Date: 3 July 2019
Ref: 30910Rlet

Meriden School
c/o Allen Jack + Cottier
Level 2/79 Myrtle Street
Chippendale NSW 2008

Attention: Anthony Di Cristo
Email: Anthony.DiCristo@architectsajc.com

GEOTECHNICAL ADVICE
PROPOSED ALTERATIONS AND ADDITIONS
MERIDEN SCHOOL, 16 MARGARET STREET, STRATHFIELD, NSW

We confirm that JK Geotechnics completed a report for proposed alterations and additions at Meriden School (Ref. 30910Rrpt Rev1) dated 30 October 2017. We understand that the Music Academy building, which originally formed part of the proposed alterations and additions did not eventuate. We note that we provided geotechnical advice to Gledhill Constructions between June 2018 and February 2019 during the construction works.

Our report (Ref. 30910Rrpt Rev1) dated 30 October 2017 provided comments on demolition, excavation, retention, site classification to AS2870, footings, soil aggression, earthworks, external paved areas and drainage. Our report also concluded that the site was suitable for the proposed alterations and additions.

We have reviewed the provided architectural drawings (Drawing Numbers DA1000, DA2100 to DA2102, DA3200 and DA3201 Rev. A, dated 23 April 2019) prepared by Allen Jack + Cottier for the Stage 2 – Lingwood Campus Project which form part of a State Significant Development submission. Our review has indicated that it is now proposed to construct a two level Administration and Student Centre building essentially over the footprint of the location of the previously proposed Music Academy building. We have attached an updated test Location Plan (Figure 2) from our previous report, which indicates the location of the proposed Administration and Student Centre building and our previous test locations.

Based on our review of the provided architectural drawings and the contents of our previous report (Ref. 30910Rrpt Rev1) dated 30 October 2017 we note the following:

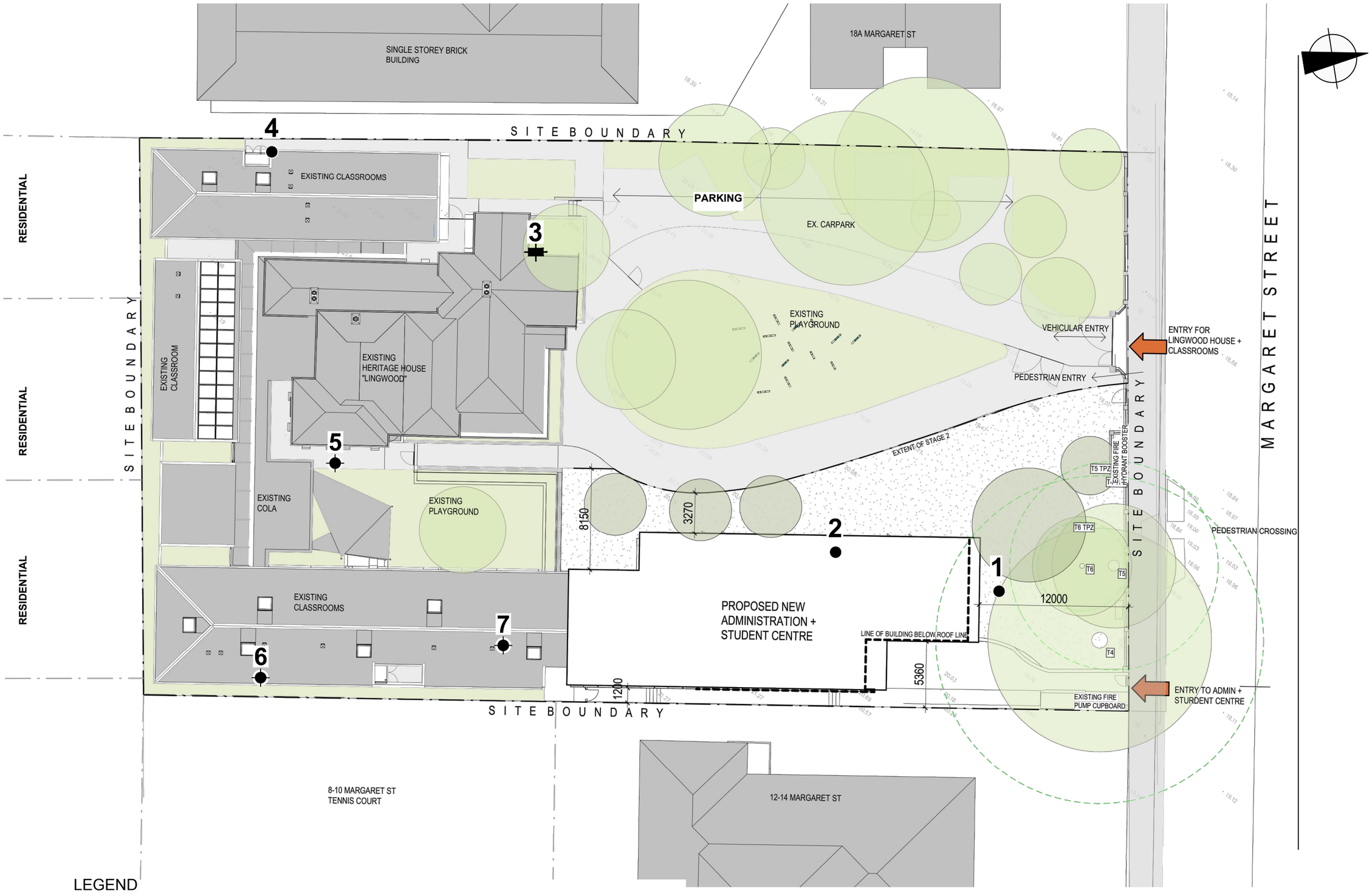
- The proposed finished floor reduced level (RL) of the Ground Floor Level will be formed at RL19.9m, 0.2m lower than the previously proposed Music Academy building. To achieve design surface levels, bulk excavations will now extend to a maximum depth of about 2.4m.
- In our opinion, our previous test locations 1, 2 and 7 provide sufficient geotechnical information over the footprint of the proposed building.

Based on the above, we confirm that the advice presented in our previous report remains valid for the proposed Administration and Student Centre building.

Should you require any further information regarding the above, please do not hesitate to contact the undersigned.

Yours faithfully
For and on behalf of
JK GEOTECHNICS

Paul Roberts
Principal Associate |Engineering Geologist



LEGEND

- ● BOREHOLE
- ✦ BOREHOLE AND DCP TEST (HAND AUGER AND DCP TEST)
- ▬ TEST PIT AND DCP TEST

0 3 6 9 12 15
SCALE 1:300 @A3 METRES

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

Title: **TEST LOCATION PLAN**

Location: 16 MARGARET STREET STRATHFIELD, NSW

Report No: 30910ZR

Figure No: 2

JK Geotechnics

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REPORT

TO
MERIDEN SCHOOL

ON
GEOTECHNICAL INVESTIGATION

FOR
PROPOSED ALTERATIONS AND ADDITIONS

AT
16 MARGARET STREET, STRATHFIELD, NSW

30 October 2017
Ref: 30910ZRrpt

JK Geotechnics
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Date: 30 October 2017
Report No: 30910ZRrpt rev1
Revision No: 1

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For and on behalf of
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TABLE OF CONTENTS

EXECUTIVE SUMMARY

1 INTRODUCTION 1

2 INVESTIGATION PROCEDURE 2

3 RESULTS OF INVESTIGATION 3

3.1 Site Description 3

3.2 Subsurface Conditions 4

3.3 Existing Footing 6

3.4 Laboratory Test Results 6

4 COMMENTS AND RECOMMENDATIONS 6

4.1 Demolition and Excavation 6

4.1.1 General 6

4.1.2 Potential Vibration Risks 8

4.1.3 Dilapidation Surveys 9

4.1.4 Seepage 9

4.2 Temporary Batter Slopes and Retention 9

4.2.1 Temporary Batters and Retention 9

4.2.2 Retention Design Parameters 10

4.3 Footings 10

4.3.1 Site Classification and Shrink Swell Movements 10

4.3.2 Footings 11

4.4 Earthworks 12

4.4.1 Site Preparation 12

4.4.2 Subgrade Drainage 13

4.4.3 Engineered Fill 13

4.5 Floor Slabs, External Paved Areas and Drainage 14

4.7 Soil Aggression 15

4.8 Further Geotechnical Input 15

5 GENERAL COMMENTS 15

STS TABLE A: MOISTURE CONTENT, ATTERBERG LIMITS & LINEAR SHRINKAGE TEST REPORT

BOREHOLE LOGS (1, 2, 4, 5, 6 AND 7)

