
Report on Geotechnical Assessment

Proposed Wollongong Private Hospital Expansion

**366 - 368 Crown Street & 15 - 23 Urunga
Parade, Wollongong**

Prepared for AA Crown Holdings Pty Ltd

Project 73522.14

18 October 2025

Document History

Details

Project No.	73522.14
Document Title	Report on Geotechnical Assessment
Site Address	366 - 368 Crown Street & 15 - 23 Urunga Parade, Wollongong
Report Prepared For	AA Crown Holdings Pty Ltd
Filename	73522.14.R.001.Rev0

Status and Review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Roderick Haselden	Scott McFarlane	18 October 2025

Distribution of Copies

Status	Issued to
Revision 0	AA Crown Holdings Pty Ltd, Mr Marcelo Remirez

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

Signature

Date

Author	18 October 2025
Reviewer	18 October 2025

Executive Summary

A geotechnical assessment has been carried out for the proposed Wollongong Private Hospital Expansion at 366 – 368 Crown Street and 15 – 23 Urunga Parade, Wollongong. The assessment included review of recent and previous borehole drilling, groundwater monitoring, laboratory testing of soil and rock samples and engineering analysis.

The site slopes from RL 44 m in the rear of No. 368 Crown Street to RL 40 AHD in the north-western part of the site and to RL 42 along Crown Street. The subsurface profile for the site comprises up to 1.6 m of fill overlying generally stiff to hard residual clay soils that grades into the weathered bedrock profile. The rock quality varies across the site and includes an initial medium to high strength ‘cap rock’ in the northern and eastern parts of the site, extremely weathered material to very low strength and then grades into medium then high strength with depth. The site is also affected by faulting, which has resulted in an increased depth of weathering and fracturing in parts of the site. Recent and previous groundwater observations generally indicated groundwater levels in the soil and upper (ie weathered) rock profile.

The proposed bulk excavation levels of approximately RL 20.5 and RL 26.5 m for the development will necessitate cuts of 11.5 m to 23.5 m for the five to six level basement car park and oncology section. It is expected that excavations to depths up to 0.4 m to 6.0 m could be readily carried out using hydraulic excavators fitted with buckets, with ripping and rock-hammering required in the weathered and fractured sandstone to depths of 5.2 m to 10.5 m. Below these depths though, high strength sandstone will require medium to heavy rock breaking, rock sawing, rock grinding and ripping equipment.

As the proposed excavation is close to adjacent buildings and site boundaries, batters will not be feasible in many areas and construction of support will be required in advance of excavation. Feasible support options include anchored soldier piles with either close shuttering or shotcrete infill panels, or contiguous piling. The installation of a pattern of rock bolts and reinforced shotcrete will also be a likely requirement in the fractured rock. Design of retaining structures and floor slabs will also require consideration of drainage and water disposal systems. Drainage of the excavation will also be required during construction.

The base of the excavations will generally comprise medium to high strength rock. Strip and pad footings have been recommended in at least medium strength rock and local deepening will be required where medium strength rock is not exposed in the floor of the basement excavation (for example, where an increased depth of weathering has occurred in the vicinity of faulting). Design bearing pressures are given within together with an option for higher bearing pressures provided that spoon testing or additional rock coring is carried out during construction.

Table of Contents

	Page No
1. Introduction	1
2. Proposed development	1
3. Background	2
4. Site description	3
5. Published data	3
5.1 Geology	3
5.2 Soil landscape	3
5.3 Acid sulfate soils	4
6. Information review	4
6.1 Previous investigations	4
6.2 Inspections and site observations	5
6.3 Subsurface investigation	5
6.4 Groundwater	6
6.5 Mechanical testing	7
6.6 Salinity and aggressivity testing	8
6.7 Acid sulfate soil testing	9
7. Comments	10
7.1 Geotechnical model	10
7.2 Bedrock classification	11
7.3 Salinity potential	12
7.4 Acid sulfate soil potential	12
7.5 Excavation	12
7.6 Groundwater	16
7.7 Excavation support	16
7.8 Anchors	18
7.9 Retaining structures	19
7.10 Footings	20
7.11 Basement ground slabs	22
7.12 Mobile cranes	22
8. Geotechnical requirement for additional borehole investigation	22
9. Geotechnical review	22

10.	Geotechnical requirements during construction	22
11.	References	23
12.	Limitations	24

Appendix A: About This Report

Appendix B: Drawings 1 – 3
Figure 1

Appendix C: Notes on Terminology, Soil and Rock Descriptions
Results of Previous Field Work
Photo Plates 1 – 4 (Photographs 1 – 16)

Appendix D: Results of Previous Laboratory Testing

Appendix E: NSW GTD 2020/001
WCC Extraction Water Fact Sheet

Appendix F: Vibration Guidelines

Report on Geotechnical Assessment

Proposed Wollongong Private Hospital Expansion

366 - 368 Crown Street & 15 - 23 Urunga Parade, Wollongong

1. Introduction

This report prepared by Douglas Partners Pty Ltd (Douglas) presents the results of a geotechnical assessment undertaken for the proposed Wollongong Private Hospital Expansion (WPHE) located at 366 – 368 Crown Street and 15 – 23 Urunga Parade, Wollongong (herein after referred to as ‘the site’). The investigation was commissioned by email instructing to proceed dated 29 September 2025 from Mr Marcelo Ramirez of 360 Property Agency acting on behalf of AA Crown Holdings Pty Ltd, and was undertaken in accordance with Douglas’ email proposal dated 8 August 2025.

It is understood that the proposed WPHE will comprise an extension of the existing Wollongong Private Hospital (WPH) across seven acquired lots to the west of the existing hospital footprint. The proposed development will comprise the construction of a twelve-storey building over 5 – 6 levels of basement car parking. The aim of the assessment was to assess the subsurface soil, rock and groundwater conditions across the site to provide:

- a review of existing geotechnical information;
- an assessment of soil salinity;
- an assessment of acid sulfate soil;
- likely excavation conditions, plant requirements and vibration considerations;
- recommendations on excavation support options and design parameters; and
- footing options and design parameters.

The current assessment included a review of existing geotechnical information from previous and recent geotechnical investigations. The details of the previous field work are presented in this report, together with comments and recommendations on the items listed above.

Douglas’ geotechnical investigation for the WPHE was carried out in conjunction with a preliminary site investigation (contamination) with limited sampling (PSI) (Project 73522.15.R.001.Rev0), and a preliminary groundwater assessment (73522.15.R.002.Rev0), which have been reported separately.

This report must be read in conjunction with all appendices including the notes provided in Appendix A.

2. Proposed development

The information provided by the client indicates that the proposed WPHE, a state significant development application (SSDA), will comprise a twelve-storey building over 5 – 6 basement levels that includes car parking and an oncology section in Basement Level 6.

Based on the Wollongong Private Hospital Master Plan prepared by Conybeare Morrison International Pty Ltd dated 18 August to 2 September 2025, the proposed building and basement footprint is mostly located in the lots adjacent to Urunga Parade and extends into the rear part of the lots adjacent to Crown Street (ie the footprint doesn't extend into the heritage buildings located in the Crown Street lots). The proposed excavation will be set back approximately 0.5 m to 1.5 m from Urunga Parade pavement, approximately 5.8 m to 10.3 m from the western site boundary with 25 Urunga Parade, 2.8 m to 3.8 m from southern and western site boundaries with 370 Crown Street, and about 42 m from the Crown Street pavement. The proposed excavation abuts and ties into the existing basement for the current WPH site.

The plans show that the finished floor levels for Basement Levels 5 and 6 will be RL 26.9 and RL 20.9, respectively. To achieve the proposed finished floor levels, excavation depths in the range of about 12 m to 18 m for Basement Level 5 and 20.0 m to 23.5 m for Basement Level 6 (oncology) are anticipated.

No information has been provided on the structural loads, but previous experience with similar developments indicate working column load will be in the range 9000 kN to 11,500 kN.

3. Background

Douglas and others have previously carried out geotechnical investigations for the WPH site. From a review of accessible files, the most relevant reports are:

- Geo-Environmental Engineering (GEE) Report ID: GI002TPG-R01F "Geotechnical Investigation Report, Proposed Wollongong Private Hospital", dated 29 March 2010;
- Arup Pty Ltd (Arup) Ref Rep/224118/GIR "Wollongong Private Hospital, Geotechnical Interpretive Report" dated 14 May 2012;
- Douglas Project 73522 "Supplementary Report on Geotechnical Investigation, Proposed Wollongong Private Hospital, 360 – 364 Crown Street, Wollongong" dated 17 July 2013;
- Douglas Project 73522.07 "Report on Geotechnical Investigation, Proposed Wollongong Private Hospital Expansion, 366 – 368 Crown Street & 15 – 21 Urunga Parade, Wollongong" dated 22 April 2022; and
- Douglas Project 73522.11 "Report on Geotechnical Investigation, Proposed Wollongong Private Hospital Expansion, 366 – 368 Crown Street & 15 – 23 Urunga Parade, Wollongong" dated 16 April 2025.

Douglas also provided geotechnical consulting services during construction for the Wollongong Private Hospital between October 2013 and September 2015, which include inspections for shoring piles, rock face stability, support designs for adverse jointing a section of the excavation adjacent to the Proposed Wollongong Day Surgery basement excavation, foundation and crane pad assessments.

The relevant information from the above site investigations (refer Appendix C) has been incorporated into this report.

4. Site description

The site, which comprises Lots A and B in DP 343680, Lots 9, 46 and 47 of DP 5507, Lot D in DP 402234 and Lot 1 in SP 73256, is an irregular shaped area of approximately 4,415 m² with a 31 m frontage to the northern side of Crown Street and a 76 m frontage to the southern side of Urunga Parade at Wollongong (refer Drawing 1 in Appendix B). It is bounded to the east by the existing WPH and to the west by low-density residential developments.

Surface levels generally fall in the north-westerly direction and south-westerly directions from the rear boundaries of the existing lots at average grades of 1 in 5 to 1 in 20, from approximately RL 44 relative to the Australian Height Datum (AHD) in the north-eastern corner section of No. 366 Crown Street to RL 41 along the eastern edge of No. 15 Urunga Parade, and RL 39 along the north western edge of 23 Urunga Parade.

Site improvements at the time of the investigation comprised low-density residential dwellings at No.'s 366 and 368 Crown Street and No.'s 15, 19, 21 and 23 Urunga Parade and a 2 – 3 storey residential unit block at No. 17 Urunga Parade. The residential dwellings at No.'s 366 and 368 Crown Street and No. 15 Urunga Parade appeared to have historically been converted into medical practices and included concrete and asphalt surfaced parking areas to the rear. The remaining properties generally included grassed and landscape gardens at the front and/or rear. Retaining walls of various construction were located on the northern boundaries of No.'s 15, 21 and 23 Urunga Parade, along the side boundaries and driveways of No. 368 Crown Street and No.'s 15 and 17 Urunga Parade. Batters were also located along the southern boundaries of No.'s 366 and 368 Crown Street and 15 Urunga Parade.

5. Published data

5.1 Geology

The NSW Seamless Geology dataset (GSNSW, 2023) indicates that the site is underlain by the Broughton Formation Sandstone of Permian age. The Broughton Formation typically comprises red brown or green grey, lithic to feldspathic and sporadically quartzose sandstone with minor interbedded siltstone and pebble conglomerate, sporadic shelly fossils and varying degrees of bioturbation. This formation typically weathers to form clays of medium to high plasticity. The results of the investigation were consistent with the large-scale geological mapping with sandstone intersected within all boreholes.

Geological mapping indicates no regional structural geology in the vicinity of the site. Notwithstanding this, inspections during construction of the existing WPH indicated the presence of faulting (refer to Drawing 1 in Appendix B for approximate surface locations).

5.2 Soil landscape

The NSW Soil Landscape (NSW SCS, 1990) indicates that the site is underlain by the Gwynneville soil landscape. The Gwynneville soil landscape comprises residual soils developed on the footslopes of the Illawarra Escarpment and isolated rises of the Wollongong Plain. It is characterised by gentle to steep slopes (slope of 3° to 25°) with local relief of 10 m to 70 m.

5.3 Acid sulfate soils

The NSW Acid Sulfate Soil Risk Mapping (NSW DECC, 2008) indicates that the site is not located in an area mapped as requiring investigations for acid sulfate soils and marked as '*No Known Occurrence*'. The site is approximately 1.7 km west from an area mapped as '*High Probability of Occurrence*' of acid sulfate soils and approximately 680 m southwest from soils mapped as '*Low Probability of Occurrence*'.

6. Information review

6.1 Previous investigations

Previous subsurface investigations at the WPH and WPHE sites used as part of this assessment comprised:

- borehole drilling using an Edson 3000 truck-mounted soil sampling and drilling rig (GEE Bores 2 and 3). The boreholes were drilled using auger drilling techniques to depths of 3.5 m to 4.5 m. The boreholes were extended into the rock using NMLC (50 mm diameter core) diamond drilling equipment to the termination depths of 20.6 m and 18.0 m, respectively.
- borehole drilling using a JK300 track-mounted soil sampling and drilling rig (Arup Bore 101). The borehole was drilled using auger drilling techniques to a depth of 3.1 m, then extended into the rock using NMLC (52 mm diameter core) diamond drilling equipment to a termination depth of 28.8 m.
- borehole drilling using a Scout truck-mounted soil sampling and drilling rig (Douglas Bores 201 - 203). The boreholes were drilled using auger drilling techniques to depths of 2.2 m. The boreholes were extended into the rock using NMLC (50 mm diameter core) diamond drilling equipment to the termination depths of 15.0 m and 15.2 m, respectively. Standpipe piezometers were installed in Bores 201 and 203 for long-term monitoring of groundwater levels.
- borehole drilling using a Hanjin TD115 track-mounted soil sampling and drilling rig (Bores 301 – 304). The boreholes were drilled using a combination of 100 mm diameter spiral flight augers and rotary drilling to levels of moderate resistance at depths of 2.6 – 4.8 m. The boreholes were then extended into the underlying rock using NMLC (50 mm diameter core) diamond drilling equipment to the termination depths of 11.8 m to 16.8 m.
- Borehole drilling using a Hanjin 8D track-mounted soil sampling and drilling rig (Bore 401). Bore 401 was drilled using a combination of 100 mm diameter spiral flight augers and rotary drilling to levels of moderate resistance at a depth of 2.1 m. Bore 401 was then extended into the underlying rock using NMLC (50 mm diameter core) diamond drilling equipment to the termination depth of 15.7 m.

It is noted that only one borehole (Arup Bore 101 located in the WPH site) extends to below the proposed Basement Level 6 Oncology, and that it does not extend to below the zone of influence for footings for this level.

6.2 Inspections and site observations

The principal geotechnical and geological observations within and immediately adjacent to the site are summarised below with selected items shown in Photos 1 – 8 (refer Plates 1 and 2 in Appendix C).

- Sandstone blocks are exposed in the nature strip at the front of No. 17 Urunga Parade (refer Photo 5), which is probably the 'cap-rock' previously identified at the Wollongong Private Hospital site and encountered in Bores 302 and 201.
- Sandstone blocks were also observed near the north-western corner of No. 23 Urunga Parade, which is probably the 'caprock' encountered in Bore 401.
- Seepage was previously observed along the driveway (refer Photo 6) at No. 17 Urunga Parade during the 2022 investigation. While there were wet surfaces on all of the lots during the inspection (ie following rainy weather), no other seepage points were identified.
- Seepage was previously observed from the nature strips on the northern side of No. 49 Urunga Parade and No. 59 Rosemont Street during the 2022 investigation.

Douglas also provided geotechnical consulting services during construction of the WPH. The principal geotechnical and geological observations relevant to the current project are summarised below with selected items shown on Drawing 1 in Appendix B and in Photos 9 – 16 (refer Plates 3 and 4 in Appendix C).

- A medium to high strength band of 'cap rock' was encountered in the upper bedrock profile in the northern and central parts of the WPH site.
- A weathered igneous intrusion (ie a 'sill') was encountered in boreholes and in the excavation in the northern part of the site, below the 'cap rock'. The sill was typically very low to medium strength and up to about 0.3 m thick.
- Faulting was observed to intersect the southern excavation face, adjacent to Crown Street (refer Photo 10). The strike and dip of the fault was 120°/40° to the south.
- Faulting was observed to intersect the western excavation face, adjacent to the boundary with No. 366 Crown Street (refer Photos 11 and 12). The strike and dip of the fault was 175°/70° east. The fault was adversely oriented (ie dipping into the excavation) and required the installation of additional temporary anchors to support the face during construction.
- Both faults had resulted in an increased depth of weathering, which extending below the basement excavation level in the south-western section of the WPH site.
- Bedding within the excavation dips to the north/northwest at between 6° and 10° (refer Photo 14).
- The excavated rock faces adjacent to No. 15 Urunga Parade comprised medium becoming high strength, slightly weathered then fresh sandstone in the lower 4 – 5 m in the south-western section of No. 15 Urunga Parade (refer Photos 15 and 16).

6.3 Subsurface investigation

Borehole logs from the previous investigations for the WPHE and at the WPH are in Appendix C, together with notes defining classification methods and descriptive terms. Summary geological cross sections (Sections A – A' and B – B') are given on Drawings 2 and 3 in Appendix B.

The previous field work by Douglas and others indicated the general succession of strata can be broadly summarised as follows:

Fill: encountered in Bores 301 – 304 and Bore 401 (eg within the site) to depths of 0.6 m to 1.6 m and to depths of 0.1 m to 1.0 m in nearby WPH boreholes. The fill comprised concrete, bituminous concrete, sandy gravel, silty and gravelly sand, clayey silt, sandy and silty clay.

Residual Soil: residual silty and sandy clay of generally stiff to hard consistency encountered to depths in the range of 2.1 m to 6.0 m in Bores 301 – 304 and Bore 401 (eg within the site) and to depths of 0.4 m to 3.9 m in nearby WPH boreholes, grading into the underlying extremely to highly weathered rock.

Bedrock: Bores 301 – 304 and Bore 401 encountered a variable bedrock profile across the site. In Bores 301, 303, 304 the bedrock initially comprises very low to medium strength sandstone with clay seams increasing to low to medium strength with depth. In Bores 302 and 401, high strength 'cap-rock' (1.7 m thick), was initially encountered above the abovementioned profile. Core samples of consistent medium strength were recovered below depths of 5.6 m to 9.5 m. Consistent high strength sandstone was recovered below depths of 8.7 m to 13.3 m and continued to the termination depths of 11.8 m to 16.8 m.

Nearby boreholes in the WPH site also encountered a variable bedrock profile. GEE Bore 2, Arup Bore 101 and Bores 201 and 203 initially comprises extremely low (ie extremely low strength refers to material with a point load index of less than 0.03 MPa and has soil-like properties) to medium strength sandstone with clay seams, increasing to low to medium strength with depth. In GEE Bores 3 and Bore 202 high strength 'cap-rock' (1.9 m thick), was initially encountered above the abovementioned profile. Core samples of consistent medium strength were recovered below depths of 5.2 m to 10.6 m. Consistent medium high strength sandstone was recovered below depths of 8.5 m to 15.0 m and continued to the termination depths of 15.0 m to 28.8 m. Different conditions were encountered in GEE Bore 2, which appears to be affected by faulting to a depth of about 18 m, with consistent medium strength sandstone encountered below 19.0 m. A local zone of faulting was also inferred in Arup Bore 101 between approximately 16.9 m and 18.1 m

Based on the fracture spacing values shown on the borehole logs, an upper 'fractured zone' is apparent to depths in the range of 2.5 m to 8.0 m, with the exception of GEE Bore 2 and Arup Bore 101 that are located close to faulting, which indicates that the fracture zone extends to 19.0 m and 10.5 m respectively. Fracture spacing in the 'fractured zone' is typically in the range of 0.1 m to 0.6 m with clay seams up to 200 mm thick. Jointing intersecting the fractured zone was generally tight and predominantly moderately to steeply inclined (30° to 70°) with sub-vertical jointing also present. Below the fractured zone, discontinuities in the recovered core were generally tight with but similar the jointing intersected, healed in places (cemented) with fracture spacing generally exceeding 1.0 m. Unbroken sections of core were recovered below depths of 9.6 m to 13.0 m in Bores 301 – 303, 201, 202 and GEE Bore 3, with rock quality designations (RQD) values of 100% and corresponding high overall fracture spacing values (exceeding 5 m to 10 m).

6.4 Groundwater

No free groundwater was observed in Bores 301 – 304 or Bore 401 (ie within the site) during auger drilling through the soil profile, whilst the use of water as a drilling fluid during rotary and core drilling prevented groundwater observations being made thereafter. Standpipe piezometers were installed within Bores 301 – 303 and Bore 401 at the completion of drilling. Groundwater

levels are transient and vary with time, due to preceding rainfall and strata permeability, but also possibly due to damaged and leaking services and dewatering of the existing hospital basement. It is noted that the 2022 boreholes were completed following a period of above average rainfall.

Table 1: Summary of groundwater monitoring

Bore No.	Surface RL (m AHD)	Screen Interval (m)	Screened Strata	Groundwater Monitoring					
				8/3/22		13/4/22		21/02/25	
				m (bgl)	RL (AHD)	m (bgl)	RL (AHD)	m (bgl)	RL (AHD)
301	40.8	0.65 – 12.65	Fill, clay, weathered and fresh rock	1.10	39.70	1.61	39.19	5.05	35.75
302	41.7	2.55 – 14.55	Weathered and fresh rock	9.63	32.07	8.98	32.72	9.47	32.23
303	43.0	1.75 – 16.75	Clay, weathered and fresh rock	1.98	41.02	2.43	40.57	6.58	36.42
401	40.1	2.60 – 5.60	Clay and weathered rock	n/a	n/a	n/a	n/a	4.51	35.49

where: bgl = metres below ground level n/a = not applicable

No free groundwater was observed in the previous boreholes adjacent to the site during auger drilling through the soil profile, and the use of water as a drilling fluid during rotary and core drilling prevented groundwater observations being made thereafter. All of these boreholes were backfilled immediately following the completion of drilling, precluding long-term monitoring of groundwater levels.

Standpipe piezometers were previously installed in Douglas' Bore 201 and 203. Groundwater monitoring of these standpipes on 12 August 2013 indicated groundwater depths of 1.5 m (RL 41.1 m AHD) and 2.4 m (RL 40.8 m AHD), respectively.

6.5 Mechanical testing

Selected samples from the boreholes investigation within the WPHE site were tested in the laboratory for measurement of field moisture content and Atterberg limits. The detailed test report sheets are included in Appendix D, with the results summarised in Table 2.

Table 2: Summary of plasticity test results

Bore No	Depth (m)	W _F (%)	W _L (%)	W _P (%)	PI (%)	Material Description
301	2.0 – 2.45	14.7	33	20	13	Sandy CLAY
302	1.0 – 1.45	20.0	37	25	12	Silty CLAY
401	1.0 – 1.45	20.9	49	19	30	Silty CLAY

Where: W_F = Field moisture content PI = Plasticity Index
 W_P = Plastic limit W_L = Liquid Limit

The results indicate that the samples tested are variably of low to intermediate plasticity and would therefore be slightly to moderately susceptible to shrinkage and swelling movements with changes in soil moisture content.

Point load strength index ($I_{s[50]}$) tests were carried out on samples of rock core. The test results are shown on the borehole logs (Appendix C). The results indicate point load strengths in the range of 0.2 MPa to 4.1 MPa representing a banded weathering profile with the strength typically increasing in value in the fresh rock. Inferred values for uniaxial compressive strength (UCS), based on a correlation factor of 20, are in the range 4 MPa to 82 MPa. The results are consistent with those from previous investigations by others. Figure 1 (Appendix B) profiles point load strength index with depth from all the site boreholes.

6.6 Salinity and aggressivity testing

A summary table (refer Table D1 in Appendix D) presents the results of laboratory tests, assessments of aggressivity to concrete and steel, textural classification, calculated salinity electrical conductivity (ECe) and salinity class inferred from ECe values using the method of Richards (Richards, 1954). The detailed laboratory test reports and chain of custody information are provided in Appendix D. The total test sample numbers and the range of test results obtained are summarised in Table 3.

Table 3: Summary of salinity test results

Parameter		Units	Samples	Minimum	Maximum
pH		pH units	26	4.1	9.9
Chloride		(mg/kg)	9	<10	110
Sulfate		(mg/kg)	9	<10	66
Aggressivity	to Concrete	[AS 2159]	-	Non-Aggressive	Moderate
	to Steel	[AS 2159]	-	Non-Aggressive	Moderate
EC1:5 [Lab.]		(μ S/cm)	26	25	940 (1200)*
Resistivity		Ω .cm	26	833	31,250 (40,000)*
ECe [M x EC1:5] ¹		(dS/m)	22	< 2	17
Salinity Class		[after Richards 1954]	-	Non-Saline	Slightly saline (Highly saline)*

Where 1 = M is soil textural factor
* = Outlier (one sample of fill tested)

It is noted that the electrical conductivity of one sample of fill (Bore 301: 0.1 – 0.2 m) was significantly greater than the remainder of the samples tested at the site.

Discussion on the test results is given in Section 7.3 of this report.

