REPORT TO

HEALTH INFRASTRUCTURE

ON

SUPPLEMENTARY GEOTECHNICAL INVESTIGATION

FOR

PROPOSED CESSNOCK HOSPITAL REDEVELOPMENT

AT

24 VIEW STREET, CESSNOCK, NSW

Date: 5 November 2024
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Table of Contents

<u>ATTACHMENTS</u>

STS Table A and A1: Moisture Content, Atterberg Limits & Linear Shrinkage Test Report
STS Table B and B1: Four Day Soaked California Bearing Ratio Test Report
STS Table C and C1: Shrink-Swell Test Report
Table D: Point Load Strength Index Test Report
Envirolab Services Certificate of Analysis No. 332629
Borehole Logs 1 to 21 and 101 to 106 Inclusive (With Core Photographs)
Figure 1: Site Location Plan

1 INTRODUCTION

This geotechnical report has been prepared by JK Geotechnics Pty Ltd on behalf of Health Infrastructure to assess the potential environmental impacts that could arise from the redevelopment of the Cessnock Hospital health service at 24 View Street, Cessnock. This report has been prepared to present the results of the geotechnical investigation and provide our comments and recommendations on the proposed development.

This report accompanies a Review of Environment Factors that seeks approval for the construction and operation of a new two-storey clinical services building including:

- Demolition of select existing structures.
- Construction of a new hospital building on the site's northern portion.
- Realignment of internal roads and a new primary vehicular and pedestrian entrance to the hospital campus from Jurd Street.
- Refurbishment of the existing at-grade car park
- Installation and realignment of selected services
- Installation of ancillary development including, but not limited to, lighting and signage
- Landscaping
- New kerb, gutter and road resurfacing on Jurd Street

For a detailed project description, refer to the Review of Environmental Factors prepared by Ethos Urban.

This report presents the results of geotechnical investigations for the proposed Cessnock Hospital redevelopment at 24 View Street, Cessnock, NSW. The location of the site is shown in Figure 1. The investigation was commissioned by Health Infrastructure (Contract No. HI23152) in consultation with the project manager, Turner and Townsend. This report has been revised to include the results of the additional geotechnical investigations and to reflect the proposed development.

To assist with our report, we have been provided with the following documents:

- Architectural drawings prepared by Fitzpatrick and Partners, Project No. 22212, Dwg. No. CHR-AR-DRG-010001^{C}, 010002^{C}, 010003^{A}, 100000^{D}, 100100^{D}, 100200^{D} and 100300^{D}, dated 22 July 2024;

- Structural drawings prepared by Enstruct Group, Dwg. CHR-ST-DRG-003-00 to 03 and 100-00 to 03, Rev B dated 19 July 2024;

- Civil drawings prepared by Enstruct Group, Project No. 6850, Sheet 6850-CV-2001, 4001, 4002 Rev 11 dated 25 October 2024;

- Bulk Earthworks Plan prepared by Enstruct Group, Project No. 6850, Sheet SK05, Rev 01 dated 25 September 2024;

- Survey plan prepared by De Witt Consulting, Ref: 13835, Sheets 1 to 16, Rev B dated 24 April 2023.

We understand from the above documents that it is proposed to demolish existing structures (The engineering, pathology stores department and the incinerator) which exist within the north-western portion of the site and construct a two storey building with rooftop plant. A borrow pit will be excavated and backfilled and will be located wholly below the proposed building footprint. The floor of the borrow pit will be at RL78.90m resulting in excavation depths between about 2.6m to 4.3m below existing surface levels, however the borrow pit floor level will be 3m deep below the proposed finished ground level for the proposed building, as the building will be constructed above existing surface levels at the low northern end of the proposed building. Beyond the borrow pit area, filling will be required of up to about 1.5m over the northern portion of the area. The site won clayey material is currently proposed to be utilised for filling. For the proposed two to three storey building, the proposed ground floor has a Finished Floor Level (FFL) and Bulk Excavation Level (BEL) at RL82.4m and RL82.0m. The building structural loads are proposed to be supported by piles founded on the underling bedrock. We expect moderate structural loads for a structure of this type. Due to the borrow pit, the proposed ground floor slab will be fully suspended.

The existing on-grade car park within the western portion of the site will be demolished, the site levels generally raised by less than 1m, except at the western end where cuts of less than 0.3 are expected and then a new on-grade car park constructed. An enclosed elevated walkway will connect the southern side of the proposed building to the existing structures south of the development area. The southern side of Jurd Street will be upgraded and new driveway accesses provided.

The purpose of the investigations were to obtain geotechnical information on the subsurface conditions, and to use this as a basis for providing comments and recommendations on site preparation and earthworks, retaining wall design parameters, footing design, on-grade floor slabs, and external pavements.

2 INVESTIGATION PROCEDURE

The fieldwork for the investigations comprised the following:

- Twenty-one boreholes, BH1 to BH21, were drilled between 28 and 31 August 2023 to depths ranging from 1.8m (BH11) to 6.0m (BH10) below the existing ground surface using spiral augering techniques with our track mounted JK305 drill rig.
- Six boreholes, BH101 to BH106, were drilled between 6 and 8 August 2024 to depths ranging from 2.0m and 5.51m below the existing ground surface using spiral augering techniques with our truck mounted JK400 drill rig. BH104 to BH106 were then extended to depths ranging from 9.74m to 11.67m using an NMLC triple tube barrel fitted with a diamond coring bit and water flush.
- The borehole locations are shown on the attached Figure 2.

The estimated fill compaction and the strength of the natural clays were assessed from the results of Standard Penetration Tests (SPTs) completed in the boreholes and hand penetrometer tests on recovered cohesive soil samples. The strength of the bedrock was assessed from observation of the drilling resistance of a Tungsten Carbide (TC) drill bit attached to the augers, tactile examination of recovered rock chips, and subsequent correlation with the results of laboratory moisture content tests. We note the assessment of rock strength in this manner is approximate, and variation by about one order of strength would not be unexpected.

Groundwater observation were made during and on completion of drilling of each borehole. Groundwater monitoring wells were installed in BH2, BH11 and BH17 to allow for future measurement of groundwater levels. No longer term groundwater monitoring was completed.

The grid coordinates and surface level of each borehole were measured using a differential GPS survey unit to Map Grid Australia (MGA2020) and AHD, respectively. The order of accuracy in the vertical and horizontal is expected to be within 50mm. The measured surface levels are presented on the attached borehole logs.

Our geotechnical engineers, Anh Ngoc Phung and Andrew Griffith, were on site full time during the fieldwork and set out the borehole locations, nominated the sampling and testing, directed the monitoring well installation, and prepared the attached borehole logs. For details of the investigation techniques adopted, and a glossary of logging terms and symbols used, reference should be made to the attached Report Explanation Notes.

Selected samples were returned to Soil Test Services Pty Ltd (STS), a NATA accredited laboratory, for moisture content, Atterberg Limits, linear shrinkage, shrink-swell index and four days soaked CBR testing. The results of the STS testing are presented on the attached STS Tables A/A1, B/B1 and C/C1. Selected samples were also returned to Envirolab Services Pty Ltd, another NATA accredited laboratory, for pH, chloride content, sulfate content, and electrical conductivity testing, the results of which are presented in the attached Envirolab 'Certificate of Analysis 332629.

Where bedrock was diamond cored, the recovered core was returned for photographing and Point Load Strength Index (Is_{50}) testing. Using established correlations the Unconfined Compressive Strength (UCS) of the bedrock was then calculated from the Is_{50} results. The results have been provided in the attached Table D and also shown in the borehole logs. Copies of the colour photographs are provided with the borehole logs.

3 RESULTS OF INVESTIGATION

3.1 Brief Site History

Based on publicly available historical aerial imagery, in 1944 the majority of the existing southern portion of the site has been developed, with many of the structures shown still present at the time of our investigation albeit with minor alterations, as shown in Plate 1 below. The northern portion of the site remained largely undeveloped. There is also evidence of a drainage channel in the northern portion of the site which potentially is a natural gully landform.

Plate 1 – 1944 historical aerial imagery

The aerial imagery from 2006 shows the construction of the external on-grade car park within the western portion of the site and the access road from Jurd Street. The single storey structures that bound the external car park to the north and west are also present. Reference should be made to Plate 2 below.

Plate 2 – 2006 historical aerial imagery

The site then appears to have mostly been untouched since 2006 and reflects site conditions at the time of our investigation, as shown in the attached Figure 1.

Please note, this section is not intended to be a comprehensive review of the site history but rather provide general context for this geotechnical report.

3.2 Site Description

The site is located on the crest of a gently sloping hill which grades down north at approximately 3° to 4°. The site is bounded by Jurd Street and View Street along the northern and southern boundaries, respectively, with Foster Street as the main access route to the site through the eastern boundary.

At the time of our investigation the site contained multiple one and two storey buildings typically of brick or concrete construction. The buildings were concentrated within the central, southern and north-eastern portion the site. The northern portion was predominantly grassed with an access driveway from Jurd Street, a helipad and a small single storey brick structure near the driveway entrance. During our 2024 investigation, the grassed area was very wet and boggy which limited access. The building did not appear to be in regular use. The existing buildings within the site generally appeared to be in good condition based on a cursory external inspection. Two asphaltic concrete (AC) paved on-grade car parks located at the western and eastern ends of site appeared to be in poor condition with regular potholes, cracking and ravelling, particularly within the western end car park. Several medium to large trees were located within and around the perimeter of the site.

The neighbouring properties located beyond the south-western boundary (Nos. 34, 36, 38, 40, 42 View Street) comprised residential allotments containing one storey houses. Typically the rear yards of these properties bounded the site, with structures set back further from the site boundary. However, No. 34 View Street contained a single storey brick garage set back about 1.3m from the boundary. Surface levels across the common boundary with Nos 34 to 42 View Street appeared lower than the subject site varying between about 0.4m to 1.5m. The measurements were estimated in some instances due to boundary fences preventing direct measurement.

The neighbouring properties bounding the subject site along the western boundaries (Nos. 20, 22, 24, 26 and 28 Buckland Ave) also comprised residential allotments containing one storey houses and the rear yard areas of these properties adjoining the subject site. No. 28 Buckland Avenue contained a large tree set back about 2.1m from the common boundary, whilst Nos 20 to 26 Buckland Avenue contained shrubs setback a maximum of 3.4m from the common boundary. Surface levels across this common boundary were generally similar to those within the subject site. An NSW Ambulance property bounded the site in the north-western corner and contained a single storey structure set back about 3m from the common boundary. The remaining areas of the ambulance property contained an external on-grade car park and landscape areas with grass and small to medium sized trees.

The neighbouring eastern properties on Foster Street contained single storey residences that were set back as close as 1.5m from the common boundary. The structures generally appeared in good external condition based upon a cursory inspection from within the subject site and the street frontage. Occasional medium sized trees were present in the neighbouring properties in close proximity to the common boundary.

3.3 Subsurface Conditions

The *Singleton 1:250,000 Geological Series Sheets* indicate that the southern portion of the site is underlain by the Greta Coal Measures, which typically comprises sandstone, conglomerate, shale and coal seams. The northern portion of the site is mapped as being underlain by the Farley Formation which typically comprises mudstone, sandstone, shale and limestone. Reference should be made to Plate 3 below.

Plate 3 – Excerpt from Singleton 1:250,000 Geological Series Sheet (Pdf-Farley Formation, Pg-Greta Coal Measure)

The boreholes encountered a generalised subsurface profile comprising shallow to moderately deep fill over residual clay soils, with bedrock at predominately shallow to moderate depths. Groundwater was only encountered in a select few boreholes but was considered to be perched water seepage rather than the groundwater table. The more pertinent details of the materials encountered are provided below. Reference should be made to the borehole logs for details of the encountered subsurface conditions at each location and Figures 3 to 5 for Section A-A, B-B and C-C.

Pavement

In BH3, BH8, BH13 to BH18 and BH20, Asphaltic concrete (AC) was encountered of 40mm to 160mm thickness.

In BH6 and BH9, concrete was encountered of 160mm and 85mm thickness, respectively. In BH6, brick pavers of 75mm thickness were present below the concrete.

No distinct granular base or subbase layers were observed below the AC or concrete, apart from BH6 and BH20 where gravel fill was encountered that could be a base or subbase layer.

Fill

Fill was encountered in all boreholes to variable depths ranging from 0.2m to 1.9m. There was no pattern within the site of the fill being deeper in a particular area with the depth varying between adjacent boreholes. The fill predominantly comprised silty clay with varying proportions of sand, gravel, ash and slag. The clayey fill was assessed to be of low to medium plasticity. The estimated compaction of the fill generally varied between poorly to moderately compacted, with some well compacted layers.

In BH8, gravel fill comprising slag was encountered below the AC and extended to a depth of 1.4m.

Residual soil

The residual soils predominantly comprised silty clay, with some silty sandy clay layers. The plasticity of the clays varied, with the clays with little or no sand inclusions of medium to high plasticity and the clays with a higher percent of sand inclusions being of low to medium plasticity. The clays also contained varying amounts of ironstone gravel. The moisture condition of the clays were generally greater than the plastic limit. The clays were generally of very stiff to hard strength, with some stiff layers and clays of firm strength in BH6.

Bedrock

The bedrock predominantly comprised sandstone, with some siltstone layers in BH10, BH19 and BH21. The rock was encountered at depths ranging from 0.9m to 2.9m. On first contact the rock was generally assessed to be distinctly weathered and of low strength, increasing shortly thereafter to at least medium strength. All boreholes apart form BH10 refused within inferred high strength rock at depths ranging from 1.8m to 4.85m.

Within BH104 to BH106 we have classified the rock in general accordance with Pells et al “Classification of Sandstones and Shales in the Sydney Region: A Forty Year Review”, Australian Geomechanics, June 2019. Table 1 below provides the depths and levels where each class of rock was encountered in each borehole. We note that this classification system was formulated to assist with design of footings and as such the classification should take into account the footing width, pile diameter and pile socket length. At the time of writing this report, the pile diameters varied between 600mm to 1050mm. The classifications given in Table 1 are based on representative lengths of core and some judgement, and should be treated as approximate only. In addition, within each rock class there may be some subsections of rock being a rock class higher or lower than the overall rock classification. These classifications should be further refined once the footing widths, pile diameters and pile socket lengths are known.

Table 1: Showing Assessed Rock Classification

BH	Depth and Level To the Start of Each Rock Class							
	Class V Sandstone		Class IV Sandstone		Class III Sandstone		Class II Sandstone	
	Depth	RL (AHD)	Depth	RL (AHD)	Depth	RL (AHD)	Depth	RL (AHD)
104	3.2	79.6	3.7	79.0	-	-	6.0	76.7
105	5.4	76.4	1.9 6.7	79.8 75.0	8.4	73.4	-	-
106	-	-	3.2	80.3	-	-	3.6	79.9

Groundwater

In BH4 and BH9, groundwater seepage was encountered during drilling at depths of 2.7m and 2.5m, respectively. On completion of drilling, standing water was measured in BH9 at a depth of 4.5m, and the remaining boreholes were 'dry', including BH4.

The following tables summarises the subsurface conditions encountered in each of the boreholes. Reference should be made to the borehole logs for further details.

	Depth (m) to Top of Unit							
	BH1	**BH2**	**BH3**	**BH4**	**BH5**	**BH6**	**BH7**	**BH8**
Surface RL (mAHD)	83.10	84.81	85.60	81.82	84.16	85.57	81.32	84.09
Fill	0	0	0	0	0	0	0	0
Natural Clay	1.9	1.2	0.8	0.4	1.1	1.5	0.4	1.8
Bedrock	2.5	1.9	1.6	2.3	1.6	2.5	2.0	2.8
Groundwater	-	-	-	-*	-	-	-	-

	Depth (m) to Top of Unit							
	BH9	**BH10**	**BH11**	**BH12**	**BH13**	**BH14**	**BH15**	**BH16**
Surface RL (mAHD)	84.58	84.76	84.51	81.39	83.31	84.10	83.07	83.79
Fill	0	0	0	0	0	0	0	0
Natural Clay	0.5	0.6	0.4	0.4	1.5	0.2	1.1	0.8
Bedrock	1.5	1.45	0.9	2.9	2.0	1.2	1.75	1.1
Groundwater	4.5	-	-	-	-	-	-	-

	Depth (m) to Top of Unit							
	BH17	**BH18**	**BH19**	**BH20**	**BH21**	**BH101**	**BH102**	**BH103**
Surface RL (mAHD)	83.50	83.77	83.35	83.50	80.71	80.87	80.97	81.65
Fill	0	0	0	0	0	0	0	0
Natural Clay	0.8	0.5	1.1	0.2	1.4	0.9	0.5	0.5
Bedrock	1.2	1.85	1.4	1.5	2.5	2.9	2.6	1.6
Groundwater	-	-	-	-	-	-	-	

	Depth (m) to Top of Unit		
	BH104	**BH105**	**BH106**
Surface RL (mAHD)	82.72	81.71	83.47
Fill	0	0	0
Natural Clay	0.5	0.4	0.6
Bedrock	3.2	1.9	3.2
Groundwater	5.0	0.7	0.8

Notes - * Groundwater seepage encountered during drilling but the borehole was dry on completion.