DYNAMIC CONE PENETRATION TEST RESULTS (3, 5, 6 AND 7)

FIGURE 1: SITE LOCATION PLAN

FIGURE 2: TEST LOCATION PLAN

FIGURE 3: TEST PIT 3 CROSS SECTIONAL SKETCH

VIBRATION EMISSION DESIGN GOALS

REPORT EXPLANATION NOTES

APPENDIX A: ENVIROLAB SERVICES REPORT NO: 177007

EXECUTIVE SUMMARY

JK Geotechnics were commissioned to complete a geotechnical investigation for the proposed alterations and additions at Meriden School, 16 Margaret Street, Strathfield, NSW. The proposed alterations and additions will comprise:

- Construction of new single and two storey buildings (Music Academy, Prep, Amenities, K1 and K2-3 Buildings) along the southern and eastern sides of the school grounds.
- Reconfiguration of the existing historic Lingwood House building.
- A new covered walkway, COLA and external paved areas.
- The proposed finished floor reduced levels (RLs) of the new buildings will be at RL21.82m (Prep, Amenities, K1 and K2-3 Buildings and the COLA) and RL22m (Music Academy). Excavations to a maximum depth of about 0.8m (Prep, Amenities, K1 and K2-3 Buildings and the COLA) and 2.2m (Music Academy) are expected to achieve design subgrade levels.

The geotechnical investigation included six boreholes, one test pit and Four Dynamic Cone Penetration (DCP) tests. The subsurface profile comprised a limited thickness of fill overlying high plasticity, highly reactive residual silty clay with shale bedrock encountered/inferred at shallow to moderate depth. Groundwater was not encountered over the depth of the investigation. The footings supporting the Lingwood Building at the test pit location were founded below 1.35m depth and have been inferred to be founded within residual silty clay or possibly bedrock.

The bulk excavations will generally encounter the soil profile and are expected to be satisfactorily completed, provided appropriate care is exercised during excavation and formation of temporary batter slopes, and that the advice presented in this report is adhered to.

For uniformity of support, we have recommended that the heavier loaded buildings be founded on bedrock whilst lightly loaded buildings may be founded in the residual clay profile.

Provided the design and construction of the footings, floor slabs end external pavements are completed with due regard for the advice presented in this report and the advice presented in AS2870 (particularly with regard to the precautionary advice in AS 2870 with regard to trees in close proximity to buildings) then we do not foresee that any particular geotechnical issues will arise.

Based on the above, we consider that the site is suitable for the proposed alterations and additions.

1 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed alterations and additions at Meriden School, 16 Margaret Street, Strathfield, NSW. The investigation was commissioned on behalf of Meriden School by Pip Bowling of Allen Jack + Cottier (AJ+C) in an email dated 22 September 2017. The commission was on the basis of our fee proposal (Ref. P45764ZR) dated 14 September 2017.

We have been provided with the following information:

- Architectural drawings (Drawing Numbers DA1005 and DA1006 Issue 1, dated 7 September 2017, DA2100, Issue 7, dated 12 October 2017 and DA3202 Issue 2, dated 26 September 2017) prepared by AJ+C.
- A site survey plan (Projects No. 33598, Drawing No. 44549DT, dated 12 April 2017) prepared by LTS Lockley.
- A geotechnical investigation brief (Project Number 17209) prepared by SDA Structures Pty Ltd (SDA).

Based on a review of the provided information, we understand that following demolition of selected buildings and structures, the proposed alterations and additions will comprise:

- Construction of new single and two storey buildings (Music Academy, Prep, Amenities, K1 and K2-3 Buildings) along the southern and eastern sides of the school grounds.
- Reconfiguration of the existing historic Lingwood House building.
- A new covered walkway, COLA and external paved areas.
- The proposed finished floor reduced levels (RLs) of the new buildings will be at RL21.82m (Prep, Amenities, K1 and K2-3 Buildings and the COLA) and RL22m (Music Academy). Excavations to a maximum depth of about 0.8m (Prep, Amenities, K1 and K2-3 Buildings and the COLA) and 2.2m (Music Academy) are expected to achieve design subgrade levels.

The column loads for the new buildings are expected to be of the order of 600kN.

The purpose of the investigation was to obtain geotechnical information on subsurface conditions as a basis for comments and recommendations on demolition, excavation, retention, site classification to AS2870, footings, soil aggression, earthworks, external paved areas and drainage.

Our specialist division Environmental Investigation Services (EIS) was also commissioned to complete a Preliminary Stage 1/Stage 2 Environmental Site Assessment and the results are presented in their report (Ref. E30910KGrpt), which should be read in conjunction with this report.

2 INVESTIGATION PROCEDURE

The fieldwork for the investigation was carried out on 27 and 29 September 2017 and, in some areas of the site, was limited by access constraints to the use of portable hand-held equipment. The fieldwork was completed at the locations nominated by SDA and comprised the following:

- Three boreholes (BH1, BH2 and BH4) auger drilled to depths of 4.5m (BH2) and 6m (BH1 and BH4) using our JK308 track mounted drill rig.
- Three boreholes (BH5, BH6 and BH7) hand auger drilled to a refusal depth of 1.5m (BH5 and BH7) and to 1.2m depth (BH6).
- One test pit (TP3) excavated to 1.35m depth using hand held equipment. The test pit was located adjacent to the northern portion of the western wall of the existing Lingwood House building in an attempt to reveal the extent of the existing footings and confirm foundation conditions.
- Four Dynamic Cone Penetration (DCP) tests (DCP3, DCP5, DCP6 and DCP7) completed adjacent to the test pit and the hand auger boreholes. The DCP tests were extended to refusal depths of about 1.6m (BH7), 1.7m (DCP5 and DCP6) and 1.9m (DCP3).

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

The test locations, as shown on the attached Figure 2 (which is based on the provided survey plan), were set out by taped measurements from existing surface features. The surface reduced levels shown on the attached test pit cross sectional sketch (Figure 3), borehole logs and DCP test results were interpolated between spot levels indicated on the provided survey plan. The survey datum is the Australian Height Datum (AHD).

The state of compaction of the fill and the strength of the residual silty clay soils were assessed from the Standard Penetration Test (SPT) 'N' values, which were augmented by the results of hand penetrometer readings on cohesive soil samples recovered in the SPT split tube and the sides of the test pit. The strength of the augered bedrock profile was assessed from observation of drilling resistance when using a tungsten carbide ('TC') bit, examination of the recovered rock cuttings and subsequent correlation with laboratory moisture content test results.

Groundwater observations were made in the boreholes and test pit during, and on completion of, auger drilling and excavation. No longer term groundwater monitoring was carried out.

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

The fieldwork was carried out under the full time direction of our engineering geologist (Andrew Frost), who set out the test locations, directed the electro-magnetic scan for buried services, logged the encountered subsurface profile and nominated in-situ testing and sampling. The borehole logs (which include field test results and groundwater observations), DCP test results sheets and test pit cross sectional sketch (presented as Figure 3) are attached, together with a glossary of logging terms and symbols used.

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

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

3 RESULTS OF INVESTIGATION

3.1 Site Description

The site is situated within gently undulating topography on a hillside that gently slopes down to the north-east at approximately 3° to 4°. The site has a northern frontage on Margaret Street.

At the time of the investigation, the southern half of the site was generally occupied by a number of single storey brick, sandstone block, weatherboard clad and demountable buildings and fibro clad sheds with concrete and brick paved surrounds.

The northern half of the site comprised grass surfaced areas and planter beds (containing a number of medium to large sized trees) and asphaltic concrete (AC) paved access roads. A gravel surfaced parking area and synthetic grass surfaced play area were located over the western and south-

eastern portions of the site, respectively. The northern and western sides of the synthetic grass surfaced play area were supported by 0.5m high segmental concrete block retaining walls.

Three neighbouring one and two storey brick houses were set back in excess of 10m from the southern site boundary. A neighbouring two storey brick apartment building was set back at least 3.5m from the northern portion of the eastern site boundary. A concrete surfaced basketball court lined the southern portion of the eastern site boundary. Surface levels were similar across the eastern and southern site boundaries.