6.7 Acid sulfate soil testing

Laboratory testing for acid sulfate soils was undertaken on fill samples collected during the investigations within the WPHE site, in two stages, with reference to the *Acid Sulfate Soils Manual* (Stone, Ahern, & Blunden, 1998) and *Queensland Acid Sulphate Soil Technical Manual* (QASSIT, 2005).

Fill samples from the investigation (a total of 6 samples) were tested for measurement of pH in H₂O (pH_f) and pH after oxidation with H₂O₂ (pH_{fox}) using a calibrated pH meter. The detailed results of screening tests (pH_f and pH_{fox}) are given in Appendix D.

A positive indicator of potential acid sulfate soil (ie the lowering of the pH by more than one unit) was observed in all the samples tested during pH screening. Five samples also had the final pH's < 4 with two samples final pH being 3.5. Vigorous effervescence was observed from the same sample.

One sample with a final pH of less than 3.5 was despatched to Envirolab Pty Ltd, a NATA registered laboratory for confirmation (or otherwise) of acid sulfate potential by Chromium Suite testing. The method includes measurement of pH in potassium chloride (KCl), sulfidic – Titratable Actual Acidity (s-TAA) and Chromium Reducible Sulfur (S_{CR}) to determine Net Acidity. The results of testing are summarised in Table 4 with the detailed report sheets in Appendix D.

Table 4: Summary of chromium suite test results

Borehole No.	Depth (m)	RL (m AHD)	pH in KCl	S _{CR} (%S)	s-TAA (%S)	Net Acidity (%S)	Material
304	0.5	42.7	6.2	<0.005	<0.01	<0.005	Sandy CLAY (Fill)
Action Criteria for >1000 tonnes of soil disturbed (Stone, Ahern, & Blunden, 1998)						0.03	Sandy Loam to light clay

Where S_{CR} = Chromium Reducible Sulfur s-TAA = Titratable Actual Acidity
 Net Acidity = S_{CR} + s-TAA + s-S_{NAS}

Discussion on the test results is given in Section 7.4 of this report.

7. Comments

7.1 Geotechnical model

Based on the results of all investigations, the geological model for the site comprises:

- Fill associated with existing site improvements. Fill depths at the borehole locations were in the range 0.1 m to 1.6 m and included concrete, bituminous concrete sand, gravelly sand, sandy and silty clay; overlying
- Residual soil comprising stiff to hard sandy and silty clay to depths of 0.4 m to 3.9 m. An increased depth of soil in Bores 301 and 303, which extended to depths of 6 m and 4.8 m respectively, is probably due to a geological structure (eg faulting) located nearby; grading into
- Initially extremely to highly weathered sandstone bedrock. The core recovered indicated that the sandstone is typically fractured, weathered and of variably of very low to medium strength with some clay seams (ie the fractured zone)
- Different conditions were initially encountered in the sandstone bedrock in north-western, northern and eastern parts of the site, with a thickly bedded, medium to high strength 'cap rock' up to 1.9 m thick.
- Fresh, massive, medium to very high strength sandstone was encountered below depths of 8.5 m to 13.0 m (RL 30.3 to 35.1 AHD) and continuing to the termination depths of 11.8 m to 28.8 m;
- Faulting and an increased depth of weathering was previously observed along the boundary between No. 366 Crown Street and the WPH. A second fault observed in the southern face of the WPH excavation and encountered at a depth of 13.96 m in Bore 203 is also expected to extend through the current site. The locations of the faults are shown on Drawing 1 in Appendix B with the inferred/extrapolated locations of the faults extending into the site also shown.
- Groundwater was observed at depths of 4.5 m to 6.6 m (RL 35.5 to 36.4 AHD) during recent monitoring of standpipe piezometers in February 2025. Monitoring following extended rainfall in March 2022 observed groundwater levels at depths of 1.1 m to 2.4 m (RL 39.2 to 41.0 AHD). A lower groundwater table was observed in Bore 302 at depths of 9.0 m to 9.6 m (RL 32.1 to 32.7 AHD). It is noted that the lower groundwater is close to the level of fresh, high strength sandstone and only just above the level of 'unbroken' core. The lower groundwater

levels measured in Bore 302 may be due to open fractures in the weathered and fractured bedrock profile, possibly due to a geological structure or de-stressing by the adjacent excavation. It is noted that groundwater levels are affected by factors such as soil/rock permeability and preceding climatic conditions and can therefore fluctuate over time.

As only one borehole (Arup Bore 101, which is located on the WPH site) has extended below the proposed Basement Level 6, the geotechnical model for the site has by necessity assumed that fresh, massive, medium to high strength bedrock extends to a depth of at least two footing widths below proposed foundation levels for the Level 6 basement. Additional deep cored boreholes will be required to confirm this assumption prior to the commencement of construction.

7.2 Bedrock classification

The bedrock from the cored boreholes has been assigned equivalent rock classes as described by Pells et al (Pells, Mostyn, & Walker, 1998). The depth and RL's to the top of various rock classes encountered are summarised in Table 5. The rock level and assigned classes generally increase in depth to the north and the east. The table below does not include the 'cap-rock' encountered at Bores GEE2, 202, 302 and 401, due to its variability in thickness and strength.

Table 5: Depth/level of rock classes

Bore No.	Surface RL (AHD)	Equivalent Rock Class					
		Class IV [†]		Class III – II [†]		Class I [†]	
		Depth (m)*	RL (AHD)*	Depth (m)*	RL (AHD)*	Depth (m)*	RL (AHD)*
2	44.0	4.7	39.3	18.2	25.8	(n/e)	(n/e)
3	45.3	5.4	39.9	5.2	40.1	15.0	30.3
101	44.5	5.4	39.1	10.6	33.9	(n/e)	(n/e)
201	42.6	7.2	35.4	9.8	32.8	10.0	32.6
202	43.6	5.2	38.4	8.4	35.2	8.5	35.1
203	43.2	2.5	40.7	(n/e)	(n/e)	(n/e)	(n/e)
301	40.8	n/e	n/e	6.7	34.1	8.7	32.1
302	41.7	4.9	36.8	6.0	35.7	8.8	32.9
303	43.0	6.3	36.7	9.5	33.5	9.7	33.3
304	43.2	3.6	39.6	6.8	36.4	10.3	32.9
401	40.1	4.7	35.4	6.0	34.1	13.3	26.8

where: Class IV Sandstone minimum requirements: low strength, fractured, 10% allowable defects.

Class III Sandstone minimum requirements: medium strength, fractured, 5% allowable defects.

Class I Sandstone minimum requirements: high strength, slightly fractured, 1.5% allowable defects.

* Depth/level to top of Class

n/e not encountered

7.3 Salinity potential

The Summary Table D1 (in Appendix D) indicates that 17 of the 22 soil samples tested were classified as 'Non-Saline', 4 of the 22 samples tested were 'Slightly-Saline', and one sample of fill (Bore 301: 0.1 – 0.2 m) was classified as 'Highly-Saline'. As the site is underlain by residual soils and the majority of samples tested were classified as 'Non-Saline' and 'Slightly-Saline', a 'worst case' approach to a preliminary salinity classification of the site is not considered appropriate.

It is suggested that the fill in the vicinity of Bore 301 (ie No. 21 Urunga Parade) is investigated further to delineate the extent of the highly saline fill soil. Provided that all fill that is classified as greater than 'Moderately Saline' is excavated and removed during earthworks, a Salinity Management Plan will not be required for the site.

7.4 Acid sulfate soil potential

The site elevation and geology are inconsistent with the development of estuarine acid sulfate soil (ASS) conditions. Furthermore, the site is located further than 500 m from known occurrences of acid sulfate soils. In accordance with ASSMAC, the assessment of ASS conditions is not required for the residual soil and bedrock at the site.

The results of the initial screening tests for fill indicate pH in H₂O (pH_f) in the range of 5.2 to 7.9 for all, which indicates Actual Acid Sulfate Soil (AASS) conditions are not present at the locations and depths sampled.

The results of the initial screening tests for pH following addition of H₂O₂ (pH_{fox}) indicate samples tested were in the range 3.5 to 6.7 with pH drops in the range 0.6 to 1.6 when compared to respective pH_f values for all but one sample. Indicators for the potential for forming acidic conditions upon oxidation include pH drops in excess of 1 pH unit, a final pH of < 3.5 (but preferably 3.0) and effervescence. Three samples had a pH drop of ≥ 1, two of those had a final pH value of 3.5 and one sample effervesced, which indicates that localised Potential Acid Sulfate Soil (PASS) conditions may be present in fill at the site.

Additional laboratory testing was undertaken on one sample recovered from the test pit which indicated the possible presence of PASS. The test results indicated a Net Acidity of <0.005 %S and could be indicative of 'acidic' rather than 'acid-sulfate' conditions. The Net Acidity value is below the action criteria required for the preparation of an Acid Sulfate Soil Management Plan (ASSMP), and as such, the preparation of an ASSMP is not required for this project.

7.5 Excavation

7.5.1 Dilapidation surveys and monitoring

It is suggested that dilapidation surveys are carried out on surrounding buildings and pavements that may be affected by the construction. The dilapidation surveys should be undertaken for a baseline assessment before the commencement of any site preparation or excavation work to document any existing defects so that any claims for damage due to construction related activities can be accurately assessed.

The proposed excavation is located more than 35 m from Crown Street, which is a Transport for NSW (TfNSW) arterial road. Therefore, it is unlikely that the TfNSW will nominate that monitoring

is carried out prior to and during excavation in accordance with Technical Direction GTS 2020/002 (refer Appendix E). It is noted, however, that Wollongong City Council has also adopted GTD 2020/001 where excavation have been carried out adjacent to their assets (eg Urunga Parade).

As a geotechnical consultant, Douglas Partners Pty Ltd has the capabilities to assist with the installation and monitoring of instrumentation, if required.

7.5.2 Excavation conditions

Excavation for the proposed basement car park will necessitate cuts of 12 m to 18 m to achieve a basement floor level at RL 26.9 for Basement Level 5, and 20.0 m to 23.5 m to achieve a basement floor level at RL 20.9 for Basement Level 6 (oncology). The depth of excavation will increase from about 12.0 m in the north western part of the site up to 23.5 m in the central southern part of Basement Level 6. Within this depth of excavation, a wide range of materials will be encountered (refer Sections A – A` and B – B`, Drawings 2 and 3 in Appendix B) initially comprising fill to depths of up to 1.6 m in the boreholes, overlying residual clays grading into extremely low to medium strength sandstone (equivalent Class V – IV) below depths of 2.1 – 6.0 m. It is noted that medium to high strength 'cap-rock' was initially encountered in Bores 302, 401, 201 and 3 (in the north-western, northern and eastern parts of the site). The weathered sandstone profile is of variably low to high strength and fractured to depths of 2.5 m to 6.8 m (RL 34.1 to RL 40.0 AHD). Medium to high strength (equivalent to Class II/I, respectively) sandstone was retrieved below depths of 8.5 m to 15.0 m (RL 26.8 to RL 35.1 AHD) in Bores 301 – 304 and 401, however, it is noted that faulting at depth may result in local areas with reduced rock strength (eg very low to low strength).

7.5.3 Excavation equipment

The methods used in the drilling of the boreholes provide an indication and guide to the excavatability of the materials to be removed in bulk.

It is expected that initially the excavation could be readily carried out using hydraulic excavators with buckets, possibly with some light ripping in the weathered sandstone to depths of 2.1 m to 6.0 m (RL 35.4 to RL 40.7 AHD). Excavation in the 'fractured zone' to depths of 2.5 m to 6.8 m (RL 34.1 to RL 40.0 AHD) of variably low to high strength sandstone will require ripping and/or rock hammering at reduced production rates. Excavation of 'cap-rock' in the north-western, northern and eastern parts of the site and medium to high strength, slightly fractured and unbroken sandstone below the above-mentioned depths and levels will require heavy rock hammering, rock sawing, rock grinding and/or ripping equipment, probably at low production rates. Percussion methods, possibly in conjunction with rock sawing or grinding equipment would be required for detailed excavation work.

Assessment of excavation difficulties, however, is best determined by intending contractors based on inspection of core samples, consideration of the equipment they have at their disposal and the experience of the operators.

7.5.4 Vibration induced by excavation plant

Vibration and noise associated with rock excavation, particularly the use of rock hammers, may be unacceptable to neighbouring properties, and operating restrictions are likely to be required,

particularly in the cap rock, and slightly fractured and unbroken rock strata below depths of 2.5 m to 6.8 m (RL 34.1 to RL 40.0 AHD) for the basement excavation.

During excavation, it will be necessary to use appropriate methods and equipment to keep ground vibrations at adjacent buildings within acceptable limits. There are three aspects of vibration which will need to be assessed: effects on structures; effects on the architectural finishes; and effects on humans.

From current knowledge of site conditions and proposed works, and subject to the results of building condition surveys and on-site vibration trials (including vibration attenuation rates and dominant vibration frequencies of excavation plant), the standards, guidelines and limits outlined in Appendix F are considered appropriate for management of ground vibration generated by the proposed works.

AS 2670.2:1990 “*Evaluation of human exposure to whole-body vibrations – continuous and shock-induced vibrations in buildings (1 – 80 Hz)*” recommends that a Provisional Allowed Vibration Limit of 8 mm/s peak particle velocity (PPV) be set during working normal working hours, measured at the foundation level of the potentially affected structures. This limit is based on a single phase and only on the vertical component. It is recommended that the above PPV are extended to any directional component and also consider the potential for two component to be in phase, for conservative vibration management. As such, a vector sum peak particle velocity (VSPPV) is proposed as the control parameter. Vibration limits may also need to be modified as the results of building and/or foundation condition surveys. Based on the above guidelines and requirements, a VSPPV of 8 mm/s is recommended for the site, which has been downgraded to a PPVi of 5.7 mm/s, to consider two components in phase.

Douglas maintains a database of vibration trial results (generally VSPPV versus distance) which can guide the selection of excavation plant unlikely to produce frequent vibration exceedances. The database comprises trial data from many sites and the results are dependent on these specific site conditions and equipment used. Hence actual vibration levels on this site may differ from predicted and a specific trial is recommended at the commencement of rock excavation.

The database suggests that the approximate buffer distances given in Table 6 should be maintained between various types of excavation plant and the foundations of the adjacent buildings, to reduce the likelihood of vibrations exceeding the Provisional Allowed Vibration Limit. The buffer distances tabulated correspond with the upper limit of vibration levels measured during trials.

The estimates given in Table 6 should be examined in relation to the distances between adjacent buildings and the proposed excavation footprint to make a preliminary selection of plant.

Table 6: Approximate buffer distances for excavation plant

Provisional Allowed Vibration Limit:	8 mm/sec VSPPV
Likely equivalent maximum peak particle velocity:	5.7 mm/sec PPVi
Excavation Plant	Buffer Distance
Rock Saw on Excavator	1.1 m
Ripper on 20 T Excavator	3.4 m

Rock Hammer < 500 kg operating weight	7.4 m
Rock Hammer 501 – 1000 kg operating weight	7.5 m

It is noted that people may find vibration levels above 3 – 5 mm/sec as being *strongly perceptible* to *disturbing*, even though they may not cause structural damage to structures. Hence, complaints from neighbours are possible and some reassurance, possibly by vibration monitoring, is likely to be necessary. Consequently, the excavation process should include:

- Notification to neighbours of the proposed timing of the excavation so that any vibration sensitive items can be secured.
- Excavation of loose or rippable sandstone blocks by bucket or single tyne attachments before commencement of rock hammering.
- Progressive breakage from open excavated faces.
- Selective breakage along open joints where these are present.
- Use of rock hammers in short bursts to prevent generation of resonant frequencies.
- The movement of large blocks away from the structures before breaking up for transport from the site.
- Start the excavation as far away from other structures as possible and monitor vibration while working towards these buildings.
- The use of rock sawing or grinding equipment adjacent to the site boundaries, noting that this equipment also reduces impact damage, overbreak and loosening of the rock mass, typically resulting in a reduced requirement for rock support measures.

As a geo-environmental consultant, Douglas Partners Pty Ltd has the capabilities to carry out vibration monitoring, if required.

7.5.5 Dust generation

Douglas' experience with similar excavations in the Wollongong area is that dust generation will occur during earthworks and excavation activities, particularly during rock hammering, rock sawing, rock grinding and ripping of high and very high strength sandstone. Accordingly, monitoring of air pollutants (particulates – deposited matter) in accordance with the NSW Department of Environment and Conservation (DEC 2005) Approved Methods should be expected at the site. Dust suppression methods are to be incorporated into the earthworks contractor's construction methodology.

As a geo-environmental consultant, Douglas Partners Pty Ltd has the capabilities to monitor and assess air pollutants, if required.

7.5.6 Disposal of excavated materials

Douglas carried out environmental testing and assessment for the project, which has been provided in a separate report (Project 73522.15.R.001.Rev0) dated 18 October 2025. For comments on the disposal of excavated material, reference is to be made to Douglas' Report on Preliminary Site Investigation referred to above.

7.6 Groundwater

Douglas carried out a preliminary groundwater assessment for the project, which has been provided in a separate report (Project 73522.15.R.002.Rev0) dated 20 October 2025.

Excavation of the sandstone on the site is expected to produce fine particles that easily become suspended in water that collects in on-site detention ponds. Wollongong City Council has a set of criteria for the disposal of excavation pit water into Council's stormwater system. A fact sheet with disposal options and criteria is provided in Appendix F.

7.7 Excavation support

7.7.1 General

Excavation of the proposed basement footprint will be relatively regular in layout and depths with excavation approaching to within 0.5 m to 10 m of the site boundaries. Maximum excavation depths will be in the range 12 m to 23.5 m with the depth increasing in the central and eastern parts of the site where Basement Level 6 (oncology) is located.

Due care will be required when working adjacent to existing structures. As discussed in Section 7.5.1, it is recommended that dilapidation surveys of adjacent properties be undertaken to provide baseline conditions of structures for assessment of possible claims of damage. The risk to adjacent buildings during excavation will depend on the level of the underside of adjacent footings, founding strata and any adverse jointing in the bedrock in the zone of influence below the footings.

7.7.2 Soil profile

Fill, clay soils and extremely weathered rock will not be able to stand vertically without support. Where space permits, temporary and or permanent batters could be used. Suggested maximum batter slopes and heights are summarised in Table 7.

Table 7: Suggested batter slopes

Material	Height (m)	Safe Batter Slope (H:V)	
		Temporary	Permanent
Uncontrolled Fill	<2	1.5:1	3:1
Stiff to Very Stiff Clay and Extremely Low Strength Rock	<2	1:1	2:1
Low Strength Rock	<4	0.5:1	1:1
Medium Strength, Slightly Fractured Rock	<4	Vertical	Vertical

Where excavation depth and proximity to boundaries precludes the construction of safe batters, either temporary shoring or the construction of permanent walls designed to support the boundaries will be necessary.

Unless it can be shown otherwise, it must be assumed that adjacent buildings are constructed on high-level footings. As such, the design of shoring will need to consider lateral loads induced on basement walls due to adjacent structures and or infrastructure (ie roads and services). Where adjacent structures are within the zone of influence of the excavation, it will be necessary to establish the nature and founding levels of the footings of the adjacent buildings to determine underpinning requirements (if any) and to ensure that an appropriate construction methodology is established. In the absence of details of adjacent footings, contiguous piling must be allowed for lateral retention of the excavations adjacent to neighbouring buildings. The zone of influence is the envelope of ground above a plane drawn at 45° (ie 1:1 [H:V]) from the bottom edge of the excavation to the ground surface.

Where retaining wall design includes piles to provide support to adjacent structures, anchoring will probably be required near the surface, as a cantilever system is unlikely to provide sufficient rigidity to avoid excessive lateral surface deflections. To achieve required embedment within the rock, it will be necessary to employ an appropriate high torque piling rig or alternatively, anchors may need to be installed in the toe of each pier to provide support/restraint should they found above the excavation level. Feasible options could include either anchored soldier piles (drilled at maximum 2.4 m spacings) with close shuttering or shotcrete infill panels or contiguous piling. Unsupported lift heights within the soil and extremely low strength rock profile should be limited to 1.5 m. The piles should be installed to at least 1 m below the base of any proposed excavation. Alternatively, if piles terminate above the excavation level, then installation of rock bolts will be required to provide lateral toe support until the internal support structure is complete.

7.7.3 Fractured rock

As a result of predominantly moderately to steeply-inclined jointing within the 'fractured zone', the slightly fractured rock and faulting at the site, there is potential for 'wedge' and 'planar' failures from within the excavation face and allowance will need to be made for support of the fractured sandstone to depths in the order of 5.2 m to 10.5 m (RL 32.0 to RL 40.1 AHD) for the basement excavation. Localised deeper fractured zones may be present, particularly associated with faulting. The support requirements will depend on a number of factors including the extent of disturbance during excavation; orientation, persistence (lateral continuity) and spacing of jointing; clay infilling of open joints; and groundwater. Detailed design and identification of face sections requiring retention can only be undertaken by progressive inspection of the excavation face where soldier piles are used. Therefore, all batters and rock faces are to be subject to assessment of jointing in the rock by an experienced engineering geologist or geotechnical engineer at maximum 1.5 m depth intervals. If adverse jointing is present in the rock, then stabilisation with rock-bolting may be required.

It is suggested that the preliminary design should allow for the application of a steel mesh-reinforced shotcrete layer with a minimum nominal thickness of 150 mm where permanent support is required or 100 mm for temporary support. The installation of mesh and a pattern of rock bolts of nominal 1.5 m spacing (vertically and horizontally) will also be likely requirements in 'fractured zone'. While the required bolt lengths can only be determined following an assessment of fracture characteristics; it is suggested that preliminary design is based on 24 mm diameter rock bolts with a minimum length of 2.4 m. Drainage behind all permanent linings will be required to ensure long-term dissipation of groundwater pressures and could include vertical strip drains at 2 m horizontal spacings.

7.7.4 Fresh rock

The high strength, massive sandstone that will be exposed in the lower part of the excavation, below the 'fractured zone', would normally be stable in vertical faces provided adverse jointing is not present within the excavation faces and disturbance during excavation is minimal. To fully assess the rock mass characteristics, the potential variability of rock defects and support requirements, inspection of excavations should be made by an experienced engineering geologist or geotechnical engineer during the course of bulk excavation work, at maximum 2 m depth intervals.

7.7.5 Batter deterioration

Where sandstone batters and rock faces are exposed to air and moisture, including being open to the weather or exposed to groundwater seepage, leaking pipes, etc., ongoing fretting of the rock face (ie falling apart) should be expected. Deterioration of the rock is unacceptable in rock faces that are adjacent to and below foundations (ie within the zone of influence of foundations, refer Section 7.7.2), and as such a minimum thickness of 80 mm of shotcrete should be applied to such faces. A shotcrete cover is also recommended where minimal maintenance is proposed or required. Alternatively, the remaining rock faces (subject to support requirements), could be left exposed provided ongoing maintenance, such as cleaning of debris blocking drains and repairs to walls, is accepted by the end client.

7.8 Anchors

The anchoring of soldier or contiguous piles may be accomplished by pre-stressed anchors. It is suggested that these be inclined as steeply as possible, but not exceeding 30°, to allow anchoring in the stronger rock. Design of anchors for temporary excavation support may be carried out using the maximum ultimate bond stresses given in Table 8. Where anchor inclination is increased to provide better rock bond conditions, the anchor load must also be increased to account for diminishing horizontal component of support.

Table 8: Suggested ultimate bond stress for temporary anchor design

Material	Maximum Ultimate Average Bond Stress ^(1,2) (τ_{ult} , kPa)
Equivalent Class IV Sandstone [†]	300
Equivalent Class III Sandstone [†]	1000
Equivalent Class I Sandstone [†]	2000

Notes: (1) Values are for straight shaft boreholes.
 (2) Ultimate values with no reduction factor.

Anchors should be designed to have a free length equal to their height above the base of the 'fractured zone' or a minimum free length of 3 m, whichever is greater. After installation anchors should be proof loaded to 125% of the design working load for temporary anchors and locked off at 60% to 80% of the working load for active pressure conditions and 100% of the working load for 'at rest' pressure conditions. Testing should be undertaken to ensure that the load is maintained in the anchor throughout the construction period and is not lost.

In normal circumstances, the building would be designed to retain the basement excavation over the long-term and therefore ground anchors would be temporary only. While specific corrosion protection is not required for temporary anchors, Douglas recommends providing a relatively inexpensive corrosion protection by coating strands with epoxy or grease and then sheathing the strand, to provide some insurance if building activities are suspended.

The use of permanent anchors will require specific design advice, careful attention to corrosion protection and permission from adjacent landholders. Further advice should be sought from Douglas if permanent anchors are to be employed at the site.

The parameters given in Table 8 can only be safely adopted on the condition that anchor holes are cleaned and thoroughly flushed, with grouting and other installation procedures carried out in accordance with normal good anchoring practice.

Inspection during anchor construction by a geotechnical consultant is recommended to provide validation of the socket material and site conditions encountered are consistent with the anchor design.

