstone: silty CLAY, medium plasticity, light grey, with ironstone and dark grey low strength siltstone bands.	XW	(Hd)		ASHFIELD SHALE
	■			■			1	‖						LOW TO MODERATE BANDS OF RESISTANCE
						180				REFER TO CORED BOREHOLE LOG				
							2							
						179								
							3							
						178								
							4							
						177								
							5							
						176								
							6							
						175								

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CORED BOREHOLE LOG

Borehole No.
1
2 / 2

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L **Core Size:** NMLC **R.L. Surface:** ~181.2 m
Date: 5/9/18 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK308 **Bearing:** N/A **Logged/Checked By:** A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT DETAILS SPACING (mm) 600, 200, 60, 20	DEFECT DETAILS DESCRIPTION Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness Specific General	Formation
					START CORING AT 1.20m						
100% RETURN		180 179	2		NO CORE 1.09m						
					SILTSTONE: dark grey and light grey, bedded subhorizontally.	XW - HW	Hd - VL				Ashfield Shale
		178	3		SILTSTONE: dark grey, bedded subhorizontally.	HW	VL - L	0.20		(2.92m) J, 90°, P, R, Fe Sn (3.13m) J, 90°, P, S, Cn (3.18m) J, 10°, P, S, Fe Sn	
						XW	Hd			(3.30m) J, 90°, P, R, Cn	
0% RETURN					NO CORE 0.18m						
			4		SILTSTONE: light grey and dark grey, with iron indurated and low strength bands.	XW	Hd				Ashfield Shale
		177			NO CORE 0.31m						
		176	5		SILTSTONE: dark grey, with iron indurated bands bedded subhorizontally.	HW	VL - L	0.20		(4.33m) J, 50°, P, S, Fe Sn (4.39m) J, 30 - 90°, P, S, Fe Sn (4.45m) XWS, 0°, 7 mm.t (4.57m) J, 30°, P, S, Fe Sn (4.65m) XWS, 0°, 60 mm.t (4.71m) J, 50°, P, S, Fe Sn (4.75m) XWS, 0°, 70 mm.t (4.84m) J, 60 - 90°, P, S, Fe Sn (4.91m) Be, 0°, P, R, Cn (5.04m) XWS, 0°, 70 mm.t (5.12m) J, 90°, P, R, Cn	Ashfield Shale
						XW	Hd				
					NO CORE 0.07m						
					SILTSTONE: orange brown and light grey, with clay seams.	XW	Hd			(5.71m) Be, 0°, P, S, Cn	Ashfield Shale
		175	6		SANDSTONE: fine to medium grained, orange brown.	SW	H	0.30 1.7			Hawkesbury Sandstone
		174	7		as above, but light grey with dark grey bands, bedded subhorizontally.	FR		1.3 1.1 1.7		(6.54m) J, 80°, P, R, Cn	

COPYRIGHT END OF BOREHOLE AT 7.90 m FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JK Geotechnics
JOB No. 31772L BH1 START CORING AT 1.20m
1
CORE LOSS: 1.09m
2
3
CL: 0.18m
4
CORE LOSS: 0.31m
5
0.07
6
7
EOBH AT 7.90m

Borehole No.
2
1 / 2

BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Method: SPIRAL AUGER
R.L. Surface: ~183.8 m
Date: 5/9/18
Datum: AHD
Plant Type: JK308
Logged/Checked By: A.B./L.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING	■								-	ASPHALTIC CONCRETE: 40mm.t	M			APPEARS MODERATELY COMPACTED
										FILL: Silty gravelly sand, fine to coarse grained, dark grey, fine to medium grained igneous gravel.				
					N=SPT 5/ 20mm REFUSAL	183	1			FILL: Gravelly sand, fine to coarse grained, light brown, fine to coarse grained, grey igneous gravel.				
	■			■	N = 15 6,4,11	182			CH	Silty CLAY: high plasticity, light grey and grey, trace fine to medium grained ironstone gravel.	w>PL	VSt - Hd	460 400 360	
				■		181	2 3		-	Extremely Weathered siltstone: silty CLAY, medium plasticity, grey with ironstone and low strength bands.	XW	Hd		ASHFIELD SHALE VERY LOW 'TC' BIT RESISTANCE
						180 179 178 177	4 5 6			REFER TO CORED BOREHOLE LOG				

JK 9.01.2 LIB.GLB Log JK AUGERHOLE - MASTER 31772L NORMANHURST.GPJ <<DrawingFile>> 25/10/2018 10:26 10.0.000 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.01.2 2018-04-02 Prj: JK 9.01.0 2018-03-20

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CORED BOREHOLE LOG

Borehole No.
2
2 / 2

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Core Size: NMLC
R.L. Surface: ~183.8 m
Date: 5/9/18
Inclination: VERTICAL
Datum: AHD
Plant Type: JK308
Bearing: N/A
Logged/Checked By: A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS DESCRIPTION Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness Specific General	Formation
				START CORING AT 3.26m					
100% RETURN		180		NO CORE 0.63m					
		179	4 5	SILTSTONE: dark grey, with iron indurated bands, bedded subhorizontally.	HW	VL	0.10 0.10	(3.91m) XWS, 0°, 20 mm.t (3.92m) J, 70°, P, R, Cn (4.00m) XWS, 0°, 40 mm.t (4.07m) J, 60°, P, R, Cn (4.11m) XWS, 0°, 10 mm.t (4.18m) J, 90°, P, R, Fe Sn (4.24m) CS, 0°, 15 mm.t (4.32m) J, 90°, P, R, Cn (4.41m) J, 90°, P, R, Cn (4.45m) CS, 0°, 5 mm.t (4.54m) J, 60 - 90°, P, R, Cn, XWS IN FILL (4.64m) XWS, 0°, 70 mm.t (4.77m) Be, 0°, P, R, Fe Sn (4.89m) J, 90°, P, R, Fe Sn (4.97m) CS, 0°, 15 mm.t (5.16m) J, 90°, P, R, Fe Sn (5.26m) Be, 0°, P, S, Cn, XWS, IN FILL (5.45m) CS, 0°, 55 mm.t	Ashfield Shale
					XW	Hd			
80% RETURN		178	6	NO CORE 0.38m					
		177 176	7 8	SILTSTONE: dark grey, bedded subhorizontally.	MW	VL - L L M	0.050 0.10 0.30 0.50	(6.14m) J, 90°, P, R, Cn (6.20m) J, 90°, P, R, Cn (6.47m) CS, 0°, 4 mm.t (6.49m) J, 90°, P, R, Cn (6.54m) Be, 0°, P, S, Fe Sn (6.70m) J, 20°, P, S, Fe Sn (6.75m) J, 30°, P, S, Fe Sn (6.92m) CS, 0°, 1 mm.t (7.04m) J, 90°, P, R, Cn, WITH XWS SEAM, 25mm.t (7.30m) J, 70°, P, R, Cn (7.34m) CS, 0°, 1 mm.t (7.38m) Be, 0°, P, R, Cn (7.44m) J, 20°, P, S, Cn (7.59m) J, 90°, P, R, Cn, WITH XWS SEAM, 30mm.t (7.81m) J, 40 - 90°, Un, S, Cn (7.96m) J, 90°, P, R, Cn (8.17m) J, 90°, P, R, Cn (8.31m) XWS, 0°, 30 mm.t	Ashfield Shale
				NO CORE 0.14m					
		175	9	SILTSTONE: dark grey with light grey bands, bedded subhorizontally.	FR	H	0.40 1.5 1.8	(8.57m) J, 70°, P, S, Cn (8.70m) J, 30°, P, R, Cn (8.76m) J, 30°, Un, S, Cn (8.96m) J, 20°, P, S, Cn (9.17m) J, 20°, P, S, Cn (9.29m) J, 80°, P, S, Cn	Ashfield Shale
		174		as above, but bedded at 10°.			2.2	(9.80m) J, 70°, P, S, Cn	