A neighbouring three storey brick apartment building and a single storey brick building were set back approximately 5m from the northern and southern portions of the western site boundary, respectively. Surface levels stepped down between about 0.5m and 2m to the west across the northern and southern portions of the western site boundary, respectively. The northern and southern portions of the subject site surface levels were respectively supported by a timber retaining wall (in fair condition) and a rendered retaining wall (in good condition).

Based on a cursory inspection from within the site, unless otherwise described above, the buildings and structures within and neighbouring the site were generally in good condition, with the following exceptions within the subject site:

- The fibro clad buildings were in poor condition.
- The (AC) paved access roads were in in fair condition with crocodile cracking and numerous pot holes evident.
- The verandah located on the north eastern corner of the Lingwood House building appeared to be in poor condition, with cracking of the tiled surface and separation from the building wall (maximum about 10mm width) evident. In addition, there was maximum vertical displacement of about 8mm at the crack interfaces.

3.2 Subsurface Conditions

The 1:100,000 geological map of Sydney indicates the site is underlain by Ashfield Shale. The investigation has disclosed a generalised subsurface profile comprising fill over residual silty clay with shale bedrock encountered/inferred at shallow to moderate depth. Groundwater was not encountered over the depth of the investigation. Reference should be made to the attached borehole logs and test pit cross sectional sketch for detailed subsurface conditions at the specific locations. A summary of the pertinent subsurface conditions is presented below:

Topsoil

Silty clay topsoil assessed to be of low to medium plasticity was encountered from surface level in BH1 and BH2 and extended to respective depths of 0.3m and 0.2m.

Fill

Surficial fill comprising silty clay (BH5), silty sand (BH6 and BH7) and silty sandy gravel (BH4) extended to respective depths of 0.3m, 0.55m, 0.4m and 0.2m. In TP3, silty sand fill extended to 0.5m depth and was overlying silty clay fill, which extended to 0.8m depth. The clayey fill was assessed to be of medium to high plasticity. The sandy fill in in BH7 was situated within a sand pit. Based on the DCP tests, the fill was assessed to be poorly (occasionally moderately) compacted.

Residual Silty Clay

Residual silty clay assessed to be of high plasticity, and containing ironstone gravel, was encountered below the fill in all the boreholes and TP3. Generally the silty clay was very stiff to hard strength. However, in TP3, BH6 and BH7, the strength of the silty clay was firm to stiff or stiff to very stiff

TP3, BH5 and BH7 were terminated within the residual silty clay. The hand auger refusal in BH5 at 1.5m depth has been inferred to be due to the presence of ironstone gravel or a band of weathered shale bedrock. The results of DCP3, DCP5, DCP6 and DCP7 below the base of the test pit and the boreholes have been interpreted to indicate residual silty clays typically containing ironstone gravels and/or thin bands of weathered shale bedrock extending to their refusal depths of about 1.6m (BH7), 1.7m (DCP5 and DCP6) and 1.9m (DCP3).

Weathered Shale Bedrock

Weathered shale bedrock was encountered below the residual silty clay in BH1, BH2, BH4 and BH6 at respective depths of 1.8m, 1.5m, 2.8m and 1.1m. On first contact the shale bedrock was assessed to be extremely weathered and of extremely low strength with iron indurated bands, improving with depth to distinctly (occasionally slightly) weathered and medium (occasionally medium to high) strength.

Based on the results of the boreholes, the refusal of the following DCP tests at depths of about 1.6m (BH7), 1.7m (DCP5) and 1.9m (DCP3) have been interpreted to indicate the top surface of weathered shale bedrock. However, the presence of a more continuous band of ironstone and or a band of weathered bedrock within the residual silty clays cannot be discounted.

Groundwater

The boreholes and test pit were 'dry' during, and on completion of, auger drilling and excavation. However, we note that the groundwater levels may not have stabilised within the short observation period. No long term groundwater monitoring was carried out.

3.3 Existing Footing

At the location of TP3, the northern portion of the western wall of the Lingwood Building was supported on a sandstone block footing which extended to 0.9m depth which was in turn supported by a brick footing which extended below the base of the test pit at 1.35m depth. We therefore infer that the building has been founded within residual silty clay of at least stiff to very stiff strength or possibly bedrock.

3.4 Laboratory Test Results

The results of the moisture content tests carried out on recovered rock cutting samples generally correlated well with our field assessment of bedrock strength.

Based on the Liquid Limit and Linear Shrinkage determinations the residual silty clays were confirmed to be of high plasticity with an assessed high potential for shrink/swell reactivity with changes in moisture content.

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

Borehole Number	Sample Depth (m)	Description	pH (Units)	Chloride (mg/kg)	Sulphate (mg/kg)
BH2	0.5-0.95	Silty Clay	4.6	300	450
TP3	0.8 – 1.0	Silty Clay	8.5	31	54
BH7	0.6 – 1.0	Silty Clay	5.3	36	220

4 COMMENTS AND RECOMMENDATIONS

4.1 Demolition and Excavation

4.1.1 General

Excavation recommendations provided below should be complemented by reference to the Safe Work Australia Code of Practice 'Excavation Work', dated July 2015.

Following demolition of the existing buildings, paved surfaces and landscape retaining walls, excavations to a maximum depth of about 0.8m (Prep, Amenities, K1 and K2-3 Buildings and the COLA) and 2.2m (Music Academy building) are expected to achieve design subgrade levels.

Care will be required during demolition and excavation in order to maintain the stability of adjacent sections of buildings and structures within the site that will remain and adjacent neighbouring structures lining, or close to the site boundaries. This work will need to be completed using suitably experienced (and insured) contractors.

Following demolition, removal of trees and stripping of topsoil and root affected soils, the proposed excavations will encounter the soil profile and possibly penetrate weathered shale bedrock over the southern end of the Music Academy building excavation. We expect the excavations to be readily completed using bucket attachments to tracked excavators and possibly ripping tyne attachments for excavation of any low (or higher) strength shale bedrock or ironstone. Rock breaker attachments are not expected to be required to excavate bedrock. Any topsoil or root affected soils may be separately stockpiled for re-use in landscape areas as they are not suitable for reuse as engineered fill.

Tree root systems dry out the surrounding clayey soils and their removal will result in localised moisture recovery leading to swelling which may have a detrimental impact on the performance of nearby buildings and paved surfaces founded/supported in the clayey soil profile within the site. Therefore, trees should only be removed where absolutely necessary and as soon as practicable, in order for the moisture content of the clayey subsoils to recover.

Prior to commencement of the removal of paved surfaces, we recommend that a saw cut be provided where the paved surfaces abut adjacent buildings, structures or sections of paved surfaces that will remain. This will assist in controlling potential damage associated with removal of the adjacent paved surfaces. We expect the saw cut pieces to be removed using ripping tyne and bucket attachments to tracked excavators and possibly a rock breaker required to break up larger pieces of concrete. We expect that if required, small size rock breaker attachments will be used.

When using the rock breaker, ripping tyne or saw attachments, the resulting dust should be suppressed by spraying with water.

4.1.2 Potential Vibration Risks

The localised poorly compacted fill may be present at other locations within the site not disclosed by the investigation. Such fill may extend beyond the area of the proposed works and the site boundaries. We therefore advise that sudden stop/start movements of tracked equipment should be avoided in order to reduce transmission of ground vibrations to adjoining buildings and structures.

Care should be taken where rock breakers are used during demolition so that ground vibrations do not adversely affect adjacent sections of buildings and structures within and neighbouring the site.

For the expected short duration use of the small size rock breakers for demolition activities, we do not expect potentially damaging vibrations to be generated. However, site personnel should qualitatively monitor vibrations and if there are causes for concern then the use of rock breakers should cease and further geotechnical advice sought. We note that the vibrations, although not expected to cause damage, may still result in discomfort to occupants of the school buildings and neighbouring buildings.

To reduce vibrations we recommend that the rock breakers be continually orientated towards the face, be operated one at a time and in short bursts only to reduce amplification of vibrations. When using the rock breakers and/or rock saws the resulting dust should be suppressed by spraying with water.

