REPORT TO

HAMMONDCARE

ON

GEOTECHNICAL ASSESSMENT

FOR

PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

AT

4-12 NERINGAH AVENUE SOUTH,
WAHROONGA, NSW

Date: 2 November 2022
Ref: 35312Brpt

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Table of Contents

1 INTRODUCTION 1

2 PREVIOUS 2010 GEOTECHNICAL INVESTIGATION PROCEDURE 2

3 CURRENT 2022 JKE INVESTIGATION 2

4 RESULTS OF INVESTIGATION 3

- 4.1 Site Description 3
- 4.2 Subsurface Conditions 4

5 COMMENTS AND RECOMMENDATIONS 5

- 5.1 Generalised subsurface Profile and Additional Geotechnical Investigation 5
- 5.2 Excavation 6
- 5.3 Groundwater 7
- 5.4 Retention 8
- 5.5 Footings 9
- 5.6 Earthworks Design Parameters 10
- 5.7 Soil Aggression 10
- 5.8 Basement Slabs 10

6 GENERAL COMMENTS 10

ATTACHMENTS

Appendix A – Results from 2010 Geotechnical Investigation 24031SP2
- STS Table A: Summary of Laboratory Test Results
- STS Table B: Summary of Point Load Strength Index Test Results
- Envirolab Services Pty Ltd Certificate of Analysis 41631
- Borehole Logs 1 to 12 Inclusive (With Core Photographs)
- Figure 1: Borehole Location Plan
- Figure 2a and 2b: Graphical Borehole Summaries
- Report Explanation Notes

Appendix B – Results from 2022 JKE Environmental Investigation (E35312BR)
- JKE Borehole Logs 101 to 115 Inclusive
- Figure 1: Site Location Plan
- Figure 2: Sample Location Plan
- JKE Report Explanation Notes

1 INTRODUCTION

This report presents the results of a geotechnical assessment for the proposed redevelopment of Neringah Hospital located at 4-12 Neringah Avenue South, Wahroonga, NSW. The location of the site is shown in the JKE Figure 1 provided in Appendix B. The assessment was commissioned by Alex Lisney of HammondCare and was carried out in accordance with our proposal dated 27 May 2022, Ref: P56645B.

We understand that an application will be submitted to the Department of Planning and Environment (DPE) in support of a State Significant Development Application (SSD-45121248) for the redevelopment of the eastern part of Neringah Hospital at 4-12 Neringah Avenue South for the purposes of delivering additional health services, aged care and seniors housing, as well as upgraded palliative care facilities, that will contribute to the broader operation of Neringah Hospital.

From the supplied information and review of the preliminary architectural drawings by Bickerton Masters (Project No. 01368, dated 19/10/22) we understand that the SSDA seeks approval for the following:

- Site preparation works comprising:
  - Demolition of the Neringah Hospital building, kiosk, and existing at-grade carparks;
  - Clearing of nominated vegetation within the proposed development areas;
  - Bulk earthworks including basement excavation; and
  - Remediation works where necessary across the site.
- Construction and use of an integrated seniors housing and health services facility across two buildings ranging from four to five storeys above ground, comprising:
  - Two basement levels containing a minimum of 130 car parking spaces and service dock;
  - 12 residential aged care facility beds (extension to existing Stage 1 provision);
  - 18 palliative care hospice beds (Schedule 3 health services facility);
  - Community healthcare services, including outpatient palliative care, centre for positive aging and Hammond at Home;
  - 57 seniors housing dwellings; and
  - On-site administration, amenities, and ancillary operations spaces.
- The lowest basement level is proposed at RL192.92m, with the basement above at RL196.26m extending further to the south that the lower basement. Excavation for the basements is anticipated to range from about 7m at the northern end of the site to about 13m at the southern end;
- Ground level and on-building landscaping works, including the provision of a through site pedestrian link connecting Archdale Park and Balcombe Park;
- Public domain works, specifically, regrading of part of the pedestrian walkway known as 'Archdale Walk' to provide accessible connection; and
- Extension and augmentation of infrastructure and services as required including new site signage.

The purpose of the assessment was to review geotechnical information on the subsurface conditions obtained during a geotechnical investigation completed in 2010 and to review the results of a current environmental investigation by our specialist division, JK Environments, and to use this as a basis for providing

comments and recommendations on excavation, groundwater, retention, footings and any geotechnical investigations required for the development.
The results of the JKE environmental investigation are provided within a separate report, Ref: E35312BRrpt.

2 PREVIOUS 2010 GEOTECHNICAL INVESTIGATION PROCEDURE

We completed a geotechnical investigation of the hospital site in 2010 for the then redevelopment, in particular the western portion of the site. This comprised the drilling of boreholes, BH1 to BH12, at the locations shown on Figure 1 within Appendix A. The results of the 2010 investigation are provided in Appendix A.

BH1 to BH9 were drilled using our track mounted JK250 drilling rig, with BH1 to BH4 and BH6 to BH8 auger drilled only to depths ranging from 7m to 7.5m. BH5 and BH9 were auger drilled to depths of 5.79m and 7.29m, respectively and were then continued using diamond coring techniques using an NMLC core barrel with water flush to total depths of 11.86m and 11.94m. BH10 to BH12 were drilled using a hand auger to depths of 0.5m.

The strength of the residual silty clay was assessed from Standard Penetration Test (SPT) ‘N’ values, augmented by hand penetrometer readings on cohesive samples recovered by the SPT split tube sampler. The strength of the augered rock was assessed from observations of the resistance to drilling of a Tungsten Carbide (TC) bit attached to the augers, together with inspection of the recovered rock chip samples and subsequent correlation with laboratory moisture content test results. Rock strengths assessed in this manner are approximate only and variations of one strength order should not be unexpected. In BH5 and BH9, the strength of the cored rock was assessed from laboratory Point Load Strength Index ($I_{S(50)}$) test results. The point load strength index test results are summarised in STS Table B and on the cored borehole logs.

Groundwater observations were made during and on completion of drilling. No longer term monitoring of groundwater levels was carried out.

Our geotechnical engineer set out the borehole location, nominated the sampling and testing locations and logged the subsurface conditions encountered.

Selected samples were returned to Soil Test Services Pty Ltd (STS) and Envirolab Services Pty Ltd, both NATA accredited laboratories, for testing to determine moisture contents, Atterberg limits, linear shrinkages, point load strength index values, pH, sulphate contents, and chloride contents. The results of the laboratory testing are provided in STS Tables A and B and Envirolab Certificate of Analysis 41631.

3 CURRENT 2022 JKE INVESTIGATION

The investigation by JKE involved the drilling of BH101 to BH115 at the locations shown on JKE Figure 2 in Appendix B. Copies of the JKE borehole logs are provided in Appendix B.

The majority of the boreholes were drilled using either an Eziprobe push tube rig, or using a hand auger and so were terminated within the residual silty clay at depths ranging from 0.5m to 2.4m. BH102, BH107, BH109 and BH114 were auger drilled using our track mounted JK305 or truck mounted JK400 drill rigs to depths ranging from 8.2m to 14m and so encountered the siltstone bedrock. During the drilling of BH114 a geotechnical engineer from JKG was present and logged the subsurface conditions encountered and assessed the strength of the residual silty clay and the weathered siltstone. The remaining boreholes were logged by an environmental scientist and so estimation of the soil or rock strengths were not made.

Groundwater monitoring wells were installed in BH102, BH107, BH109 and BH114 and two site visits made by JKE a few days after completion to measure groundwater levels. No longer term monitoring of groundwater levels were carried out.

4 RESULTS OF INVESTIGATION

4.1 Site Description

The site is located approximately mid-slope on the northern side of a hill that generally slopes at about 4° to 5° down to the north from the Pacific Highway. The site itself is on the western side of Neringah Avenue South and slopes with the hillside down to the north, with a total change in level of about 12m from the southern end of the site to the northern end.

The site contains a four-storey brick hospital building, with a two-storey building connected to the northern side. In the middle of the building is an open courtyard. The hospital building appears to be in fair to good condition. A concrete footpath and staircase run along the western side of the hospital. Directly to the south of the hospital is an asphalt driveway and a concrete carpark that appeared to be in good condition. East of the carpark is a single storey sandstone block and fibro kiosk. The kiosk appeared to be in fair external condition.

The southern portion of site comprised a vacant grassed area, with an asphalt driveway off Neringah Avenue south. This area generally slopes down to the north at about 2°, but the ground surface is uneven and small mounds are present. On the northern side of the vacant portion of the site is a garden bed that steps down about 2m to 3m to the hospital's concrete carpark.

To the north of the hospital building is an asphalt/gravel car park, which appeared to be in fair condition.

Along the eastern boundary of site, with Neringah Avenue South, is a sandstone block wall, where driveways are not present, that ranged from 1m to 1.8m in height and appeared to be in fair condition. On the eastern side of Neringah Avenue south are medium to high density residential unit developments.

To the west of the site is the Neringah Residential Aged Care building, which comprises a three and four storey brick building, set back about 6m to 8m from the hospital building within the subject site. The building appears to be in good external condition and is at a similar ground level to the subject site. From our previous involvement we understand that this building has basement levels. To the south of the adjoining building is a single storey rendered cottage that appeared to be in good condition. The ground surface around the cottage is about 2m higher than the ground level of the concrete carpark within the subject site. To the west of the vacant portion of the subject site is a two-storey sandstone block and fibro residential development, set back about 8m from the common boundary. The building appears to be in fair external condition and is at a similar ground level to the vacant portion of the subject site.

The neighbouring property to the north contains a five-storey rendered brick apartment building, set back about 5m from the common boundary. The building appears to be relatively new and in good external condition. A basement carpark was observed from the street below this building. The neighbouring site slopes at about 2° to 3° down to the north, but adjacent to the subject site is at a similar level.

To the south of site is a large brick water reservoir of about 10m to 12m in height. The water reservoir is set back about 1m from the common boundary and the ground surface appeared to be about 0.1m to 0.3m higher than the subject site.

4.2 Subsurface Conditions

Reference to the Sydney 1:100,000 Geological Series Sheet indicates that the site is mapped to be underlain by Ashfield Shale, which compromises grey and dark grey shale with laminite bands. We note that there are differences in the terms used between the geotechnical boreholes drilled in 2010 and the environmental boreholes drilled in 2022 due to changes to the Australia Standard AS1798:2017. The main difference is the terminology used for the bedrock encountered, with the rock described as "shale" in the 2010 logs and "siltstone" in the 2022 logs. This change is description does not change the condition of the rock as both shale and siltstone described form part of the Ashfield Shale geological unit. For the purposes of this report the terms shale and siltstone may be interchangeable and describe the same rock as part of the Ashfield Shale.

In summary, the boreholes encountered fill covering residual silty clay that graded into weathered shale or siltstone bedrock. However, the bedrock is of poor quality with extremely weathered rock extending for significant depths. Further comments on the subsurface conditions encountered are provided below. The results have not been separated between the western portion of the site that has been redeveloped and the eastern sections that will be redeveloped as part of the current works, as the overall subsurface conditions provide a general profile for the site. Reference should be made to the borehole logs for detailed descriptions of the conditions encountered at each location.

Pavements and Fill

Concrete and asphaltic concrete was initially encountered at some locations between 10mm and 160mm thickness. Fill was encountered in the 2010 boreholes to depths ranging from 0.4m to 1.1m, but this may have been disturbed since the time of drilling and the fill depth may now vary. In the 2022 JKE boreholes, fill was encountered to depths ranging from 0.15m to 2.2m. The fill predominantly comprised silty clay and silty sandy clay with varying proportions of igneous, ironstone and sandstone gravel and root fibres.

Topsoil

In some of the 2010 boreholes topsoil was encountered generally of 0.15m thickness, but this is unlikely to still be present given the redevelopment of the site.

Residual Silty Clay

The residual silty clay was generally assessed to be of high plasticity. Initially the silty clays were of stiff to very stiff strength, becoming hard strength with depth. The clays contained ironstone gravel bands.

Weathered Rock

Weathered shale or siltstone was encountered at depths ranging from 1.2m to 3.6m. The rock was deeply weathered, being extremely weathered and of extremely low to very low strength for several metres. Even where the rock was cored in BH5 and BH9 it was generally of extremely low to very low strength with core loss zones where this weak rock was unable to be retrieved during coring. Rock of medium strength was encountered in BH5 and BH9 at depths of 10.9m and 8.8m, but contained many defects such as bedding partings, joints and extremely weathered seams. In BH114, siltstone assessed to be of medium strength was not encountered until a depth of 12.5m, but this was only auger drilled so no details of the defects within the rock could be obtained. Increased drilling resistance was encountered in the JKE BH102, BH107and BH109 below depths ranging from 6.5m to 8m indicating higher strength rock, but again these boreholes were only auger drilled.

