Douglas PARTNERS

GROUNDED EXPERTISE

Report on Geotechnical Investigation

Indigenous Centre of Excellence

171 Victoria Road, Parramatta NSW

Prepared for Western Sydney University

Project 227190.00

26 June 2024

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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.

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Douglas Partners acknowledges Australia's First Peoples as the Traditional Owners of the Land and Sea on which we operate. We pay our respects to Elders past and present and to all Aboriginal and Torres Strait Islander peoples across the many communities in which we live, visit and work. We recognise and respect their ongoing cultural and spiritual connection to Country.

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Report on Geotechnical Investigation
Indigenous Centre of Excellence

171 Victoria Road, Parramatta NSW

1. Introduction

This report prepared by Douglas Partners Pty Ltd (Douglas) presents the results of a geotechnical investigation undertaken for the proposed Indigenous Centre of Excellence (ICoE), located at 171 Victoria Road, Parramatta NSW (the site). The investigation was commissioned by email instructing to proceed dated 14 February 2024 from Steven Botterill of Western Sydney University (WSU) and was undertaken in general accordance with Douglas' proposal 227190.00.P.001.Rev0 dated 24 January 2024 and Work Change Notification No. 1 dated 6 March 2024.

It is understood that the proposed development of the site will include a three-storey building with a ground floor. Excavation is expected to be limited to utility trenches and foundations.

The purpose of the geotechnical investigation was to the confirm the ground profile and provide comments on the following issues:

- Site preparation and earthworks;
- Excavations and groundwater;
- Excavation support;
- Footings and foundations;
- Potential impacts on soil resources, related infrastructure and riparian lands on and near the site, including soil erosion, salinity and acid sulfate soils; and
- Potential impacts on groundwater resources in accordance with the Groundwater Guidelines.

The investigation included the drilling of six boreholes, laboratory testing of selected samples and groundwater monitoring. The details of the field work and laboratory testing are presented in this report, together with comments and recommendations on the issues listed above.

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

A Detailed Site Investigation (DSI) for contamination was carried out concurrently with the geotechnical investigation and has been reported separately (Ref 227190.01.R.001).

2. Site Description

The Western Sydney University South Parramatta Campus is located within the City of Parramatta Local Government Area (LGA).

The site comprises one (1) singular allotment, which is legally described as Lot 100 in DP 816829. The project site is known as the P1 Car Park in the northern portion of the wider site campus. The project site is approximately 12,150 m^2 in size and is broadly rectangular in shape. It currently comprises of a hardstand area that accommodates approximately 284 car parking spaces.

The site is in a valley with a relatively flat topography. It is an L-shaped area that is flat and level in the middle but fringed by raised embankments. The site is bound by Victoria Road to the north, by internal university campus roads to the east (being Railway Street) and south (being Fifth Street) and by a Co-Generation Plant to the west.

East of Railway Street, the tributary Vineyard Creek flows southward some 40 m east of the site to its confluence with the Parramatta River some 500 m south of the site.

Table 1 presents site identification details.

Table 1: Site Identification

Item	Details
Allotment Identification	Lot 100 DP 816829
Street Address	171 Victoria Road
Locality	Paramatta, NSW
Site Area	12,150 m^2
Local Government Area	City of Parramatta (CoP)
Zoning	SP2 Educational Establishment
Planning Instrument(s)	Parramatta DCP (2023); LEP (2023)
Current Land use	At-grade carpark
Current Owner	Western Sydney University

3. Published Data

3.1 Geology

With reference to Figure 1, the Geological Survey of NSW Seamless Geology Web Map indicates that the site is predominantly underlain by alluvial (clastic) sediments of the Quaternary Period. The map notes of the Geological Survey of NSW 1:100 000 Geological Series Sheet 9130 (Sydney) further indicate that the alluvium typically comprises silty to peaty quartz sand, silt, and clay with ferruginous and humic cementation in places and common shell layers.

The bedrock underlying the alluvium and the western end of the site is indicated to be Hawkesbury Sandstone of the Triassic Period. Hawkesbury Sandstone typically comprises medium to coarse-grained quartz sandstone with minor shale and laminite lenses.



Figure 1: NSW Seamless Geology map with approximate site location: NSW Seamless Geology map with approximate site location

3.2 Hydrogeology

Based on the site's geology, two groundwater systems could be present within the site:

- An alluvial aquifer within the clastic alluvial sediments; and
- A fractured aquifer system within the secondary permeability of the Hawkesbury Sandstone.

The Water NSW map of groundwater wells indicates that a water bore was installed by others at Rippon Avenue, Dundas, in September 2010. This well is located approximately 170 m south-east of the site. The Water NSW report on this bore indicates that it was drilled to a depth of 6.0 m and encountered standing groundwater at a depth of 2.7 m within natural sandy clay.

This Water NSW report suggests that the regional groundwater table is within the alluvium below the site. Further and as previously noted, the tributary Vineyard Creek flows southward some 40 m east of the site, so the groundwater is likely to be draining towards the creek.

A review of the groundwater dependent ecosystems (GDE) Atlas showed there is one mapped potential GDE within 500 m of the site, being The Sydney Hinterland Transition Woodland within the Sydney Coast – Georges River area mapped as having high potential for groundwater dependence.

3.3 Soil Landscape

With reference to Figure 2, the Soil Conservation Service of NSW 1:100 000 Soil Landscape Series Sheet 9130 (Sydney) indicates that most of the site is located within the 'Birrong' alluvial soil landscape unit, with the southern end of the site located within the 'Blacktown' residual soil landscape unit.

The Birrong alluvial soil landscape unit is characterised by a topography of level to gently undulating alluvial floodplain with broad valley flats draining the Wianamatta Group shales. The map notes indicated that local relief of up to 5 m is typical with slope grade of less than 3% and the typical soil profile comprises:

- deep (i.e., greater than 2.5 m deep) yellow podzolic soils and yellow solodic soils on older alluvial terraces; and
- deep solodic soils and yellow solonetzic soils on current floodplain.

The Blacktown residual soil landscape unit is characterised by a topography of gently undulating rises on Wianamatta Group shales and Hawkesbury Sandstone, having broad, rounded crests and ridges with gently inclined slopes. The map notes indicate that local relief of up to 30 m is typical, with slope grade usually less than 5% and the typical soil profile comprises:

- Shallow to moderately deep (i.e., greater than 1.0 m deep) red and brown podzolic soils on crests, upper slopes and well drained areas; and
- Deep (i.e., 1.5-3.0 m deep) yellow podzolic soils and soloths on lower slopes and in areas of poor drainage.



Figure 2: Soil landscape mapping with approximate site location (Based on digital data supplied by the NSW Department of Environment and Climate Change 2008.)

3.4 Acid Sulfate Soils

The Australian Soil Resource Information System (ASRIS) national map of published acid sulfate soil mapping indicates that there is a low probability of occurrence of acid sulfate soils (ASS) within the site.

3.5 Salinity

The NSW Department of Infrastructure, Planning and Natural Resources map of salinity potential in Western Sydney (2002) indicates that the site is in an area of moderate salinity potential.

4. Field Work

4.1 Methods

The field work was carried out over five days (1, 2, 9, 10 and 24 March 2024), and comprised:

- On-site electromagnetic scanning and ground penetrating radar survey for buried services at proposed borehole locations;
- Drilling of six boreholes (BH1 – BH6) by track-mounted drilling rigs using solid flight augers and rotary (wash-boring) through pavements and soils to depths ranging from 2.5 m to 10.0 m, then progressing three of the boreholes (BH1, BH2 and BH6) through soils and bedrock to termination depths of between 9.9 m and 17.9 m;
- Standard penetration tests (SPTs) at regular intervals within the soil profile;
- Discrete disturbed, undisturbed and bulk sampling of soil;
- Retrieval of rock core samples from the bedrock profile;
- Installation of standpipe monitoring wells in boreholes BH2, BH5 and BH6; and
- Standpipe monitoring well development and groundwater level measurement.

Boreholes BH1, BH3 and BH4 were backfilled with site spoil upon completion and made safe, with the surface temporarily restored using approximately 100 mm of coldmix asphalt. Where monitoring standpipes (wells) were installed at BH2, BH5 and BH6, these were covered with a steel 'Gatic' cover set into concrete installed flush with the existing pavement surface. The locations of the boreholes and monitoring standpipes are shown on Drawing 1 in Appendix A. The borehole locations and levels were determined by survey using a differential GPS receiver, typically accurate to ±0.1 m.

4.2 Results

4.2.1 Geotechnical

The detailed borehole logs and rock core photographs are included in Appendix C. Notes defining classification methods and terms used to describe the soils and rocks are given in Appendix B.

Based on the results of the site investigation, the ground profile is summarised as follows:

- **Asphaltic Concrete** – wearing surface 20 – 100 mm thick; overlying
- **Fill** – apparently variably compacted and of varying composition, including sandy gravel, gravelly sand, sand, and clay / sand / gravel mixtures, to depths ranging from 0.3 m to 1.5 m; overlying
- **Alluvium** – predominantly medium to high plasticity clay, silty clay and sandy clay of varying consistency ranging from firm to hard, with some discontinuous, medium dense or dense clayey sand and sand layers to depths ranging from 2.0 m to 12.9 m, deepening to the north-east; overlying
- **Residual Soil / Extremely Weathered Sandstone** – of varying composition from sand, clayey sand and sandy clay, being medium dense or dense, which discontinuously underlies the alluvium over the south-eastern part of the site to depths ranging from 4.1 m to at least 8.5 m; overlying
- **Sandstone** – fine to medium-grained, typically medium to high and high strength, moderately weathered and slightly fractured to unbroken sandstone. The upper 3 – 5 m of the rock profile in the northern part of the site contained typically very low to medium strength, moderately to highly weathered sandstone with frequent decomposed seams.

4.2.2 Groundwater

Free groundwater was not observed in most boreholes during auger drilling, except at BH1 where water seepage was observed at about 7.2 – 7.9 m depth. The use of water as a drilling fluid during washboring and NMLC diamond coring of the natural soil and bedrock precluded further observation of the groundwater levels during the drilling.

Monitoring wells were installed in BH2, BH5 and BH6. A summary of well construction details and intercepted lithology is provided in Table 2.

Table 2: Monitoring Wells Overview

Well	Surface RL (m AHD)	Screen depth (m bgl)	Screened lithology
BH2	7.9	2.0 – 8.0	Tertiary alluvial clay
BH5	7.9	2.5 – 4.5	Residual soil: sandy clay
BH6	7.3	5.0 – 9.9	Sandstone, slightly fractured

Notes: bgl: below ground level

The groundwater levels obtained from the monitoring wells, following their development on 24 March 2024, are summarised in Table 3. Data loggers recording groundwater levels at hourly intervals have been installed in BH2 and BH6.

Table 3: Summary of Manual Groundwater Measurements on 24 March 2024

Test Location	Depth (m bgl)	Reduced Level (m AHD)
BH2	2.2	5.7
BH5	1.9	6.0
BH6	5.2	2.1

Notes: bgl: below ground level

5. Laboratory Testing

Laboratory testing of selected soil and rock core samples was carried out by NATA accredited laboratories following completion of the field work. The laboratory test schedule comprised:

- Acid sulfate soil (ASS) screening tests at 0.5 m depth intervals through the soil profile to 3 m depth;
- Soil aggressivity and salinity suites, consisting of:
  - Soil pH, electrical conductivity (EC (1:5)) and textural class;
  - Soil chloride- and sulfate-ion concentrations;
  - Soil sodicity (Exchangeable Sodium Percent & CEC); and
  - Emerson crumb tests for assessment of soil dispersibility.
- Shrink-Swell index tests for assessment of soil reactivity;
- 4-day soaked, California bearing ratio (CBR) tests for pavement design parameters; and
- Point load strength index testing of rock core samples at approximate 1 m depth intervals.

The details and results of the laboratory testing are provided on the test reports in Appendix D, except the point load strength index test results, which are recorded on the borehole logs in Appendix C at the relevant depths. The laboratory test results are briefly summarised in Tables 4 – 7.

Table 4: Summary of Laboratory Soil Classification Test Results

Test Location	Depth (m)	Shrinkage Strain (%)	Moisture Content, wet (%)	Shrink-Swell Index (%/ΔpF)
BH2	4.0 – 4.45	1.1	-0.0	0.6

Table 5: Summary of ASS Screening Test Results

Test Location	Depth (m)	Soil Description	pH_F[1]	pH_{FOX}[2]	$pH_{FOX} - pH_F$	Reaction[3]
BH1	0.5 – 0.6	Fill/Sandy Gravel	8.3	7.2	-1.1	Medium
BH1	1.0 – 1.1	Clay	8.7	5.8	-2.9	Medium
BH1	1.5 – 1.6	Clay	8.3	6.2	-2.1	Medium
BH1	2.0 – 2.1	Clay	5.2	4.7	-0.5	Medium
BH1	2.5 – 2.6	Clay	5.6	4.0	-1.6	Medium
BH1	3.0 – 3.1	Clay	5.5	3.7	-1.8	Medium
BH2	0.1	Fill/Sand	10.0	7.4	-2.6	Medium
BH2	0.5	Clay	5.5	4.7	-0.8	Medium
BH2	1.0	Clay	6.2	5.3	-0.9	Medium
BH2	1.5	Clay	5.9	4.4	-1.5	Medium
BH2	2.0	Clay	4.6	4.2	-0.4	Medium
BH2	2.5	Clay	4.5	4.2	-0.3	Medium
BH2	3.0	Clay	4.4	3.8	-0.6	Medium
BH3	0.5	Fill / Clay, Sand &Gravel Mixture	8.9	7.0	-1.9	Medium
BH3	1.0	Fill / Clay, Sand &Gravel Mixture	8.8	6.8	-2.0	Medium
BH3	1.5	Sandy Clay	6.7	4.5	-2.2	Medium
BH3	2.0	Sandy Clay	5.6	3.9	-1.7	Medium
BH3	2.5	Sandy Clay	6.0	4.4	-1.6	Medium
BH3	3.0	Clay	5.6	3.9	-1.7	Medium
BH4	1.0	Clay	6.0	5.4	-0.6	Medium
BH4	1.5	Clay	4.7	3.7	-1.0	Medium
BH4	2.0	Clay	5.1	4.3	-0.8	Medium
BH4	2.5	Clay	4.1	4.1	0	Medium
BH4	3.0	Clay	4.2	4.2	0	Medium
BH5	0.5	Fill / Clay & Gravel	7.4	4.3	-3.1	Medium

Test Location	Depth (m)	Soil Description	pH_F[1]	pH_{FOX}[2]	$pH_{FOX} - pH_F$	Reaction[3]
BH5	1.0	Clay	7.5	4.2	-3.3	Medium
BH5	1.5	Clay	5.1	4.0	-1.1	Medium
BH5	2.0	Sandy Clay	4.5	4.3	-0.2	Medium
BH5	2.5	Sandy Clay	6.1	4.5	-1.6	Medium
BH5	3.5	Sandy Clay	6.2	4.2	-2.0	Medium
BH6	0.5	Fill / Clay & Gravel	10.5	10.3	-0.2	Medium
BH6	1.0	Fill / Clay	10.6	10.3	-0.3	Medium
BH6	1.5	Sandy Clay	9.8	6.9	-2.9	Medium
BH6	2.0	Clayey Sand	5.0	5.6	0.6	Medium
BH6	2.5	Clayey Sand	5.6	4.4	-1.2	Medium
BH6	3.0	Clayey Sand	5.7	3.6	-2.1	Medium

Notes: 1 Field pH test.
2 Field peroxide test.
3 Test not covered by NATA.

Table 6: Summary of Laboratory Aggressivity, Salinity and Dispersivity Test Results

Test Location	Depth (m)	pH	SO_4 (mg/kg)	Cl (mg/kg)	EC (dS/m)	Multiplication Factor	EC_e (dS/m)	Emerson Class
BH2	0.5	5.9	380	10	0.21	7.0	<2	-
BH2	1.0 – 1.5	-	-	-	-	-	-	6
BH2	1.5	5.4	-	-	0.078	7.0	<2	-
BH2	3.5	5.1	-	-	0.083	8.0	<2	-
BH2	5.0	5.1	-	-	0.048	8.0	<2	-
BH2	6.5	5.1	-	-	0.055	8.5	<2	-
BH3	0.5	10.7	-	-	0.10	9.0	<2	-
BH3	1.0	8.5	-	-	0.092	9.0	<2	-
BH3	1.5	5.0	-	-	0.13	9.0	<2	-
BH3	3.0	5.1	-	-	0.11	8.0	<2	-
BH3	4.5	5.5	-	-	0.086	8.5	<2	-
BH3	5.5	5.2	-	-	0.068	8.0	<2	-
BH3	6.5	5.4	-	-	0.080	8.5	<2	-

Test Location	Depth (m)	pH	SO_4 (mg/kg)	Cl (mg/kg)	EC (dS/m)	Multiplication Factor	EC_e (dS/m)	Emerson Class
BH4	1.0	5.5	-	-	0.19	9.0	<2	-
BH4	2.5	5.2	-	-	0.066	7.0	<2	-
BH4	5.0	5.1	-	-	0.092	9.0	<2	-
BH4	6.5	5.4	-	-	0.048	8.5	<2	-
BH4	7.0	5.3	-	-	0.078	8.5	<2	-
BH5	0.5	7.8	-	-	0.20	7.0	<2	-
BH5	1.0	7.6	-	-	0.085	9.0	<2	-
BH5	2.0	5.8	-	-	0.31	7.0	2.1	-
BH6	0.5	10.7	-	-	0.45	9.0	4.0	-
BH6	1.0	10.6	-	-	0.38	9.0	3.4	-
BH6	1.5	8.4	-	-	0.32	9.0	2.9	-
BH6	2.5	5.4	-	-	0.057	7.0	<2	-
BH6	2.5 – 2.95	-	-	-	-	-	-	6
BH6	3.0	-	75	<10	-	-	-	-
BH6	3.5	5.3	-	-	0.046	7.0	<2	-
BH6	4.0	5.9	-	-	0.027	7.0	<2	-

Notes: Cl = Chloride-ion concentration SO_4 = Sulphate-ion concentration EC = Electrical Conductivity
EC_e = calculated salinity

Table 7: Summary of CBR Test Results

Borehole	Depth (m)	Soil Description	FMC[1] (%)	CBR (%)	Swell (%)	SMDD[2] (t/m^3)	OMC[3] (%)
BH2	1.0 – 1.5	Clay	25.3	4	2.0	1.62	23.5
BH5	1.0 – 1.5	Clay	16.2	6	0.0	1.90	14.5

[1] Field moisture content
[2] Standard maximum dry density
[3] Optimum moisture content

6. Proposed Development

The Applicant seeks development consent for the construction of a new state-of-the-art Indigenous Centre of Excellence as a new tertiary education facility on campus. The Indigenous Centre of Excellence project is funded by the NSW Government's Western Sydney Infrastructure Grants Program in association with Western Sydney University. The new Indigenous Centre of Excellence will be an important asset for both the University and local community alike, providing a space for the commitment to advancing Indigenous education, leadership, and reconciliation. The Indigenous Centre of Excellence will stand as a symbol of recognition of Indigenous land and the University's relationship with Indigenous communities. The Indigenous Centre of Excellence

will represent a celebration of tens of thousands of years of Indigenous knowledges and histories, a legacy that the University is honoured to nurture and promote through further education opportunities for students and communities.

Through the Indigenous Centre of Excellence, the University will aim to drive positive change, increase Indigenous participation in higher education, and contribute to the preservation and sharing of Indigenous cultures.

This State Significant Development Application (SSDA) specifically seeks detailed approval for the following works:

- Site preparation including demolition of the existing car park, tree removal and installation of inground utility infrastructure services;
- Construction of a four-storey Indigenous Centre of Excellence encompassing:
    - Ground level facilities, including but not limited to; a dedicated arrival area, outdoor amphitheatre, cinema and lecture theatre, performance space, artist studios and exhibition space. Associated workspaces, meeting areas, lounge areas and other amenities are to be provided throughout the ground floor;
    - First floor level upwards comprising dedicated educational facilities including library facilities, learning areas and teaching spaces;
    - Second floor level comprising staff / student foyer, offices, meeting rooms and collaboration spaces;
    - Third level comprising a multi-functional recreational sports court, with associated ancillary amenities, alongside an astronomy garden and BBQ area; and
    - Roof level plant and services.
- Construction of internal driveway with hardstand area to provide 13 car parking spaces; and
- Landscaping works to provide outdoor educational and recreational spaces.