In the unlikely event that rock breakers are used to locally excavate areas of bedrock or ironstone within the proposed footprint of the Music Academy building, we recommend that periodic quantitative vibration monitoring of the neighbouring building to the east be undertaken. The purpose of the quantitative vibration monitoring is to confirm that peak particle velocities fall within acceptable limits. Subject to viewing the dilapidation reports outlined in Section 4.1.3 below, we recommend that the peak particle velocities along the eastern site boundary do not exceed say 5mm/sec. Should higher vibrations be measured they should be assessed against the attached Vibration Emission Design Goals as higher vibrations may be acceptable depending on the vibration frequency. We note that this vibration limit will reduce the risk of vibration damage to the neighbouring buildings and structures. However, these vibrations may still result in discomfort to occupants of the neighbouring building. If potentially damaging vibrations are confirmed it will be necessary to use lower energy equipment such as smaller rock breakers.

4.1.3 Dilapidation Surveys

Prior to demolition and excavation commencing, detailed dilapidation reports should be compiled on the neighbouring buildings and structures to the east, south and west, within a horizontal distance from the excavation perimeter of at least 5m. In addition, Council may also require that dilapidation survey reports be completed on their assets lining the street frontage, i.e. the paved footpaths, the roadway and kerb and gutter. The property owners should be asked to confirm that the reports present a fair record of existing conditions as the reports may assist the client in defending themselves from unfair damage claims.

4.1.4 Seepage

Groundwater was not encountered during the excavation. However, localised inflows may occur after periods of heavy rain close to, or at, the contact with the underlying bedrock. In general, we expect that inflows, if any, to be of small volume, short duration and managed by conventional sump and pump techniques. Inspection and monitoring of groundwater seepage during excavations is recommended, so that any unexpected conditions, which may be revealed can be incorporated into the drainage design.

4.2 Temporary Batter Slopes and Retention

4.2.1 Temporary Batters and Retention

Temporary batter slopes through the soil profile and any extremely weathered shale bedrock no steeper than 1 Vertical (V) in 1 Horizontal (H) are considered to be appropriate, subject to geotechnical inspection. We expect that the above batter slopes will generally be achievable within the site geometry. This assumes that footings supporting any adjacent existing buildings and structures are founded below bulk excavation level or below a zone of influence line projected up from the toe of the excavation at 1V in 2H.

Locally, over the south-eastern portion of the proposed Music Academy building, the batter slopes may need to be locally steeped. In this instance, the steeper batter slopes should be supported by stiff formwork timbers and engineer designed props. In addition, the excavation over the western side of the proposed K2-3 Building may expose the rear of the existing retaining wall and will need to be completed with care.

4.2.2 Retention Design Parameters

The following characteristic earth pressure coefficients and subsoil parameters may be adopted for the static design of conventional retaining walls and any landscape walls:

- For design of conventional walls that will be supported by the structure, we recommend the use of a triangular lateral earth pressure distribution with an 'at rest' earth pressure coefficient (k_o) of 0.55 for the retained profile, assuming a horizontal backfill surface.
- Where some minor movements of retaining walls may be tolerated (e.g. landscape walls), they may be designed using a triangular lateral earth pressure distribution and a coefficient of 'active' earth pressure, (k_a), of 0.3 for the soil profile, assuming a horizontal backfill surface.
- A bulk unit weight of 20kN/m^3 should be adopted for the retained profile.
- Any surcharge affecting the walls (e.g. nearby footings, compaction stresses, sloping retained surfaces, construction loads etc) should be allowed for in the design using the appropriate earth pressure coefficient from above.
- The retaining walls should be designed as drained and provision made for permanent and effective drainage of the ground behind the walls. Subsurface drains should incorporate a non-woven geotextile fabric, such as Bidim A34, to act as a filter against subsoil erosion. The subsoil drains should discharge into the stormwater system.
- For conventional retaining wall footings keyed into the bedrock below bulk excavation level, an allowable lateral stress of 100kPa may be adopted for shale of at least very low strength. The key depth should commence below the base of any nearby excavations such as for service trenches or footings.
- Lateral restraint of landscape walls founded in the soil profile below bulk excavation level and/or adjacent surface levels may be provided by the passive pressure of the soil below these levels. A 'passive' earth pressure coefficient, K_p, of 3 may be adopted, provided a Factor of Safety of 2 is used in order to reduce deflections. Localised excavations in front of the walls e.g. for buried services etc should also be taken into account in the design.

4.3 <u>Footings</u>

4.3.1 Site Classification and Shrink Swell Movements

We note that AS 2870-2011 does not apply for this type of development. However, due to the removal of existing concrete floor slabs and the presence of a number of trees that will need to be removed, the site is regarded as being impacted by abnormal moisture conditions and a 'P' site classification in accordance with the AS 2870-2011 applies.

Based on the laboratory test results, the residual silty clays are highly reactive and therefore subject to shrink-swell movements with changes in moisture content. We have carried out an indicative assessment of shrink-swell movements using an approximate instability index value based on the linear shrinkage test result. Assuming the trees are removed well ahead of construction (i.e. at least 2 years), the predicted shrink-swell movements are about 55mm. If tree removal is delayed, and/or if some trees remain in place, the predicted shrink-swell movements increase to a maximum of about 75mm. All high levels footings founding in the residual silty clays, floor slabs and on grade external paved areas should be designed with due regard for the recommendations contained in AS2870-2011 for a Class H1 site (if all the trees are removed well in advance) or a Class H2 site if some trees remain and/or if trees are not removed well in advance. We also draw attention to the precautionary advice in AS 2870 with regard to trees in close proximity to buildings.

We note that the existing building footings at the location of TP3 were founded at a depth in excess of 1.35m in either residual silty clay or possibly weathered shale bedrock. Based on the current recommendations for a Class H1 or Class H2 site presented in AS2870, these footings are likely to be founded at sufficient depth. However, we note that the verandah located adjacent to the north eastern corner of Lingwood House was in poor condition and the damage has been interpreted to be due to shrink swell movements with changes in moisture content. On-going cracking of the verandah is therefore inevitable based on the current site conditions. To reduce the on-going impact of shrink swell movements on the existing verandah, consideration may be given to reconstruction of the verandah with footings founded at an appropriate depth for the site classification.

4.3.2 Footings

With regard to the expected column loads for the new buildings, the reactivity of the clay soils and the relatively shallow depth to bedrock, we recommend that the new building footings be founded in the weathered shale bedrock. A combination of pad or strip footings, bucket piers and/or bored piles (drilled using an auger attachment to an excavator) are suitable for the site. Footings founded in weathered shale bedrock may be designed using an allowable bearing pressure of 700kPa, subject to geotechnical inspection. Allowable shaft adhesion values of 70kPa (in compression) and 35kPa (in tension) may be adopted for bedrock pile sockets.

The floor slabs should be suspended between the piles and void formers provided.

For any lightly loaded buildings, consideration may be given to the use of a stiffened raft slab with the slab thickenings founded in the stiff (or higher strength) residual clays and designed for the

appropriate site classification using an allowable bearing pressure of 100kPa, subject to geotechnical inspection.

Any new landscape retaining wall footings may be founded within the stiff (or higher strength) residual clays and designed using an allowable bearing pressure of 100kPa, subject to geotechnical inspection.

We note that the residual silty clays and weathered shale bedrock are susceptible to softening in the presence of water. All loose and any water softened material and any standing water must be removed prior to pouring concrete; some over excavation/over drilling may be required. If there is a delay in pouring concrete then high level footings may be provided with a blinding layer of concrete to protect the footing base. The blinding layer should be poured following geotechnical inspection of the footing bases.

4.4 Earthworks

All earthworks recommendations should be complemented by reference to AS3798-2007.

4.4.1 Site Preparation

The earthworks recommendations provided below should be complemented by reference to AS3798-2007.

Prior to construction of external paved areas, any stiffened raft slabs and prior to placement of any engineered fill, the soil subgrade should be prepared as follows:

- Proof roll the subgrade using at least 6 passes of a minimum 5 tonne dead weight smooth drum static (non-vibration) roller to achieve a compaction of at least 98% of Standard Maximum Dry Density (SMDD). The aim of the proof rolling is to improve near surface compaction and to identify any unstable subgrade areas.
- Proof rolling should be closely monitored by the site supervisor or an experienced geotechnical engineer to detect soft or unstable areas which should be locally excavated down to a stiff base and replaced with engineered fill (as outlined below in section 4.4.3). Care should be taken not to over compact clayey subgrade areas.
- Sections of clay subgrade that contain shrinkage cracks should be watered and rolled until the shrinkage cracks disappear.
- Care will need to be exercised close to nearby existing structures, the new structures and any buried services as ground borne vibrations caused by the proof rolling may cause damage. If

there any causes for concern during proof rolling, then further advice should be sought and/or the non-vibration (static) mode of the roller used.