Point load strength scale: VL -0.1, L -0.3, M -1, H -3, VH -10, EH
Spacing (mm): 600, 200, 60, 20

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END OF BOREHOLE AT 9.90 m

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JOB No. 31772L BH2 START CORING AT 3.26m
3
CORE LOSS: 0.63m
4
5
CORE LOSS 0.38m
6
7
8
CL:0.14m
9
EOBH AT 9.90m

Borehole No.
3
1 / 3

BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Method: SPIRAL AUGER
R.L. Surface: ~189.6 m
Date: 6/9/18
Datum: AHD
Plant Type: JK308
Logged/Checked By: A.B./L.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING	■									FILL: Silty sandy clay, low plasticity, dark brown, fine to medium grained, trace fine to medium grained igneous gravel.	w<PL			GRASS COVER
	■			■	N = 16 3,6,10				CH	Silty CLAY; high plasticity, orange brown.	w>PL	VSt - Hd		RESIDUAL
				■		189				as above, but light grey with fine to coarse grained ironstone gravel, trace of fine to coarse grained very low strength siltstone gravel.		Hd	440 320 470	
				■			1		-	Extremely Weathered siltstone: silty CLAY, medium plasticity, light grey, with ironstone and very low to low strength bands.	XW	Hd		ASHFIELD SHALE
				■		188 187	2 3				XW - DW	Hd - VL		VERY LOW TO LOW 'TC' BIT RESISTANCE
				■		186	4			SILTSTONE: grey brown and dark grey, with iron indurated bands and extremely weathered seams.	DW	VL - L		LOW RESISTANCE
						185 184 183	5 6			REFER TO CORED BOREHOLE LOG				Groundwater monitoring well installed to 12.67m. Class 18 machine slotted 50mm dia. PVC standpipe 6.67m to 12.67m. Casing 0.1m to 6.67m. 2mm sand filter pack 5.70m to 12.67m. Bentonite seal 1.25m to 5.70m. Completed with a concreted gatic cover

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No.
3

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Core Size: NMLC
R.L. Surface: ~189.6 m
Date: 6/9/18
Inclination: VERTICAL
Datum: AHD
Plant Type: JK308
Bearing: N/A
Logged/Checked By: A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL 0.1, L 0.3, M 1, H 3, VH 10, EH	DEFECT DETAILS SPACING (mm) 600, 200, 60, 20	DEFECT DETAILS DESCRIPTION Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness Specific General	Formation
					START CORING AT 4.34m						
		185			NO CORE 0.52m						
			5		SILTSTONE: light grey.	XW	Hd				
		184 183	6 7		SILTSTONE: dark grey, with iron indurated bands, bedded subhorizontally.	MW	VL - L	0.30 0.030 0.060 0.080		(5.02m) J, 90°, P, S, Fe Sn (5.16m) Be, 0°, P, S, Fe Sn (5.23m) Be, 0°, P, S, Fe Sn (5.38m) XWS, 0°, 12 mm.t (5.45m) CS, 0°, 4 mm.t (5.49m) Be, 0°, P, S, Fe Sn (5.60m) J, 90°, P, S, Fe Sn (5.68m) J, 60°, P, R, Fe Sn (5.73m) J, 90°, P, R, Cn (5.76m) CS, 0°, 3 mm.t (5.78m) CS, 0°, 2 mm.t (5.91m) J, 60°, P, S, Fe Sn (6.02m) CS, 0°, 20 mm.t (6.10m) Be, 0°, P, S, Fe Sn (6.18m) XWS, 0°, 30 mm.t (6.30m) J, 20°, P, R, Cn (6.32m) CS, 0°, 5 mm.t (6.36m) J, 90°, P, S, Cn (6.41m) XWS, 0°, 30 mm.t (6.58m) J, 90°, P, S, Fe Sn (6.70m) J, 90°, P, S, Fe Sn (6.90m) J, 90°, P, R, Cn (7.02m) XWS, 0°, 30 mm.t (7.07m) XWS, 0°, 10 mm.t	Ashfield Shale
ON 9/10/18					NO CORE 0.37m						
100% RETURN		182 181 180	8 9 10		SILTSTONE: dark grey with light grey bands, bedded subhorizontally.	MW	L - M	0.40 0.50 0.30 0.20 0.20		(7.51m) Be, 0°, P, S, Fe Sn (7.60m) Healed J, 70-80°, P (7.85m) J, 90°, P, S, Fe Sn (8.03m) J, 90°, P, S, Fe Sn (8.13m) J, 20°, P, S, Fe Sn (8.24m) J, 60°, P, S, Fe Sn (8.32m) J, 90°, P, R, Cn (8.42m) J, 90°, P, R, Cn (8.50m) J, 10°, P, S, Fe Sn (8.67m) J, 60°, P, S, Cn (8.73m) J, 10°, P, S, Cn (8.76m) XWS, 0°, 4 mm.t (8.83m) Healed J, 90°, P (8.88m) XWS, 0°, 25 mm.t (8.96m) XWS, 0°, 10 mm.t (9.02m) J, 30°, P, S, Cn (9.04m) Be, 0°, P, S, Cn (9.12m) J, 90°, P, S, Cn (9.30m) J, 90°, P, S, Cn (9.38m) Healed J, 40°, P (9.42m) J, 50°, P, R, Cn, XWS FILLED (9.45m) Healed J. 40°, P (9.57m) J, 90°, P, R, Cn (9.86m) Healed J, 80°-90°, Un (9.88m) J, 30°, P, R, Fe Sn (9.99m) J, 30°, P, S, Fe Sn	Ashfield Shale
					NO CORE 0.16m						
		179			SILTSTONE: dark grey, bedded subhorizontally.	MW	L	0.30 0.20		(10.27m) J, 60 - 90°, Un, R, Fe Sn (10.37m) J, 30°, P, S, Fe Sn (10.43m) CS, 0°, 2 mm.t (10.46m) J, 90°, P, R, Cn (10.52m) XWS, 0°, 50 mm.t (10.57m) J, 10°, P, S, Cn (10.81m) J, 90°, P, S, Fe Sn (10.92m) J, 80°, P, R, Cn	Ashfield Shale

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CORED BOREHOLE LOG

Borehole No.
3
3 / 3

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Core Size: NMLC
R.L. Surface: ~189.6 m
Date: 6/9/18
Inclination: VERTICAL
Datum: AHD
Plant Type: JK308
Bearing: N/A
Logged/Checked By: A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL -0.1, L -0.3, M -1, H -3, VH -10, EH	SPACING (mm) 600 200 60 20	DEFECT DETAILS DESCRIPTION Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness Specific	General	Formation
100% RETURN					SILTSTONE: dark grey, bedded subhorizontally.	MW	L - M	•0.20		(11.12m) XWS, 0°, 25 mm.t (11.20m) J, 80°, P, S, Cn (11.27m) XWS, 0°, 70 mm.t		
					NO CORE 0.14m							
		178			SILTSTONE: dark grey, bedded subhorizontally.	MW	L	•0.20		(11.46m) J, 30°, P, S, Cn (11.55m) J, 90°, P, S, Cn (11.62m) J, 60 - 90°, Un, S, Cn		Ashfield Shale
						XW - HW	Hd - VL					
			12			SW	M	•0.40		(11.98m) J, 20°, P, S, Cn (12.04m) XWS, 0°, 10 mm.t (12.17m) J, 20°, P, S, Cn (12.21m) J, 10°, P, S, Cn (12.25m) J, 20°, P, S, Cn (12.28m) J, 50°, P, S, Cn		
		177			SILTSTONE: dark grey with light grey bands, bedded at 20°.		M - H	•1.0		(12.39m) J, 30°, P, S, Cn (12.48m) J, 10°, P, S, Cn (12.56m) J, 80°, P, S, Cn		
					END OF BOREHOLE AT 12.67 m							
			13									
		176										
			14									
		175							600 200 60 20			
			15									
		174										
			16									
		173										
			17									
		172							600 200 60 20			