Groundwater

In 2010, where boreholes could be left open on the day of drilling groundwater was measured at depth ranging from 4.7m to 6.3m. Within the wells installed in the recent JKE boreholes, groundwater was measured on completion at depth ranging from 3.6m to 7.5m, with measurements taken several days after installation summarised in the table below.

Borehole/ Monitoring Well	Date Installed	Measured Groundwater Depths and Approximate Levels			
		4/8/22		8/8/22	
		Depth	≅RL (AHD)	Depth	≅RL (AHD)
102	1/8/22	2.3m	195.2m	2.4m	195.1m
107	1/8/22	3.7m	198.8m	3.8m	198.7m
109	1/8/22	2.5m	199.0	2.6m	198.9m
114	29/7/22	4.7m	200.9m	5.3m	200.3m

These groundwater results show a fall in groundwater levels down towards the north, with the hillside slope.

5 COMMENTS AND RECOMMENDATIONS

5.1 Generalised subsurface Profile and Additional Geotechnical Investigation

The results of our 2010 geotechnical investigation and the 2022 JKE environmental investigation encountered similar subsurface conditions generally comprised fill covering residual silty and then weathered rock of poor quality. Groundwater seepage was measured within the wells generally within the weathered rock flowing down to the north.

The comments and recommendations provided below are based on the above generalised subsurface profile, and are considered sufficient for planning and DA purposes. We recommend that additional geotechnical investigations be required to allow detailed design given the general wide spacing of the geotechnical boreholes drilled within the subject site (i.e. the western portion of Neringah Hospital). Advice should be obtained from the structural engineer on the likely retention and footing design so that the scope of any additional geotechnical investigations can be assessed.

In addition to the need for any additional geotechnical investigations based on the structural design, additional investigations may also be required in regard to groundwater. As discussed in Section 5.3 below, groundwater as measured within the wells above the base of the proposed excavation and therefore, the development may be referred to WaterNSW for approval. If that is the case investigation of the site in accordance with the WaterNSW guideline “Minimum Requirements for Building Site Groundwater Investigations and Reporting” DPIE, January 2021, may be required. This will require the installation of additional groundwater wells with the slotted screens targeted to the proposed basement levels, ongoing monitoring of groundwater levels and estimation of seepage volumes, as discussed in Section 5.3.

The effect of the proposed development on the reservoir to the south may also be required by Sydney Water in the form of a Specialist Engineering Assessment (SEA). This would require modelling of the proposed retention system to estimate the movements of the retention system and the reservoir behind the retaining wall. Additional geotechnical boreholes are likely to be required as part of this assessment to confirm the subsurface profile adjacent to the reservoir. Advice should be obtained from Sydney Water on the need for a SEA so this can be taken into account when determining the scope of any additional geotechnical investigations required. If possible information on the existing footings of the reservoir should be obtained, but if these are not available test pits may need to be excavated in an attempt to expose the footings.

5.2 Excavation

Prior to the start of excavation, dilapidation surveys should be carried out on adjoining structures located within a distance of twice the excavation depth from the basement perimeter. However, dilapidation surveys would not necessarily be required for structures owned by HammondCare. We expect that dilapidation surveys will be required for the residential developments to the south-west and the north and the reservoir to the south, but for the unit buildings the internal inspections could be limited to the units closest to the proposed excavation.

Dilapidation surveys should comprise detailed inspections of the adjoining properties, both externally and internally, with all defects rigorously described, i.e. defect type, defect location, crack width, crack length, etc.. The respective owners of the adjoining properties should be asked to confirm in writing that the dilapidation reports represent a fair record of existing conditions. The reports can then be used as a baseline for assessment for damage that may have been caused by the excavation and will also help to guard against opportunistic claims for damage that was present prior to the start of excavation.

Excavation to the anticipated depths of 7m to 13m is expected to encounter fill, residual silty clay and predominantly poor quality weathered rock. Some bands of low to medium strength or medium strength rock may be encountered, particularly within the deeper excavation areas.

Excavation of the soils and the extremely weathered rock will be achievable using conventional excavation equipment, such as the buckets of hydraulic excavators. Excavation of any bands of low to medium strength or medium strength rock may require assistance with rock excavation equipment, such as hydraulic rock hammers, ripping hooks, rotary grinders or rock saws. Given the variable quality of the rock it may be that such equipment may be needed to break through a higher strength band and then a bucket can be used to excavated further within extremely weathered rock.

Hydraulic rock hammers must be used with care due to the risk of vibrations causing damage to adjacent structures. We recommend that during rock hammer use that the vibrations transmitted to the adjoining structures be quantitively monitored. The extent of the monitoring required will depend on the location of the excavation from the adjoining structures and the amount of rock hammer excavation required. The monitoring may range from trial excavations to assess how close the hammer can operate to the existing structures to full time monitoring during rock hammer use. Where the transmitted vibrations are excessive it will be necessary to change to alternative lower vibration emitting techniques, such as ripping hooks, rotary grinder or rock saws.

5.3 Groundwater

Groundwater was measured within the wells above the base of the expected excavation, with the groundwater appearing to flow down towards the north. Therefore, allowance must be made for groundwater seepage into the excavation, which would tend to occur along the soil/rock interface and through joints within the rock, particularly during and following rainfall.

During construction any seepage that does occur should be able to be controlled using conventional sump and pump techniques.

In the long term, drainage should be provided behind all basement retaining walls and possibly below the basement slab. The completed excavation should be inspected by the hydraulic consultant to assess if the designed drainage system is adequate for the actual seepage flows.

Since the measured groundwater levels are above the expected lowest basement level, approval for the development may be required from WaterNSW. If that is the case then an additional investigation of the site would be required order to satisfy the WaterNSW guidelines “Minimum Requirements for Building Site Groundwater Investigations and Reporting” DPIE, January 2021. This would require additional boreholes to install at least three groundwater monitoring wells with slotted sections extending above and below the excavation level, deeper boreholes to meet the minimum depth requirements, monitoring of groundwater levels for at least three months, analysis to estimate the volume of seepage into the excavation and preparation of a dewatering management plan. These investigations and analysis would be required in order to obtain a Water Access Licence (WAL) and a Water supply Works (WSW) approval from WaterNSW. We note that the existing JKE wells would not be suitable for this purpose as the slotted sections of the wells were not targeted to the proposed basement level. Since the extent of the investigation, and in particular borehole and well depths, are dependent on the proposed bulk excavation level the final scope of the investigation should not be confirmed unless the basement levels have been finalised with no chance of changes being required.

WaterNSW may also insist on design of the basement as a tanked structure to resist hydrostatic uplift loads. Given the subsurface conditions the need for a tanked basement will not be required from a geotechnical perspective, but may be imposed by WaterNSW as a regulatory requirement.

5.4 Retention

Given the depth of excavation and the poor quality of the rock, full depth retention systems will need to be installed prior to the start of excavation. Although rock will be encountered it will not be of sufficient quality to stand unsupported.

Where excavations are limited outside of the main building to no more than 3m, temporary batters could be used if space permits. Such temporary batters should be no steeper than 1 Vertical in 1 Horizontal (1V:1H) and should remain stable in the short term provided all surcharge loads, including construction loads, are kept well clear of the crest of the batters. Permanent batters of no more than 3m in height should be no steeper than 1V:2H, but flatter batters of the order of 1V:3H may be preferred to allow access for maintenance of vegetation. All permanent batters should be covered with topsoil and planted with a deep rooted runner grass, or other suitable coverings, to reduce erosion. All stormwater runoff should be directed away from all temporary and permanent batters to also reduce erosion.

Suitable retention systems would comprise solider pile retaining walls with shotcrete infill panels. However, where movements are to be reduced a closer pile spacing or even contiguous pile walls may be required. Bored piers are likely to be suitable for the piled walls, but some groundwater seepage may be encountered requiring the piles to be poured without delay and the use of tremie concreting techniques. Piles should be drilled to extend at least 0.5m below the base of the excavation, including local excavations for footings or services, but are likely to extend deeper for overall stability and loading requirements.

For retention system where some movements are tolerable and adjacent buildings and movement sensitive services are located a horizontal distance of at least 2H from the wall, design may be based on an apparent trapezoidal earth pressure distribution within the soils and rock of magnitude 6H kPa (where H is the retained height in metres). Where movements are to be reduced and adjacent buildings and movement sensitive services are located within 2H of the wall, an apparent trapezoidal earth pressure distribution of 8H kPa should be used. These maximum pressures should be uniform over the central 50% of the trapezoidal distribution.

Retention systems should also be checked to ensure that they can resist a wedge formed within the weathered rock and extending up through the soils at 45° from the bulk excavation level.

The above pressures assume horizontal backfill behind the walls and any sloping backfill must be taken as a surcharge load. All surcharge loads must be allowed for, such as sloping backfill, existing structures, traffic, etc.. The reservoir to the south will probably impose a high surcharge load and it would be advantageous to keep the proposed basement as far away from the reservoir as practical. Full hydrostatic pressures must also be allowed unless full and complete drainage can be provided.

During design of the retention system for the basement below the Aged Care Facility to the west we completed detailed finite element analysis of the retaining walls. Such analysis can help to optimise the design when compared to the pressure distributions given above and can result in a cost saving for the project. Such analysis may also be required for the retaining walls at the southern end of the site if a Specialist Engineering Assessment of the effect of the development on the Sydney Water reservoir is required.

Anchors should have their bond within rock and may provisionally be designed based on an allowable bond stress of 50kPa for extremely weathered rock or 150kPa for rock of at least very low strength. Higher allowable bond stress values would be applicable for anchors bonded into rock of higher than very low strength. The anchor bond should be formed outside a line drawn up at 45° from the bulk excavation level, with a minimum free length of 3m and a minimum bond length of 3m. All anchors should be proof loaded to at least 1.3 times their design working load before locking off at about 85% of the working load. Lift-off tests should be carried out on at least 10% of the anchors 24 to 48 hours after locking off to confirm that the anchors are holding their load. Anchors should be installed on a design and construct contract so that optimisation of bond stresses does not become a contractual issue in the event of an anchor failing the test load.

Installation of anchors below adjoining properties will require permission from the adjoining property owners prior to installation below their property. This can often take some time to organise, and therefore we recommend that this process be commenced at an early stage to reduce the risk of delays during construction. The level and extent of the basement to the west must be considered as this will affect the location of anchors if the proposed basement does not abut the existing basement.

Passive toe resistance of the retention system below the base of the bulk excavation may be estimated based on a maximum allowable lateral resistance of 150kPa for rock of at least very low strength. The passive resistance should be ignored to at least 0.5m below the nominal base of the excavation, including footing and service excavations.

5.5 Footings

Following completion of bulk excavation, weathered rock is expected to be encountered throughout the base of the excavation. However, the rock is expected to be of poor quality, being mostly extremely weathered. Therefore, shallow pad or strip footings would be appropriate, but they should be designed for a low allowable bearing pressure of 700kPa. We note that pad and strip footings were used for the Aged Care Facility designed for a similar allowable bearing pressure.

If footings were to be founded within rock suitable for higher bearing pressures piles would be required and are unlikely to be economical compared with pad footings. Additional deeper cored boreholes would be required to determine the depth and quality of rock suitable for higher bearing pressures, with higher strength rock only encountered for short lengths within the boreholes drilled to date.

All footings should be inspected and poured as soon as possible after excavation, but on at least the same day as excavation. Where there is a delay in pouring concrete, the base of pad/strip footings should be protected by the placement of a blinding layer of concrete.

5.6 Earthworks Design Parameters

Based on the results available to date, preliminary design of the structure for earthquake loads my be based on a site sub-soil class of C_e. This must be confirmed as part of any detailed geotechnical investigation.

5.7 Soil Aggression

The soil pH values ranged from 3.9 to 4.3, indicating acidic soil conditions. The sulphate contents ranged from 32mg/kg to 82mg/kg, and the chloride contents ranged from 16mg/kg to 89mg/kg. Based on these results, the soils would be classified as ‘moderate’ exposure classification for concrete piles in accordance with Table 6.4.2(C) of AS2159-2009 ‘Piling – Design and Installation’. For steel piles, the soils would be classified as ‘mild’ exposure classification in accordance with Table 6.5.2(C) of AS2159-2009

5.8 Basement Slabs

The basement slabs are expected to be cast on a weathered rock subgrade. The subgrade should be inspected by a geotechnical engineer to confirm the suitability.