7.9 Retaining structures

Earth pressures acting on multi-anchored shoring structures and retaining walls of height H can be estimated by a trapezoidal pressure distribution consisting of a triangular pressure distribution from 0 to $0.2H$ and a rectangular pressure distribution from $0.2H$ to H (as measured from the top of the shoring). The maximum pressure of these distributions should be $4.8H$ for walls which can be allowed to move slightly, or $6H$ where adjacent structures are movement sensitive, where H is the depth of the excavation. Detailed design of walls with multiple rows of anchors using a computer program to model soil-structure interactions such as WALLAP, FLAC or PLAXIS, may be required to refine the preliminary design.

Earth pressures acting on gravity walls, walls supported with single anchors or cantilever walls can be estimated by a triangular pressure distribution with depth using appropriate values of unit weight and active (K_a) or 'at rest' (K_o) earth pressure coefficients as set out in Table 9.

Table 9: Suggested design parameters – retaining structures

Retained Material	Bulk Unit Weight (kN/m ³)	$K_o^{(1)}$	$K_p^{(1)}$	$K_a^{(1)}$	
				Short Term	Long Term
Uncontrolled Fill	20	0.58	2.0	0.30	0.4
Stiff to Hard Clay	21	0.46	2.0	0.25	0.3
Equivalent Class IV Sandstone ⁽²⁾	24	0.33	400 kPa	0.15	0.2
Equivalent Class III Sandstone ⁽²⁾	24	0.18	4000 kPa	10 kPa ⁽³⁾	10 kPa ⁽³⁾
Equivalent Class I Sandstone ⁽²⁾	25	0	6000 kPa	10 kPa ⁽³⁾	10 kPa ⁽³⁾

Notes: (1) Ultimate values with no reduction factor.

(2) Subject to inspection during the early stages of excavation to confirm the absence of adversely oriented bedding/jointing

- (3) To account for wedges.

'At rest' pressure coefficients are appropriate where support must be provided to boundaries and where movement-intolerant structures or services (eg in the adjacent footpath or road reserve) are present.

Unless positive drainage measures, such as strip drains, can be incorporated to prevent water pressure build-up behind the shoring walls (ie for a drained basement), full hydrostatic head should be allowed for in design while, at the same time, allowing for the soil unit weight to reduce to the buoyant condition. Surcharge pressures from adjacent structures, construction machinery and traffic should also be incorporated into the design of the walls as necessary.

The design of temporary and permanent support will also need to consider the possibility that 45 degree joints in the rock will daylight near the base of the shoring wall leading to wedges of rock which need to be supported by the temporary and permanent retaining structures. The support system would typically comprise rock bolts or ground anchors spaced at regular intervals over the rock face, preferably through the shoring piles.

7.10 Footings

Based on the results of the investigation and proposed basement floor levels, founding materials exposed at design excavation levels are typically expected to comprise medium to high strength sandstone (Class III – I Sandstone, refer Drawings 2 and 3). It is noted that Class IV – V material should also be expected in the vicinity of faulting (refer GEE Bore 2 where Class IV material extended to a depth of 18.2 m [RL 25.8]).

Based on the anticipated design loads, it is expected that footings could comprise pad footings within at least equivalent Class III Sandstone exposed in the floor of the basement excavation. Deep pads (ie additional excavation) will be required where equivalent Class IV Sandstone and faulting is encountered in the floor of the basement excavation to ensure uniform founding on at least Class III. Design bearing pressures, based on the recommendations of Pells et al (Pells, Mostyn, & Walker, 1998) are given in Table 10.

Table 10: Suggested design parameters – foundations

Material	Ultimate Bearing Pressure (kPa)		Allowable Bearing Pressure (kPa)	
	Base ³	Shaft ^{5,6}	Base ⁴	Shaft ^{5,6}
Equivalent Class III Sandstone ¹	15,000	800	3500	350
Equivalent Class I Sandstone ²	120,000	3000	12,000	1200

- Notes:
- 1 = No additional requirements for spoon-testing or coring drilling.
 - 2 = Inspection of all footings with spoon-testing (or coring drilling) required of at least 30% of footings.
 - 3 = Ultimate values occur at large settlements (>5% of minimum footing dimension).
 - 4 = End bearing pressure to cause settlement <1% of minimum footing dimension.
 - 5 = Shaft adhesion applicable to the design of bored piers, uncased over rock socket length, where adequate sidewall cleanliness and roughness are achieved (ie clean socket of roughness category R2 or better).
 - 6 = Where uplift loads are to be accommodated, the design should be based on half the shaft adhesion values given, which are for compression only.

Allowance should be made for bearing pressure reduction where footings are located within the zone of influence of the excavations including adjacent to the Level 6 basement for Oncology, as well as for local excavations for services, tanks and lift wells. As a guide, footings with one side facing an excavation in a defect-free rock mass should have their bearing capacity reduced by 25% and footings with two sides facing an excavation should have their bearing pressure reduced by 50%. Additional requirements, such as rock bolting, may be required where adverse jointing is exposed beneath proposed footings. These requirements can only be determined following a detailed inspection of the excavation by an experienced engineering geologist or geotechnical engineer. The pull-out resistance of the rock mass for assessment of the uplift capacity of piles must consider adjacent excavations (ie for a reduce failure envelope). The zone of influence is the envelope of ground above a plane drawn at 45° (ie 1:1 [H:V]) from the bottom edge of the excavation to the ground surface. Furthermore, detailed inspection of rock faces adjacent to foundations must be undertaken by an experienced engineering geologist or geotechnical engineer to assess the stability of the face and provide remedial options (if required). Alternatively, local deepening or the inclusion of piles will most likely be required.

Based on the results of previous and current investigations undertaken, individual risk ratings (IRR) in Table 11 can be adopted in order to determine an average risk rating (ARR) and hence a basic geotechnical strength reduction factor (ϕ_{gb}) for pile design in accordance with Section 4.3.2 of AS 2159:2009.

Table 11: Individual risk ratings

Risk Factor		Individual Risk Rating
Site	Geological complexity of the site	3
	Extent of ground investigation	3
	Amount and quality of geotechnical data	3
Design	Experience with similar foundations in similar geological conditions	2
	Method of assessment of geotechnical parameters for design	4

Earthquake Hazard Maps published by the Australian Geological Survey Organisation are reproduced in AS 1170.4:2007 Structural Design Actions Part 4: Earthquake actions in Australia. The anticipated peak ground acceleration or acceleration coefficient for the Wollongong area is quoted as 0.09. Following excavation at the site, the site is classified as Class B_e – rock site sub-soil in accordance with AS 1170.4:2007.

A high torque piling rig capable of drilling in medium to high strength sandstone will be required for the site conditions encountered. Water ingress should be expected within pile excavations and accordingly allowance made for the inclusion of liners or CFA piles. Piling contractors should have appropriate cleaning buckets.

Inspection during construction of foundations and piles for shoring structures by a geotechnical consultant is recommended to provide validation of the bearing pressures and site conditions encountered are consistent with the design.

7.11 Basement ground slabs

The basement floor slabs can be designed as slabs-on-ground supported by the rock that is likely to be exposed at the excavated surface. Under these circumstances, floor slab design could be based on a subgrade CBR of 6% for rock with sub-floor drainage provided. Articulation and control jointing should be provided to allow for differential movements. The slabs should also be cast independently of the footings to allow for differential movement.

7.12 Mobile cranes

Due to the extent of the basement excavation footprint, it would be prudent to consider mobile crane requirements during the design for the development (ie the potential location of outrigger pads, the lift radius and load). Outriggers must not be located in the zone of influence for the excavation unless the retaining structure (temporary or permanent) has been designed to support these loads. As such, it may be necessary to design retaining structures to accommodate mobile crane loads or to install piles for outriggers to transfer loads to below the zone of influence of walls and excavations.

It is recommended that a geotechnical assessment is undertaken for all mobile crane lifts.

8. Geotechnical requirement for additional borehole investigation

To confirm the rock quality assumptions and the subsurface profile/s for Basement Levels 5 and 6, additional deep cored boreholes will be required at the site. Borehole depths should be targeted considering the proposed footing dimensions, founding depths, the depth of influence of the footing on the subsurface profile and any local excavations such as lift pits, sumps, etc.

Following the completion of additional deep cored boreholes, the geotechnical model adopted in this report, the design parameters and advice must be reviewed and confirmed by Douglas.

9. Geotechnical review

It is recommended that a geotechnical review of the design drawings be undertaken to ensure that the geotechnical requirements of this report have been incorporated in the design.

10. Geotechnical requirements during construction

Geotechnical and environmental aspects that are discussed in this report and which will require input during construction are summarised below:

- Vibration monitoring during excavation including foundation construction.
- Inspection during pile construction for excavation support/shoring by a geotechnical consultant to provide validation that the founding conditions are consistent with the design.
- Inspection of excavations to be made by an experienced engineering geologist or geotechnical engineer during the course of bulk excavation work at maximum excavation depth intervals of 1.5 m in the soil profile and 2 m within the underlying bedrock.

- Inspection during anchor construction by a geotechnical consultant to provide validation that the shaft conditions are consistent with the design bond stress.
- Inspections during foundation construction by a geotechnical consultant to provide validation that the bearing pressures and site conditions encountered are consistent with the foundation design. Spoon testing or coring may also be required should high bearing pressures be required (i.e. Class I Sandstone).
- Working platform assessments for mobile crane lifts.

Notwithstanding the above-mentioned items, the client and the building contractor should also be aware of any conditions in the development consent that require professional input during design and construction.

11. References

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Stone, Y., Ahern, C. R., & Blunden, B. (1998). *Acid Sulfate Soil Manual*. Acid Sulfate Soil Management Committee (ASSMAC).

12. Limitations

Douglas Partners Pty Ltd (Douglas) has prepared this report for this project at 366 – 368 Crown Street and 15 – 23 Urunga Parade, Wollongong in line with Douglas' email proposal dated 8 August 2025 and acceptance received from Mr Marcelo Ramirez on behalf of AA Crown Holdings Pty Ltd dated 29 September 2025. The work was carried out under Douglas' Engagement Terms. This report is provided for the exclusive use of AA Crown Holdings Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or be relied upon for other projects or purposes on the same or another site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of Douglas, does so entirely at its own risk and without recourse to Douglas for any loss or damage. In preparing this report Douglas has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the subsurface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and as a result of human influences. Such changes may occur after Douglas' field testing has been completed.

Douglas' advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by Douglas in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. Douglas cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by Douglas. This is because this report has been written as advice and opinion rather than instructions for construction.

Appendix A

About this Report

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

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

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole 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. They may not be the same at

the time of construction as are indicated in the report; and

- 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 first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or 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 a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

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

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

continued next page

About this Report

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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, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report 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. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

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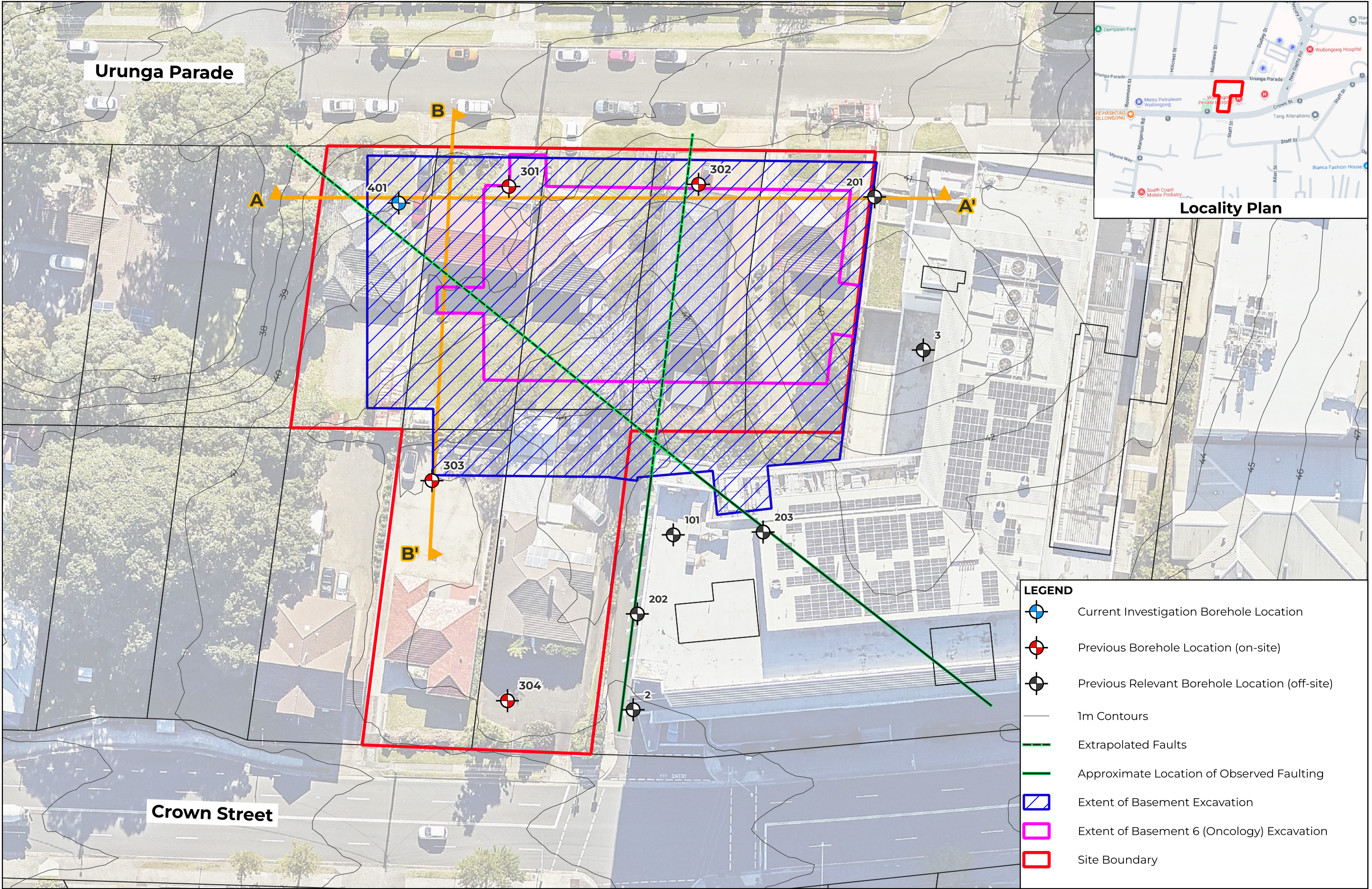
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Appendix B

Drawings 1 – 3

Figure 1



- LEGEND**
- Current Investigation Borehole Location
 - Previous Borehole Location (on-site)
 - Previous Relevant Borehole Location (off-site)
 - 1m Contours
 - Extrapolated Faults
 - Approximate Location of Observed Faulting
 - Extent of Basement Excavation
 - Extent of Basement 6 (Oncology) Excavation
 - Site Boundary

REV	DESCRIPTION/COMMENT	DATE	DRAWN BY
0	Borehole Location Plan	07.10.2025	ZAK

05102530m

1:500 @ A3

N

Douglas
PARTNERS
OFFICE: Wollongong
1 Luso Drive, Unanderra NSW
(02) 4271 1836

CLIENT:
AA Crown Holdings Pty Ltd

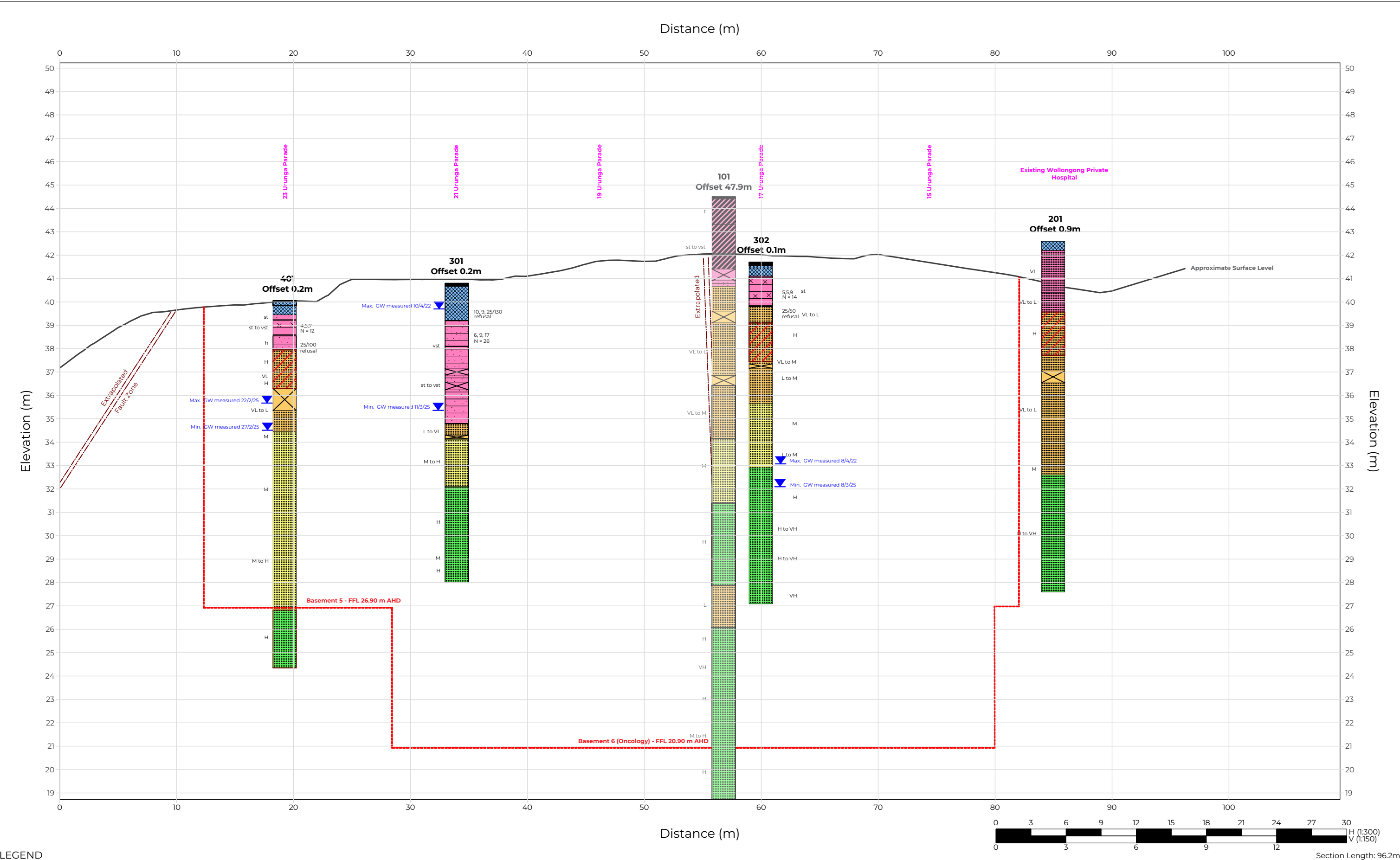
NOTE:
1: Basemap from Metromap.com (Dated 7.10.2025)

COORDINATE REFERENCE SYSTEM: GDA2020, MGA ZONE 56

PROJECT NAME:
Wollongong Private
Hospital Expansion
PROJECT ADDRESS:
366-368 Crown Street & 15-23
Urunga Parade, Wollongong

DRAWING TITLE:
Borehole Location Plan

PROJECT NO: 73522.14
DRAWING NO: 1
REVISION: 0



LEGEND

- ASPHALT / CONCRETE
- CORE LOSS
- Sandy CLAY
- Silty CLAY
- CORE LOSS
- FILL
- SOIL
- SANDSTONE
- Ground Surface
- Water Level
- Class V-IV* Sandstone
- Class III-II* Sandstone
- Class I* Sandstone
- 'Cap Rock'

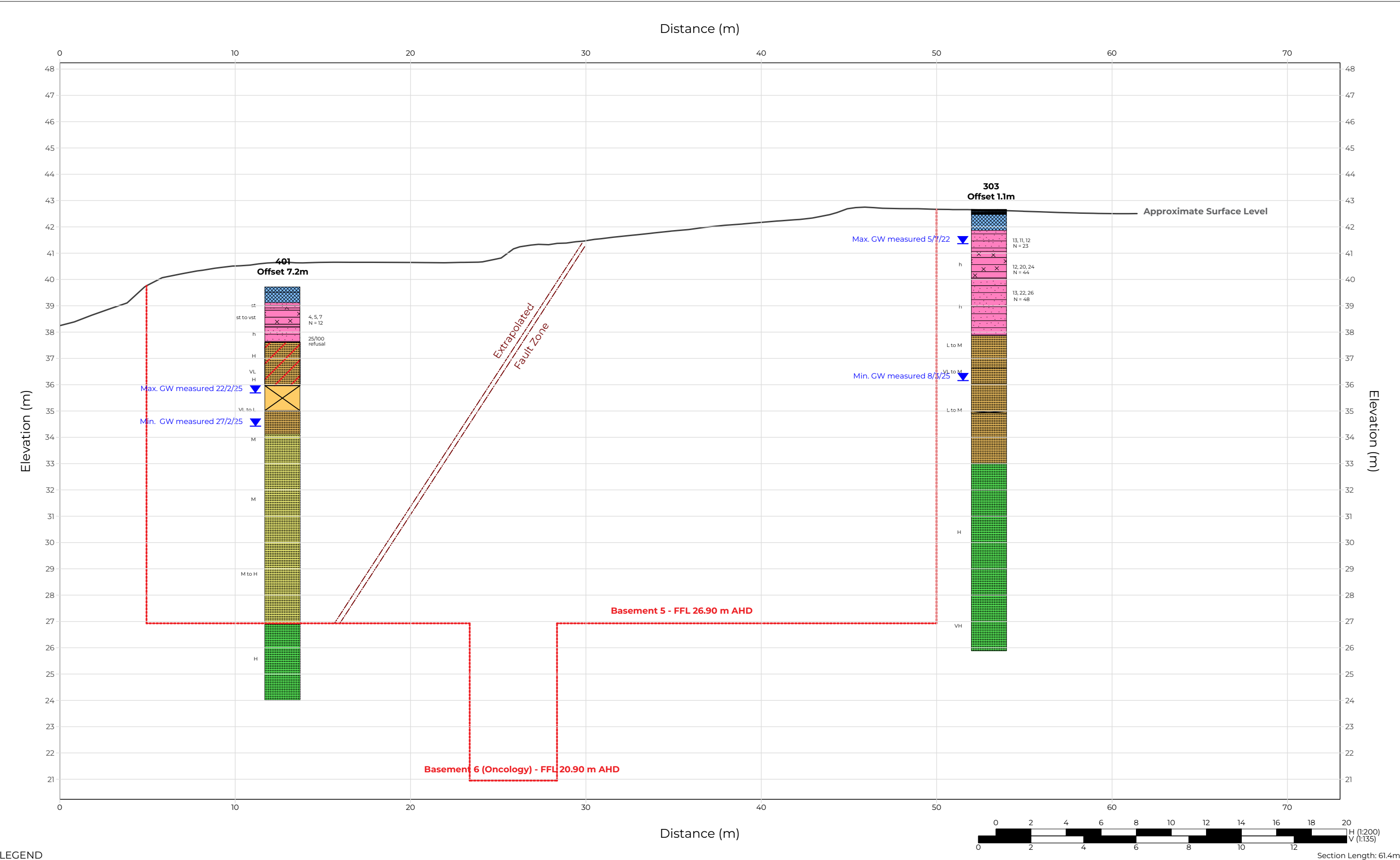
Rock Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High

Soil Consistency
vs - very soft
s - soft
f - firm
st - stiff
vst - very stiff
h - hard
vl - very loose
l - loose
md - medium dense
d - dense
vd - very dense



TITLE: Cross Section A - A' Wollongong Private Hospital Expansion 366 - 368 Crown Street & 15 - 23 Urunga Parade, Wollongong NSW			DRAWN: ZAK	DATE: 7-10-25
CHECKED: RJH			DATE: 7-10-25	
SCALE: H 1:300 V 1:150			A3	
PROJECT No: 73522.14			FIGURE No: D.002	

Section Length: 96.2m



ASPHALT/CONCRETE

CORE LOSS

SANDY CLAY

SILTY CLAY

CORE LOSS

FILL

SOIL

SANDSTONE

Ground Surface

Water Level

Class V-IV* Sandstone

Class III-II* Sandstone

Class I* Sandstone

Cap Rock

Rock Strength

VL - Very Low

L - Low

M - Medium

H - High

VH - Very High

Soil Consistency

vs - very soft

s - soft

f - firm

st - stiff

vst - very stiff

h - hard

vl - very loose

l - loose

md - medium dense

d - dense

vd - very dense

Douglas
PARTNERS

TITLE:

Cross Section B - B'