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JK Geotechnics
JOB No. 31772L BH3 START CORING AT
4
5
6
7
CORE LOSS: 0.37m
8
9
10
CL: 0.16m
11
CL: 0.12m
12
EOBH 12.67m

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
4
1 / 3

BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L **Method:** SPIRAL AUGER **R.L. Surface:** ~186.0 m
Date: 4/9/18 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.B./L.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING	■								CI-CH	Silty CLAY: medium to high plasticity, orange brown.	w<PL	Hd		RESIDUAL
			■	■	N = 25 6,9,16				CH	Silty CLAY: high plasticity, light grey, trace fine to medium grained ironstone gravel.			>600 >600	
						185	1		-	Extremely Weathered siltstone: silty CLAY, medium plasticity, light grey with ironstone bands and low strength bands.	XW	Hd		ASHFIELD SHALE VERY LOW 'TC' BIT RESISTANCE
						184	2							
				■						SILTSTONE: dark grey, with iron indurated bands.	DW	VL - L		LOW TO MODERATE RESISTANCE
						183	3							
										REFER TO CORED BOREHOLE LOG				
						182	4							
						181	5							
						180	6							

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
4
2 / 3

CORED BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Core Size: NMLC
R.L. Surface: ~186.0 m
Date: 4/9/18
Inclination: VERTICAL
Datum: AHD
Plant Type: JK308
Bearing: N/A
Logged/Checked By: A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT DETAILS SPACING (mm) 600 200 60 20	DEFECT DETAILS DESCRIPTION Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness Specific General	Formation
					START CORING AT 3.20m						
100% RETURN					NO CORE 0.20m						
		182	4		SILTSTONE: dark grey, with iron indurated bands, bedded subhorizontally.	HW	VL - L	0.070 0.10 0.20		(3.46m) Be, 0°, P, R, Fe Sn (3.50m) CS, 0°, 35 mm.t (3.55m) J, 90°, P, R, Cn (3.60m) XWS, 0°, 20 mm.t (3.75m) XWS, 0°, 130 mm.t (3.91m) XWS, 0°, 70 mm.t (4.03m) XWS, 0°, 100 mm.t (4.12m) Be, 0°, P, S, Cn	Ashfield Shale
					NO CORE 0.69m						
50% RETURN		181	5		SILTSTONE: dark grey, bedded subhorizontally.	HW	VL - L	0.40		(4.90m) XWS, 0°, 50 mm.t (4.97m) J, 20°, P, S, Fe Sn (5.05m) XWS, 0°, 15 mm.t (5.17m) FRAGMENTED ZONE, 0°, 200mm.t (5.31m) J, 90°, P, R, Cn	Ashfield Shale
						XW	Hd				
		180	6			HW	L	0.20 0.30	60 20	(5.70m) XWS, 0°, 20 mm.t (5.75m) J, 90°, P, R, Cn (5.82m) J, 80°, P, S, Fe Sn (5.92m) J, 90°, P, S, Fe Sn (5.97m) XWS, 0°, 20 mm.t (6.08m) XWS, 0°, 10 mm.t (6.13m) Be, 0°, P, R, Fe Sn (6.21m) J, 90°, P, R, Cn (6.32m) FRAGMENTED ZONE, 0°, 170mm.t (6.49m) CS, 0°, 150 mm.t	
					NO CORE 0.36m						
		179 178	7 8		SILTSTONE: dark grey, bedded subhorizontally.	HW	L	0.40 0.20		(7.05m) FRAGMENTED ZONE, 0°, 100mm.t (7.18m) Be, 0°, P, S, Fe Sn (7.24m) J, 90°, P, R, Cn (7.32m) CS, 0°, 20 mm.t (7.38m) XWS, 0°, 70 mm.t (7.43m) J, 30°, P, S, Fe Sn (7.48m) Be, 0°, P, S, Fe Sn (7.51m) XWS, 0°, 5 mm.t (7.69m) J, 90°, P, R, Clay FILLED (7.77m) J, 90°, P, R, Fe Sn (7.87m) J, 90°, P, S, XWS, Clay FILLED (7.96m) XWS, 0°, 70 mm.t (8.13m) J, 40°, P, R, Fe Sn (8.22m) XWS, 0°, 120 mm.t	Ashfield Shale
					NO CORE 0.23m						
		177	9		SILTSTONE: dark grey, bedded subhorizontally.	HW MW	M	0.60 0.70		(8.62m) J, 90°, P, R, Fe Sn, FRAGMENTING (8.81m) XWS, 0°, 15 mm.t (8.97m) J, 90°, P, R, Fe Sn, FRAGMENTING (9.03m) XWS, 0°, 3 mm.t (9.17m) CS, 0°, 3 mm.t (9.29m) Be, 0°, P, R, Fe, XWS, FILLED	Ashfield Shale
					SANDSTONE: fine grained, grey, bedded subhorizontally.	SW	M	0.50		(9.48m) XWS, 0°, 10 mm.t (9.51m) J, 90°, P, S, Cn (9.61m) Be, 0°, P, S, Fe Sn	
					as above, but fine to medium grained, light grey with dark grey bands, bedded subhorizontally.	FR	H	2.3	600 200 60 20		

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CORED BOREHOLE LOG

Borehole No.
4
3 / 3

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Core Size: NMLC
R.L. Surface: ~186.0 m
Date: 4/9/18
Inclination: VERTICAL
Datum: AHD
Plant Type: JK308
Bearing: N/A
Logged/Checked By: A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT DETAILS SPACING (mm) 600 200 60 20	DEFECT DETAILS DESCRIPTION Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness Specific General	Formation
50% RETURN		175	11		SANDSTONE: fine to medium grained, light grey with dark grey bands, bedded subhorizontally.	FR	H	1.8 1.0 1.2			Hawkesbury Sandstone
		174 173 172 171 170	12 13 14 15 16		END OF BOREHOLE AT 11.28 m						


JK Geotechnics
JOB No. 31772L BH4 START CORING AT 3.20m
3
CL: 0.20m
4
CORE LOSS: 0.69m
5
6
CORE LOSS: 0.36m
7
8
CORE LOSS: 0.23m
9
10
11
EOBH AT 11.28m

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
5
1 / 3

BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L **Method:** SPIRAL AUGEER **R.L. Surface:** ~188.4 m
Date: 4/9/18 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.B./L.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING	■									TOPSOIL: Silty clay, low plasticity, brown, trace of root fibres.	w<PL			
	■			■	N > 16 8,16/ 150mm REFUSAL	188			CI-CH	Silty CLAY: medium to high plasticity, orange brown, trace of fine to coarse grained ironstone gravel.	w<PL	Hd	>600 >600	RESIDUAL
				■					-	Extremely Weathered siltstone: silty CLAY, medium plasticity, light grey with ironstone bands.	XW	Hd		ASHFIELD SHALE
				■		187	1			SILTSTONE: dark grey, with iron indurated bands and extremely weathered seams.	DW	VL - L		VERY LOW 'TC' BIT RESISTANCE
				■		186	2					L - M		MODERATE RESISTANCE
						185 184 183 182	3 4 5 6			REFER TO CORED BOREHOLE LOG				