4.4.2 Subgrade Drainage

The subgrade will generally comprise clayey fill and residual clay soils. The clays may be found to be unstable if proper site drainage is not implemented during construction. It is therefore important to provide good drainage in order to promote run-off and reduce ponding. Earthworks platforms should be graded to maintain cross-falls during construction. If the clays are exposed to periods of rainfall, softening may result and site trafficability will be poor. If softening occurs, the subgrade should be over-excavated to below the depth of moisture softening. The material removed should be replaced with engineered fill. Trafficability may be improved by the use of a sacrificial surface layer of demolition rubble.

4.4.3 Engineered Fill

Any fill required to raise site surface levels should comprise engineered fill.

Engineered fill should be free from organic materials, other contaminants and deleterious substances and have a maximum particle size not exceeding 40mm. We expect the excavated clay soils from the localised excavations may be used as engineered fill. However, we expect that fill will need to be imported to site. Engineered fill should be placed in layers of maximum 100mm loose thickness and compacted with the above mentioned roller to within 2% of Standard Optimum Moisture Content (SOMC) and to at least 95% of SMDD. We note that use of clayey materials for engineered fill requires careful control of moisture contents and will likely have a low soaked CBR value.

To confirm the above specification has been achieved, density tests should be completed at the frequencies defined in AS3798. At least Level 2 testing of earthworks should be carried out in accordance with AS3798. Any areas of insufficient compaction will require reworking.

Alternatively, imported well graded granular material (ripped or crushed sandstone or building rubble) free of deleterious substances and having a maximum particle size of 40mm may be used as engineered fill and also backfill behind retaining walls. Such fill should be compacted in horizontal layers to a minimum density of 95% SMDD using the above mentioned roller. However, close to the rear of retaining walls a hand held plate compactor will most likely need to be used. Care will be required to ensure excessive compaction stresses are not transferred to the retaining

walls. We warn that effective compaction may not be achieved behind retaining walls and post construction settlements may occur.

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

4.5 Floor Slabs, External Paved Areas and Drainage

We forewarn that the clayey soils at the proposed design subgrade levels may be susceptible to weathering and degradation following exposure to the elements and in particular rainfall periods. We therefore recommend that good and effective drainage be provided during construction. The principal aim of the drainage is to promote run-off towards designated sumps by cross-falls and to reduce ponding. Any softened material should be scraped off prior to stiffened raft slab construction (if selected).

Any external paved areas supporting traffic loads should be provided with at least a 100mm thick subbase of good quality, durable, single size, crushed rock (free of 'fines') such as 'blue metal' gravel, which will also act as drainage. The subbase will also provide more uniform support and will reduce the "pumping" of "fines" at joints.

Sub-soil drains should be provided along the perimeter of any external paved areas, with inverts not less than 0.2m below subgrade level. The drainage trenches should be excavated with a longitudinal fall to appropriate discharge points so as to reduce the risk of water ponding. The subgrade of the paved areas should be graded to promote water flow or infiltration towards sub-soil drains.

Due to the shrink-swell nature of the residual silty clays and any clayey fill subgrades, any garden beds should be avoided adjacent to the proposed buildings as moisture ingress into the subgrade at these locations could cause movement and damage to nearby structural elements. If planter boxes are proposed, then they should be completely encased in concrete with base drainage connected to the stormwater system. Furthermore, to reduce rainwater sheeting flows off the external walls from entering the subgrade, we recommend that all joints between the buildings and external pavements be infilled using a flexible "Mastic" sealer.

Where paved edges are lined by landscaping strips, we recommend that an edge thickening be provided for protection against erosion and the effects of possible future topsoil stripping.

4.7 Soil Aggression

Based on the advice provided in Table 4.8.1 of AS3600-2009 “Concrete Structures” we note that the laboratory chemical test results have indicated that an A1 and A2 Exposure Classification applies. We recommend that an A2 Exposure Classification is adopted.

For concrete pile footings, based on the advice provided in AS2159-2009 “Piling Design and Installation”, a ‘Non-Aggressive’ and ‘Mild’ Exposure Classification would apply (based on Table 6.4.2(C) of AS2159). We recommend that a ‘Mild’ Exposure Classification is adopted.

4.8 Further Geotechnical Input

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

- Dilapidation surveys.
- Monitoring groundwater seepage into the excavation.
- Proof-rolling inspections.
- Density testing of all engineered fill.
- Inspection of bored piles, bucket piers and/or high level footings.

5 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and JK Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

Occasionally, the subsurface conditions between and below the completed boreholes, test pit and DCP tests 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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North Ryde, BC 1670
Telephone: 02 9888 5000
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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 Alterations and Additions
Location: 16 Margaret Street, Strathfield, NSW

Ref No: 30910ZR
Report: A
Report Date: 11/10/2017
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	0.50-0.95	29.6	71	24	47	16.5
2	2.50-3.00	6.6				
2	3.50-4.50	5.3				
4	4.00-4.50	5.9				
4	5.00-6.00	4.3				
5	0.50-1.00	24.5	66	22	44	15.5

Notes:

- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 4/10/2017

All services provided by STS are subject to our standard terms and conditions. A copy is available on request.

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
1
1/1

Client: MERIDEN SCHOOL
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: 16 MARGARET STREET, STRATHFIELD, NSW

Job No. 30910ZR
Date: 27-9-17
Method: SPIRAL AUGER JK308
R.L. Surface: ≈ 19.8m
Datum: AHD
Logged/Checked by: A.F./P.R.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0			TOPSOIL: Silty clay, low to medium plasticity, brown, trace of roots and root fibres, ash and fine to medium grained sand.	MC>PL			GRASS COVER
								CH	SILTY CLAY: high plasticity, orange brown, trace of ironstone gravel.	MC>PL	VSt		RESIDUAL
	■			■	N = 8 3,3,5							250 280 300	
						1							
				■	N = 18 5,8,10						H	420 420 420	
				■		2		-	SHALE: grey brown, with iron indurated bands and clay bands.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
						3				DW	VL		VERY LOW TO LOW 'TC' BIT RESISTANCE
				■					as above, but without iron indurated bands, dark grey.		L-M		LOW TO MODERATE RESISTANCE
						4							
				■		5				SW	M		MODERATE RESISTANCE
						6			END OF BOREHOLE AT 6.0m				
						7							

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BOREHOLE LOG

Borehole No.
2
1/1

Client: MERIDEN SCHOOL
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: 16 MARGARET STREET, STRATHFIELD, NSW

Job No. 30910ZR
Date: 27-9-17
Method: SPIRAL AUGER JK308
R.L. Surface: ≈ 20.4m
Datum: AHD
Logged/Checked by: A.F./P.R.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION & AFTER 1 HR	■					0			TOPSOIL: Silty clay, low to medium plasticity, brown, trace of fine grained sand and root fibres.	MC<PL			GRASS COVER
								CH	SILTY CLAY: high plasticity, orange brown, trace of fine grained ironstone gravel.	MC≈PL	H		RESIDUAL
	■			■	N = 12 4,6,6							400 >600 >600	
						1							
				■	N = 22 7,11,11			-	SHALE: grey brown, with iron indurated bands.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
						2							
				■					as above, but without iron indurated bands.	DW	L-M		LOW RESISTANCE
						3							
				■						SW	M		MODERATE RESISTANCE
						4							
									END OF BOREHOLE AT 4.5m				
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
4
1/1

Client: MERIDEN SCHOOL
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: 16 MARGARET STREET, STRATHFIELD, NSW