This report responds to the SSD-64916225 Secretary's Environmental Assessment Requirement (SEARs) number #13 which was issued by the Department of Planning, Housing and Infrastructure on 21st November 2023.

7. Geotechnical Model

Interpreted geotechnical cross-sections through the site, based on the borehole logs, are shown on Drawings 2 and 3 in Appendix A.

The geotechnical model for the site is summarised in Table 8.

Table 8: Summary of Site Geotechnical Model

Borehole	Surface Level (m AHD)	Depth (and Reduced Level) to Top of Stratum (m (& m AHD))				
		Asphaltic Concrete	Fill	Alluvium	Residual Soil / Extremely Weathered Sandstone	Sandstone
BH1	8.1	0 (8.1)	0.1 (8.0)	0.7 (7.4)	-	9.9 (-1.8)
BH2	7.9	0 (7.9)	0.02 (7.88)	0.3 (7.6)	-	12.9 (-5.0)
BH3	7.9	0 (7.9)	0.05 (7.85)	1.5 (6.4)	-	-
BH4	7.7	0 (7.7)	0.05 (7.65)	0.5 (7.2)	7.2 (0.5)	-
BH5	7.9	0 (7.9)	0.05 (7.85)	0.7 (7.2)	2.0 (5.9)	4.5 (3.4)
BH6	7.3	0 (7.3)	0.05 (7.25)	1.5 (5.8)	2.5 (4.8)	4.1 (3.2)

Below a ground surface that is relatively flat and level, the asphaltic concrete wearing surface is generally 50 mm thick, overlying fill that has an average thickness of 0.8 m. The underlying alluvium thickens in the north-east of the site above a discontinuous layer of residual soil and extremely weathered sandstone that underlies the alluvium over the south-eastern half of the site. A sandstone bedrock surface underlies the soil overburden and steps down to the north-east across the site.

Below the asphaltic concrete wearing surface, the fill is variably compacted and of varying composition, including sandy gravel, gravelly sand, sand, and clay / sand/gravel mixtures.

The alluvium is predominantly medium to high plasticity clay, silty clay and sandy clay of varying consistency ranging from firm to hard, with some discontinuous, medium dense or dense clayey sand and sand layers.

The residual soil is of varying composition including sand, clayey sand and sandy clay, being medium dense or dense, which discontinuously underlies the alluvium over the south-eastern part of the site.

Extremely weathered sandstone was encountered at the south-eastern corner of the site below the residual soil.

The upper 3 – 5 m of the sandstone bedrock is variably very low, low, medium and medium to high strength, moderately to highly weathered with frequent decomposed seams and slightly fractured in the northern part of the site only; it is otherwise medium to high and high strength, moderately weathered and slightly fractured to unbroken.

Two groundwater systems have been identified during the investigation:

- A shallow groundwater system within the alluvial clay and residual soil in which the groundwater monitoring wells in BH2 and BH6 are screened. Groundwater levels within this system were measured at about 2 m depth (RL 6 m AHD) during groundwater monitoring

on 24 March 2024. Permeability is likely to be relatively low given the fine nature of the sediments. Groundwater flow direction within this system appears to be to the south, following surface topography; and

- A deeper groundwater system within the underlying sandstone (targeted by monitoring well BH5). Groundwater level in this system has been found to be deeper than in the overlying soil (at about 5 m depth or RL 2 m AHD). Permeability of the sandstone is also likely to be low given the limited defects observed during the geotechnical investigation and slow recovery of the water within the well following well development.

Groundwater levels will fluctuate with weather and time and may increase following periods of rainfall.

8. Comments

8.1 Impact on Adjacent Structures and Infrastructure

The proposed works are expected to have negligible impact an adjacent building, transport infrastructure and above and below-ground utilities, as excavation is likely limited to utility trenches and foundations for the structure.

8.2 Dilapidation Surveys

It is suggested that dilapidation surveys be carried out on surrounding buildings, pavements and utilities that may be affected by construction works. Dilapidation surveys should occur before the commencement of any site works to document any existing defects so that any claims for damage due to construction related activities can be assessed.

8.3 Site preparation and Earthworks

Site preparation for the purpose of trafficking of the site by construction plant, such as piling rigs and mobile cranes, should be carried out in accordance with the guidelines contained in AS 3798:2007. This includes clearing, to the minimum extent necessary for the works, of all materials unsuitable for incorporation into the works, as well as the removal of all debris (such as old footings, buried pipes and the like) to sufficient depth so as to prevent obstruction of subsequent excavation and foundation works. For the proposed works, this will include tree removal, the demolition of the light poles and pavement surfaces and relocation and / or decommissioning and removal of some existing buried services.

The following procedure is suggested for site preparation and engineered filling for slab-on-ground footings and pavements at this site:

- Strip any organic topsoil and 'uncontrolled' fill down to stable natural subgrade;
- Tyne the exposed subgrade and adjust the subgrade to optimum moisture content (OMC);
- Compact the moisture conditioned subgrade with at least six passes of a minimum 10-12-tonne deadweight roller, with a final test roll pass ('proof roll') accompanied by a careful visual inspection by a geotechnical engineer or senior geotechnician to ensure that any deleterious materials such as loose, wet or highly compressible soil and organic materials are identified for removal;

- Strip and remove the weak material and replace with select approved filling in the event that excessive movement is observed under passage of the roller;
- Place fill, if required, in near horizontal layers of maximum 200 mm loose thickness. Fill should be approved, homogeneous, free of organic or other deleterious material, and have a maximum particle size of 75 mm;
- Compact each fill layer to at least 98% Standard maximum dry density ratio;
- Maintain moisture contents for fill exhibiting clay-like properties in the range 2% dry to 2% wet of optimum moisture content for Standard compaction; and
- Seal or cover any natural or compacted clay foundation soil, at or close to formation level, as soon as practicable, to reduce the opportunity for desiccation and cracking, or swelling and softening.

From a geotechnical engineering perspective, the existing fill material and alluvial silty clay is considered capable of re-use in an engineered fill, provided it is first screened to remove any deleterious and / or oversize material that may be present, then thoroughly mixed and moisture-conditioned to within ±2% of its optimum moisture content. An experienced geotechnical engineer should inspect and approve any stripped and stockpiled spoil material proposed for re-use in an engineered fill prior to its incorporation. With respect to the suitability of the existing fill and alluvial silty clay for incorporation in a fill from an environmental standpoint, please refer to the associated contamination report prepared by Douglas.

Level 1 inspection and testing, as defined in Section 8 of AS 3798 – 2007 is required where structural loads are to be supported by fill.

Due to the medium to high plasticity of the near surface clayey soils, it is expected that rubber-tyred vehicles will have trafficability problems during and after periods of rainfall or other increases in subgrade moisture content, and in some cases tracked plant may experience some difficulty. It will be essential to keep the site well drained during construction. A granular working platform is suggested to reduce potential lost time during or following wet weather.

8.4 **Vibrations**

Given that no significant demolition or excavation is proposed it is expected that vibrations will not be a significant issue however the following comments are provided for reference. Care will be required when using compaction and earthworks machinery in close proximity to existing buildings and infrastructure so as to reduce the potential for damage due to vibrations. The level of acceptable vibration at adjacent buildings and infrastructure is dependent on various factors, including the type of building structure (e.g., reinforced concrete, brick, etc.), its structural condition, the frequency range of vibrations produced by the construction equipment, the natural frequency of the building and the vibration transmitting medium (ground profile).

The Australian Standard AS 2187.2 – 1993 (Explosives Code) recommends a maximum vector sum peak particle velocity (VSPPV) of 10 mm/s for houses and low-rise residential or commercial buildings. Ground vibration arising from construction plant is of a continuous, rather than transient, nature, unlike blasting events. Thus, more stringent vibration limits than those given for blasting should generally apply. Buildings supported on shallow foundations are particularly prone to the detrimental effects of settlement and vibration.

If the neighbouring Co-Generation Building has footings founded at shallow levels, it is suggested that the VSPPV be provisionally limited to 8 mm/s at the building line, unless the client has more stringent vibration criteria for this building. Depending on the construction plant to be used, vibration monitoring at the Co-Generation Plant may be necessary for control of construction activities.

8.5 Excavations and Groundwater

Excavation is expected to be limited to utility trenches and foundations for the structure. Such excavations will be through fill and alluvium and may be readily carried out using conventional earthmoving equipment.

All excavated materials to be removed off-site will need to be disposed of in accordance with current EPA (2014) guidelines. Reference should be made to Douglas's contamination report for more information on waste classification of this site.

Groundwater was encountered at about 2 m depth below existing surface. It is possible that some water seepage will enter trench excavations or any deep foundations (such as piles). The cohesive, low-permeability nature of the alluvium suggests, however, that seepage volumes will likely be low and should likely be handled using normal 'sump-and-pump' methods for seepage removal.

The discharge of any groundwater will need to be in accordance with the Protection of the Environment Operations Act 1997 (POEO Act). Ultimately, this requires that any water discharged into the natural environment should comply with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).

8.6 Excavation Support and Batters

8.6.1 Batters

Where space permits, batter slopes for un-surcharged slopes above the groundwater table not higher than 2 m should be constructed no steeper than 1.5H:1V (horizontal:vertical) in the temporary case, and 2H:1V in the permanent case. If maintenance and vegetation of a permanent slope is required, then flatter 3H:1V batters are recommended.

8.6.2 Shoring / Retaining Walls

Temporary excavation support for trenches and other localised excavations could utilise proprietary shields and shoring boxes.

Shoring may be designed on the basis of the parameters shown in Table 9. A triangular earth pressure distribution may be adopted on the rear of the wall in these circumstances.

Table 9: Suggested Retaining Wall Design Parameters

Material	Bulk Unit Weight, γ_b (kN/m^3)	Active Earth Pressure Coefficient, K_a		Ultimate Passive Earth Pressure Coefficient, K_p
		Temporary	Permanent	
Fill	20	0.3	0.4	-
Alluvium	20	0.3	0.4	2

The values of K_a in Table 9 should generally be increased by 50% to reduce lateral (inward) wall deflections near sensitive, existing structures (e.g., utilities). Additional allowance should be made for surcharge loads behind the walls and for hydrostatic pressures.

8.7 Footings and Foundations

Douglas notes that the building columns are anticipated to have working loads up to 2500 kN (Tender Addendum 1).

The principal requirement for all new shallow footings is to found on a stratum with uniform engineering properties, to reduce the risk of excessive differential settlement and consequent potential damage to the supported structures.

Due to the presence of uncontrolled fill over the site, all shallow footings should be founded below the existing fill. Nevertheless, given the column working load indicated, shallow footings founded in the firm to stiff alluvium would also be unsuitable for practical reasons related to the excessive size of the shallow footings that would be required to support the proposed loadings.

Consequently, to support the design structural loadings for the proposed building, either a raft slab or conventional bored piles or piers may be used to access the required founding stratum at depth.

8.7.1 Raft Slab

A raft slab foundation could be designed to support the structure but would require all fill to be reworked and compacted as engineered fill. A raft foundation should not exceed a maximum contact pressure of 50 kPa, however, settlements typically govern the design for a raft. Elastic theory can be used to estimate the settlements at this site. Soil modulus values of 8-15 MPa and 30-50 MPa for alluvium and residual soil, respectively, could be used in preliminary raft design and settlement assessment. If a raft foundation is considered to be the most favourable founding option, Douglas could assist with the soil structure interaction analysis if required. Additional investigation with cone penetration tests (CPTs) is also suggested.

8.7.2 Piles

Uncased bored piles may not be suitable where sandy fill and sandy layers in alluvium is present due to the potential for collapse of this soil. Bored piles with temporary liners to support the sandy soils could be considered, however, this piling technique can be difficult if obstructions are encountered in the fill or if significant groundwater seepage occurs. To reduce the risk of concrete segregation below the groundwater table, placement of concrete using tremie methods may be necessary for bored piles/piers, whether they are cased or uncased.

Continuous flight auger (CFA) piles would be a more suitable option to avoid problems associated with collapsing soils or groundwater seepage and inflows. Large piling rigs with a high torque capacity may be required to penetrate the medium strength (or stronger) sandstone. The piling contractor should be made aware of the ground conditions and should make their own assessment on the type of equipment required to carry out the piling works.

Subject to their structural capacity, consideration may also be given to the use of steel screw piles, although the possible presence of obstructions (e.g., building rubble) within the fill material may make the penetration (or drilling) of any piles difficult, but particularly for steel screw piling. As the depth of fill is limited to 0.3 – 1.5 m, it may be practical to mobilise an excavator at the time of piling, to locally remove any obstructions from the fill material at column/pile locations, if encountered.

Due to the significant variation in the thickness of the alluvium across the site, there is a risk of excessive differential settlement across the site, with consequent cracking of the building. If piles are to be founded in the alluvium, therefore, further geotechnical analysis would be required at the detailed design stage to determine appropriate pile lengths across the proposed building footprint to reduce the risk of excessive differential settlement. Nevertheless, for preliminary design purposes, the suggested maximum ultimate and allowable end bearing capacities for piles founded in at least very stiff alluvial clay are 900 kPa and 350 kPa, respectively.

Alternatively, the piles could be socketed into the underlying sandstone bedrock. The rock encountered in the cored boreholes of this investigation has been classified in accordance with the procedures given in Pells et al (1998), which use a combination of rock strength, fracture spacing and allowable defects to divide the rock into five classes ranging from Class I (high strength with very few defects) to Class V (very low strength and/or highly fractured). The interpreted depth and Reduced Level (RL) at the top of the various rock classes in each of the cored boreholes is shown in Table 11.

Table 11: Summary of Depths (and Reduced Levels) to Top of Various Rock Strata

Borehole	Surface RL (AHD)	Depth (& RL) to Top of Sandstone Strata (m (& m AHD))		
		Class V	Class III	Class II
BH1	8.1	9.9 (-1.8)	NE	12.6 (-4.4)
BH2	7.9	12.9 (-5.0)	17.5 (-9.6)	NE
BH3	7.9	NE	NE	NE
BH4	7.7	NE	NE	NE
BH5	7.9	4.5 (3.4)	NE	NE
BH6	7.3	NE	4.1 (3.2)	6.4 (0.9)

[1]NE = not encountered

The design of foundation piles loaded in axial compression may be based on the parameters suggested in Table 12. In sandstone, shaft adhesion values for uplift (tension) loading may be taken as being equal to 70% of the shaft adhesion values for compression. Shaft adhesion should not be considered for steel screw piles (i.e., only end bearing).

Table 12: Suggested Design Parameters for Foundation Pile Design

Foundation Stratum	Maximum Allowable		Maximum Ultimate		Elastic (Young's) Modulus (MPa)	Poisson's Ratio, ν
	End Bearing (kPa)	Shaft Adhesion[2] (Compression) (kPa)	End Bearing (kPa)	Shaft Adhesion[2] (Compression) (kPa)		
Class V Sandstone	800	75	3000	150	50	0.35
Class III or better Sandstone[1]	3500	400	20,000	800	350	0.25

[1] Class III or better sandstone should not be used for steel screw pile design.
[2] Shaft adhesion will require sidewall (socket) roughness to at least "R2" category, as defined in Pells et al (1998).

Where limit state methods are used to design the piles, the design geotechnical strength (R_{dg}) can be calculated by multiplying the ultimate geotechnical strength (R_{ug}) by a suitable geotechnical strength reduction factor (ϕ_g). Where no pile testing is carried out, a ϕ_g value of 0.4 is suggested.

Piles designed on the allowable parameters in Table 12 are expected to experience settlements in the order of 1% of the pile diameter. Piles designed using the ultimate values also need to consider serviceability / settlements.

It is essential that bored pile / pier sockets be inspected by an experienced geotechnical engineer during drilling to ensure the design parameters adopted are suitable for ground conditions and to ensure that there is no soft or loose material remaining at the base of the excavations. Ground conditions can vary, and it is essential that adequate provision be made throughout the project to vary footing designs to suit differing ground conditions.

As CFA and screw piles are 'blind' piling techniques (and hence not suited to geotechnical inspection), such piles will need to be certified by the piling contractor to confirm that the piles have reached a suitable depth, and that the material encountered is consistent with the design assumptions.

8.8 Seismic Design

Based on the subsurface conditions encountered at the boreholes, the site has been assessed in accordance with Section 4 of AS 1170.4 – 2007 (Structural Design Actions: Part 4 - Earthquake Actions in Australia) and has been assigned to the site sub-soil Class C_e ('Shallow Soil').

8.9 Potential Impacts on Soil Resources

8.9.1 Acid Sulfate Soils

The Acid Sulfate Soils Management Advisory Committee (ASSMAC) prepared an Acid Sulfate Soil Manual (August 1998) which includes guidelines for assessing Actual Acid Sulfate Soils (AASS) and Potential Acid Sulfate Soils (PASS).

The screening test results were assessed for the possible presence of AASS or PASS on the basis of the following guidance indicators specified in the ASSMAC Guidelines:

- $pH_F \leq 4$ strongly indicates oxidation has occurred in the past and that AASS are likely to be present; and
- $pH_{FOX} < 3.5$ plus preferably one or more of the following strongly indicates the presence of PASS, a pH_{FOX} reading at least one pH unit below the corresponding pH_F, a strong reaction with peroxide, change in soil colour from grey tones to brown tones, or a release of sulphurous gases.

Based on the above, all pH_F values were above pH 4 and all PH_{FOX} values were above pH 3.5. Since the results fall below the selected action criteria, it is considered that an Acid Sulfate Soil Management Plan is not warranted at this stage.

8.9.2 Soil Aggressivity

Using a 'worst-case' methodology of classification, the site has 'mildly aggressive' soils to buried steel and concrete elements.

For rafts and ground slabs, an exposure classification of A2 is therefore considered appropriate for the site in accordance with Tables 5.1 and 5.2 of AS 2870, which requires a minimum characteristic compressive strength (f_c') of 25 MPa, a minimum cover to reinforcement of 45 mm and a minimum continuous curing time of three days for a 50-year design life.

With reference to Table 6.4.3 of AS 2159, reinforced concrete bored piles should have a minimum f_c' of 32 MPa and a minimum cover to reinforcement of 60 mm to limit the corrosive effects of the surrounding soils for a 50-year design life.

8.9.3 Soil Salinity

Non-saline to slightly saline conditions were generally found within the investigated depth zones; however, moderately saline soils were found locally within fill at 0.5 m depth at BH6 located at the south-eastern corner of the site. The presence of moderately saline soils suggests that there is potential for salt-induced damage to buried steel and concrete. It is therefore considered that concrete ground slabs and footings should have a minimum compressive strength of 32 MPa with a minimum cover to reinforcement of 50 mm from unprotected ground near the south-eastern corner of the site, and concrete should be allowed to cure for a minimum of seven days to limit the corrosive effects of the surrounding soils.

It is further considered that a Salinity Management Plan may be required for the south-eastern corner of the site where moderately saline fill was encountered.

8.10 Potential Impacts on Groundwater Resources

There is no proposed basement so no significant impact to groundwater systems, sensitive receptors or resources is expected. Water seepage can be expected in deep trench excavations (for utilities) and in pile hole excavations.

Douglas is undertaking at least 3-months of monitoring of water levels in the three groundwater wells, the results of which will be reported in the future.

No groundwater water bores or GDEs are present in the vicinity of the site (see Section 3.2), therefore.

8.11 **Ground Slabs and Pavements**

Following site preparation in accordance with Section 8.3, the prepared surface would be expected to provide adequate support to floor slabs and pavements. Design could be based on a subgrade CBR of 3%, based on the CBR test results obtained and Douglas's experience with subgrade materials of this type.

Ground slabs should be cast independently of the column pads or pile and beam footings and incorporate control joints to allow for differential movements. Edge protection, such as deepened stiffening edge beams (possibly with internal ribs) in conjunction with surface paving should also be included to minimise the effects of reactivity movements.

Care should be taken to avoid external influences on the soil moisture regime. Following reworking and compaction of uncontrolled fill the site classification in accordance with AS 2870:2011, for pavements and ground slabs supported on the natural subgrade, is assessed to be Class M. Detailing of surface and subsurface drainage should be aimed at avoiding substantial wetting of the soils beneath building areas. Surface water should be directed away from building or hardstand areas and services trenches should be backfilled with compacted clay soil to avoid the trench acting as an inlet drain. Subsoil drains to at least 0.5 m below the subgrade level along the high side of all pavements and along all adjacent garden and lawn areas.