3.4 Laboratory Test Results

Based on the Atterberg limits and linear shrinkage test results, the clayey fill and natural clay tested ranges from low plasticity to high plasticity. The moisture content test results on samples of the weathered rock showed reasonably good correlation with our field assessment of rock strengths. Reference should be made to the attached STS Table A and A1 for further details.

The four day soaked CBR tests on a clayey fill and residual clay samples compacted to 98% of their Standard Maximum Dry Density (SMDD) returned CBR values ranging from 0.5% to 3.5%. Reference should be made to the attached STS Table B and B1 for further details.

The results of the shrink-swell testing from samples taken from BH3, BH7 and BH20 returned values of 1.05%/pF, 1.52%/pF and 1.20%/pF, respectively. This indicates the soils tested have a moderate potential for shrink/swell reactivity with changes in moisture content. Reference should be made to the attached STS Table C and C1 for further details.

The results of the point load strength index tests on the recovered rock core correlated well with our field assessments of rock strength. Based on a correlation of the Unconfined Compressive Strength (UCS) being 20 times the $I_{S(50)}$ result, the UCS values generally ranged between 2MPa and 34MPa, although there were occasional values up to 54MPa. Reference should be made to the attached Table D for further details.

The following table summarises the soil chemistry test results from Envirolab Services. Reference should be made to the attached Certificates of Analysis No. 332629 for further details.

Samples	Material	pH	Chloride (mg/kg)	Sulphate (mg/kg)	Resistivity* (ohm.cm)
BH1 1.5m-1.9m	FILL: Silty clay	5.4	26	50	10,200
BH5 1.1m-1.2m	Silty CLAY	7.0	75	64	5,560
BH8 0.5m-0.95m	FILL: Gravel	5.3	45	390	3,230
BH11 0.5m-0.9m	Silty CLAY	7.8	81	59	5,560
BH18 1.5m-1.85m	Silty CLAY	5.7	330	170	2,500
BH18 3.2m-3.5m	SANDSTONE	7.9	230	230	3,570

* Calculated from electrical conductivity

4 COMMENTS AND RECOMMENDATIONS

Based on the identification of potential issues and an assessment of the nature and extent of the impacts of the proposed development, it is determined that:

- The extent and nature of potential impacts are low and are not expected to have significant adverse effects on the locality, community and the environment.
- Potential impacts can be appropriately mitigated or managed to ensure that there is minimal effect on the locality and community.

4.1 Geotechnical Issues

Based on the results of this investigation the following are the main geotechnical issues expected for the proposed development. Further comments on these issues are provided within the following sections of this report.

Cut and fill earthworks will be required, which will extend through the fill and soils, and potentially a limited depth of bedrock. If excavation of the rock is required then the use of rock excavation equipment will be required. Care will be required that the use of percussive excavation equipment does not result in unacceptable vibrations being transmitted to the existing or adjoining buildings.

Fill was encountered within most of the boreholes to variable depths ranging from 0.2m to a maximum depth of 1.9m. We are unaware of any records of placement or compaction control of the fill and due to this and the variable estimated compaction based on our testing carried out in the boreholes, the existing fill is considered to be 'uncontrolled' and is not suitable to support footings or floor slabs. Where the fill is not removed as part of the earthworks, footings will need to be founded below the fill and within the natural clays or weathered rock, with floor slabs designed as a fully suspended slabs. Alternatively, the fill may be removed and replaced with controlled engineered fill to allow the slab to be supported on the fill, however will need to be designed appropriately for the potential shrink-swell movements.

The clayey fill and natural clay appear to provide a poor subgrade for proposed pavements given the very low CBR values. We expect relatively thick pavements will be required for the site or the integration of a select fill layer.

4.2 Mitigation Measures

The following table summarises the potential mitigation measures required from a geotechnical perspective. Further discussion of these are provided in the following sections as referenced in the table.

Project Stage **Design (D)** **Construction (C)** **Operation (O)**	**Mitigation Measures**	**Relevant Section of Report**
D/C	The existing fill is not considered a suitable founding stratum. Given the shallow nature of the bedrock, all footings must be uniformly founded on bedrock suitable for the design allowable bearing pressure.	4.8
D/C	Support of the excavation sides for the borrow pit should be formed at no steeper than 1 Vertical to 1 Horizontal to maintain stability of the excavation.	4.7
D	Buried services that extend between the borrow pit footprint and external areas will need to be design to accommodate differential shrink-swell movements and consolidation/creep settlement of the borrow pit backfill.	4.8
D	For pavement, the clays provide a poor subgrade and therefore pavements will either comprise thick pavements based on a low CBR value, or consideration will need to be given to adopting a select fill layer in order to reduce the pavement thickness.	4.11
C	Unexpected ground conditions, such as weak soil subgrade or very high strength bedrock. Contractors should be provided with the geotechnical report to make their own assessment of piling and excavation conditions.	4.4
C	Groundwater management during excavation and backfilling of the borrow pit will need to be appropriately considered. Construction of temporary bunds and dish drains to capture surface run-off should be allowed for, as well as grading the borrow pit floor to promote run-off into a sump to minimise ponding of water within the borrow pit floor.	4.6
C	Compaction of existing fill that will remain below proposed external pavements is required to minimise settlements.	4.11
C	The allowable bearing pressures for the proposed piles will need to be checked by a geotechnical engineer. The inspections required will be dependent on the adopted design allowable bearing pressure. Where design values based on Class III bedrock are adopted, then full-time inspections by a geotechnical engineer are recommended.	4.8

4.3 Excavation

Excavations about 4.3m deep are expected as part of the bulk earthworks for the borrow pit. We expect the excavations to predominantly encounter clayey fill and natural clay, as well as the upper layers of the weathered rock. The bedrock strength is expected to mostly be of very low to low strength, however over the eastern portion of the site, in the vicinity of BH106, we expect medium to high strength bedrock to be encountered.

Excavation of soils and bedrock up to very low strength will be achievable using conventional excavation equipment, such as the buckets of hydraulic excavators, although we acknowledge that demolition of existing pavements and/or structures will potentially require the use of percussive techniques, such as hydraulic impact hammers. Excavation of the rock of low strength or better will require assistance with rock excavation equipment, such as hydraulic rock hammers, ripping hooks, rotary grinders or rock saws.

We recommend that where hydraulic impact hammers are to be used, at least some initial quantitative vibration monitoring by the geotechnical engineers be carried out to assess if the vibrations transmitted to the existing or adjoining buildings are within tolerable limits. Where there are concerns, full time monitoring of the transmitted vibrations may be required.

Where vibrations are found to be excessive then alternative lower vibration emitting equipment would need to be used, such as ripping hooks rotary grinder or rock saws. Reference should be made to the attached Vibration Emission Design Goals for acceptable limits of transmitted vibrations.

4.4 Earthworks and Subgrade Preparation

As discussed, in Section 4.1, we are unaware of any records of placement or compaction control of the fill and it must be considered 'uncontrolled' and is not suitable to support footings. Where the fill has not been removed as part of the excavation, then to allow footings to be appropriately supported, the existing uncontrolled fill would need to be fully excavated and replaced with controlled, engineered fill. Within any proposed pavement areas, the existing fill may remain in place provided it is proof rolled as recommended below and treatment of any weak areas carried out. Within landscaped areas the recommendations provided below should be followed, however density testing of any placed fill in landscaped areas would not be required.

Due to the proposed borrow pit, a fully suspended floor slab will be adopted and therefore no particular subgrade preparation would be required, but any vegetation, root affected soils or deleterious fill material should be stripped. Fill may then be placed as 'form fill' with only nominal compaction and without the need for density testing of the fill during placement. Where a clay subgrade is present below the suspended slab, we recommend placement of void formers at least 50mm thick, below slabs and thickening beams, to mitigate the risk of swelling clays imposing an uplift force on the slab.

The following subgrade preparation measures should be followed for external pavements:

- Strip all vegetation, root affected soils or any deleterious fill material exposed.
- Within building areas where the subgrade exposes existing fill, excavate all existing fill to expose the underlying residual soils.
- Proof roll the exposed residual soil subgrade with at least 6 passes of a minimum 12 tonne dead weight, smooth drum, non-vibratory roller. The final pass of the proof rolling should be carried out in the presence of a geotechnical engineer to detect any weak subgrade areas.
- Any weak subgrade areas detected during proof rolling should be locally excavated to a sound base and the excavated material replaced with controlled, engineered fill, or as directed by the geotechnical engineer during the proof rolling inspection.
- Within pavement areas, if the existing fill extends to significant depth, the use of a bridging layer may be required to avoid excessive excavation. The bridging layer would need to be designed at the time, but we expect it would comprise good quality granular fill, containing geotextile layers, of at least 0.5m

to 0.6m thickness. If weak areas below slabs extend to significant depths, then the slabs may then need to be redesigned as fully suspended slabs.

- Following treatment of any weak layers, engineered fill should be placed as required in thin horizontal layers not greater than 200mm loose thickness to the design levels.

We expect that some weak subgrade areas may be encountered where the existing uncontrolled fill is left in place in pavement areas, or where the clays are of lower strength, such as the firm strength clay encountered in BH6. The extent of the weak areas may be reduced if the earthworks are carried out during dry weather and adequate site drainage is provided and maintained. If the clay fill or residual silty clay is exposed to prolonged periods of rainfall, softening will result and site trafficability will be poor. If soil softening occurs, the subgrade should be over-excavated to below the depth of moisture softening and the excavated material replaced with engineered fill. The placement of a layer of good quality granular material as the final fill layer is recommended to improve the trafficability of the site during construction.

Any fill to be removed from site should be appropriately classified by an environmental consultant for disposal prior to removal from site.

During construction of the fill platform runoff should be enhanced by providing suitable falls to reduce ponding of water on the surface of the fill. Ponding of water may lead to softening of the fill and subsequent delays in the earthworks program.

4.5 Engineered Fill and Compaction Control

Engineered fill should preferably comprise well graded granular materials, such as crushed sandstone, free of deleterious substances and having a maximum particle size not exceeding 75mm. From a geotechnical perspective, the existing fill generally appears suitable for re-use as engineered fill, although the slag gravel encountered in BH8 may be difficult to re-use. Any excavated fill proposed for re-use should be inspected by a geotechnical engineer following excavation to confirm the suitability, as deleterious inclusions may not have been identified within our small diameter boreholes.

Fill should be compacted in horizontal layers of not greater than 200mm loose thickness, to a density of at least 98% of Standard Maximum Dry Density (SMDD). However, where clayey fill is used it should be compacted to a density strictly between 98% and 102% of SMDD and at moisture contents within 2% of Standard Optimum Moisture content (SOMC). For backfilling confined excavations such as service trenches, a similar compaction to engineered fill should be adhered to, but if light compaction equipment is used then the layer thickness should be limited to 100mm loose thickness.

For backfilling of the borrow pit, we recommend it is carried out under Level 1 inspection and testing in accordance with AS3798-2007. Elsewhere, Level 2 control of fill compaction may be adhered to. Density tests should be regularly carried out on the fill to confirm the above specifications are achieved. The frequency of density testing should be at least one test per layer per 1,000m^2 or 1 test per 200m^3 distributed reasonably evenly throughout the fill depth, whichever requires the most tests. Preferably the geotechnical testing authority should be engaged directly on behalf of the client and not by the earthworks subcontractor.

4.6 Hydrogeological Considerations

We do not expect any excavations to encounter the groundwater table, but seepage will likely be encountered along the soil-rock interface and through defects in the bedrock. However, the subsurface profile is of low permeability and therefore any seepage encountered should be easily managed by either gravity or sump and pump drainage systems. Furthermore, we do not expect stormwater infiltration systems will likely be a viable option, particularly given the low permeability and the assumed size of the proposed building. As such, any captured stormwater (rooftop, surface run-off, etc.) will need to be disposed of appropriately into the Council stormwater systems or waterways, pending approval.

It was noted during our 2024 investigation, the grassed area that currently covers a large portion of the proposed building was very waterlogged and boggy. As such, allowance for remediation of the grass area should be allowed for on commencement of construction to provide site accessibility. Furthermore, whilst the proposed borrow pit excavation will not intercept the groundwater table, given the excavation will form a low point in the area, any surface run-off and seepage along the soil-rock interface will flow into the borrow pit excavation. Therefore, it will be critical to appropriately manage the site drainage to limit surface run-off into the excavation given it will form a low point in the area.

Whilst groundwater ingress into the borrow pit during excavation is not particularly problematic, during backfilling it will be difficult to achieve adequate compaction should water be allowed to pond in the base of the pit and soften the materials. Construction of temporary bunds and dish drains around the perimeter of the borrow put should be considered to capture any surface run-off. Where seepage along the soil-rock interface occurs, the flows are expected to be very low given the low permeability of the subsurface profile and we recommend maintaining a suitable grade during backfilling of the borrow pit floor to encourage water to flow to a sump in one corner of the pit which should not be allowed to overflow. Whilst this will not fully remove potentially issues associated with the ponding water in the base of the borrow pit, it will assist to minimise the potential impact. Lastly, the design of any retaining walls must include provision for adequate drainage.

4.7 Retention Systems

We expect that permanent batters would be feasible given the slope of the site and space available, or alternatively low height retaining walls may be adopted. Given the proposed excavations are sufficiently away from site boundaries, the use of temporary batters appears feasible to allow construction of permanent retaining walls at the base of the batters. If this is not the case and buildings are proposed close to site boundaries or existing structures, additional geotechnical advice should be obtained on appropriate in-situ retention systems that may need to be installed prior to excavation, which are likely to comprise of soldier piled walls or soil nails.

Temporary batters of no more than 3m in height, such as those for the proposed borrow pit, should be no steeper than 1 Vertical in 1 Horizontal (1V:1H). Such batters should remain stable in the short term provided all surcharge loads, including construction loads, are kept well clear of the crest of the batters. Where batter heights exceed 3m, further advice should be sought from a geotechnical engineer once the exact batter locations and heights are known.

Permanent batters through soils should be no steeper than 1V:2H, but flatter batters in the order of 1V:3H are preferred to allow access for maintenance of vegetation. Where soils are exposed, 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.

Where fill is placed to form permanent batters, the fill should be placed in horizontal layers that extend at least 1.5m past the final geometry of the permanent batters. Following placement of the fill, the batter should then be cut back to the final geometry so that any loose fill on the edge of the batter is removed.

Permanent retaining walls supporting no more than about 3m may be designed as cantilevered walls based on a triangular earth pressure distribution. The major consideration in the selection of lateral earth pressures for the design of retaining walls is the need to limit deformations occurring outside the excavation. Where the resulting ground movements are of little concern design may be based on an active earth pressure coefficient, K_a, of 0.33. Where movements are to be reduced, or where walls are restrained from movement by other structural elements in front of the wall, an 'at rest' earth pressure coefficient, K_0, of 0.6 should be used for the design of cantilevered walls. A bulk unit weight of $20kN/m^3$ should be adopted for the retained material.

The above coefficients assume horizontal backfill surfaces and where inclined backfill is proposed the coefficients should be increased or the inclined backfill taken as a surcharge load. All surcharge loads should be allowed for in the design, plus full hydrostatic pressures, unless measures are undertaken to provide complete and permanent drainage behind the wall.

4.8 Footings

Based on the results of the investigation and the excavations for the proposed borrow pit, along the southern edge of the proposed building, we generally expect bedrock to be at, or less than 1m deep below the proposed BEL. However, the bedrock surface appears to deepen relatively quickly and therefore we expect bedrock to be greater than 1m deep for the majority of the building footprint, and will be greater than 3m within the borrow pit footprint. Along the northern side of the proposed building, bedrock is expected to be between about 2.4m and 3.6m below the proposed BEL.

Given the relatively shallow depth to bedrock at the southern edge of the building, we recommend the entire building be uniformly founded on bedrock to prevent potential differential settlements occurring. As such, the building will need to be supported on piles socketed into the underlying bedrock, although high level footings may be feasible along the southern edge of the building. Further discussion of high level footings and piled footings are provided in Sections 4.8.1 and 4.8.2 below.

We understand that it is currently proposed for the structural loads to be supported by piles founded on the bedrock and the ground floor slab to be fully suspended. Given the potential shrink-swell movements of the clayey subgrade, we recommend the use of 50mm void formers below the floor slab.

Given the floor slab will be fully suspended and due to the presence of the backfilled borrow pit, careful consideration must be given the services that extend between the borrow pit footprint and external areas given the potential for differential movements. Differential shrink-swell movements will occur but also settlement of the borrow pit backfill will occur. For shrink-swell, we expect movements similar to a lower bound Class ‘H1’ site in accordance with AS2870-2011. The compacted backfill of the borrow pit, assumed to predominantly comprise of clay soils, is expected to undergo consolidation settlement and also longer term creep settlement. We expect these settlements to be in the order of 0.5%H per log cycle, where H is the fill depth, i.e. for 3m of fill, we estimate settlements in the order of 15mm may occur per log cycle, in other words an estimated total settlement of about 30mm over an approximate 30 year time period. This is on the basis that backfilling is carried out in accordance with our recommendations in Section 4.5 above for engineered fill.