Job No. 30910ZR
Date: 27-9-17
Method: SPIRAL AUGER JK308
R.L. Surface: ≈ 21.9m
Datum: AHD
Logged/Checked by: A.F./P.R.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0			FILL: Silty sandy gravel, fine to medium grained, angular igneous gravel, light brown, fine to medium grained sand.	D			
								CH	SILTY CLAY: high plasticity, brown, trace of fine grained ironstone gravel.	MC≈PL	H		RESIDUAL
	■			■	N = 15 6,8,7							400 500 470	
						1							
				■	N = 15 5,7,8					MC>PL	VSt	310 260 300	
						2							
						3		-	SHALE: orange brown and grey brown, with iron indurated bands.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
				■		4			as above, but dark grey.	DW	L-M		LOW TO MODERATE RESISTANCE
						5				SW	M-H		MODERATE TO HIGH RESISTANCE
						6			END OF BOREHOLE AT 6.0m				
						7							

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BOREHOLE LOG

Borehole No.
5
1/1

Client: MERIDEN SCHOOL
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: 16 MARGARET STREET, STRATHFIELD, NSW

Job No. 30910ZR **Method:** HAND AUGER **R.L. Surface:** ≈ 22.2m
Date: 27-9-17 **Datum:** AHD
Logged/Checked by: A.F./P.R

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■				REFER TO DCP TEST RESULTS	0			MULCH: 100mm.t				APPEARS MODERATELY COMPACTED
								CH	FILL: Silty clay, medium to high plasticity, brown, trace of fine grained igneous and ironstone gravel, fine grained sand and root fibres.	MC≈PL			
										MC>PL	VSt		
	■			■					SILTY CLAY: high plasticity, orange brown, trace of fine grained ironstone gravel.			300 280 270	RESIDUAL
						1							
									as above, but light grey.	MC<PL	(H)		TOO FRIABLE FOR HP TESTING
									END OF BOREHOLE AT 1.5m				HAND AUGER REFUSAL
						2							
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
6
1/1

Client: MERIDEN SCHOOL
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: 16 MARGARET STREET, STRATHFIELD, NSW

Job No. 30910ZR **Method:** HAND AUGER **R.L. Surface:** ≈ 22.2m
Date: 29-9-17 **Datum:** AHD
Logged/Checked by: A.F./P.R.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION	■			■	REFER TO DCP TEST RESULTS	0			FILL: Silty sand, fine to medium grained, brown, with root fibres and clay fines.	D			GARDEN BED COVER APPEARS POORLY COMPACTED
	■							CH	SILTY CLAY: high plasticity, mottled red brown and light grey, trace of fine to medium grained ironstone gravel.	MC>PL	F-St	100	RESIDUAL
	■			■								50	
											St-VSt	80	
				■		1			as above, but light grey, with ironstone gravel.			180	
				■				-		XW	EL	160	
									SHALE: light grey, with L-M strength iron indurated bands.			180	HAND AUGER REFUSAL ON INFERRED IRONSTONE BAND
									END OF BOREHOLE AT 1.2m			250	
												200	
												210	
						2							
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
7
1/1

Client: MERIDEN SCHOOL
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: 16 MARGARET STREET, STRATHFIELD, NSW

Job No. 30910ZR **Method:** HAND AUGER **R.L. Surface:** ≈ 22.0m
Date: 29-9-17 **Datum:** AHD
Logged/Checked by: A.F./P.R.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■				REFER TO DCP TEST RESULTS	0			FILL: Sand, fine to medium grained, yellow brown.	D			SAND PIT APPEARS POORLY COMPACTED
	■			■		1		CH	SILTY CLAY: high plasticity, orange grey brown, trace of medium grained ironstone gravel.	MC>PL	St	150 170 160	RESIDUAL
									as above, but light grey.	MC≈PL	H		TOO FRIABLE FOR HP TESTING
									END OF BOREHOLE AT 1.5m				
						2							
						3							
						4							
						5							
						6							
						7							

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DYNAMIC CONE PENETRATION TEST RESULTS

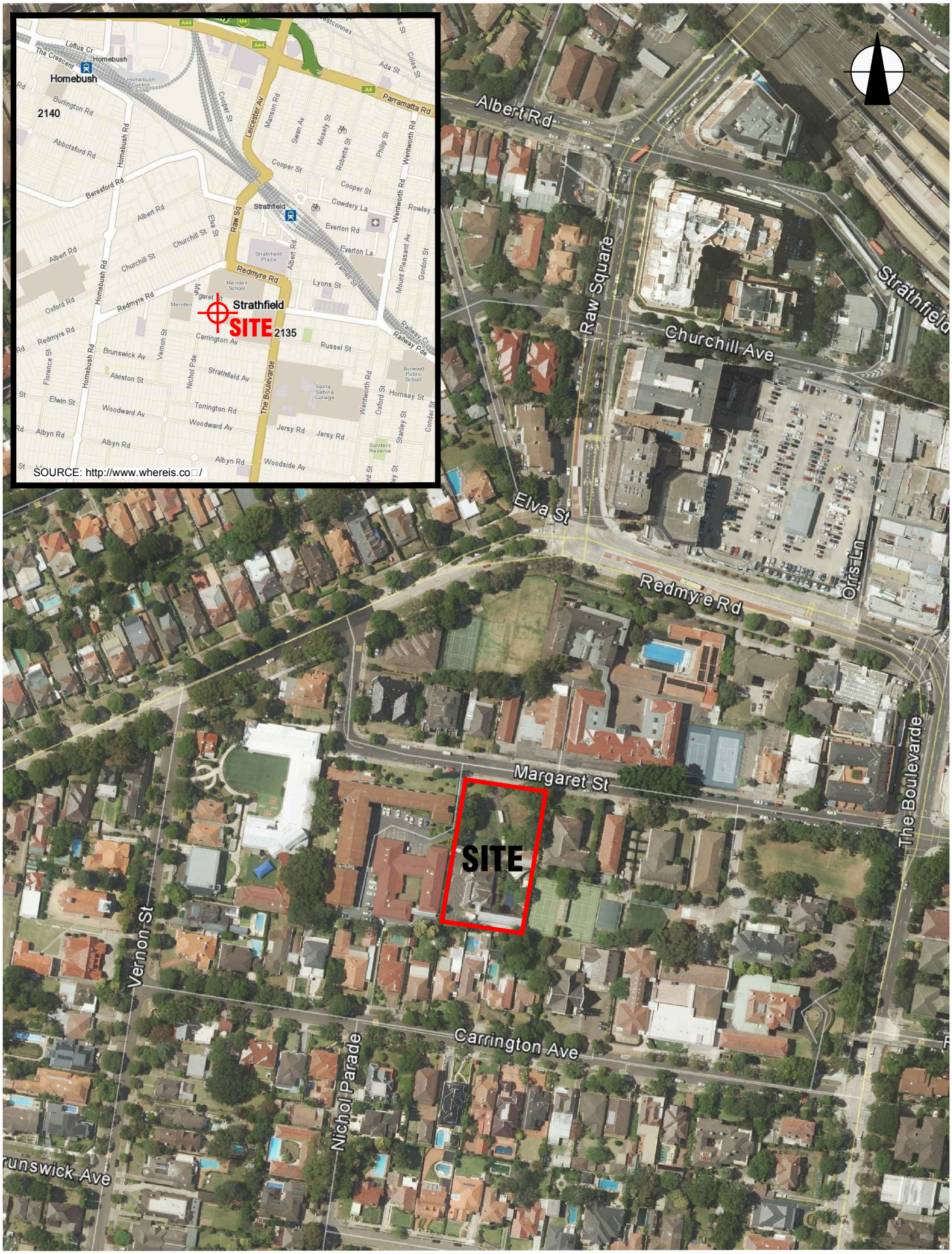
Client:	MERIDEN SCHOOL		
Project:	PROPOSED ALTERATIONS AND ADDITONS		
Location:	16 MARGARET STREET, STRATHFIELD, NSW		
Job No.	30109ZR	Hammer Weight & Drop: 9kg/510mm	
Date:	29-9-17	Rod Diameter: 16mm	
Tested By:	A.F.	Point Diameter: 20mm	