Similarly, care should be taken to reduce the drying influence of trees and shrubs on the site soils. The planting of trees or shrubs should be avoided within 1.5 times the mature height of the tree. Reference should also be made to the CSIRO Information Sheet BTF 18 given in Appendix E, which provides further comments on site maintenance and footing performance.

9. References

ANZG. (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Canberra, ACT: Australian and New Zealand Governments and Australian state and territory governments.

AS 1170.4. (2007). *Structural Design Actions, Part 4: Earthquake Actions in Australia.* Reconfirmed 2018. Incorporating Amendments 1 & 2: Standards Australia.

AS 2159. (2009). *Piling - Design and Installation.* Standards Australia.

AS 2870. (2011). *Residential Slabs and Footings.* Standards Australia.

AS 3600. (2018). *Concrete Structures.* including Amendment 1:2018 and Amendment 2:2021: Standard Australia.

AS 3798. (2007). *Guidelines on Earthworks for Commercial and Residential Developments.* Standards Australia.

AS 4678. (2002). *Earth-retaining structures.* Standards Australia.

Australian Soil Resource Information System (ASRIS). (2023, March 3). Retrieved from http://www.asris.csiro.au/

10. Limitations

Douglas Partners Pty Ltd (Douglas) has prepared this report for this project at 171 Victoria Road, Parramatta NSW in accordance with Douglas' proposal dated 24 January 2024 and instructions received from Steven Botterill of Western Sydney University (WSU) dated 14 February 2024. The work was carried out under a Minor Consultancy Agreement (Non-Design Services) between WSU and Douglas. This report is provided for the exclusive use of Western Sydney University 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 sites, 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 sub-surface 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. Sub-surface conditions can change abruptly due to variable geological processes and also 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.

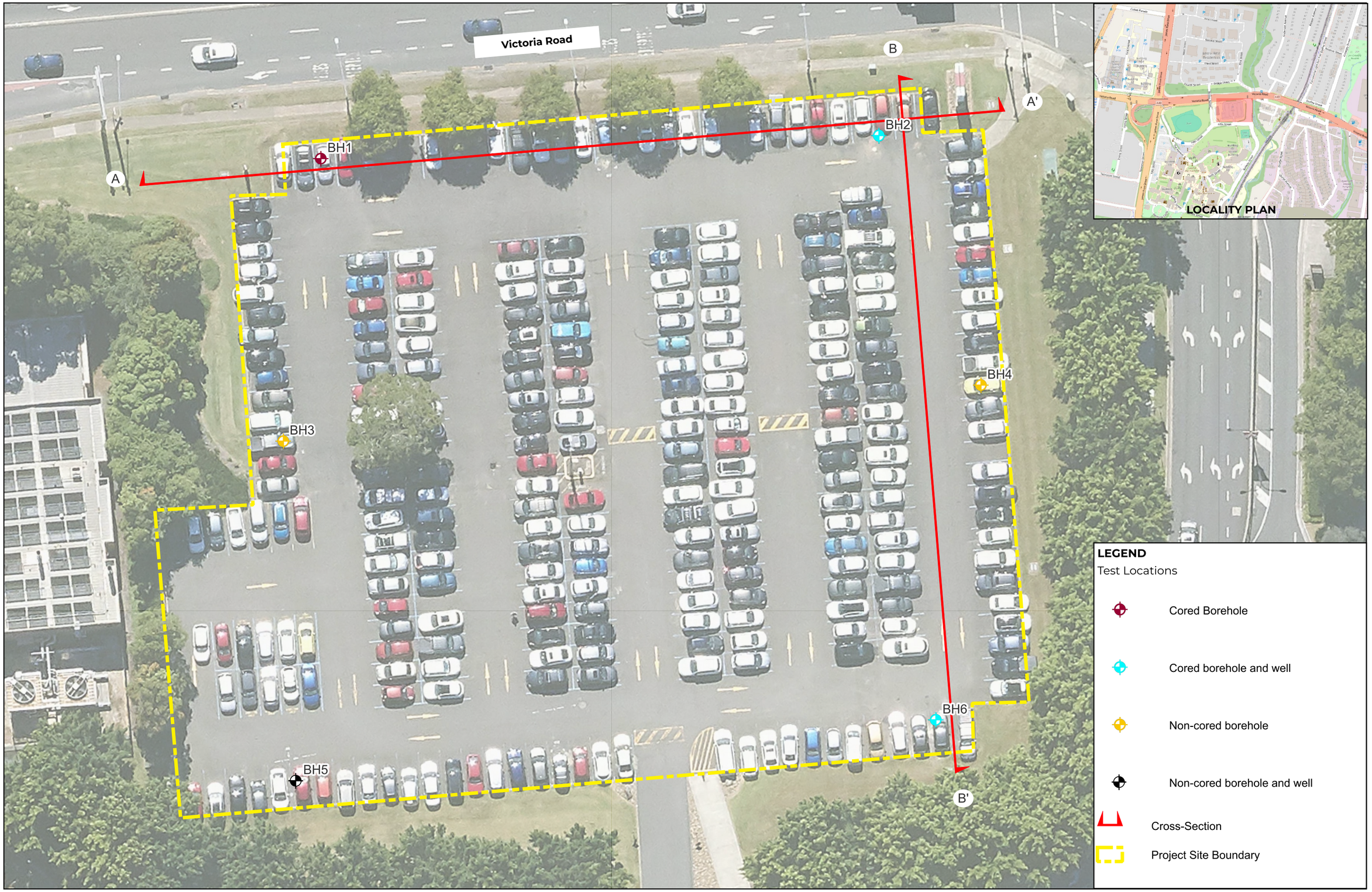
The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical and groundwater components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed ‘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 the attached notes 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

Drawings



REV	DESCRIPTION/COMMENT	DATE	DRAWN BY
0	Test Locations & Sections	16.04.2024	AK
1	Updated Site Address	25.06.2024	AK

SCALE: 0 5 10 15 m — 1:400 @ A3

Douglas PARTNERS
OFFICE: SYDNEY
96-98 Hermitage Rd, West Ryde NSW 2114
(02)9809 0666

CLIENT: **Western Sydney University**

NOTE:
1: Basemap from Metromaps

COORDINATE REFERENCE SYSTEM: GDA2020, MGA ZONE56

PROJECT NAME: **Indigenous Centre of Excellence**

PROJECT ADRESS: **171 Victoria Road, Parramatta**

DRAWING TITLE: **TEST LOCATION PLAN**

PROJECT NO: **227190.00**

DRAWING NO: **1**

REVISION: **1**

A WEST — SOUTH A'

APPROXIMATE SITE BOUNDARY

APPROXIMATE SITE BOUNDARY

BH1

BH2

Asphaltic Concrete (wearing surface)

Fill

Alluvium

Sandstone

CLASS V

CLASS II

CLASS V

CLASS III

ELEVATION (AHD)

14.0 12.0 10.0 8.0 6.0 4.0 2.0 0.0 -2.0 -4.0 -6.0 -8.0 -10.0 -12.0 -14.0 -16.0

0 10 20 30 40 50 60 70 80 90 100

DISTANCE ALONG PROFILE (m)

LEGEND

- ASPHALTIC CONCRETE
- CI - Medium Plasticity CLAY
- CI-CH - Medium to High Plasticity CLAY
- CLAY
- Sandy CLAY
- NO CORE
- FILL
- SANDSTONE
- SC - Clayey SAND

TESTS / OTHER

- Interpreted geotechnical boundary
- Water level
- Interpreted Groundwater Level

REV	DESCRIPTION/COMMENT	DATE	DRAWN BY
0	INITIAL ISSUE	19.04.2024	EC

SCALE: 0 1 2 4 6 8 10 15

1:300 @ A3
Vertical Exaggeration = 2.0

Douglas PARTNERS
OFFICE: SYDNEY
96-98 Hermitage Rd, West Ryde NSW 2114
(02) 9809 0666

CLIENT:
Western Sydney University

NOTES
1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only and should be read in conjunction with detailed logs.
3. Horizontal and vertical scales are not equal.

PROJECT NAME:
Indigenous Centre of Excellence

PROJECT ADDRESS:
171 Victoria Road, Rydalmere

DRAWING TITLE:
INTERPRETED GEOTECHNICAL CROSS SECTION A-A'

PROJECT No: **227190.00**

DRAWING No: **2**

REVISION: **0**

B NORTH — SOUTH B'

APPROXIMATE SITE BOUNDARY

APPROXIMATE SITE BOUNDARY

VICTORIA ROAD

BH2

BH4

BH6

Asphaltic Concrete (wearing surface)

Fill

Alluvium

Residual Soil

Extremely Weathered Sandstone

Sandstone

CLASS V

CLASS III

CLASS III

CLASS II

ELEVATION (AHD)

14.0 12.0 10.0 8.0 6.0 4.0 2.0 0.0 -2.0 -4.0 -6.0 -8.0 -10.0 -12.0 -14.0 -16.0

0 10 20 30 40 50 60 70 80 90 100

DISTANCE ALONG PROFILE (m)

LEGEND

- ASPHALTIC CONCRETE
- CH - High Plasticity CLAY
- CI - Medium Plasticity CLAY
- CI-CH - Medium to High Plasticity CLAY
- CLAY
- Sandy CLAY
- NO CORE
- FILL
- Clayey SAND
- Some/scattered Sand
- SANDSTONE
- SC - Clayey SAND

TESTS / OTHER

- Interpreted geotechnical boundary
- Water level
- Interpreted Groundwater Level

REV	DESCRIPTION/COMMENT	DATE	DRAWN BY
0	INITIAL ISSUE	19.04.2024	EC

SCALE: 0 1 2 4 6 8 10 15

1:300 @ A3
Vertical Exaggeration = 2.0

Douglas PARTNERS
OFFICE: SYDNEY
96-98 Hermitage Rd, West Ryde NSW 2114
(02) 9809 0666

CLIENT:
Western Sydney University

NOTES
1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only and should be read in conjunction with detailed logs.
3. Horizontal and vertical scales are not equal.

PROJECT NAME:
Indigenous Centre of Excellence

PROJECT ADDRESS:
171 Victoria Road, Rydalmere

DRAWING TITLE:
INTERPRETED GEOTECHNICAL CROSS SECTION B-B'

PROJECT No: **227190.00**

DRAWING No: **3**

REVISION: **0**

Appendix B

Notes

About this Report

November 2023

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

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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Terminology, Symbols and Abbreviations

November 2023

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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Soil Descriptions

Terminology
Symbols
Abbreviations

March 2024

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".

Soil Descriptions

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	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.

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:

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

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

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.

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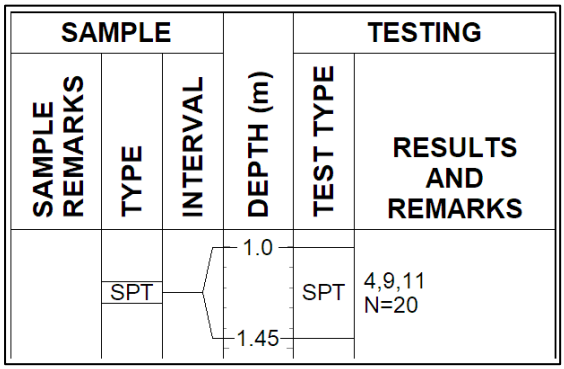
Sampling, Testing and Excavation Methodology

Terminology
Symbols
Abbreviations

March 2024

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:



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(_)
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]
Vibrocore	VC[1]
Vacuum excavation	VE
Wash bore (unspecified bit type)	WB[1]

[1] – numeric suffixes indicate tool diameter/width in mm

Douglas PARTNERS

Cone Penetration Testing

November 2023

Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination (from vertical) i
- Depth below ground z

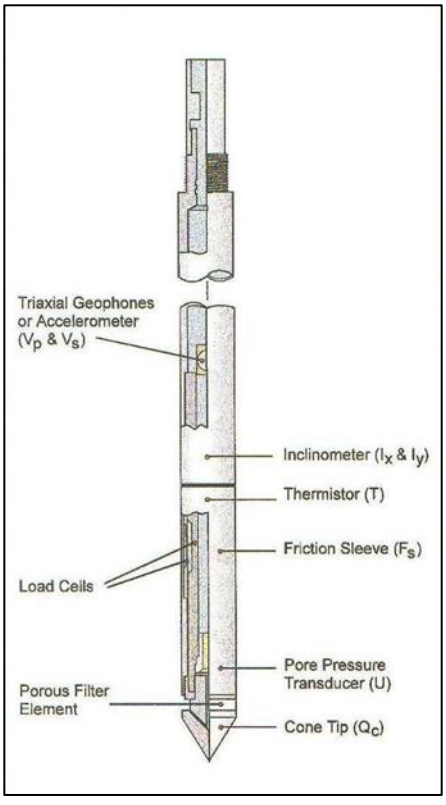


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.



Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (qc, fs, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (□) plus basic parameters
Seismic	Shear wave velocity (Vs), compression wave velocity (Vp), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration testing

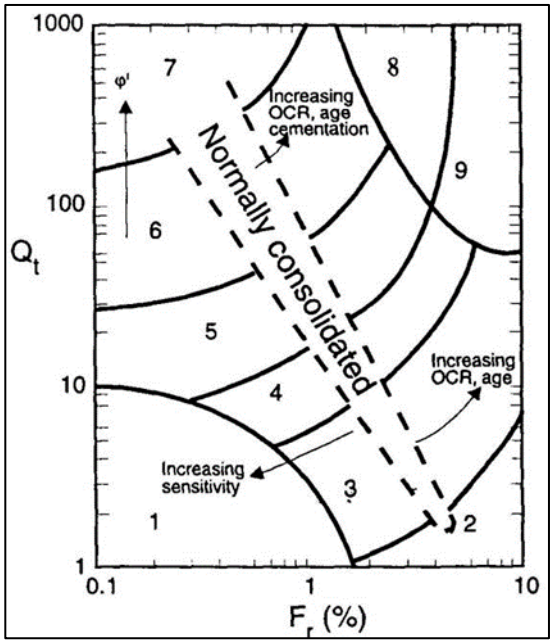


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation.

The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

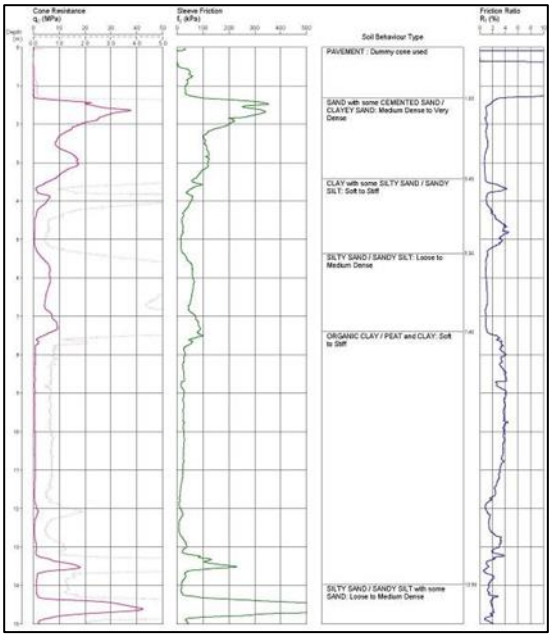


Figure 4: Sample Cone Plot

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Appendix C

Field Work Results

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 8.1 AHD
COORDINATE: E:317339.2, N:6257241.3
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH1
PROJECT No: 227190.00
DATE: 01/03/24 - 02/03/24
SHEET: 1 of 3

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN[#]	CONSIS.[*] / DENSITY.[*]	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
		0.10	ASPHALTIC CONCRETE: wearing surface			NA	NA		A/ES		0.10		
			FILL / Sandy GRAVEL: grey; fine to medium; fine to coarse sand; (probably roadbase).		FILL	(WC)	D to M		A/ES		0.50		
		0.60			FILL								
		0.70	FILL / CLAY AND GRAVEL; mixture.										
	7	1	CLAY (CI-CH): grey mottled orange-brown; medium to high plasticity.		ALV	F	w>PL		A/ES		1.00	SPT	0,2,3 N=5
									A/ES		1.50		
	6	2.00	CLAY (CI-CH): grey stained red-brown; medium to high plasticity.		ALV				A		2.00		
									A		2.50	SPT	4,5,7 N=12
	5	3									3		
		3.55	CORE LOSS: 650mm										
	4	4									4		
		4.20	CLAY (CI-CH): grey stained red-brown; medium to high plasticity.		ALV								
		4.50	CORE LOSS: 900mm			St	w<PL						
	3	5									5		
		5.40	CLAY (CI-CH): grey stained red-brown; medium to high plasticity.		ALV								
		5.80	CORE LOSS: 1200mm										
	2	6									6		
		7.00	CLAY (CI-CH): grey stained red-brown; medium to high plasticity.		ALV								
		7.20											
		7.40	CORE LOSS: 200mm		ALV								
	1	7.74	Sandy CLAY (CI): grey and dark grey mottled red-brown; medium plasticity; fine to medium sand; with iron-cemented bands; possibly tertiary-aged alluvium.								7		
		7.88	CORE LOSS: 140mm										
	0	8	Sandy CLAY (CI): grey and dark grey; medium plasticity; fine sand.		ALV	F	w=PL				8	PP	80kPa
	-1	9									9	PP	85kPa
												PP	90kPa
	-2	9.85											
		10	Continued as rock								10		

Possible seepage between 7.2m and 7.9m during auger drilling 01/03/24

Generated with CORE-GS by Geroc - Split Soil-Rock Log

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: Comacchio 205
METHOD: AD/T to 2.5m; NMLC to 15.9m
REMARKS:

OPERATOR: Terratest

LOGGED: JBC/CC/AK
CASING: HW to 2.5m

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 8.1 AHD
COORDINATE: E:317339.2, N:6257241.3
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH1
PROJECT No: 227190.00
DATE: 01/03/24 - 02/03/24
SHEET: 2 of 3

CONDITIONS ENCOUNTERED													SAMPLE				TESTING			
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)	DEFECTS & REMARKS	SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
Possible seepage between 7.2m and 7.9m during auger drilling 01/03/24	8	0			DW PS XW HW MW SW FR	0.00	VL L M H VH EH												
	7	1						100	0						1				
	6	2						32	0						2				
	5	3						31	0						3				
	4	4						14	0						4				
	3	5						81	0						5				
	2	6						100	0						6				
	1	7													7				
	0	8	Continued from soil												8				
	-1	9	SANDSTONE: pale grey-brown grading to orange-brown stained red-brown, fine to medium grained. Hawkesbury Sandstone		SEAM HW	9.85	SEAM VL	100	0	SEAM	9.88-10.02m: DS				9				
	-2	10	CORE LOSS: 110mm		SEAM	10.02	SEAM	100	0	SEAM	10.06-10.08m: DS 10.13-10.17m: CS 10.44m: JT, 50°, UN, CN, RF				10	PLT PP	PL(A)=0.09MPa 70kPa		
		10.09 10.20			HW SEAM	10.17 10.53	VL SEAM	100	0	SEAM	10.62-10.76m: DS								
					SEAM	10.77 10.80	SEAM			SEAM									

NOTES: [a] Soil origin is "probable" unless otherwise stated.

