Report on Geotechnical Investigation

2 Settlers Boulevard, Chisholm NSW

Prepared for: AVID Residential Estate Pty Ltd C/-ADW Johnson

EP4322.002 11 November 2025

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EP RISK

Report on Geotechnical Investigation

2 Settlers Boulevard, Chisholm NSW

AVID Residential Estate Pty Ltd C/-ADW Johnson

Level 35, One international Tower,
100 Barangaroo Avenue, Sydney NSW 2000

11 November 2025

Our Ref: EP4322.002

LIMITATIONS

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1 Introduction

EP Risk Management Pty Ltd (EP Risk) was engaged by AVID Residential Estate Pty Ltd C/- ADW Johnson to undertake a Geotechnical Investigation at 2 Settlers Boulevard, Chisholm NSW (the Site).

The engagement was carried out in line with the conditions of engagement and the investigation scope as outlined in our proposal EP19306 dated 17 June 2025.

A Preliminary Site Investigation (PSI) was also undertaken concurrently with the geotechnical investigations reference EP4322.001 dated 7 November 2025.

1.1 Objectives and Scope

It is understood that the geotechnical investigation is required to support the development application (D.A) for residential development for the site.

EP Risk carried out the following scope of works for the geotechnical investigation:

- Prepared of all the work health and safety documentation and procured Before you Dig Australia plans for the site.
- Engaged a certified service locator to identify and locate the underground services at locations of interest for the geotechnical investigation.
- Advanced twelve (12) test pits (TP) to a maximum depth of 3.0m below ground level (BGL) or prior bedrock refusal within the proposed residential lots and road alignments.
- Conducted Dynamic Cone Penetrometer (DCP) testing at the test pit locations to assess the consistency of the subsurface.
- Logged the soil/rock material encountered as per AS1726.
- Collected representative soil/rock samples for further laboratory testing.
- Upon completion, the test pits were filled with spoil, nominally compacted with the bucket and tracked over by the excavator.
- Prepared a Geotechnical Investigation Report including the investigation findings, laboratory test results, preliminary site classifications and preliminary pavement design.

2 Site Location and Description

The Site is legally described as part of Lot 9120 and part of Lot 9100 DP1295941 and is located at 2 Settlers Boulevard, Chisholm NSW (Waterford site). The site is bound by residential areas to the west and north, future residential areas to the east, and Raymond terrace Road to the south.

The elevation of the site ranges from approximately Reduced Level (R.L) 42-43m above the Australian Height Datum (AHD) along the western boundary of the site to approximately R.L 37-38m AHD along the east boundary of the site. Site drainage is assumed to follow surface gradient in a predominately eastern direction towards the eastern boundary of the site with Stage 96

The site is currently occupied by two temporary structured which included, The Kitchen at Waterford Café / Restaurant and Waterford Sales Office with associated carparking and access road. Site vegetation generally comprised of short, maintained grass, shrubs and mature trees along the eastern part of the site.

Photos collected during the site investigation are shown in **Appendix A – Photolog**.

An excerpt from NearMap with the indicative site location is shown in Figure 1.

Figure 1 - Indicative Site Location

3 Desktop Study

3.1 Regional Geology

Based on geological data sourced from NSW Government website (www.minview.geoscience.nsw.gov.au), the Site is underlain by:

- Guadalupian Aged (272.95 – 259.1 Ma) – Mulbring Siltstone (Pmtm) of Maitland Group known to contain medium to dark grey siltstone, minor claystone, sporadic thin cherty beds (resistant), rare thin sandstone and limestone beds, sporadic marine fossils.
- Lopingian Aged (259.1 – 251.902 Ma) – Tomago Coal Measures (Pto) of Singleton Supergroup known to contain very fine to medium grained grey lithic sandstone, (sporadically interbedded with) laminated to carbonaceous shale, mudstone, siltstone, coal with sporadic interbeds of carbonaceous shale, claystone, sideritic bands and rare pebbles paraconglomerate.

An excerpt of the geological map is shown in Figure 2.