Wollongong Private Hospital
Expansion

366 - 368 Crown Street & 15 - 23 Urunga
Parade, Wollongong NSW

DRAWN:
ZAK

CHECKED:
RJH

SCALE:
H 1:200 V 1:135

PROJECT No:
73522.14

DATE:
7-10-25

DATE:
7-10-25

A3

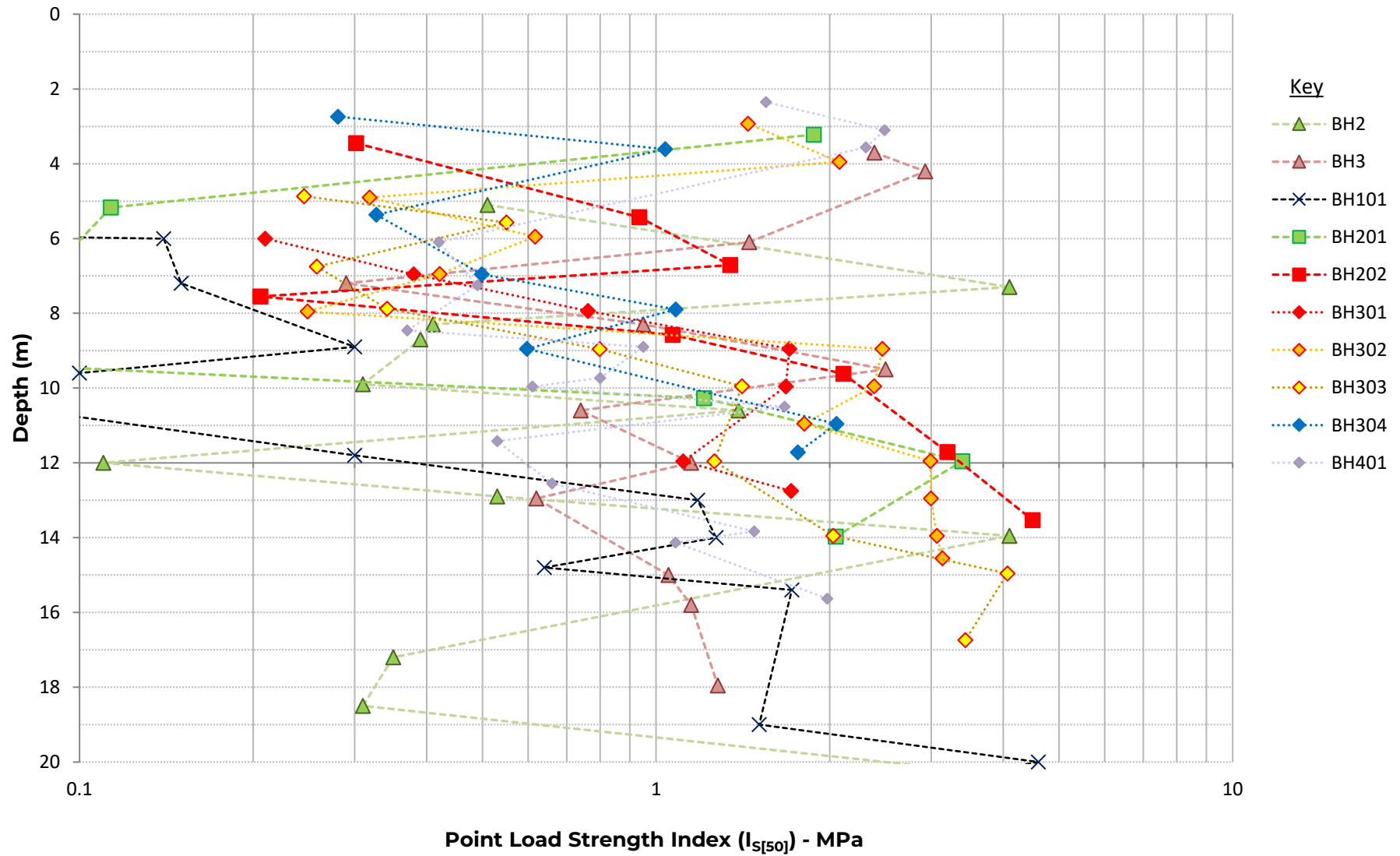
FIGURE No:
D.003

Section Length: 61.4m

0 2 4 6 8 10 12 14 16 18 20

H (1:200)
V (1:135)

Figure 1: Point Load Strength vs Depth



Appendix C

Notes on Terminology, Soil and Rock Descriptions

Results of Previous Field Work

Photo Plates 1 – 4 (Photographs 1 – 16)

Introduction to Terminology, Symbols and Abbreviations

Douglas Partners' reports, investigation logs, and other correspondence may use terminology which has quantitative or qualitative connotations. To remove ambiguity or uncertainty surrounding the use of such terms, the following sets of notes pages may be attached Douglas Partners' reports, depending on the work performed and conditions encountered:

- □ Soil Descriptions;
- □ Rock Descriptions; and
- □ Sampling, insitu testing, and drilling methodologies

In addition to these pages, the following notes generally apply to most documents.

Abbreviation Codes

Site conditions may also be presented in a number of different formats, such as investigation logs, field mapping, or as a written summary. In some of these formats textual or symbolic terminology may be presented using textual abbreviation codes or graphic symbols, and, where commonly used, these are listed alongside the terminology definition. For ease of identification in these note pages, textual codes are presented in these notes in the following style **XW**. Code usage conforms with the following guidelines:

- □ Textual codes are case insensitive, although herein they are generally presented in upper case; and
- □ Textual codes are contextual (i.e. the same or similar combinations of characters may be used in different contexts with different meanings (for example `PL` is used for plastic limit in the context of soil moisture condition, as well as in `PL(A)` for point load test result in the testing results column)).

Data Integrity Codes

Subsurface investigation data recorded by Douglas Partners is generally managed in a highly structured database environment, where records "span" between a top and bottom depth interval. Depth interval "gaps" between records are considered to introduce ambiguity, and, where appropriate, our practice guidelines may require contiguous data sets. Recording meaningful data is not always appropriate (for example assigning a "strength" to a concrete pavement) and the following codes may be used to maintain contiguity in such circumstances.

Term	Description	Abbreviation Code
Core loss	No core recovery	KL
Unknown	Information was not available to allow classification of the property. For example, when auguring in loose, saturated sand auger cuttings may not be returned.	UK
No data	Information required to allow classification of the property was not available. For example if drilling is commenced from the base of a hole predrilled by others	ND
Not Applicable	Derivation of the properties not appropriate or beyond the scope of the investigation. For example providing a description of the strength of a concrete pavement	NA

Graphic Symbols

Douglas Partners' logs contain a "graphic" column which provides a pictorial representation of the basic composition of the material. The symbols used are directly representing the material name stated in the adjacent "Description of Strata" column, and as such no specific graphic symbology legend has been provided in these notes.

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Introduction

All materials which are not considered to be “in-situ rock” are described in general accordance with the soil description model of AS 1726-2017 Part 6.1.3, and can be broken down into the following description structure:



The “classification” comprises a two character “group symbol” providing a general summary of dominant soil characteristics. The “name” summarises the particle sizes within the soil which most influence its behaviour. The detailed description presents more information about composition, condition, structure, and origin of the soil.

Classification, naming and description of soils require the relative proportion of particles of different sizes within the whole soil mixture to be considered.

Particle size designation and Behaviour Model

Solid particles within a soil are differentiated on the basis of size.

The engineering behaviour properties of a soil can subsequently be modelled to be either “fine grained” (also known as “cohesive” behaviour) or “coarse grained” (“non cohesive” behaviour), depending on the relative proportion of fine or coarse fractions in the soil mixture.

Particle Size Designation	Particle Size (mm)	Behaviour Model	
		Behaviour	Approximate Dry Mass
Boulder	>200	Excluded from particle behaviour model as “oversize”	
Cobble	63 - 200		
Gravel ¹	2.36 - 63	Coarse	>65%
Sand ¹	0.075 - 2.36		
Silt	0.002 - 0.075	Fine	>35%
Clay	<0.002		

¹ – refer grain size subdivision descriptions below

The behaviour model boundaries defined above are not precise, and the material behaviour should be assumed from the name given to the material (which considers the particle fraction which dominates the behaviour, refer “component proportions” below), rather than strict observance of the proportions of particle sizes. For example, if a material is named a “Sandy CLAY”, this is indicative that the material exhibits fine grained behaviour, even if the dry mass of coarse grained material may exceed 65%.

Component proportions

The relative proportion of the dry mass of each particle size fraction is assessed to be a “primary”, “secondary”, or “minor” component of the soil mixture, depending on its influence over the soil behaviour.

Component Proportion Designation	Definition ¹	Relative Proportion	
		In Fine Grained Soil	In Coarse Grained Soil
Primary	The component (particle size designation, refer above) which dominates the engineering behaviour of the soil	The clay/silt component with the greater proportion	The sand/gravel component with the greater proportion
Secondary	Any component which is not the primary, but is significant to the engineering properties of the soil	Any component with greater than 30% proportion	Any granular component with greater than 30%; or Any fine component with greater than 12%
Minor ²	Present in the soil, but not significant to its engineering properties	All other components	All other components

¹ As defined in AS1726-2017 6.1.4.4

² In the detailed material description, minor components are split into two further sub-categories. Refer “identification of minor components” below.

Composite Materials

In certain situations, a lithology description may describe more than one material, for example, collectively describing a layer of interbedded sand and clay. In such a scenario, the two materials would be described independently, with the names preceded or followed by a statement describing the arrangement by which the materials co-exist. For example, “INTERBEDDED Silty CLAY AND SAND”.



Classification

The soil classification comprises a two character group symbol. The first character identifies the primary component. The second character identifies either the grading or presence of fines in a coarse grained soil, or the plasticity in a fine grained soil. Refer AS1726-2017 6.1.6 for further clarification.

Soil Name

For most soils, the name is derived with the primary component included as the noun (in upper case), preceded by any secondary components stated in an adjective form. In this way, the soil name also describes the general composition and indicates the dominant behaviour of the material.

Component ¹	Prominence in Soil Name
Primary	Noun (eg "CLAY")
Secondary	Adjective modifier (eg "Sandy")
Minor	No influence

¹ – for determination of component proportions, refer component proportions on previous page

For materials which cannot be disaggregated, or which are not comprised of rock or mineral fragments, the names "ORGANIC MATTER" or "ARTIFICIAL MATERIAL" may be used, in accordance with AS1726-2017 Table 14.

Commercial or colloquial names are not used for the soil name where a component derived name is possible (for example "Gravelly SAND" rather than "CRACKER DUST").

Materials of "fill" or "topsoil" origin are generally assigned a name derived from the primary/secondary component (where appropriate). In log descriptions this is preceded by uppercase "FILL" or "TOPSOIL". Origin uncertainty is indicated in the description by the characters (?), with the degree of uncertainty described (using the terms "probably" or "possibly" in the origin column, or at the end of the description).

Identification of minor components

Minor components are identified in the soil description immediately following the soil name. The minor component fraction is usually preceded with a term indicating the relative proportion of the component.

Minor Component Proportion Term	Relative Proportion	
	In Fine Grained Soil	In Coarse Grained Soil
With	All fractions: 15-30%	Clay/silt: 5-12% sand/gravel: 15-30%
Trace	All fractions: 0-15%	Clay/silt: 0-5% sand/gravel: 0-15%

The terms "with" and "trace" generally apply only to gravel or fine particle fractions. Where cobbles/boulders are encountered in minor proportions (generally less than about 12%) the term "occasional" may be used. This term describes the sporadic distribution of the material within the confines of the investigation excavation only, and there may be considerable variation in proportion over a wider area which is difficult to factually characterise due to the relative size of the particles and the investigation methods.

Soil Composition

Plasticity

Descriptive Term	Laboratory liquid limit range	
	Silt	Clay
Non-plastic materials	Not applicable	Not applicable
Low plasticity	≤50	≤35
Medium plasticity	Not applicable	>35 and ≤50
High plasticity	>50	>50

Note, Plasticity descriptions generally describe the plasticity behaviour of the whole of the fine grained soil, not individual fine grained fractions.

Grain Size

Type	Particle size (mm)	
	Gravel	Sand
Gravel	Coarse	19 - 63
	Medium	6.7 - 19
	Fine	2.36 - 6.7
Sand	Coarse	0.6 - 2.36
	Medium	0.21 - 0.6
	Fine	0.075 - 0.21

Grading

Grading Term	Particle size (mm)
Well	A good representation of all particle sizes
Poorly	An excess or deficiency of particular sizes within the specified range
Uniformly	Essentially of one size
Gap	A deficiency of a particular size or size range within the total range

Note, AS1726-2017 provides terminology for additional attributes not listed here.



Soil Condition

Moisture

The moisture condition of soils is assessed relative to the plastic limit for fine grained soils, while for coarse grained soils it is assessed based on the appearance and feel of the material. The moisture condition of a material is considered to be independent of stratigraphy (although commonly these are related), and this data is presented in its own column on logs.

Applicability	Term	Tactile Assessment	Abbreviation code
Fine	Dry of plastic limit	Hard and friable or powdery	w<PL
	Near plastic limit	Can be moulded	w=PL
	Wet of plastic limit	Water residue remains on hands when handling	w>PL
	Near liquid limit	"oozes" when agitated	w=LL
	Wet of liquid limit	"oozes"	w>LL
Coarse	Dry	Non-cohesive and free running	D
	Moist	Feels cool, darkened in colour, particles may stick together	M
	Wet	Feels cool, darkened in colour, particles may stick together, free water forms when handling	W

The abbreviation code **NDF**, meaning "not-assessable due to drilling fluid use" may also be used.

Note, observations relating to free ground water or drilling fluids are provided independent of soil moisture condition.

Consistency/Density/Compaction/Cementation/Extremely Weathered Material

These concepts give an indication of how the material may respond to applied forces (when considered in conjunction with other attributes of the soil). This behaviour can vary independent of the composition of the material, and on logs these are described in an independent column and are generally mutually exclusive (i.e it is inappropriate to describe both consistency and compaction at the same time). The method by which the behaviour is described depends on the behaviour model and other characteristics of the soil as follows:

- In fine grained soils, the "consistency" describes the ease with which the soil can be remoulded, and is generally correlated against the materials undrained shear strength;
- In granular materials, the relative density describes how tightly packed the particles are, and is generally correlated against the density index;
- In anthropogenically modified materials, the compaction of the material is described qualitatively;
- In cemented soils (both natural and anthropogenic), the cemented "strength" is described qualitatively, relative to the difficulty with which the material is disaggregated; and
- In soils of extremely weathered material origin, the engineering behaviour may be governed by relic rock features, and expected behaviour needs to be assessed based the overall material description.

Quantitative engineering performance of these materials may be determined by laboratory testing or estimated by correlated field tests (for example penetration or shear vane testing). In some cases, performance may be assessed by tactile or other subjective methods, in which case investigation logs will show the estimated value enclosed in round brackets, for example (VS).

Consistency (fine grained soils)

Consistency Term	Tactile Assessment	Undrained Shear Strength (kPa)	Abbreviation Code
Very soft	Extrudes between fingers when squeezed	<12	VS
Soft	Mouldable with light finger pressure	>12 - ≤25	S
Firm	Mouldable with strong finger pressure	>25 - ≤50	F
Stiff	Cannot be moulded by fingers	>50 - ≤100	St
Very stiff	Indented by thumbnail	>100 - ≤200	VSt
Hard	Indented by thumbnail with difficulty	>200	H
Friable	Easily crumbled or broken into small pieces by hand	-	Fr

Relative Density (coarse grained soils)

Relative Density Term	Density Index	Abbreviation Code
Very loose	<15	VL
Loose	>15 - ≤35	L
Medium dense	>35 - ≤65	MD
Dense	>65 - ≤85	D
Very dense	>85	VD

Note, tactile assessment of relative density is difficult, and generally requires penetration testing, hence a tactile assessment guide is not provided □

Soil Descriptions

Terminology
Symbols
Abbreviations

□

Compaction (anthropogenically modified soil)

Compaction Term	Abbreviation Code
Well compacted	WC
Poorly compacted	PC
Moderately compacted	MC
Variably compacted	VC

Cementation (natural and anthropogenic)

Cementation Term	Abbreviation Code
Moderately cemented	MOD
Weakly cemented	WEK

Extremely Weathered Material

AS1726-2017 considers weathered material to be soil if the unconfined compressive strength is less than 0.6 MPa (i.e. less than very low strength rock). These materials may be identified as “extremely weathered material” in reports and by the abbreviation code **XWM** on log sheets. This identification is not correlated to any specific qualitative or quantitative behaviour, and the engineering properties of this material must therefore be assessed according to engineering principles with reference to any relic rock structure, fabric, or texture described in the description.

Soil Origin

Term	Description	Abbreviation Code
Residual	Derived from in-situ weathering of the underlying rock	RS
Extremely weathered material	Formed from in-situ weathering of geological formations. Has strength of less than ‘very low’ as per as1726 but retains the structure or fabric of the parent rock.	XWM
Alluvial	Deposited by streams and rivers	ALV
Fluvial	Deposited by channel fill and overbank (natural levee, crevasse splay or flood basin)	FLV
Estuarine	Deposited in coastal estuaries	EST
Marine	Deposited in a marine environment	MAR
Lacustrine	Deposited in freshwater lakes	LAC
Aeolian	Carried and deposited by wind	AEO
Colluvial	Soil and rock debris transported down slopes by gravity	COL
Slopewash	Thin layers of soil and rock debris gradually and slowly deposited by gravity and possibly water	SW
Topsoil	Mantle of surface soil, often with high levels of organic material	TOP
Fill	Any material which has been moved by man	FILL
Littoral	Deposited on the lake or seashore	LIT
Unidentifiable	Not able to be identified	UID

Cobbles and Boulders

The presence of particles considered to be “oversize” may be described using one of the following strategies:

- Oversize encountered in a minor proportion (when considered relative to the wider area) are noted in the soil description; or
- Where a significant proportion of oversize is encountered, the cobbles/boulders are described independent of the soil description, in a similar manner to composite soils (described above) but qualified with “MIXTURE OF”.

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Rock Strength

Rock strength is defined by the unconfined compressive strength, and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $I_{s(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

Strength Term	Unconfined Compressive Strength (MPa)	Point Load Index ¹ $I_{s(50)}$ MPa	Abbreviation Code
Very low	0.6 - 2	0.03 - 0.1	VL
Low	2 - 6	0.1 - 0.3	L
Medium	6 - 20	0.3 - 1.0	M
High	20 - 60	1 - 3	H
Very high	60 - 200	3 - 10	VH
Extremely high	>200	>10	EH

¹ Rock strength classification is based on UCS. The UCS to $I_{s(50)}$ ratio varies significantly for different rock types and specific ratios may be required for each site. The point load Index ranges shown above are as suggested in AS1726 and should not be relied upon without supporting evidence.

The following abbreviation codes are used for soil layers or seams of material “within rock” but for which the equivalent UCS strength is less than 0.6 MPa.

Scenario	Abbreviation Code
The material encountered has an equivalent UCS strength of less than 0.6 MPa, and therefore is considered to be soil (as per Note 1 of Table 20 of AS 1726-2017). The properties of the material encountered over this interval are described in the “Description of Strata” and soil properties columns.	SOIL
The material encountered has an equivalent UCS strength of less than 0.6 MPa, and therefore is considered to be soil (as per Note 1 of Table 20 of AS 1726-2017). The prominence of the material is such that it can be considered to be a seam (as defined in Table 22 of AS1726-2017) and the properties of the material are described in the defect column.	SEAM

Degree of Weathering

The degree of weathering of rock is classified as follows:

Weathering Term	Description	Abbreviation Code
Residual Soil ¹	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.	RS
Extremely weathered ¹	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	XW
Highly weathered	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.	HW
Moderately weathered	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.	MW
Slightly weathered	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.	SW
Fresh	No signs of decomposition or staining.	FR
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	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 weathered products in pores.	DW

¹ The parent rock type, of which the residual/extremely weathered material is a derivative, will be stated in the description (where discernible).



Degree of Alteration

The degree of alteration of the rock material (physical or chemical changes caused by hot gasses or liquids at depth) is classified as follows:

Term	Description	Abbreviation Code
Extremely altered	Material is altered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.	XA
Highly altered	The whole of the rock material is discoloured, usually by staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is changed by alteration. Some primary minerals are altered to clay minerals. Porosity may be increased by leaching or may be decreased due to precipitation of secondary materials in pores.	HA
Moderately altered	The whole of the rock material is discoloured, usually by 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.	MA
Slightly altered	Rock is slightly discoloured but shows little or no change of strength from fresh rock	SA
Note: If HA and MA cannot be differentiated use DA (see below)		
Distinctly altered	Rock strength usually changed by alteration. The rock may be highly discoloured, usually by staining or bleaching. Porosity may be increased by leaching or may be decreased due to precipitation of secondary minerals in pores.	DA

Degree of Fracturing

The following descriptive classification apply to the spacing of natural occurring fractures in the rock mass. It includes bedding plane partings, joints and other defects, but excludes drilling breaks. These terms are generally not required on investigation logs where fracture spacing is presented as a histogram, and where used are presented in an unabbreviated format.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$RQD \% = \frac{\text{cumulative length of 'sound' core sections} > 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or stronger. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e., drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

These terms may be used to describe the spacing of bedding partings in sedimentary rocks. Where used, these terms are generally presented in an unabbreviated format

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Rock Descriptions

Terminology
Symbols
Abbreviations

□

Defect Descriptions

Defect Type

Term	Abbreviation Code
Bedding plane	B
Cleavage	CL
Crushed seam	CS
Crushed zone	CZ
Drilling break	DB
Decomposed seam	DS
Drill lift	DL
Extremely Weathered seam	EW
Fault	F
Fracture	FC
Fragmented	FG
Handling break	HB
Infilled seam	IS
Joint	JT
Lamination	LAM
Shear seam	SS
Shear zone	SZ
Vein	VN
Mechanical break	MB
Parting	P
Sheared Surface	S

Rock Defect Orientation

Term	Abbreviation Code
Horizontal	H
Vertical	V
Sub-horizontal	SH
Sub-vertical	SV

Rock Defect Coating

Term	Abbreviation Code
Clean	CN
Coating	CT
Healed	HE
Infilled	INF
Stained	SN
Tight	TI
Veneer	VNR

Rock Defect Infill

Term	Abbreviation Code
Calcite	CA
Carbonaceous	CBS
Clay	CLAY
Iron oxide	FE
Manganese	MN
Pyrite	Py
Secondary material	MS
Silt	M
Quartz	Qz
Unidentified material	MU

□

□

Rock Defect Shape/Planarity

Term	Abbreviation Code
Curved	CU
Discontinuous	DIS
Irregular	IR
Planar	PR
Stepped	ST
Undulating	UN

Rock Defect Roughness

Term	Abbreviation Code
Polished	PO
Rough	RF
Smooth	SM
Slickensided	SL
Very rough	VR

Defect Orientation

The inclination of defects is always measured from the perpendicular to the core axis □

intentionally blank

□

□

Sampling and Testing

A record of samples retained, and field testing performed is usually shown on a Douglas Partners' log with samples appearing to the left of a depth scale, and selected field and laboratory testing (including results, where relevant) appearing to the right of the scale, as illustrated below:

SAMPLE			DEPTH (m)	TESTING	
SAMPLE REMARKS	TYPE	INTERVAL		TEST TYPE	RESULTS AND REMARKS
	SPT		1.0 1.45	SPT	4,9,11 N=20

Sampling

The type or intended purpose for which a sample was taken is indicated by the following abbreviation codes.

Sample Type	Code
Auger sample	A
Acid Sulfate sample	ASS
Bulk sample	B
Core sample	C
Disturbed sample	D
Environmental sample	ES
Gas sample	G
Piston sample	P
Sample from SPT test	SPT
Undisturbed tube sample	U ¹
Water sample	W
Material Sample	MT
Core sample for unconfined compressive strength testing	UCS

¹ – numeric suffixes indicate tube diameter/width in mm □

The above codes only indicate that a sample was retained, and not that testing was scheduled or performed.

Field and Laboratory Testing

A record that field and laboratory testing was performed is indicated by the following abbreviation codes.

Test Type	Code
Pocket penetrometer (kPa)	PP
Photo ionisation detector (ppm)	PID
Standard Penetration Test x/y = x blows for y mm penetration HB = hammer bouncing HW = fell under weight of hammer	SPT
Shear vane (kPa)	V
Unconfined compressive strength, (MPa)	UCS

Field and laboratory testing (continued)

Test Type	Code
Point load test, (MPa), axial (A), diametric (D), irregular (I)	PLT(L)
Dynamic cone penetrometer, followed by blow count penetration increment in mm (cone tip, generally in accordance with AS1289.6.3.2)	DCP/150
Perth sand penetrometer, followed by blow count penetration increment in mm (flat tip, generally in accordance with AS1289.6.3.3)	PSP/150

Groundwater Observations

▷	seepage/inflow
▽	standing or observed water level
NFGWO	no free groundwater observed
OBS	observations obscured by drilling fluids

Drilling or Excavation Methods/Tools

The drilling/excavation methods used to perform the investigation may be shown either in a dedicated column down the left-hand edge of the log, or stated in the log footer. In some circumstances abbreviation codes may be used.