4.8.1 Footings Founded within Rock

The design of footings founded within the rock may be based on the parameters given in the table below. We note that the serviceability parameters given are based on settlement of less than 1% of the pile diameter or footing width at the toe of the pile. The ultimate parameters may be used with a limit state design methodology on the understanding that detailed settlement analysis of footings must also be carried out to assess likely settlements under these higher pressures. We note that the use of ultimate pressures can produce settlements up to 5% of the pile diameter or footing width at the toe of the pile. The designer may use the modulus values given below for the given class of rock to estimate the settlements of particular footings. Consideration will also need to be given to differential settlements between adjoining footings, particularly if they are of variable sizes. We recommend further advice in regard to potential settlements be obtained from the geotechnical engineers once footing sizes are determined.

For suspended slabs over a clayey subgrade supported by piles, we recommend the inclusion of 50mm void formers below the slab and all thickening beams to mitigate the risk of swelling clays imposing an uplift force on the slab.

Sandstone Rock Class	Allowable End Bearing Pressure (kPa)	Allowable Shaft Adhesion in Compression (kPa)	Ultimate End Bearing Pressure (kPa)	Ultimate Shaft Adhesion in Compression (kPa)	Elastic Modulus (MPa)
Class V	700	70	2,000	150	100
Class IV	1,200	120	4,000	300	300
Class III	6,000	600	30,000	1,000	1,000

We recommend the piling contractor take into consideration the presence of high and even very high strength bands when determining appropriate piling equipment for drilling piles. Penetration of such bands would produce greater equipment wear and tear than would be usual. Decreased productivity as a result of higher strength rock layers should also be allowed for in the piling program.

Where the design of footings is based on limit state design methodology, the above ultimate values must be used in conjunction with an appropriate geotechnical strength reduction factor (ϕ_g) which must be calculated in accordance with the methodology outlined in AS2159-2009 '*Piling Design and Installation*'. It is not possible at this stage to accurately determine the geotechnical strength factor as we have no knowledge of the design and installation factors. However, as a guide we have estimated the Average Risk Rating (ARR) and geotechnical strength reduction factor based on the following assumptions:

- The designer has extensive experience with similar foundations in similar geological conditions.
- The design method adopted is well established and soundly based.
- The method for utilising results of in-situ test data and installation data is based on indirect measurements used during installation and not calibrated to static load tests.
- There is a detailed level of construction control with professional geotechnical supervision and construction processes that are well established and relatively straightforward are adopted.
- No monitoring of the structure after construction will be undertaken.

Based on the above assumptions and our geotechnical knowledge, we estimate an ARR of 2.24 in accordance with Equation 4.3.2 and Table 4.3.2(A) of AS2159-2009. Accordingly, the overall risk category is 'Low', resulting in a geotechnical strength reduction factor of 0.56 for low redundancy systems and 0.64 for high redundancy systems, in accordance with Table 4.3.2(C) of AS2159-2009.

All piles should be founded with a nominal socket of at least 0.3m into the appropriate class of rock. For the design of sockets into the rock, the shaft adhesion should be ignored within the upper 0.3m nominal socket. For the design of piles in uplift, shaft adhesions of 70% the shaft adhesions in compression may be used. The shaft adhesion values assume that adequate socket roughness and cleanliness is maintained.

Where footings are founded within Class V or Class IV Rock, we consider that at least the initial stages of footing excavation should be inspected by a geotechnical engineer to confirm that a suitable founding stratum has been achieved. The requirements for further inspections can be decided at that time, and the frequency will depend on the level of 'sign-off' required. We note that the geotechnical engineers will only be able to 'sign-off' on footings or piles that they have inspected.

Where footings are founded within Class III bedrock, we recommend the drilling of all piles be inspected by a geotechnical engineer.

A piling platform will need to be constructed to support the piling rig. The platform should be constructed using good quality granular material, but the thickness will depend on the piling rig and platform material used and will need to be determined once details of the piling rig are known. Working platforms will typically comprise a high quality crushed sandstone or a similarly approved material.

4.8.2 Shallow Footings

As discussed above, we recommend that where part of a structure is founded on bedrock, that the entire structure is uniformly founded on bedrock to prevent potential differential settlement. However, we have provided advice for high level footings, such as for external retaining walls.

High level pad or strip footings founded on engineered fill or residual silty clay of at least stiff strength may be designed based upon a maximum allowable bearing pressure (ABP) of 100kPa. Where high level pad or strip footings are founded on at least very stiff residual clays, then we consider that such footings may be designed for a maximum allowable bearing pressure of 200kPa.

The footings must be inspected by a geotechnical engineer to confirm a suitable founding stratum has been achieved. We recommend the footings are poured without delay as if water is allowed to pond in the base of the footings, then they will no longer be suitable for the above ABP and will need to be excavated until suitable material is again encountered. If delays in pouring the footings are expected, then consideration could be given to a concrete blinding layer to protect the base of the footings.

4.9 Soil Aggressiveness

Based on the soil aggressivity testing, the soils and weathered rock would be classified as having a 'Mild' 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 'Non-aggressive' in accordance with Table 6.5.2(c) of AS2159-2009.

4.10 Earthquake Design Classification

Based upon AS1170.4-2007 "*Structural Design Actions, Part 4: Earthquake Actions in Australia*", the following design parameters may be adopted:

- Hazard Factor (Z) – 0.10;
- Class C_e – Shallow Rock site.

Whilst the subject area in its current state would technically be Class B_e-Rock site, due to the proposed borrow pit excavation and backfilling, Class C_e applies to the proposed development.

4.11 Pavements

We assume that new access roads and external on-grade car parks will require pavement design. Any pavement subgrade should be prepared as recommended in Section 4.4.

The CBR testing of soil samples returned CBR values ranging from 0.5% to 3.5%, although along Jurd Street, the CBR tests returned a minimum value of 1.5%. Therefore, we recommend that design of the pavement thickness be based on a soaked CBR of 1.0% (i.e. the 10th percentile value which is in accordance with Austroads 2024) or a modulus of subgrade reaction of 20kPa/mm (750mm plate). Where fill is used to raise site levels, or replace unsuitable subgrade by the appropriate depth, pavement design may reflect the thickness and four day soaked CBR value of the imported material, provided such layer is suitably thick to satisfy effective subgrade strength criteria.

The measured CBR value of 1.0% is low and will result in a relatively thick pavement. Therefore, consideration could be given to some form of subgrade improvement to reduce the thickness of the pavement materials. The following are possible options for improving the subgrade.

1. Provide an appropriate select fill layer as part of the overall pavement thickness. The select fill should be well graded ripped or crushed sandstone or good quality granular material with a minimum soaked CBR value of 10%.

OR

2. Stabilise the subgrade to a depth of 200mm to 300mm by the addition of lime or cement. When thoroughly mixed and re-compacted to a minimum of 98% of SMDD, a reduction in reactivity along with substantial increase in strength will be achieved. As a guide, the addition of approximately 4% lime by dry weight of clay should result in a soaked CBR value of around 10% or an equivalent subgrade reaction modulus of 60kPa/mm. This should, however, be confirmed by laboratory testing. The design of the pavement may then take into account this treated layer of higher CBR material. If lime stabilisation is undertaken, an experienced contractor with appropriate equipment should complete it. Appropriate dust suppression will be required, particularly given the proximity of the existing Hospital.

We understand that over the western portion of the site where the proposed on-grade car park will be constructed, consideration is being given to utilising the existing pavement as a ‘bridging’ layer for the new pavement. The existing pavement was generally in moderate condition, although there are some areas in poor condition evidenced by occasional potholes and crocodile cracking. Furthermore, from review of the borehole logs in this area, the existing pavement comprises a 40mm thick AC pavement that generally appears to directly overly a clay fill subgrade. It is likely the pavement once had a gravel base layer but it has become spoiled over time due to pumping of fines up from the clay subgrade into the base layer. As such, from a geotechnical perspective, there appears to be minimal benefit in utilising the existing pavement. We would recommend the pavement be removed to prevent it forming an impermeable layer.

Surface and subsoil drainage should be provided on both sides of the pavements to prevent moisture ingress into the subgrade and pavement. The subsoil drains should have an invert level of at least 300mm below the adjacent subgrade level and be excavated with a uniform longitudinal fall to appropriate discharge points so as to reduce the risk of ponding in the base of the drain. In addition, the surface of the adjacent pavement subgrade should be provided with a uniform cross fall towards the subsoil drain to assist with drainage.

Concrete pavements should have 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), which is compacted to at least 100% of SMDD. Concrete pavements should be designed with effective shear transmission at all joints by way of either doweled or keyed joints.

4.12 Mine Subsidence

Based upon the NSW Government ePlanning Spatial Viewer and at the date of this report, the site does not fall within an identified Mine Subsidence District and therefore does not require approval from Subsidence Advisory NSW, see Plate 4 below.

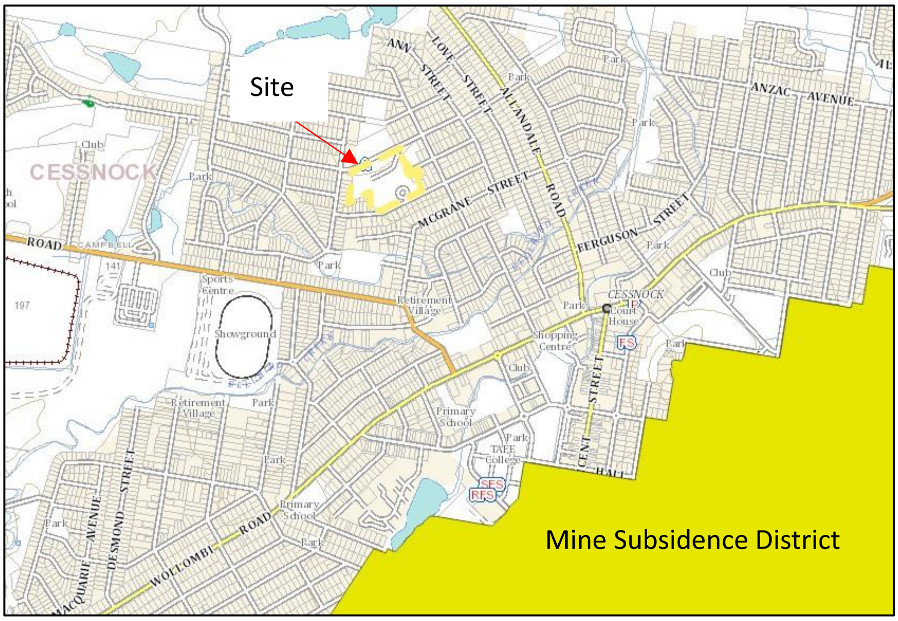

Plate 4 - NSW Government ePlanning Spatial Viewer: Mine Subsidence District

4.13 Further Geotechnical Input

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

- Inspection of proof roiling of soil areas.
- Level 1 inspection and testing for backfilling of the borrow pit.
- Density testing of any fill placed.
- Inspection of footing excavations or pile drilling.

5 GENERAL COMMENTS

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

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

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.

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

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SOIL TEST SERVICES
ABN 43 002 145 173

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

Client: JK Geotechnics
Project: Cessnock Hospital Redevelopment
Location: Cessnock Hospital, 24 View Street, Cessnock, NSW

Report No.: 36230BF - A
Report Date: 15/09/2023
Page 1 of 1

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	**DEPTH m**	**MOISTURE CONTENT %**	**LIQUID LIMIT %**	**PLASTIC LIMIT %**	**PLASTICITY INDEX %**	**LINEAR SHRINKAGE %**
1	2.50 - 3.00	7.6	-	-	-	-
2	0.50 - 0.95	13.2	31	13	18	8.0
2	2.80 - 2.85	4.0	-	-	-	-
3	2.80 - 2.90	7.2	-	-	-	-
7	0.50 - 0.95	18	43	14	29	12.0
7	2.00 - 2.40	8.2	-	-	-	-
9	0.50 - 0.95	23.8	52	19	33	12.5
9	1.70 - 2.00	6.2	-	-	-	-
10	4.30 - 4.40	8.6	-	-	-	-
13	2.60 - 2.90	5.8	-	-	-	-
16	1.50 - 1.70	4.8	-	-	-	-
18	2.50 - 2.70	6.9	-	-	-	-
19	3.80 - 4.00	5.5	-	-	-	-
20	2.00 - 2.30	6.7	-	-	-	-
21	1.50 - 1.95	19.4	36	17	19	9.5

Notes:

- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 05/09/2023.
- Sampled and supplied by client. Samples tested as received.

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15/09/2023
Authorised Signature / Date
(D. Treweek)

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SOIL TEST SERVICES
ABN 43 002 145 173

TABLE A1
MOISTURE CONTENT, ATTERBERG LIMITS AND LINEAR SHRINKAGE TEST REPORT

Client: JK Geotechnics
Project: Cessnock Hospital Redevelopment
Location: Cessnock Hospital, 24 View Street, Cessnock, NSW

Report No.: 36230BF - A1
Report Date: 27/08/2024
Page 1 of 1

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	**DEPTH m**	**MOISTURE CONTENT %**	**LIQUID LIMIT %**	**PLASTIC LIMIT %**	**PLASTICITY INDEX %**	**LINEAR SHRINKAGE %**
104	1.00 - 1.40	27.3	56	19	37	9.5

Notes:

- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 13/08/2024.
- Sampled and supplied by client. Samples tested as received.

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SOIL TEST SERVICES
ABN 43 002 145 173

TABLE B
FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client: JK Geotechnics
Project: Cessnock Hospital Redevelopment
Location: Cessnock Hospital, 24 View Street, Cessnock, NSW

Report No.: 36230BF - B
Report Date: 15/09/2023
Page 1 of 1

BOREHOLE NUMBER	BH 3	BH 12	BH 13	BH 17
DEPTH (m)	0.20 - 0.80	0.40 - 1.00	0.20 - 0.80	0.10 - 0.80
Surcharge (kg)	4.5	4.5	4.5	4.5
Maximum Dry Density (t/m^3)	1.83 STD	1.72 STD	1.67 STD	1.86 STD
Optimum Moisture Content (%)	14.3	20.6	20.3	14.1
Moulded Dry Density (t/m^3)	1.80	1.68	1.63	1.83
Sample Density Ratio (%)	98	98	98	98
Sample Moisture Ratio (%)	97	100	99	98
Moisture Contents				
Insitu (%)	15.4	23.8	23.7	14.1
Moulded (%)	13.9	20.7	20.2	13.8
After soaking and After Test, Top 30mm(%)	22.7	29.8	22.7	22.0
Remaining Depth (%)	15.8	20.4	18.3	15.9
Material Retained on 19mm Sieve (%)	0	0	0	0
Swell (%)	1.0	2.0	1.0	0.5
C.B.R. value: @2.5mm penetration	0.5	0.5	2.5	1.0

NOTES: Sampled and supplied by client. Samples tested as received. BH 13 dried back prior to testing as it was too saturated.

- Refer to appropriate Borehole logs for soil descriptions
- Date of receipt of sample: 05/09/2023.
- Test Methods : AS 1289 6.1.1, 5.1.1 & 2.1.1.
- BH 12 had insufficient material supplied to complete a four-point compaction curve.

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SOIL TEST SERVICES
ABN 43 002 145 173

TABLE B1
FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client: JK Geotechnics
Project: Cessnock Hospital Redevelopment
Location: Cessnock Hospital, 24 View Street, Cessnock, NSW

Report No.: 36230BF - B1
Report Date: 27/08/2024
Page 1 of 1

BOREHOLE NUMBER	BH 101	BH 102	BH 103	BH 106
DEPTH (m)	0.03 - 0.90	0.50 - 1.50	0.50 - 1.50	0.50 - 1.50
Surcharge (kg)	9.0	9.0	9.0	9.0
Maximum Dry Density (t/m^3)	1.88 STD	1.73 STD	1.85 STD	1.75 STD
Optimum Moisture Content (%)	13.4	18.8	15.9	15.8
Moulded Dry Density (t/m^3)	1.84	1.69	1.81	1.72
Sample Density Ratio (%)	98	98	98	98
Sample Moisture Ratio (%)	101	102	101	99
Moisture Contents				
Insitu (%)	9.5	20.5	15.8	21.3
Moulded (%)	13.6	19.2	16.0	15.6
After soaking and After Test, Top 30mm(%)	17.1	23.0	26.1	22.7
Remaining Depth (%)	17.1	20.3	17.3	17.3
Material Retained on 19mm Sieve (%)	0	0	0	0
Swell (%)	0	0	1.0	0.5
C.B.R. value: @2.5mm penetration	3.5	2.5	1.5	
@5.0mm penetration				3.0

NOTES: Sampled and supplied by client. Samples tested as received.
- Refer to appropriate Borehole logs for soil descriptions
- Test Methods : AS 1289 6.1.1, 5.1.1 & 2.1.1.
- Date of receipt of sample: 13/08/2024.