The basement slab should be provided with a subbase layer of at least 100mm thickness of crushed rock to TfNSW QA specification 3051 unbound base material (or similar good quality and durable fine crushed rock) to provide a uniform base and act as a separation layer between the slab and the weathered rock subgrade. The subbase layer should be compacted to at least 100% of its Standard Maximum Dry Density (SMDD).

If a drained basement is adopted the subbase layer could be used as a drainage blanket by the adoption of a uniform, free draining gravel. Alternatively, a grid of subsoil drains could be constructed below the slab. The drainage system should direct the collected seepage into sumps with automatic pumps to direct the collected seepage into the stormwater system. As discussed in Section 5.3 the basement may be required to be designed as a tanked structure if approval from WaterNSW is required.

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

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

A waste classification is required for any soil and/or bedrock excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), Excavated Natural Material (ENM), General Solid, Restricted Solid or Hazardous Waste. Analysis can take up to seven to ten 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) could be expected. We strongly recommend that this requirement is addressed prior to the commencement of excavation on site.

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APPENDIX A

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Facsimile: 02 9888 5001

SOIL TEST SERVICES
ABN 43 002 145 173

Ref No:24031SP
Table A: Page 1 of 1

TABLE A
SUMMARY OF LABORATORY TEST RESULTS

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	LINEAR SHRINKAGE %
1	1.20-1.40	15.2	57	20	37	15.0
1	4.00-4.50	10.8				
1	5.50-6.00	10.7				
2	0.50-0.95	23.6				
2	1.00-1.30	16.2	56	20	36	15.0
2	3.00-3.10	13.9				
3	2.30-2.60	14.6				
3	3.00-3.10	11.8				
3	3.50-4.00	8.6				
4	3.00-3.25	16.0				
4	3.30-3.50	9.7				
4	5.50-6.00	10.6				
4	6.50-7.00	11.9				

Notes:

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

115 Wicks Road
Macquarie Park, NSW 2113
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SOIL TEST SERVICES
ABN 43 002 145 173

Ref No:24031SP2
Table A: Page 1 of 1

TABLE A
SUMMARY OF LABORATORY TEST RESULTS

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	LINEAR SHRINKAGE %
5	0.50-0.95	31.0	65	27	38	17.0
5	1.20-1.30	13.8				
5	3.00-3.20	16.3				
5	5.50-5.80	14.0				
6	0.50-0.95	24.8				
6	2.30-2.50	10.3				
6	5.50-6.00	8.3				
7	0.50-0.95	22.4				
7	2.50-3.00	12.2				
7	5.00-5.50	12.4				
8	0.50-0.95	21.8				
8	2.50-3.00	8.2				
8	5.50-6.00	15.0				
9	1.00-1.40	24.6	61	24	37	16.0
9	3.00-3.15	18.2				
9	7.00-7.30	11.5				

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

115 Wicks Road
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SOIL TEST SERVICES
ABN 43 002 145 173

Ref No: 24031SP2
Table B: Page 1 of 1

TABLE B
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
5	6.68-6.72	0.04	<1
	7.44-7.48	0.1	2
	7.89-7.93	0.1	2
	8.10-8.13	0.1	2
	9.75-9.78	0.03	<1
	10.36-10.40	0.3	6
	10.75-10.79	0.2	4
	11.15-11.19	0.5	10
	11.78-11.82	0.4	8
9	7.87-7.90	0.04	<1
	8.84-8.87	0.1	2
	9.79-9.83	0.5	10
	10.10-10.14	0.8	16
	10.75-10.80	1.2	24
	11.27-11.30	0.4	8
	11.70-11.74	0.5	10

NOTES:

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

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

CERTIFICATE OF ANALYSIS 41631

Client:
Jeffery and Katauskas
Rear 115 Wicks Road
Macquarie Park
NSW 2113

Attention: Brendan Page

Sample log in details:

Your Reference:	**24031SP2, Wahroonga**
No. of samples:	4 Soils
Date samples received:	02/06/10
Date completed instructions received:	02/06/10

Analysis Details:

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

Report Details:

Date results requested by:	9/06/10
Date of Preliminary Report:	Not Issued
Issue Date:	9/06/10

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

Results Approved By:

Nick Sarlamis
Inorganics Supervisor

NATA
ACCREDITED FOR
TECHNICAL
COMPETENCE

Miscellaneous Inorg - soil Our Reference:	UNITS	41631-1	41631-3	41631-4
Your Reference	-------------	BH5	BH8	BH9
Depth	------------	1.2-1.5	1.5-1.95	1.5-1.95
Date Sampled		26/06/2010	26/06/2010	26/06/2010
Type of sample		Soil	Soil	Soil
Date prepared	-	3/6/2010	3/6/2010	3/6/2010
Date analysed	-	4/6/2010	4/6/2010	4/6/2010
pH 1:5 soil:water	pH Units	3.9	4.3	4.2
Chloride, Cl 1:5 soil:water	mg/kg	42	89	16
Sulphate, SO4 1:5 soil:water	mg/kg	70	82	32

Method ID	Methodology Summary
LAB.1	pH - Measured using pH meter and electrode in accordance with APHA 20th ED, 4500-H+.
LAB.81	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 21st ED, 4110-B.

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			3/6/2010	[NT]	[NT]	LCS-1	3/6/2010
Date analysed	-			4/6/2010	[NT]	[NT]	LCS-1	4/6/2010
pH 1:5 soil:water	pH Units		LAB.1	[NT]	[NT]	[NT]	LCS-1	98%
Chloride, Cl 1:5 soil:water	mg/kg	2	LAB.81	<2.0	[NT]	[NT]	LCS-1	98%
Sulphate, SO4 1:5 soil:water	mg/kg	2	LAB.81	<2.0	[NT]	[NT]	LCS-1	103%

Report Comments:

Asbestos was analysed by Approved Identifier: Not applicable for this job
Asbestos was authorised by Approved Signatory: Not applicable for this job
INS: Insufficient sample for this test NT: Not tested PQL: Practical Quantitation Limit <: Less than >: Greater than
RPD: Relative Percent Difference NA: Test not required LCS: Laboratory Control Sample NR: Not requested

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike: A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample): This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria:

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the sample batch were within laboratory acceptance criteria.
Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes and LCS: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable. Surrogates: 60-140% is acceptable for general organics and 10-140% for

Borehole No.
1
1/2

BOREHOLE LOG

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP
Date: 21-5-10
Method: SPIRAL AUGER JK250
Logged/Checked by: M.T./P.W.
R.L. Surface: N/A
Datum:

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			CONCRETE: 160mm.t				6mm DIAMETER REINFORCEMENT, 20mm TOP COVER
	■							-	FILL: Silty sand, fine to medium grained, grey.	W	-	-	
	■				N = 7 3,3,4			CH	FILL: Silty clay, medium plasticity, light brown and light grey.	MC>PL			
									SILTY CLAY: high plasticity, light grey mottled red and orange brown, with ironstone bands.	MC<PL	VSt	250 200 200	RESIDUAL
						1							
				■									
				■	N = 15 4,5,10						H	420 450 350	
				■		2							
				■	N > 25 27,25/ 100mm REFUSAL	3						>600 >600 >600	
								-	SHALE: light grey.	XW-DW	EL-VL	-	VERY LOW 'TC' BIT RESISTANCE
				■		4							
▼ AFTER 1/2 HR													
						5			SHALE: light grey, with M-H strength iron indurated bands.				
				■						DW	L		LOW RESISTANCE
						6							
						7							

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Borehole No.
1
2/2

BOREHOLE LOG

Client: HAMMONDCARE

Project: PROPOSED FUTURE REDEVELOPMENT

Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP

Date: 21-5-10

Method: SPIRAL AUGER
JK250

R.L. Surface: N/A

Datum:

Logged/Checked by: M.T./P.W.

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
				■			▤		SHALE: light grey.	DW	L		
									END OF BOREHOLE AT 7.5m				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

BOREHOLE LOG

Borehole No.
2
1/1

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP
Method: SPIRAL AUGER JK250
R.L. Surface: N/A
Date: 21-5-10
Datum:
Logged/Checked by: M.T./P.W.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0			TOPSOIL: Silty clay, medium plasticity, dark brown, with a trace of roots.	MC>PL			GRASS COVER
	■							CH	SILTY CLAY: high plasticity, light grey mottled red and orange brown, with ironstone bands.	MC>PL	VSt	-	RESIDUAL
				■	N = 11 3,5,6							350 350 320	
				■		1				MC<PL	H		
				■	N > 25 20,25/ 100mm REFUSAL							>600 >600 >600	
						2							
				■				-	SHALE: light grey, with M-H strength iron indurated bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE
				■	SPT 17/100mm REFUSAL	3							
				■						DW	L		LOW RESISTANCE
						4							
						5							
				■						SW	L-M		
						6							
▼ AFTER 1 HR				■									
						7			END OF BOREHOLE AT 7.0m				

Borehole No.
3
1/1

BOREHOLE LOG

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP
Date: 21-5-10
Method: SPIRAL AUGER JK250
R.L. Surface: N/A
Datum:
Logged/Checked by: M.T./P.W.

Groundwater Record	Samples	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	ES		0	-	ASPHALTIC CONCRETE: 20mm.t FILL: Silty sandy clay, low plasticity, dark grey, with a trace of fine to medium grained crushed igneous rock gravel.	MC>PL	-	-	APPEARS POORLY COMPACTED
	ES	N = 5 1,2,3	0.5						
	DS		1.1	CH	SILTY CLAY: high plasticity, light grey mottled red and orange brown, with ironstone bands.	MC≈PL	(VSt - H)	-	RESIDUAL
	ES	N = 23 6,10,13	1.5			MC<PL	H	550 600 550	
	DS		2.3						
	DS	SPT 25/100mm REFUSAL	3	-	SHALE: light grey, with L-M strength iron indurated bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE
	DS		3.5			DW	L		LOW RESISTANCE
			4						
			5						
▼ AFTER 30 MINS			6				L-M		
			7		END OF BOREHOLE AT 7.0m				

BOREHOLE LOG

Borehole No.
4
1/1

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP
Method: SPIRAL AUGER JK250
R.L. Surface: N/A
Date: 21-5-10
Datum:
Logged/Checked by: M.T./P.W.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0		-	ASPHALTIC CONCRETE: 40mm.t FILL: Silty sandy clay, low plasticity, dark grey, with a trace of fine to medium grained crushed igneous rock gravel.	MC>PL	-	-	
	■			■	N = 12 5,6,6			CH	SILTY CLAY: high plasticity, red brown mottled orange brown, with ironstone bands.	MC≈PL	VSt	- 250 300 350	RESIDUAL
						1							
					N = 12 4,5,7							350 380 340	
				■		2							
				■	N > 25 12,25/ 100mm REFUSAL	3					H		
				■				-	SHALE: light grey, with L-M strength iron indurated bands.	XW	EL	>600 >600 >600	VERY LOW 'TC' BIT RESISTANCE
										XW	VL-L		
						4				DW			
											L		VERY LOW TO LOW RESISTANCE
						5							
				■									LOW RESISTANCE
						6							
				■		7			END OF BOREHOLE AT 7.0m				

BOREHOLE LOG

Borehole No.
5
1/2

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2
Date: 26&27-5-10
Method: SPIRAL AUGER
JK250
Logged/Checked by: M.T./P.W.
R.L. Surface: N/A
Datum:

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION OF AUGERING	■					0			TOPSOIL: Silty clay, medium plasticity, dark brown, with occasional root fibres.				GRASS COVER
	■			■	N = 12 4,5,7			CH	SILTY CLAY: high plasticity, light brown mottled orange brown, with ironstone bands.	MC>PL	H	- 470 450 500	RESIDUAL
				■		1							
				■	N = 27 8,9,18								
						2		-	SHALE: light grey, with occasional clay bands and iron indurated bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE
▼ ON COMPLETION OF CORING													
				■	N > 25 25,25/ 50mm REFUSAL	3							
													LOW RESISTANCE
				■		4							
						5				DW	VL		
				■									
						6			REFER TO CORED BOREHOLE LOG				
						7							

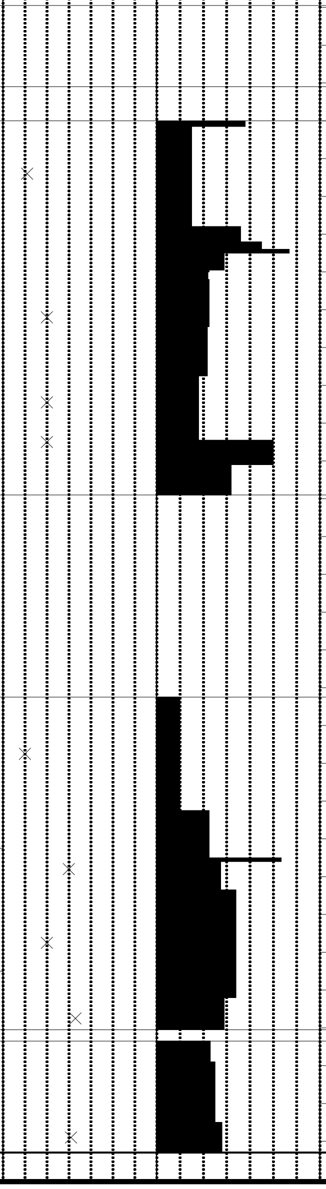

JEFFERY & KATAUSKAS PTY LTD
JOB # 24031SP2 BH # 5 START CORING AT: 5.79m
5
6
CORE LOSS: 0.17m
7
8
CORE LOSS
9
CORE LOSS
10
11
CORE LOSS
END OF BH AT 11.86m
END OF BH 5 AT 11.86m

Borehole No.
5
2/2

CORED BOREHOLE LOG

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2 **Core Size:** NMLC **R.L. Surface:** N/A
Date: 26&27-5-10 **Inclination:** VERTICAL **Datum:**
Drill Type: JK250 **Bearing:** - **Logged/Checked by:** M.T./P.W.



Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_{s}(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS – DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		5		START CORING AT 5.79m						
		6		SILTY CLAY: high plasticity, light grey, with bands of XW/ EL strength bands.	RS	H			- HP = 450,550,450kPa	
				CORE LOSS 0.17m						
		7		SHALE: grey and dark grey, with clay bands sub horizontally bedded.	DW	VL			- J, 65°, Un, S - Be, 0°, P, S - J, 65°, P, S - J, 55-90°, Un, S - Be, 0°, P, S - Be, 0°, P, S - CS, 0°, 60mm.t	
		8			XW	EL			- CS, 0°, 20mm.t - J, 85°, Un, S - Be, 0°, Un, R - J, 80°, P, S - XWS, 0°, 30mm.t, P, Un, IS - 8.09-8.26m 6xBe, 0°, P, S, 2-3mm.t	
					DW	VL			- XWS, 50°, 50mm.t - CS, 0°, 40mm.t	
		9		CORE LOSS 1.10m						
		10		SHALE: grey and dark grey, with clay bands sub horizontally bedded.	XW	EL			- J, 45°, P, R	
				SHALE: grey and dark grey, with occasional iron indurated bands.	DW	L			- J, 70, P, S - J, 70°, P, R - J, 30°, P, R - 10.41-10.75m 5xXWS, 0°, 10-30mm.t, R, 40-120 SPACED - J, 60-70°, P, S	
		11				M			- 3xBe, 0°, P, S, ROUGHLY SPACED 10-20mm - Cr, 20°, 20mm.t	
				CORE LOSS 0.06m						
				SHALE: grey and dark grey, with occasional iron indurated bands.	DW	M			- Cr, 0°, 40mm.t - Be, 0°, CLAY INFILL, 4mm.t - Be, 0°, P, S	
				END OF BOREHOLE AT 11.86m						

Borehole No.
6
1/2

BOREHOLE LOG

Client: HAMMONDCARE

Project: PROPOSED FUTURE REDEVELOPMENT

Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2 **Method:** SPIRAL AUGER JK250 **R.L. Surface:** N/A

Date: 27-5-10 **Datum:**

Logged/Checked by: M.T./P.W.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0		TOPSOIL: Silty clay, medium plasticity, dark brown, with occasional root fibres.	MC<PL			
			CH	SILTY CLAY: high plasticity, light brown mottled orange brown, with iron indurated bands.	MC<PL	H	-	RESIDUAL
	N = 16 6,8,8						500 410 450	
		1		SILTY CLAY: high plasticity, light grey, with iron indurated bands				
	N = 26 6,9,17						550 >600 580	
		2	-	SHALE: light grey, with L-M strength iron indurated bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE
					DW	L		VERY LOW TO LOW RESISTANCE
		3						
		4						
		5						
		6						
				SHALE: light grey, with L-M strength iron indurated bands.	DW	L		
		7						

BOREHOLE LOG

Borehole No.
6
2/2

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2
Date: 27-5-10
Method: SPIRAL AUGER JK250
R.L. Surface: N/A
Datum:
Logged/Checked by: M.T./P.W.

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
							▤		SHALE: light grey, with L-M strength iron indurated bands.	DW	L		
						8 9 10 11 12 13 14			END OF BOREHOLE AT 7.5m				

BOREHOLE LOG

Borehole No.
7
1/2

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2
Date: 27-5-10
Method: SPIRAL AUGER JK250
R.L. Surface: N/A
Datum:
Logged/Checked by: M.T./P.W.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0		TOPSOIL: Silty clay, medium plasticity, dark brown, with root fibres.	MC>PL			
							CH	SILTY CLAY: high plasticity, light brown mottled orange brown.	MC>PL	St	-	RESIDUAL
				■	N = 8 2,2,6						130 150 190	
				■		1		SILTY CLAY: high plasticity, light grey mottled red brown, with iron indurated bands.	MC<PL	(H)		
							-	SHALE: light grey, with L strength iron indurated bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE
						2						
				■					DW	VL-L		LOW RESISTANCE
						3						
				■		4						
				■		5						LOW RESISTANCE WITH VERY LOW BANDS
						6						
				■								LOW RESISTANCE
						7						

BOREHOLE LOG

Borehole No.
7
2/2

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2
Date: 27-5-10
Method: SPIRAL AUGER
JK250
R.L. Surface: N/A
Datum:
Logged/Checked by: M.T./P.W.

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
									SHALE: light grey, with L strength iron indurated bands.	DW	L		
						8 9 10 11 12 13 14			END OF BOREHOLE AT 7.5m				

Borehole No.
8
1/2

BOREHOLE LOG

Client: HAMMONDCARE

Project: PROPOSED FUTURE REDEVELOPMENT

Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2
Method: SPIRAL AUGER JK250
R.L. Surface: N/A

Date: 28-5-10
Datum:

Logged/Checked by: M.T./P.W.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0		TOPSOIL: Silty sandy clay, medium plasticity, dark brown, with a trace of root fibres.				GRASS COVER
							CL	SILTY CLAY: medium plasticity, light brown mottled light orange, with iron indurated bands.	MC<PL	H	-	RESIDUAL
	■			■	N = 17 6,8,9						>600 >600 >600	
						1	CH	SILTY CLAY: high plasticity, light grey mottled red brown, with iron indurated bands.				
							-	SHALE: light grey, with clay bands and L strength iron indurated bands.	XW	EL	-	
				■	N = 27 13,13,14							
						2						VERY LOW TO LOW 'TC' BIT RESISTANCE
				■								
						3						
				■								
						4						
						5						
				■								
						6						
						7						

BOREHOLE LOG

Borehole No.
8
2/2

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2
Date: 28-5-10
Method: SPIRAL AUGER JK250
R.L. Surface: N/A
Datum:
Logged/Checked by: M.T./P.W.

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
				■					SHALE: light grey, with L-M strength iron indurated bands.	XW	EL		
									END OF BOREHOLE AT 7.5m				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

BOREHOLE LOG

Borehole No.
9
1/3

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2
Date: 28-5-10
Method: SPIRAL AUGER JK250
R.L. Surface: N/A
Datum:
Logged/Checked by: M.T./P.W.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION OF AUGERING	■					0			TOPSOIL: Silty clay, medium plasticity, brown, with a trace of root fibres.	MC>PL			GRASS COVER
								CL	SILTY CLAY: medium plasticity, brown mottled orange, with ironstone bands.	MC>PL	VSt	-	RESIDUAL
	■				N = 7 1,3,4							230 250 230	
				■		1		CH	SILTY CLAY: high plasticity, light grey mottled red brown, with ironstone bands.	MC<PL	H		
				■	N = 17 5,7,10							>600 >600 >600	
						2							
				■				-	SHALE: light grey, with clay bands and L strength iron indurated bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE
				■	SPT 25/150mm REFUSAL	3							
▼ 40 MINS AFTER CORING													
				■		4				DW	VL-L		LOW RESISTANCE
						5							
				■		6							
						7							

Borehole No.
9
2/3

BOREHOLE LOG

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2
Date: 28-5-10
Method: SPIRAL AUGER
JK250
R.L. Surface: N/A
Datum:
Logged/Checked by: M.T./P.W.

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
				■					SHALE: light grey, with clay bands and L strength iron indurated bands.	DW	VL-L		LOW RESISTANCE
									REFER TO CORED BOREHOLE LOG				
						8							
						9							
						10							
						11							
						12							
						13							
						14							


JEFFERY & KATAUSKAS PTY LTD
JOB # 243031SP2. BH #9. START CORING AT: 7.29m
7
CORE LOSS: 0.26m
8
9
10
11
E.O.H.
12
END OF BH 9 AT 11.94m

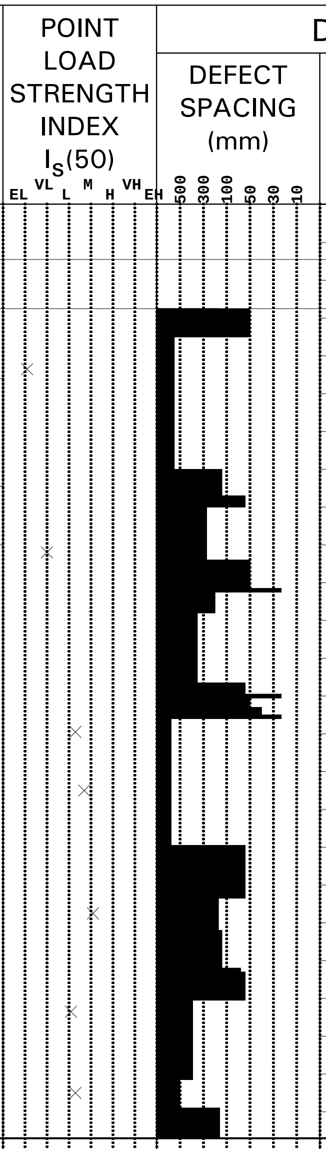
CORED BOREHOLE LOG

Borehole No.
9
3/3

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2
Core Size: NMLC
R.L. Surface: N/A
Date: 28-5-10
Inclination: VERTICAL
Datum:
Drill Type: JK250
Bearing: -
Logged/Checked by: M.T./P.W.

Depth (m)	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
7	START CORING AT 7.29m				
	CORE LOSS 0.26m				
	SHALE: grey and dark grey, with clay bands, sub horizontally bedded.	DW	L	- XWS, 0°, 150mm.t - Be, 0°, P, S - Cr/XWS, 0°, 40mm.t	
8		XW	EL		
	SHALE: grey and dark grey, with a trace of ironstone bands sub horizontally bedded.			- Be, 0°, P, S	
		DW	L	- J, 70°, P, S, Cr, 20mm.t INFILL - Cr, 0°, 10mm.t - FRACTURED BAND 190mm.t	
9			M	- Cr, 25mm.t - 8.93-9.03m FRACTURED BAND, 0°, 100mm.t - J, 20-50°, Un, R, IS - XWS, 90mm.t - 9.15-9.51m NUMEROUS Cr,Be, 0-20°, 2-5mm.t, P, S, IS - XWS, 15mm.t - Be, 0°, P, S, IS - Be, 0°, P, S, IS - J, 25-30°, P, R, IS - Be, 0°, P, S, IS	
10				- Cr, 0°, 25mm.t - Be, 0°, P, S, IS - Be, 0° P, S, IS - Be, 0° P, R, IS - Be, 0°, P, R - Be, 0° P, S, IS - J, 50-70°, Un, S - J, 60-80°, Un, S - Be, 0° P, S, IS - 10.5-10.84m 10xBe, 0-5° P, S, IS, 10-80mm SPACING - XWS, 0°, 20mm.t	
11				- XWS, 0°, 30mm.t - Be, 0°, P, R, 2mm.t - 2x INTERSECTING J, 30°, P, R - XWS, 0°, 4mm.t - J, 40°, P, S, IS - J, 20°, Un, R, IS - Cr, 0°, 5mm.t - J, 45°, P, R, IS - Be, 0°, 1mm.t, P, S - J, 40-60°, Un, S - Be, 0°, 1mm.t, P, S - Be, 0°, 3mm.t SILT INFILLED	
12	END OF BOREHOLE AT 11.94m				
13					



BOREHOLE LOG

Borehole No.
10
1/1

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2 **Method:** HAND AUGER **R.L. Surface:** N/A
Date: 28-5-10 **Datum:**
Logged/Checked by: M.T./P.W.