Method	Abbreviation Code
Direct Push	DP
Solid flight auger. Suffixes: /T = tungsten carbide tip, /V = v-shaped tip	AD ¹
Air Track	AT
Diatube	DT ¹
Hand auger	HA ¹
Hand tools (unspecified)	HAND
Existing exposure	X
Hollow flight auger	HSA ¹
HQ coring	HQ3
HMLC series coring	HMLC
NMLC series coring	NMLC
NQ coring	NQ3
PQ coring	PQ3
Predrilled	PD
Push tube	PT ¹
Ripping tyne/ripper	R
Rock roller	RR ¹
Rock breaker/hydraulic hammer	EH
Sonic drilling	SON ¹
Mud/blade bucket	MB ¹
Toothed bucket	TB ¹
Vibrocure	VC ¹
Vacuum excavation	VE
Wash bore (unspecified bit type)	WB ¹

¹ – numeric suffixes indicate tool diameter/width in mm □

□

Borehole Log Report

Geo Environmental Engineering
275A Stoney Creek Road
Kingsgrove NSW 2208
T 02 9592 0218



Hole ID: **BH2**
Hole Depth: **20.55 m**
Sheet: **1 of 4**

Project Name: **Geotechnical Investigation**
Location / Site: **360-364 Crown Street, Wollongong NSW**

Project Number: **G10002TPG**
Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **4/02/2010** Ground Level: **RL44.0m** approx
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **4/02/2010** Easting: **-----**
Equipment: **Hydropower Scout V** Northing: **-----**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Observations / Comments	Casing & Core Lifts
							Surface: Asphalt			
							FILL - Asphalt / Roadbase.			
		0.5	43.5		CL	Residual Soil	Sandy CLAY - red / brown, grey mottled, low to medium plasticity, medium to coarse grained sand (EW Sandstone).	M		
		1.0	43.0				SANDSTONE - red / brown, grey mottled, medium to coarse grained, very low to low strength.			
		1.5	42.5							
		2.0	42.0							
		2.5	41.5			Bedrock	some bands of low to medium strength Sandstone chips present from 2.5m.			
		3.0	41.0							
		3.5	40.5							
		4.0	40.0							
		4.5	39.5							
		5.0	39.0				BH2 continued as cored hole from 4.5m			
		5.5	38.5							
		6.0	38.0							

Moisture	Additional Comments
D Dry	
Dp Damp	
SM Slightly Moist	
M Moist	
VM Very Moist	
W Wet	
Sd Saturated	

Logged By: **Stephen McCormack** Date: **4/02/2010**

Checked By: **Stephen McCormack** Date: **1/03/2010**

GEE BH LOG G10002TPG WOLLONGONG.GPJ GEE LOG 2.GDT 01/03/10 11:15:28 AM

Borehole Log Report

Geo Environmental Engineering
275A Stoney Creek Road
Kingsgrove NSW 2208
T 02 9592 0218



Hole ID: **BH2**
Hole Depth: **20.55 m**
Sheet: **2 of 4**

Project Name: **Geotechnical Investigation**
Location / Site: **360-364 Crown Street, Wollongong NSW**

Project Number: **G10002TPG**
Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **4/02/2010** Ground Level: **RL44.0m approx**
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **4/02/2010** Easting: **-----**
Equipment: **Hydropower Scout V** Northing: **-----**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa)	Is, MPa	Rock Mass Defects				Depth (m)	Core Photo	Casing & Core Lifts
								EL 0.03 VL 0.1 ML 0.3 H 1 VH 3 EH 10	D=diametral A=axial	RQD %	Defect Spacing (mm) 20 60 200 600 2000	Defect Description type, inclination, thickness, shape, roughness, coating	Specific			
		4.5	39.5			Continued from non-cored borehole from 4.5m							4.5			
Diamond Drilling						CORE LOSS.										
		5.0	39.0		Bedrock	SANDSTONE - orange / brown, dark grey to black carbonaceous lenses, fine to coarse grained, up to gravel size, laminated, with intermittent and irregular Siltstone lenses / inclusions, occasional clay seams.	DW		D=0.25 A=0.51	84		JT, HZ, IR, CN, RF JT, 10°, IR, FE, RF FZ JT, 30°, IR, FE, RF JT, 45°, IR, FE, RF JT, 10°, IR, FE, RF JT, 20°, IR, FE, RF JT, 20°, IR, FE, RF JT, HZ, 40°, FE, RF JT, 20°, PLN, FE, RF JT, 45°, PLN, FE, RF JT, HZ, IR, FE, RF SM, CLAY, HZ, 5mm JT, 10°, IR, FE SM, CLAY, 10mm JT, HZ, FE, PLN ST, 45°, CLAY, SO, PLN JT, 45°, FE, PLN SM, 70°, CLAY JT, HZ, IR, FE, RF JT, HZ, IR, FE, RF SM, CLAY, HZ SM, 70°, CLAY JT, 70°, PLN, FE, CLAY SM, 80°, FE/CLAY, IR JT, 80°, IR, FE, Closed JT, HZ, IR, CN JT, 45°, IR, CN JT, 45°, IR, CN JT, HZ, IR, CLAY JT, HZ, IR JT, VT, IR, FE, Closed		5.6		
		5.5	38.5													
		6.0	38.0													
		6.5	37.5													
		7.0	37.0													
		7.5	36.5													
		8.0	36.0													
		8.5	35.5													
		9.0	35.0													
	9.5	34.5													SILTSTONE band 10mm thick at 9.31m.	
	10.0	34.0			becoming red / orange / grey from 9.5m.											

Additional Comments

Logged By: **Stephen McCormack** Date: **4/02/2010**

Checked By: **Stephen McCormack** Date: **1/03/2010**

Geo Environmental Engineering 275A Stoney Creek Road Kingsgrove NSW 2208 T 02 9592 0218		Hole ID. BH2 Hole Depth: 20.55 m Sheet: 3 of 4
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Drilling Company:	Macquaire Drilling	Date Started:	4/02/2010	Ground Level:	RL44.0m approx
Drill Method:	Solid Flight Auger / Diamond Drilling	Date Completed:	4/02/2010	Easting:	-----
Equipment:	Hydropower Scout V			Northing:	-----

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa)	Is, MPa	Rock Mass Defects				Depth (m)	Core Photo	Casing & Core Lifts
										D=diаметral A=axial	RQD %	Defect Spacing (mm)	Defect Description type, inclination, thickness, shape, roughness, coating			
Diamond Drilling		10.5	33.5		Bedrock	SANDSTONE - orange / brown, with some red lenses / bands throughout, fine to medium grained.	DW		D=1.38 A=1.39	100		JT, HZ, IR, CN, RF JT, 10°, IR, CN JT, VT, FE, IR, Closed JT, 10°, IR, FE JT, 10°, IR, FE JT, 30°, IR, FE JT, 45°, IR, FE JT, 30°, IR, FE JT, 45°, FE, PLN JT, 45°, CLAY, PLN JT, 45°, FE, PLN JT, 45°, FE, PLN SM, 45°, CLAY JT, HZ, PLN, CLAY SM, HZ, CLAY, 5mm JT, HZ, IR, CN JT, 45°, PLN, FR JT, 20°, PLN, FR JT, 45°, PLN, FE, Closed JT, HZ, IR, FE SM, HZ, CLAY, 10mm FZ JT, HZ, IR, CN JT, HZ, IR, CN JT, 10°, PLN, FE JT, 10°, PLN, CN FZ, IR, FE JT, 75°, PLN, white coating, Calcite? JT, 50°, PLN, white coating, Calcite? JT, 60°, PLN, white coating, Calcite? FZ, some FE, white infilling / coating	10.5			
		11.0	33.0													
		11.5	32.5													
		12.0	32.0													
		12.5	31.5													
		13.0	31.0													
		13.5	30.5													
		14.0	30.0													
		14.5	29.5													
		15.0	29.0													
	15.5	28.5			VESICULAR LATITE - dark grey to black, with some orange / brown and red staining, highly fractured, cobble size rock recovery, (Volcanic intrusion).	SW				0		FZ	15.5			
	16.0	28.0														

Additional Comments

Checked By: **Stephen McCormack** Date: **1/03/2010**

Borehole Log Report

Geo Environmental Engineering
275A Stoney Creek Road
Kingsgrove NSW 2208
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Hole ID:	BH2
Hole Depth:	20.55 m
Sheet:	4 of 4

Project Name: **Geotechnical Investigation**

Location / Site: **360-364 Crown Street, Wollongong NSW**

Project Number: **G10002TPG**

Client: **TPG**

Drilling Company:	Macquaire Drilling	Date Started:	4/02/2010	Ground Level:	RL44.0m approx
Drill Method:	Solid Flight Auger / Diamond Drilling	Date Completed:	4/02/2010	Easting:	-----
Equipment:	Hydropower Scout V			Northing:	-----

[illegible]

Additional Comments

Logged By: **Stephen McCormack** Date: **4/02/2010**

Checked By: **Stephen McCormack** Date: **1/03/2010**

SEE CORE LOG G1002TPG WOLLONGONG.GPJ GEE LOG 2.GDT 01/03/10 11:16:26 AM



Borehole BH2: Start of Core (4.5m) to 9.0m



Borehole BH2: 9.0m to 14.0m



Borehole BH2: 14.0m to 20.55m (End)

Borehole Log Report

Geo Environmental Engineering
275A Stoney Creek Road
Kingsgrove NSW 2208
T 02 9592 0218



Hole ID. **BH3**
Hole Depth: **18.00 m**
Sheet: **1 of 4**

Project Name: **Geotechnical Investigation**
Location / Site: **360-364 Crown Street, Wollongong NSW**

Project Number: **G10002TPG**
Client: **TPG**

Drilling Company: **Macquaire Drilling** **Date Started:** **4/02/2010** **Ground Level:** **RL45.3m approx**
Drill Method: **Solid Flight Auger / Diamond Drilling** **Date Completed:** **5/02/2010** **Easting:** **-----**
Equipment: **Hydropower Scout V** **Northing:** **-----**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Observations / Comments	Casing & Core Lifts
							Surface: Asphalt		
Solid Flight Auger - TC Bit		45.0			Fill		FILL - Asphalt / Roadbase.		
		44.5					FILL - Sandy Gravel / Gravelly Sand, red / brown, medium to coarse grained.		
		44.0					FILL - Clayey Silt (topsoil), dark brown, low plasticity.		
		43.5			CL		Silty CLAY - red / brown, orange / brown and grey mottled, stiff, medium plasticity, with some fine to coarse sandstone gravel.		
		43.0					SANDSTONE, extremely to highly weathered - orange / brown, medium to coarse grained.		
		42.5			Bedrock		harder from 2.5m.		
		42.0							
		41.5							
		41.0							
		40.5							
		40.0					BH3 continued as cored hole from 3.5m		
		39.5							
		39.0							
		38.5							
		38.0							
		37.5							

Moisture	Additional Comments
D Dry	
Dp Damp	
SM Slightly Moist	
M Moist	
VM Very Moist	
W Wet	
Sd Saturated	

Logged By: **Stephen McCormack** Date: **4/02/2010**

Checked By: **Stephen McCormack** Date: **24/02/2010**

Borehole Log Report

Geo Environmental Engineering
275A Stoney Creek Road
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Hole ID: **BH3**
Hole Depth: **18.00 m**
Sheet: **2 of 4**

Project Name: **Geotechnical Investigation**
Location / Site: **360-364 Crown Street, Wollongong NSW**

Project Number: **G10002TPG**
Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **4/02/2010** Ground Level: **RL45.3m approx**
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **5/02/2010** Easting: **-----**
Equipment: **Hydropower Scout V** Northing: **-----**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa)	IS ₉₀ MPa	Rock Mass Defects	Defect Description	Depth (m)	Core Photo	Casing & Core Lifts
		42.0												
		3.5				<i>Continued from non-cored borehole from 3.5m</i>								
		41.5				SANDSTONE - orange / brown, fine to medium grained, some dark grey / black lenses and inclusions.	SW		D=1.88 A=2.39		JT, HZ, IR, CN			
		4.0				some grey bands present from.			D=3.05 A=2.93		BP, HZ, PLN, CN			
		41.0									JT, 70°, PLN, Clay, RF			
		4.5									JT, HZ, IR, CN			
		40.5					XW				SM, Clay, 20°, 50mm			
		5.0					SW				SM, Clay, 80mm, HZ			
		40.0					XW				SM, Clay			
		5.5					SW				SM, Clay, HZ			
		39.5					DW							
		6.0					XW							
		39.0					DW							
		6.5				SANDSTONE - grey, fine to medium grained, dark grey / black inclusions.	SW		D=1.04 A=1.45		JT, 10°, IR, CN			
		38.5									JT, 10°, PLN, CN			
		7.0									JT, 10°, PLN, FE			
		38.0							D=0.35 A=0.29		JT, 10°, PLN, FE			
		7.5												
		37.5									JT, 10°, IR, CN			
		8.0							D=0.93 A=0.95		JT, HZ, IR, Clay			
		37.0												
		8.5												
		36.5									JT, 20°, FE, PLN			
		9.0												

Additional Comments

Logged By: **Stephen McCormack** Date: **4/02/2010**

Checked By: **Stephen McCormack** Date: **24/02/2010**

GEE CORE LOG G10002TPG WOLLONGONG.GPJ GEE LOG 2.GDT 24/02/10 2:26:35 PM

Borehole Log Report

Geo Environmental Engineering
275A Stoney Creek Road
Kingsgrove NSW 2208
T 02 9592 0218



Hole ID: **BH3**
Hole Depth: **18.00 m**
Sheet: **3 of 4**

Project Name: **Geotechnical Investigation**
Location / Site: **360-364 Crown Street, Wollongong NSW**

Project Number: **G10002TPG**
Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **4/02/2010** Ground Level: **RL45.3m approx**
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **5/02/2010** Easting: **-----**
Equipment: **Hydropower Scout V** Northing: **-----**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa)					Is ₉₀ MPa		Rock Mass Defects				Depth (m)	Core Photo	Casing & Core Lifts			
								EL 0.03	VL 0.1	ML 0.3	HL 1	EH 3	D=diametral A=axial	RQD %	Defect Spacing (mm)	Defect Description type, inclination, thickness, shape, roughness, coating								
Diamond Drilling		36.0			Bedrock	SANDSTONE - grey, fine to medium grained, dark grey / black inclusions.	SW																	
		9.5				some coarse grained sand and fine gravel between 9.55 and 10.0m.																		
		35.5																						
		10.0																						
		35.0																						
		10.5																						
		34.5																						
		11.0																						
		34.0																						
		11.5						SILTSTONE - dark grey.																
		33.5			SANDSTONE - grey, with minor dark grey siltstone lenses.																			
		12.0																						
		33.0																						
		12.5																						
		32.5																						
		13.0																						
		32.0																						
		13.5																						
		31.5																						
		14.0																						
		31.0																						
		14.5																						
		30.5																						
		15.0																						

Additional Comments

Logged By: **Stephen McCormack** Date: **4/02/2010**

Checked By: **Stephen McCormack** Date: **24/02/2010**

GEE CORE LOG G10002TPG WOLLONGONG.GPJ GEE LOG 2.GDT 24/02/10 2:26:35 PM

Borehole Log Report

Geo Environmental Engineering
275A Stoney Creek Road
Kingsgrove NSW 2208
T 02 9592 0218



Hole ID: **BH3**
Hole Depth: **18.00 m**
Sheet: **4 of 4**

Project Name: **Geotechnical Investigation**
Location / Site: **360-364 Crown Street, Wollongong NSW**

Project Number: **G10002TPG**
Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **4/02/2010** Ground Level: **RL45.3m approx**
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **5/02/2010** Easting: **-----**
Equipment: **Hydropower Scout V** Northing: **-----**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa)					Is ₅₀ MPa	D=diametral A=axial	Rock Mass Defects				Depth (m)	Core Photo	Casing & Core Lifts				
								EL 0.03	VL 0.1	ML 0.3	HL 1	VH 3			EH 10	RQD %	Defect Spacing (mm)	Defect Description type, inclination, thickness, shape, roughness, coating							
Diamond Drilling					Bedrock	SANDSTONE - grey, with minor dark grey siltstone lenses.	SW																		
			30.0																						
			15.5																						
			29.5																						
			16.0																						
			29.0																						
			16.5																						
			28.5																						
			17.0																						
			28.0																						
		17.5																							
		27.5																							
		18.0																							
						Hole Terminated at 18.00 m																			
			27.0																						
			18.5																						
			26.5																						
			19.0																						
			26.0																						
			19.5																						
			25.5																						
			20.0																						
			25.0																						
		20.5																							
		24.5																							
		21.0																							

Additional Comments

Logged By: **Stephen McCormack** Date: **4/02/2010**

Checked By: **Stephen McCormack** Date: **24/02/2010**

GEE CORE LOG G10002TPG WOLLONGONG.GPJ GEE LOG 2.GDT 24/02/10 2:26:36 PM



Borehole BH3: Start of Core (3.5m) to 8.0m



Borehole BH3: 8.0m to 13.0m



Borehole BH3: 13.0m to 18.0m (End)

ARUP		BOREHOLE RECORD					BH101		SHEET 1							
							HOLE		OF 4							
CLIENT		AA Crown Holdings					LOGGED BY		RG / CH / PC							
PROJECT		Wollongong Private Hospital					CHECKED BY		MVU							
							DRILLED DATE		18-Apr-12 to 19-Apr-12							
CONTRACTOR		Terratest			ANGLE		60°		GROUND LEVEL							
DRILL MODEL		Edson 3000			BEARING		180		LOCATION							
DRILLER		Terratest			HOLE DIAMETER		100mm ()		ELEVATION DATUM							
							COORDINATE SYSTEM		Australian Map Grid (AMG)							
DRILLING		STRATA			MATERIAL DESCRIPTION			CONDITION		OBSERVATION						
SAMPLE, TEST, BIT, SUPPORT, ETC.		R.L.	DEPTH	GROUP SYMBOL	LEGEND	SOIL TYPE Plasticity / Grain Size, Colour, Minor Components	WATER / MOISTURE	CONSISTENCY								SOIL ORIGIN, STRUCTURE, ETC.
		mAHD	m					COHESIVE				NON COHESIVE				
								VS	SL	ST	VST	H	VL	J	MD	
		44.41	0.10	CH	XXXX	Bitumen. CLAY (CH) highly plasticity, brown mottled dark grey, trace of sand, fine to medium, trace of gravel, fine grained.	M									FILL RES
						 0.80m - 1.20m sandstone boulder, resistance to auger and silty sand recovered.										
		43.46	1.20	CH		CLAY (CH) medium plasticity, brown mottled white-grey, trace of sand, fine to medium grained, sub-angular, poorly graded.	D									RES

CLIENT AA Crown Holdings
PROJECT Wollongong Private Hospital

LOGGED BY RG / CH / PC
CHECKED BY MVU
DRILLED DATE 18-Apr-12 to 19-Apr-12

CONTRACTOR Terratest
DRILL MODEL Edson 3000
DRILLER Terratest
ANGLE 60°
BEARING 180
HOLE DIAMETER 100mm ()

GROUND LEVEL ~RL 44.50m
LOCATION 305230 E 6188597 N
ELEVATION DATUM Australian Height Datum
COORDINATE SYSTEM Australian Map Grid (AMG)

DRILLING				STRATA		MATERIAL DESCRIPTION				DISCONTINUITIES					
TCR % (Drill rate)	SCR / (RQD)	FLUSH RETURN % (TYPE)	SAMPLES (CaCO ₃ , SPT, UCS, etc)	R.L.	DEPTH	GRAPHIC LOG	ROCK TYPE Grain Size, Texture/Fabric, Colour, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	Is 50 (MPa)	FREQUENCY (per m)	SPECIFIC		GENERAL DESCRIPTION	
				mAHD	m							TYPE	ANGLE	THICKNESS (mm)	Planarity, Roughness, Coating, Infill
					1										
					2										
				41.82	3.10		Continued from Borehole CORE LOSS.								
				41.38	3.60										
				41.17	3.85		Sandy CLAY, medium plasticity, brown mottled grey, firm.								
					4		SANDSTONE, fine to coarse grained, thinly bedded, well developed bedding, brown mottled grey.. 3.85m - 7.55m white clay infill within fractures.	DW/XW							
				40.26	4.90		 4.86m - 4.90m no intact rock recovery, recovered as clayey gravel								
				39.82	5.40		CORE LOSS.								
					6		SANDSTONE, fine to coarse grained, thinly bedded, well developed bedding, brown mottled grey.. 5.70m - 5.80m no intact rock recovery, recovered as gravel.	DW							
					7		 7.00m - 12.50m banded in colour, dark brown to pale brown, orientated in line with fractures.								
				37.70	7.85										
				37.50	8.08		CORE LOSS.								
					8		SANDSTONE, fine to coarse grain, thinly bedded, well developed bedding, brown mottled grey..								
					9		 9.20m - 9.22m 2mm thick laminated iron deposit on 90 degrees fracture.								

NOTES
Hole Diameter 100mm to 3.10m depth. (Augered, 52mm from 3.1m, NMLC)
Hole cased to 3.10m.

See explanatory notes for details of abbreviations and basis of descriptions

JOB
224118

CLIENT AA Crown Holdings
PROJECT Wollongong Private Hospital

LOGGED BY RG / CH / PC
CHECKED BY MVU
DRILLED DATE 18-Apr-12 to 19-Apr-12

CONTRACTOR Terratest
DRILL MODEL Edson 3000
DRILLER Terratest
ANGLE 60°
BEARING 180
HOLE DIAMETER 100mm ()

GROUND LEVEL ~RL 44.50m
LOCATION 305230 E 6188597 N
ELEVATION DATUM Australian Height Datum
COORDINATE SYSTEM Australian Map Grid (AMG)

DRILLING				STRATA		MATERIAL DESCRIPTION				DISCONTINUITIES					
TCR % (Drill rate)	SCR / (RQD)	FLUSH RETURN % (TYPE)	SAMPLES (CaCO ₃ , SPT, UCS, etc)	R.L.	DEPTH	GRAPHIC LOG	ROCK TYPE Grain Size, Texture/Fabric, Colour, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	Is 50 (MPa)	FREQUENCY (per m)	SPECIFIC		GENERAL DESCRIPTION	
				mAHD	m							TYPE	ANGLE	THICKNESS (mm)	Planarity, Roughness, Coating, Infill
92()	92(77)	100 %	UCS < 2.0 MPa		11		SANDSTONE, fine to coarse grain, thinly bedded, well developed bedding, brown mottled grey, (continued)	DW		A0.06 D0.13		Jo	20	1	PL Ro3 M
								SW/DW				Jo	20	3	UN Ro3 FE+M PL Ro3 C+S PL Ro3 C+S PL Ro4 M+FE PL Ro4 M+S
												Jo	35	2	UN Ro4 S+FE
												Jo	20	2	UN Ro4 FE
												Jo	5	2	PL Ro4 FE
					12					A0.30 D0.56		Jo	50	2	PL Ro5 FE
												Jo	55	1	PL Ro3 M
							 12.50m becoming fine to medium grained 12.50m - 12.52m become pale grey in colour 12.65m dark grey, fine grained carbonaceous inclusions/lamination.	FR/SW				Jo	5	1	PL Ro3 M
												Be	5	1	PL Ro3 M
					13					A1.18 D2.00		Jo	35	1	PL Ro4 M+S
												Jo	50	1	PL Ro3 C UN Ro3 C
												Jo	20	1	UN Ro3 M+S
					14					A1.27 D1.77		Jo	50	1	UN Ro3 M+S
					15		 14.60m - 16.40m white calcite veins and irregular shape inclusion from 1 to 5mm thick			A0.64 D0.99		Jo	20	2	PL Ro4 S
												Jo	5	1	UN Ro3 M+S
					16					A1.72 D2.88		Jo	40	1	PL Ro4 M
												Jo	50	1	UN Ro3 M+S
					17		 16.45m - 17.20m 80 degrees undulating seam of clay with root fragments, weathered zone > 30mm thick			D1.43		Jo	50	1	UN Ro3 M+S
												Jo	50	1	UN Ro3 M+S PL Ro2 C
					18		 17.20m - 18.10m microfractures, irregularly orientated.			D0.17		Jo	90	1	IR Ro3 M+S
					19		 19.00m - 20.35m irregular shape calcite inclusions.			A1.51 D1.57		Jo	60	1	PL Ro3 M+S
												Jo	20	1	PL Ro4 FE
												Jo	20	1	PL Ro3 M+S
										D3.35					
NOTES Hole Diameter 100mm to 3.10m depth. (Augered, 52mm from 3.1m, NMLC) Hole cased to 3.10m.								See explanatory notes for details of abbreviations and basis of descriptions						JOB 224118	

LOGGED BY	RG / CH / PC
CHECKED BY	MVU
DRILLED DATE	18-Apr-12 to 19-Apr-12
GROUND LEVEL	~RL 44.50m
LOCATION	305230 E 6188597 N
ELEVATION DATUM	Australian Height Datum
COORDINATE SYSTEM	Australian Map Grid (AMG)

224118

ARUP	Core Photographs	BH101
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The photograph shows a core sample tray with a label and five core sections. The label is white with black text and a color calibration strip. The text on the label includes: ARUP, PROJECT: WOLLONGONG PRIVATE HOSPITAL, LOCATION: BH101, DATE: 19/4/2012, JOB NO. 224118, and DEPTH: 8.00m to 17.00m. The color calibration strip is a horizontal bar with various colored squares. Below the label, there are five core sections, each labeled with a depth range on the left side: 5.00m, 7.00m, 9.00m, 11.00m, and 13.00m. The core sections are cylindrical and show a brown, textured surface. The bottom section is labeled 'CORE LOSS'.