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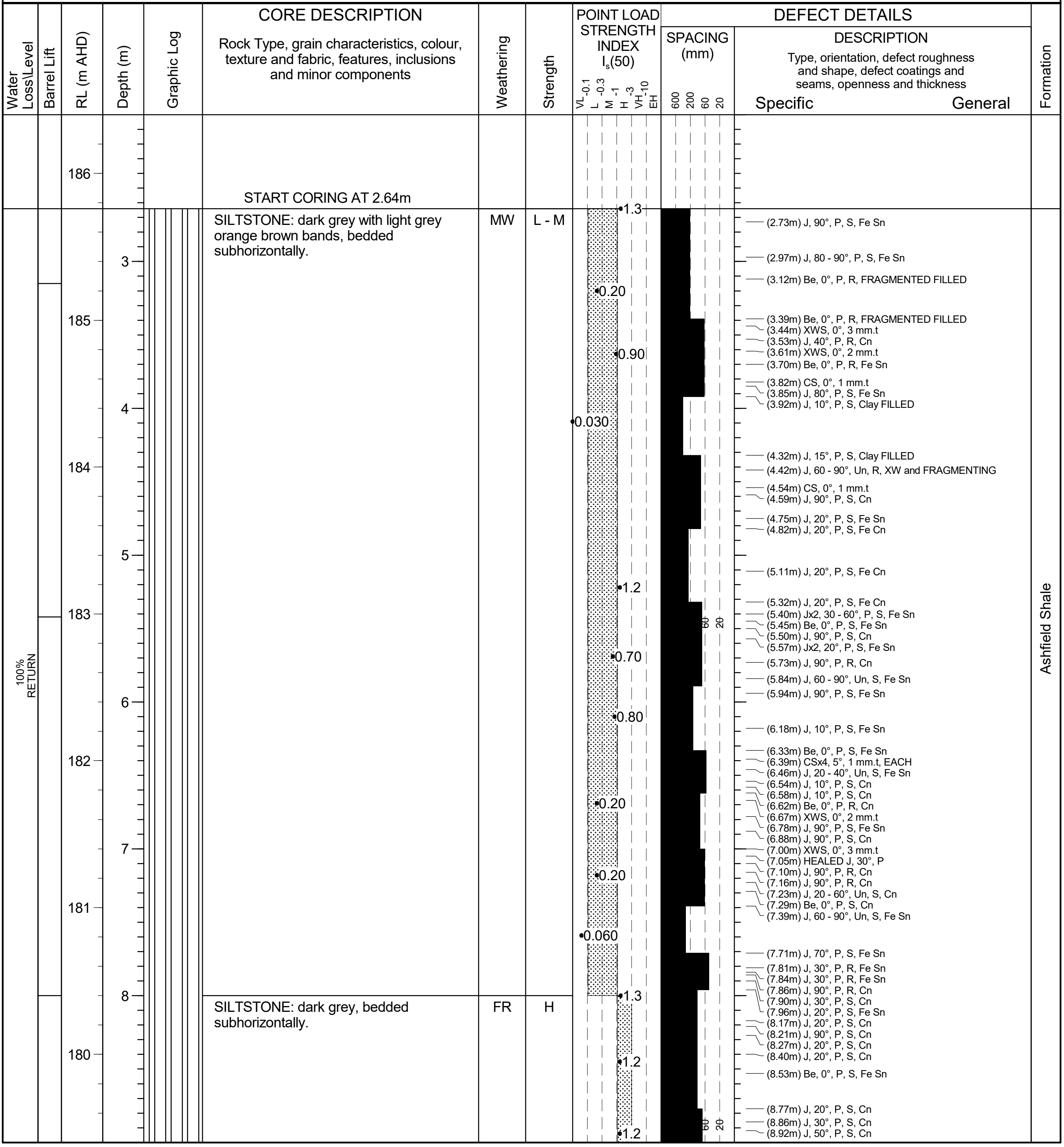
Borehole No.
5
2 / 3

CORED BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L	**Core Size:** NMLC	**R.L. Surface:** ~188.4 m
Date: 4/9/18	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK308	**Bearing:** N/A	**Logged/Checked By:** A.B./L.S.



START CORING AT 2.64m

Core Description	Weathering	Strength
SILTSTONE: dark grey with light grey orange brown bands, bedded subhorizontally.	MW	L - M
SILTSTONE: dark grey, bedded subhorizontally.	FR	H

(2.73m) J, 90°, P, S, Fe Sn
(2.97m) J, 80 - 90°, P, S, Fe Sn
(3.12m) Be, 0°, P, R, FRAGMENTED FILLED
(3.39m) Be, 0°, P, R, FRAGMENTED FILLED
(3.44m) XWS, 0°, 3 mm.t
(3.53m) J, 40°, P, R, Cn
(3.61m) XWS, 0°, 2 mm.t
(3.70m) Be, 0°, P, R, Fe Sn
(3.82m) CS, 0°, 1 mm.t
(3.85m) J, 80°, P, S, Fe Sn
(3.92m) J, 10°, P, S, Clay FILLED
(4.32m) J, 15°, P, S, Clay FILLED
(4.42m) J, 60 - 90°, Un, R, XW and FRAGMENTING
(4.54m) CS, 0°, 1 mm.t
(4.59m) J, 90°, P, S, Cn
(4.75m) J, 20°, P, S, Fe Sn
(4.82m) J, 20°, P, S, Fe Cn
(5.11m) J, 20°, P, S, Fe Cn
(5.32m) J, 20°, P, S, Fe Cn
(5.40m) Jx2, 30 - 60°, P, S, Fe Sn
(5.45m) Be, 0°, P, S, Fe Sn
(5.50m) J, 90°, P, S, Cn
(5.57m) Jx2, 20°, P, S, Fe Sn
(5.73m) J, 90°, P, R, Cn
(5.84m) J, 60 - 90°, Un, S, Fe Sn
(5.94m) J, 90°, P, S, Fe Sn
(6.18m) J, 10°, P, S, Fe Sn
(6.33m) Be, 0°, P, S, Fe Sn
(6.39m) CSx4, 5°, 1 mm.t, EACH
(6.46m) J, 20 - 40°, Un, S, Fe Sn
(6.54m) J, 10°, P, S, Cn
(6.58m) J, 10°, P, S, Cn
(6.62m) Be, 0°, P, R, Cn
(6.67m) XWS, 0°, 2 mm.t
(6.78m) J, 90°, P, S, Fe Sn
(6.88m) J, 90°, P, S, Cn
(7.00m) XWS, 0°, 3 mm.t
(7.05m) HEALED J, 30°, P
(7.10m) J, 90°, P, R, Cn
(7.16m) J, 90°, P, R, Cn
(7.23m) J, 20 - 60°, Un, S, Cn
(7.29m) Be, 0°, P, S, Cn
(7.39m) J, 60 - 90°, Un, S, Fe Sn
(7.71m) J, 70°, P, S, Fe Sn
(7.81m) J, 30°, P, R, Fe Sn
(7.84m) J, 30°, P, R, Fe Sn
(7.86m) J, 90°, P, R, Cn
(7.90m) J, 30°, P, S, Cn
(7.96m) J, 20°, P, S, Fe Sn
(8.17m) J, 20°, P, S, Cn
(8.21m) J, 90°, P, S, Cn
(8.27m) J, 20°, P, S, Cn
(8.40m) J, 20°, P, S, Cn
(8.53m) Be, 0°, P, S, Fe Sn
(8.77m) J, 20°, P, S, Cn
(8.86m) J, 30°, P, S, Cn
(8.92m) J, 50°, P, S, Cn

JK 9.01.2 LIB.GLB Log JK CORED BOREHOLE - MASTER 31772L NORMANHURST.GPJ <<DrawingFile>> 25/10/2018 10:27 10.0.000 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.01.2 2018-04-02 Prj: JK 9.01.0 2018-03-20

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Borehole No.
5
3 / 3

CORED BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Core Size: NMLC
R.L. Surface: ~188.4 m
Date: 4/9/18
Inclination: VERTICAL
Datum: AHD
Plant Type: JK308
Bearing: N/A
Logged/Checked By: A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL 0.1 L 0.3 M 1 H 3 VH 10 EH	DEFECT DETAILS SPACING (mm) 600 200 60 20	DEFECT DETAILS DESCRIPTION Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness Specific General	Formation
100% RETURN		179 178	10		SILTSTONE: dark grey, bedded subhorizontally. *(continued)*	FR	H	1.3 0.70		(9.05m) J, 40°, P, S, Cn (9.08m) J, 20°, P, S, Cn (9.20m) J, 10°, P, S, Cn (9.25m) J, 15°, P, S, Cn (9.36m) J, 60°, P, S, Cn (9.74m) J, 85°, P, R, Fe Sn (9.90m) J, 85 - 90°, P, R, Fe Sn (10.22m) J, 40°, P, S, Cn (10.28m) J, 30°, P, S, Cn (10.45m) J, 40 - 90°, Un, R, Cn	Ashfield Shale
		177 176 175 174 173	11 12 13 14 15		END OF BOREHOLE AT 10.48 m				600 200 60 20 600 200 60 20		