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 sand, brown, fine to medium grained, with a trace of root fibres.	MC<PL			GRASS COVER
	■							CH	SILTY CLAY: high plasticity, light brown mottled light orange, with ironstone bands.	MC<PL	(VSt)	-	RESIDUAL
									END OF BOREHOLE AT 0.5m				
						1							
						2							
						3							
						4							
						5							
						6							
						7							

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
11
1/1

BOREHOLE LOG

Client: HAMMONDCARE

Project: PROPOSED FUTURE REDEVELOPMENT

Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2

Method: HAND AUGER

R.L. Surface: N/A

Date: 28-5-10

Datum:

Logged/Checked by: M.T./P.W.

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 sand, medium plasticity, brown, with root fibres.	MC>PL			GRASS COVER
	■							CL	SILTY CLAY: low plasticity, light brown, with a trace of root fibres.	MC>PL	(VSt)	-	RESIDUAL
									END OF BOREHOLE AT 0.5m				
						1							
						2							
						3							
						4							
						5							
						6							
						7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
12
1/1

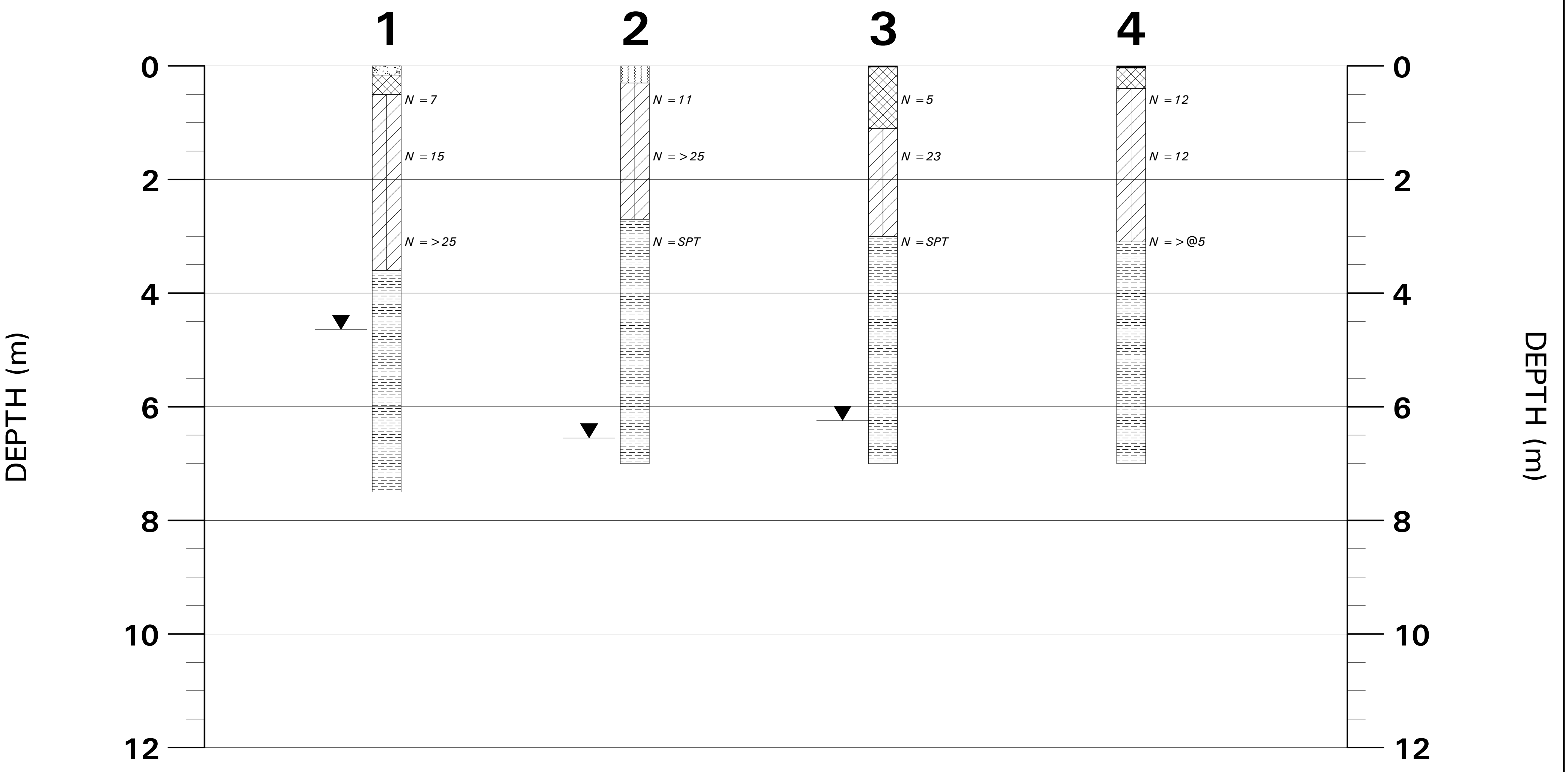
BOREHOLE LOG

Client: HAMMONDCARE
Project: PROPOSED FUTURE REDEVELOPMENT
Location: 3-9 WOONONA AVE & 2-12 NERINGAH AVE SOUTH, WAHROONGA, NSW

Job No. 24031SP2
Method: HAND AUGER
R.L. Surface: N/A
Date: 28-5-10
Datum:
Logged/Checked by: M.T./P.W.

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
DRY ON COMPLETION	■					0			TOPSOIL: Silty clay, medium plasticity, brown, with root fibres.	MC≈PL			GRASS COVER
	■							CH	SILTY CLAY: high plasticity, light brown mottled orange, with ironstone bands.	MC≈PL	(VSt)	-	RESIDUAL
									END OF BOREHOLE AT 0.5m				
						1							
						2							
						3							
						4							
						5							
						6							
						7							

GRAPHICAL BOREHOLE SUMMARY



▨ Concrete
▨ Fill
▨ Silty Clay

▤ Shale
▥ Topsoil

■ Asphaltic/ Bituminous Paving or Coal
▼ Observed water level

N	SPT "N" VALUE
Nc	SOLID CONE BLOW COUNTS PER 150mm

NOTE: REFER TO BOREHOLE LOGS

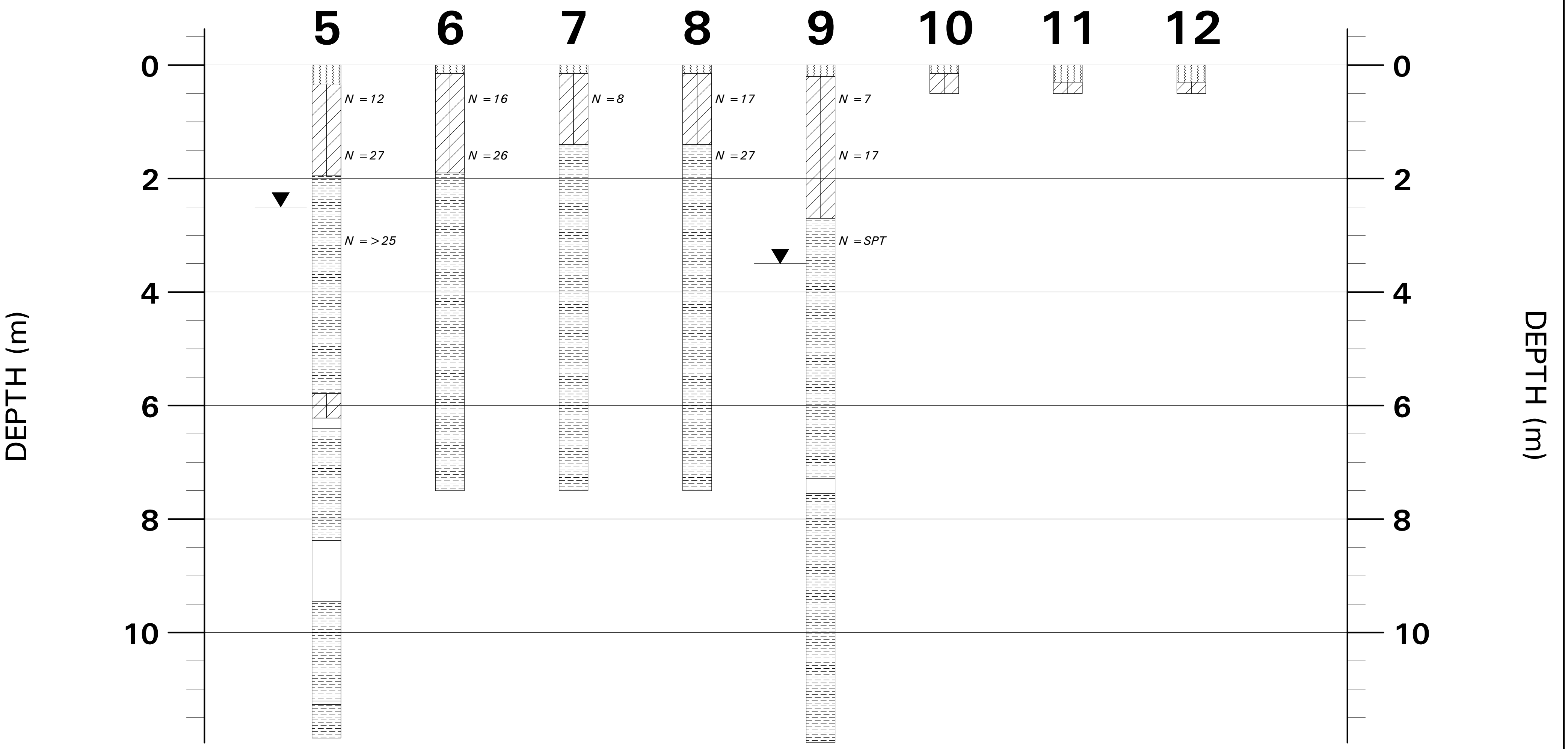
Scale: 1 : 100 (vert) ; NTS (horiz)

Jeffery and Katauskas Pty Ltd

Job No.: 24031SP

Figure No.: 2a

GRAPHICAL BOREHOLE SUMMARY



▥ Topsoil

▨ Silty Clay

▤ Shale

☐ Core Loss/ Empty

▼ Observed water level

N SPT "N" VALUE

Nc SOLID CONE BLOW COUNTS PER 150mm

NOTE: REFER TO BOREHOLE LOGS

Scale: 1 : 100 (vert) ; NTS (horiz)

Jeffery and Katauskas Pty Ltd

Job No.: 24031SP2

Figure No.: 2b

LEGEND

● **BOREHOLE**

━ **SITE BOUNDARY**

BOREHOLE LOCATION PLAN

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL & ENVIRONMENTAL ENGINEERS

Report No. 24031SP2 **Figure No. 1**

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 an Electronic Friction Cone Penetrometer (EFCP). The test is described in Australian Standard 1289, Test F5.1.

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

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

The information provided on the charts comprise:

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

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

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

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

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

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

Two relatively similar tests are used:

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

LOGS

The borehole or test pit logs presented herein are an engineering and/or geological interpretation of the subsurface 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.