8.00m to 13.00m

ARUP	Core Photographs	BH101
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ARUP
JOB NO. 224118

PROJECT: WOLLONGONG PRIVATE HOSPITAL
LOCATION: BH101
DATE: 19/4/2012
DEPTH: 23.00m to 28.00m

23.00
24.00
25.00
26.00
27.00

23.50
27.50

23.00m to 28.00m

ARUP	Core Photographs	BH101
 ARUP PROJECT: WOLLONGONG PRIVATE HOSPITAL LOCATION: BH101 DATE: 19/4/2012 JOB NO. 224118 DEPTH: 28.00m to 28.80m 28.00 28.80 END OF HOLE		
28.00m to 28.80m		

DOUGLAS PARTNERS PTY LTD

WOLLONGONG PRIVATE HOSPITAL
360 – 364 CROWN STREET, WOLLONGONG

BORE: 201

DEPTH: 2.20m – 15.00m

PROJECT: 73522

JUL 2013

WOLLONGONG-73522.00-BH=201-3-7-13-START=2.20m



BOREHOLE LOG

CLIENT: A W Edwards
PROJECT: Wollongong Private Hospital
LOCATION: 360 - 364 Crown Street, Wollongong

SURFACE LEVEL: 42.6 AHD
EASTING: 305258
NORTHING: 6188644
DIP/AZIMUTH: 90°/-

BORE No: 201
PROJECT No: 73522
DATE: 3/7/2013
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing				
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %
42 1 41 2 40 3 39 4 38 5 37 6 36 7 35 8 34 9 33	0.02	BITUMINOUS CONCRETE																A				
	0.4	FILLING - dark grey, sandy, fine to medium gravel with trace silt, damp																A				
		TUFFACEOUS SANDSTONE - very low strength, highly weathered, orange brown, tuffaceous sandstone																A				
		- becoming low strength below 2.0m																A				
	2.2	TUFFACEOUS SANDSTONE - extremely low strength, extremely weathered, slightly fractured, orange brown, fine to coarse grained, tuffaceous sandstone with some very low to high strength, highly to moderately weathered bands																C	100	26	PL(A) = 1.9	
	3.03	TUFFACEOUS SANDSTONE - high strength, highly weathered becoming slightly weathered, slightly fractured, orange brown and grey, fine to coarse, tuffaceous sandstone																C	85	54	PL(A) = 0.1	
	4.9	TUFFACEOUS SANDSTONE - interbedded extremely low to low strength, extremely to highly weathered, slightly fractured, white, orange brown and grey, fine to medium grained, tuffaceous sandstone with some medium strength bands																C	100	34	PL(A) = 0.1	
	6.05																	C	100	94	PL(A) = 0.1	
	10.0	- grading into medium strength, fresh stained, tuffaceous sandstone																C	100	94	PL(A) = 0.1	

RIG: Scout 4 **DRILLER:** Gound Test **LOGGED:** BNG/RJH **CASING:** HW to 2.2m
TYPE OF BORING: SFA (TC bit) to 2.2m, coring (NMLC) to 15.0m
WATER OBSERVATIONS: No free groundwater observed
REMARKS: Standpipe installed: Solid casing to 3.0m, screen casing to 15.0m. Backfill to 2.5m, bentonite to 3.0m, gravel to 15m.

SAMPLING & IN SITU TESTING LEGEND			
A Auger sample	G Gas sample	PID Photo ionisation detector (ppm)	
B Bulk sample	P Piston sample	PL(A) Point load axial test Is(50) (MPa)	
BLK Block sample	U Tube sample (x mm dia.)	PL(D) Point load diametral test Is(50) (MPa)	
C Core drilling	W Water sample	pp Pocket penetrometer (kPa)	
D Disturbed sample	> Water seep	sp Standard penetration test	
E Environmental sample	≡ Water level	V Shear vane (kPa)	

BOREHOLE LOG

CLIENT: A W Edwards
PROJECT: Wollongong Private Hospital
LOCATION: 360 - 364 Crown Street, Wollongong

SURFACE LEVEL: 42.6 AHD
EASTING: 305258
NORTHING: 6188644
DIP/AZIMUTH: 90°/-

BORE No: 201
PROJECT No: 73522
DATE: 3/7/2013
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering				Graphic Log	Rock Strength						Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW		FS	FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
		below 9.63m																			
	32	TUFFACEOUS SANDSTONE - high becoming very high strength, fresh stained becoming fresh, slightly fractured becoming unbroken, grey, fine to medium grained, tuffaceous sandstone																			PL(A) = 1.2
	11																				
	31																				
	12																				UCS = 52.4
	30																				PL(A) = 3.4
	13																				
	29																				
	14																				
	28																				
	15	15.0																			
	27	Bore discontinued at 15.0m Limit of Investigation																			
	16																				
	26																				
	17																				
	25																				
	18																				
	24																				
	19																				
	23																				

RIG: Scout 4

DRILLER: Gound Test

LOGGED: BNG/RJH

CASING: HW to 2.2m

TYPE OF BORING: SFA (TC bit) to 2.2m, coring (NMLC) to 15.0m

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Standpipe installed: Solid casing to 3.0m, screen casing to 15.0m. Backfill to 2.5m, bentonite to 3.0m, gravel to 15m.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



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DOUGLAS PARTNERS PTY LTD

WOLLONGONG PRIVATE HOSPITAL
360 – 364 CROWN STREET, WOLLONGONG

BORE: 202

DEPTH: 2.20m – 15.20m

PROJECT: 73522

JUL 2013



BOREHOLE LOG

CLIENT: A W Edwards
PROJECT: Wollongong Private Hospital
LOCATION: 360 - 364 Crown Street, Wollongong

SURFACE LEVEL: 43.6 AHD
EASTING: 305225
NORTHING: 6188586
DIP/AZIMUTH: 90°/-

BORE No: 202
PROJECT No: 73522
DATE: 2/7/2013
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing					
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium		High	Very High	Ex High	0.01	0.05	0.10	0.50	1.00	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %
43 0.5 0.7 1 42 2		FILLING - grey, fine to coarse gravel (sandstone) with some clay and sand, damp																							20/100mm	
		CLAY - light orange brown, slightly silty, slightly sandy clay																				A				
		SANDY CLAY - light orange brown, slightly silty, sandy clay with some extremely low to very low strength, extremely to highly weathered, sandstone bands, damp																				A				
																						S				
																							A			
41 3 3.17 40 4 4.21 39 5 5.15 38 6 37 7 7.08 36 8 35 8.53 9 34		TUFFACEOUS SANDSTONE - interbedded extremely low to medium strength, extremely to highly weathered, slightly fractured, white, orange brown and grey, fine to medium grained, tuffaceous sandstone																								PL(A) = 0.3 <

RIG: Scout 4
DRILLER: Gound Test
TYPE OF BORING: SFA (TC bit) to 2.2m, coring (NMLC) to 15.20m
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

LOGGED: BNG/RJH
CASING: HW to 2.2m

SAMPLING & IN SITU TESTING LEGEND			
A Auger sample	G Gas sample	PID Photo ionisation detector (ppm)	
B Bulk sample	P Piston sample	PL(A) Point load axial test Is(50) (MPa)	
BLK Block sample	U Tube sample (x mm dia.)	PL(D) Point load diametral test Is(50) (MPa)	
C Core drilling	W Water sample	pp Pocket penetrometer (kPa)	
D Disturbed sample	> Water seep	SP Standard penetration test	
E Environmental sample	≡ Water level	V Shear vane (kPa)	

BOREHOLE LOG

CLIENT: A W Edwards
PROJECT: Wollongong Private Hospital
LOCATION: 360 - 364 Crown Street, Wollongong

SURFACE LEVEL: 43.6 AHD
EASTING: 305225
NORTHING: 6188586
DIP/AZIMUTH: 90°/-

BORE No: 202
PROJECT No: 73522
DATE: 2/7/2013
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering				Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing				
			EW	HW	MW	SW		FS	FR	Ex Low	Very Low	Low			Medium	High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
33	11	TUFFACEOUS SANDSTONE - high strength, moderately weathered becoming fresh, slightly fractured, grey and grey brown, fine to medium grained, tuffaceous sandstone (continued)														10.09m: J 40°, rough 10.22m: J 40°, rough 10.35m: J 40°, rough	C	100	98	PL(A) = 3.2	
32	12																C	100	99		
31	13	- becoming very high strength below 13.0m														12.52m: 10mm highly weathered 12.68m: rough, undulating					
30	14																			PL(A) = 4.5	
29	15																			UCS = 46.4	
15.2	15.2	Bore discontinued at 15.2m Limit of Investigation																			
28	16																				
27	17																				
26	18																				
25	19																				
24																					

RIG: Scout 4

DRILLER: Gound Test

LOGGED: BNG/RJH

CASING: HW to 2.2m

TYPE OF BORING: SFA (TC bit) to 2.2m, coring (NMLC) to 15.20m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



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WOLLONGONG PRIVATE HOSPITAL
360 – 364 CROWN STREET, WOLLONGONG

BORE: 203

DEPTH: 2.20m – 15.00m

PROJECT: 73522

JUL 2013

WOLLONGONG-73522.00-BH-203-4-7-13-START=2.20m



BOREHOLE LOG

CLIENT: A W Edwards
PROJECT: Wollongong Private Hospital
LOCATION: 360 - 364 Crown Street, Wollongong

SURFACE LEVEL: 43.2 AHD
EASTING: 305242
NORTHING: 6188569
DIP/AZIMUTH: 90°/--

BORE No: 203
PROJECT No: 73522
DATE: 4/7/2013
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing				
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %
43	0.1	FILLING - orange brown, slightly silty, sandy, gravelly (fine to coarse sandstone) clay, damp																A			23/100mm	
		CLAY - mottled grey, orange brown, slightly silty, slightly sandy, slightly gravelly (fine to medium sandstone) clay, damp																A				
1	0.9	SILTY CLAY - light grey and orange brown, silty clay with some extremely low to very low strength, extremely to highly weathered sandstone bands																S				
42																						
2																		A				
41	2.2	CLAY - orange brown, slightly gravelly, (fine sandstone, siltstone) clay, moist																			PL(A) = 0.5	
2.47		TUFFACEOUS SANDSTONE - low strength, highly becoming moderately weathered, slightly fractured, orange brown, fine to medium grained, tuffaceous sandstone with some extremely low strength, extremely weathered and medium strength, highly to moderately weathered bands																C	100	41		
3																						
40																						
4																						
39																						
5																		C	100	93	PL(A) = 0.2	
38																						
6																						
37																						
7																						
36	7.3	TUFFACEOUS SANDSTONE - high strength, slightly weathered to fresh stained, slightly fractured, orange brown and grey, fine to medium grained, tuffaceous sandstone with some extremely low strength, extremely weathered bands																			PL(A) = 0.5	
8																						
35																		C	100	92	PL(A) = 1.4	
9																						
34																		C	100	100	PL(A) = 1.4	

RIG: Scout 4

DRILLER: Gound Test

LOGGED: BNG/RJH

CASING: HW to 2.2m

TYPE OF BORING: SFA (TC bit) to 2.2m, coring (NMLC) to 15.28m

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Standpipe installed: Solid casing to 3.0m, screen casing to 6.0m. Backfill to 1.5m, bentonite to 2.5m, gravel to 6.0m.

SAMPLING & IN SITU TESTING LEGEND

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	▷	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test ts(50) (MPa)
		PL(D)	Point load diametral test ts(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: A W Edwards
PROJECT: Wollongong Private Hospital
LOCATION: 360 - 364 Crown Street, Wollongong

SURFACE LEVEL: 43.2 AHD
EASTING: 305242
NORTHING: 6188569
DIP/AZIMUTH: 90°/-

BORE No: 203
PROJECT No: 73522
DATE: 4/7/2013
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
33		TUFFACEOUS SANDSTONE - high strength, slightly weathered to fresh stained, slightly fractured, orange brown and grey, fine to medium grained, tuffaceous sandstone with some extremely low strength, extremely weathered bands <i>(continued)</i>																			
11																					
32																					
11.36		TUFFACEOUS SANDSTONE - medium to high strength, moderately weathered to fresh stained, slightly fractured, orange brown and grey, fine to medium grained, tuffaceous sandstone with some extremely low to low strength, extremely to highly weathered bands																			
12																					
31																					
13																					
30																					
14																					
29																					
15																					
28																					
15.28		Bore discontinued at 15.28m Limit of Investigation																			
16																					
27																					
17																					
26																					
18																					
25																					
19																					
24																					

RIG: Scout 4 **DRILLER:** Gound Test **LOGGED:** BNG/RJH **CASING:** HW to 2.2m
TYPE OF BORING: SFA (TC bit) to 2.2m, coring (NMLC) to 15.28m
WATER OBSERVATIONS: No free groundwater observed
REMARKS: Standpipe installed: Solid casing to 3.0m, screen casing to 6.0m. Backfill to 1.5m, bentonite to 2.5m, gravel to 6.0m.

SAMPLING & IN SITU TESTING LEGEND			
A Auger sample	G Gas sample	PID Photo ionisation detector (ppm)	
B Bulk sample	P Piston sample	PL(A) Point load axial test Is(50) (MPa)	
BLK Block sample	U Tube sample (x mm dia.)	PL(D) Point load diametral test Is(50) (MPa)	
C Core drilling	W Water sample	pp Pocket penetrometer (kPa)	
D Disturbed sample	> Water seep	S Standard penetration test	
E Environmental sample	≡ Water level	V Shear vane (kPa)	



BOREHOLE LOG

CLIENT: Erilyan Pty Ltd
PROJECT: Wollongong Private Hospital Extension
LOCATION: 366-368 Crown Street & 15-21 Urunga Parade, Wollongong

SURFACE LEVEL: 40.8 AHD
EASTING: 305207
NORTHING: 6188645
DIP/AZIMUTH: 90°/-

BORE No: 301
PROJECT No: 73522.07
DATE: 18/2/2022
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
								B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
0.09	0.12	CONCRETE: grey, fine to coarse latite aggregates, <5% voids								E			PID = 0.5
		FILL/Gravelly SAND SP: poorly graded, black, fine to coarse grained, with fine angular to subangular gravels, bedding sand, moist								E/D			PID = 1.2
1		FILL/Sandy CLAY CL: low plasticity, dark brown, fine to medium sand, with trace fine angular to subrounded gravel, w<PL								E/D			PID = 1.4
1.6		= with fine to medium subangular to subrounded gravel below 0.7m								S			10,9,25/130 refusal
2		= sandstone cobble at 1.4m								E			PID = 4.0
2.7		Sandy CLAY CL: low plasticity, orange brown mottled grey, fine to medium sand, with silt, w<PL, very stiff, residual								S			6,9,17 N = 26
3		Sandy CLAY CL: medium plasticity, red brown mottled pale grey and orange brown, with seams of highly weathered sandstone, w<PL, stiff to very stiff, extremely weathered sandstone								C	74		
3.93													
4.56													
5										C	84		
6													
6.0		SANDSTONE: fine to medium grained, brown, thinly to medium bedded, low strength, highly weathered, fractured to slightly fractured, with extremely weathered seams, Broughton Formation								C	77	29	PL(A) = 0.2
6.66													
6.68													
7		SANDSTONE: fine to medium grained, orange brown and grey, thickly bedded to massive, medium to high strength, moderately becoming slightly weathered, slightly fractured, trace coaly laminae, Broughton Formation											PL(A) = 0.4
8										C	100	93	PL(A) = 0.8
8.71		SANDSTONE: fine grained, grey, massive, high strength, slightly weathered becoming fresh, slightly fractured becoming unbroken, trace coaly laminae, Broughton Formation											
9		= medium to coarse grained											
9.22-9.60m										C	100	94	PL(A) = 1.7

RIG: Hanjin TD115 **DRILLER:** South Coast Drilling **LOGGED:** ZK/SL **CASING:** HWT to 2.6m

TYPE OF BORING: Concrete coring to 0.09m, SFA (TC bit) to 2m, rotary (water) to 2.7m, coring (NMLC) to 12.79m

WATER OBSERVATIONS: No free groundwater observed during auger drilling

REMARKS: w= moisture content, PL= Plastic Limit
 Standpipe installed: screen 0.65-12.65m, sand 0.5-12.65m, bentonite 0.2-0.5m, gatic cover

SAMPLING & IN SITU TESTING LEGEND			
A Auger sample	G Gas sample	PID Photo ionisation detector (ppm)	
B Bulk sample	P Piston sample	PL(A) Point load axial test Is(50) (MPa)	
BLK Block sample	U Tube sample (x mm dia.)	PL(D) Point load diametral test Is(50) (MPa)	
C Core drilling	W Water sample	pp Pocket penetrometer (kPa)	
D Disturbed sample	> Water seep	sp Standard penetration test	
E Environmental sample	≡ Water level	V Shear vane (kPa)	

BOREHOLE LOG

CLIENT: Erilyan Pty Ltd
PROJECT: Wollongong Private Hospital Extension
LOCATION: 366-368 Crown Street & 15-21 Urunga Parade, Wollongong

SURFACE LEVEL: 40.8 AHD
EASTING: 305207
NORTHING: 6188645
DIP/AZIMUTH: 90°/--

BORE No: 301
PROJECT No: 73522.07
DATE: 18/2/2022
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering						Graphic Log	Rock Strength						Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS	FR		Ex Low	Very Low	Low	Medium	High	Very High			Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %
	30	SANDSTONE: fine grained, grey, massive, high strength, slightly weathered becoming fresh, slightly fractured becoming unbroken, trace coaly laminae, Broughton Formation (continued) - medium to coarse grained 11.70-11.80m																				PL(A) = 1.7	
	11																						
	29																						
	12																					PL(A) = 1.1	
	28																					PL(A) = 1.7	
	12.79	Bore discontinued at 12.79m Limit of investigation																					
	13																						
	27																						
	14																						
	26																						
	15																						
	25																						
	16																						
	24																						
	17																						
	23																						
	18																						
	22																						
	19																						
	21																						

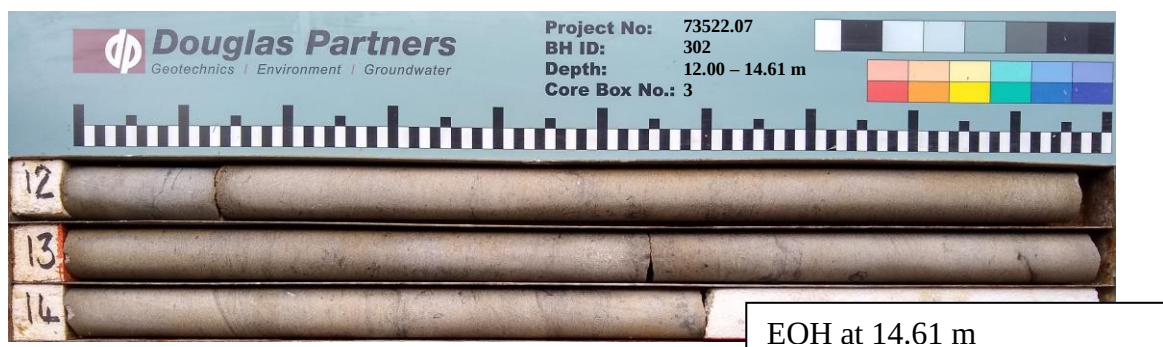
RIG: Hanjin TD115 **DRILLER:** South Coast Drilling **LOGGED:** ZK/SL **CASING:** HWT to 2.6m

TYPE OF BORING: Concrete coring to 0.09m, SFA (TC bit) to 2m, rotary (water) to 2.7m, coring (NMLC) to 12.79m

WATER OBSERVATIONS: No free groundwater observed during auger drilling

REMARKS: w= moisture content, PL= Plastic Limit
 Standpipe installed: screen 0.65-12.65m, sand 0.5-12.65m, bentonite 0.2-0.5m, gatic cover

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



BOREHOLE LOG

CLIENT: Erilyan Pty Ltd
PROJECT: Wollongong Private Hospital Extension
LOCATION: 366-368 Crown Street & 15-21 Urunga Parade, Wollongong

SURFACE LEVEL: 41.7 AHD
EASTING: 305233
NORTHING: 6188645
DIP/AZIMUTH: 90°/-

BORE No: 302
PROJECT No: 73522.07
DATE: 17/2/2022
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
	0.15	CONCRETE: grey, fine to coarse latite aggregate, <5% voids																E			PID = 1.6
	0.25																	E/D			PID = 2.3
41	0.6	FILL/SAND SP: poorly graded, brown, fine to medium grained, with coarse subrounded gravel, trace brick and plastic, moist																			
1		FILL/Sandy CLAY CL: low plasticity, brown mottled yellow brown, fine to coarse sand, with fine to medium subangular to subrounded gravel, w<PL																S			5,5,9 N = 14 PID = 2.8
40																					
2	1.9	Silty CLAY CL: medium plasticity, orange brown mottled red brown, with fine to medium sand, trace fine subangular to subrounded gravel, w<PL, stiff, residual																S			25/50 refusal
39	2.6	becoming mottled red brown and pale grey below 1m																			
3		becoming red grey below 1.8m																			PL(A) = 1.4
38		SANDSTONE: fine to medium grained, red brown and grey, very low strength to low strength, highly weathered, Broughton Formation																C	100	95	
4		SANDSTONE: fine to medium grained, grey orange brown and red brown, medium to thickly bedded, high strength, highly to slightly weathered, slightly fractured, Broughton Formation																			PL(A) = 2.1
4.25																			46	0	
4.54		SANDSTONE: fine to medium grained, grey orange brown and white, thinly to medium bedded, low to medium strength, highly to moderately weathered, slightly fractured, with extremely weathered seams, Broughton Formation																			PL(A) = 0.3
5																			100	56	
36																					PL(A) = 0.6
6	6.03	SANDSTONE: fine to medium grained, orange brown and pale grey, medium to thickly bedded, medium strength, highly to slightly weathered, slightly fractured, Broughton Formation																C			
35																			100	94	PL(A) = 0.4
7																					
34																					PL(A) = 0.3
8																					
33																					
9	8.8	SANDSTONE: fine to medium grained, pale grey, massive, high becoming very high strength, fresh-stained becoming massive, slightly fractured becoming massive, Broughton Formation																C	100	95	PL(A) = 2.5
32		coarse grain band from 9.49m - 9.60m																			PL(A) = 2.4

RIG: Hanjin TD115 **DRILLER:** South Coast Drilling **LOGGED:** ZK/SL **CASING:** HWT to 2.6m

TYPE OF BORING: Concrete Core to 0.15m, SFA (TC bit) to 2m, rotary (water) to 2.6m, coring (NMLC) to 14.55m

WATER OBSERVATIONS: No free groundwater observed during auger drilling

REMARKS: w= moisture content, PL= Plastic Limit
 Standpipe installed: screen 2.55-14.55m, sand 1.10-14.55m, bentonite 0.2-1.1m, gatic cover

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	sp	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Erilyan Pty Ltd
PROJECT: Wollongong Private Hospital Extension
LOCATION: 366-368 Crown Street & 15-21 Urunga Parade,
Wollongong

SURFACE LEVEL: 41.7 AHD
EASTING: 305233
NORTHING: 6188645
DIP/AZIMUTH: 90°/--

BORE No: 302
PROJECT No: 73522.07
DATE: 17/2/2022
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering						Graphic Log	Rock Strength						Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
			EW	HW	MW	SW	FS	FR		Ex Low	Very Low	Low	Medium	High	Very High			Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	31	SANDSTONE: fine to medium grained, pale grey, massive, high becoming very high strength, fresh-stained becoming fresh, slightly fractured becoming massive, Broughton Formation <i>(continued)</i>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		

RIG: Hanjin TD115 **DRILLER:** South Coast Drilling **LOGGED:** ZK/SL **CASING:** HWT to 2.6m

TYPE OF BORING: Concrete Core to 0.15m, SFA (TC bit) to 2m, rotary (water) to 2.6m, coring (NMLC) to 14.55m

WATER OBSERVATIONS: No free groundwater observed during auger drilling

REMARKS: w= moisture content, PL= Plastic Limit
Standpipe installed: screen 2.55-14.55m, sand 1.10-14.55m, bentonite 0.2-1.1m, gatic cover

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



BOREHOLE LOG

CLIENT: Erilyan Pty Ltd
PROJECT: Wollongong Private Hospital Extension
LOCATION: 366-368 Crown Street & 15-21 Urunga Parade,
Wollongong