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JK Geotechnics
JOB No. 31772L BH5 START CORING AT 2.64m
2
3
4
5
6
7
8
9
10
EOBH AT 10.48m

JK Geotechnics

GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
6
1 / 3

BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L **Method:** SPIRAL AUGER **R.L. Surface:** ~191.0 m
Date: 7/9/18 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.B./L.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING	■									FILL: Silty clay, low plasticity, dark brown, trace fine to medium grained sand and root fibres.	w<PL			
				■	N = 27 5,9,18				CH	Silty CLAY: high plasticity, orange brown, trace fine to coarse grained ironstone gravel.	w>PL	Hd	580 500	RESIDUAL
	■			■					-	SILTSTONE: light grey and dark grey, with ironstone bands.	XW - DW	Hd - VL		ASHFIELD SHALE
						190	1							
				■										
						189	2							
				■							DW	VL - L		VERY LOW 'TC' BIT RESISTANCE WITH MODERATE BANDS
						188	3							
				■								L		LOW TO MODERATE RESISTANCE
						187	4							
										REFER TO CORED BOREHOLE LOG				Groundwater monitoring well installed to 14.0m. Class 18 machine slotted 50mm dia. PVC standpipe 8.0m to 14.0m. Casing 0.15m to 8.0m. 2mm sand filter pack 7.5m to14.0m. Bentonite seal 4.0m to 7.5m. Backfilled with sand to the surface. Completed with a concreted gatic cover
						186	5							
						185	6							

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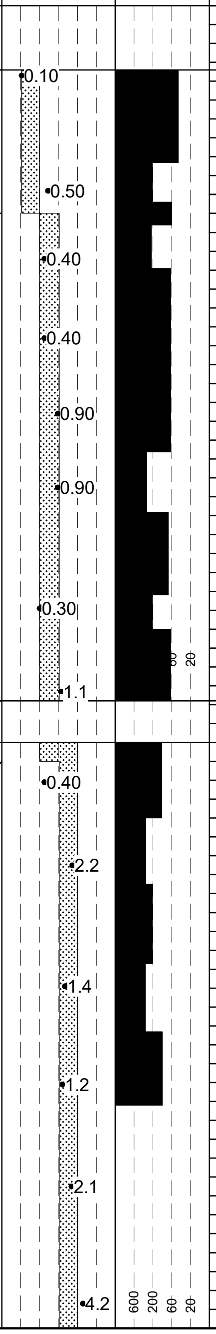
Borehole No.
6

CORED BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Core Size: NMLC
R.L. Surface: ~191.0 m
Date: 7/9/18
Inclination: VERTICAL
Datum: AHD
Plant Type: JK308
Bearing: N/A
Logged/Checked By: A.B./L.S.



Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS DESCRIPTION Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness Specific General	Formation
					START CORING AT 4.34m					
					SILTSTONE: dark grey, with iron indurated bands, bedded subhorizontally.	HW	L	0.10	(4.36m) XWS, 0°, 5 mm.t (4.40m) J, 90°, P, S, Fe Sn (4.44m) CSx2, 0°, 1 mm.t (4.46m) J, 90°, P, S, Cn (4.48m) CS, 0°, 20 mm.t (4.51m) J, 90°, P, S, Cn (4.56m) CS, 0°, 55 mm.t (4.62m) CS, 0°, 3 mm.t (4.65m) J, 90°, P, S, Fe Sn (4.68m) J, 60°, P, S, Fe Sn (4.70m) CS, 0°, 2 mm.t (4.78m) XWS, 0°, 12 mm.t (4.83m) Be, 0°, P, S, Fe Sn	Ashfield Shale
		186	5		as above, but with light grey bands.	MW		0.50	(5.04m) XWS, 0°, 10 mm.t (5.09m) J, 90°, P, R, Cn	
							M	0.40 0.40	(5.16m) CS, 0°, 1 mm.t (5.39m) CS, 0°, 6 mm.t (5.43m) J, 90°, P, S, Fe Sn (5.50m) CS, 0°, 22 mm.t (5.61m) CS, 0°, 12 mm.t (5.64m) J, 20°, P, S, Fe Sn (5.72m) J, 20°, P, S, Fe Sn (5.82m) CS, 0°, 5 mm.t (5.86m) XWS, 0°, 30 mm.t (5.94m) XWS, 0°, 30 mm.t (5.99m) J, 90°, P, S, Cn	
ON 9/10/18		185	6					0.90 0.90	(6.06m) J, 90°, P, S, Fe Sn (6.15m) Healed J, 90°, P (6.20m) Be, 0°, P, S, Fe Sn (6.34m) J, 90°, P, S, Cn (6.36m) CS, 0°, 7 mm.t (6.68m) J, 80°, P, R, Fe Sn (6.79m) J, 60 - 90°, Un, R, Fe Sn (6.96m) J, 30°, P, R, Fe Sn	
100% RETURN		184	7		SILTSTONE: dark grey with light grey bands, bedded at 20-30°.			0.30 1.1	(7.02m) XWS, 0°, 50 mm.t (7.05m) J, 30°, P, S, Cn (7.12m) J, 60 - 90°, Un, S, Fe Sn (7.34m) J, 10°, P, S, Fe Sn (7.44m) J, 90°, P, S, Fe Sn (7.51m) J, 15°, P, S, Fe Sn (7.58m) J, 40°, P, S, Fe Sn (7.65m) Be, 0°, P, S, Cn	
					NO CORE 0.22m					
		183	8		SILTSTONE: dark grey with light grey bands, bedded at 20°.	SW	M - H H	0.40 2.2	(7.97m) J, 80°, P, S, Cn (8.20m) J, 80°, P, S, Cn (8.30m) J, 90°, P, S, Cn (8.65m) J, 70°, P, S, XW Infill (8.85m) J, 80°, P, S, Cn	Ashfield Shale
		182	9					1.4	(9.07m) XWS, 20°, 10 mm.t (9.43m) J, 80°, P, R, Fe Sn	
						FR		1.2	(9.56m) J, 40°, P, R, Fe Sn (9.69m) J, 70°, P, S, Cn (9.82m) J, 70°, P, S, Cn	
		181	10					2.1 4.2		

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CORED BOREHOLE LOG

Borehole No.
6
3 / 3

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Core Size: NMLC
R.L. Surface: ~191.0 m
Date: 7/9/18
Inclination: VERTICAL
Datum: AHD
Plant Type: JK308
Bearing: N/A
Logged/Checked By: A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT DETAILS SPACING (mm) 600 200 60 20	DEFECT DETAILS DESCRIPTION Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness Specific General	Formation
100% RETURN		179	12		SILTSTONE: dark grey with light grey bands, bedded at 20°. *(continued)*	FR	H	2.4 1.7		(11.82m) J, 90°, P, S, Cn (12.10m) J, 90°, P, S, Cn	Ashfield Shale
		178	13		SILTSTONE: dark grey, bedded subhorizontally.			1.8 2.4 1.2 1.1		(12.54m) J, 70°, P, S, Cn (12.82m) J, 30°, P, S, Cn (12.87m) J, 30°, P, S, Cn (12.90m) J, 40°, P, S, Cn (13.33m) J, 80°, P, S, Cn (13.74m) J, 70°, P, S, Cn	
		177	14		END OF BOREHOLE AT 14.00 m						
		176	15								
		175	16								
		174	17								

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JK Geotechnics
JOB No. 31772L BH6 START CORING AT 4.34m
4
5
6
7
CL:0.22m
8
9
10
11
12
13
EOBH AT 14.00m