NATA
NATA Accredited Laboratory Number:1327

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27/08/2024
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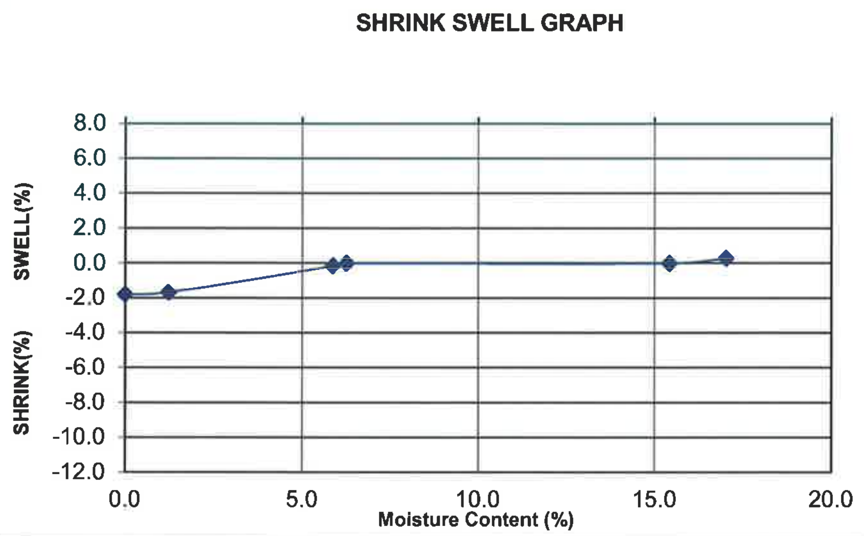
TABLE C
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client: JK Geotechnics
Project: Cessnock Hospital Redevelopment
Location: Cessnock Hospital, 24 View Street, Cessnock, NSW

Report No.: 36230BF - C
Report Date: 15/09/2023
Page 1 of 3

Borehole No.: 3		Depth: 0.50 - 0.88m	
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH	
BEFORE TEST	AFTER TEST	BEFORE TEST	AFTER TEST
15.4%	17.0%	330,520 kPa	>320 kPa
LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION	SWELL ON SATURATION	SHRINKAGE
25	-0.8%	0.3%	1.7%



SHRINK SWELL INDEX
1.05 %/pF

Notes: Sampled and supplied by client. Sample tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Visually estimated inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 05/09/2023.

NATA Accredited Laboratory
Number:1327

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the items tested or sampled.

Authorised Signature / Date
(D. Treweek)
15/9/23

115 Wicks Road
Macquarie Park, NSW 2113
PO Box 976
North Ryde, Bc 1670
Telephone: 02 9888 5000
Facsimile: 02 9888 5001

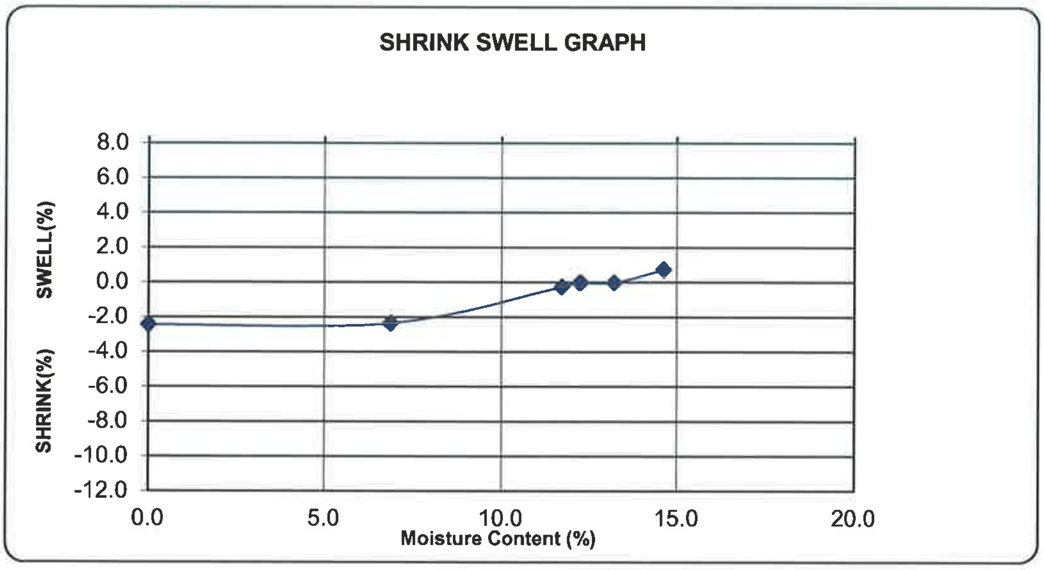
SOIL TEST SERVICES
ABN 43 002 145 173

TABLE C
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client: JK Geotechnics
Project: Cessnock Hospital Redevelopment
Location: Cessnock Hospital, 24 View Street, Cessnock, NSW

Report No.: 36230BF - C
Report Date: 15/09/2023
Page 2 of 3

Borehole No.: 7		Depth: 1.50 - 1.89m	
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH	
BEFORE TEST	AFTER TEST	BEFORE TEST	AFTER TEST
13.2%	14.6%	200,280 kPa	>290 kPa
LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION	SWELL ON SATURATION	SHRINKAGE
25	-0.8%	0.7%	2.4%



SHRINK SWELL INDEX
1.52 %/pF

Notes: Sampled and supplied by client. Sample tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Visually estimated inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 05/09/2023.

NATA
NATA Accredited Laboratory
Number:1327

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Authorised Signature / Date
(D. Treweek)
15/9/23

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Telephone: 02 9888 5000
Facsimile: 02 9888 5001

SOIL TEST SERVICES
ABN 43 002 145 173

TABLE C
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

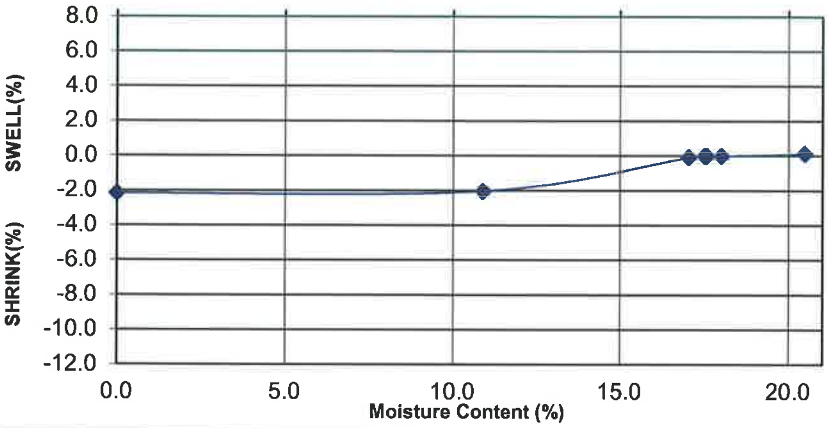
Client: JK Geotechnics
Project: Cessnock Hospital Redevelopment
Location: Cessnock Hospital, 24 View Street, Cessnock, NSW

Report No.: 36230BF - C
Report Date: 15/09/2023
Page 3 of 3

Borehole No.: 20		Depth: 0.60 - 0.91m	
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH	
BEFORE TEST	AFTER TEST	BEFORE TEST	AFTER TEST
18.0%	20.5%	400,440 kPa	>280 kPa

LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION	SWELL ON SATURATION	SHRINKAGE
25	-2.0%	0.1%	2.1%

SHRINK SWELL GRAPH



SHRINK SWELL INDEX
1.20 %/pF

Notes: Sampled and supplied by client. Sample tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Visually estimated inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 05/09/2023.

NATA
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Authorised Signature / Date
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15/9/23

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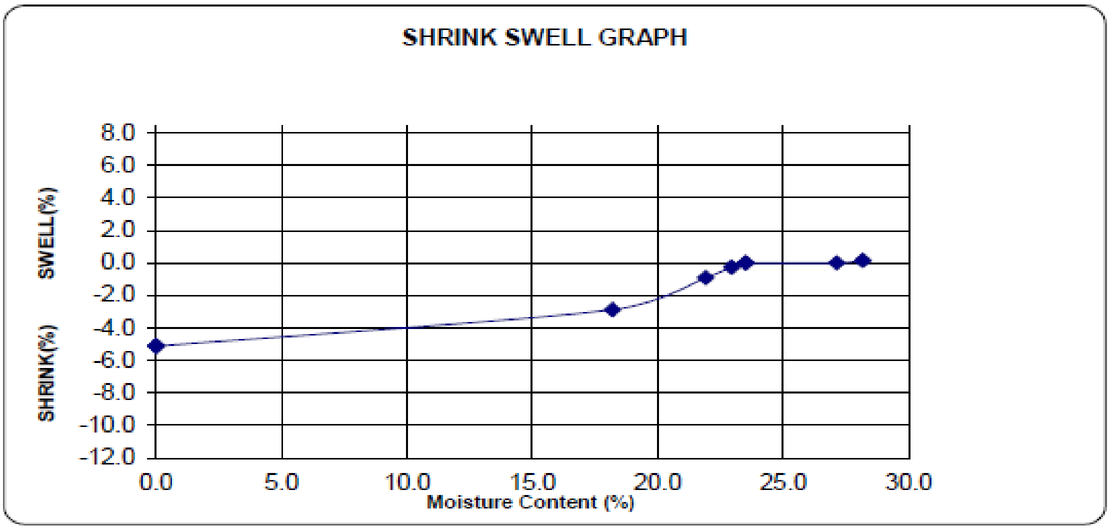
SOIL TEST SERVICES
ABN 43 002 145 173

TABLE C1
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client: JK Geotechnics
Project: Cessnock Hospital Redevelopment
Location: Cessnock Hospital, 24 View Street, Cessnock, NSW

Report No.: 36230BF - C1
Report Date: 23/08/2024
Page 1 of 1

Borehole No.: 105		Depth: 0.50 - 0.80m		
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH		
BEFORE TEST	AFTER TEST	BEFORE TEST	AFTER TEST	
27.1%	28.2%	90,140 kPa	100 kPa	
LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION		SWELL ON SATURATION	SHRINKAGE
25	-1.9%		0.1%	5.0%



SHRINK SWELL INDEX
2.80 %/pF

Notes: Sampled and supplied by client. Sample tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Visually estimated inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 13/08/2024.

NATA
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23/08/2024
Authorised Signature / Date
(D. Treweek)

TABLE D
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	Health Infrastructure	**Ref No:**	36230BF
Project:	Cessnock Hospital Redevelopment	**Report:**	D
Location:	Cessnock Hospital, 24 View Street, CESSNOCK, NSW	**Report Date:**	9/08/24

Page 1 of 2

BOREHOLE NUMBER	DEPTH (m)	$I_{S(50)}$ (MPa)	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)	TEST DIRECTION
BH104	5.55 - 5.57	0.1	2	A
	6.29 - 6.32	1	20	A
	6.66 - 6.69	1.7	34	A
	7.28 - 7.32	1.5	30	A
	7.66 - 7.70	1.3	26	A
	8.28 - 8.31	0.5	10	A
	8.66 - 8.70	1	20	A
	9.28 - 9.32	2.1	42	A
	9.66 - 9.69	1.2	24	A
	10.28 - 10.31	1.6	32	A
	10.64 - 10.68	1.1	22	A
	11.27 - 11.30	1.2	24	A
	11.63 - 11.67	2.7	54	A
BH105	3.73 - 3.75	0.6	12	A
	4.21 - 4.25	1.1	22	A
	4.57 - 4.61	0.7	14	A
	5.25 - 5.29	0.3	6	A
	6.82 - 6.86	0.9	18	A
	7.26 - 7.29	0.7	14	A
	7.67 - 7.71	0.2	4	A
	8.07 - 8.10	1.3	26	A
	8.21 - 8.24	0.1	2	A
	8.38 - 8.41	0.7	14	A
	8.75 - 8.78	1.3	26	A
	9.21 - 9.24	0.6	12	A

NOTE: SEE PAGE 2

TABLE D
POINT LOAD STRENGTH INDEX TEST REPORT

Client: Health Infrastructure

Ref No: 36230BF

Project: Cessnock Hospital Redevelopment

Report: D

Location: Cessnock Hospital, 24 View Street, CESSNOCK, NSW

Report Date: 9/08/24

Page 2 of 2

BOREHOLE NUMBER	DEPTH (m)	$I_{S\ (50)}$ (MPa)	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)	TEST DIRECTION
BH105	9.63 - 9.66	0.8	16	A
BH106	3.75 - 3.79	0.7	14	A
	4.25 - 4.29	1.1	22	A
	4.69 - 4.72	1	20	A
	5.24 - 5.29	0.9	18	A
	5.70 - 5.73	0.2	4	A
	6.25 - 6.30	1.7	34	A
	6.71 - 6.75	0.7	14	A
	7.26 - 7.30	0.8	16	A
	7.70 - 7.73	1.2	24	A
	8.25 - 8.29	1.2	24	A
	8.73 - 8.76	0.7	14	A
	9.25 - 9.29	1	20	A
	9.71 - 9.75	1	20	A

NOTES

1. In the above table, testing was completed in test direction A for the axial direction, D for the diametral direction, B for the block test and L for the lump test.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RMS T223.
4. For reporting purposes, the $I_{S(50)}$ has been rounded to the nearest 0.1MPa, or to one significant figure if less than 0.1MPa.
5. The estimated Unconfined Compressive Strength was calculated from the Point Load Strength Index based on the correlation provided in AS1726:2017 'Geotechnical Site Investigations' and rounded off to the nearest whole number: U.C.S. = 20 $I_{S(50)}$.

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CERTIFICATE OF ANALYSIS 332629

Client Details

Client	JK Geotechnics
Attention	Anh Ngoc Phung
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**36230BF CESSNOCK**
Number of Samples	6 Soil
Date samples received	08/09/2023
Date completed instructions received	08/09/2023

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	15/09/2023
Date of Issue	15/09/2023

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Results Approved By
Nick Sarlamis, Assistant Operation Manager

Authorised By
Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		332629-1	332629-2	332629-3	332629-4	332629-5
Your Reference	UNITS	BH1	BH8	BH5	BH11	BH18
Depth		1.5-1.90	0.5-0.95	1.1-1.2	0.5-0.90	1.5-1.85
Date Sampled		30/08/2023	30/08/2023	30/08/2023	30/08/2023	30/08/2023
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	12/09/2023	12/09/2023	12/09/2023	12/09/2023	12/09/2023
Date analysed	-	12/09/2023	12/09/2023	12/09/2023	12/09/2023	12/09/2023
pH 1:5 soil:water	pH Units	5.4	5.3	7.0	7.8	5.7
Electrical Conductivity 1:5 soil:water	µS/cm	98	310	180	180	400
Chloride, Cl 1:5 soil:water	mg/kg	26	45	75	81	330
Sulphate, SO4 1:5 soil:water	mg/kg	50	390	64	59	170

Misc Inorg - Soil		
Our Reference		332629-6
Your Reference	UNITS	BH18
Depth		3.2-3.5
Date Sampled		30/08/2023
Type of sample		Soil
Date prepared	-	12/09/2023
Date analysed	-	12/09/2023
pH 1:5 soil:water	pH Units	7.9
Electrical Conductivity 1:5 soil:water	µS/cm	280
Chloride, Cl 1:5 soil:water	mg/kg	230
Sulphate, SO4 1:5 soil:water	mg/kg	63

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			12/09/2023	1	12/09/2023	12/09/2023		12/09/2023	[NT]
Date analysed	-			12/09/2023	1	12/09/2023	12/09/2023		12/09/2023	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	5.4	5.3	2	99	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	98	87	12	102	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	26	23	12	106	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	50	43	15	103	[NT]

Result Definitions

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

Quality Control Definitions

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

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

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

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

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

Samples were out of the recommended holding time for this analysis. - pH

BOREHOLE LOG

Borehole No.
1
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 83.10m

Date: 30/8/23 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** N.A.P./O.F.