Figure 2 - Geological Map Excerpt (Pmtm – Mulbring Siltstone, Pto – Tomago Coal Measures)

3.2 Soil Landscape

Based on the information provided by the NSW Office of Environment and Heritage, Soil Landscapes of Central and Eastern NSW, on site soil landscape has been identified as:

- **Beresfield (9232be)** – This soil landscape covers undulating low hills and rises on Permian sediments in the East Maitland Hills region. Slope gradients 3 – 15%, local relief to 50m, elevation is 20 – 50m with partially cleared tall open forest. The limitations for this soil landscape are high foundation hazard, water erosion hazard, seasonal waterlogging, high run-on on localised lower slopes and highly acidic soils of low fertility.

3.3 Mine Subsidence

Reference to the Mine Subsidence District Data Source, the Site is not located within a Mine Subsidence District.

3.4 Acid Sulfate Soils (ASS)

The NSW Government data available on NSW Planning Portal indicates the site is located within Class 5 acid sulphate soil classification. Acid sulphate soils are not typically found in Class 5 areas. Areas classified as Class 5 are located within 500 metres on adjacent class 1,2,3 or 4 land. An extract of the acid sulphate soil map is shown in Figure 3.

Figure 3 - ASS Map Excerpt

4 Geotechnical Investigation

4.1 Investigation Methodology

The site investigation was conducted on 1 September 2025 under full time supervision of an experienced EP Risk Geotechnical Professional in accordance with AS1726-2017 Geotechnical Site Investigations. The investigations involved the following:

- Advancing twelve (12) test pits within the footprint of the proposed works.
- Logging of soil/rocks encountered and collection of representative soil and rock samples to be tested by a NATA-accredited laboratory.
- Reinstatement of test pits with spoil and compacted at the surface.

The test pits were excavated with a 5T excavator fitted with a 550mm bucket. The locations of the test pits are shown in **Appendix B – Geotechnical Investigation Locations**.

4.2 Subsurface Profile

A project geological classification has been developed based on the results of the investigation and a summary of the units and their distribution are presented in **Table 1** and **Table 2**. The investigation logs and accompanying explanatory notes are presented in **Appendix C – Engineering Logs**

Table 1. Observed Geological Units

Unit	Origin	Material	Description
Unit 1	Topsoil	Silty SAND	Fine to medium grained, brown, dark brown, with some coal chitter
Unit 2	Residual Soil	Silty/Gravelly CLAY	Low to high plasticity, grey, dark grey, with fine to coarse grained sand, fine to coarse grained, sub-angular to angular gravel, minor brick fragments
Unit 3	XW* Material	Sandstone	Sandy GRAVEL, fine to coarse grained, sub-angular to angular, grey, orange/brown, fine to coarse grained sand, with boulders up to 400mm

XW – Extremely weathered

Table 2. Distribution of Subsurface Geological Units Across the Investigated Area			
TP ID	Depth Below Ground Level (m BGL)		
	Topsoil	Residual Soil	XW Material
	Unit 1	Unit 2	Unit 3
TP01	0.0-0.1	0.1-1.2	1.2-1.4*
TP02	0.0-0.12	0.12-0.5	0.5-0.6*
TP03	0.0-0.1	0.1-0.5	0.5-0.6*
TP04	0.0-0.1	0.1-0.5	0.5-0.7*
TP05	0.0-0.2	0.2-1.2	1.2-1.4*
TP06	0.0-0.2	0.2-1.4	1.4-1.5*
TP07	0.0-0.2	0.2-1.3	1.3-1.4*
TP08	0.0-0.2	NE	0.2-0.6*
TP09	0.0-0.1	0.1-0.6	0.6-0.8*
TP10	0.0-0.2	0.2-1.1	1.1-1.2*
TP11	0.0-0.12	0.12-1.0	1.0-1.2*
TP12	0.0-0.1	0.1-0.6	0.6-0.9*
*) – Limit of the investigation NE – Not encountered			

4.3 Groundwater

Groundwater was not encountered during the investigation. It should be noted that the groundwater conditions will vary with seasonal changes and weather conditions along with related site conditions.