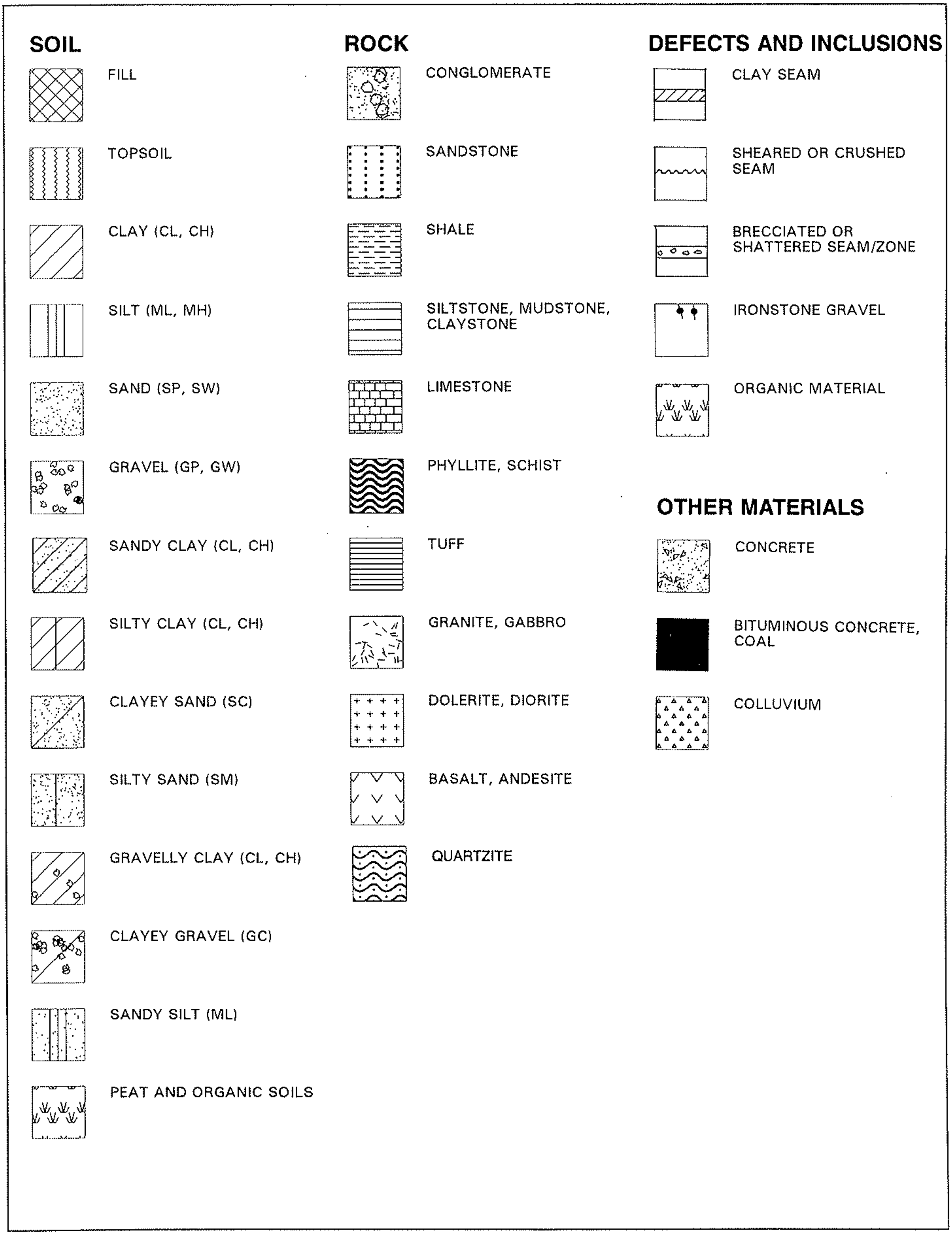
SITE INSPECTION

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



SOIL

- FILL
- TOPSOIL
- CLAY (CL, CH)
- SILT (ML, MH)
- SAND (SP, SW)
- GRAVEL (GP, GW)
- SANDY CLAY (CL, CH)
- SILTY CLAY (CL, CH)
- CLAYEY SAND (SC)
- SILTY SAND (SM)
- GRAVELLY CLAY (CL, CH)
- CLAYEY GRAVEL (GC)
- SANDY SILT (ML)
- PEAT AND ORGANIC SOILS

ROCK

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

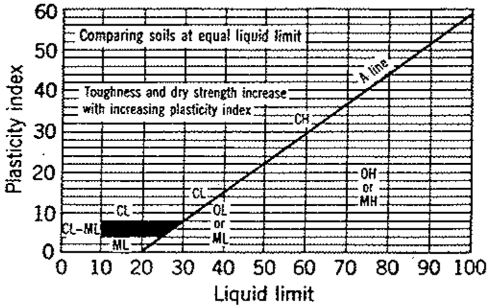
DEFECTS AND INCLUSIONS

- CLAY SEAM
- SHEARED OR CRUSHED SEAM
- BRECCIATED OR SHATTERED SEAM/ZONE
- IRONSTONE GRAVEL
- ORGANIC MATERIAL

OTHER MATERIALS

- CONCRETE
- BITUMINOUS CONCRETE, COAL
- COLLUVIUM

UNIFIED SOIL CLASSIFICATION TABLE

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

NOTE: 1) Soils possessing characteristics of two groups are designated by combinations of group symbols (e.g. 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.

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
ABN 17 003 550 801

LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record	—τ—	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.

Ref: Standard Sheets/Log Symbols
November 2007

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
ABN 17 003 550 801

LOG SYMBOLS

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	

Ref: Standard Sheets/Log Symbols

APPENDIX B

JKEnvironments

ENVIRONMENTAL LOG

Log No.
BH101
1/1

Environmental logs are not to be used for geotechnical purposes

Client: HAMMONDCARE

Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR **Method:** PUSHTUBE / SPIRAL AUGER **R.L. Surface:** ≈ 198.5m

Date: 28/7/22 **Datum:** AHD

Plant Type: EZI PROBE **Logged/Checked by:** A.D./T.H.

Groundwater Record	SAMPLES					Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	ASS	ASB	PFAS	DB									
DRY ON COMPLETION							0	■		ASPHALTIC CONCRETE: 50mm.t				
	■			■	■			▩		FILL: Clayey sand, fine to medium grained, light brown, trace of igneous and ironstone gravel, and glass.	M w≈PL			SCREEN: 3.03kg 0.05-0.2m NO FCF
	■		■	■	■			▨	CI-CH	FILL: Silty clay, medium to high plasticity, brown, trace of igneous and ironstone gravel, ash and root fibres.	w≈PL			SCREEN: 3.98kg 0.2-0.5m NO FCF
	■		■	■			1	▨		Silty CLAY: medium to high plasticity, yellow brown mottled red, trace of ironstone gravel, and root fibres.				RESIDUAL
										as above, but grey mottled red.				
										END OF BOREHOLE AT 1.4m				
							2							
							3							
							4							
							5							
							6							
							7							

ENVIRONMENTAL LOG

Log No.
BH102
1/2

Environmental logs are not to be used for geotechnical purposes

Client: HAMMONDCARE

Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 197.5m

Date: 1/8/22 **Datum:** AHD

Plant Type: JK400 **Logged/Checked by:** H.W./T.H.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		0	-	ASPHALTIC CONCRETE: 10mm.t	M			SCREEN: 5.4kg 0.01-0.1m NO FCF
				FILL: Silty sand, fine to medium grained, brown, trace of igneous and sandstone gravel.	w≈PL			
			CI-CH	FILL: Silty clay, medium to high plasticity, brown, trace of igneous and ironstone gravel, and ash.	w≈PL			SCREEN: 3.4kg 0.1-0.5m NO FCF
		1		Silty CLAY: medium to high plasticity, orange brown, trace of ironstone gravel, and root fibres.				RESIDUAL
	N = 18 4,8,10			as above, but grey.				
4/8/22 8/8/22		2	-	Extremely Weathered siltstone: silty CLAY, low to medium plasticity, grey.	XW			ASHFIELD SHALE LOW 'TC' BIT RESISTANCE
	N > 7 4,7/50mm REFUSAL	3						
					DW			
		4						
		5						
		6						
				SILTSTONE: dark grey.	SW			MODERATE RESISTANCE
		7						

SAMPLES: ES, ASS, ASB, PFAS, DB

ENVIRONMENTAL LOG

Log No.
BH102
2/2

Environmental logs are not to be used for geotechnical purposes

Client: HAMMONDCARE

Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR
Method: SPIRAL AUGER
R.L. Surface: ≈ 197.5m

Date: 1/8/22
Datum: AHD

Plant Type: JK400
Logged/Checked by: H.W./T.H.

Groundwater Record	SAMPLES ES	ASS	ASB	PFAS	DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
▼	■ ■						8			SILTSTONE: dark grey.	SW			
							9 10 11 12 13 14			END OF BOREHOLE AT 9.0m				GROUNDWATER MONITORING WELL INSTALLED TO 8.0m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 2.0m TO 8.0m. CASING 0m TO 2.0m. 2mm SAND FILTER PACK 1.8m TO 8.0m. BENTONITE SEAL 1.2m TO 1.8m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER.

ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No.
BH103
1/1

Client: HAMMONDCARE
Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL
Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR
Method: HAND AUGER
R.L. Surface: ≈ 196.7m
Date: 28/7/22
Datum: AHD
Plant Type: -
Logged/Checked by: A.D./T.H.

Groundwater Record	SAMPLES					Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	ASS	ASB	PFAS	DB									
DRY ON COMPLETION							0			ASPHALTIC CONCRETE: 50mm.t				
									-	FILL: Clayey sand, fine to medium grained, light brown, trace of igneous and ironstone gravel.	w≈PL			SCREEN: 14.3kg 0.05-0.2m NO FCF
									CI-CH	FILL: Silty clay, medium to high plasticity, brown, trace of igneous and ironstone gravel, sand and root fibres.	w≈PL			SCREEN: 12.13kg 0.2-0.6m NO FCF
							1			Silty CLAY: medium to high plasticity, red brown, trace of ironstone gravel.				RESIDUAL
										END OF BOREHOLE AT 1.0m				HAND AUGER REFUSAL
							2							
							3							
							4							
							5							
							6							
							7							

ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No.
BH104
1/1

SDUP5: 0-0.1m

Client: HAMMONDCARE

Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR

Method: HAND AUGER

R.L. Surface: ≈ 199.4m

Date: 28/7/22

Datum: AHD

Plant Type: -

Logged/Checked by: A.D./T.H.

Groundwater Record	SAMPLES ES	ASS	ASB	PFAS	DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■		■	■	■		0	▩		FILL: Silty clay, medium to high plasticity, brown, trace of igneous gravel, sand, tile fragments, bark mulch and root fibres.	w≈PL			SCREEN: 10.5kg 0-0.15m NO FCF
	■		■	■				▨	CI-CH	Silty CLAY: medium to high plasticity, grey mottled red and orange, trace of ironstone gravel and root fibres.	w≈PL			RESIDUAL
							1			END OF BOREHOKE AT 0.8m				
							2							
							3							
							4							
							5							
							6							
							7							

JKEnvironments

ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No.
BH105
1/1

SDUP4: 0-0.1m

Client: HAMMONDCARE
Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL
Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR **Method:** PUSHTUBE / SPIRAL AUGER **R.L. Surface:** ≈ 199.3m
Date: 28/7/22 **Datum:** AHD
Plant Type: EZI PROBE **Logged/Checked by:** A.D./T.H.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES PFAS	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■		■	■	■		0			FILL: Silty clay, medium to high plasticity, brown, trace of ironstone and sandstone gravel, sand and root fibres.	w≈PL			GRAS COVER SCREEN: 11.52kg 0-0.15m NO FCF
	■		■	■					CI-CH	Silty CLAY: medium to high plasticity, grey mottled yellow and red brown, trace of ironstone gravel and root fibres.	w≈PL			RESIDUAL
							1		-	Extremely Weathered siltstone: silty CLAY, low to medium plasticity, grey, with ironstone gravel bands.	XW			ASHFIELD SHALE
										END OF BOREHOLE AT 1.2m				
							2							
							3							
							4							
							5							
							6							
							7							

JKEnvironments

ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No.
BH106
1/1

Client: HAMMONDCARE

Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR
Method: HAND AUGER
R.L. Surface: ≈ 198.6m

Date: 4/8/22
Datum: AHD

Plant Type: -
Logged/Checked by: E.W./T.H.

Groundwater Record	SAMPLES ES	ASS	ASB	PFAS	DB	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 clay, low to medium plasticity, dark brown, trace of sandstone gravel and roots.	w<PL			SCREEN: 10.46kg 0-0.1m NO FCF
										FILL: Silty clay, medium to high plasticity, red brown mottled grey, trace of sandstone gravel.	w≈PL			INSUFFICENT RETURN FOR BULK SCREEN
										END OF BOREHOLE AT 0.5m				HAND AUGER REFUSAL
							1							
							2							
							3							
							4							
							5							
							6							
							7							

ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No. BH107

1/2

Client: HAMMONDCARE

Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 202.5m

Date: 1/8/22 **Datum:** AHD

Plant Type: JK400 **Logged/Checked by:** H.W./T.H.