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 COMPLET-ION						0			FILL: Silty clay, low plasticity, dark brown, with fine to medium grained igneous gravel, trace of fine to coarse grained sand and root fibres.	w>PL			GRASS COVER APPEARS POORLY COMPACTED
					N = 5 3,2,3				FILL: Silty clay, high plasticity, red brown and dark brown, trace of fine to medium grained ironstone and ash.			150 150 110	
						1							
									as above, but without ash.				
					N = 10 3,4,6				as above, but light grey and brown, trace of fine to medium grained sand, and metal fragments.			250 210 240	APPEARS MODERATELY COMPACTED
						2		CL	Silty CLAY: low plasticity, light grey and yellow brown, trace of fine to medium grained sand.	w>PL	St-VSt	150 170 210	RESIDUAL HP TESTING ON REMOULDED SAMPLE
								-	SANDSTONE: fine to medium grained, orange brown, trace of ironstone bands.	DW	L-M		GRETA COAL MEASURE LOW TO MODERATE 'TC' BIT RESISTANCE
						3							
											M		MODERATE RESISTANCE
						4			as above, but grey.				
									END OF BOREHOLE AT 4.6m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK
						5							
						6							
						7							

JKGeotechnics

BOREHOLE LOG

Borehole No.
2
1/1

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Method: SPIRAL AUGER
R.L. Surface: 84.81m
Date: 31/8/23
Datum: AHD
Plant Type: JK305
Logged/Checked by: N.A.P./O.F.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay, low plasticity, dark brown, trace of fine to medium grained sand, fine to medium grained igneous gravel, and root fibres.	w>PL w≈PL			GRASS COVER APPEARS WELL COMPACTED
					N = 13 3,5,8				FILL: Silty clay, low plasticity, brown, trace of fine to medium grained sand, and root fibres.			600 600 550	
						1							
					N > 15 4,8,7/ 100mm REFUSAL			CI-CH	Silty CLAY: medium to high plasticity, light grey and orange brown, trace of fine to medium grained sand.	w≈PL	VSt	350 300 390	RESIDUAL
						2		-	SANDSTONE: fine to medium grained, orange brown, trace of ironstone bands.	DW	L M		GRETA COAL MEASURE LOW TO MEDIUM 'TC' BIT RESISTANCE MODERATE TO HIGH RESISTANCE HIGH RESISTANCE
						3			END OF BOREHOLE AT 2.85m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK GROUNDWATER MONITORING WELL INSTALLED TO 2.85m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 1.35m TO 2.85m. CASING 0.1m TO 1.35m. 2mm SAND FILTER PACK 1.5m TO 2.85m. BENTONITE SEAL 0.1m TO 1.5m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER.
						4							
						5							
						6							
						7							

BOREHOLE LOG

Borehole No.
3
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 85.60m

Date: 28/8/23 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** N.A.P./O.F.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION						0		-	ASPHALTIC CONCRETE: 40mm.t	w>PL			
									FILL: Silty clay, low plasticity, orange brown, trace of fine grained igneous gravel and fine to medium grained sand.				
						1		CH	Silty CLAY: high plasticity, orange brown, trace of fine to medium grained ironstone gravel.	w>PL	VSt	230 250 300	RESIDUAL HP TESTING ON REMOULDED SAMPLE
					N = SPT 1/50mm REFUSAL			CL	Silty Sandy CLAY: low plasticity, orange brown, fine to medium grained sand, trace of ironstone gravel.				
						2 3		-	SILTSTONE: dark brown, trace of ironstone bands.	DW	L		GRETA COAL MEASURE LOW TO MODERATE 'TC' BIT RESISTANCE
						4		-	SANDSTONE: fine to coarse grained, brown, trace of ironstone bands and siltstone.				
											M-H		MODERATE TO HIGH RESISTANCE
						5 6 7			END OF BOREHOLE AT 4.85m				HIGH RESISTANCE 'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK

JKGeotechnics

BOREHOLE LOG

Borehole No.
4
1/1

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Method: SPIRAL AUGER
R.L. Surface: 81.82m
Date: 29/8/23
Datum: AHD
Plant Type: JK305
Logged/Checked by: N.A.P./O.F.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION				■		0			FILL: Silty clay, medium plasticity, dark brown and brown, trace of fine to medium grained sand and fine to medium grained ironstone and igneous gravel.	w≈PL			GRASS COVER
				■	N = 9 3,4,5	1		CI	Silty CLAY: medium plasticity, yellow brown and red brown.	w>PL	VSt	260 260 220	RESIDUAL
				■	N = 22 7,9,13	2			as above, but light grey, trace of fine to medium grained ironstone gravel and fine to medium grained sand.	w≈PL	Hd	600 550 500	
▶				■		3		-	SANDSTONE: fine to medium grained, brown, trace of ironstone bands.	DW	M-H		GRETA COAL MEASURE MODERATE TO HIGH 'TC' BIT RESISTANCE HIGH RESISTANCE
						4 5 6 7			END OF BOREHOLE AT 3.65m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK

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BOREHOLE LOG

Borehole No.
5
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Method: SPIRAL AUGER
R.L. Surface: 84.16m

Date: 28/8/23
Datum: AHD

Plant Type: JK305
Logged/Checked by: N.A.P./O.F.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay, low plasticity, dark brown, with fine to medium grained sand, trace of igneous gravel and root fibres.	w<PL			GRASS COVER APPEARS MODERATELY COMPACTED
					N = 7 3,3,4				as above, but dark brown mottled orange brown, trace of fine to medium grained ironstone gravel and slag.	w>PL		350 380 410	
						1		CI	Silty CLAY: medium plasticity, orange brown, trace of fine to medium grained sand, and fine to medium grained ironstone gravel.	w>PL	VSt		RESIDUAL
					N = SPT 2/50mm REFUSAL			-	SANDSTONE: fine to medium grained, orange brown, trace of ironstone gravel band.	DW	M-H	250 240 170	GRETA COAL MEASURE
						2			as above, but light grey.				HIGH 'TC' BIT RESISTANCE
									END OF BOREHOLE AT 1.85m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
6
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 85.57m

Date: 28/8/23 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** N.A.P./O.F.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION						0			CONCRETE: 160mm.t				NO OBSERVED REINFORCEMENT
								-	PAVERS: 75mm.t				
								-	FILL: Silty gravel, fine to medium grained, brown, igneous.	D			HIGH 'TC' BIT RESISTANCE
						1			FILL: Silty clay, low to medium plasticity, brown mottled orange brown, trace of fine to medium grained sand.				SOIL RESISTANCE (POSSIBLY NATURAL)
					N = 10 3,4,6			CL	Silty CLAY: low plasticity, brown and light grey, with fine to medium grained sand.	w>PL	F	70 70 80	RESIDUAL
						2		CL	Silty sandy CLAY: low plasticity, orange brown, fine to medium grained sand.				
								-	SANDSTONE: fine to medium grained, light orange brown.	DW	L		GRETA COAL MEASURE LOW RESISTANCE
						3			SANDSTONE: fine to medium grained, brown, with siltstone bands.				LOW RESISTANCE WITH MODERATE BANDS HIGH RESISTANCE
						4			END OF BOREHOLE AT 4.0m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK
						5							
						6							
						7							

BOREHOLE LOG

Borehole No.
7
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 81.32m

Date: 29/8/23 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** N.A.P./O.F.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay, low to medium plasticity, brown and dark brown, trace of fine to medium grained sand, and root fibres.				GRASS COVER
					N = 10 3,5,5	1		CI	Silty CLAY: medium plasticity, light grey and brown, trace of fine to medium grained ironstone gravel, fine to medium grained sand, and root fibres.	w>PL	VSt	350 450 300	RESIDUAL
						2		-	SANDSTONE: fine to medium grained, brown, trace of ironstone bands.	DW	L-M		GRETA COAL MEASURE HIGH 'TC' BIT RESISTANCE
						3 4 5 6 7			END OF BOREHOLE AT 2.8m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK

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BOREHOLE LOG

Borehole No.
8
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 84.09m

Date: 28/8/23 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** N.A.P./O.F.

Groundwater Record	SAMPLES ES U50 DB DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION			0		-	ASPHALTIC CONCRETE: 40mm.t FILL: Gravel, fine to medium grained, dark grey, slag, trace of fine to medium grained sand and clay.	M			APPEARS POORLY COMPACTED
		N = 7 5,3,4								
			1							
						FILL: Silty clay, high plasticity, brown, trace of fine to medium grained sand.			210 290 240	
		N = 10 4,4,6								
					CH	Silty CLAY: high plasticity, red brown and light grey.	w>PL	VSt	350 380 300	RESIDUAL
			2							
					-	SANDSTONE: fine to medium grained, light grey and brown, trace of fine to medium grained ironstone gravel.	DW	L-M		GRETA COAL MEASURE HIGH 'TC' BIT RESISTANCE
			3							
			4			as above, but light grey. END OF BOREHOLE AT 4.1m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK
			5							
			6							
			7							

BOREHOLE LOG

Borehole No.
9
1/1

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Method: SPIRAL AUGER
R.L. Surface: 84.58m
Date: 29/8/23
Datum: AHD
Plant Type: JK305
Logged/Checked by: N.A.P./O.F.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			CONCRETE: 85mm.t				NO OBSERVED REINFORCEMENT
				■				-	FILL: Silty clay, low plasticity, dark brown, with slag and ash, trace of fine to medium grained sand, and igneous gravel.	w>PL			
				■	N = 10 3,5,5			CH	Silty CLAY: high plasticity, red brown, trace of fine to medium grained ironstone gravel.	w>PL	St	140 180 150	RESIDUAL
				■		1			as above, but light red brown.				
									as above, but yellow brown, trace of fine to medium grained sand.				
				■		2		-	SANDSTONE: fine to medium grained, trace of fine to medium grained ironstone bands.	DW	M-H		GRETA COAL MEASURE MODERATE TO HIGH 'TC' BIT RESISTANCE
▶													
				■		3							
				■					as above, but light grey.		L		LOW RESISTANCE
ON COMPLETION ▼				■		4			as above, but brown.				
									END OF BOREHOLE AT 4.65m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK
						5							
						6							
						7							

BOREHOLE LOG

Borehole No.
10
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 84.76m

Date: 31/8/23 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** N.A.P./O.F.

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				■	N = 9 4,4,5	0	▨		FILL: Silty clay, low plasticity, brown, trace of fine to medium grained sand, igneous gravel, and root fibres.	w>PL			GRASS COVER
						1	▨	CH	Silty CLAY: high plasticity, orange brown, trace of ironstone gravel and fine to medium grained sand.	w>PL	VSt-Hd	390 390 450	RESIDUAL
				■ ■		2	⋮	-	SANDSTONE: fine to medium grained, grey, trace of ironstone bands.	DW	L-M		GRETA COAL MEASURE LOW TO MODERATE 'TC' BIT RESISTANCE
				■		3 4	⋮				M-H		HIGH RESISTANCE WITH MODERATE BAND
				■		5	⋮		SANDSTONE: fine to medium grained, brown, with dark grey siltstone.				
				■			▥		SILTSTONE: dark grey.				
						6 7			END OF BOREHOLE AT 6.0m				

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BOREHOLE LOG

Borehole No.
11
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Method: SPIRAL AUGER
R.L. Surface: 84.51m

Date: 31/8/23
Datum: AHD

Plant Type: JK305
Logged/Checked by: N.A.P./O.F.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION				■		0			FILL: Silty clay, low plasticity, brown, trace of fine to medium grained sand, and root fibres.	w<PL			GRASS COVER
				■	N > 20 5,8, 12/50mm REFUSAL			CI	Silty CLAY: medium plasticity, brown and light grey, trace of fine to medium grained sand and ironstone gravel.	w≈PL	Hd	500 550 560	RESIDUAL
				■		1		-	SANDSTONE: fine to medium grained, brown, trace of ironstone bands.	DW	L-M		GRETA COAL MEASURE
				■							H		LOW TO MODERATE 'TC' BIT RESISTANCE
													HIGH RESISTANCE
						2 3 4 5 6 7			END OF BOREHOLE AT 1.8m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK GROUNDWATER MONITORING WELL INSTALLED TO 1.5m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 0.9m TO 1.5m. CASING 0.1m TO 0.9m. 2mm SAND FILTER PACK 1.3m TO 1.5m. BENTONITE SEAL 0.1m TO 1.3m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER.

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BOREHOLE LOG

Borehole No.
12
1/1

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 81.39m
Date: 29/8/23 **Datum:** AHD
Plant Type: JK305 **Logged/Checked by:** N.A.P./O.F.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION				●		0	▨		FILL: Silty clay, low plasticity, dark brown and brown, trace of fine to medium grained sand, and root fibres.	w>PL			GRASS COVER
			●	●	N = 9 4,4,5		▨	CH	as above, but high plasticity, brown.	w>PL	VSt	200 280 210	RESIDUAL
						1	▨		Silty CLAY: high plasticity, yellow brown and light grey, trace of fine to medium grained ironstone gravel.				
				●	N = 24 11,12,12	2	▨		as above, but trace of fine to medium grained sand.	w≈PL	Hd	400 450 500	
				●		3	▨	-	SANDSTONE: fine to medium grained, yellow brown, trace of ironstone gravel.	DW	M		GRETA COAL MEASURE
				●			▨				H		MODERATE 'TC' BIT RESISTANCE HIGH RESISTANCE
						4 5 6 7			END OF BOREHOLE AT 3.8m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK

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BOREHOLE LOG

Borehole No.
13
1/1

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Method: SPIRAL AUGER
R.L. Surface: 83.31m
Date: 29/8/23
Datum: AHD
Plant Type: JK305
Logged/Checked by: N.A.P./O.F.

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	w>PL			APPEARS POORLY COMPACTED
					N = 5 2,2,3				FILL: Silty clay, low plasticity, dark brown, with slag and ash, trace of fine to medium grained sand, and igneous gravel.				
						1			FILL: Silty clay, high plasticity, brown, trace of fine to medium grained ironstone gravel, and root fibres.				
					N = 25 9,12,13			CH	Silty CLAY: high plasticity, light grey, trace of fine to medium grained ironstone gravel, and fine to coarse grained sand.	w>PL	VSt- Hd	450 300 250	RESIDUAL
						2		-	SANDSTONE: fine to medium grained, brown.	DW	H		GRETA COAL MEASURE HIGH 'TC' BIT RESISTANCE
						3			END OF BOREHOLE AT 2.9m				'TC' BIT REFUSAL ON HIGH STRENGTH BEDROCK
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
14
1/1

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Method: SPIRAL AUGER
R.L. Surface: 84.10m
Date: 29/8/23
Datum: AHD
Plant Type: JK305
Logged/Checked by: N.A.P./O.F.

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 clay, low plasticity, brown, trace of fine to medium grained sand and igneous gravel.	w>PL			
					N = 15 5,6,9	1		CH	Silty CLAY: high plasticity, red brown, trace of fine to medium grained sand, and fine to medium grained ironstone gravel.	w>PL	VSt	310 330 380	RESIDUAL
						2		-	SANDSTONE: fine to medium grained, brown, trace of ironstone bands.	DW	H		GRETA COAL MEASURE
											M		HIGH 'TC' BIT RESISTANCE MODERATE RESISTANCE
									as above, but with quartz gravel.		H		HIGH RESISTANCE
						3			END OF BOREHOLE AT 2.7m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
15
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 83.07m

Date: 30/8/23 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** N.A.P./O.F.

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 COMPLET-ION		■		■		0		-	ASPHALTIC CONCRETE: 40mm.t	w>PL			APPEARS WELL COMPACTED
				■	N = 12 3,5,7				FILL: Silty clay, low plasticity, brown and dark brown, with fine to coarse grained sand, trace of fine to medium grained igneous and ironstone gravel.			150 150 170	
				■	N > 5 6,5/50mm REFUSAL	1		CL	Silty CLAY: low plasticity, orange brown, trace of fine to coarse grained sand and fine to medium grained ironstone gravel.	w>PL	VSt	290 250	RESIDUAL
									as above, but light grey.			210	
				■				-	SANDSTONE: fine to medium grained, orange brown.	DW	H		GRETA COAL MEASURE HIGH 'TC' BIT RESISTANCE
						2			END OF BOREHOLE AT 1.95m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
16
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 83.79m

Date: 30/8/23 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** N.A.P./O.F.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION						0		-	ASPHALTIC CONCRETE: 40mm.t	w>PL			APPEARS POORLY COMPACTED
					N = 11 3,5,6				FILL: Silty clay, low plasticity, brown and dark brown, with fine to medium grained sand, trace of igneous and ironstone gravel.			350 200	
									FILL: Silty clay, medium to high plasticity, brown, yellow brown and orange brown, trace of fine to medium grained ironstone gravel and fine to medium grained sand.				
						1		CH	Silty CLAY: high plasticity, light grey and orange brown, trace of fine to medium grained ironstone and quartz gravel.	w>PL	VSt	250 220 250 280	RESIDUAL
								-	SANDSTONE: fine to medium grained, orange brown.	DW	M		GRETA COAL MEASURE
											H		MODERATE 'TC' BIT RESISTANCE
													HIGH RESISTANCE
						2			END OF BOREHOLE AT 1.9m				'TC' BIT REFUSAL ON HIGH STRENGTH BEDROCK
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
17
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 83.50m

Date: 31/8/23 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** N.A.P./O.F.

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 COMPLET-ION						0		-	ASPHALTIC CONCRETE: 40mm.t				
					N = 13 5,6,7				FILL: Silty clay, low to medium plasticity, brown and dark brown, trace of fine to medium grained sand and fine to medium grained ironstone and igneous gravel.	w>PL		250 480	APPEARS MODERATELY COMPACTED
						1		CH	as above, but orange brown, brown and light grey.	w>PL	Hd	310 410 430 510	RESIDUAL
								-	Silty CLAY: high plasticity, light grey.				
									SANDSTONE: fine to medium grained, brown, trace of ironstone bands.	DW	L		GRETA COAL MEASURE
											M-H		LOW TO MODERATE 'TC' BIT RESISTANCE
						2							MODERATE RESISTANCE
									as above, but light grey.				HIGH RESISTANCE
						3 4 5 6 7			END OF BOREHOLE AT 2.6m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK GROUNDWATER MONITORING WELL INSTALLED TO 2.6m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 1.4m TO 2.6m. CASING 0.1m TO 1.4m. 2mm SAND FILTER PACK 1.4m TO 2.6m. BENTONITE SEAL 0.1m TO 1.4m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER.