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
7
1 / 2

BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L **Method:** SPIRAL AUGER **R.L. Surface:** ~187.1 m
Date: 3/9/18 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.B./L.S.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING	■					187				FILL: Silty clay, low plasticity, brown, trace of roots.	w<PL			GRASS COVER
									CI	Silty CLAY: medium plasticity, light grey mottled red brown, trace fine to medium grained, ironstone gravel.	w~PL	Hd		RESIDUAL
	■			■	N = 17 4,7,10								590 >600 600	
						186	1							
										as above, but with extremely weathered bands.				
				■	N = 24 9,10,14								>600 >600 >600	
						185	2		-	Extremely Weathered siltstone: silty CLAY, medium plasticity, light grey, with ironstone bands.	XW	Hd		ASHFIELD SHALE
				■										
						184	3							
				■		183	4			SILTSTONE: dark grey, with iron indurated bands.	DW	L		LOW 'TC' BIT RESISTANCE
										REFER TO CORED BOREHOLE LOG				
						182	5							
						181	6							

JK 9.01.2 LIB.GLB Log JK AUGERHOLE - MASTER 31772L NORMANHURST.GPJ <<DrawingFile>> 25/10/2018 10:27 10.0.000 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.01.2 2018-04-02 Prj: JK 9.01.0 2018-03-20

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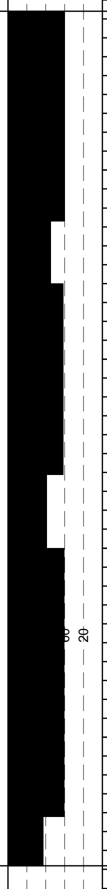
CORED BOREHOLE LOG

Borehole No.
7
2 / 2

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Core Size: NMLC
R.L. Surface: ~187.1 m
Date: 3/9/18
Inclination: VERTICAL
Datum: AHD
Plant Type: JK308
Bearing: N/A
Logged/Checked By: A.B./L.S.



Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	DEFECT DETAILS: DESCRIPTION — Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness (Specific / General)	Formation
		183		START CORING AT 4.16m					
100% RETURN		182	5	SILTSTONE: dark grey, with light grey, and iron indurated bands, bedded subhorizontally.	MW	L	0.20 0.30 0.40	(4.20m) XWS, 0°, 12 mm.t (4.25m) J, 90°, P, R, Cn (4.32m) CS, 0°, 15 mm.t (4.37m) CS, 0°, 6 mm.t (4.44m) CS, 0°, 6 mm.t (4.52m) Be, 0°, P, S, Fe Sn (4.59m) XWS, 0°, 2 mm.t (4.67m) CS, 0°, 4 mm.t (4.72m) CS, 0°, 3 mm.t (4.79m) Be, 0°, P, S, Fe Sn (4.83m) CS, 0°, 35 mm.t (4.88m) CS, 0°, 10 mm.t (4.98m) XWS, 0°, 20 mm.t (5.11m) J, 90°, P, R, Clay FILLED (5.17m) XWS, 0°, 35 mm.t (5.24m) Be, 0°, P, R, Fe Sn (5.27m) CS, 0°, 15 mm.t (5.47m) XWS, 0°, 25 mm.t	Ashfield Shale
				as above, but bedded at 10-15°.		L - M	0.30	(5.60m) J, 15°, P, R, Fe Sn (5.70m) Healed Joint, 90°, P, Cn (5.88m) J, 80°, P, R, Cn (5.96m) J, 40°, P, R, Fe Sn	
		181 180	6 7			M	0.40 0.70 0.90	(6.08m) Be, 0°, P, R, Fe Sn (6.13m) Be, 5°, P, R, Fe Sn (6.22m) Be, 10°, P, R, Fe Sn (6.31m) Helaed Joint, 90°, P, Cn (6.50m) J, 10 - 15°, Un, R, Fe Sn (6.53m) XWS, 0°, 1 mm.t (6.61m) XWS, 0°, 1 mm.t (6.78m) CS, 10°, 3 mm.t (7.00m) Be, 10°, P, R, Fe Sn (7.11m) Be, 10°, P, R, Fe Sn	
		179	8	SILTSTONE: dark grey, with light grey bands, bedded at 10-15°.	SW		1.0 0.50 0.40 1.7	(7.16m) Be, 0°, P, R, Fe Sn (7.21m) Healed Joint, 80°, P, Cn (7.33m) CS, 0°, 2 mm.t (7.43m) J, 50°, P, S, Cn (7.50m) J, 60°, P, S, Fe Sn (7.59m) Fragmented Zone, 0°, 50mm.t (7.65m) J, 90°, P, R, Cn (7.68m) J, 90°, P, S, Cn (7.70m) Be, 5°, P, S, Fe Sn (7.75-7.82m) J, 30°, P, R, Fe Sn (7.90m) Be, 0°, P, R, Fe Sn (8.01m) Be, 0°, P, R, Cn (8.11m) J, 20°, P, S, Cn (8.14m) Be, 0°, P, R, Cn, With Fragments (8.22m) J, 40°, P, S, Fe Sn (8.39m) XWS, 0°, 1 mm.t (8.42m) J, 20°, P, R, Cn	
		178 177	9 10	END OF BOREHOLE AT 8.68 m					

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JK Geotechnics
JOB No. 31772L BH7 START CORING AT 4.16m
4
5
6
7
8
EOBH 8.68m

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
8
1 / 2

BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L **Method:** SPIRAL AUGER **R.L. Surface:** ~186.7 m
Date: 31/8/18 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.B./L.S.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING	■									FILL: Sandy silty clay, low plasticity, light brown, trace of fine grained, gravel and roots.	w<PL			GRASS COVER
				■					CH	Silty CLAY: high plasticity, light grey mottled red brown.	w>PL	Hd	520 566	RESIDUAL
	■			■	N = 20 4,9,11	186	1			as above, but with fine to coarse grained ironstone gravel.			550 >600	
				■	N = 39 8,18,21	185	2			Silty CLAY: high plasticity, light grey, trace fine to coarse grained, ironstone gravel.	w~PL		>600 >600 >600	
				■		184	3		-	Extremely Weathered siltstone: silty CLAY, medium plasticity, light grey.	XW	Hd		ASHFIELD SHALE
										SILTSTONE: dark grey, with iron indurated bands.	DW	L		LOW 'TC' BIT RESISTANCE
						183 182 181 180	4 5 6			REFER TO CORED BOREHOLE LOG				

JK 9.01.2 LIB.GLB Log JK AUGERHOLE - MASTER 31772L NORMANHURST.GPJ <<DrawingFile>> 25/10/2018 10:28 10.0.000 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.01.2 2018-04-02 Prj: JK 9.01.0 2018-03-20