Generated with CORE-GS by Geroc - Split Soil-Rock Log

PLANT: Comacchio 205
METHOD: AD/T to 2.5m; NMLC to 15.9m
REMARKS:

OPERATOR: Terratest

LOGGED: JBC/CC/AK
CASING: HW to 2.5m

Douglas PARTNERS

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 8.1 AHD
COORDINATE: E:317339.2, N:6257241.3
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH1
PROJECT No: 227190.00
DATE: 01/03/24 - 02/03/24
SHEET: 3 of 3

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	WEATH. (DW: PS, XW, HW, MW, SW, FR)	DEPTH (m)	STRENGTH (VL, L, M, H, VH, EH)	RECOVERY (%)	RQD	FRACTURE SPACING (m) (0.03, 0.06, 0.20, 0.60, 2.00, 6.00)	DEFECTS & REMARKS	SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
	3		SANDSTONE: pale grey-brown grading to orange-brown stained red-brown, fine to medium grained. Hawkesbury Sandstone		SEAM		SEAM	88	0	SEAM	10.80-11.96m: DS					PP	115kPa		
	12	-4			HW	11.96	L								12	PLT	PL(A)=0.06MPa		
					SEAM	12.08	SEAM	100	0	SEAM	12.08m: B, 5°, PR, SN, RF 12.10-12.64m: DS					PP	145kPa		
						12.64										PP	55kPa		
	13	-5			MW		H	100	83		12.71m: B, 10°, PR, CN, RF				13	PLT	PL(A)=1.1MPa		
								100	100		13.34m: B, 10°, UN, CN, RF								
	14	-6													14	PLT	PL(A)=1MPa		
	14.40		SANDSTONE: brown, fine to medium grained. Hawkesbury Sandstone		HW	14.39 14.42	H				14.39m: B, 5°, PR, SN, RF 14.39-14.42m: CS								
	15	-7													15				
	15.13		SANDSTONE: pale grey stained orange-brown, medium to coarse grained. Hawkesbury Sandstone		SW	15.13		100	51		15.06-15.13m: B x4x, 5-10°, UN, SN CBS, RF 15.20m: B, 10°, ST, CN, RF								
					SW to MW	15.49	H				15.49-15.50m: CS 15.55m: B, 0°, PR, CN, RF 15.57m: B, 5°, PR, CN, RF					PLT	PL(A)=0.96MPa		
	16	-8	Borehole discontinued at 15.90m depth. Limit of investigation.																
	17	-9																	
	18	-10																	
	19	-11																	
	20	-12																	
	21	-13																	

NOTES: [a] Soil origin is "probable" unless otherwise stated.

PLANT: Comacchio 205
METHOD: AD/T to 2.5m; NMLC to 15.9m
REMARKS:

OPERATOR: Terratest

LOGGED: JBC/CC/AK
CASING: HW to 2.5m

Refer to explanatory notes for symbol and abbreviation definitions

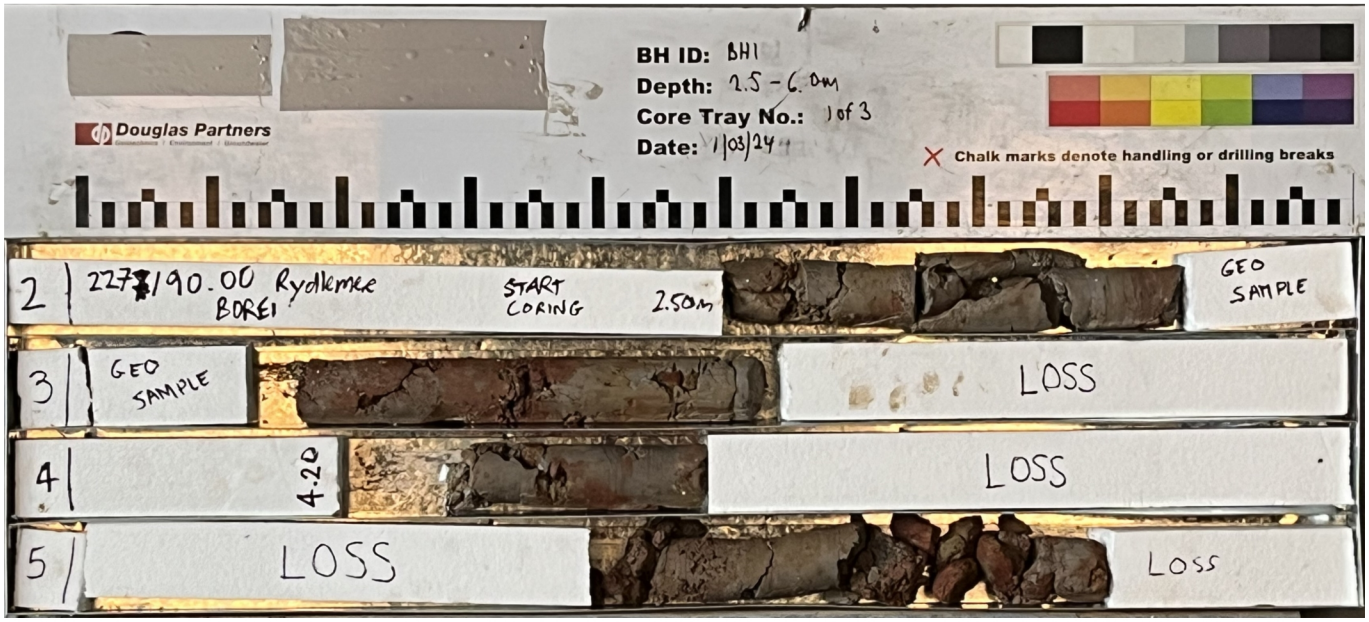
Generated with CORE-GS by Geroc - Split Soil-Rock Log

CORE PHOTO LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 8.1 AHD
COORDINATE: E:317339.2, N:6257241.3
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH1
PROJECT No: 227190.00
DATE: 01/03/24 - 02/03/24
SHEET: 1 of 2



Box 1 of 3: 2.50-6.00 m depth



Box 2 of 3: 6.00-11.00 m depth

Generated with CORE-GS by Geroc - Split Soil-Rock Log

CORE PHOTO LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 8.1 AHD
COORDINATE: E:317339.2, N:6257241.3
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH1
PROJECT No: 227190.00
DATE: 01/03/24 - 02/03/24
SHEET: 2 of 2



Box 3 of 3: 11.00-15.90 m depth

Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 7.9 AHD
COORDINATE: E:317401.5, N:6257243.8
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH2
PROJECT No: 227190.00
DATE: 09/03/24
SHEET: 1 of 3

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN[#]	CONSIS.[*] / DENSITY.[*]	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
		0.02	ASPHALTIC CONCRETE: 20mm thick wearing surface		FILL	(WC)	D		ES		0.10			Bentonite Concrete Flush cover	
		0.30	FILL / SAND: dark grey and dark brown; with igneous gravel; trace silt and asphalt fragments; slight bituminous odour.			St			* ES		0.50				
	7	1	CLAY (CI-CH): brown, red-brown and pale grey; medium to high plasticity; trace rootlets .						ES		1.00	SPT	4,6,8 N=14		50mm
						VSt			ES		1.50				
▼ 24/03/24	6	2							ES		2.00				
									* ES		2.50	SPT	3,7,10 N=17		
	5	3	From 3.50m: trace silt			H			ES		3.00				
									ES		3.50				
	4	4	From 4.00m: bands of iron cemented soil (ironstone)		ALV				ES		4.00				
									U50		4.45			Gravel	
	3	5					w=PL		ES		5.00	SPT	8,18,14 N=32		50mm
									ES		5.50				
	2	6	From 6.50m: trace fine to medium sand			VSt			ES		6.00				
									ES		6.50	SPT	5,8,14 N=22		
	1	7							ES		7.00				
	0	8									8	PP	235-205kPa		
		8.50	Silty CLAY (CI): grey mottled red-brown and orange-brown; medium plasticity.											Bentonite	
	-1	9			ALV	VSt to H					9	PP	370-340kPa		
												PP	410kPa		

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: Comacchio MC450 P1
OPERATOR: Terratest
LOGGED: JBC/AK
METHOD: AD/T to 7.5m; NMLC to 17.9m
CASING: HW to 7.5m
REMARKS: *Field Replicate BD1/20243009 taken from 0.5m, BD02/20240309 taken from 2.5m

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 7.9 AHD
COORDINATE: E:317401.5, N:6257243.8
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH2
PROJECT No: 227190.00
DATE: 09/03/24
SHEET: 2 of 3

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS			
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(##)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
	10 / 2	[CONT] Silty CLAY (CI): grey mottled red-brown and orange-brown; medium plasticity. From 9.60m: dark-grey mottled red-brown and brown		ALV	VSt to H	w=PL				10	PP	455-375kPa	Gravel	
	11 / 3									11	PP	370-340kPa		
	11.93 / 4	Clayey SAND (SC): grey; fine to medium; medium plasticity clay.		ALV	(D)	W				12				
	12.90 / 5	Continued as rock								13				
	14 / 6									14				
	15 / 7									15				
	16 / 8									16				
	17 / 9									17				
	18 / 10									18				
	19 / 11									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.

PLANT: Comacchio MC450 P1
OPERATOR: Terratest
LOGGED: JBC/AK
METHOD: AD/T to 7.5m; NMLC to 17.9m
CASING: HW to 7.5m
REMARKS: *Field Replicate BD1/20243009 taken from 0.5m, BD02/20240309 taken from 2.5m

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 7.9 AHD
COORDINATE: E:317401.5, N:6257243.8
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH2
PROJECT No: 227190.00
DATE: 09/03/24
SHEET: 3 of 3

CONDITIONS ENCOUNTERED													SAMPLE				TESTING			
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)	DEFECTS & REMARKS	SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
	10 / 2						100	0						10				
	11 / 3													11				
	12 / 4						100	11		12.50m: , Unless otherwise noted, defects are B, 0-10 degrees, PR, RF, CN				12				
		Continued from soil																
	13 / 5	SANDSTONE: pale grey-brown, fine to medium grained. Hawkesbury Sandstone		SW	12.90	M				13.03m: B, 10°, PR, SN, RF				13	PLT	PL(A)=1.5MPa	Gravel	
				MW	13.35					13.43m: B, PR, VNR Clay, RF								
				SEAM	13.85	SEAM			SEAM									
	14 / 6			SW	14.09	L to M				13.85-14.35m: DS, Clay				14	PLT	PL(A)=0.25MPa		
				SEAM	14.45	SEAM			SEAM	14.40m: JT, 70°, UN, INF Clay 3mm, RF								
	14.70 / 7	CORE LOSS: 300mm			14.70		87	79		14.45-14.65m: DS, Clay								
	15.00	SANDSTONE: pale grey-brown stained orange-brown and red-brown, fine to medium grained. Hawkesbury Sandstone		MW	15.00	L to M				15.18m: B, PR, SN CBS, RF				15	PLT	PL(A)=0.35MPa		
	15.43			SEAM	15.30	SEAM			SEAM									
	15.61				15.43					15.61-15.66m: DS, Clay								
		CORE LOSS: 170mm			15.61													
	16 / 8	SANDSTONE: pale grey-brown stained orange-brown, fine to medium grained. Hawkesbury Sandstone		SW	15.66	M								16	PLT	PL(A)=0.94MPa		
					16.00													
				SW														
				SW to FR	16.70	M												
	17.03 / 9	SANDSTONE: orange-brown stained red-brown, medium to coarse grained. Hawkesbury Sandstone		MW	17.03		100	97		16.98m: B, UN, CN, RF				17	PLT	PL(A)=0.46MPa		
										17.17m: B, 5°, UN, CN, RF								
				SEAM	17.33	SEAM			SEAM	17.33-17.49m: DS								
				MW	17.49	H				17.60m: CS								
				MW	17.60	H												
	18 / 10	Borehole discontinued at 17.90m depth. Limit of investigation.																
	19 / 11																	

NOTES: [a] Soil origin is "probable" unless otherwise stated.

PLANT: Comacchio MC450 P1
METHOD: AD/T to 7.5m; NMLC to 17.9m
REMARKS: *Field Replicate BD1/20243009 taken from 0.5m, BD02/20240309 taken from 2.5m

OPERATOR: Terratest

LOGGED: JBC/AK
CASING: HW to 7.5m

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Split Soil-Rock Log

CORE PHOTO LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 7.9 AHD
COORDINATE: E:317401.5, N:6257243.8
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH2
PROJECT No: 227190.00
DATE: 09/03/24
SHEET: 1 of 2



Box 1 of 3: 7.50-12.00 m depth



Box 2 of 3: 12.00-17.00 m depth

Generated with CORE-GS by Geroc - Split Soil-Rock Log

CORE PHOTO LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 7.9 AHD
COORDINATE: E:317401.5, N:6257243.8
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH2
PROJECT No: 227190.00
DATE: 09/03/24
SHEET: 2 of 2



Biox 3 of 3: 17.00-17.90 m depth

Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 7.9 AHD
COORDINATE: E:317335.0, N:6257209.8
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH3
PROJECT No: 227190.00
DATE: 10/03/24
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	SAMPLE TYPE	SAMPLE INTERVAL	DEPTH (m)	TESTING AND REMARKS: TEST TYPE	TESTING AND REMARKS: RESULTS AND REMARKS
10/03/24 Possible groundwater seepage at 1.0m whilst auger drilling		0.05	CONCRETE AND ROADBASE GRAVEL						ES		0.10		
			FILL / CLAY, SAND AND GRAVEL.		FILL	(VC)	D / w<PL		A/ES		0.50		
	7	1							A/ES		1.00		
		1.10	FILL / GRAVELLY SANDSTONE, SAND AND GRAVEL.		FILL							SPT	2,4,4 N=8
		1.50	Sandy CLAY (CH): grey-brown; high plasticity; medium sand.						A/ES		1.50		
	6	2			ALV	St	w<PL		A/ES		2.00		
									A		2.50		
		2.80	CLAY (CI): dark grey mottled red and brown; medium plasticity; trace sand. Teritary alluvium.									SPT	3,6,10 N=16
	5	3							A		3.00		
					ALV				A		3.50		
	4	4									4	SPT	9,10,13 N=23
		4.50	CLAY (CH): dark grey mottled red and brown; high plasticity. Tertiary alluvium.						A		4.50		
	3	5							A		5.00		
												SPT	8,14,16 N=30
	2	6				VSt	w=PL		A		6.00		
									A		6.50		
	1	7			ALV						7	SPT	5,8,11 N=19
									A		7.50		
	0	8							A		8.00		
	-1	9									9	SPT	7,8,11 N=19
	-2		Borehole discontinued at 10.00m depth. Limit of investigation - hole caved in.										

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: Comacchio 405
METHOD: AD/T to 10.0m
REMARKS:

OPERATOR: Terratest

LOGGED: CC
CASING: Uncased

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Soil Log

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 7.7 AHD
COORDINATE: E:317412.8, N:6257216.0
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH4
PROJECT No: 227190.00
DATE: 10/03/24
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(##)	CONSIS.(*) DENSITY.(*)	MOISTURE	REMARKS	SAMPLE TYPE	SAMPLE INTERVAL	DEPTH (m)	TESTING TEST TYPE	TESTING RESULTS AND REMARKS
		0.05	ASPHALTIC CONCRETE: wearing surface FILL / CLAY AND GRAVEL; mixture.		FILL	(VC)	D / w<PL		ES		0.10		
		0.50	CLAY (CI): orange-brown; medium plasticity; trace sand .		ALV				A/ES		0.50		
		1									1	SPT	6,9,11 N=20 no recovery
		1.50							A/ES		1.50		
		2					w<PL		A/ES		2.00		
		2.50	CLAY (CI-CH): red and grey grading to grey mottled brown and red; medium to high plasticity; trace fine sand.		ALV	VSt						SPT	6,8,11 N=19
		3							A		3.00		
		3.50							A		3.50		
▼ 10/03/24		4	From 4.00m-5.00m: pale grey-brown						A		4.00	SPT	7,10,14 N=24
		4.50					w=PL		A		4.50		
		5.00	CLAY (CH): dark red; high plasticity.		ALV				A		5.00		
		5.50							A		5.50	SPT	7,9,11 N=20
		6					w>PL		A		6.00		
		6.50	CLAY (CH): dark grey; high plasticity; with sand .		ALV	H			A		6.50		
		7									7		
		7.20	SAND (SP): grey; fine to medium; with low plasticity fines.		RS	D	M to W					SPT	12,16,18 N=34
		8									8		
			Borehole discontinued at 8.50m depth. Limit of investigation - due to sidewall collapse below 7.2m.									SPT	no sample and recovery
		9											

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: Comacchio 405
METHOD: AD/T to 8.50m
REMARKS:

OPERATOR: Terratest

LOGGED: CC
CASING: Uncased

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Soil Log

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 7.9 AHD
COORDINATE: E:317336.6, N:6257172.0
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH5
PROJECT No: 227190.00
DATE: 10/03/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE			TESTING AND REMARKS			
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(##)	CONSIS.(*) DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL / WELL PIPE
	7	0.05	ASPHALTIC CONCRETE: wearing surface FILL / CLAY AND GRAVEL; mixture.		FILL	(WC)	D / w<PL		ES		0.10			Bentonite Concrete Flush cover
		0.70	CLAY (CI): grey mottled brown; medium plasticity; with sand.		ALV				A/ES		0.50			
		1.00	CLAY (CI); medium plasticity; with sand; medium quartz; well sorted. Alluvium.		ALV	St	w<PL		A/ES		1.00			
▼ 24/03/24	6	2.00	Sandy CLAY (CL): grey; low plasticity; fine sand.						A/B/ES		1.20	SPT	4,5,6 N=11	
			From 3.00m: brown mottled red-brown		RS	F	w=PL		A/ES		2.50	SPT	3,3,4 N=7 No recovery	Gravel
	5	3				VSt					3			50mm
	4	4									4	SPT	6,9,18 N=27	
	3	4.45	SANDSTONE: orange-grey mottled red-brown, fine to medium grained; distinctly weathered. Hawkesbury Sandstone											50mm
	2	5	Borehole discontinued at 4.50m depth. Limit of investigation.											
	1	6												
	0	7												
	-1	8												
	-2	9												

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: Comacchio 405
METHOD: AD/T to 4.5m
REMARKS:

OPERATOR: Terratest

LOGGED: CC
CASING: Uncased

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Soil Log

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 7.3 AHD
COORDINATE: E:317407.8, N:6257178.7
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH6
PROJECT No: 227190.00
DATE: 09/03/24
SHEET: 1 of 2

CONDITIONS ENCOUNTERED							SAMPLE				TESTING AND REMARKS			
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(##)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
	7 / 0.05	ASPHALTIC CONCRETE: wearing surface											Concrete Flush cover	
		FILL / Gravelly SAND: grey; fine to coarse; fine to medium gravel.		FILL	(WC)	D								
	0.50	FILL / CLAY AND GRAVEL; mixture.		FILL	(VC)	M / w<PL								
	6 / 1.00	FILL / CLAY: pale brown-orange; medium plasticity; with fine to medium sand.		FILL	(WC)	w<PL				1	SPT	4,8,18 N=26		
	1.50	Sandy CLAY (CI): orange-brown; medium plasticity; fine to medium sand.		ALV	(VSt)	D							Backfill	
	5 / 2.00	Clayey SAND (SC): orange-brown mottled red-brown; fine to medium; low plasticity clay.		ALV possibly RS	(MD)	D to M				2			Bentonite	50mm
	2.50	Clayey SAND (SC): red-brown; medium to coarse; low plasticity clay.		RS	MD					3	SPT	12,10,9 N=19		
	4 / 3.10	Clayey SAND (SC): pale grey-brown; medium to coarse; low plasticity clay; extremely weathered sandstone.		XWM	(VD)	D								
	3 / 4.10	Continued as rock								4				
24/03/24	2									5			Gravel	50mm
	1									6				
	0									7				
	-1									8				
	-2									9				
	-3									10				

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: Comacchio 405
METHOD: AD/T to 4.1m; NMLC to 9.85m
REMARKS:

OPERATOR: Terratest

LOGGED: CC/AK
CASING: HW to 4.1m

Refer to explanatory notes for symbol and abbreviation definitions

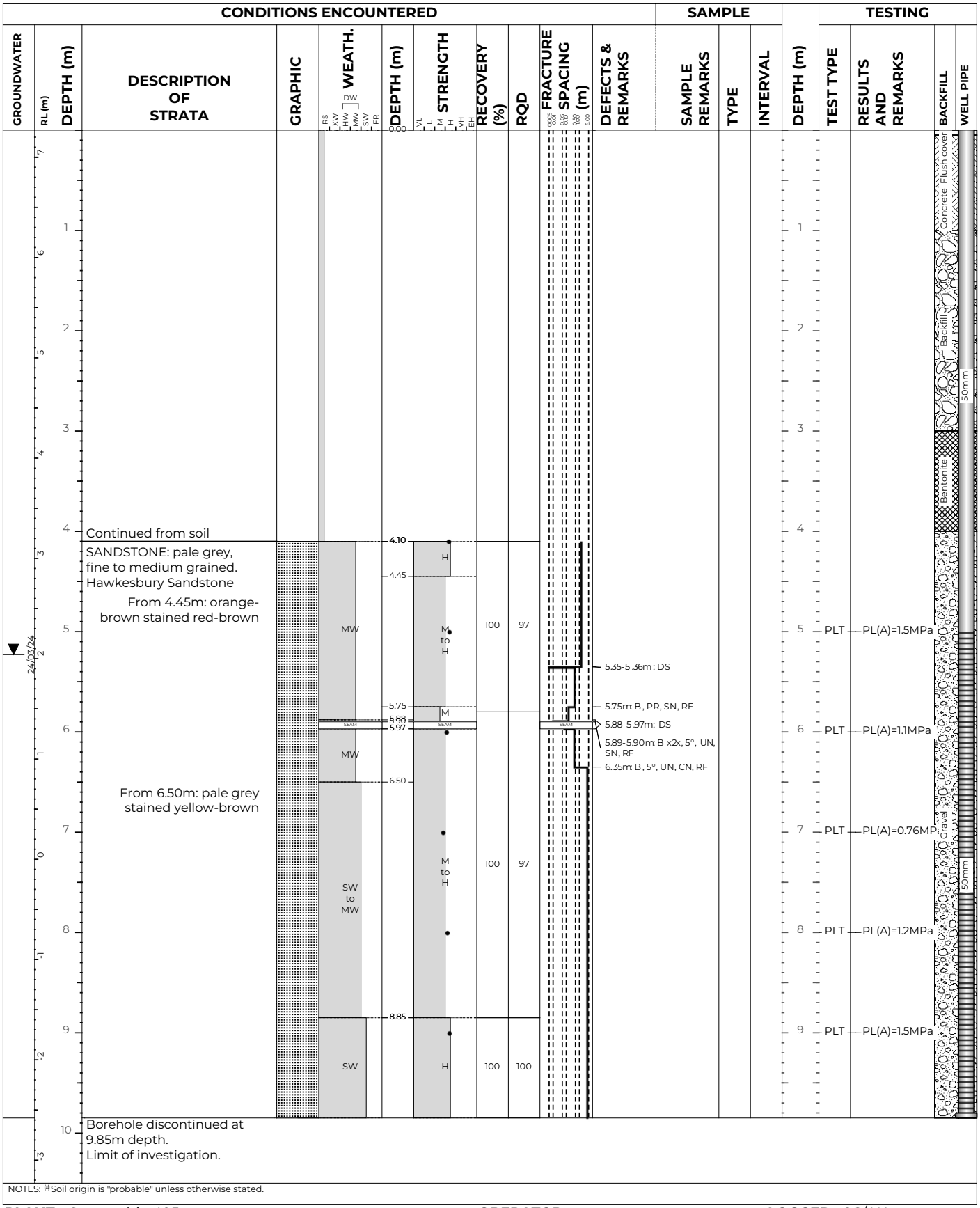
Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 7.3 AHD
COORDINATE: E:317407.8, N:6257178.7
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH6
PROJECT No: 227190.00
DATE: 09/03/24
SHEET: 2 of 2



NOTES: [a] Soil origin is "probable" unless otherwise stated.