Number of Blows per 100mm Penetration

Test Location	RL ~21.2m	RL ~22.2m	RL ~22.2m	RL ~22.0m			
Depth (mm)	**3**	**5**	**6**	**7**			
0 - 100	SUNK	SUNK	3	1			
100 - 200	2	6	6	1			
200 - 300	2	9	5	2			
300 - 400	3	9	1	8			
400 - 500	11	8	2	6			
500 - 600	7	8	2	6			
600 - 700	5	7	1	3			
700 - 800	3	6	2	2			
800 - 900	3	7	4	3			
900 - 1000	3	7	5	4			
1000 - 1100	4	8	5	3			
1100 - 1200	4	7	6	4			
1200 - 1300	4	14	8	4			
1300 - 1400	4	17	10	7			
1400 - 1500	9	17	9	9			
1500 - 1600	7	22	10	14			
1600 - 1700	9	25	15/50mm	10/20mm			
1700 - 1800	16	REFUSAL	REFUSAL	REFUSAL			
1800 - 1900	24						
1900 - 2000	REFUSAL						
2000 - 2100							
2100 - 2200							
2200 - 2300							
2300 - 2400							
2400 - 2500							
2500 - 2600							
2600 - 2700							
2700 - 2800							
2800 - 2900							
2900 - 3000							

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

Ref: JK Geotechnics DCP 0-3m July 2012



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:	16 MARGARET STREET STRATHFIELD, NSW
Report No:	30910ZR
Figure No:	1

JK Geotechnics

PLOT DATE: 16/10/2017 3:15:37 PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\30000'S\30910ZR STRATHFIELD\CAD\30910ZR.DWG

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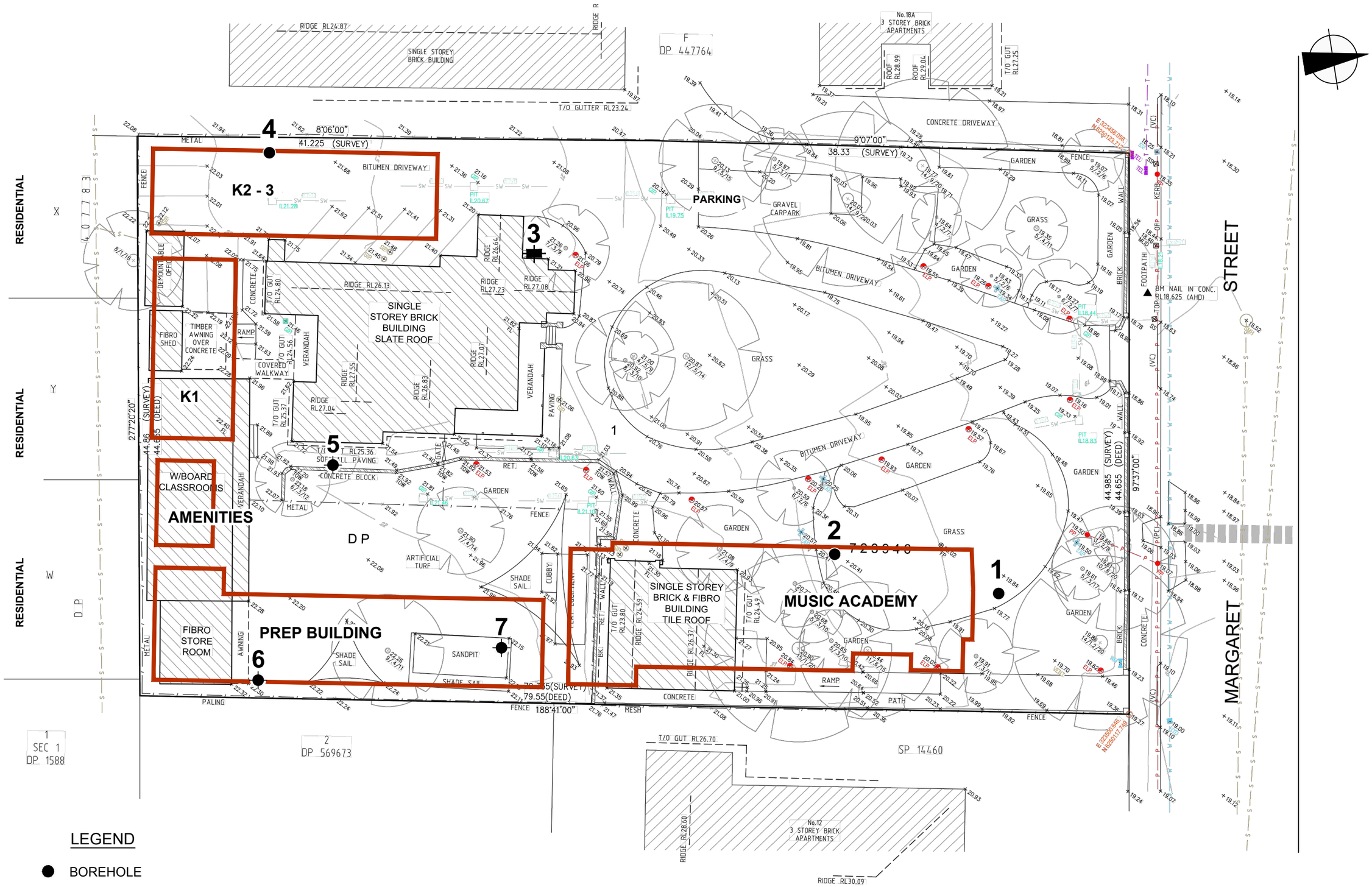

LEGEND

- ● BOREHOLE
- BOREHOLE AND DCP TEST (HAND AUGER AND DCP TEST)
- TEST PIT AND DCP TEST
- APPROXIMATE OUTLINE OF PROPOSED BUILDINGS

0 3 6 9 12 15
SCALE 1:300 @A3 METRES

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

Title:	TEST LOCATION PLAN
Location:	16 MARGARET STREET STRATHFIELD, NSW
Report No: 30910ZR	Figure No: 2
	JK Geotechnics

PLOT DATE: 20/10/2017 12:13:56 PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\30000'S\30910ZR STRATHFIELD\CAD\30910ZR.DWG

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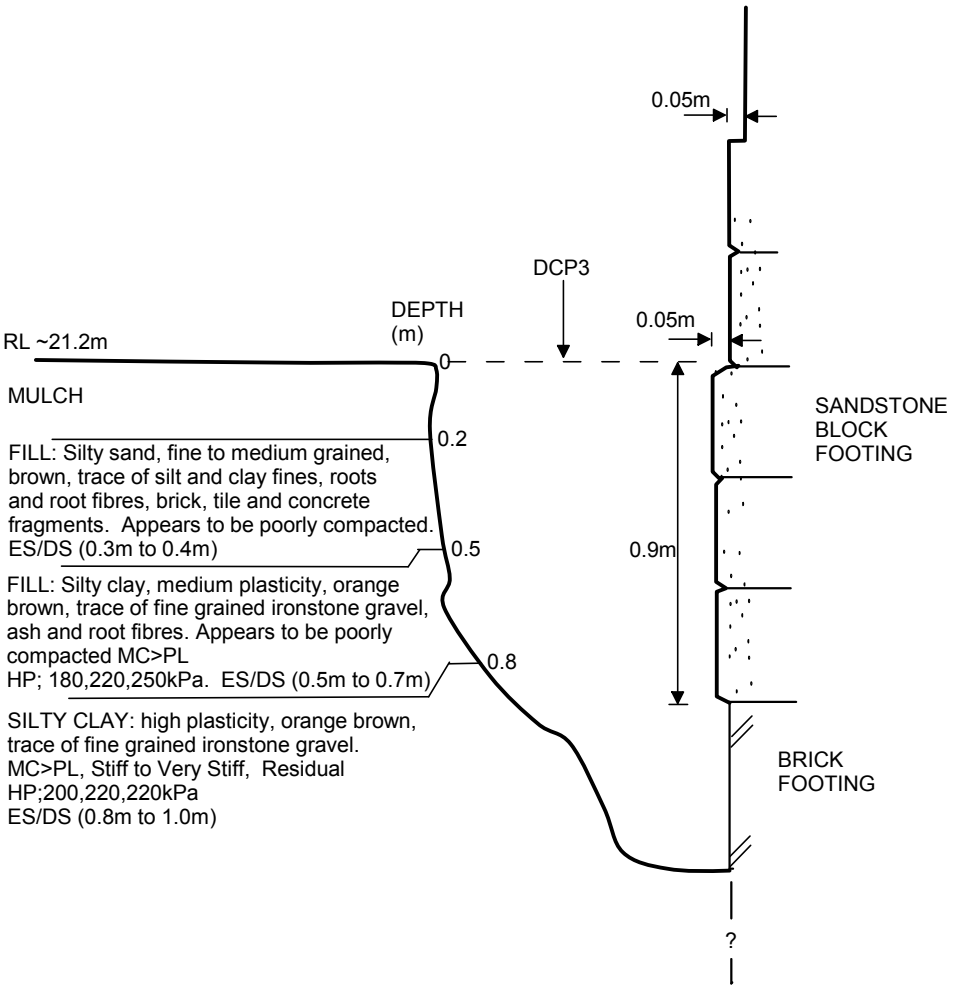

END OF TEST PIT AT 1.35m
DRY ON COMPLETION

TEST PIT 3
CROSS SECTIONAL SKETCH
LOOKING EAST

0 1.0
Scale 1:20 @A4 Metres

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Report No. 30910ZR Figure No. 3

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VIBRATION EMISSION DESIGN GOALS

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

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

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

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

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

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

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

REPORT EXPLANATION NOTES

INTRODUCTION

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

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

DESCRIPTION AND CLASSIFICATION METHODS

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

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

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

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

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

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

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

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

SAMPLING

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

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

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

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

INVESTIGATION METHODS

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

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

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

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

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

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration.