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
8
2 / 2

CORED BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Core Size: NMLC
R.L. Surface: ~186.7 m
Date: 31/8/18
Inclination: VERTICAL
Datum: AHD
Plant Type: JK308
Bearing: N/A
Logged/Checked By: A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT DETAILS SPACING (mm) 600 200 60 20	DEFECT DETAILS DESCRIPTION Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness Specific General	Formation
					START CORING AT 3.56m						
100% RETURN		183 182	4		SILTSTONE: dark grey, with iron indurated bands and light grey bands, bedded subhorizontally.	HW	L	0.50 0.40 0.090		(3.60m) Be, P, S, Fe Sn (3.64m) CS, 2 mm.t (3.66m) J, P, S, Cn (3.70m) CS, 2 mm.t (3.78m) CS, 35 mm.t (3.84m) CS, 3 mm.t (3.93m) CS, 1 mm.t (4.02m) CS, 5 mm.t (4.07m) Be, P, R, Fe Sn (4.19m) Be, P, R, Fe Sn (4.21m) CS, 5 mm.t (4.28m) XWS, 0°, 30 mm.t (4.36m) Be, 0°, P, R, Fe Sn (4.41m) CS, 0°, 5 mm.t (4.48m) Be, 0°, P, R, Fe Sn (4.56m) Be, 0°, P, R, Fe Sn (4.64m) CS, 0°, 4 mm.t (4.68m) J, 90°, P, R, Cn (4.80m) CS, 0°, 45 mm.t	Ashfield Shale
		181	5 6		as above, but bedded at 10-15°.	MW	L - M	0.20 0.40 0.30		(4.90m) CS, 0°, 2 mm.t (4.96m) Be, 0°, Clay FILLED (5.10m) CS, 10°, 5 mm.t (5.35m) CS, 0°, 6 mm.t (5.42m) CS, 0°, 20 mm.t (5.50m) CS, 0°, 5 mm.t (5.56m) Be, 10°, P, R, Fe Sn (5.62m) Be, 10°, P, R, Clay FILLED (5.88m) XWS, 0°, 2 mm.t (6.05m) J, 30 - 90°, Un, R, Cn	
		180	7		as above, but bedded subhorizontally.			0.40	600 200 60 20	(6.15m) Be, 0°, P, R, Fe Sn (6.27m) Healed Joint, 90°, P, Cn (6.53m) XWS, 0°, 3 mm.t (6.66m) J, 90°, P, R, Cn (6.77m) Be, 0°, P, R, Fe Sn (6.87m) Be, 0°, P, S, Fe Sn (6.97m) XWS, 0°, 50 mm.t (7.04m) J, 90°, P, S, Cn	
		179				SW	M - H	1.0 0.80		(7.10m) CS, 0°, 2 mm.t (7.15m) J, 90°, P, R, Cn (7.25m) J, 20°, P, S, Fe Sn (7.40m) CS, 0°, 2 mm.t (7.53m) Healed Joint, 30°, P, Cn (7.57m) Healed Joint, 90°, P, Cn (7.81m) Healed joint, 30°, P, Cn	
		178 177	8 9		END OF BOREHOLE AT 8.01 m				600 200 60 20		

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JK Geotechnics
JOB No. 31772L BH8 START CORING AT 3.56m
3
4
5
6
7
8
EOBH AT 8.02m

Borehole No.
9
1 / 2

BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Method: SPIRAL AUGER
R.L. Surface: ~185.8 m
Date: 3/9/18
Datum: AHD
Plant Type: JK308
Logged/Checked By: A.B./L.S.

Groundwater Record	Field Tests	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING			FILL: Silty clay, low plasticity, brown, trace of roots.	w<PL			GRASS COVER
	N = 11 4,5,6		FILL: Silty clay, high plasticity, dark brown, light grey, trace fine to medium grained, ironstone gravel.	w>PL			APPEARS MODERATELY COMPACTED
	N = 10 3,4,6		as above, but trace of ash and fine to medium grained, sand.				
		CH	Silty CLAY: high plasticity, light brown.	w>PL	VSt		RESIDUAL
	N = 8 3,3,5		as above, but light brown mottled red brown.			260 300 300	
			Silty CLAY: high plasticity, light grey mottled red brown.				
	N = 24 5,9,15		as above, but trace fine to coarse grained, ironstone gravel.		Hd	570 590 580	
		-	Extremely Weathered siltstone: silty CLAY, medium to high plasticity, light gey, with ironstone bands.	XW	Hd		ASHFIELD SHALE
			SILTSTONE: dark grey, with iron indurated bands.	DW	L		LOW 'TC' BIT RESISTANCE
			REFER TO CORED BOREHOLE LOG				

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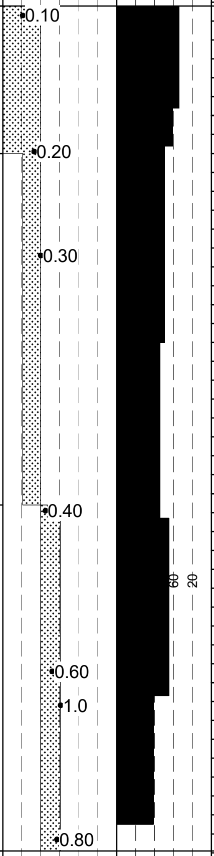
CORED BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L
Core Size: NMLC
R.L. Surface: ~185.8 m
Date: 3/9/18
Inclination: VERTICAL
Datum: AHD
Plant Type: JK308
Bearing: N/A
Logged/Checked By: A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL 0.1, L 0.3, M 1, H 3, VH 10, EH	DEFECT DETAILS SPACING (mm) 600 200 60 20	DEFECT DETAILS DESCRIPTION Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness Specific General	Formation
					START CORING AT 5.42m						
100% RETURN		180	6		SILTSTONE: dark grey, with light grey, iron indurated bands, bedded subhorizontally.	HW	VL - L	0.10		(5.46m) J, 30°, P, S, Cn (5.50m) J, 90°, P, S, Cn (5.55m) XWS, 0°, 6 mm.t (5.58m) CS, 0°, 22 mm.t (5.63m) XWS, 0°, 20 mm.t (5.67m) Be, 0°, P, R, Fe Sn (5.74m) XWS, 0°, 45 mm.t (5.80m) XWS, 0°, 4 mm.t (5.87m) CS, 0°, 80 mm.t (5.93m) J, 90°, P, R, Fe Sn (5.96m) XWS, 0°, 7 mm.t (6.09m) J, 10°, P, R, Cn (6.14m) Be, 0°, P, S, Fe Sn (6.16m) CS, 0°, 3 mm.t	Ashfield Shale
		179	7			MW	L	0.20 0.30		(6.40m) CS, 0°, 12 mm.t (6.43m) CS, 0°, 5 mm.t (6.65m) XWS, 0°, 85 mm.t (6.78m) Be, 0°, 2 mm.t (6.86m) XWS, 0°, 15 mm.t (6.95m) XWS, 0°, 15 mm.t (7.00m) CS, 0°, 1 mm.t (7.20m) J, 85°, P, R, Cn (7.47m) CS, 0°, 1 mm.t (7.56m) J, 90°, P, R, Fe Sn (7.78m) J, 90°, P, R, Cn (7.93m) J, 90°, P, R, Cn	
		178	8				M	0.40		(8.00m) Be, 0°, P, R, Fe Sn (8.13m) Be, 0°, P, R, Fe Sn (8.21m) J, 30°, P, S, Fe Sn (8.30m) J, 90°, P, R, Cn (8.39m) J, 20°, P, S, Cn (8.52m) J, 90°, P, S, Cn	
		177 176	9		SILTSTONE: dark grey, with light grey bands, bedded subhorizontally.	SW		0.60 1.0 0.80		(8.60m) Be, 0°, P, S, Fe Sn (8.73m) Be, 0°, P, S, Fe Sn (8.81m) J, 30°, P, R, Fe Sn (8.83m) Be, 0°, P, S, Fe Sn (9.02m) Healed Joint, 30°, P, Cn (9.07m) Healed Joint, 50°, P, Cn (9.29m) Be, 0°, P, S, Cn (9.50m) Be, 0°, P, R, Fe Sn (9.75m) J, 20°, P, R, Fe Sn	
		175 174	10 11		END OF BOREHOLE AT 9.89 m						



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JK Geotechnics
JOB No. 31772L
BH9
START CORING AT 5.42m
5
6
7
8
9
EOBH AT 9.89m

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
10
1 / 2

BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L **Method:** SPIRAL AUGER **R.L. Surface:** ~184.2 m
Date: 31/8/18 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.B./L.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING	■					184		▩		FILL: Silty clay, low plasticity, dark brown, with fine to medium grained sand, trace of roots.	w<PL			GRASS COVER
	■							▨	CH	Silty CLAY: high plasticity, dark brown, trace of ash.	w>PL	VSt		RESIDUAL
	■			■	N = 12 4,5,7	183	1	▨		Silty CLAY: high plasticity, orange brown.		Hd	390 400 510	
				■	N = 28 5,11,17			▨		as above, but light grey, trace fine to medium grained, ironstone gravel.			>600	
						182	2	▥	-	Extremely Weathered siltstone: silty CLAY, medium plasticity, light grey, with ironstone bands.	XW	Hd		ASHFIELD SHALE
				■		181	3	▥		SILTSTONE: light grey.	DW	VL - L		LOW 'TC' BIT RESISTANCE
						180 179 178	4 5 6			REFER TO CORED BOREHOLE LOG				