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BOREHOLE LOG

Borehole No.
18
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 83.77m

Date: 30/8/23 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** N.A.P./O.F.

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	w>PL			
									FILL: Silty clay, low plasticity, brown and dark brown, with fine to medium grained sand, trace of igneous and ironstone gravel.				
					N = 10 4,5,5			CH	Silty CLAY: high plasticity, yellow brown and orange brown, trace of fine to medium grained ironstone gravel and fine to medium grained sand.	w>PL	VSt	240 310 300	RESIDUAL
						1			as above, but orange brown.	w≈PL	Hd		
					N > 16 9,11, 5/100mm REFUSAL							410 420 450	
						2		-	SANDSTONE: fine to medium grained, orange brown, trace of ironstone bands.	DW	M-H		GRETA COAL MEASURE MODERATE TO HIGH 'TC' BIT RESISTANCE
						3					H		HIGH RESISTANCE
									END OF BOREHOLE AT 3.5m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
19
1/1

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 83.35m
Date: 1/9/23 **Datum:** AHD
Plant Type: JK305 **Logged/Checked by:** N.A.P./O.F.

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				■	N = 13 6,6,7	0	▨		FILL: Silty clay, low plasticity, brown, trace of fine to medium grained sand, fine to medium grained igneous gravel, and root fibres.	w<PL		>600 >600 >600	GRASS COVER APPEARS WELL COMPACTED
				■		1		CL	Silty CLAY: low plasticity, yellow brown, trace of fine to medium grained ironstone gravel and fine to medium grained sand.	w<PL	(VSt)		RESIDUAL
				■				-	SANDSTONE: fine to medium grained, brown, with dark grey siltstone bands.	DW	L		GRETA COAL MEASURE LOW 'TC' BIT RESISTANCE
				■		3			SILTSTONE: dark grey, trace of ironstone bands.		M		MODERATE RESISTANCE HIGH RESISTANCE
						4			END OF BOREHOLE AT 4.0m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
20
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Method: SPIRAL AUGER
R.L. Surface: 83.50m

Date: 31/8/23
Datum: AHD

Plant Type: JK305
Logged/Checked by: N.A.P./O.F.

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 COMPLET-ION						0			ASPHALTIC CONCRETE: 140mm.t				
								-	FILL: Silty clayey gravel, fine to medium grained, dark brown, igneous, trace of fine to medium grained sand.	M			
								CH	Silty CLAY: high plasticity, yellow brown, trace of fine to medium grained ironstone gravel.	w>PL w<PL	(VSt)		RESIDUAL
						1							
								-	SANDSTONE: fine to medium grained, brown, trace of siltstone and ironstone bands.	DW	L		GRETA COAL MEASURE
						2					M		LOW 'TC' BIT RESISTANCE MODERATE RESISTANCE HIGH RESISTANCE
						3							
									END OF BOREHOLE AT 3.5m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
21
1/1

Client: HEALTH INFRASTRUCTURE

Project: CESSNOCK HOSPITAL REDEVELOPMENT

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 80.71m

Date: 31/8/23 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** N.A.P./O.F.

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					N = 12 5,6,6	0			FILL: Silty clay, low plasticity, dark brown, trace of fine to medium grained sand and igneous gravel, and root fibres.	w>PL			GRASS COVER APPEARS WELL COMPACTED
						1			as above, but medium plasticity, brown, trace of fine to medium grained ironstone gravel.				
					N = 15 4,6,9	2		CI	Silty CLAY: medium plasticity, orange brown and grey, trace of fine to medium grained ironstone gravel.	w>PL	Hd	600 450 500	RESIDUAL
						3		-	SILTSTONE: dark grey.	DW	VL-L		GRETA COAL MEASURE VERY LOW 'TC' BIT RESISTANCE MODERATE RESISTANCE
									SANDSTONE: fine to medium grained, grey.		H		HIGH RESISTANCE
						4 5 6 7			END OF BOREHOLE AT 3.6m				'TC' BIT REFUSAL ON INFERRED HIGH STRENGTH BEDROCK

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BOREHOLE LOG

Borehole No.
101
1 / 1

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Method: SPIRAL AUGER
R.L. Surface: 80.87 m
Date: 8/8/24
Datum: AHD
Plant Type: JK400
Logged/Checked By: A.G./O.F.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION			■	■				■	-	ASPHALTIC CONCRETE: 25mm.t	w<PL			
			■	■	N = 16 6,9,7			▩		FILL: Silty gravelly clay, low plasticity, brown and light brown, fine to medium grained igneous gravel, with fine to medium grained sand.				
			■	■		80		▩		as above, but dark brown, trace of metal fragments.				
				■			1	▨	CH	Silty CLAY: high plasticity, dark brown and brown, trace of fine grained ironstone gravel, and root fibres.	w>PL	Hd	>600 >600 >600	RESIDUAL
				■	N = 14 5,6,8	79 78	2	▨		Silty CLAY: high plasticity, light grey, light brown and red brown, trace of fine grained sand.		VSt - Hd	320 390 420	
				■			3	⠿	-	SANDSTONE: fine grained, brown and dark grey.	DW	M		FARLEY FORMATION HIGH 'TC' BIT RESISTANCE
						77 76 75 74	4 5 6			END OF BOREHOLE AT 3.60 m				'TC' BIT REFUSAL ON HIGH STRENGTH BEDROCK

JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 36230BF CESSNOCK.GPJ <<DrawingFile>> 02/09/2024 12:31 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

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BOREHOLE LOG

Borehole No.
102
1 / 1

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 80.97 m
Date: 8/8/24 **Datum:** AHD
Plant Type: JK400 **Logged/Checked By:** A.G./O.F.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION								■	-	ASPHALTIC CONCRETE: 25mm.t	w<PL			
								▩		FILL: Gravelly silty clay, low plasticity, brown, fine to coarse grained igneous gravel.				
			■	■	N = 6 2,3,3	80	1	▨	CH	Silty CLAY: high plasticity, dark brown, trace of fine grained ironstone gravel, and ash.	w>PL	VSt	270 300 320	RESIDUAL
			■					▨		Silty CLAY: high plasticity, light brown and red brown.				
				■	N = 18 3,9,9	79	2	▨		Silty CLAY: high plasticity, light brown and light grey, trace of fine grained sand.	w<PL	VSt - Hd	>600 300 >600	
				■				⠿	-	SANDSTONE: fine grained, light brown and dark grey.	DW	L - M		FARLEY FORMATION MODERATE TO HIGH RESISTANCE HIGH RESISTANCE
						78	3			END OF BOREHOLE AT 3.00 m				'TC' BIT REFUSAL ON HIGH STRENGTH BEDROCK
						77	4							
						76	5							
						75	6							

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BOREHOLE LOG

Borehole No.
103
1 / 1

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Method: SPIRAL AUGER
R.L. Surface: 81.65 m
Date: 8/8/24
Datum: AHD
Plant Type: JK400
Logged/Checked By: A.G./O.F.

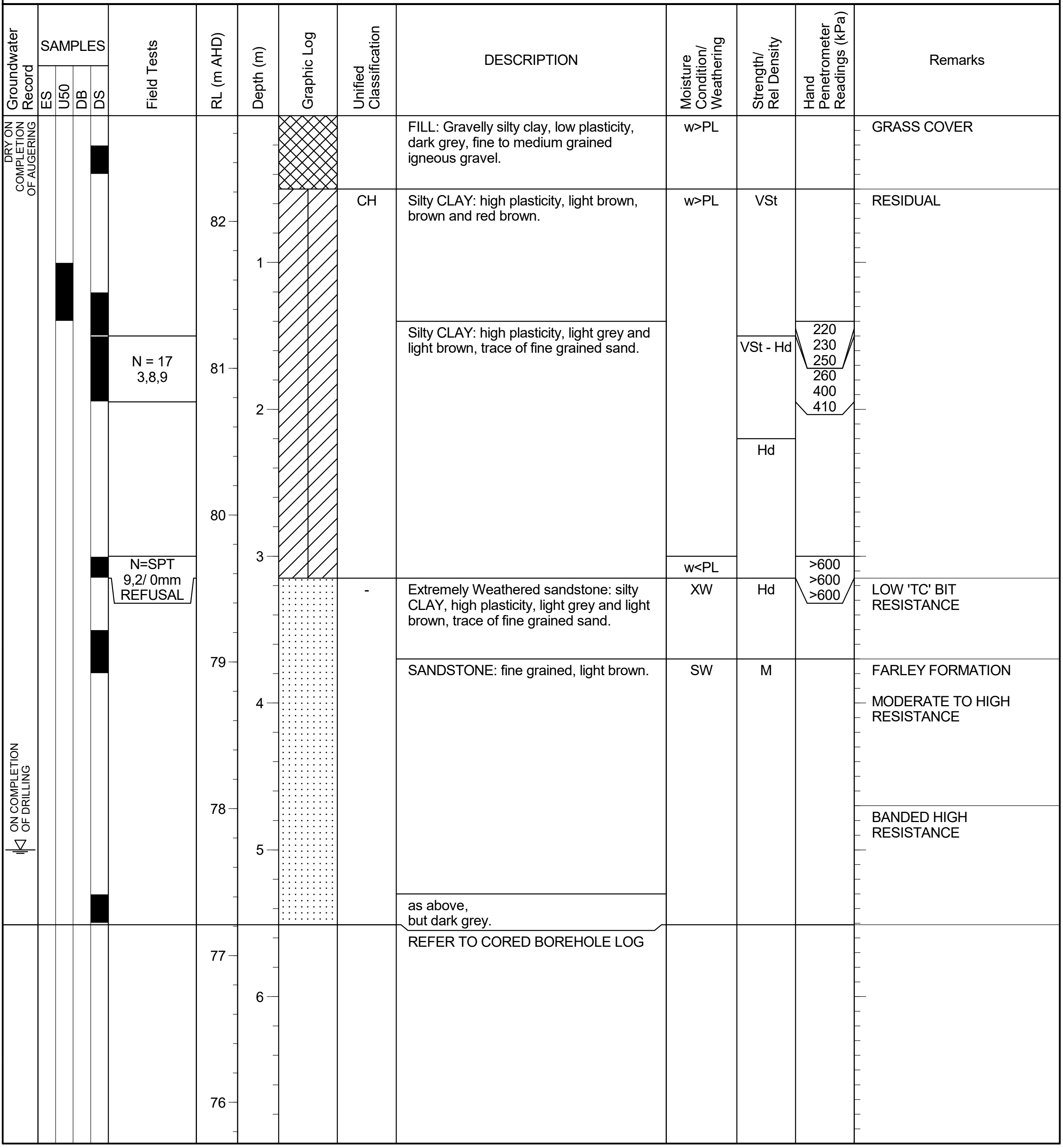
Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION				■					-	ASPHALTIC CONCRETE: 25mm.t	w~PL			
				■						FILL: Gravelly silty clay, low plasticity, brown, fine to medium grained igneous gravel.				
			■		N = 10 3,4,6	81	1		CH	Silty CLAY: high plasticity, light grey and red brown, trace of root fibres.	w>PL	VSt - Hd	310 400 430	RESIDUAL
				■	N > 18 6,10,8/ 50mm REFUSAL	80			CI	Silty CLAY: medium plasticity, light grey and red brown, with fine grained sand, trace of root fibres.	w<PL		220 290 340 590	
				■					-	SANDSTONE: fine grained, brown and light brown.	DW	M		FARLEY FORMATION HIGH 'TC' BIT RESISTANCE
							2			END OF BOREHOLE AT 2.00 m				'TC' BIT REFUSAL ON HIGH STRENGTH BEDROCK
						79								
							3							
						78								
							4							
						77								
							5							
						76								
							6							
						75								

BOREHOLE LOG

Borehole No.
104
1 / 2

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Method: SPIRAL AUGER
R.L. Surface: 82.72 m
Date: 7/8/24
Datum: AHD
Plant Type: JK400
Logged/Checked By: A.G./O.F.



Groundwater Record	Field Tests	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING			FILL: Gravelly silty clay, low plasticity, dark grey, fine to medium grained igneous gravel.	w>PL			GRASS COVER
		CH	Silty CLAY: high plasticity, light brown, brown and red brown.	w>PL	VSt		RESIDUAL
	N = 17 3,8,9		Silty CLAY: high plasticity, light grey and light brown, trace of fine grained sand.		VSt - Hd Hd	220 230 250 260 400 410	
	N=SPT 9,2/ 0mm REFUSAL			w<PL		>600 >600 >600	
		-	Extremely Weathered sandstone: silty CLAY, high plasticity, light grey and light brown, trace of fine grained sand.	XW	Hd		LOW 'TC' BIT RESISTANCE
ON COMPLETION OF DRILLING			SANDSTONE: fine grained, light brown.	SW	M		FARLEY FORMATION MODERATE TO HIGH RESISTANCE BANDED HIGH RESISTANCE
			as above, but dark grey.				
			REFER TO CORED BOREHOLE LOG				

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CORED BOREHOLE LOG

Borehole No.
104
2 / 2

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Core Size: NMLC
R.L. Surface: 82.72 m
Date: 7/8/24
Inclination: VERTICAL
Datum: AHD
Plant Type: JK400
Bearing: N/A
Logged/Checked By: A.G./O.F.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT DETAILS SPACING (mm) 600, 200, 60, 20	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific / General	Formation
					START CORING AT 5.51m						
100% RETURN		77			SANDSTONE: fine grained, dark grey, bedded at 0°.	SW HW	L	0.10		(5.72m) CS, 0°, 110 mm.t	Farley Formation
					NO CORE 0.10m						
		76 75 74 73	6 7 8 9 10		SANDSTONE: fine grained, dark grey, bedded at 0-10°.	FR	H	1.0 1.7 1.5 1.3 0.50 1.0 2.1 1.2			
		72	11		as above, but with calcium carbonate speckles and clasts.			1.6 1.1 1.2 2.7		(11.37m) J, 60°, P, R, Cn (11.56m) Jh, 90°, Un, R, Ca FILLED	
		71			END OF BOREHOLE AT 11.67 m						

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FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

Job No: 36230BF
Borehole No: BH104
Depth: 5.51m to 11.67m

BOREHOLE LOG

Borehole No.
105
1 / 2

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Method: SPIRAL AUGER
R.L. Surface: 81.71 m
Date: 6/8/24
Datum: AHD
Plant Type: JK400
Logged/Checked By: A.G./O.F.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
				■				▩		FILL: Silty clay, low plasticity, dark brown, with fine to medium grained sand, and fine to medium grained ironstone gravel, trace of root fibres.	w>PL			TOPSOIL
ON 8/7/24 ▽		■		■	N = 17 5,8,9	81	1	▨	CH	Silty CLAY: high plasticity, light grey, light brown and red brown, trace of fine grained sand.	w>PL	VSt - Hd	300 540 >600 590 590	RESIDUAL
				■	N > 23 3,12,11/ 120mm REFUSAL	80		▨		as above, but trace of fine to medium grained ironstone gravel.			>600 >600 >600 450	
ON COMPLETION OF AUGERING ▽				■		79	2 3	⁘	-	SANDSTONE: fine grained, brown, trace of fine grained quartz gravel.	HW - DW	VL - L	450	FARLEY FORMATION LOW 'TC' BIT RESISTANCE
				■				⁘		SANDSTONE: fine grained, dark grey.	MW	M - H		HIGH RESISTANCE
						78 77 76 75	4 5 6			REFER TO CORED BOREHOLE LOG				'TC' BIT REFUSAL ON HIGH STRENGTH BEDROCK

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CORED BOREHOLE LOG

Borehole No.
105
2 / 2

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Core Size: NMLC
R.L. Surface: 81.71 m
Date: 6/8/24
Inclination: VERTICAL
Datum: AHD
Plant Type: JK400
Bearing: N/A
Logged/Checked By: A.G./O.F.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL -0.1 L -0.3 M -1 H -3 VH -10 EH	SPACING (mm) 600 200 60 20	DEFECT DETAILS – DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific	General	Formation
					START CORING AT 3.66m							
		78	4		SANDSTONE: fine grained, grey, trace of fine grained quartz gravel, bedded at 0°.	MW	M - H	0.60				Farley Formation
		77	5		SANDSTONE: fine grained, light brown, with occasional dark grey bands up to 150mm.t, bedded at 0-10°.			1.1 0.70		(4.39m) Be, 5°, Un, R, Clay Vn (4.71m) XWS, 0°, 11 mm.t (4.77m) Be, 0°, P, S, Fe Sn (4.78m) Be, 5°, P, S, Fe Sn (4.78m) XWS, 0°, 3 mm.t		
					SANDSTONE: fine grained, light grey, light brown, red brown and purple, bedded at 0-5°.		L	0.30		(5.14m) XWS, 0°, 3 mm.t		
		76			Extremely Weathered sandstone: silty CLAY, high plasticity, light brown and light grey, with occasional sandstone bands, up to 70mm.t.	XW	Hd			(5.76m) J, 20°, P, S, Clay Vn (5.80m) J, 15°, P, S, Cn		
			6		NO CORE 0.74m				600 200 60 20			
		75	7		SANDSTONE: fine grained, dark grey, bedded at 0°, with calcium carbonate speckles and clasts.	FR	M	0.90 0.70				Farley Formation
		74	8				L - M	0.20 1.3				
						HW		0.10		(8.14m) XWS, 0°, 15 mm.t		
		73 72	9			FR	M - H	0.70 1.3 0.60 0.80		(8.27m) CS, 0°, 84 mm.t (8.91m) Be, 10°, Un, R, Ca Ct (9.32m) XWS, 0°, 12 mm.t (9.36m) Be, 0°, Un, S, Cn		
					END OF BOREHOLE AT 9.76 m				600 200 60 20			

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

Job No: 36230BF
Borehole No: BH105
Depth: 3.66m to 9.76m

BOREHOLE LOG

Borehole No.
106
1 / 2

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF **Method:** SPIRAL AUGER **R.L. Surface:** 83.47 m
Date: 7/8/24 **Datum:** AHD
Plant Type: JK400 **Logged/Checked By:** A.G./O.F.