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

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

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" – Test F3.1.

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

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

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

  N>30
  15, 30/40mm

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

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

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

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

In the tests, a 35mm or 44mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm or 165mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

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

The information provided on the charts comprise:

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

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

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

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

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

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

Two relatively similar tests are used:

- Cone penetrometer (commonly known as the Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS1289, Test F3.2). The test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various Road Authorities.
- Perth sand penetrometer – a 16mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test F3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

LOGS

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

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

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

GROUNDWATER

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

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

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

FILL

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

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

LABORATORY TESTING

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

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the company will be pleased to review the report and the sufficiency of the investigation work.

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

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

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

SITE ANOMALIES

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

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Attention is drawn to the document *'Guidelines for the Provision of Geotechnical Information in Tender Documents'*, published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

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

REVIEW OF DESIGN

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

SITE INSPECTION

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

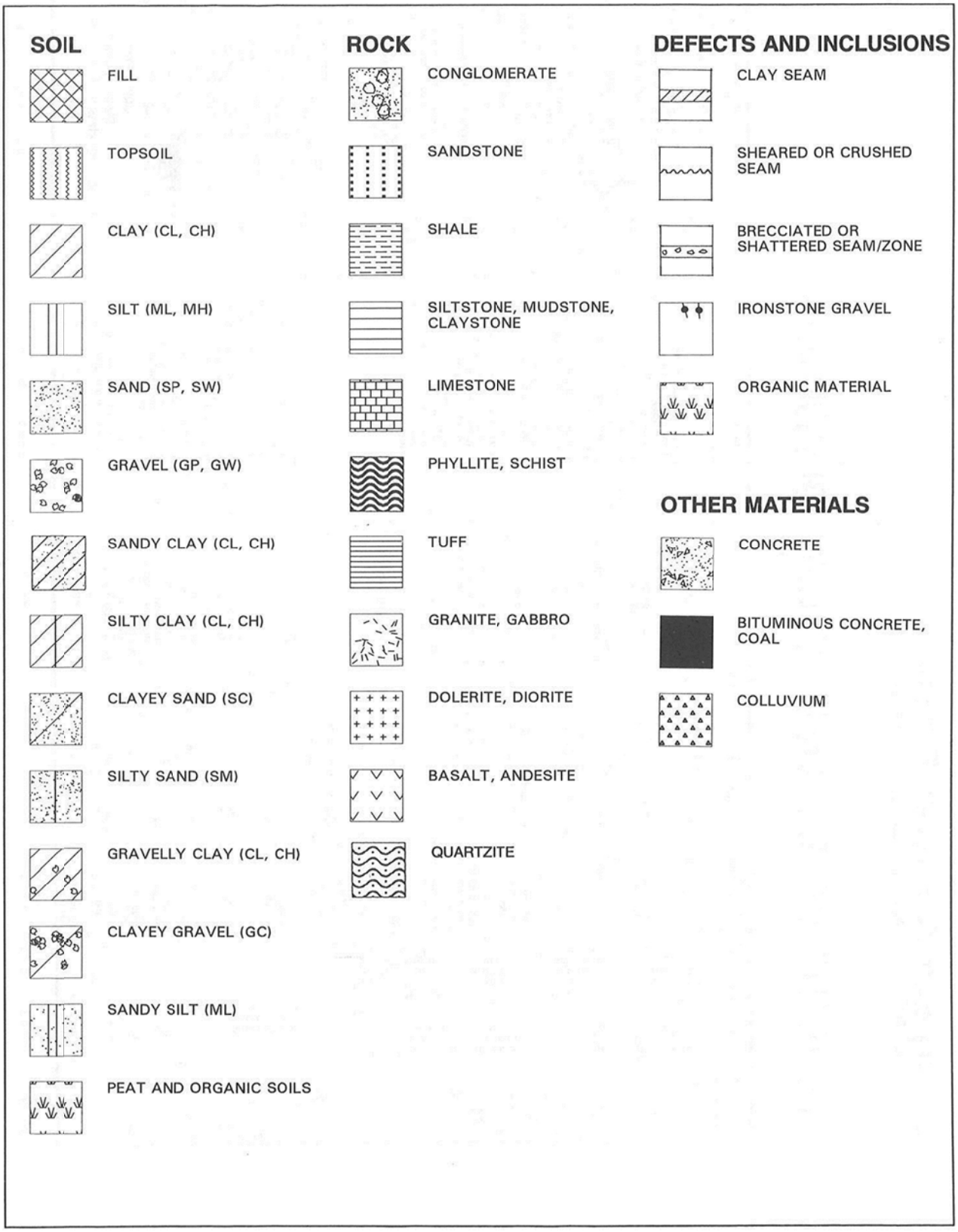
Requirements could range from:

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

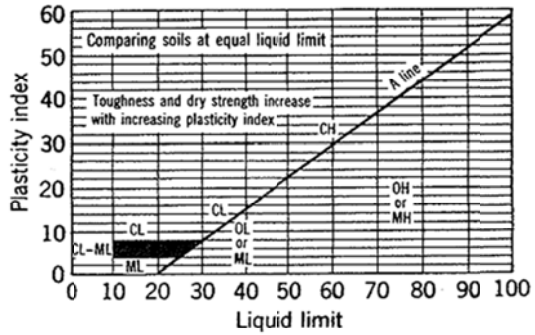
ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or

iii) full time engineering presence on site.

GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS



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



Plasticity chart
for laboratory classification of fine grained soils

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

LOG SYMBOLS

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

LOG SYMBOLS continued

ROCK MATERIAL WEATHERING CLASSIFICATION

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

ROCK STRENGTH

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

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

ABBREVIATIONS USED IN DEFECT DESCRIPTION

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

APPENDIX A

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CERTIFICATE OF ANALYSIS 177007

Client Details

Client	JK Geotechnics
Attention	A Frost
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**30910ZR, Strathfield**
Number of Samples	3 Soil
Date samples received	04/10/2017
Date completed instructions received	04/10/2017

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.

Report Details

Date results requested by	11/10/2017
Date of Issue	09/10/2017

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

Results Approved By
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Misc Inorg - Soil				
Our Reference		177007-1	177007-2	177007-3
Your Reference	UNITS	BH2	BH3	BH7
Depth		0.5-0.95	0.8-1.0	0.6-1.0
Date Sampled		29/09/2017	29/09/2017	29/09/2017
Type of sample		Soil	Soil	Soil
Date prepared	-	06/10/2017	06/10/2017	06/10/2017
Date analysed	-	06/10/2017	06/10/2017	06/10/2017
pH 1:5 soil:water	pH Units	4.6	8.5	5.3
Sulphate, SO4 1:5 soil:water	mg/kg	450	54	220
Chloride, Cl 1:5 soil:water	mg/kg	300	31	36

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-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	177007-2
Date prepared	-			06/10/2017	1	06/10/2017	06/10/2017		06/10/2017	06/10/2017
Date analysed	-			06/10/2017	1	06/10/2017	06/10/2017		06/10/2017	06/10/2017
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	4.6	4.6	0	102	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	450	410	9	98	95
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	300	260	14	100	99

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: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-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.