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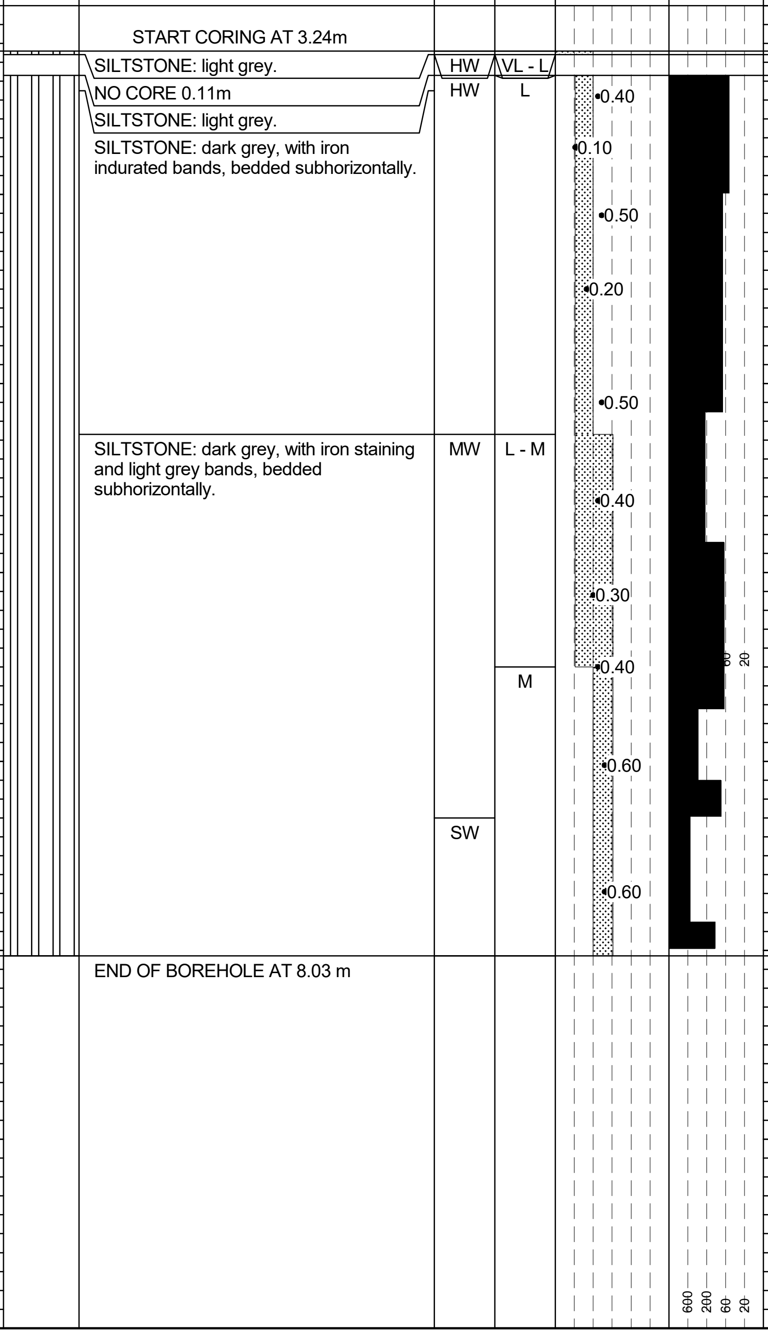
Borehole No.
10
2 / 2

CORED BOREHOLE LOG

Client: TTW
Project: PROPOSED NEW SCHOOL BUILDING
Location: LORETO NORMANHURST GIRLS SCHOOL, NORMANHURST, NSW

Job No.: 31772L **Core Size:** NMLC **R.L. Surface:** ~184.2 m
Date: 31/8/18 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK308 **Bearing:** N/A **Logged/Checked By:** A.B./L.S.

Water Loss\Level	RL (m AHD)	Depth (m)	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	Formation
	181		START CORING AT 3.24m			Ashfield Shale
100% RETURN			SILTSTONE: light grey.	HW	VL - L	Ashfield Shale
			NO CORE 0.11m	HW	L	
			SILTSTONE: light grey.			
	180	4	SILTSTONE: dark grey, with iron indurated bands, bedded subhorizontally.			
25% RETURN	179	5				
			SILTSTONE: dark grey, with iron staining and light grey bands, bedded subhorizontally.	MW	L - M	Ashfield Shale
0% RETURN	178	6				
					M	
	177	7				
				SW		
		8	END OF BOREHOLE AT 8.03 m			
	176					
		9				
	175					



DEFECT DETAILS
DESCRIPTION
Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness
Specific General

- (3.39m) J, 90°, P, S, Cn
- (3.47m) Be, 0°, P, S, Fe Sn
- (3.52m) Be, 0°, P, S, Fe Sn
- (3.54m) XWS, 0°, 4 mm.t
- (3.63m) J, 70 - 90°, P, S, Cn
- (3.69m) CS, 0°, 2 mm.t
- (3.70m) XWS, 0°, 2 mm.t
- (3.79m) Be, 0°, P, S, Fe Sn
- (3.83m) Be, 0°, P, R, Fe Sn
- (3.87m) J, 60°, P, R, Cn
- (3.94m) J, 90°, P, S, Cn, With associated fragments
- (3.99m) XWS, 0°, 15 mm.t
- (4.10m) CS, 0°, 7 mm.t
- (4.17m) Be, 0°, P, R, Cn, With associated fragments
- (4.25m) CS, 0°, 3 mm.t
- (4.27m) Be, 0°, P, R, Fe Sn
- (4.33m) Be, 0°, P, R, Cn
- (4.36m) Be, 0°, P, R, Fe Sn
- (4.52m) CS, 0°, 6 mm.t
- (4.55m) CS, 0°, 12 mm.t
- (4.64m) J, 90°, P, R, Cn
- (4.72m) Fragmented Joint, 0°, 80mm.t
- (4.81m) CS, 0°, 8 mm.t
- (4.96m) J, 20°, P, S, Fe Sn
- (5.05m) CS, 0°, 1 mm.t
- (5.15m) XWS, 0°, 1 mm.t
- (5.40m) CS, 0°, 3 mm.t
- (5.50m) J, 90°, P, S, Cn
- (5.84m) J, 90°, P, R, Fe Sn, With associated fragments
- (5.94m) J, 10°, P, R, Fe Sn
- (5.97m) J, 80°, P, S, Cn
- (6.10m) J, 30°, P, S, Fe Sn
- (6.17m) CS, 0°, 2 mm.t
- (6.27m) J, 20°, P, R, Fe Sn
- (6.42m) J, 90°, P, R, Cn, With associated fragments
- (6.50m) Be, 0°, P, S, Fe Sn
- (6.57m) Be, 0°, P, R, Fe Sn
- (6.72m) J, 20°, P, R, Fe Sn
- (7.10m) J, 90°, P, R, Fe Sn
- (7.20m) Be, 0°, P, R, Fe Sn
- (7.29m) Be, 0°, P, R, Fe Sn
- (7.85m) J, 30°, P, S, Fe Sn
- (7.99m) J, 30°, P, S, Fe Sn

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JOB No. 31772L
BH10
START CORING AT 3.24m
3
CL: 0.11m
4
5
6
7
8
EOBH AT 8.03m

AERIAL IMAGE SOURCE: GOOGLE EARTH PRO 7.1.5.1557
AERIAL IMAGE ©: 2015 GOOGLE INC.

This plan should be read in conjunction with the JK Geotechnics report.

Title:
SITE LOCATION PLAN

Location: LORETO NORMANHURST, 91-93 PENNANT HILLS ROAD
NORMANHURST, NSW

Report No: 31772L

Figure No: 1

JK Geotechnics

PLOT DATE: 25/10/2018 5:02:45 PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\31000'S\31772L NORMANHURST\CAD\31772L.DWG

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