Generated with CORE-GS by Geroc - Split Soil-Rock Log

PLANT: Comacchio 405
METHOD: AD/T to 4.1m; NMLC to 9.85m
REMARKS:

OPERATOR: Terratest

LOGGED: CC/AK
CASING: HW to 4.1m

Refer to explanatory notes for symbol and abbreviation definitions

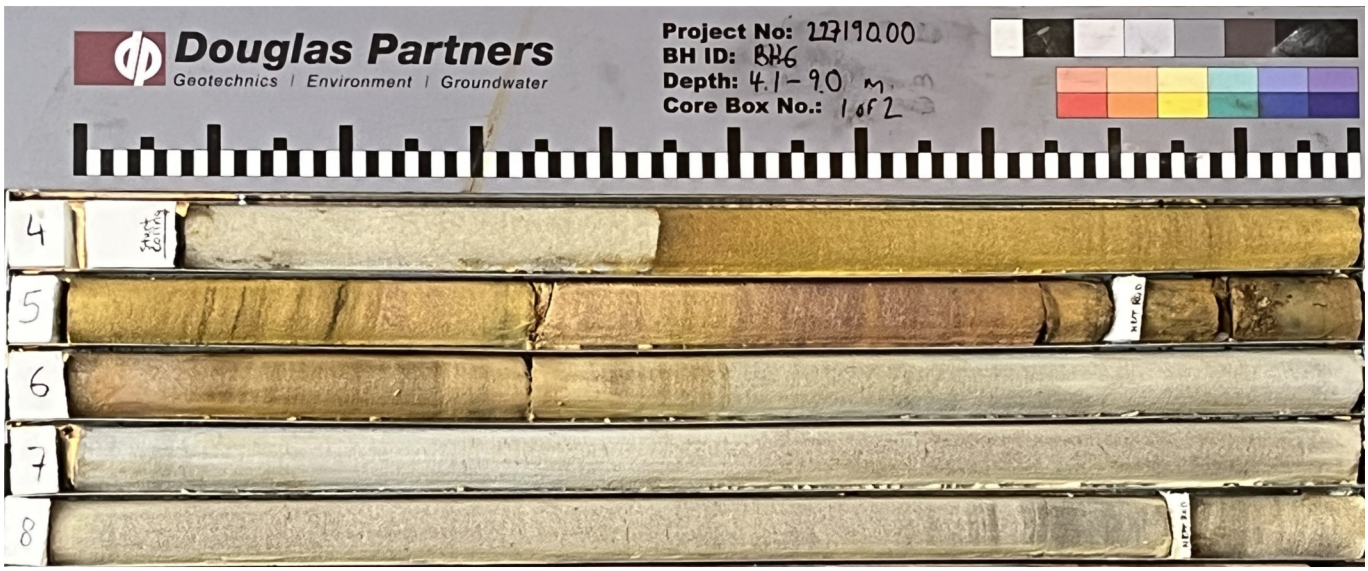
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CORE PHOTO LOG

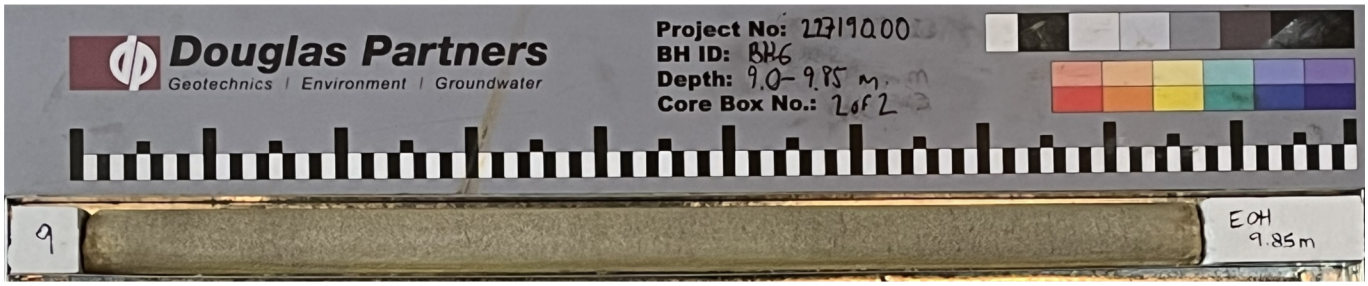
CLIENT: Western Sydney University
PROJECT: Indigenous Centre of Excellence
LOCATION: 171 Victoria Road, Parramatta, NSW

SURFACE LEVEL: 7.3 AHD
COORDINATE: E:317407.8, N:6257178.7
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH6
PROJECT No: 227190.00
DATE: 09/03/24
SHEET: 1 of 1



Box 1 of 2: 4.10-9.00 m depth



Box 2 of 2: 9.00-9.85 m depth

Generated with CORE:GS by Geroc - Split Soil-Rock Log

Appendix D

Laboratory Test Results

Material Test Report

Report Number:	**227190.00-1**
Issue Number:	2 - *This version supersedes all previous issues*
Reissue Reason:	*Addition of ISS result*
Date Issued:	18/04/2024
Client:	Western Sydney University
	Victoria Road, Rydalmere NSW 2116
Contact:	Mikayla Renwick
Project Number:	227190.00
Project Name:	Indigenous Centre of Excellence
Project Location:	171 Victoria Road, Rydalmere NSW
Work Request:	11280
Sample Number:	SY-11280A
Date Sampled:	10/03/2024
Dates Tested:	19/03/2024 - 09/04/2024
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:	**BH2 (1.0-1.5m)**
Material:	CLAY: red-brown and pale grey, trace rootlets

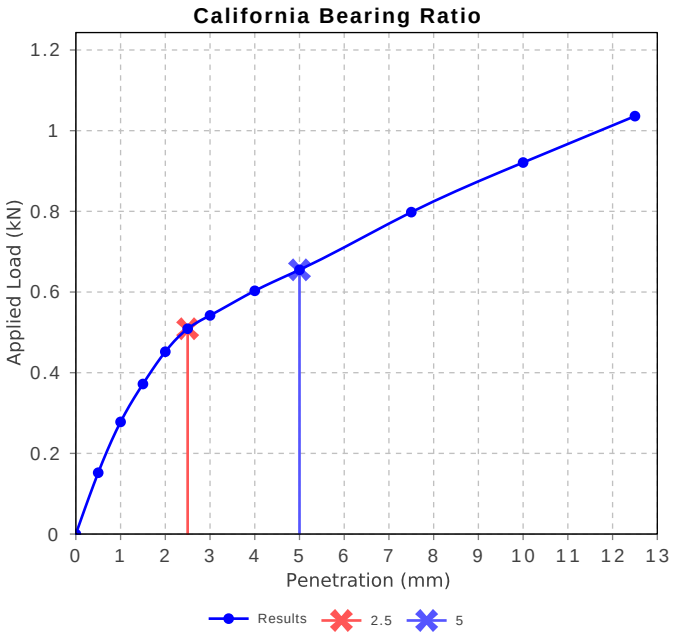
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Email: andrew.hutchings@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Andrew Hutchings
Associate / Laboratory Manager
Laboratory Accreditation Number: 828

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**4.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.62		
Optimum Moisture Content (%)	23.5		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	98.5		
Dry Density after Soaking (t/m^3)	1.59		
Field Moisture Content (%)	25.3		
Moisture Content at Placement (%)	23.3		
Moisture Content Top 30mm (%)	27.6		
Moisture Content Rest of Sample (%)	24.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours (h)	75.8		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	CLAY: red-brown and pale grey		
Nature of Water	Demineralised		
Temperature of Water (^{o}C)	22		



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Results relate only to the items tested/sampled.

Material Test Report

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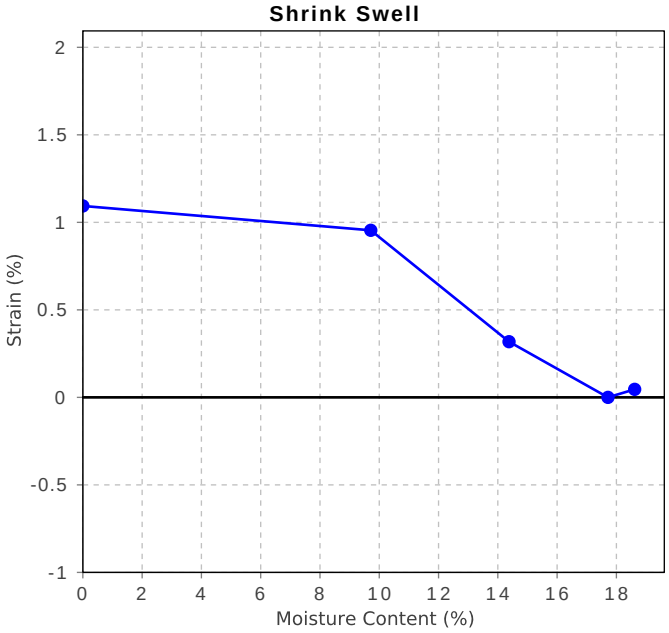
Approved Signatory: Andrew Hutchings
Associate / Laboratory Manager
Laboratory Accreditation Number: 828

Report Number:	**227190.00-1**
Issue Number:	2 - *This version supersedes all previous issues*
Reissue Reason:	*Addition of ISS result*
Date Issued:	18/04/2024
Client:	Western Sydney University
	Victoria Road, Rydalmere NSW 2116
Contact:	Mikayla Renwick
Project Number:	227190.00
Project Name:	Indigenous Centre of Excellence
Project Location:	171 Victoria Road, Rydalmere NSW
Work Request:	11280
Sample Number:	SY-11280B
Date Sampled:	10/03/2024
Dates Tested:	19/03/2024 - 19/03/2024
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:	**BH2 (4-4.45m)**
Material:	CLAY: brown, red-brown and pale grey, bands of iron cemented stone/ironstone

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**0.6**
Visual Description	CLAY: brown, red-brown and pale grey, bands of iron cemented stone/ironstone
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**1.1**
Estimated % by volume of significant inert inclusions	0
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	17.7

Swell Test	
Initial Pocket Penetrometer (kPa)	220
Final Pocket Penetrometer (kPa)	250
Initial Moisture Content (%)	17.9
Final Moisture Content (%)	18.6
Swell (%)	**-0.0**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



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Material Test Report

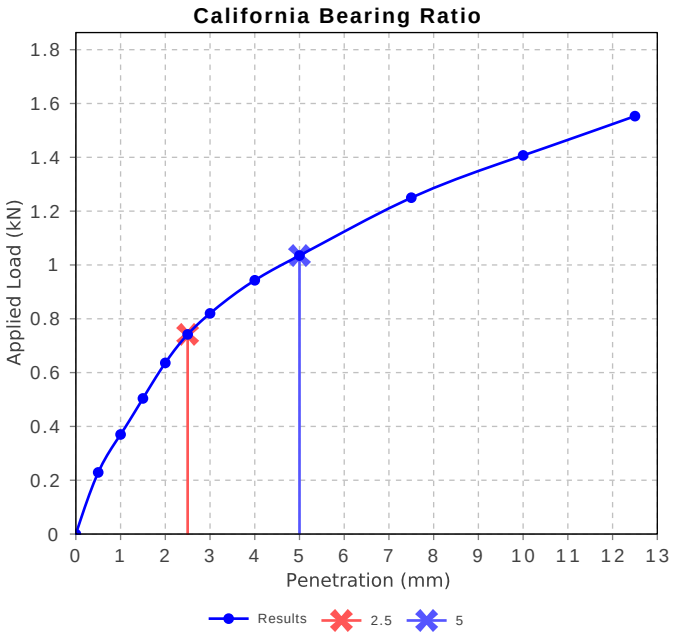
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Report Number:	**227190.00-1**
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Reissue Reason:	*Addition of ISS result*
Date Issued:	18/04/2024
Client:	Western Sydney University
	Victoria Road, Rydalmere NSW 2116
Contact:	Mikayla Renwick
Project Number:	227190.00
Project Name:	Indigenous Centre of Excellence
Project Location:	171 Victoria Road, Rydalmere NSW
Work Request:	11280
Sample Number:	SY-11280C
Date Sampled:	10/03/2024
Dates Tested:	19/03/2024 - 09/04/2024
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:	**BH5 (1.0-1.5m)**
Material:	CLAY: with sand, medium quartz

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**6**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.90		
Optimum Moisture Content (%)	14.5		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	97.5		
Dry Density after Soaking (t/m^3)	1.91		
Field Moisture Content (%)	16.2		
Moisture Content at Placement (%)	14.2		
Moisture Content Top 30mm (%)	16.7		
Moisture Content Rest of Sample (%)	15.8		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours (h)	75.8		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



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Material Test Report

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Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Andrew Hutchings
Associate / Laboratory Manager
Laboratory Accreditation Number: 828

Report Number: **227190.00-1**
Issue Number: 2 - *This version supersedes all previous issues*
Reissue Reason: *Addition of ISS result*
Date Issued: 18/04/2024
Client: Western Sydney University
Victoria Road, Rydalmere NSW 2116
Contact: Mikayla Renwick
Project Number: 227190.00
Project Name: Indigenous Centre of Excellence
Project Location: 171 Victoria Road, Rydalmere NSW
Work Request: 11280
Sample Number: SY-11280E
Date Sampled: 10/03/2024
Dates Tested: 19/03/2024 - 21/03/2024
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: **BH6 (2.5-2.95m)**
Material: Sandy CLAY: red-brown, coarse sand

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	Sandy Clay		
Nature of Water	Demineralised		
Temperature of Water (^{o}C)	22		

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www.envirolab.com.au

CERTIFICATE OF ANALYSIS 345656

Client Details

Client	Douglas Partners Pty Ltd
Attention	Atha Kapitanof
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**227190.00 Rydalmere**
Number of Samples	6 Soil
Date samples received	05/03/2024
Date completed instructions received	05/03/2024

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	13/03/2024
Date of Issue	13/03/2024

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Results Approved By
Diego Bigolin, Inorganics Supervisor
Nick Sarlamis, Assistant Operation Manager

Authorised By
Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		345656-1	345656-2	345656-3	345656-4	345656-5
Your Reference	UNITS	BH1	BH1	BH1	BH1	BH1
Depth		0.5-0.6	1.0-1.1	1.5-1.6	2.0-2.1	2.5-2.6
Date Sampled		01/03/2024	01/03/2024	01/03/2024	01/03/2024	01/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	13/03/2024	13/03/2024	13/03/2024	13/03/2024	13/03/2024
Date analysed	-	13/03/2024	13/03/2024	13/03/2024	13/03/2024	13/03/2024
Estimated Salinity*	mg/kg	900	670	520	300	250

Misc Inorg - Soil		
Our Reference		345656-6
Your Reference	UNITS	BH1
Depth		3.0-3.1
Date Sampled		01/03/2024
Type of sample		Soil
Date prepared	-	13/03/2024
Date analysed	-	13/03/2024
Estimated Salinity*	mg/kg	180

sPOCAS field test						
Our Reference		345656-1	345656-2	345656-3	345656-4	345656-5
Your Reference	UNITS	BH1	BH1	BH1	BH1	BH1
Depth		0.5-0.6	1.0-1.1	1.5-1.6	2.0-2.1	2.5-2.6
Date Sampled		01/03/2024	01/03/2024	01/03/2024	01/03/2024	01/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	06/03/2024	06/03/2024	06/03/2024	06/03/2024	06/03/2024
Date analysed	-	07/03/2024	07/03/2024	07/03/2024	07/03/2024	07/03/2024
pH_F (field pH test)	pH Units	8.3	8.7	8.3	5.2	5.6
pH_{FOX} (field peroxide test)	pH Units	7.2	5.8	6.2	4.7	4.0
Reaction Rate*	-	Medium reaction	Medium reaction	Medium reaction	Medium reaction	Medium reaction

sPOCAS field test		
Our Reference		345656-6
Your Reference	UNITS	BH1
Depth		3.0-3.1
Date Sampled		01/03/2024
Type of sample		Soil
Date prepared	-	06/03/2024
Date analysed	-	07/03/2024
pH_F (field pH test)	pH Units	5.5
pH_{FOX} (field peroxide test)	pH Units	3.7
Reaction Rate*	-	Medium reaction

Method ID	Methodology Summary
Inorg-034	Soil samples are extracted and measured using a conductivity cell and dedicated meter.
Inorg-063	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			13/03/2024	1	13/03/2024	13/03/2024		13/03/2024	[NT]
Date analysed	-			13/03/2024	1	13/03/2024	13/03/2024		13/03/2024	[NT]
Estimated Salinity*	mg/kg	5	Inorg-034	<5	1	900	950	5	106	[NT]

QUALITY CONTROL: sPOCAS field test						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			06/03/2024	[NT]	[NT]	[NT]	[NT]	06/03/2024	[NT]
Date analysed	-			07/03/2024	[NT]	[NT]	[NT]	[NT]	07/03/2024	[NT]
pH_F (field pH test)	pH Units		Inorg-063	[NT]	[NT]	[NT]	[NT]	[NT]	100	[NT]
pH_{FOX} (field peroxide test)	pH Units		Inorg-063	[NT]	[NT]	[NT]	[NT]	[NT]	100	[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.