4.4 Laboratory Test Results

Geotechnical laboratory testing was conducted on selected bulk, disturbed and undisturbed samples collected during the site investigation. All testing was performed by Coffey Testing (Newcastle) – NATA accredited laboratory in accordance with the relevant Australian Standards and technical procedures. The detailed results of laboratory testing are presented in **Appendix D – Laboratory Test Results** and are summarised in the following sections.

4.4.1 Atterberg Limits

A summary of Atterberg Limits and Linear Shrinkage Test results are presented in **Table 3** and are plotted graphically in Figure 4.

Table 3. Atterberg Limits Test Results

Test ID	Depth (m BGL)	Soil	Classification	Atterberg Limits			Linear Shrinkage (%)
				LL (%)	PL (%)	PI (%)	
TP03	0.1-0.4	Silty CLAY	CI-CH	46	19	27	13
TP04	0.1-0.4	Silty CLAY	CL-CI	30	17	13	*
TP05	1.0-1.2	Silty CLAY	CI-CH	69	19	50	18
TP06	0.9-1.3	Gravelly CLAY	CI-CH	53	22	31	14
TP10	0.12-1.0	Gravelly CLAY	CI-CH	42	22	20	9.5

LL – Liquid Limit
PL – Plastic Limit
PI – Plasticity Index
*-not enough sample for linear shrinkage test

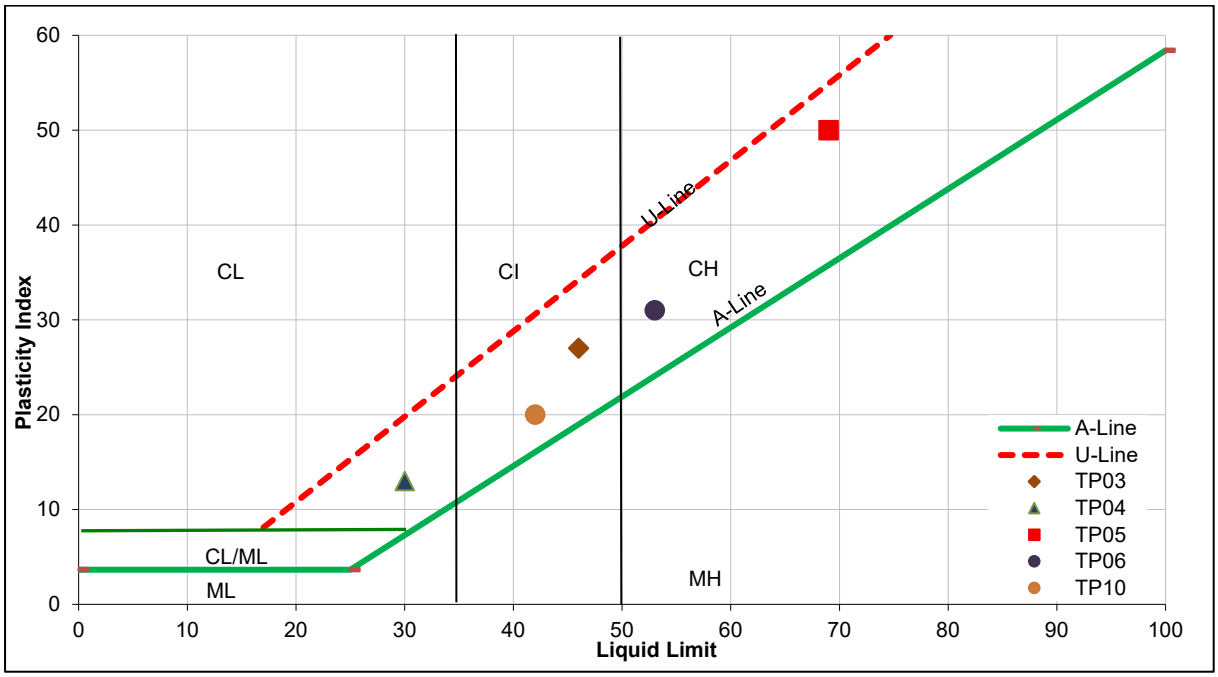


Figure 4 - Atterberg Limit Plot

4.4.2 Particle Size Distribution

Particle Size Distribution (PSD) test results undertaken on samples of soil are presented in **Table 4** confirming the material description from the test pit logs.