Groundwater Record	SAMPLES ES ASS ASB PFAS DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0			ASPHALTIC CONCRETE: 70mm.t				
					-	FILL: Silty sand, fine to medium grained, grey, with igneous gravel.	D			SCREEN: 2.5kg 0.07-0.3m NO FCF
						FILL: Silty sandy clay, low to medium plasticity, brown, fine to medium grained sand, trace of ironstone gravel.	w≈PL			SCREEN: 4.77kg 0.3-0.5m NO FCF
		N = 9 4,4,5			CI-CH	Silty CLAY: medium to high plasticity, red brown, trace of ironstone gravel.	w≈PL			RESIDUAL
			1							
		N = 26 7,12,14								
			2							
						as above, but grey and red brown.				
		N > 5 17,5/ 50mm	3							
4/8/22 ▼ ▼ 8/8/22						Extremely Weathered siltstone:silty CLAY, medium to high plasticity, grey.	XW			ASHFIELD SHALE
			4							
		N = 29 10,12,17								
ON COMPLET-ION ▼			5							
			6			as above, but brown.	DW			MODERATE 'TC' BIT RESISTANCE
▶										
			7							

JKEnvironments

ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No.
BH107
2/2

Client: HAMMONDCARE
Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL
Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR
Method: SPIRAL AUGER
R.L. Surface: ≈ 202.5m
Date: 1/8/22
Datum: AHD
Plant Type: JK400
Logged/Checked by: H.W./T.H.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES PFAS	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■							▥		Extremely Weathered siltstone:silty CLAY, medium to high plasticity, brown.	DW			
	■	■					8	▥		SILTSTONE: dark grey.	SW			HIGH RESISTANCE
										END OF BOREHOLE AT 8.2m				'TC' BIT REFUSAL GROUNDWATER MONITORING WELL INSTALLED TO 8.2m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 2.0m TO 8.2m. CASING 0m TO 2.0m. 2mm SAND FILTER PACK 1.8m TO 8.2m. BENTONITE SEAL 1.0m TO 1.8m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER.
							9							
							10							
							11							
							12							
							13							
							14							

ENVIRONMENTAL LOG

Log No.
BH108
1/1

Environmental logs are not to be used for geotechnical purposes

Client: HAMMONDCARE

Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR **Method:** PUSHTUBE / SPIRAL AUGER **R.L. Surface:** ≈ 202m

Date: 28/7/22 **Datum:** AHD

Plant Type: EZI PROBE **Logged/Checked by:** A.D./T.H.

Groundwater Record	SAMPLES					Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	ASS	ASB	PFAS	DB									
DRY ON COMPLETION							0			ASPHALTIC CONCRETE: 100mm.t				
									-	FILL: Silty sand, fine to medium grained, light grey mottled yellow brown, trace of igneous and sandstone gravel.	M			INSUFFICIENT RETURN FOR BULK SCREEN
										FILL: Silty sand, fine to medium grained, yellow brown, trace of igneous and sandstone gravel and metal slag.	w≈PL			SCREEN: 4.03kg 0.3-1.2m NO FCF
							1		CI-CH	FILL: Silty clay, medium to high plasticity, brown, trace of igneous and sandstone gravel and ash.	w≈PL			RESIDUAL
										Silty CLAY: medium to high plasticity, grey mottled red brown, trace of ironstone gravel.				
							2			END OF BOREHOE AT 2.0m				
							3							
							4							
							5							
							6							
							7							

ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No.
BH109
1/2

Client: HAMMONDCARE
Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL
Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR
Method: SPIRAL AUGER
R.L. Surface: ≈ 201.5m
Date: 1/8/22
Datum: AHD
Plant Type: JK400
Logged/Checked by: H.W./T.H.

Groundwater Record	SAMPLES ES ASS ASB PFAS DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0		-	ASPHALTIC CONCRETE: 40mm.t	M			SCREEN: 2.02kg 0.04-0.1m NO FCF
		N = 5 2,3,2				FILL: Silty sand, fine to medium grained, brown and yellow brown, trace of sandstone gravel, clay nodules and ash.	w>PL			SCREEN: 5.25kg 0.1-0.3m NO FCF
			1		CI-CH	FILL: Silty clay, medium to high plasticity, grey, trace of sand, ironstone gravel and ash.	w≈PL			SCREEN: 4.75kg 0.3-0.7m NO FCF
						Silty CLAY: medium to high plasticity, orange brown mottled yellow brown, trace of ironstone gravel.				RESIDUAL
4/8/22 8/8/22		N = 20 7,10,10 N > 19 8,19/ 150mm REFUSAL	2 3			as above, but grey mottled red.				
ON COMPLET-ION		N > 9 13,9/ 50mm REFUSAL	4 5 6 7		-	Extremely Weathered siltstone: silty CLAY, medium to high plasticity, brown	XW DW			ASHFIELD SHALE LOW 'TC' BIT RESISTANCE

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ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No.
BH109
2/2

Client: HAMMONDCARE

Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 201.5m

Date: 1/8/22 **Datum:** AHD

Plant Type: JK400 **Logged/Checked by:** H.W./T.H.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES PFAS	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■									Extremely Weathered siltstone: silty CLAY, medium to high plasticity, dark grey.	DW			
	■	■					8			SILTSTONE: grey.	SW			MODERATE TO HIGH RESISTANCE
							9 10 11 12 13 14			END OF BOREHOLE AT 8.2m				GROUNDWATER MONITORING WELL INSTALLED TO 8.2m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 2.0m TO 8.2m. CASING 0m TO 2.0m. 2mm SAND FILTER PACK 1.8m TO 8.2m. BENTONITE SEAL 1.0m TO 1.8m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER.

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ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No.
BH110
1/1

SDUP3: 0-0.1m

Client: HAMMONDCARE

Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR

Method: PUSHTUBE / SPIRAL AUGER

R.L. Surface: ≈ 203.5m

Date: 28/7/22

Datum: AHD

Plant Type: EZI PROBE

Logged/Checked by: A.D./T.H.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES PFAS	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION							0			FILL: Silty clay, medium to high plasticity, red brown mottled grey and orange, trace of igneous, ironstone and sandstone gravel, sand, tile and concrete fragments, plastic, bark mulch and root fibres.	w≈PL			MULCH COVER SCREEN: 10.3kg 0-0.1m NO FCF
							1		CI-CH	Silty CLAY: medium to high plasticity, grey mottled red brown, trace of ironstone gravel and root fibres.	w≈PL			SCREEN: 11.05kg 0.1-0.6m NO FCF RESIDUAL
							2			END OF BOREHOLE AT 1.4m				
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No.
BH111
1/1

Environmental logs are not to be used for geotechnical purposes

SDUP6: 0-0.1m

Client: HAMMONDCARE

Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR **Method:** HAND AUGER **R.L. Surface:** ≈ 203m

Date: 28/7/22 **Datum:** AHD

Plant Type: - **Logged/Checked by:** A.D./T.H.

Groundwater Record	SAMPLES ES	ASS	ASB	PFAS	DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■		■	■	■		0			FILL: Silty clay, medium to high plasticity, brown, trace of igneous, ironstone and sandstone gravel, sand, ceramic, glass and plastic fragments, and root fibres.	w≈PL			GRASS COVER SCREEN: 10.2kg 0-0.1m NO FCF SCREEN: 10.11kg 0.1-0.2m NO FCF
	■		■	■					CI-CH	Silty CLAY: medium to high plasticity, grey mottled red, trace of ironstone gravel.	W≈PL			RESIDUAL
							1			END OF BOREHOLE AT 0.8m				
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Log No.
BH112
1/1

Environmental logs are not to be used for geotechnical purposes

Client: HAMMONDCARE

Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR **Method:** HAND AUGER **R.L. Surface:** ≈ 203m

Date: 28/7/22 **Datum:** AHD

Plant Type: - **Logged/Checked by:** A.D./T.H.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES PFAS	SAMPLES DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■		■	■	■		0	▩		FILL: Silty clay, medium to high plasticity, brown, trace of igneous and sandstone gravel, plastic and root fibres.	w≈PL			GRASS COVER SCREEN: 10.64kg 0-0.1m NO FCF
	■		■	■			1	▨	CI-CH	Silty CLAY: medium to high plasticity, red brown mottled grey, trace of ironstone gravel.	w≈PL			SCREEN: 10.3kg 0.1-0.7m NO FCF RESIDUAL
							2 3 4 5 6 7			END OF BOREHOLE AT 1.3m				

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ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No.
BH113
1/1
SDUP2: 0-0.1m

Client: HAMMONDCARE
Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL
Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR
Method: PUSHTUBE / SPIRAL AUGER
R.L. Surface: ≈ 205.7m
Date: 28/7/22
Datum: AHD
Plant Type: EZI PROBE
Logged/Checked by: A.D./T.H.

Groundwater Record	SAMPLES ES	ASS	ASB	PFAS	DB	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 clay, low to medium plasticity, brown, fine to medium grained sand, trace of igneous, ironstone and sandstone gravel, concrete, tile and glass fragments, bark mulch and root fibres.	w≈PL			MULCH COVER SCREEN: 10.1kg 0-0.1m NO FCF
									CI-CH	Silty CLAY: medium to high plasticity, yellow brown mottled red, trace of ironstone gravel and root fibres.	w≈PL			SCREEN: 14.6kg 0.1-0.7m NO FCF
							1			as above, but grey mottled red and orange.	w<PL			RESIDUAL
										END OF BOREHOLE AT 1.4m				
							2							
							3							
							4							
							5							
							6							
							7							

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ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No.
BH114
1/2

Client: HAMMONDCARE

Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 205.6m

Date: 29/7/22 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** T.F./T.H.

Groundwater Record	SAMPLES ES ASS ASB PFAS DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		N = 11 8,6,5	0			FILL: Silty clay, low plasticity, dark grey, grey and brown, with igneous, ironstone and sandstone gravel, trace of concrete and tile fragments, rubber, ash and root fibres.	w>PL			GRASS COVER APPEARS MODERATELY TO WELL COMPACTED SCREEN: 11.52kg 0-0.1m NO FCF SCREEN: 10.22kg 0.1-1.0m NO FCF
			1			FILL: Silty clay, low plasticity, grey brown, trace of igneous and ironstone gravel.			200 180 140	HP TESTING ON DISTURBED SAMPLE
					CH	Silty CLAY: high plasticity, light grey mottled orange and red, trace of ironstone gravel.	w>PL	St-VSt		RESIDUAL
							w<PL	Hd	450 520 520 420	HP TESTING ON DISTURBED SAMPLE
			2							
ON COMPLET-ION			3							
			4		-	Extremely Weathered siltstone: silty CLAY, light grey, medium plasticity, with occasional ironstone gravel bands.	XW	Hd		ASHFIELD SHALE VERY LOW 'TC' BIT RESISTANCE
4/8/22										
8/8/22			5							
						SILTSTONE: light grey and grey, with occasional ironstone gravel bands and, medium to high plasticity, grey brown, silty clay bands.	DW	VL		LOW RESISTANCE WITH VERY LOW RESISTANCE BANDS
			6							
			7							

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ENVIRONMENTAL LOG

Log No.
BH114
2/2

Environmental logs are not to be used for geotechnical purposes

Client: HAMMONDCARE

Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 205.6m

Date: 29/7/22 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** T.F./T.H.

Groundwater Record	SAMPLES ES	ASS	ASB	PFAS	DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
										SILTSTONE: light grey and grey, with occasional ironstone gravel bands and, medium to high plasticity, grey brown, silty clay bands.	DW	VL		
▶														
	■													
							8			SILTSTONE: grey.	DW	L		LOW RESISTANCE
	■													
							9							GROUNDWATER MONITORING WELL INSTALLED TO 14.0m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 14.0m TO 8.0m. CASING 8.0m TO 0m. 2mm SAND FILTER PACK 14.0m TO 7.8m. BENTONITE SEAL 7.8m TO 6.8m. BACKFILLED WITH SAND AND CUTTINGS TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER.
	■													
							10							
	■													
							11				SW	L-M		
	■													
							12							
												M		LOW TO MODERATE RESISTANCE
	■													
							13							MODERATE RESISTANCE
	■	■								END OF BOREHOLE AT 14.0m				
							14							

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ENVIRONMENTAL LOG

Environmental logs are not to be used for geotechnical purposes

Log No.
BH115
1/1

SDUP15: 0-0.1m

Client: HAMMONDCARE
Project: PROPOSED REDEVELOPMENT OF NERINGAH HOSPITAL
Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Job No.: E35312BR
Method: PUSHTUBE / SPIRAL AUGER
R.L. Surface: ≈ 205.8m
Date: 28/7/22
Datum: AHD
Plant Type: EZI PROBE
Logged/Checked by: A.D./T.H.

Groundwater Record	SAMPLES ES	ASS	ASB	PFAS	DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■		■	■	■		0	▨		FILL: Silty clay, low to medium plasticity, brown, trace of sand, ironstone and sandstone gravel, brick and tile fragments and root fibres.	w≈PL			GRASS COVER SCREEN: 11.4kg 0-0.1m NO FCF SCREEN: 9.8kg 0.1-0.8m NO FCF
	■		■	■			1	▨	CI-CH	Silty CLAY: medium to high plasticity, yellow brown mottled red brown, trace of ironstone gravel.	w≈PL			RESIDUAL
▶							2	▨		as above, but grey.	w>PL			
										END OF BOREHOLE AT 2.4m				
							3							
							4							
							5							
							6							
							7							

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AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

This plan should be read in conjunction with the Environmental report.