SURFACE LEVEL: 43.0 AHD
EASTING: 305196
NORTHING: 6188604
DIP/AZIMUTH: 90°/-

BORE No: 303
PROJECT No: 73522.07
DATE: 10/2/2022
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing				
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %
48	0.1	CONCRETE: grey, fine to coarse latitie aggregate, <5% voids																				PID = 0.2
	0.12	ASPHALTIC CONCRETE : dark grey to black, fine to coarse igneous aggregate, bituminous binder																E/D				PID = 0.4
	0.2																	E/D				
	0.8	CONCRETE: grey, fine to coarse latitie aggregate, <5% voids																E/D				PID = 0.7
	1	FILL/Silty CLAY CL: low plasticity, dark brown, with fine to coarse sand and fine to coarse subangular to subrounded gravel, w<PL = becoming brown 0.4m																S				13,11,12 N = 23
	1.6																					
	2	Sandy CLAY CL: low plasticity, orange brown mottled pale grey and red brown, fine to coarse sand, with silt, w<PL, very stiff, residual																S				12,20,24 N = 44
	2.6	Silty CLAY CL: medium plasticity, pale red brown mottled pale grey and brown, with fine to medium sand, w<PL, hard, extremely weathered sandstone																				
	3	Sandy CLAY CL: low plasticity, orange brown mottled pale grey, fine to medium sand, w<PL, hard, extremely weathered sandstone																S				13,22,26 N = 48
	4																					
	4.8																					
	5	SANDSTONE: fine to medium grained, orange brown, medium to thickly bedded, low to medium and medium strength, highly to moderately weathered, slightly fractured, Broughton Formation																				PL(A) = 0.3
	6																					
	6.03	SANDSTONE: fine to medium grained, orange brown, medium bedded, interbedded extremely low to medium strength, extremely to moderately weathered, fractured, Broughton Formation																				PL(A) = 0.6
	6.63																					
	7	SANDSTONE: fine to medium grained, orange brown and pale grey, medium to thickly bedded, low to medium strength, moderatly becoming slightly weathered, slightly fractured, with extremely low strength, extremely weathered seams, Broughton Formation																				PL(A) = 0.3
	7.75																					
	8																					PL(A) = 0.4
	9																					
	9.66																					PL(A) = 0.8

RIG: Hanjin TD115 **DRILLER:** South Coast Drilling **LOGGED:** ZK/AM **CASING:** HWT to 4.6m

TYPE OF BORING: Concrete Core to 0.10m, SFA (TC bit) to 2.6m, rotary (water) to 4.8m, coring (NMLC) to 16.78m

WATER OBSERVATIONS: No free groundwater observed during auger drilling

REMARKS: w= moisture content, PL= Plastic Limit
Standpipe installed: screen 1.75-16.75m, sand 1.00-16.75, bentonite 0.3-1.0m, gatic cover

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	sp	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Erilyan Pty Ltd
PROJECT: Wollongong Private Hospital Extension
LOCATION: 366-368 Crown Street & 15-21 Urunga Parade,
 Wollongong

SURFACE LEVEL: 43.0 AHD
EASTING: 305196
NORTHING: 6188604
DIP/AZIMUTH: 90°/--

BORE No: 303
PROJECT No: 73522.07
DATE: 10/2/2022
SHEET 2 OF 2

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RIG: Hanjin TD115 **DRILLER:** South Coast Drilling **LOGGED:** ZK/AM **CASING:** HWT to 4.6m

TYPE OF BORING: Concrete Core to 0.10m, SFA (TC bit) to 2.6m, rotary (water) to 4.8m, coring (NMLC) to 16.78m

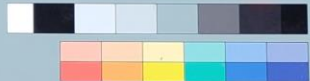
WATER OBSERVATIONS: No free groundwater observed during auger drilling

REMARKS: w= moisture content, PL= Plastic Limit

Standpipe installed: screen 1.75-16.75m, sand 1.00-16.75, bentonite 0.3-1.0m, gatic cover

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test ls(50) (MPa)
		PL(D)	Point load diametral test ls(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)





BOREHOLE LOG

CLIENT: Erilyan Pty Ltd
PROJECT: Wollongong Private Hospital Extension
LOCATION: 366-368 Crown Street & 15-21 Urunga Parade, Wollongong

SURFACE LEVEL: 43.2 AHD
EASTING: 305206
NORTHING: 6188573
DIP/AZIMUTH: 90°/-

BORE No: 304
PROJECT No: 73522.07
DATE: 11/2/2022
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing										
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium		High	Very High	Ex High	0.01	0.05	0.10	0.50	1.00	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments			
43	0.04	ASPHALTIC CONCRETE: dark grey to black, fine to coarse igneous aggregate, bituminous binder, wearing course FILL/gravelly SAND SP: poorly sorted, fine to medium angular to subangular gravel, fine to coarse sand, damp FILL/Sandy CLAY CL: low plasticity, dark brown, fine to medium sand, with silt, w<PL Silty CLAY CL: medium plasticity, orange brown mottled red brown, with trace fine sand, w<PL, stiff, residual																											PID = 1.2		
	0.08																						E						PID = 0.7		
1	0.8																						E/D						PID = 0.7 4,5,8 N = 13		
42																							E/D								
41																							S						26 refusal		
3	2.6	Sandy CLAY CL: low plasticity, orange brown, fine to medium sand, with very low to medium strength seams, w<PL, hard, extremely weathered sandstone SANDSTONE: fine to medium grained, orange-brown, thinly bedded, low strength, highly weathered, fractured, with clay seams, Broughton Formation SANDSTONE: fine to medium grained, orange brown and pale grey, medium to thickly bedded, interbedded very low to medium strength, highly to moderately weathered, fractured to slightly fractured, with clay and extremely weathered seams, Broughton Formation																											PL(A) = 0.3		
2.8																															
2.95																															
40																															
3.63																															PL(A) = 1
4																															
39																															
5																															
5.1																															PL(A) = 0.3
6																															
37																															
6.79																															PL(A) = 0.5
7																															
8																															PL(A) = 1.1
35																															
9																														PL(A) = 0.6	
34																															

RIG: Hanjin TD115 **DRILLER:** South Coast Drilling **LOGGED:** ZK/AM **CASING:** HWT to 2.6m
TYPE OF BORING: SFA (TC bit) to 2.0m, rotary (water) to 2.6m, coring (NMLC) to 11.76m
WATER OBSERVATIONS: No free groundwater observed during auger drilling
REMARKS: w= moisture content, PL= Plastic Limit

SAMPLING & IN SITU TESTING LEGEND			
A Auger sample	G Gas sample	PID Photo ionisation detector (ppm)	
B Bulk sample	P Piston sample	PL(A) Point load axial test Is(50) (MPa)	
BLK Block sample	U Tube sample (x mm dia.)	PL(D) Point load diametral test Is(50) (MPa)	
C Core drilling	W Water sample	pp Pocket penetrometer (kPa)	
D Disturbed sample	> Water seep	SP Standard penetration test	
E Environmental sample	≡ Water level	V Shear vane (kPa)	

BOREHOLE LOG

CLIENT: Erilyan Pty Ltd
PROJECT: Wollongong Private Hospital Extension
LOCATION: 366-368 Crown Street & 15-21 Urunga Parade,
Wollongong

SURFACE LEVEL: 43.2 AHD
EASTING: 305206
NORTHING: 6188573
DIP/AZIMUTH: 90°/--

BORE No: 304
PROJECT No: 73522.07
DATE: 11/2/2022
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
33	10.3	SANDSTONE: fine to medium grained, pale grey and orange brown, thickly bedded, high strength, fresh stained, slightly fractured, Broughton Formation																C	100	93	PL(A) = 2.1
11																					
32																					
11.76		Bore discontinued at 11.76m Limit of investigation															11.61m: J 70° 11.64m: J 45°				PL(A) = 1.8
12																					
31																					
13																					
30																					
14																					
29																					
15																					
28																					
16																					
27																					
17																					
26																					
18																					
25																					
19																					
24																					

RIG: Hanjin TD115 **DRILLER:** South Coast Drilling **LOGGED:** ZK/AM **CASING:** HWT to 2.6m
TYPE OF BORING: SFA (TC bit) to 2.0m, rotary (water) to 2.6m, coring (NMLC) to 11.76m
WATER OBSERVATIONS: No free groundwater observed during auger drilling
REMARKS: w= moisture content, PL= Plastic Limit

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: AA Crown Holdings Pty Ltd

PROJECT: Proposed Wollongong Private Hospital Expansion

LOCATION: 366 - 368 Crown Street & 15 - 23 Urunga Parade,, WOLLONGONG

SURFACE LEVEL: 40.1 AHD

COORDINATE: E:305192.3, N:6188644.6

DATUM/GRID: MGA2020 Zone 56

DIP/AZIMUTH: 90°/---

LOCATION ID: 401

PROJECT No: 73522.11

DATE: 13/02/25

SHEET: 1 of 2

CONDITIONS ENCOUNTERED											SAMPLE		TESTING							
GROUNDWATER	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK						SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
				ORIGIN ^(#)	CONSIS. ^(*)	DENSITY ^(*)	MOISTURE	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD								
	0.20	TOPSOIL / Sandy SILT (ML), trace rootlets: dark brown; low plasticity; fine to medium sand.	TS	FILL		W<PL							ES		0.10	PID	<1ppm	Concrete		
	0.60					W<PL							ES		0.50	PID	<1ppm	Concrete		
	0.80	FILL / Sandy SILT (ML), with clay, with gravel: dark brown; low plasticity; fine to medium sand; fine to medium, sub-angular gravel.	RS	St		W<PL							D/ES		1.00	PID	<1ppm	Backfill		
	1.00		RS	St to VSt		W<PL							SPT/SPT		1.10	SPT	4,5,7 N=12	Backfill		
	1.50														1.45					
	2.10	Sandy CLAY (Cl): grey brown; medium plasticity; fine to medium sand.	XWM	H		W<PL							SPT/SPT		2.00	SPT	25/100 (HB)	Bentonite		
	2.10	Silty CLAY (Cl), trace sand: orange brown mottled red; medium plasticity; fine sand.						2.10							2.10	PLT	PL(A)=1.6MPa			
	3.00	Sandy CLAY (Cl), with gravel: orange brown mottled red and white; medium plasticity; fine to medium sand; fine to medium, angular to sub-angular gravel; extremely weathered sandstone.					SW													
	3.15						XW	3.15								3	PLT	PL(A)=2.5MPa		
	3.29							3.29												
	3.75						SW										PLT	PL(A)=2.3MPa		
	3.75	SANDSTONE: pale brown, brown, fine to coarse grained, granular														4			Sand	
	4.70																			
	5.00	SANDSTONE: pale yellow, pale brown, mottled orange brown					HW									5				
	5.60	4.70m-5.60m: with 10-50mm bands of HW sandstone																		
	5.60						HW													
	6.00	SANDSTONE: pale brown, brown, fine to medium grained, granular														6	PLT	PL(A)=0.42MPa	Bentonite	
	7.00																			
	8.00						MW									7	PLT	PL(A)=0.49MPa		
	9.00																			
	9.31	SANDSTONE: grey, fine to medium grained, granular					MW									8	PLT	PL(A)=0.37MPa		
																9	PLT	PL(A)=0.95MPa		

NOTES: "Soil origin is "probable" unless otherwise stated. "Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Hanjin 8D

METHOD: Auger/SPT to 2.0m. NMLC coring to 15.70m

REMARKS: BD1 = 0-0.1m

OPERATOR: SCD (Craig Martin)

LOGGED: ZAK/AR

CASING: HW to 2.1m

Refer to explanatory notes for symbol and abbreviation definitions

BOREHOLE LOG

CLIENT: AA Crown Holdings Pty Ltd

SURFACE LEVEL: 40.1 AHD

LOCATION ID: 401

PROJECT: Proposed Wollongong Private Hospital Expansion

COORDINATE: E:305192.3, N:6188644.6

PROJECT No: 73522.11

LOCATION: 366 - 368 Crown Street & 15 - 23 Urunga Parade,, WOLLONGONG

DATUM/GRID: MGA2020 Zone 56

DATE: 13/02/25

DIP/AZIMUTH: 90°/---°

SHEET: 2 of 2

CONDITIONS ENCOUNTERED										SAMPLE			TESTING							
GROUNDWATER	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK						SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
				ORIGIN ^(#)	CONSIS. ^(*) DENSITY. ^(*)	MOISTURE	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)								
	10.13	[CONT] SANDSTONE: grey, fine to medium grained, granular																		
	10.43																			
	11																			
	12																			
	13																			
	14																			
	15																			
	16	Borehole discontinued at 15.70m depth. Limit of investigation.																		
	17																			
	18																			
	19																			

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ^(*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

CORE PHOTO LOG

CLIENT: AA Crown Holdings Pty Ltd

PROJECT: Proposed Wollongong Private Hospital Expansion

LOCATION: 366 - 368 Crown Street & 15 - 23 Urunga Parade,, WOLLONGONG

SURFACE LEVEL: 40.1 AHD

COORDINATE: E:305192.3, N:6188644.6

DATUM/GRID: MGA2020 Zone 56

DIP/AZIMUTH: 90°/---°

LOCATION ID: 401

PROJECT No: 73522.11

DATE: 13/02/25

SHEET: 1 of 1



2.10-15.70 m depth



Photo 1: View looking south east towards No. 17 - 21 Urunga Parade (the site).



Photo 2: View looking south west towards No. 15 and 17 Urunga Parade (the site).



Photo 3: View looking south across the rear of No. 368 Crown Street. Note: Bore 303 in the lower left of the photo.



Photo 4: View looking east across the front of No. 366 Crown Street. Note: Bore 304 in the centre of the photo.



CLIENT: AA Crown Holdings Pty Ltd	
OFFICE: Wollongong	DRAWN BY: RJH
SCALE: NTS	DATE: Various 2022

Site Photographs 1 to 4
Wollongong Private Hospital Expansion
366 - 368 Crown Street and 15 - 23 Urunga Parade, Wollongong

PROJECT No:	73522.11
PLATE No:	1
REVISION:	0



Photo 5: View looking at medium strength sandstone blocks exposed in the nature strip at the front of No. 17 Urunga Parade.



Photo 6: View looking at seepage from No. 17 Urunga Parade.



Photo 7: View looking north east towards No. 368 Crown Street.



Photo 8: View looking north at the backyard of No. 21 Urunga Parade.



Photo 9: View looking at the weathered sandstone profile exposed in the second bench of the Wollongong Private Hospital excavation adjacent to Crown Street.



Photo 10: View looking south east at the weathered sandstone profile exposed in the second bench of the Wollongong Private Hospital excavation, adjacent to Crown Street.



Photo 11: View looking west at a fault zone daylighting in the third bench of the Wollongong Private Hospital site adjacent to the western boundary with No. 366 Crown Street.



Photo 12: View looking south west at the shear surface exposed in a fault plane exposed in the third bench of the Wollongong Private Hospital adjacent to the western boundary with No. 366 Crown Street.



Photo 13: View looking south west toward the fifth bench of the Wollongong Private Hospital excavation adjacent to Crown Street. Note: this is the design (ie completed)



Photo 14: View looking west towards the fourth bench of the Wollongong Private Hospital excavation adjacent to the south eastern corner of No. 15 Urunga Parade.



Photo 15: View looking north toward the fifth bench of the Wollongong Private Hospital excavation adjacent to the rear boundary of No. 15 and 17 Urunga Parade. Note: this is the design (ie completed) basement excavation level.



Photo 16: View looking north west toward the fifth bench of the Wollongong Private Hospital excavation adjacent to the south eastern corner of No. 15 Urunga Parade. Note: this is the design (ie completed) basement excavation level.

	CLIENT: AA Crown Holdings Pty Ltd		Site Photographs 13 to 16 Wollongong Private Hospital Expansion 366 - 368 Crown Street and 15 - 23 Urunga Parade, Wollongong	PROJECT No: 73522.11
	OFFICE: Wollongong	DRAWN BY: RJH		PLATE No: 4
	SCALE: NTS	DATE: Various 2014		REVISION: 0

Appendix D

Results of Previous Laboratory Testing

Material Test Report

Report Number: 73522.11-1
Issue Number: 1
Date Issued: 27/02/2025
Client: AA Crown Holdings Pty Ltd
Level 5, Wollongong NSW
Contact: Jack Ramirez
Project Number: 73522.11
Project Name: Proposed Wollongong Private Hospital Expansion
Project Location: 366 - 368 Crown Street & 15 - 23 Urunga Parade,,
WOLLONGONG NSW
Work Request: 14236
Sample Number: WO-14236A
Date Sampled: 13/02/2025
Dates Tested: 17/02/2025 - 24/02/2025
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and Preparation of Soils
Sample Location: 401, Depth: 1.0 - 1.45m
Material: Silty Clay



Douglas Partners Pty Ltd

Wollongong Laboratory

Unit 1/1 Luso Drive Unanderra NSW 2526

Phone: (02) 4271 1836

Email: wollongong@douglaspartners.com.au



Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Kevin Spicer

Laboratory Manager

Laboratory Accreditation Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	49		
Plastic Limit (%)	19		
Plasticity Index (%)	30		
Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	13.0		
Cracking Crumbling Curling	Curling		
Moisture Content (AS 1289 2.1.1)		Min	Max
Moisture Content (%)	20.9		

Material Test Report

Report Number: 73522.07-1
Issue Number: 1
Date Issued: 21/03/2022
Client: Erilyan Pty Ltd
1/27 Hotham Parade, Artarmon NSW 2064
Contact: Christina Gordon
Project Number: 73522.07
Project Name: Wollongong Private Hospital Extension
Project Location: 15-19 Urunga Parade, Wollongong NSW
Work Request: 8172
Sample Number: WO-8172A
Date Sampled: 18/02/2022
Dates Tested: 14/03/2022 - 16/03/2022
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Sample Location: 301 , Depth: 2.0 - 2.45m
Material: Sandy CLAY



Accredited for compliance with ISO/IEC 17025 - Testing



Approved Signatory: Kevin Spicer

Laboratory Manager

Laboratory Accreditation Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	33		
Plastic Limit (%)	20		
Plasticity Index (%)	13		
Moisture Content (AS 1289 2.1.1)			
Moisture Content (%)		14.7	

Material Test Report

Report Number: 73522.07-1
Issue Number: 1
Date Issued: 21/03/2022
Client: Erilyan Pty Ltd
1/27 Hotham Parade, Artarmon NSW 2064
Contact: Christina Gordon
Project Number: 73522.07
Project Name: Wollongong Private Hospital Extension
Project Location: 15-19 Urunga Parade, Wollongong NSW
Work Request: 8172
Sample Number: WO-8172B
Date Sampled: 18/02/2022
Dates Tested: 14/03/2022 - 16/03/2022
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Sample Location: 302 , Depth: 1.0 - 1.45m
Material: Silty CLAY



Accredited for compliance with ISO/IEC 17025 - Testing



Approved Signatory: Kevin Spicer

Laboratory Manager

Laboratory Accreditation Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	37		
Plastic Limit (%)	25		
Plasticity Index (%)	12		
Moisture Content (AS 1289 2.1.1)			
Moisture Content (%)		20.0	

CERTIFICATE OF ANALYSIS 373211-A

Client Details

Client	Douglas Partners Unanderra
Attention	Roderick Haselden
Address	Unit 1, 1 Luso Drive, Unanderra, NSW, 2526

Sample Details

Your Reference	<u>73522.12, Wollongong</u>
Number of Samples	5 Soil
Date samples received	17/02/2025
Date completed instructions received	17/02/2025

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	24/02/2025
Date of Issue	21/02/2025
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil				
Our Reference		373211-A-2	373211-A-3	373211-A-5
Your Reference	UNITS	401	401	401
Depth		0.5-0.6	1-1.1	7.4-7.5
Date Sampled		13/02/2025	13/02/2025	13/02/2025
Type of sample		Soil	Soil	Soil
Date prepared	-	20/02/2025	20/02/2025	20/02/2025
Date analysed	-	20/02/2025	20/02/2025	20/02/2025
pH 1:5 soil:water	pH Units	7.2	5.4	8.1
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	42	20

Texture and Salinity*				
Our Reference		373211-A-2	373211-A-3	373211-A-5
Your Reference	UNITS	401	401	401
Depth		0.5-0.6	1-1.1	7.4-7.5
Date Sampled		13/02/2025	13/02/2025	13/02/2025
Type of sample		Soil	Soil	Soil
Date prepared	-	19/02/2025	19/02/2025	19/02/2025
Date analysed	-	19/02/2025	19/02/2025	19/02/2025
Electrical Conductivity 1:5 soil:water	µS/cm	46	43	54
Texture Value	-	9.0	7.0	9.0
Texture	-	CLAY LOAM	MEDIUM CLAY	CLAY LOAM
ECe	dS/m	<2	<2	<2
Class	-	NON SALINE	NON SALINE	NON SALINE

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode. 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.
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.
INORG-123	Determined using a "Texture by Feel" method.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			20/02/2025	2	20/02/2025	20/02/2025		20/02/2025	[NT]
Date analysed	-			20/02/2025	2	20/02/2025	20/02/2025		20/02/2025	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	2	7.2	7.2	0	102	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	<10	<10	0	108	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	<10	<10	0	106	[NT]

Client Reference: 73522.12, Wollongong

QUALITY CONTROL: Texture and Salinity*						Duplicate		Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			19/02/2025	2	19/02/2025	19/02/2025		19/02/2025	[NT]
Date analysed	-			19/02/2025	2	19/02/2025	19/02/2025		19/02/2025	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	2	46	44	4	103	[NT]
Texture Value	-		INORG-123	[NT]	2	9.0	9.0	0	[NT]	[NT]

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	
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.

CERTIFICATE OF ANALYSIS 291116

Client Details

Client	Douglas Partners Unanderra
Attention	Roderick Haselden
Address	Unit 1, 1 Luso Drive, Unanderra, NSW, 2526

Sample Details

Your Reference	<u>73522.07, Wollongong</u>
Number of Samples	12 Soil
Date samples received	16/03/2022
Date completed instructions received	16/03/2022

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	23/03/2022
Date of Issue	22/03/2022
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil

Our Reference		291116-1	291116-2	291116-3	291116-4	291116-5
Your Reference	UNITS	301	301	301	301	301
Depth		2.7-2.8	3.4-3.5	5.4-5.5	7.4-7.5	9.3-9.4
Date Sampled		18/02/2022	18/02/2022	18/02/2022	18/02/2022	18/02/2022
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	21/03/2022	21/03/2022	21/03/2022	21/03/2022	21/03/2022
Date analysed	-	21/03/2022	21/03/2022	21/03/2022	21/03/2022	21/03/2022
pH 1:5 soil:water	pH Units	4.6	4.5	4.9	9.8	9.8

Misc Inorg - Soil

Our Reference		291116-6	291116-7	291116-8	291116-9	291116-10
Your Reference	UNITS	301	304	304	304	304
Depth		12-12.1	2-2.45	3.6-3.7	5.6-5.7	7.7-7.8
Date Sampled		11/02/2022	11/02/2022	11/02/2022	11/02/2022	11/02/2022
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	21/03/2022	21/03/2022	21/03/2022	21/03/2022	21/03/2022
Date analysed	-	21/03/2022	21/03/2022	21/03/2022	21/03/2022	21/03/2022
pH 1:5 soil:water	pH Units	9.8	5.2	5.3	6.1	9.7

Misc Inorg - Soil

Our Reference		291116-11	291116-12
Your Reference	UNITS	304	304
Depth		9.6-9.7	11.5-11.6
Date Sampled		11/02/2022	11/02/2022
Type of sample		Soil	Soil
Date prepared	-	21/03/2022	21/03/2022
Date analysed	-	21/03/2022	21/03/2022
pH 1:5 soil:water	pH Units	9.7	9.9

Texture and Salinity*						
Our Reference	UNITS	291116-1	291116-2	291116-3	291116-4	291116-5
Your Reference		301	301	301	301	301
Depth		2.7-2.8	3.4-3.5	5.4-5.5	7.4-7.5	9.3-9.4
Date Sampled		18/02/2022	18/02/2022	18/02/2022	18/02/2022	18/02/2022
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/03/2022	17/03/2022	17/03/2022	17/03/2022	17/03/2022
Date analysed	-	17/03/2022	17/03/2022	17/03/2022	17/03/2022	17/03/2022
Electrical Conductivity 1:5 soil:water	µS/cm	49	59	38	140	140
Texture Value	-	14	8.5	8.0	14	14
Texture	-	SANDY LOAM	LIGHT CLAY	LIGHT MEDIUM CLAY	SANDY LOAM	SANDY LOAM
ECe	dS/m	<2	<2	<2	<2	<2
Class	-	NON SALINE	NON SALINE	NON SALINE	NON SALINE	NON SALINE

Texture and Salinity*						
Our Reference	UNITS	291116-6	291116-7	291116-8	291116-9	291116-10
Your Reference		301	304	304	304	304
Depth		12-12.1	2-2.45	3.6-3.7	5.6-5.7	7.7-7.8
Date Sampled		11/02/2022	11/02/2022	11/02/2022	11/02/2022	11/02/2022
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/03/2022	17/03/2022	17/03/2022	17/03/2022	17/03/2022
Date analysed	-	17/03/2022	17/03/2022	17/03/2022	17/03/2022	17/03/2022
Electrical Conductivity 1:5 soil:water	µS/cm	110	56	36	34	150
Texture Value	-	14	7.0	14	6.0	14
Texture	-	SANDY LOAM	MEDIUM CLAY	SANDY LOAM	HEAVY CLAY	SANDY LOAM
ECe	dS/m	<2	<2	<2	<2	2.1
Class	-	NON SALINE	NON SALINE	NON SALINE	NON SALINE	SLIGHTLY SALINE

Texture and Salinity*			
Our Reference	UNITS	291116-11	291116-12
Your Reference		304	304
Depth		9.6-9.7	11.5-11.6
Date Sampled		11/02/2022	11/02/2022
Type of sample		Soil	Soil
Date prepared	-	17/03/2022	17/03/2022
Date analysed	-	17/03/2022	17/03/2022
Electrical Conductivity 1:5 soil:water	µS/cm	120	140
Texture Value	-	14	14
Texture	-	SANDY LOAM	SANDY LOAM
ECe	dS/m	<2	<2
Class	-	NON SALINE	NON SALINE

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-123	Determined using a "Texture by Feel" method.