Douglas PARTNERS

CHAIN OF CUSTODY DESPATCH SHEET

Project No:	227190.00	**Suburb:**	Rydalmere	**To:**	Envirolab Services
Project Manager:	Atha Kapitanof	**Order Number:**	-	**Sampler:**	CC
					12 Ashley St, Chatswood NSW 2067
Email:	atha.kapitanof@douglaspartners.com.au			**Attn:**	Sample Receipt
Turnaround time	☑ Standard ☐ 72 hour ☐ 48 hour ☐ 24 hour ☐ Same day				(02) 9910 6200 samplereceipt@envirolab.com
Prior Storage	☐ Fridge ☑ Freezer ☐ Esky ☐ Shelf	**Do samples contain 'potential' HBM?**	☐ No ☐ Yes (If YES, handle, transport, store in accordance with FPM HAZID)		

Lab ID	Sample ID: Location / Other ID	Depth From	Depth To	Date Sampled	Sample Type: S - soil W - water M - Material	Container Type: G - glass P - plastic	Analytes: ASS	Salinity									Notes/ Preservation/ Additional Requirements
1	BH1	0.5	0.6	1/03/24	S	P	x	x									
2	BH1	1.0	1.1	1/03/24	S	P	x	x									
3	BH1	1.5	1.6	1/03/24	S	P	x	x									
4	BH1	2.0	2.1	1/03/24	S	P	x	x									
5	BH1	2.5	2.6	1/03/24	S	P	x	x									
6	BH1	3.0	3.1	1/3/24	S	P	X	X									

ENVIROLAB

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 345656
Date Received 5/3/24
Time Received 1700
Received By: DL
Temp: Cool/Ambient 1°C -
Cooling Ice/Icepack
Security: Intact/Broken/None

Metals to analyse:	✓		
Number of samples in container:	6	**Transported to laboratory by:**	Courier
Send results to:	Douglas Partners Pty Ltd		
Address:	96 Hermitage Road, West Ryde NSW 211	**Phone:**	(02) 9809 0666
Relinquished by:	CC	**Date:**	5/03/2024
		Signed:	

LAB RECEIPT

Lab Ref. No:	345656
Received by:	DL Huynh
Date & Time	5/3/24. 1700
Signed:	

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

CERTIFICATE OF ANALYSIS 347582

Client Details

Client	Douglas Partners Pty Ltd
Attention	Atha Kapitanof
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**227190.00 Rydalmere**
Number of Samples	3 Water
Date samples received	26/03/2024
Date completed instructions received	26/03/2024

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	04/04/2024
Date of Issue	04/04/2024

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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
Dragana Tomas, Senior Chemist
Loren Bardwell, Development Chemist
Sean McAlary, Chemist (FAS)
Timothy Toll, Senior Chemist

Authorised By
Nancy Zhang, Laboratory Manager

VOCs in water		
Our Reference		347582-1
Your Reference	UNITS	BH2
Date Sampled		24/03/2024
Type of sample		Water
Date Extracted	-	30/03/2024
Date Analysed	-	02/04/2024
Dichlorodifluoromethane	µg/L	<10
Chloromethane	µg/L	<10
Vinyl Chloride	µg/L	<10
Bromomethane	µg/L	<10
Chloroethane	µg/L	<10
Trichlorofluoromethane	µg/L	<10
1,1-Dichloroethene	µg/L	<1
Trans-1,2-dichloroethene	µg/L	<1
1,1-dichloroethane	µg/L	<1
Cis-1,2-dichloroethene	µg/L	<1
Bromochloromethane	µg/L	<1
Chloroform	µg/L	15
2,2-dichloropropane	µg/L	<1
1,2-dichloroethane	µg/L	<1
1,1,1-trichloroethane	µg/L	<1
1,1-dichloropropene	µg/L	<1
Cyclohexane	µg/L	<1
Carbon tetrachloride	µg/L	<1
Benzene	µg/L	<1
Dibromomethane	µg/L	<1
1,2-dichloropropane	µg/L	<1
Trichloroethene	µg/L	<1
Bromodichloromethane	µg/L	2
trans-1,3-dichloropropene	µg/L	<1
cis-1,3-dichloropropene	µg/L	<1
1,1,2-trichloroethane	µg/L	1
Toluene	µg/L	<1
1,3-dichloropropane	µg/L	<1
Dibromochloromethane	µg/L	<1
1,2-dibromoethane	µg/L	<1
Tetrachloroethene	µg/L	<1
1,1,1,2-tetrachloroethane	µg/L	<1
Chlorobenzene	µg/L	<1
Ethylbenzene	µg/L	<1

VOCs in water		
Our Reference		347582-1
Your Reference	UNITS	BH2
Date Sampled		24/03/2024
Type of sample		Water
Bromoform	µg/L	<1
m+p-xylene	µg/L	<2
Styrene	µg/L	<1
1,1,2,2-tetrachloroethane	µg/L	<1
o-xylene	µg/L	<1
1,2,3-trichloropropane	µg/L	<1
Isopropylbenzene	µg/L	<1
Bromobenzene	µg/L	<1
n-propyl benzene	µg/L	<1
2-chlorotoluene	µg/L	<1
4-chlorotoluene	µg/L	<1
1,3,5-trimethyl benzene	µg/L	<1
Tert-butyl benzene	µg/L	<1
1,2,4-trimethyl benzene	µg/L	<1
1,3-dichlorobenzene	µg/L	<1
Sec-butyl benzene	µg/L	<1
1,4-dichlorobenzene	µg/L	<1
4-isopropyl toluene	µg/L	<1
1,2-dichlorobenzene	µg/L	<1
n-butyl benzene	µg/L	<1
1,2-dibromo-3-chloropropane	µg/L	<1
1,2,4-trichlorobenzene	µg/L	<1
Hexachlorobutadiene	µg/L	<1
1,2,3-trichlorobenzene	µg/L	<1
Surrogate Dibromofluoromethane	%	99
Surrogate Toluene-d8	%	100
Surrogate 4-Bromofluorobenzene	%	100

vTRH(C6-C10)/BTEXN in Water		
Our Reference		347582-1
Your Reference	UNITS	BH2
Date Sampled		24/03/2024
Type of sample		Water
Date extracted	-	30/03/2024
Date analysed	-	02/04/2024
TRH C_6 - C_9	µg/L	37
TRH C_6 - C_{10}	µg/L	43
TRH C_6 - C_{10} less BTEX (F1)	µg/L	43
Benzene	µg/L	<1
Toluene	µg/L	<1
Ethylbenzene	µg/L	<1
m+p-xylene	µg/L	<2
o-xylene	µg/L	<1
Naphthalene	µg/L	<1
Surrogate Dibromofluoromethane	%	99
Surrogate Toluene-d8	%	100
Surrogate 4-Bromofluorobenzene	%	100

svTRH (C10-C40) in Water		
Our Reference		347582-1
Your Reference	UNITS	BH2
Date Sampled		24/03/2024
Type of sample		Water
Date extracted	-	28/03/2024
Date analysed	-	29/03/2024
TRH C_{10} - C_{14}	µg/L	130
TRH C_{15} - C_{28}	µg/L	<100
TRH C_{29} - C_{36}	µg/L	<100
Total +ve TRH (C10-C36)	µg/L	130
TRH >C_{10} - C_{16}	µg/L	130
TRH >C_{10} - C_{16} less Naphthalene (F2)	µg/L	130
TRH >C_{16} - C_{34}	µg/L	<100
TRH >C_{34} - C_{40}	µg/L	<100
Total +ve TRH (>C10-C40)	µg/L	130
Surrogate o-Terphenyl	%	90

PAHs in Water		
Our Reference		347582-1
Your Reference	UNITS	BH2
Date Sampled		24/03/2024
Type of sample		Water
Date extracted	-	28/03/2024
Date analysed	-	02/04/2024
Naphthalene	µg/L	<0.1
Acenaphthylene	µg/L	<0.1
Acenaphthene	µg/L	<0.1
Fluorene	µg/L	<0.1
Phenanthrene	µg/L	<0.1
Anthracene	µg/L	<0.1
Fluoranthene	µg/L	<0.1
Pyrene	µg/L	<0.1
Benzo(a)anthracene	µg/L	<0.1
Chrysene	µg/L	<0.1
Benzo(b,j+k)fluoranthene	µg/L	<0.2
Benzo(a)pyrene	µg/L	<0.1
Indeno(1,2,3-c,d)pyrene	µg/L	<0.1
Dibenzo(a,h)anthracene	µg/L	<0.1
Benzo(g,h,i)perylene	µg/L	<0.1
Benzo(a)pyrene TEQ	µg/L	<0.5
Total +ve PAH's	µg/L	<0.1
Surrogate p-Terphenyl-d14	%	106

Organochlorine Pesticides in Water		
Our Reference		347582-1
Your Reference	UNITS	BH2
Date Sampled		24/03/2024
Type of sample		Water
Date extracted	-	28/03/2024
Date analysed	-	02/04/2024
alpha-BHC	µg/L	<0.2
HCB	µg/L	<0.2
beta-BHC	µg/L	<0.2
gamma-BHC	µg/L	<0.2
Heptachlor	µg/L	<0.2
delta-BHC	µg/L	<0.2
Aldrin	µg/L	<0.2
Heptachlor Epoxide	µg/L	<0.2
gamma-Chlordane	µg/L	<0.2
alpha-Chlordane	µg/L	<0.2
Endosulfan I	µg/L	<0.2
pp-DDE	µg/L	<0.2
Dieldrin	µg/L	<0.2
Endrin	µg/L	<0.2
Endosulfan II	µg/L	<0.2
pp-DDD	µg/L	<0.2
Endrin Aldehyde	µg/L	<0.2
pp-DDT	µg/L	<0.2
Endosulfan Sulphate	µg/L	<0.2
Methoxychlor	µg/L	<0.2
Mirex	ug/L	<0.2
Surrogate 4-Chloro-3-NBTF	%	97

OP Pesticides in Water		
Our Reference	UNITS	347582-1
Your Reference		BH2
Date Sampled		24/03/2024
Type of sample		Water
Date extracted	-	28/03/2024
Date analysed	-	02/04/2024
Dichlorvos	µg/L	<0.2
Mevinphos	µg/L	<0.2
Phorate	µg/L	<0.2
Dimethoate	µg/L	<0.2
Diazinon	µg/L	<0.2
Disulfoton	µg/L	<0.2
Chlorpyriphos-methyl	µg/L	<0.2
Parathion-Methyl	µg/L	<0.2
Ronnel	µg/L	<0.2
Fenitrothion	µg/L	<0.2
Malathion	µg/L	<0.2
Chlorpyriphos	µg/L	<0.2
Fenthion	µg/L	<0.2
Parathion	µg/L	<0.2
Bromophos ethyl	µg/L	<0.2
Methidathion	µg/L	<0.2
Fenamiphos	µg/L	<0.2
Ethion	µg/L	<0.2
Phosalone	µg/L	<0.2
Azinphos-methyl (Guthion)	µg/L	<0.2
Coumaphos	µg/L	<0.2
Surrogate 4-Chloro-3-NBTF	%	97

PCBs in Water		
Our Reference		347582-1
Your Reference	UNITS	BH2
Date Sampled		24/03/2024
Type of sample		Water
Date extracted	-	28/03/2024
Date analysed	-	02/04/2024
Aroclor 1016	µg/L	<2
Aroclor 1221	µg/L	<2
Aroclor 1232	µg/L	<2
Aroclor 1242	µg/L	<2
Aroclor 1248	µg/L	<2
Aroclor 1254	µg/L	<2
Aroclor 1260	µg/L	<2
Surrogate 2-Fluorobiphenyl	%	100

Total Phenolics in Water		
Our Reference		347582-1
Your Reference	UNITS	BH2
Date Sampled		24/03/2024
Type of sample		Water
Date extracted	-	28/03/2024
Date analysed	-	28/03/2024
Total Phenolics (as Phenol)	mg/L	<0.05

HM in water - dissolved		
Our Reference		347582-1
Your Reference	UNITS	BH2
Date Sampled		24/03/2024
Type of sample		Water
Date prepared	-	28/03/2024
Date analysed	-	28/03/2024
Arsenic-Dissolved	µg/L	<1
Cadmium-Dissolved	µg/L	<0.1
Chromium-Dissolved	µg/L	<1
Copper-Dissolved	µg/L	<1
Lead-Dissolved	µg/L	<1
Mercury-Dissolved	µg/L	<0.05
Nickel-Dissolved	µg/L	2
Zinc-Dissolved	µg/L	21
Iron-Dissolved	µg/L	1,400

Miscellaneous Inorganics		
Our Reference	UNITS	347582-1
Your Reference		BH2
Date Sampled		24/03/2024
Type of sample		Water
Date prepared	-	27/03/2024
Date analysed	-	27/03/2024
pH	pH Units	6.0
Electrical Conductivity	µS/cm	490
Chloride, Cl	mg/L	72
Sulphate, SO4	mg/L	63
Ferrous Iron	mg/L	1.3
Ferric Iron (by calculation)	mg/L	0.11

PFAS in Water TRACE Short		
Our Reference		347582-1
Your Reference	UNITS	BH2
Date Sampled		24/03/2024
Type of sample		Water
Date prepared	-	02/04/2024
Date analysed	-	02/04/2024
Perfluorohexanesulfonic acid - PFHxS	µg/L	0.0033
Perfluorooctanesulfonic acid PFOS	µg/L	0.0040
Perfluorooctanoic acid PFOA	µg/L	0.001
6:2 FTS	µg/L	<0.0004
8:2 FTS	µg/L	<0.0004
Surrogate $^{13}C_8$ *PFOS*	%	98
Surrogate $^{13}C_2$ *PFOA*	%	95
Extracted ISTD $^{18}O_2$ *PFHxS*	%	81
Extracted ISTD $^{13}C_4$ *PFOS*	%	81
Extracted ISTD $^{13}C_4$ *PFOA*	%	103
Extracted ISTD$^{13}C_2$ *6:2FTS*	%	#
Extracted ISTD $^{13}C_2$ *8:2FTS*	%	187
Total Positive PFHxS & PFOS	µg/L	0.0073
Total Positive PFOS & PFOA	µg/L	0.0052
Total Positive PFAS	µg/L	0.0085

Cations in water Dissolved		
Our Reference	UNITS	347582-1
Your Reference		BH2
Date Sampled		24/03/2024
Type of sample		Water
Date digested	-	28/03/2024
Date analysed	-	28/03/2024
Calcium - Dissolved	mg/L	8.3
Magnesium - Dissolved	mg/L	3
Hardness	mgCaCO 3 /L	33

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-031	Total Phenolics by segmented flow analyser (in line distillation with colourimetric finish). Solids are extracted in a caustic media prior to analysis.
Inorg-076	Ferrous Iron is determined colourimetrically by discrete analyser. Waters samples are filtered on receipt prior to analysis.
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.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS. Please note for Bromine and Iodine, any forms of these elements that are present are included together in the one result reported for each of these two elements. Salt forms (e.g. FeO, PbO, ZnO) are determinined stoichiometrically from the base metal concentration.
Org-020	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-021/022/025	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD and/or GC-MS/GC-MSMS. Note, the Total +ve PCBs PQL is reflective of the lowest individual PQL and is therefore" Total +ve PCBs" is simply a sum of the positive individual PCBs.
Org-022/025	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS/GC-MSMS.
Org-022/025	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS/GC-MSMS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013.
Org-023	Water samples are analysed directly by purge and trap GC-MS.
Org-023	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.

Method ID	Methodology Summary
Org-029	Soil samples are extracted with basified Methanol. Waters and soil extracts are directly injected and/or concentrated/extracted using SPE. TCLPs/ASLP leachates are centrifuged, the supernatant is then analysed (including amendment with solvent) - as per the option in AS4439.3. Analysis is undertaken with LC-MS/MS. PFAS results include the sum of branched and linear isomers where applicable. Please note that PFAS results are corrected for Extracted Internal Standards (QSM 5.4 Table B-15 terminology), which are mass labelled analytes added prior to sample preparation to assess matrix effects and verify processing of the sample. PFAS analytes without a commercially available mass labelled analogue are corrected vs a closely eluting mass labelled PFAS compound. Surrogates are also reported, in this context they are mass labelled PFAS compounds added prior to extraction but are used as monitoring compounds only (not used for result correction). Envicarb (or similar) is used discretionally to remove interfering matrix components. Please contact the laboratory if estimates of Measurement Uncertainty are required as per WA DER.

QUALITY CONTROL: VOCs in water					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W3	[NT]
Date Extracted	-			30/03/2024	[NT]	[NT]	[NT]	[NT]	30/03/2024	[NT]
Date Analysed	-			02/04/2024	[NT]	[NT]	[NT]	[NT]	02/04/2024	[NT]
Dichlorodifluoromethane	µg/L	10	Org-023	<10	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chloromethane	µg/L	10	Org-023	<10	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Vinyl Chloride	µg/L	10	Org-023	<10	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Bromomethane	µg/L	10	Org-023	<10	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chloroethane	µg/L	10	Org-023	<10	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Trichlorofluoromethane	µg/L	10	Org-023	<10	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,1-Dichloroethene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Trans-1,2-dichloroethene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,1-dichloroethane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	110	[NT]
Cis-1,2-dichloroethene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Bromochloromethane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chloroform	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	109	[NT]
2,2-dichloropropane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2-dichloroethane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	106	[NT]
1,1,1-trichloroethane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	113	[NT]
1,1-dichloropropene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Cyclohexane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Carbon tetrachloride	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	113	[NT]
Dibromomethane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2-dichloropropane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Trichloroethene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	112	[NT]
Bromodichloromethane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	110	[NT]
trans-1,3-dichloropropene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
cis-1,3-dichloropropene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,1,2-trichloroethane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Toluene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	112	[NT]
1,3-dichloropropane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Dibromochloromethane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	111	[NT]
1,2-dibromoethane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Tetrachloroethene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	114	[NT]
1,1,1,2-tetrachloroethane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chlorobenzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Ethylbenzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	121	[NT]
Bromoform	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
m+p-xylene	µg/L	2	Org-023	<2	[NT]	[NT]	[NT]	[NT]	122	[NT]
Styrene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,1,2,2-tetrachloroethane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

QUALITY CONTROL: VOCs in water					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W3	[NT]
o-xylene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	121	[NT]
1,2,3-trichloropropane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Isopropylbenzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Bromobenzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
n-propyl benzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
2-chlorotoluene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
4-chlorotoluene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,3,5-trimethyl benzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Tert-butyl benzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2,4-trimethyl benzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,3-dichlorobenzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Sec-butyl benzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,4-dichlorobenzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
4-isopropyl toluene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2-dichlorobenzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
n-butyl benzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2-dibromo-3-chloropropane	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2,4-trichlorobenzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Hexachlorobutadiene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2,3-trichlorobenzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate Dibromofluoromethane	%		Org-023	93	[NT]	[NT]	[NT]	[NT]	102	[NT]
Surrogate Toluene-d8	%		Org-023	94	[NT]	[NT]	[NT]	[NT]	99	[NT]
Surrogate 4-Bromofluorobenzene	%		Org-023	101	[NT]	[NT]	[NT]	[NT]	108	[NT]

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Water					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W4	[NT]
Date extracted	-			30/03/2024	[NT]	[NT]	[NT]	[NT]	30/03/2024	[NT]
Date analysed	-			02/04/2024	[NT]	[NT]	[NT]	[NT]	02/04/2024	[NT]
TRH C_6 - C_9	µg/L	10	Org-023	<10	[NT]	[NT]	[NT]	[NT]	116	[NT]
TRH C_6 - C_{10}	µg/L	10	Org-023	<10	[NT]	[NT]	[NT]	[NT]	116	[NT]
Benzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	110	[NT]
Toluene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	112	[NT]
Ethylbenzene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	119	[NT]
m+p-xylene	µg/L	2	Org-023	<2	[NT]	[NT]	[NT]	[NT]	119	[NT]
o-xylene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	118	[NT]
Naphthalene	µg/L	1	Org-023	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate Dibromofluoromethane	%		Org-023	93	[NT]	[NT]	[NT]	[NT]	83	[NT]
Surrogate Toluene-d8	%		Org-023	94	[NT]	[NT]	[NT]	[NT]	101	[NT]
Surrogate 4-Bromofluorobenzene	%		Org-023	101	[NT]	[NT]	[NT]	[NT]	107	[NT]