Table 4. Particle Size Distribution Test Results

Test ID	Depth (m BGL)	% passing 2.36 mm sieve	% passing 75 µm sieve	Sample Description
TP05	1.0-1.2	93	86	Silty CLAY
TP09	0.1-0.5	58	41	Gravelly CLAY with sand

4.4.3 California Bearing Ratio (CBR)

CBR test was conducted on three (3) soil samples to inform the design CBR for the proposed road within the eastern part of the proposed development. The results are summarised in **Table 5**.

Table 5. California Bearing Ratio Test Results

Test ID	Depth (m BGL)	Sample Description	W[1](%)	SOMC[2] (%)	SMDD[3] (t/m³)	Swell (%)	CBR (%)
TP03	0.1-0.4	Silty CLAY	24.9	26.0	1.48	0.5	**5.0**
TP05	1.0-1.2	Silty CLAY	31.7	33.0	1.36	1.0	**3.5**
TP06	0.9-1.3	Silty CLAY	28.8	27.0	1.48	1.0	**3.0**

[1] Field Moisture Content
[2] Standard Optimum Moisture Content
[3] Standard Maximum Dry Density

4.4.4 Shrink-Swell

The shrink-swell test results for the undisturbed soil sample collected during the site investigation is presented is presented in **Table 6**.

Table 6. Shrink-Swell Index Test Results

Test ID	Soil Type	Depth (m BGL)	Shrinkage		Swell			Shrink – Swell Index (Iss%)
			Shrinkage Field Moisture Content (%)	Dried Shrinkage (%)	Field Moisture Content (%)	Inundated Moisture Content (%)	Swell Strain (%)	
TP01	Silty CLAY	0.1-1.0	26.3	3.0	25.1	28.9	0.0	**1.7**
TP04	Silty CLAY	0.1-0.4	18.0	0.6	17.2	21.5	-0.1	**0.3**
TP09	Gravelly CLAY	0.1-0.5	21.1	2.8	22.5	30.7	0.6	**1.7**
TP10	Gravelly CLAY	0.12-1.0	23.1	3.2	21.4	26.3	-0.2	**1.8**

4.4.5 Point Load Testing

Point load testing has been conducted on selected rock samples collected from the boreholes and the test results are shown in **Table 7**.

Table 7. Point Load Test Results

Test ID	Rock	Depth (m BGL)	Moisture condition	Is (50) MPa	Rock strength
TP01	Sandstone	1.0-1.3	Natural	0.33*	Medium strength
TP01	Sandstone	1.0-1.3	Natural	0.36*	Medium strength
TP01	Sandstone	1.0-1.3	Natural	0.34*	Medium strength
TP01	Sandstone	1.0-1.3	Natural	0.41*	Medium strength
TP01	Sandstone	1.0-1.3	Natural	0.38*	Medium strength
TP02	Sandstone	0.3-0.6	Natural	0.87*	Medium strength
TP02	Sandstone	0.3-0.6	Natural	1.7*	High strength
TP02	Sandstone	0.3-0.6	Natural	1.3*	High strength
TP02	Sandstone	0.3-0.6	Natural	1.1*	High strength
TP02	Sandstone	0.3-0.6	Natural	0.97*	Medium strength
TP03	Sandstone	0.4-0.6	Natural	0.52*	Medium strength
TP03	Sandstone	0.4-0.6	Natural	0.55*	Medium strength