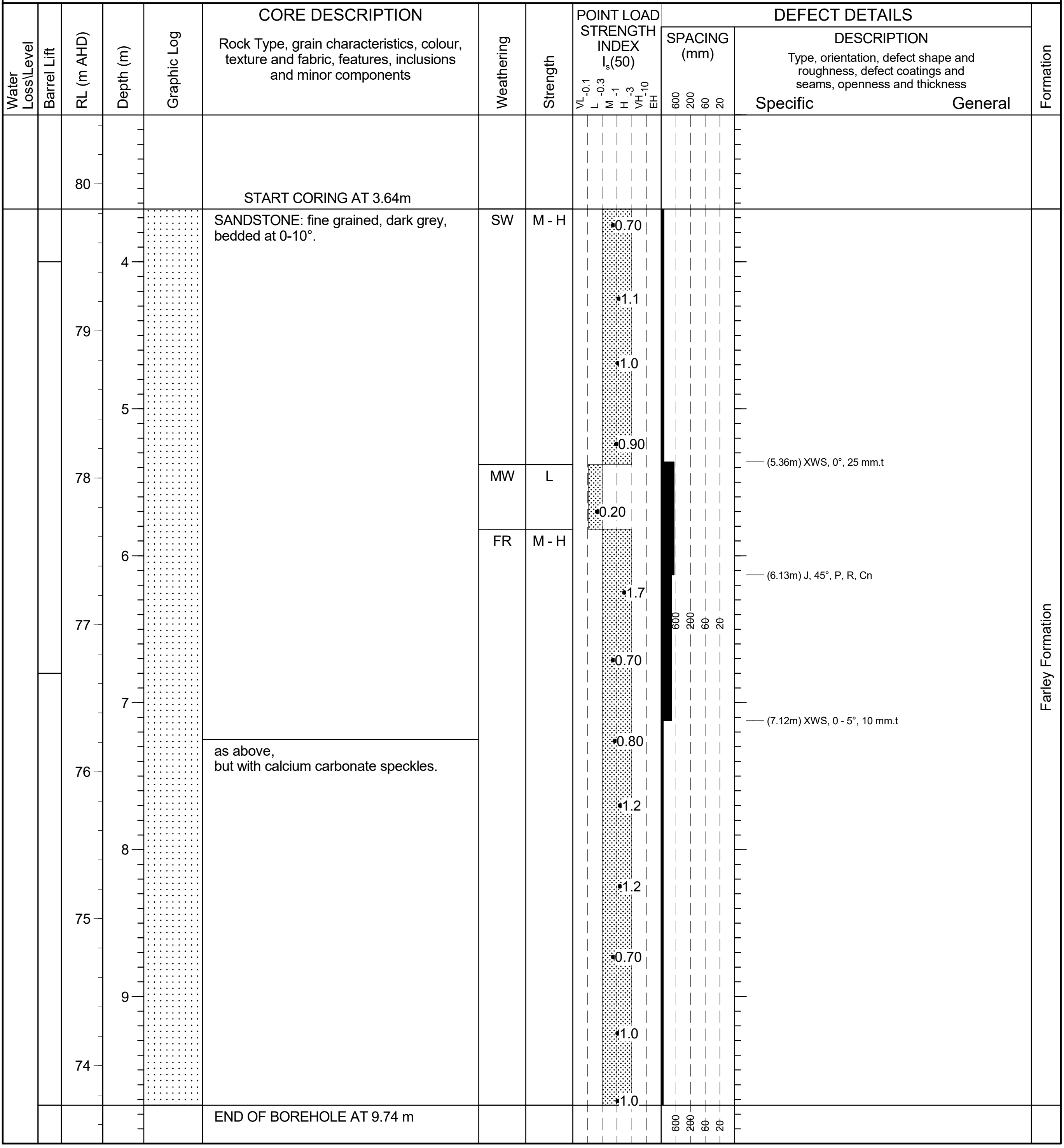
Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
								▩		FILL: Silty clay, low plasticity, dark grey, trace of root fibres.	w>PL			TOPSOIL GRASS COVER
12 HOURS AFTER DRILLING ON COMPLETION OF AUGERING			■	■	N = 6 0,3,3	83	1	▨	CH	Silty CLAY: high plasticity, light brown and red brown.	w>PL	F - St	100 90 100	RESIDUAL
				■	N = 12 2,4,8	82 81	2	▨		as above, but light grey, light brown and red brown, trace of fine grained ironstone gravel.		VSt - Hd	300 400 450 200 280	
				■	N > 2 6,2/ 50mm REFUSAL		3	▨		as above, but fine to medium grained ironstone gravel.			500 550 >600	
				■		80		░	-	SANDSTONE: fine grained, brown.	SW	M - H		FARLEY FORMATION HIGH 'TC' BIT RESISTANCE
								░		as above, but grey and dark grey.				
						79 78 77	4 5 6			REFER TO CORED BOREHOLE LOG				'TC' BIT REFUSAL ON HIGH STRENGTH BEDROCK

CORED BOREHOLE LOG

Borehole No.
106
2 / 2

Client: HEALTH INFRASTRUCTURE
Project: CESSNOCK HOSPITAL REDEVELOPMENT
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Job No.: 36230BF
Core Size: NMLC
R.L. Surface: 83.47 m
Date: 7/8/24
Inclination: VERTICAL
Datum: AHD
Plant Type: JK400
Bearing: N/A
Logged/Checked By: A.G./O.F.



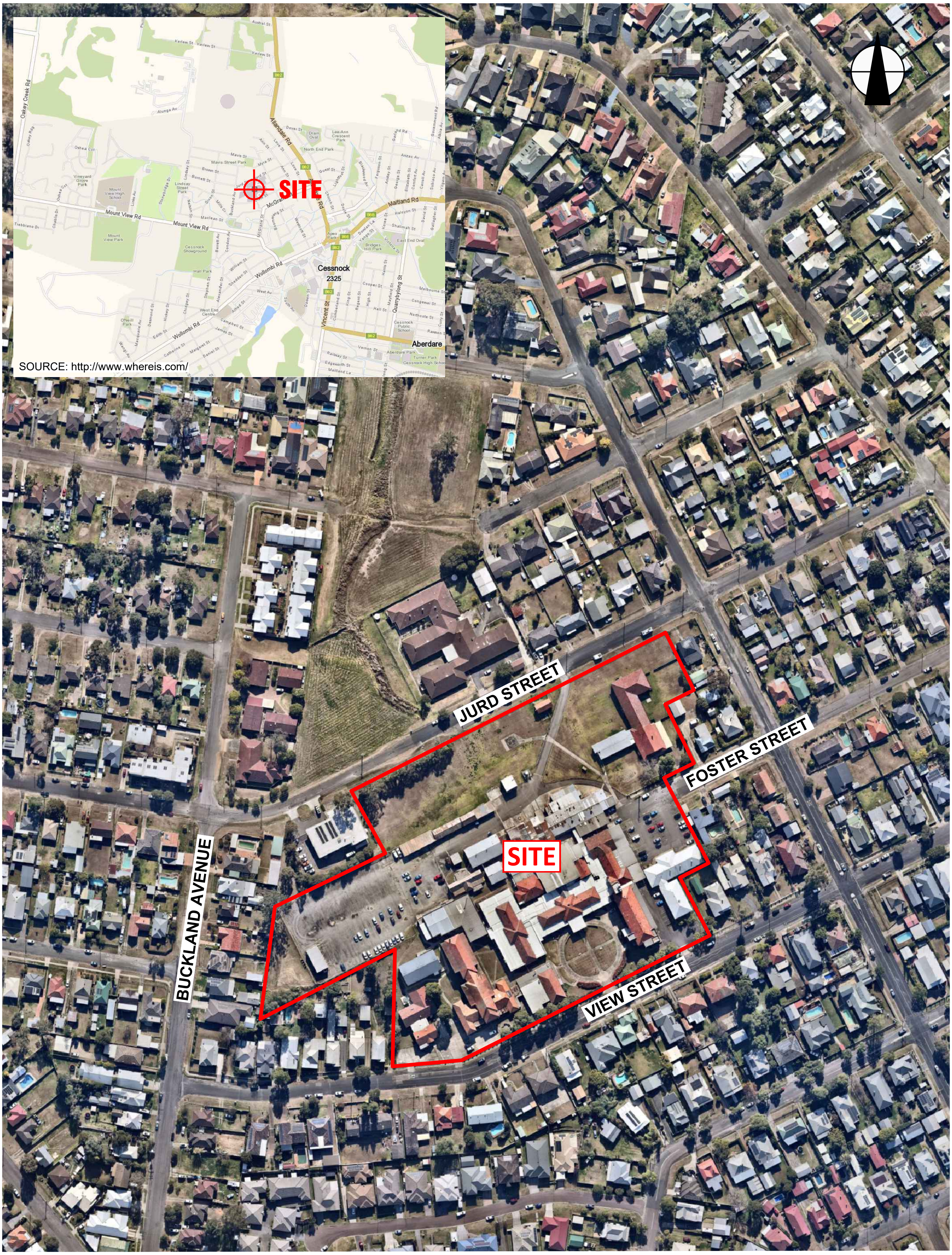
Depth (m)	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS – DESCRIPTION: Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness – Specific	General	Formation
3.64	START CORING AT 3.64m						
3.64–5.36	SANDSTONE: fine grained, dark grey, bedded at 0-10°.	SW	M - H	0.70 1.1 1.0 0.90			Farley Formation
5.36–5.8		MW	L	0.20	(5.36m) XWS, 0°, 25 mm.t		
5.8–7.25		FR	M - H	1.7 0.70	(6.13m) J, 45°, P, R, Cn (7.12m) XWS, 0 - 5°, 10 mm.t		
7.25–9.74	as above, but with calcium carbonate speckles.			0.80 1.2 1.2 0.70 1.0 1.0			
9.74	END OF BOREHOLE AT 9.74 m						

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

Job No: 36230BF

Borehole No: BH106

Depth: 3.64m to 9.74m



SOURCE: http://www.whereis.com/

AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

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

Title:

SITE LOCATION PLAN

Location: CESSNOCK HOSPITAL, 24 VIEW STREET,
CESSNOCK, NSW

Report No: 36230BF

Figure No: 1

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PLOT DATE: 27/09/2023 2:47:44 PM DWG FILE: J:\6F GEOTECHNICAL JOBS\36000'S\36230BF CESSNOCK\CAD\36230BF.DWG

NOTES:
1. REFER TO FIGURE 3 FOR SECTION A-A.
2. REFER TO FIGURE 4 FOR SECTION B-B.
3. REFER TO FIGURE 5 FOR SECTION C-C.

AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

0 15 30 45 60 75

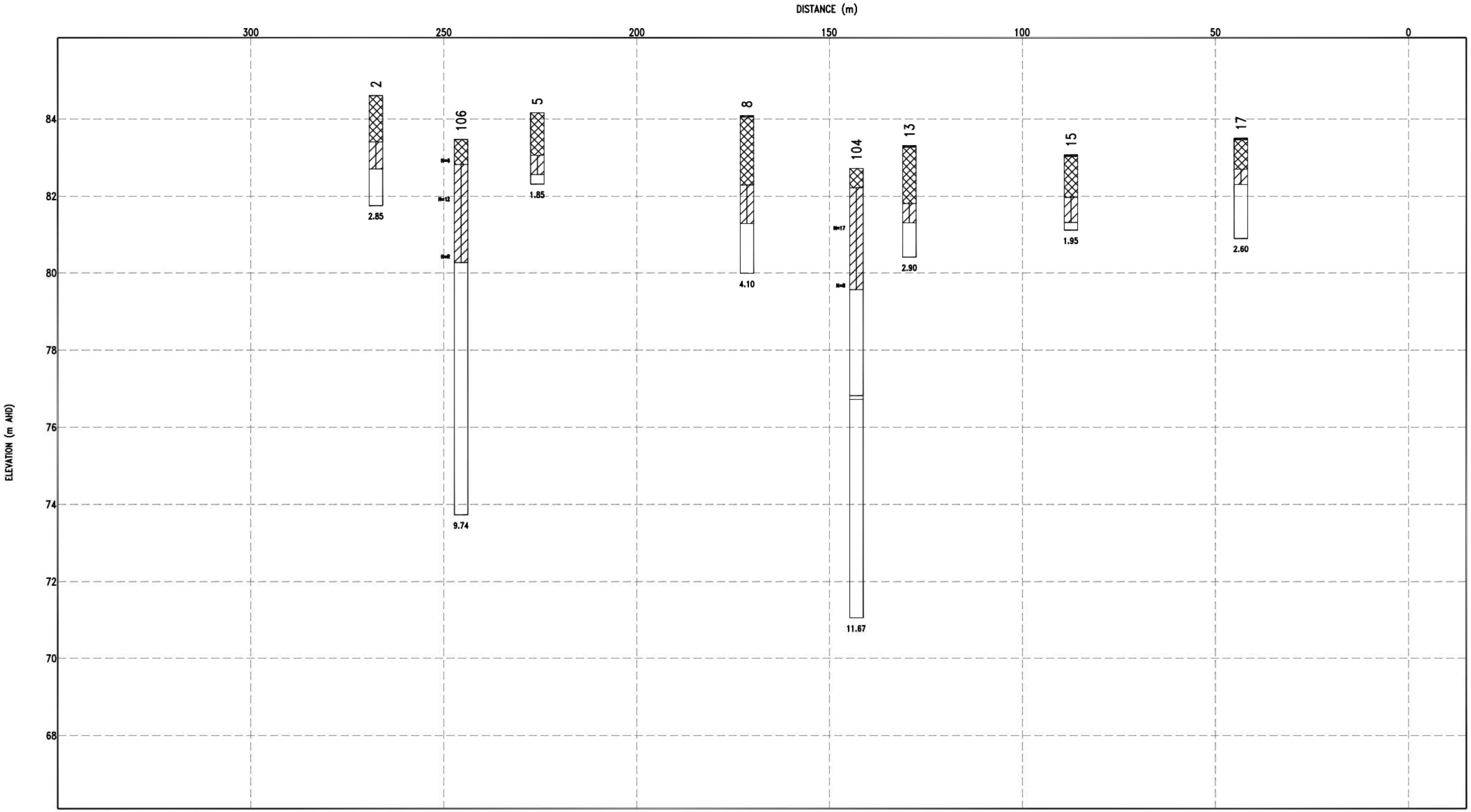
SCALE 1:1500 @A3 METRES

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

Title:	**BOREHOLE LOCATION PLAN**
Location:	CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW
Report No:	36230BF
Figure No:	2

JKGeotechnics

PLOT DATE: 5/09/2024 10:50:52 AM DWG FILE: J:\6F GEOTECHNICAL JOBS\36000'S\36230BF CESSNOCK\CAD\36230BF.DWG



MATERIAL GRAPHIC

◩ ASPHALTIC CONCRETE	▩ FILL
☐ NO CORE	☐ SANDSTONE
▨ SILTY CLAY (CL, CI, CH)	