Title:

SITE LOCATION PLAN

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Project No: E35312BR

Figure No: 1

JKEnvironments

PLOT DATE: 25/07/2022 2:59:44 PM DWG FILE: K:\5C EIS JOBS\35000'S\E35312BR WAHROONGA\CAD\E35312BR.DWG

LEGEND

▬ ▬ ▬	APPROXIMATE SITE BOUNDARY
▬▬▬	APPROXIMATE WIDER PROPERTY BOUNDARY
● BH(Fill Depth)	BOREHOLE LOCATION, NUMBER AND DEPTH OF FILL (m) (JKE, 2022)
⊕ BH/MW(Fill Depth)	BOREHOLE AND GROUNDWATER MONITORING WELL LOCATION, NUMBER AND DEPTH OF FILL (m) (JKE, 2022)
● BH(Fill Depth)	BOREHOLE LOCATION, NUMBER AND DEPTH OF FILL (m) (EIS, 2010)
⌐ ¬	APPROXIMATE LOCATION OF SUSPECTED UNDERGROUND STORAGE TANK (UST)
▬▬▬	APPROXIMATE ALIGNMENT OF SEWER

AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

0 6 12 18 24 30
SCALE 1:600 @A3 METRES

This plan should be read in conjunction with the Environmental report.

Title:
SAMPLE LOCATION PLAN

Location: NERINGAH HOSPITAL, 4-12 NERINGAH AVENUE SOUTH, WAHROONGA, NSW

Project No: E35312BR

Figure No: 2

JKEnvironments

PLOT DATE: 23/08/2022 9:02:42 AM DWG FILE: K:\5C EIS JOBS\35000'S\E35312BR WAHROONGA\CAD\E35312BR.DWG

ENVIRONMENTAL LOGS EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the environmental report in regard to classification methods, field procedures and certain matters relating to the logging of soil and rock. Not all notes are necessarily relevant to all reports.

Where geotechnical borehole logs are utilised for environmental purpose, reference should also be made to the explanatory notes included in the geotechnical report. Environmental logs are not suitable for geotechnical purposes.

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. Environmental studies include 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 1726:2017 *'Geotechnical Site Investigations'*. 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 geoenvironmental practice.

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

Soil Classification	Particle Size
Clay	< 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2.36mm
Gravel	2.36 to 63mm
Cobbles	63 to 200mm
Boulders	> 200mm

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 (VL)	< 4
Loose (L)	4 to 10
Medium dense (MD)	10 to 30
Dense (D)	30 to 50
Very Dense (VD)	> 50

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

Classification	Unconfined Compressive Strength (kPa)	Indicative Undrained Shear Strength (kPa)
Very Soft (VS)	≤ 25	≤ 12
Soft (S)	> 25 and ≤ 50	> 12 and ≤ 25
Firm (F)	> 50 and ≤ 100	> 25 and ≤ 50
Stiff (St)	> 100 and ≤ 200	> 50 and ≤ 100
Very Stiff (VSt)	> 200 and ≤ 400	> 100 and ≤ 200
Hard (Hd)	> 400	> 200
Friable (Fr)	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 fissile mudstone, with a weakness parallel to bedding. Rocks with alternating inter-laminations of different grain size (eg. siltstone/claystone and siltstone/fine grained sandstone) are referred to as 'laminite'.

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 methods except test pits, hand auger drilling and portable Dynamic Cone Penetrometers require the use of a mechanical rig which is commonly mounted on a truck chassis or track base.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils and 'weaker' bedrock 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 a large 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. Refusal of the hand auger can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, 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 limited 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 cuttings. 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 assessed 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. 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, NMLC or HQ triple tube core barrels, which give a core of about 50mm and 61mm diameter, respectively, 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 NO CORE. The location of NO CORE recovery is determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the bottom 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 1289.6.3.1–2004 (R2016) *‘Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – Standard Penetration Test (SPT)’*.

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 63.5kg 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.

A modification to the SPT 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.

LOGS

The borehole or test pit logs presented herein are an interpretation of the subsurface 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 terms and symbols used in preparation of the logs are defined in the following pages.

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 reliable water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after the groundwater level has stabilised 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 assess the extent of the fill.

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

LABORATORY TESTING

Laboratory testing has not been undertaken to confirm the soil classification and rock strengths indicated on the environmental logs unless noted in the report.

SYMBOL LEGENDS

SOIL

- ▩ FILL
- ≋ TOPSOIL
- ▨ CLAY (CL, CI, CH)
- ▥ SILT (ML, MH)
- ░ SAND (SP, SW)
- ○ GRAVEL (GP, GW)
- ▨ SANDY CLAY (CL, CI, CH)
- ▨ SILTY CLAY (CL, CI, CH)
- ▨ CLAYEY SAND (SC)
- ▥ SILTY SAND (SM)
- ▨ GRAVELLY CLAY (CL, CI, CH)
- ▨ CLAYEY GRAVEL (GC)
- ▥ SANDY SILT (ML, MH)
- ▦ PEAT AND HIGHLY ORGANIC SOILS (Pt)

ROCK

- ○ CONGLOMERATE
- ░ SANDSTONE
- ▤ SHALE/MUDSTONE
- ▥ SILTSTONE
- ▤ CLAYSTONE
- ■ COAL
- ▥ LAMINITE
- ▦ LIMESTONE
- ≋ PHYLLITE, SCHIST
- ▤ TUFF
- ░ GRANITE, GABBRO
- + DOLERITE, DIORITE
- ∨ BASALT, ANDESITE
- ≈ QUARTZITE

OTHER MATERIALS

- ▦ BRICKS OR PAVERS
- △ CONCRETE
- ■ ASPHALTIC CONCRETE

CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

Major Divisions		Group Symbol	Typical Names	Field Classification of Sand and Gravel	Laboratory Classification	
Coarse grained soil (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 4$ $1 < C_c < 3$
		GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	Fines behave as silt
		GC	Gravel-clay mixtures and gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	Fines behave as clay
	SAND (more than half of coarse fraction is smaller than 2.36mm)	SW	Sand and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 6$ $1 < C_c < 3$
		SP	Sand and gravel-sand mixtures, little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		SM	Sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	N/A
		SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	

Major Divisions		Group Symbol	Typical Names	Field Classification of Silt and Clay			Laboratory Classification
				Dry Strength	Dilatancy	Toughness	% < 0.075mm
ine grained soils (more than 35% of soil excluding oversize fraction is less than 0.075mm)	SILT and CLAY (low to medium plasticity)	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity	None to low	Slow to rapid	Low	Below A line
		CL, CI	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay	Medium to high	None to slow	Medium	Above A line
		OL	Organic silt	Low to medium	Slow	Low	Below A line
	SILT and CLAY (high plasticity)	MH	Inorganic silt	Low to medium	None to slow	Low to medium	Below A line
		CH	Inorganic clay of high plasticity	High to very high	None	High	Above A line
		OH	Organic clay of medium to high plasticity, organic silt	Medium to high	None to very slow	Low to medium	Below A line
	Highly organic soil	Pt	Peat, highly organic soil	–	–	–	–

Laboratory Classification Criteria

A well graded coarse grained soil is one for which the coefficient of uniformity $Cu > 4$ and the coefficient of curvature $1 < C_c < 3$. Otherwise, the soil is poorly graded. These coefficients are given by:

$$C_U = \frac{D_{60}}{D_{10}} \quad and \quad C_C = \frac{(D_{30})^2}{D_{10}\, D_{60}}$$

Where D_{10}, D_{30} and D_{60} are those grain sizes for which 10%, 30% and 60% of the soil grains, respectively, are smaller.

NOTES:

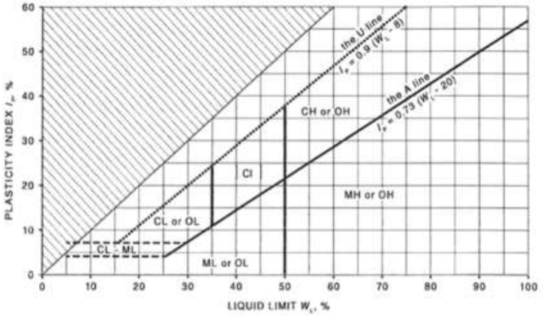
1 For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.

2 Where the grading is determined from laboratory tests, it is defined by coefficients of curvature (C_c) and uniformity (C_u) derived from the particle size distribution curve.

3 Clay soils with liquid limits > 35% and ≤ 50% may be classified as being of medium plasticity.

4 The U line on the Modified Casagrande Chart is an approximate upper bound for most natural soils.

Modified Casagrande Chart for Classifying Silts and Clays according to their Behaviour



LOG SYMBOLS

Log Column	Symbol	Definition		
Groundwater Record	▼	Standing water level. Time delay following completion of drilling/excavation may be shown.		
	—C—	Extent of borehole/test pit collapse shortly after drilling/excavation.		
	▶—	Groundwater seepage into borehole or test pit noted during drilling or excavation.		
Samples	ES	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 analysis.		
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.		
	SAL	Soil sample taken over depth indicated, for salinity analysis.		
	PFAS	Soil sample taken over depth indicated, for analysis of Per- and Polyfluoroalkyl Substances.		
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'Refusal' refers to apparent hammer refusal within the corresponding 150mm depth increment.		
	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° 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 (Fine Grained Soils)	$w > PL$	Moisture content estimated to be greater than plastic limit.		
	$w \approx PL$	Moisture content estimated to be approximately equal to plastic limit.		
	$w < PL$	Moisture content estimated to be less than plastic limit.		
	$w \approx LL$	Moisture content estimated to be near liquid limit.		
	$w > LL$	Moisture content estimated to be wet of liquid limit.		
(Coarse Grained 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 ≤ 25kPa.		
	S	SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa.		
	F	FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa.		
	St	STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa.		
	VSt	VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa.		
	Hd	HARD – unconfined compressive strength > 400kPa.		
	Fr	FRIABLE – strength not attainable, soil crumbles.		
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other assessment.		
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 and ≤ 35	4 – 10
	MD	MEDIUM DENSE	> 35 and ≤ 65	10 – 30
	D	DENSE	> 65 and ≤ 85	30 – 50
	VD	VERY DENSE	> 85	> 50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other assessment.		

Log Column	Symbol	Definition
Hand Penetrometer Readings	300 250	Measures reading in kPa of unconfined compressive strength. Numbers indicate individual test results on representative undisturbed material unless noted otherwise.
Remarks	‘V’ bit	Hardened steel ‘V’ shaped bit.
	‘TC’ bit	Twin pronged tungsten carbide bit.
	T_{60}	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.
	Soil Origin	The geological origin of the soil can generally be described as: RESIDUAL – soil formed directly from insitu weathering of the underlying rock. No visible structure or fabric of the parent rock. EXTREMELY WEATHERED – soil formed directly from insitu weathering of the underlying rock. Material is of soil strength but retains the structure and/or fabric of the parent rock. ALLUVIAL – soil deposited by creeks and rivers. ESTUARINE – soil deposited in coastal estuaries, including sediments caused by inflowing creeks and rivers, and tidal currents. MARINE – soil deposited in a marine environment. AEOLIAN – soil carried and deposited by wind. COLLUVIAL – soil and rock debris transported downslope by gravity, with or without the assistance of flowing water. Colluvium is usually a thick deposit formed from a landslide. The description ‘slopewash’ is used for thinner surficial deposits. LITTORAL – beach deposited soil.

Classification of Material Weathering

Term		Abbreviation		Definition
Residual Soil		RS		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely Weathered		XW		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.
Highly Weathered	Distinctly Weathered (Note 1)	HW	DW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately Weathered		MW		The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly Weathered		SW		Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh		FR		Rock shows no sign of decomposition of individual minerals or colour changes.

NOTE 1: The term 'Distinctly Weathered' is used where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock. 'Distinctly Weathered' is defined as follows: *'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores'*. There is some change in rock strength.

Rock Material Strength Classification

			Guide to Strength	
Term	Abbreviation	Uniaxial Compressive Strength (MPa)	Point Load Strength Index Is$_{(50)}$ (MPa)	Field Assessment
Very Low Strength	VL	0.6 to 2	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low Strength	L	2 to 6	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium Strength	M	6 to 20	0.3 to 1	Scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High Strength	H	20 to 60	1 to 3	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High Strength	VH	60 to 200	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High Strength	EH	> 200	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.