Table 7. Point Load Test Results

Test ID	Rock	Depth (m BGL)	Moisture condition	Is (50) MPa	Rock strength
TP03	Sandstone	0.4-0.6	Natural	1.2*	High strength
TP03	Sandstone	0.4-0.6	Natural	0.82*	Medium strength
TP03	Sandstone	0.4-0.6	Natural	0.55*	Medium strength
TP04	Sandstone	0.4-0.7	Natural	0.99*	Medium strength
TP04	Sandstone	0.4-0.7	Natural	0.77*	Medium strength
TP04	Sandstone	0.4-0.7	Natural	0.54*	Medium strength
TP04	Sandstone	0.4-0.7	Natural	0.95*	Medium strength
TP04	Sandstone	0.4-0.7	Natural	0.28*	Low strength
TP05	Sandstone	1.2-1.4	Natural	1.5*	High strength
TP05	Sandstone	1.2-1.4	Natural	2.3*	High strength
TP05	Sandstone	1.2-1.4	Natural	3.5*	Very high strength
TP05	Sandstone	1.2-1.4	Natural	2.5*	High strength
TP05	Sandstone	1.2-1.4	Natural	2.0*	High strength
TP06	Sandstone	1.3-1.5	Natural	0.37*	Medium strength
TP06	Sandstone	1.3-1.5	Natural	0.53*	Medium strength
TP06	Sandstone	1.3-1.5	Natural	0.52*	Medium strength
TP06	Sandstone	1.3-1.5	Natural	0.72*	Medium strength
TP06	Sandstone	1.3-1.5	Natural	0.52*	Medium strength
TP07	Sandstone	1.2-1.4	Natural	0.40*	Medium strength
TP07	Sandstone	1.2-1.4	Natural	1.3*	High strength
TP07	Sandstone	1.2-1.4	Natural	0.68*	Medium strength
TP07	Sandstone	1.2-1.4	Natural	1.3*	High strength
TP07	Sandstone	1.2-1.4	Natural	1.3*	High strength
TP08	Sandstone	0.15-0.6	Natural	0.37*	Medium strength
TP08	Sandstone	0.15-0.6	Natural	0.51*	Medium strength
TP08	Sandstone	0.15-0.6	Natural	0.49*	Medium strength
TP08	Sandstone	0.15-0.6	Natural	0.66*	Medium strength
TP08	Sandstone	0.15-0.6	Natural	0.56*	Medium strength
TP10	Sandstone	1.0-1.2	Natural	2.7*	High strength
TP10	Sandstone	1.0-1.2	Natural	1.7*	High strength
TP10	Sandstone	1.0-1.2	Natural	1.1*	High strength
TP10	Sandstone	1.0-1.2	Natural	0.43*	Medium strength
TP10	Sandstone	1.0-1.2	Natural	0.78*	Medium strength

*)- irregular

5 Preliminary Pavement Design

5.1 Design Traffic Loadings

Design traffic loadings have been selected, and pavement thickness design calculations have been undertaken by EP Risk in accordance with Maitland City Council – Manual of Engineering Standards D (MCC-MoES draft 2025).

The design traffic data has been determined based on the following assumptions presented in **Table 8**.

Table 8. Recommended Road Type and Design ESA's

Road Type	Roads Identification	Design ESA's
Local	TBC	1×10^6
Collector	TBC	1.5×10^6

Where traffic data varies from the above assumptions, a review of the pavement design will be required.

5.2 Design Parameters

Pavement thickness has been undertaken in accordance with Austroads AGPT02-25 Guide to Pavement Technology, Part 2: Pavement Structural Design based on the following parameters:

- Design subgrade CBR of 3% for Silty/Sandy CLAY.
- Design subgrade CBR of 5% for XW material – subject to confirmation following the regrade and construction of the road alignment.

The design subgrade has been determined in accordance with Section 5 of Austroads AGPT02-25 based on laboratory testing results and field interpretation.

Reference to Table 5.2 Guide to classification of expansive soils (Austroads AGPT02-25) indicate that the soils tested for CBR are low to moderately expansive.

Where filling is undertaken within the road alignments, all fill materials should generally be a minimum of CBR 3% when compacted to 100% standard relative density and SOMC.