0 10 20 30 40 50
H:SCALE 1:1000 @A3 METRES
0 1 2 3 4 5
V:SCALE 1:100 @A3 METRES

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

Title: **GRAPHICAL BOREHOLE SUMMARY SECTION A-A**

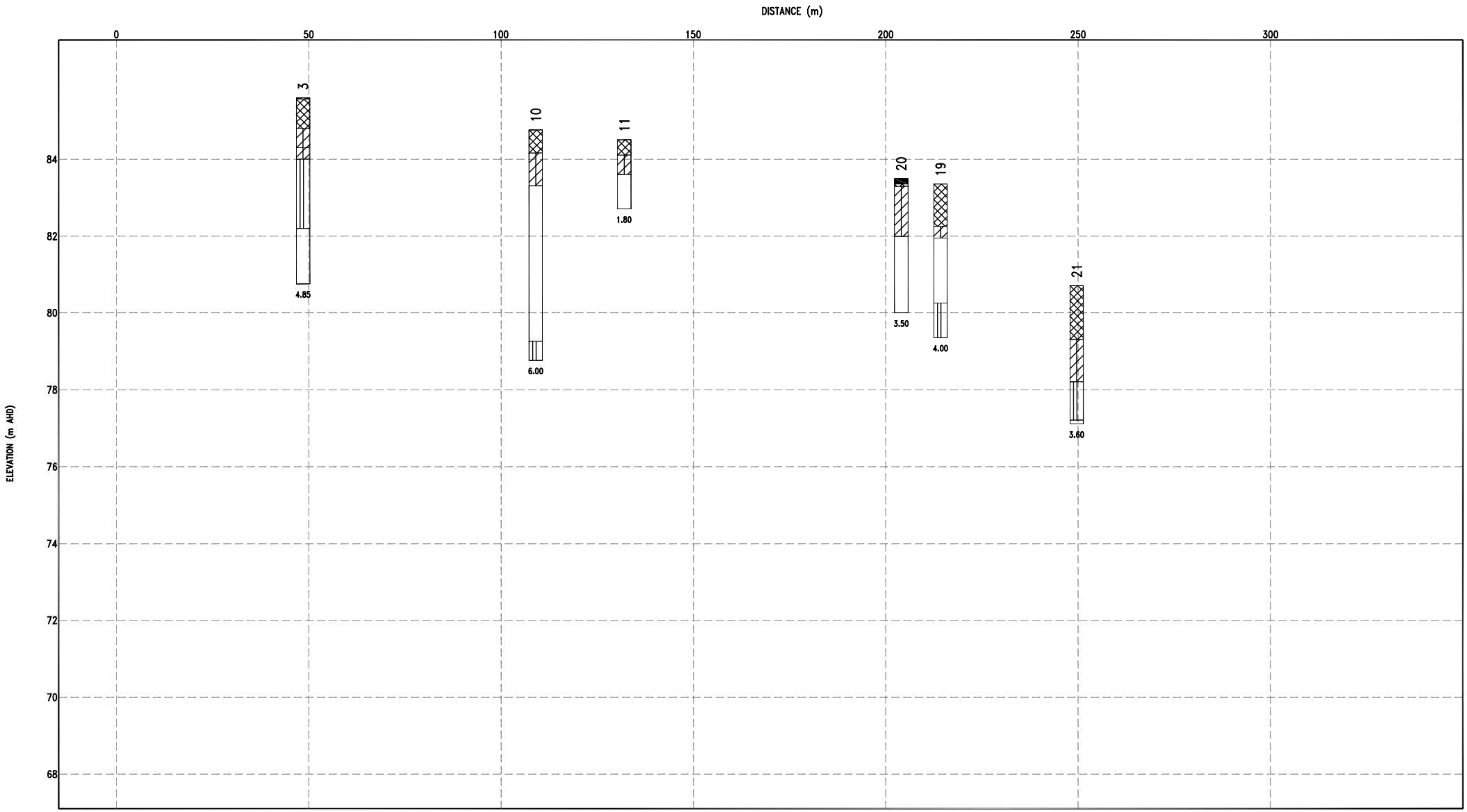
Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Report No: 36230BF

Figure No: 3

JKGeotechnics

PLOT DATE: 5/09/2024 1:43:59 PM DWG FILE: J:\6F GEOTECHNICAL JOBS\36000'S\36230BF CESSNOCK\CAD\36230BF.DWG



MATERIAL GRAPHIC

■	ASPHALTIC CONCRETE	▩	FILL
▨	SILTY CLAY (CL, CI, CH)	☐	SANDSTONE
▨	SILTY SANDY CLAY (CL, CI, CH)	▥	SILTSTONE

H:SCALE 1:1000 @A3 METRES (0 10 20 30 40 50)

V:SCALE 1:100 @A3 METRES (0 1 2 3 4 5)

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

Title: **GRAPHICAL BOREHOLE SUMMARY SECTION B-B**

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Report No: 36230BF

Figure No: 4

JKGeotechnics

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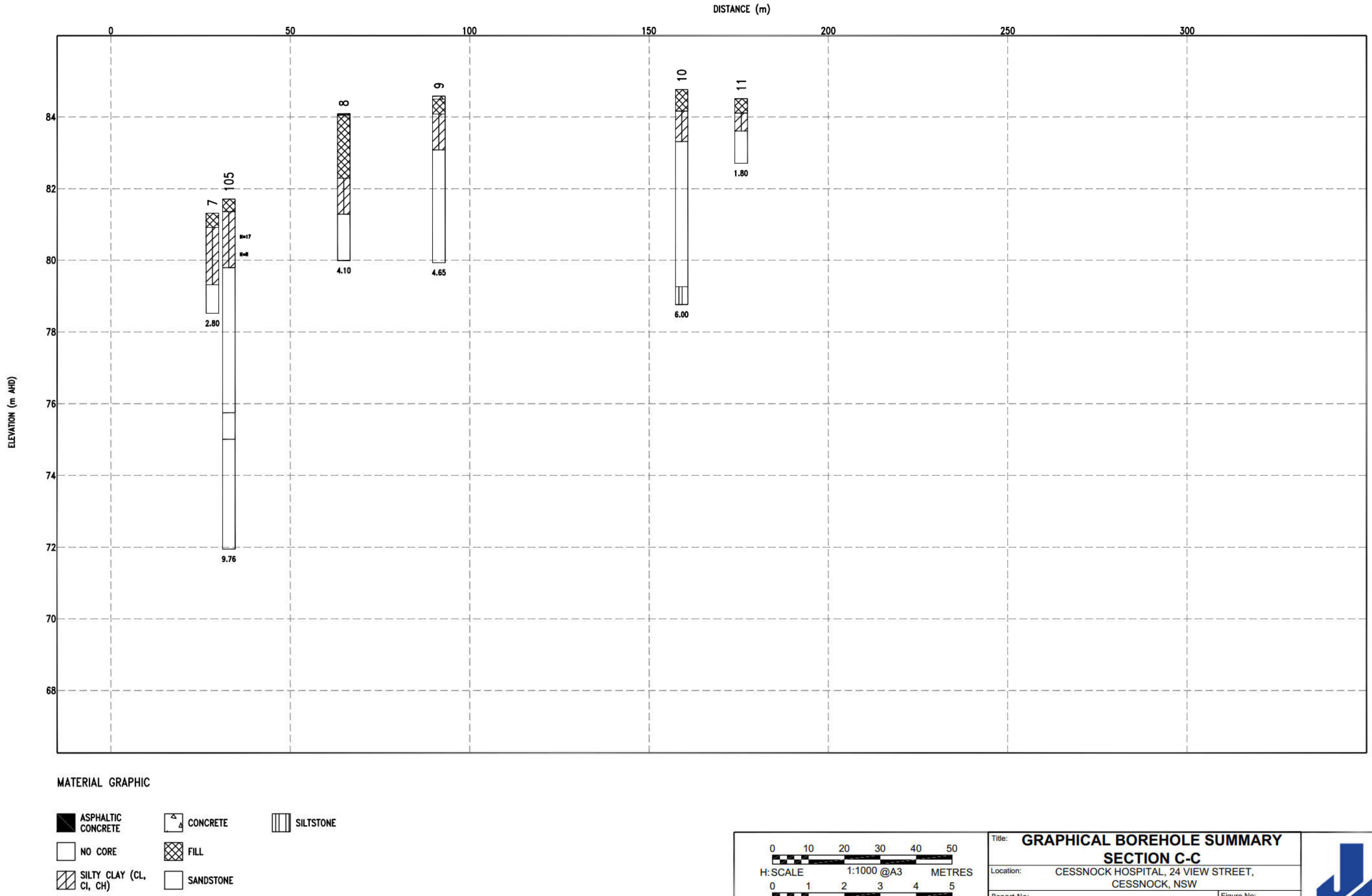

This plan should be read in conjunction with the JK Geotechnics report.

Title: **GRAPHICAL BOREHOLE SUMMARY SECTION C-C**

Location: CESSNOCK HOSPITAL, 24 VIEW STREET, CESSNOCK, NSW

Report No: 36230BF

Figure No: 5

JKGeotechnics

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VIBRATION EMISSION DESIGN GOALS

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

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

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

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

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

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

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

REPORT EXPLANATION NOTES

INTRODUCTION

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

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

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726:2017 *'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 geotechnical 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) is referred to as 'laminite'.

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 shrink-swell behaviour, 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 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.

Cone Penetrometer Testing (CPT) and Interpretation: The cone penetrometer is sometimes referred to as a Dutch Cone. The test is described in Australian Standard 1289.6.5.1–1999 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Static Cone Penetration Resistance of a Soil – Field Test using a Mechanical and Electrical Cone or Friction-Cone Penetrometer'*.

In the tests, a 35mm or 44mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm or 165mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck. The CPT does not provide soil sample recovery.

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. There are two scales presented for the cone resistance. The lower scale has a range of 0 to 5MPa and the main scale has a range of 0 to 50MPa. For cone resistance values less than 5MPa, the plot will appear on both scales.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

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

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

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

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

There are limitations when using the CPT in that it may not penetrate obstructions within any fill, thick layers of hard clay and very dense sand, gravel and weathered bedrock. Normally a 'dummy' cone is pushed through fill to protect the equipment. No information is recorded by the 'dummy' probe.

Flat Dilatometer Test: The flat dilatometer (DMT), also known as the Marchetti Dilometer comprises a stainless steel blade having a flat, circular steel membrane mounted flush on one side.

The blade is connected to a control unit at ground surface by a pneumatic-electrical tube running through the insertion rods. A gas tank, connected to the control unit by a pneumatic cable, supplies the gas pressure required to expand the membrane. The control unit is equipped with a pressure regulator, pressure gauges, an audio-visual signal and vent valves.

The blade is advanced into the ground using our CPT rig or one of our drilling rigs, and can be driven into the ground using an SPT hammer. As soon as the blade is in place, the membrane is inflated, and the pressure required to lift the membrane (approximately 0.1mm) is recorded. The pressure then required to lift the centre of the membrane by an additional 1mm is recorded. The membrane is then deflated before pushing to the next depth increment, usually 200mm down. The pressure readings are corrected for membrane stiffness.

The DMT is used to measure material index (I_D), horizontal stress index (K_D), and dilatometer modulus (E_D). Using established correlations, the DMT results can also be used to assess the 'at rest' earth pressure coefficient (K_o), over-consolidation ratio (OCR), undrained shear strength (C_u), friction angle (ϕ), coefficient of consolidation (C_h), coefficient of permeability (K_h), unit weight (γ), and vertical drained constrained modulus (M).

The seismic dilatometer (SDMT) is the combination of the DMT with an add-on seismic module for the measurement of shear wave velocity (V_s). Using established correlations, the SDMT results can also be used to assess the small strain modulus (G_o).

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a 16mm diameter rod with a 20mm diameter cone end with a 9kg hammer dropping 510mm. The test is described in Australian Standard 1289.6.3.2–1997 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – 9kg Dynamic Cone Penetrometer Test'*.

The results are used to assess the relative compaction of fill, the relative density of granular soils, and the strength of cohesive soils. Using established correlations, the DCP test results can also be used to assess California Bearing Ratio (CBR).

Refusal of the DCP 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.

Vane Shear Test: The vane shear test is used to measure the undrained shear strength (C_u) of typically very soft to firm fine grained cohesive soils. The vane shear is normally performed in the bottom of a borehole, but can be completed from surface level, the bottom and sides of test pits, and on recovered undisturbed tube samples (when using a hand vane).

The vane comprises four rectangular blades arranged in the form of a cross on the end of a thin rod, which is coupled to the bottom of a drill rod string when used in a borehole. The size of the vane is dependent on the strength of the fine grained cohesive soils; that is, larger vanes are normally used for very low strength soils. For borehole testing, the size of the vane can be limited by the size of the casing that is used.

For testing inside a borehole, a device is used at the top of the casing, which suspends the vane and rods so that they do not sink under self-weight into the 'soft' soils beyond the depth at which the test is to be carried out. A calibrated torque head is used to rotate the rods and vane and to measure the resistance of the vane to rotation.

With the vane in position, torque is applied to cause rotation of the vane at a constant rate. A rate of 6° per minute is the common rotation rate. Rotation is continued until the soil is sheared and the maximum torque has been recorded. This value is then used to calculate the undrained shear strength. The vane is then rotated rapidly a number of times and the operation repeated until a constant torque reading is obtained. This torque value is used to calculate the remoulded shear strength. Where appropriate, friction on the vane rods is measured and taken into account in the shear strength calculation.

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 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, 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 Soils for Engineering Purposes'* or appropriate NSW Government Roads & Maritime Services (RMS) test methods. 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.

Reasonable 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.
- Details of the development that the Company could not reasonably be expected to anticipate.

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 rather than at some later stage, well after the event.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

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. Licence to use the documents may be revoked without notice if the Client is in breach of any obligation to make a payment to us.

REVIEW OF DESIGN

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

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 and appropriate footing or pile founding depths, or

iii) full time engineering presence on site.

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)
- ψ 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:

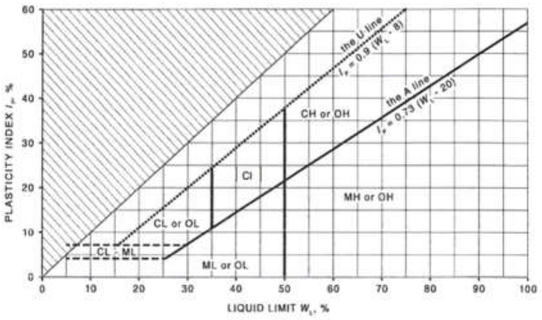
1 For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.

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	▼ C ▶	Standing water level. Time delay following completion of drilling/excavation may be shown. Extent of borehole/test pit collapse shortly after drilling/excavation. Groundwater seepage into borehole or test pit noted during drilling or excavation.
Samples	ES U50 DB DS ASB ASS SAL	Sample taken over depth indicated, for environmental analysis. Undisturbed 50mm diameter tube sample taken over depth indicated. Bulk disturbed sample taken over depth indicated. Small disturbed bag sample taken over depth indicated. Soil sample taken over depth indicated, for asbestos analysis. Soil sample taken over depth indicated, for acid sulfate soil analysis. 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. '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 PID = 100	Vane shear reading in kPa of undrained shear strength. Photoionisation detector reading in ppm (soil sample headspace test).
Moisture Condition (Fine Grained Soils)	*w* > PL *w* ≈ PL *w* < PL *w* ≈ LL *w* > LL	Moisture content estimated to be greater than plastic limit. Moisture content estimated to be approximately equal to plastic limit. Moisture content estimated to be less than plastic limit. Moisture content estimated to be near liquid limit. Moisture content estimated to be wet of liquid limit.
(Coarse Grained Soils)	D M W	DRY – runs freely through fingers. MOIST – does not run freely but no free water visible on soil surface. WET – free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS S F St VSt Hd Fr ( )	VERY SOFT – unconfined compressive strength ≤ 25kPa. SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa. FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa. STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa. VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa. HARD – unconfined compressive strength > 400kPa. 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.
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.

Log Column	Symbol	Definition
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

<table>
<tr><th colspan="2">Term</th><th colspan="2">Abbreviation</th><th>Definition</th></tr>
<tr><td colspan="2">Residual Soil</td><td colspan="2">RS</td><td>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.</td></tr>
<tr><td colspan="2">Extremely Weathered</td><td colspan="2">XW</td><td>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.</td></tr>
<tr><td>Highly Weathered</td><td rowspan="2">Distinctly Weathered (Note 1)</td><td>HW</td><td rowspan="2">DW</td><td>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.</td></tr>
<tr><td>Moderately Weathered</td><td>MW</td><td>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.</td></tr>
<tr><td colspan="2">Slightly Weathered</td><td colspan="2">SW</td><td>Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.</td></tr>
<tr><td colspan="2">Fresh</td><td colspan="2">FR</td><td>Rock shows no sign of decomposition of individual minerals or colour changes.</td></tr>
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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 $I_{s(50)}$ (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.

Abbreviations Used in Defect Description

Cored Borehole Log Column		Symbol Abbreviation	Description
Point Load Strength Index		• 0.6	Axial point load strength index test result (MPa)
		x 0.6	Diametral point load strength index test result (MPa)
Defect Details	– Type	Be	Parting – bedding or cleavage
		CS	Clay seam
		Cr	Crushed/sheared seam or zone
		J	Joint
		Jh	Healed joint
		Ji	Incipient joint
		XWS	Extremely weathered seam
	– Orientation	Degrees	Defect orientation is measured relative to normal to the core axis (ie. relative to the horizontal for a vertical borehole)
	– Shape	P	Planar
		C	Curved
		Un	Undulating
		St	Stepped
		Ir	Irregular
	– Roughness	Vr	Very rough
		R	Rough
		S	Smooth
		Po	Polished
		Sl	Slickensided
	– Infill Material	Ca	Calcite
		Cb	Carbonaceous
		Clay	Clay
		Fe	Iron
		Qz	Quartz
		Py	Pyrite
	– Coatings	Cn	Clean
		Sn	Stained – no visible coating, surface is discoloured
		Vn	Veneer – visible, too thin to measure, may be patchy
		Ct	Coating ≤ 1mm thick
		Filled	Coating > 1mm thick
	– Thickness	mm.t	Defect thickness measured in millimetres