QUALITY CONTROL: svTRH (C10-C40) in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date extracted	-			28/03/2024	1	28/03/2024	28/03/2024		28/03/2024	[NT]
Date analysed	-			29/03/2024	1	29/03/2024	29/03/2024		29/03/2024	[NT]
TRH C_{10} - C_{14}	µg/L	50	Org-020	<50	1	130	140	7	108	[NT]
TRH C_{15} - C_{28}	µg/L	100	Org-020	<100	1	<100	<100	0	113	[NT]
TRH C_{29} - C_{36}	µg/L	100	Org-020	<100	1	<100	<100	0	114	[NT]
TRH >C_{10} - C_{16}	µg/L	50	Org-020	<50	1	130	140	7	108	[NT]
TRH >C_{16} - C_{34}	µg/L	100	Org-020	<100	1	<100	<100	0	113	[NT]
TRH >C_{34} - C_{40}	µg/L	100	Org-020	<100	1	<100	<100	0	114	[NT]
Surrogate o-Terphenyl	%		Org-020	85	1	90	96	6	88	[NT]

QUALITY CONTROL: PAHs in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	[NT]
Date extracted	-			28/03/2024	1	28/03/2024	28/03/2024		28/03/2024	[NT]
Date analysed	-			02/04/2024	1	02/04/2024	02/04/2024		02/04/2024	[NT]
Naphthalene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	91	[NT]
Acenaphthylene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Acenaphthene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	85	[NT]
Fluorene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	82	[NT]
Phenanthrene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	98	[NT]
Anthracene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Fluoranthene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	97	[NT]
Pyrene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	99	[NT]
Benzo(a)anthracene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Chrysene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	80	[NT]
Benzo(b,j+k)fluoranthene	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Benzo(a)pyrene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	98	[NT]
Indeno(1,2,3-c,d)pyrene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Dibenzo(a,h)anthracene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Benzo(g,h,i)perylene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-022/025	103	1	106	116	9	93	[NT]

QUALITY CONTROL: Organochlorine Pesticides in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	[NT]
Date extracted	-			28/03/2024	1	28/03/2024	28/03/2024		28/03/2024	[NT]
Date analysed	-			02/04/2024	1	02/04/2024	02/04/2024		02/04/2024	[NT]
alpha-BHC	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	86	[NT]
HCB	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
beta-BHC	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	87	[NT]
gamma-BHC	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Heptachlor	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	93	[NT]
delta-BHC	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Aldrin	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	93	[NT]
Heptachlor Epoxide	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	98	[NT]
gamma-Chlordane	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
alpha-Chlordane	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Endosulfan I	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
pp-DDE	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	98	[NT]
Dieldrin	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	115	[NT]
Endrin	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	89	[NT]
Endosulfan II	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
pp-DDD	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	92	[NT]
Endrin Aldehyde	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
pp-DDT	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Endosulfan Sulphate	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	87	[NT]
Methoxychlor	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Mirex	ug/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Surrogate 4-Chloro-3-NBTF	%		Org-022/025	94	1	97	107	10	76	[NT]

QUALITY CONTROL: OP Pesticides in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	[NT]
Date extracted	-			28/03/2024	1	28/03/2024	28/03/2024		28/03/2024	[NT]
Date analysed	-			02/04/2024	1	02/04/2024	02/04/2024		02/04/2024	[NT]
Dichlorvos	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	119	[NT]
Mevinphos	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Phorate	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Dimethoate	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Diazinon	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Disulfoton	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Chlorpyriphos-methyl	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Parathion-Methyl	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Ronnel	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	93	[NT]
Fenitrothion	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	112	[NT]
Malathion	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	114	[NT]
Chlorpyriphos	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	100	[NT]
Fenthion	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Parathion	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	108	[NT]
Bromophos ethyl	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Methidathion	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Fenamiphos	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Ethion	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	103	[NT]
Phosalone	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Azinphos-methyl (Guthion)	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Coumaphos	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Surrogate 4-Chloro-3-NBTF	%		Org-022/025	94	1	97	107	10	76	[NT]

QUALITY CONTROL: PCBs in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	[NT]
Date extracted	-			28/03/2024	1	28/03/2024	28/03/2024		28/03/2024	[NT]
Date analysed	-			02/04/2024	1	02/04/2024	02/04/2024		02/04/2024	[NT]
Aroclor 1016	µg/L	2	Org-021/022/025	<2	1	<2	<2	0	[NT]	[NT]
Aroclor 1221	µg/L	2	Org-021/022/025	<2	1	<2	<2	0	[NT]	[NT]
Aroclor 1232	µg/L	2	Org-021/022/025	<2	1	<2	<2	0	[NT]	[NT]
Aroclor 1242	µg/L	2	Org-021/022/025	<2	1	<2	<2	0	[NT]	[NT]
Aroclor 1248	µg/L	2	Org-021/022/025	<2	1	<2	<2	0	[NT]	[NT]
Aroclor 1254	µg/L	2	Org-021/022/025	<2	1	<2	<2	0	102	[NT]
Aroclor 1260	µg/L	2	Org-021/022/025	<2	1	<2	<2	0	[NT]	[NT]
Surrogate 2-Fluorobiphenyl	%		Org-021/022/025	97	1	100	114	13	87	[NT]

QUALITY CONTROL: Total Phenolics in Water					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date extracted	-			28/03/2024	[NT]	[NT]	[NT]	[NT]	28/03/2024	[NT]
Date analysed	-			28/03/2024	[NT]	[NT]	[NT]	[NT]	28/03/2024	[NT]
Total Phenolics (as Phenol)	mg/L	0.05	Inorg-031	<0.05	[NT]	[NT]	[NT]	[NT]	98	[NT]

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W3	[NT]
Date prepared	-			28/03/2024	[NT]	[NT]	[NT]	[NT]	28/03/2024	[NT]
Date analysed	-			28/03/2024	[NT]	[NT]	[NT]	[NT]	28/03/2024	[NT]
Arsenic-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	90	[NT]
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	[NT]	[NT]	[NT]	[NT]	95	[NT]
Chromium-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	96	[NT]
Copper-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	93	[NT]
Lead-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	99	[NT]
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	[NT]	[NT]	[NT]	[NT]	94	[NT]
Nickel-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	96	[NT]
Zinc-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	97	[NT]
Iron-Dissolved	µg/L	10	Metals-022	<10	[NT]	[NT]	[NT]	[NT]	97	[NT]

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			27/03/2024	[NT]	[NT]	[NT]	[NT]	27/03/2024	[NT]
Date analysed	-			27/03/2024	[NT]	[NT]	[NT]	[NT]	27/03/2024	[NT]
pH	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	102	[NT]
Chloride, Cl	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	104	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	118	[NT]
Ferrous Iron	mg/L	0.05	Inorg-076	<0.05	[NT]	[NT]	[NT]	[NT]	98	[NT]
Ferric Iron (by calculation)	mg/L	0.05		<0.05	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

QUALITY CONTROL: PFAS in Water TRACE Short						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	[NT]
Date prepared	-			02/04/2024	[NT]	[NT]	[NT]	[NT]	02/04/2024	[NT]
Date analysed	-			02/04/2024	[NT]	[NT]	[NT]	[NT]	02/04/2024	[NT]
Perfluorohexanesulfonic acid - PFHxS	µg/L	0.0002	Org-029	<0.0002	[NT]	[NT]	[NT]	[NT]	104	[NT]
Perfluorooctanesulfonic acid PFOS	µg/L	0.0002	Org-029	<0.0002	[NT]	[NT]	[NT]	[NT]	102	[NT]
Perfluorooctanoic acid PFOA	µg/L	0.0002	Org-029	<0.0002	[NT]	[NT]	[NT]	[NT]	107	[NT]
6:2 FTS	µg/L	0.0004	Org-029	<0.0004	[NT]	[NT]	[NT]	[NT]	108	[NT]
8:2 FTS	µg/L	0.0004	Org-029	<0.0004	[NT]	[NT]	[NT]	[NT]	110	[NT]
Surrogate $^{13}C_8$ PFOS	%		Org-029	99	[NT]	[NT]	[NT]	[NT]	98	[NT]
Surrogate $^{13}C_2$ PFOA	%		Org-029	93	[NT]	[NT]	[NT]	[NT]	99	[NT]
Extracted ISTD $^{18}O_2$ PFHxS	%		Org-029	81	[NT]	[NT]	[NT]	[NT]	78	[NT]
Extracted ISTD $^{13}C_4$ PFOS	%		Org-029	73	[NT]	[NT]	[NT]	[NT]	66	[NT]
Extracted ISTD $^{13}C_4$ PFOA	%		Org-029	101	[NT]	[NT]	[NT]	[NT]	84	[NT]
Extracted ISTD$^{13}C_2$ 6:2FTS	%		Org-029	116	[NT]	[NT]	[NT]	[NT]	104	[NT]
Extracted ISTD $^{13}C_2$ 8:2FTS	%		Org-029	172	[NT]	[NT]	[NT]	[NT]	132	[NT]

QUALITY CONTROL: Cations in water Dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date digested	-			28/03/2024	[NT]	[NT]	[NT]	[NT]	28/03/2024	[NT]
Date analysed	-			28/03/2024	[NT]	[NT]	[NT]	[NT]	28/03/2024	[NT]
Calcium - Dissolved	mg/L	0.5	Metals-020	<0.5	[NT]	[NT]	[NT]	[NT]	104	[NT]
Magnesium - Dissolved	mg/L	0.5	Metals-020	<0.5	[NT]	[NT]	[NT]	[NT]	107	[NT]

Result Definitions

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

Quality Control Definitions

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

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

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

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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

Report Comments

For PFAS Extracted Internal Standards denoted with # or outside the 50-150% acceptance range, the respective target analyte results may be unaffected, in other circumstances the PQL has been raised to accommodate the outlier(s).

COC 261124, 1504.

Douglas Partners
Geotechnics | Environment | Groundwater

CHAIN OF CUSTODY DESPATCH SHEET

Project No:	227190.00	**Suburb:**	Rydalmere	**To:**	Envirolab Services
Project Manager:	Atha Kapitanof	**Order Number:**		**Sampler:**	CC
					12 Ashley St, Chatswood NSW 2067
Email:	atha.kapitanof@douglaspartners.com.au; claire.corthier@douglaspartners.com.au			**Attn:**	Sample Receipt
Turnaround time:	☑ Standard ☐ 72 hour ☐ 48 hour ☐ 24 hour ☐ Same day				(02) 9910 6200 samplereceipt@envirolab.com.au
Prior Storage:	☐ Fridge ☐ Freezer ☑ Esky ☐ Shelf	**Do samples contain 'potential' HBM?**	☑ No ☐ Yes	(If YES, then handle, transport and store in accordance with FPM HAZID)	

	Lab ID	Sample ID: Location / Other ID	Depth From	Depth To	Date Sampled	Sample Type: S - soil W - water M - Material	Container Type: G - glass P - plastic	Analytes: Combo 8 (dissolved)	pH	EC	Chloride	Sulfate	VOC Suite	Ferrous iron	Ferric Iron	Hardness	PFAS - Short Suite (trace)		Notes/ Preservation/ Additional Requirements
1		BH2			24/03/24	W	G,P	X	X	X	X	X	X	X	X	X	X		
2		BH5			24/03/24	W	G,P												Place on hold
3		BH6			24/03/24	W	G,P												Place on hold

ENVIROLAB GROUP

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 347582
Date Received: 26/3/24
Time Received: 1700
Received By: KW
Temp: Cool/Ambient
Cooling: Ice/Icepack 10°C
Security: Intact/Broken/None

Metals to analyse:			
Number of samples in container:		**Transported to laboratory by:**	Courier
Send results to:	Douglas Partners Pty Ltd		
Address:	96 Hermitage Road, West Ryde NSW 2114	**Phone:**	(02) 9809 0666
Relinquished by:	CC	**Date:**	24/03/2024
		Signed:	

LAB RECEIPT

Lab Ref. No:	347582
Received by:	Katy Lukyn
Date & Time:	26/3/24 1700
Signed:	

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

CERTIFICATE OF ANALYSIS 348487

Client Details

Client	Douglas Partners Pty Ltd
Attention	Atha Kapitanof
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**227190.00, Rydalmere**
Number of Samples	59 Soil
Date samples received	10/04/2024
Date completed instructions received	10/04/2024

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	11/04/2024
Date of Issue	11/04/2024

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

Results Approved By
Jenny He, Senior Chemist
Loren Bardwell, Development Chemist

Authorised By
Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		348487-2	348487-4	348487-8	348487-10	348487-13
Your Reference	UNITS	BH2_0.5	BH2_1.5	BH2_3.5	BH2_5.0	BH2_6.5
Date Sampled		09/03/2024	09/03/2024	09/03/2024	09/03/2024	09/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
pH 1:5 soil:water	pH Units	5.9	5.4	5.1	5.1	5.1
Chloride, Cl 1:5 soil:water	mg/kg	10	[NA]	[NA]	[NA]	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	380	[NA]	[NA]	[NA]	[NA]

Misc Inorg - Soil						
Our Reference		348487-15	348487-16	348487-17	348487-19	348487-20
Your Reference	UNITS	BH6_0.5	BH6_1.0	BH6_1.5	BH6_2.5	BH6_3.0
Date Sampled		09/03/2024	09/03/2024	09/03/2024	09/03/2024	09/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
pH 1:5 soil:water	pH Units	10.7	10.6	8.4	5.4	[NA]
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	[NA]	[NA]	[NA]	<10
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	[NA]	[NA]	[NA]	75

Misc Inorg - Soil						
Our Reference		348487-21	348487-22	348487-23	348487-24	348487-25
Your Reference	UNITS	BH6_3.5	BH6_4.0	BH3_0.5	BH3_1.0	BH3_1.5
Date Sampled		09/03/2024	09/03/2024	10/03/2024	10/03/2024	10/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
pH 1:5 soil:water	pH Units	5.3	5.9	8.5	8.5	5.0

Misc Inorg - Soil						
Our Reference		348487-28	348487-31	348487-33	348487-35	348487-40
Your Reference	UNITS	BH3_3.0	BH3_4.5	BH3_5.5	BH3_6.5	BH5_0.5
Date Sampled		10/03/2024	10/03/2024	10/03/2024	10/03/2024	10/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
pH 1:5 soil:water	pH Units	5.1	5.5	5.2	5.4	7.8

Misc Inorg - Soil						
Our Reference		348487-41	348487-43	348487-47	348487-50	348487-55
Your Reference	UNITS	BH5_1.0	BH5_2.0	BH4_1.0	BH4_2.5	BH4_5.0
Date Sampled		10/03/2024	10/03/2024	10/03/2024	10/03/2024	10/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
pH 1:5 soil:water	pH Units	7.6	5.8	5.5	5.2	5.1

Misc Inorg - Soil			
Our Reference		348487-58	348487-59
Your Reference	UNITS	BH4_6.5	BH4_7.0
Date Sampled		10/03/2024	10/03/2024
Type of sample		Soil	Soil
Date prepared	-	11/04/2024	11/04/2024
Date analysed	-	11/04/2024	11/04/2024
pH 1:5 soil:water	pH Units	5.4	5.3

Texture and Salinity*						
Our Reference		348487-2	348487-4	348487-8	348487-10	348487-13
Your Reference	UNITS	BH2_0.5	BH2_1.5	BH2_3.5	BH2_5.0	BH2_6.5
Date Sampled		09/03/2024	09/03/2024	09/03/2024	09/03/2024	09/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Electrical Conductivity 1:5 soil:water	µS/cm	210	78	83	48	55
Texture Value	-	7.0	7.0	8.0	8.0	8.5
Texture	-	MEDIUM CLAY	MEDIUM CLAY	LIGHT MEDIUM CLAY	LIGHT MEDIUM CLAY	LIGHT CLAY
ECe	dS/m	<2	<2	<2	<2	<2
Class	-	NON SALINE	NON SALINE	NON SALINE	NON SALINE	NON SALINE

Texture and Salinity*						
Our Reference		348487-15	348487-16	348487-17	348487-19	348487-21
Your Reference	UNITS	BH6_0.5	BH6_1.0	BH6_1.5	BH6_2.5	BH6_3.5
Date Sampled		09/03/2024	09/03/2024	09/03/2024	09/03/2024	09/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Electrical Conductivity 1:5 soil:water	µS/cm	450	380	320	57	46
Texture Value	-	9.0	9.0	9.0	7.0	7.0
Texture	-	CLAY LOAM	CLAY LOAM	CLAY LOAM	MEDIUM CLAY	MEDIUM CLAY
ECe	dS/m	4.0	3.4	2.9	<2	<2
Class	-	MODERATELY SALINE	SLIGHTLY SALINE	SLIGHTLY SALINE	NON SALINE	NON SALINE

Texture and Salinity*						
Our Reference		348487-22	348487-23	348487-24	348487-25	348487-28
Your Reference	UNITS	BH6_4.0	BH3_0.5	BH3_1.0	BH3_1.5	BH3_3.0
Date Sampled		09/03/2024	10/03/2024	10/03/2024	10/03/2024	10/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Electrical Conductivity 1:5 soil:water	µS/cm	27	100	92	130	110
Texture Value	-	7.0	9.0	9.0	9.0	8.0
Texture	-	MEDIUM CLAY	CLAY LOAM	CLAY LOAM	CLAY LOAM	LIGHT MEDIUM CLAY
ECe	dS/m	<2	<2	<2	<2	<2
Class	-	NON SALINE	NON SALINE	NON SALINE	NON SALINE	NON SALINE

Texture and Salinity*						
Our Reference		348487-31	348487-33	348487-35	348487-40	348487-41
Your Reference	UNITS	BH3_4.5	BH3_5.5	BH3_6.5	BH5_0.5	BH5_1.0
Date Sampled		10/03/2024	10/03/2024	10/03/2024	10/03/2024	10/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Electrical Conductivity 1:5 soil:water	µS/cm	86	68	80	200	85
Texture Value	-	8.5	8.0	8.5	7.0	9.0
Texture	-	LIGHT CLAY	LIGHT MEDIUM CLAY	LIGHT CLAY	MEDIUM CLAY	CLAY 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		348487-43	348487-47	348487-50	348487-55	348487-58
Your Reference	UNITS	BH5_2.0	BH4_1.0	BH4_2.5	BH4_5.0	BH4_6.5
Date Sampled		10/03/2024	10/03/2024	10/03/2024	10/03/2024	10/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
Electrical Conductivity 1:5 soil:water	µS/cm	310	190	66	92	48
Texture Value	-	7.0	9.0	7.0	9.0	8.5
Texture	-	MEDIUM CLAY	CLAY LOAM	MEDIUM CLAY	CLAY LOAM	LIGHT CLAY
ECe	dS/m	2.1	<2	<2	<2	<2
Class	-	SLIGHTLY SALINE	NON SALINE	NON SALINE	NON SALINE	NON SALINE

Texture and Salinity*		
Our Reference		348487-59
Your Reference	UNITS	BH4_7.0
Date Sampled		10/03/2024
Type of sample		Soil
Date prepared	-	11/04/2024
Date analysed	-	11/04/2024
Electrical Conductivity 1:5 soil:water	µS/cm	78
Texture Value	-	8.5
Texture	-	LIGHT CLAY
ECe	dS/m	<2
Class	-	NON SALINE