Client Reference: 73522.07, Wollongong

QUALITY CONTROL: Misc Inorg - Soil					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			21/03/2022	1	21/03/2022	21/03/2022		21/03/2022	[NT]
Date analysed	-			21/03/2022	1	21/03/2022	21/03/2022		21/03/2022	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	4.6	4.6	0	101	[NT]

QUALITY CONTROL: Misc Inorg - Soil					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	7	21/03/2022	21/03/2022		[NT]	[NT]
Date analysed	-			[NT]	7	21/03/2022	21/03/2022		[NT]	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	7	5.2	5.0	4	[NT]	[NT]

Client Reference: 73522.07, Wollongong

QUALITY CONTROL: Texture and Salinity*					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			17/03/2022	1	17/03/2022	17/03/2022		17/03/2022	[NT]
Date analysed	-			17/03/2022	1	17/03/2022	17/03/2022		17/03/2022	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	49	44	11	103	[NT]
Texture Value	-		INORG-123	[NT]	1	14	14	0	[NT]	[NT]

QUALITY CONTROL: Texture and Salinity*					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	7	17/03/2022	17/03/2022		[NT]	[NT]
Date analysed	-			[NT]	7	17/03/2022	17/03/2022		[NT]	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	7	56	55	2	[NT]	[NT]
Texture Value	-		INORG-123	[NT]	7	7.0	7.0	0	[NT]	[NT]

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	
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.

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.

CERTIFICATE OF ANALYSIS 288956-B

Client Details

Client	Douglas Partners Unanderra
Attention	Roderick Haselden
Address	Unit 1, 1 Luso Drive, Unanderra, NSW, 2526

Sample Details

Your Reference	<u>73522.07, Wollongong</u>
Number of Samples	additional analysis
Date samples received	16/02/2022
Date completed instructions received	15/03/2022

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	22/03/2022
Date of Issue	22/03/2022
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Diego Bigolin, Inorganics Supervisor
 Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil			
Our Reference		288956-B-4	288956-B-6
Your Reference	UNITS	304	304
Depth		0.0-0.1	1.0-1.1
Date Sampled		22/12/2021	22/12/2021
Type of sample		Soil	Soil
Date prepared	-	21/03/2022	21/03/2022
Date analysed	-	21/03/2022	21/03/2022
pH 1:5 soil:water	pH Units	6.5	4.1

Texture and Salinity*				
Our Reference		288956-B-4	288956-B-5	288956-B-6
Your Reference	UNITS	304	304	304
Depth		0.0-0.1	0.5-0.6	1.0-1.1
Date Sampled		22/12/2021	22/12/2021	22/12/2021
Type of sample		Soil	Soil	Soil
Date prepared	-	16/03/2022	16/03/2022	16/03/2022
Date analysed	-	16/03/2022	16/03/2022	16/03/2022
Electrical Conductivity 1:5 soil:water	µS/cm	300	73	280
Texture Value	-	9.0	9.0	7.0
Texture	-	CLAY LOAM	CLAY LOAM	MEDIUM CLAY
ECe	dS/m	2.7	<2	<2
Class	-	SLIGHTLY SALINE	NON SALINE	NON SALINE

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-123	Determined using a "Texture by Feel" method.

Client Reference: 73522.07, Wollongong

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			21/03/2022	4	21/03/2022	21/03/2022		21/03/2022	[NT]
Date analysed	-			21/03/2022	4	21/03/2022	21/03/2022		21/03/2022	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	4	6.5	6.7	3	101	[NT]

Client Reference: 73522.07, Wollongong

QUALITY CONTROL: Texture and Salinity*						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			21/03/2022	4	16/03/2022	16/03/2022		21/03/2022	[NT]
Date analysed	-			21/03/2022	4	16/03/2022	16/03/2022		21/03/2022	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	4	300	290	3	103	[NT]
Texture Value	-		INORG-123	[NT]	4	9.0	9.0	0	[NT]	[NT]

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	
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.

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.

CERTIFICATE OF ANALYSIS 289364-B

Client Details

Client	Douglas Partners Unanderra
Attention	Roderick Haselden
Address	Unit 1, 1 Luso Drive, Unanderra, NSW, 2526

Sample Details

Your Reference	<u>73522.08, Wollongong</u>
Number of Samples	7 Soil
Date samples received	21/02/2022
Date completed instructions received	15/03/2022

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	22/03/2022
Date of Issue	22/03/2022
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Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil					
Our Reference		289364-B-1	289364-B-2	289364-B-3	289364-B-4
Your Reference	UNITS	301	301	301	301
Depth		0.1-0.2	0.5-0.6	1-1.1	1.5-1.6
Date Sampled		18/02/2022	18/02/2022	18/02/2022	18/02/2022
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	21/03/2022	21/03/2022	21/03/2022	21/03/2022
Date analysed	-	21/03/2022	21/03/2022	21/03/2022	21/03/2022
pH 1:5 soil:water	pH Units	7.8	5.8	5.3	4.8

Texture and Salinity*					
Our Reference		289364-B-1	289364-B-2	289364-B-3	289364-B-4
Your Reference	UNITS	301	301	301	301
Depth		0.1-0.2	0.5-0.6	1-1.1	1.5-1.6
Date Sampled		18/02/2022	18/02/2022	18/02/2022	18/02/2022
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	16/03/2022	16/03/2022	16/03/2022	16/03/2022
Date analysed	-	16/03/2022	16/03/2022	16/03/2022	16/03/2022
Electrical Conductivity 1:5 soil:water	µS/cm	1,200	360	230	150
Texture Value	-	14	9.0	9.0	7.0
Texture	-	SANDY LOAM	CLAY LOAM	CLAY LOAM	MEDIUM CLAY
ECe	dS/m	17	3.2	2.1	<2
Class	-	HIGHLY SALINE	SLIGHTLY SALINE	SLIGHTLY SALINE	NON SALINE

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-123	Determined using a "Texture by Feel" method.

Client Reference: 73522.08, Wollongong

QUALITY CONTROL: Misc Inorg - Soil						Duplicate		Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			21/03/2022	[NT]	[NT]	[NT]	[NT]	21/03/2022	[NT]
Date analysed	-			21/03/2022	[NT]	[NT]	[NT]	[NT]	21/03/2022	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]

QUALITY CONTROL: Texture and Salinity*					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			21/03/2022	[NT]	[NT]	[NT]	[NT]	21/03/2022	[NT]
Date analysed	-			21/03/2022	[NT]	[NT]	[NT]	[NT]	21/03/2022	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	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
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NEPM	National Environmental Protection Measure
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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.

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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.

CERTIFICATE OF ANALYSIS 290798

Client Details

Client	Douglas Partners Unanderra
Attention	Roderick Haselden
Address	Unit 1, 1 Luso Drive, Unanderra, NSW, 2526

Sample Details

Your Reference	<u>73522.07, Wollongong</u>
Number of Samples	2 soil, 1 water
Date samples received	11/03/2022
Date completed instructions received	11/03/2022

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	18/03/2022
Date of Issue	18/03/2022
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Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Diego Bigolin, Inorganics Supervisor

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil			
Our Reference		290798-1	290798-2
Your Reference	UNITS	302	302
Depth		2.6-2.7	8.8-8.9
Date Sampled		17/02/2022	17/02/2022
Type of sample		soil	soil
Date prepared	-	17/03/2022	17/03/2022
Date analysed	-	17/03/2022	17/03/2022
pH 1:5 soil:water	pH Units	5.0	9.2
Electrical Conductivity 1:5 soil:water	µS/cm	25	84
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	32	20

Miscellaneous Inorganics		
Our Reference		290798-3
Your Reference	UNITS	302
Depth		-
Date Sampled		8/03/2022
Type of sample		water
Date prepared	-	11/03/2022
Date analysed	-	11/03/2022
pH	pH Units	7.3
Electrical Conductivity	µS/cm	940
Chloride, Cl	mg/L	110
Sulphate, SO ₄	mg/L	66

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.

Client Reference: 73522.07, Wollongong

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	290798-2
Date prepared	-			17/03/2022	1	17/03/2022	17/03/2022		17/03/2022	17/03/2022
Date analysed	-			17/03/2022	1	17/03/2022	17/03/2022		17/03/2022	17/03/2022
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	5.0	4.9	2	100	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	25	17	38	104	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	101	96
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	32	35	9	104	86

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate		Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			11/03/2022	[NT]	[NT]	[NT]	[NT]	11/03/2022	[NT]
Date analysed	-			11/03/2022	[NT]	[NT]	[NT]	[NT]	11/03/2022	[NT]
pH	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	99	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	98	[NT]
Chloride, Cl	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	107	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	93	[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.

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

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

CERTIFICATE OF ANALYSIS 288956-A

Client Details

Client	Douglas Partners Unanderra
Attention	Roderick Haselden
Address	Unit 1, 1 Luso Drive, Unanderra, NSW, 2526

Sample Details

Your Reference	<u>73522.07, Wollongong</u>
Number of Samples	additional analysis
Date samples received	16/02/2022
Date completed instructions received	17/02/2022

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	24/02/2022
Date of Issue	24/02/2022
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Diego Bigolin, Inorganics Supervisor

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil			
Our Reference		288956-A-3	288956-A-5
Your Reference	UNITS	303	304
Depth		1.0-1.1	0.5-0.6
Date Sampled		22/12/2021	22/12/2021
Type of sample		Soil	Soil
Date prepared	-	22/02/2022	22/02/2022
Date analysed	-	22/02/2022	22/02/2022
pH 1:5 soil:water	pH Units	5.5	6.8
Electrical Conductivity 1:5 soil:water	µS/cm	32	73
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	20	36

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-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.

Client Reference: 73522.07, Wollongong

QUALITY CONTROL: Misc Inorg - Soil					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			22/02/2022	3	22/02/2022	22/02/2022		22/02/2022	[NT]
Date analysed	-			22/02/2022	3	22/02/2022	22/02/2022		22/02/2022	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	3	5.5	5.3	4	100	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	3	32	31	3	101	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	3	<10	<10	0	101	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	3	20	20	0	88	[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.

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

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

CERTIFICATE OF ANALYSIS 288956-C

Client Details

Client	Douglas Partners Unanderra
Attention	Roderick Haselden
Address	Unit 1, 1 Luso Drive, Unanderra, NSW, 2526

Sample Details

Your Reference	<u>73522.08, Wollongong</u>
Number of Samples	additional analysis
Date samples received	16/02/2022
Date completed instructions received	22/03/2022

Analysis Details

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

Report Details

Date results requested by	29/03/2022
Date of Issue	29/03/2022
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Chromium Suite		
Our Reference		288956-C-5
Your Reference	UNITS	304
Depth		0.5-0.6
Date Sampled		11/02/2022
Type of sample		Soil
Date prepared	-	23/03/2022
Date analysed	-	23/03/2022
pH _{kcl}	pH units	6.2
s-TAA pH 6.5	%w/w S	<0.01
TAA pH 6.5	moles H ⁺ /t	<5
Chromium Reducible Sulfur	%w/w	<0.005
a-Chromium Reducible Sulfur	moles H ⁺ /t	<3
S _{HCl}	%w/w S	[NT]
S _{KCl}	%w/w S	[NT]
S _{NAS}	%w/w S	[NT]
ANC _{BT}	% CaCO ₃	[NT]
s-ANC _{BT}	%w/w S	[NT]
s-Net Acidity	%w/w S	<0.005
a-Net Acidity	moles H ⁺ /t	<5
Liming rate	kg CaCO ₃ /t	<0.75
a-Net Acidity without ANCE	moles H ⁺ /t	<5
Liming rate without ANCE	kg CaCO ₃ /t	<0.75
s-Net Acidity without ANCE	%w/w S	<0.005

Method ID	Methodology Summary
Inorg-068	Chromium Reducible Sulfur - Hydrogen Sulfide is quantified by iodometric titration after distillation to determine potential acidity. Net acidity including ANC has a safety factor of 1.5 applied. Neutralising value (NV) of 100% is assumed for liming rate. Based on National acid sulfate soils identification and laboratory methods manual June 2018. The recommendation that the SHCL concentration be multiplied by a factor of 2 to ensure retained acidity is not underestimated, has not been applied in the SHCL results reported.

QUALITY CONTROL: Chromium Suite					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			23/03/2022	[NT]	[NT]	[NT]	[NT]	23/03/2022	[NT]
Date analysed	-			23/03/2022	[NT]	[NT]	[NT]	[NT]	23/03/2022	[NT]
pH _{KCl}	pH units		Inorg-068	[NT]	[NT]	[NT]	[NT]	[NT]	95	[NT]
s-TAA pH 6.5	%w/w S	0.01	Inorg-068	<0.01	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
TAA pH 6.5	moles H ⁺ /t	5	Inorg-068	<5	[NT]	[NT]	[NT]	[NT]	93	[NT]
Chromium Reducible Sulfur	%w/w	0.005	Inorg-068	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
a-Chromium Reducible Sulfur	moles H ⁺ /t	3	Inorg-068	<3	[NT]	[NT]	[NT]	[NT]	120	[NT]
S _{HCl}	%w/w S	0.005	Inorg-068	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
S _{KCl}	%w/w S	0.005	Inorg-068	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
S _{NAS}	%w/w S	0.005	Inorg-068	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
ANC _{BT}	% CaCO ₃	0.05	Inorg-068	<0.05	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
s-ANC _{BT}	%w/w S	0.05	Inorg-068	<0.05	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
s-Net Acidity	%w/w S	0.005	Inorg-068	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
a-Net Acidity	moles H ⁺ /t	5	Inorg-068	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Liming rate	kg CaCO ₃ /t	0.75	Inorg-068	<0.75	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
a-Net Acidity without ANCE	moles H ⁺ /t	5	Inorg-068	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Liming rate without ANCE	kg CaCO ₃ /t	0.75	Inorg-068	<0.75	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
s-Net Acidity without ANCE	%w/w S	0.005	Inorg-068	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Result Definitions

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

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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.

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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.

☐ **Project No:** 73522.07

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Calibration Buffer: ☒ ☐ ☐ ☐ ☐ ☐ ☐

[illegible][illegible]

Sample Location	Depth (m)	pH _F (in distilled water)	pH _{FOX} (oxidised in H ₂ O ₂)				Strength of Reaction	Soil Description
		D	D	D	D			
		mm	mm	mm	mm	mm		
1	0.00	0.00	0.00	0.00	0	000	01LL000d0CLAY0	
2	0.00	0.00	0.00	0.00	0	000	01LL000d0CLAY0	
3	0.00-0.05	0.00	0.00	0.00	0	000	01LL000d0CLAY0	
4	0.00	0.00	0.00	0.00	0	000	01LL000d0CLAY0	
5	0.00	0.00	0.00	0.00	0	000	01LL0000CLAY0	
6	0.00	0.00	0.00	0.00	0	000	01LL0000CLAY0	
7	0.00	0.00	0.00	0.00	0	000	01LL000d0CLAY0	
8	0	0	0	0	0	0	0	
9	0	0	0	0	0	0	0	
10	0	0	0	0	0	0	0	
11	0	0	0	0	0	0	0	
12	0	0	0	0	0	0	0	
13	0	0	0	0	0	0	0	
14	0	0	0	0	0	0	0	
15	0	0	0	0	0	0	0	
16	0	0	0	0	0	0	0	

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Appendix E

NSW GTD 2020/001

WCC Extraction Water Fact Sheet

Technical Direction

GTD 2020/001 | Version No. 01 – 2 July 2020

GTD 2020/001 | Version No. 01 – 2 July 2020

Excavation adjacent to Transport for NSW Infrastructure

Summary:	Audience:
This document provides technical direction for the excavation of infrastructure adjacent to Transport for NSW infrastructure. It outlines the requirements for the excavation process, including the need for a detailed design and the implementation of a risk management plan. The document also provides guidance on the selection of contractors and the monitoring of the excavation process.	• Design and Construction • Design and Construction • Construction • Construction • Construction

Purpose

The purpose of this document is to provide technical direction for the excavation of infrastructure adjacent to Transport for NSW infrastructure. It outlines the requirements for the excavation process, including the need for a detailed design and the implementation of a risk management plan. The document also provides guidance on the selection of contractors and the monitoring of the excavation process.

The document provides technical direction for the excavation of infrastructure adjacent to Transport for NSW infrastructure. It outlines the requirements for the excavation process, including the need for a detailed design and the implementation of a risk management plan. The document also provides guidance on the selection of contractors and the monitoring of the excavation process.

The document provides technical direction for the excavation of infrastructure adjacent to Transport for NSW infrastructure. It outlines the requirements for the excavation process, including the need for a detailed design and the implementation of a risk management plan. The document also provides guidance on the selection of contractors and the monitoring of the excavation process.

Approvals:

Director	Director of Infrastructure	Director of Infrastructure	Director of Infrastructure
Authorised Signatory	Director of Infrastructure	Director of Infrastructure	Director of Infrastructure

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Technical requirements

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Geotechnical investigations



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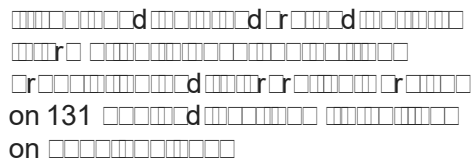
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Appendix F

Vibration Guidelines

APPENDIX F – VIBRATIONS GUIDELINES

Ground vibrations can be described by measurement of the acceleration, velocity or displacement of the ground particles at one or more locations. Triaxial geophone sensors, for example, can measure the peak velocities of radial, transverse or vertical particle motion (designated PPV_r, PPV_t and PPV_z respectively and PPV_i for any directional component) within selected sample periods and peak velocities can also be determined in the resultant direction of particle motion, from calculations of instantaneous vector sums throughout the sample period. Vector sum velocities are designated VSPPV, or in many cases simply PPV.

There are three aspects of vibrations which need to be assessed:

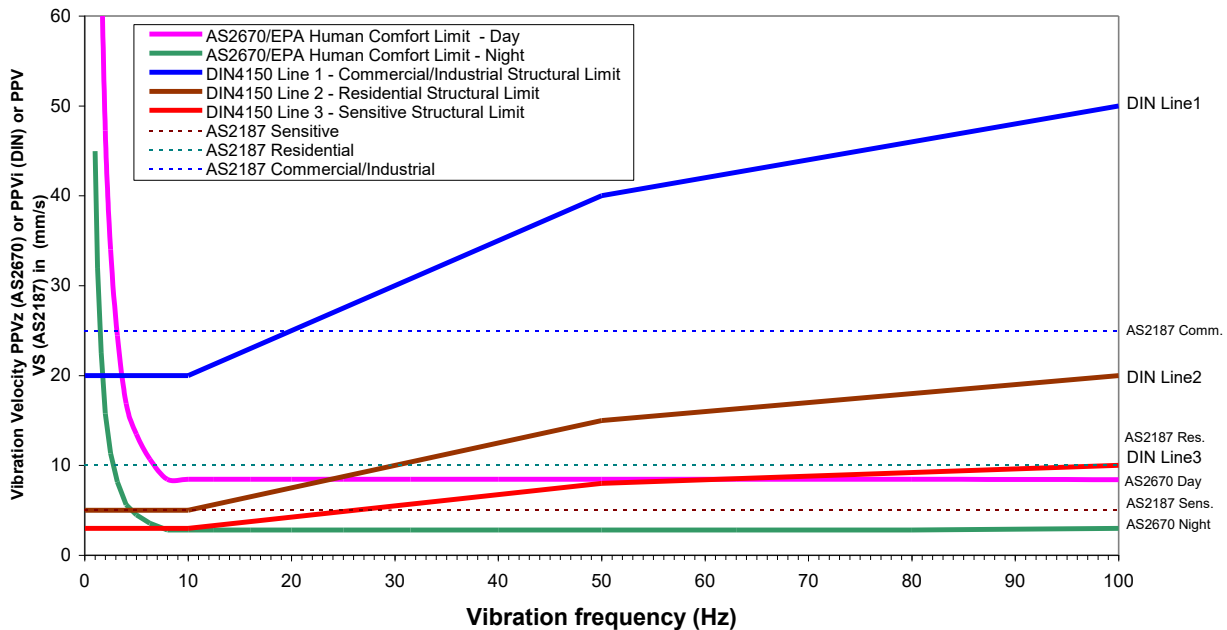
- Effects on structures
- Effects on architectural finishes
- Effects on humans

Numerous standards and guidelines exist worldwide which provide a basis for these assessments. Their focus varies from structural damage to human comfort and from transient to intermittent to continuous vibrations. Most provide guideline vibration limits for protection against damage or human discomfort. However these limits are not always consistent, and application of a particular standard or guideline should be based on the expected types of vibrations, the types and conditions of the potentially affected buildings and the potential for discomfort of their occupants.

Both the guideline and the vibration limits should be determined on a case-by-case basis and the adopted limits (damage and human comfort or the lower of the two) may vary from guideline values, according to the experience of the vibration consultant, due to the sensitivity of the building or the activities of its occupants. Some applicable guidelines are summarised in the graph below.

Depending on site conditions, proposed works, results of building condition surveys and on-site vibration trials (indicating vibration attenuation rates and dominant vibration frequencies of excavation plant), the standards, guidelines and limits discussed below are considered appropriate for the management of ground vibrations generated during rock excavation.

**Guidelines for Evaluating the Effects of Intermittent or Impulsive and Short Term
Vibrations on Human Comfort and Structures
(Based on AS2670.2/EPA ENCM Ch174 and DIN4150)**



Effects on Structures

The German Standard DIN4150-3 – 1999 “Structural vibration – effects of vibrations on structures”, recommends that ground vibrations at foundation level of residential buildings, in good condition bearing on sound rock foundations, be limited to 5 – 15 – 20 mm/s PPVi (at vibration frequencies of 10 – 50 – 100 Hz typical of excavation plant), in order to reduce the potential for structural damage. Higher limits (20 - 40 – 50 mm/s PPVi) and lower limits (3 - 8 – 10 mm/s PPVi) are recommended for commercial/industrial and sensitive buildings respectively. From Douglas’ experience where buildings are bearing on loose sand, maximum vibration levels should be significantly reduced to the order of 5 – 7 mm/s VSPPV to reduce the risk of vibration-induced sand densification and settlement.

Effects on Architectural Finishes

It has been found from experience that even with buildings bearing on rock, vibration levels as low as 10 mm/s VSPPV may cause minor defects such as cracks through rendering, cornices and skirtings. Management of vibrations may require a lowering of structural damage criteria to this architectural damage criterion, or negotiations with owners of affected buildings.

Effects on Humans

Ground vibration can be strongly perceptible to humans at levels above 2.5 mm/s VSPPV and can be disturbing at levels above 5 mm/s VSPPV. Complaints from residents and building occupants are sometimes received when levels are as low as 1 mm/s VSPPV.

The Australian Standard AS 2670.2 – 1990 “Evaluation of human exposure to whole-body vibrations – continuous and shock-induced vibrations in buildings (1-80 Hz)” indicates an acceptable day time limit of 8 mm/s PPVz for human comfort. Management of vibrations may require a lowering of damage criteria to this human comfort criterion, or negotiations with occupants of affected buildings.

Vibration Dosage

A vibration limit based on a particle velocity allows real-time control of excavation using warning systems (e.g. flashing lights) attached to vibration monitors. Occasional exceedances (vibration levels exceeding the allowed limit) are not damaging or disturbing and can be allowed but frequent exceedances should be avoided by changes in excavation methods. The difference between occasional and frequent is difficult to gauge on site but can be assessed using recorded vibration data, on the basis of experience or by application of a vibration dosage criterion.

A vibration dosage value (VDV) can be used to assess the effect of intermittent vibrations (e.g. from bursts of rock hammering) on humans over a defined period. Acceptable dosages (generally VDVz for vertical vibrations found most disturbing by humans) have been defined for occupants of residential, commercial and industrial buildings (“Assessing Vibration: a technical guideline”, Department of Environment and Conservation, 2006). Estimates of VDV (eVDV) can be calculated from recorded vibration data and can be compared with recommended maxima of 0.4, 0.8 and 1.6 m/s for residential, commercial and industrial locations respectively, to assess the need to change excavation methods to restore human comfort.

The vibration dosage guideline does not relate VDV to structural damage however it is considered that if the VDV is acceptable from a human comfort viewpoint, vibrations leading to that VDV would be unlikely to cause damage to the corresponding residential, commercial or industrial structure. Management of vibrations may require the addition of these vibration dosage criteria to other human comfort or damage criteria if the frequency of vibration exceedances becomes difficult to assess on-site or by experienced-based data review.