ESP/CEC			
Our Reference	UNITS	348487-2	348487-20
Your Reference		BH2_0.5	BH6_3.0
Date Sampled		09/03/2024	09/03/2024
Type of sample		Soil	Soil
Date prepared	-	11/04/2024	11/04/2024
Date analysed	-	11/04/2024	11/04/2024
Exchangeable Ca	meq/100g	6.2	0.4
Exchangeable K	meq/100g	0.2	<0.1
Exchangeable Mg	meq/100g	3.2	2.7
Exchangeable Na	meq/100g	1.8	0.7
Cation Exchange Capacity	meq/100g	11	3.8
ESP	%	15	18

sPOCAS field test						
Our Reference		348487-1	348487-2	348487-3	348487-4	348487-5
Your Reference	UNITS	BH2_0.1	BH2_0.5	BH2_1.0	BH2_1.5	BH2_2.0
Date Sampled		09/03/2024	09/03/2024	09/03/2024	09/03/2024	09/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	10/04/2024	10/04/2024	10/04/2024	10/04/2024	10/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
pH_F (field pH test)	pH Units	10.0	5.5	6.2	5.9	4.6
pH_{FOX} (field peroxide test)	pH Units	7.4	4.7	5.3	4.4	4.2
Reaction Rate*	-	Medium reaction	Medium reaction	Medium reaction	Medium reaction	Medium reaction

sPOCAS field test						
Our Reference		348487-6	348487-7	348487-15	348487-16	348487-17
Your Reference	UNITS	BH2_2.5	BH2_3.0	BH6_0.5	BH6_1.0	BH6_1.5
Date Sampled		09/03/2024	09/03/2024	09/03/2024	09/03/2024	09/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	10/04/2024	10/04/2024	10/04/2024	10/04/2024	10/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
pH_F (field pH test)	pH Units	4.5	4.4	10.5	10.6	9.8
pH_{FOX} (field peroxide test)	pH Units	4.2	3.8	10.3	10.3	6.9
Reaction Rate*	-	Medium reaction	Medium reaction	Medium reaction	Medium reaction	Medium reaction

sPOCAS field test						
Our Reference		348487-18	348487-19	348487-20	348487-23	348487-24
Your Reference	UNITS	BH6_2.0	BH6_2.5	BH6_3.0	BH3_0.5	BH3_1.0
Date Sampled		09/03/2024	09/03/2024	09/03/2024	10/03/2024	10/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	10/04/2024	10/04/2024	10/04/2024	10/04/2024	10/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
pH_F (field pH test)	pH Units	5.0	5.6	5.7	8.9	8.8
pH_{FOX} (field peroxide test)	pH Units	5.6	4.4	3.6	7.0	6.8
Reaction Rate*	-	Medium reaction	Medium reaction	Medium reaction	Medium reaction	Medium reaction

sPOCAS field test						
Our Reference		348487-25	348487-26	348487-27	348487-28	348487-40
Your Reference	UNITS	BH3_1.5	BH3_2.0	BH3_2.5	BH3_3.0	BH5_0.5
Date Sampled		10/03/2024	10/03/2024	10/03/2024	10/03/2024	10/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	10/04/2024	10/04/2024	10/04/2024	10/04/2024	10/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
pH_F (field pH test)	pH Units	6.7	5.6	6.0	5.6	7.4
pH_{FOX} (field peroxide test)	pH Units	4.5	3.9	4.4	3.9	4.3
Reaction Rate*	-	Medium reaction	Medium reaction	Medium reaction	Medium reaction	Medium reaction

sPOCAS field test						
Our Reference		348487-41	348487-42	348487-43	348487-44	348487-45
Your Reference	UNITS	BH5_1.0	BH5_1.5	BH5_2.0	BH5_2.5	BH5_3.5
Date Sampled		10/03/2024	10/03/2024	10/03/2024	10/03/2024	10/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	10/04/2024	10/04/2024	10/04/2024	10/04/2024	10/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
pH_F (field pH test)	pH Units	7.5	5.1	4.5	6.1	6.2
pH_{FOX} (field peroxide test)	pH Units	4.2	4.0	4.2	4.5	4.2
Reaction Rate*	-	Medium reaction	Medium reaction	Medium reaction	Medium reaction	Medium reaction

sPOCAS field test						
Our Reference		348487-47	348487-48	348487-49	348487-50	348487-51
Your Reference	UNITS	BH4_1.0	BH4_1.5	BH4_2.0	BH4_2.5	BH4_3.0
Date Sampled		10/03/2024	10/03/2024	10/03/2024	10/03/2024	10/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	10/04/2024	10/04/2024	10/04/2024	10/04/2024	10/04/2024
Date analysed	-	11/04/2024	11/04/2024	11/04/2024	11/04/2024	11/04/2024
pH_F (field pH test)	pH Units	6.0	4.7	5.1	4.1	4.2
pH_{FOX} (field peroxide test)	pH Units	5.4	3.7	4.3	4.1	4.2
Reaction Rate*	-	Medium reaction	Medium reaction	Medium reaction	Medium reaction	Medium reaction

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-063	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions.
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.
Metals-020	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-OES analytical finish.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	348487-2
Date prepared	-			11/04/2024	4	11/04/2024	11/04/2024		11/04/2024	11/04/2024
Date analysed	-			11/04/2024	4	11/04/2024	11/04/2024		11/04/2024	11/04/2024
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	4	5.4	5.3	2	100	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	113	104
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	115	#

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-2	[NT]
Date prepared	-			[NT]	21	11/04/2024	11/04/2024		11/04/2024	[NT]
Date analysed	-			[NT]	21	11/04/2024	11/04/2024		11/04/2024	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	21	5.3	5.3	0	100	[NT]

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	40	11/04/2024	11/04/2024		[NT]	[NT]
Date analysed	-			[NT]	40	11/04/2024	11/04/2024		[NT]	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	40	7.8	7.7	1	[NT]	[NT]

QUALITY CONTROL: Texture and Salinity*					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			11/04/2024	4	11/04/2024	11/04/2024		11/04/2024	[NT]
Date analysed	-			11/04/2024	4	11/04/2024	11/04/2024		11/04/2024	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	4	78	80	3	99	[NT]
Texture Value	-		INORG-123	[NT]	4	7.0	[NT]		[NT]	[NT]

QUALITY CONTROL: Texture and Salinity*					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-2	[NT]
Date prepared	-			[NT]	21	11/04/2024	11/04/2024		11/04/2024	[NT]
Date analysed	-			[NT]	21	11/04/2024	11/04/2024		11/04/2024	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	21	46	44	4	100	[NT]
Texture Value	-		INORG-123	[NT]	21	7.0	[NT]		[NT]	[NT]

QUALITY CONTROL: Texture and Salinity*					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	40	11/04/2024	11/04/2024		[NT]	[NT]
Date analysed	-			[NT]	40	11/04/2024	11/04/2024		[NT]	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	40	200	200	0	[NT]	[NT]
Texture Value	-		INORG-123	[NT]	40	7.0	[NT]		[NT]	[NT]

QUALITY CONTROL: ESP/CEC						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			11/04/2024	[NT]	[NT]	[NT]	[NT]	11/04/2024	[NT]
Date analysed	-			11/04/2024	[NT]	[NT]	[NT]	[NT]	11/04/2024	[NT]
Exchangeable Ca	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	108	[NT]
Exchangeable K	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	110	[NT]
Exchangeable Mg	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	110	[NT]
Exchangeable Na	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	105	[NT]

QUALITY CONTROL: sPOCAS field test						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			10/04/2024	[NT]	[NT]	[NT]	[NT]	10/04/2024	[NT]
Date analysed	-			11/04/2024	[NT]	[NT]	[NT]	[NT]	11/04/2024	[NT]
pH_F (field pH test)	pH Units		Inorg-063	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]
pH_{FOX} (field peroxide test)	pH Units		Inorg-063	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]

QUALITY CONTROL: sPOCAS field test						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-2	[NT]
Date prepared	-			[NT]	[NT]	[NT]	[NT]	[NT]	10/04/2024	[NT]
Date analysed	-			[NT]	[NT]	[NT]	[NT]	[NT]	11/04/2024	[NT]
pH_F (field pH test)	pH Units		Inorg-063	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]
pH_{FOX} (field peroxide test)	pH Units		Inorg-063	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]

Result Definitions

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

Quality Control Definitions

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

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

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

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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

Report Comments

MISC_INORG_DRY:# Percent recovery is not applicable due to the high concentration of the analyte/s in the sample/s. However an acceptable recovery was obtained for the LCS.

Douglas PARTNERS

CHAIN OF CUSTODY DESPATCH SHEET

Project No:	227190.00	**Suburb:**	Rydalmere	**To:**	Envirolab Services
Project Manager:	Atha Kapitanof	**Order Number:**	-	**Sampler:**	CC
					12 Ashley St, Chatswood NSW 2067
Email:	Atha.Kapitanof@douglaspartners.com.au			**Attn:**	Sample Receipt
Turnaround time:	☑ Standard ☐ 72 hour ☐ 48 hour ☒ 24 hour ☐ Same day				(02) 9910 6200 samplereceipt@envirolab.com
Prior Storage:	☐ Fridge ☑ Freezer ☐ Esky ☐ Shelf	**Do samples contain 'potential' HBM?**	☑ No ☐ Yes (If YES, handle, transport, store in accordance with FPM HAZID)		

Lab ID	Sample ID: Location / Other ID	Depth From	Depth To	Date Sampled	Sample Type: S - soil W - water M - Material	Container Type: G - glass P - plastic	Analytes: ASS screening	pH, EC, texture class	Chloride- & Sulfate-ion	ESP & CEC								Notes/ Preservation/ Additional Requirements
1	BH2_0.1	0.1		9/03/24	S	P	x											Frozen
2	BH2_0.5	0.5		9/03/24	S	P	x	x	x	x								Frozen
3	BH2_1.0	1		9/03/24	S	P	x											Frozen
4	BH2_1.5	1.5		9/03/24	S	P	x	x										Frozen
5	BH2_2.0	2		9/03/24	S	P	x											Frozen
6	BH2_2.5	2.5		9/03/24	S	P	x											Frozen
7	BH2_3.0	3		9/03/24	S	P	x											Frozen
8	BH2_3.5	3.5		9/03/24	S	P		x										Frozen
9	BH2_4.0	4		9/03/24	S	P												Frozen
NR	BH2_4.5	4.5		9/03/24	S	P												Frozen
10	BH2_5.0	5		9/03/24	S	P		x										Frozen
11	BH2_5.5	5.5		9/03/24	S	P												Frozen
12	BH2_6.0	6		9/03/24	S	P												Frozen
13	BH2_6.5	6.5		9/03/24	S	P		x										Frozen
14	BH2_7.0	7		9/03/24	S	P												Frozen

ENVIROLAB

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 348487

Metals to analyse:	HM8 (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn)
Number of samples in container:	66
Transported to laboratory by:	Courier
Send results to:	Douglas Partners Pty Ltd
Address:	96 Hermitage Road, West Ryde NSW 211
Phone:	(02) 9809 0666

LAB RECEIPT

Lab Ref. No:	
Received by:	
Date & Time:	Date Received: 10/4/24 Time Received: 1515 Received By: EW Temp: Cool/Ambient Cooling: Icepack/None Security: Intact/Broken/None

Douglas PARTNERS

CHAIN OF CUSTODY DESPATCH SHEET

Project No: 227190.00	**Suburb:** Rydalmere	**To:** Envirolab Services	
Project Manager: Atha Kapitanof		**Dispatch date:** 15/03/2024	

Lab ID	Sample ID: Location / Other ID	Sample ID: Depth From	Sample ID: Depth To	Date Sampled	Sample Type: S - soil W - water M -	Container Type: G - glass P - plastic	Analytes: ASS screening	pH, EC, texture	Chloride- & Sulfate-ion	ESP & CEC							Notes/ Preservation/ Additional Requirements
NR	BH6_0.1	0.1		9/03/24	S	P	x										Frozen
15	BH6_0.5	0.5		9/03/24	S	P	x	x									Frozen
16	BH6_1.0	1		9/03/24	S	P	x	x									Frozen
17	BH6_1.5	1.5		9/03/24	S	P	x	x									Frozen
18	BH6_2.0	2		9/03/24	S	P	x										Frozen
19	BH6_2.5	2.5		9/03/24	S	P	x	x									Frozen
20	BH6_3.0	3		9/03/24	S	P	x		x	x							Frozen
21	BH6_3.5	3.5		9/03/24	S	P		x									Frozen
22	BH6_4.0	4		9/03/24	S	P		x									Frozen
NR	BH3_0.1	0.1		10/03/24	S	P	x										Frozen
23	BH3_0.5	0.5		10/03/24	S	P	x	x									Frozen
24	BH3_1.0	1		10/03/24	S	P	x	x									Frozen
25	BH3_1.5	1.5		10/03/24	S	P	x	x									Frozen
26	BH3_2.0	2		10/03/24	S	P	x										Frozen
27	BH3_2.5	2.5		10/03/24	S	P	x										Frozen
28	BH3_3.0	3		10/03/24	S	P	x	x									Frozen
29	BH3_3.5	3.5		10/03/24	S	P											Frozen

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Douglas PARTNERS

CHAIN OF CUSTODY DESPATCH SHEET

Project No: 227190.00 | **Suburb:** Rydalmere | **To:** Envirolab Services

Project Manager: Atha Kapitanof | **Dispatch date:** 15/03/2024

Lab ID	Sample ID: Location / Other ID	Sample ID: Depth From	Sample ID: Depth To	Date Sampled	Sample Type: S - soil W - water M -	Container Type: G - glass P - plastic	Analytes: ASS screening	pH, EC, texture	Chloride- & Sulfate-ion	ESP & CEC							Notes/ Preservation/ Additional Requirements
30	BH3-4.0	4		10/03/24	S	P											Frozen
31	BH3-4.5	4.5		10/03/24	S	P		x									Frozen
32	BH3-5.0	5		10/03/24	S	P											Frozen
33	BH3-5.5	5.5		10/03/24	S	P		x									Frozen
34	BH3-6.0	6		10/03/24	S	P											Frozen
35	BH3-6.5	6.5		10/03/24	S	P		x									Frozen
36	BH3-7.0	7		10/03/24	S	P											Frozen
37	BH3-7.5	7.5		10/03/24	S	P											Frozen
38	BH3-8.0	8		10/03/24	S	P											Frozen
39	BH3-8.5	8.5		10/03/24	S	P											Frozen
NR	BH5_0.1	0.1		10/03/24	S	P	x										Frozen
40	BH5_0.5	0.5		10/03/24	S	P	x	x									Frozen
41	BH5_1.0	1		10/03/24	S	P	x	x									Frozen
42	BH5_1.5	1.5		10/03/24	S	P	x										Frozen
43	BH5_2.0	2		10/03/24	S	P	x	x									Frozen
44	BH5_2.5	2.5		10/03/24	S	P	x										Frozen
NR	BH5_3.0	3	No sample														318487
45	BH5_3.5	3.5		10/03/24	S	P	x										Frozen 1014

Project No: 227190.00 | **Suburb:** Rydalmere | **To:** Envirolab Services

Douglas PARTNERS

CHAIN OF CUSTODY DESPATCH SHEET

Project Manager: Atha Kapitanof

Dispatch date: 15/03/2024

Lab ID	Sample ID: Location / Other ID	Sample ID: Depth From	Sample ID: Depth To	Date Sampled	Sample Type: S - soil W - water M -	Container Type: G - glass P - plastic	Analytes: ASS screening	Analytes: pH, EC, texture	Analytes: Chloride- & Sulfate-ion	Analytes: ESP & CEC	Analytes	Analytes	Analytes	Analytes	Analytes	Analytes	Analytes	Notes/ Preservation/ Additional Requirements
46	BH5_4.0	4		10/03/24	S	P												Frozen
NK	BH5_4.5	4.5		10/03/24	S	P		x										Frozen
NK	BH4_0.1	0.1		10/03/24	S	P	x											Frozen
NK	BH4_0.5	0.5		10/03/24	S	P	x	x										Frozen
47	BH4_1.0	1		10/03/24	S	P	x	x										Frozen
48	BH4_1.5	1.5		10/03/24	S	P	x											Frozen
49	BH4_2.0	2		10/03/24	S	P	x											Frozen
50	BH4_2.5	2.5		10/03/24	S	P	x	x										Frozen
51	BH4_3.0	3		10/03/24	S	P	x											Frozen
52	BH4_3.5	3.5		10/03/24	S	P												Frozen
53	BH4_4.0	4		10/03/24	S	P												Frozen
54	BH4_4.5	4.5		10/03/24	S	P												Frozen
55	BH4_5.0	5		10/03/24	S	P		x										Frozen
56	BH4_5.5	5.5		10/03/24	S	P												Frozen
57	BH4_6.0	6		10/03/24	S	P												Frozen
58	BH4_6.5	6.5		10/03/24	S	P		x										Frozen
59	BH4_7.0	7		10/03/24	S	P		x										Frozen

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Douglas PARTNERS

CHAIN OF CUSTODY DESPATCH SHEET

Relinquished by:	CC	**Date:**	15/03/2024	**Signed:**	**Signed:**

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Appendix E

CSIRO Information Sheet BTF 18

FOUNDATION MAINTENANCE AND FOOTING PERFORMANCE

Understanding and preventing soil-related building movement

This Building Technology Resource is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking.

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the home owner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

SOIL TYPES

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. Table 1 below is a reproduction of Table 2.1 from Australian Standard AS 2870-2011, Residential slabs and footings.

CAUSES OF MOVEMENT

SETTLEMENT DUE TO CONSTRUCTION

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction but has been known to take many years in exceptional cases.

These problems may be the province of the builder and should be taken into consideration as part of the preparation of the site for construction.

EROSION

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

SATURATION

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume, particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

SEASONAL SWELLING AND SHRINKAGE OF SOIL

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below, from AS 2870). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

SHEAR FAILURE

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.

In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

TREE ROOT GROWTH

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.

TABLE 1. GENERAL DEFINITIONS OF SITE CLASSES.

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes
F	Extremely reactive sites, which may experience extreme ground movement from moisture changes

Source: Reproduced with the permission of Standards Australia Limited © 2011. Copyright in AS 2870-2011 Residential slabs and footings vests in Standards Australia Limited.

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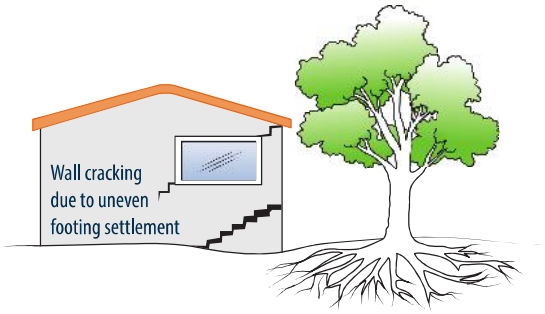


FIGURE 1 Trees can cause shrinkage and damage.

- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

UNEVENNESS OF MOVEMENT

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior through absorption. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Shrinkage usually begins on the side of the building where the sun's heat is greatest.

EFFECTS OF UNEVEN SOIL MOVEMENT ON STRUCTURES

EROSION AND SATURATION

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

SEASONAL SWELLING/SHRINKAGE IN CLAY

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated, and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry, and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

MOVEMENT CAUSED BY TREE ROOTS

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

COMPLICATIONS CAUSED BY THE STRUCTURE ITSELF

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

EFFECTS ON FULL MASONRY STRUCTURES

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also

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exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

EFFECTS ON FRAMED STRUCTURES

Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation causes a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

EFFECTS ON BRICK VENEER STRUCTURES

Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

WATER SERVICE AND DRAINAGE

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem. Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

SERIOUSNESS OF CRACKING

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. Table 2 below is a reproduction of Table C1 of AS 2870-2011.

AS 2870-2011 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

PREVENTION AND CURE

PLUMBING

Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

GROUND DRAINAGE

In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject may be regarded as an area for an expert consultant.

PROTECTION OF THE BUILDING PERIMETER

It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill.

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

CONDENSATION

In buildings with a subfloor void, such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

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TABLE 2. CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS.

Description of typical damage and required repair	Approximate crack width limit	Damage category
Hairline cracks	<0.1 mm	0 – Negligible
Fine cracks which do not need repair	<1 mm	1 – Very Slight
Cracks noticeable but easily filled. Doors and windows stick slightly.	<5 mm	2 – Slight
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired.	5–15 mm (or a number of cracks 3 mm or more in one group)	3 – Moderate
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted.	15–25 mm but also depends on number of cracks	4 – Severe

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Warning: Although this Building Technology Resource deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders, and mould.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

THE GARDEN

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

EXISTING TREES

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

INFORMATION ON TREES, PLANTS AND SHRUBS

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information.

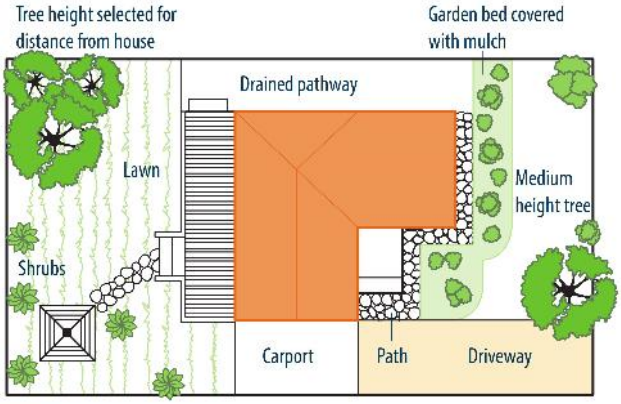


FIGURE 2 Gardens for a reactive site.

EXCAVATION

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

REMEDIATION

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the home owner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

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