5.3 Pavement Design

5.3.1 Flexible Unbound Pavement Design

Pavement thickness design was conducted based on the MCC-MoES – D 2025. In accordance with the council directive, an overall pavement thickness of 300mm minimum, with 100mm minimum base thickness (desirably 150mm to match kerb profile) and 150mm minimum sub-base thickness is required. Due to the profile of standard SA kerb and roll kerb and gutter, basecourse is normally specified as a minimum of 150mm for construction practicality with 150mm of subbase to provide the minimum granular thickness of 300mm. It is noted the minimum thickness of asphalt is 40mm AC10 "residential mix" for residential road type.

The option of pavement construction utilising flexible unbound pavement are presented from **Table 9**.

Table 9. Recommended Flexible Pavement Composition – CBR 3% and 5%				
Road Type	**Local**	**Local Collector**	**Local**	**Local Collector**
Wearing Course (mm)	40 AC10*	40 AC10*	40 AC10*	40 AC10*
Basecourse (mm)	150	150	150	150
Subbase (mm)	330(150)	350 (150)	210	220
Select (mm)**	300	300	-	-
Total Thickness (mm)	520 (640)	540 (640)	400	410
Subgrade CBR	3%		5%	
Design ESA	1×10^6	1.5×10^6	1×10^6	1.5×10^6
* AC10 residential mix with 7/10mm primer seal placed under asphaltic concrete wearing surface ** Where CBR swell is ≥2.5% (not expected) a select layer of 300mm min CBR 15% is required additional to the total thickness. Where a 300mm select minimum CBR 15% is used over design CBR 3% subgrade the pavement shown in brackets may be adopted				

A minimum of fourteen days duration shall apply prior to application of asphalt layer. That period may be extended or shortened subject to approval by Council. A 40mm of AC10 residential mix has been specified to meet the draft MoES requirements.

For areas where clay subgrade has a CBR <3 or swell ≥2.5%, the pavement design will require a minimum 300mm select layer with minimum CBR of 15% or other measures detailed in Austroads Guidelines for managing soils with a swell potential. The select layer is additional to the unbracketed total thickness shown in Table 9. i.e 920mm for local road and 840mm for a local collector.

Expansive clays subgrades soils are known in proximity to the development and a select layer should be provisioned for in construction. This will also address failed proof rolls due to elevated moisture conditions at the time of construction.

5.4 Subgrade Preparation

For construction of a new pavement, subgrade preparation should be in accordance with the following procedures:

- Remove topsoil/fill/weathered material to the design subgrade level (DSL).
- Ripping the insitu subgrade 300below DSL and recompact to a minimum 100% SMDD. Moisture content should be within 60% to 90% of SOMC for weathered bedrock and 80% to 100% for reactive clay subgrade material.
- Static proof-rolling of the exposed subgrade using a heavy (minimum 10 tonne) roller under the direction of an experienced geotechnical consultant.
- Loose or yielding areas should be excavated and replaced with compacted select fill or suitable subgrade replacement comprising of material of similar consistency to the subgrade.
- Confirmation of design subgrade parameters by a geotechnical consultant.
- Where filling or subgrade replacement is required, the materials employed should be free of organics or other deleterious material. The material should also have a maximum particle size of 100mm or one third of the layer thickness, with a minimum soaked CBR of minimum 3%. Low expansive/reactive material should be used as subgrade and general fill where possible in the top 1m to design levels.
- As select layer may be required where weak subgrade or subgrade at elevated moisture is encountered during construction.

- Low bearing capacity soil was encountered in majority of the test pits (TP4-7, TP11 and TP12 at depths up to 1.3m BGL and most likely will unlikely pass the proof roll in existing state. The low bearing capacity soils should be consolidated by compaction or excavated and replaced with suitable subgrade site won material.
- Over compaction of reactive clay material and moisture content dry of standard optimum should be avoided as this will increase the swell potential of the material.

Following satisfactory preparation of the subgrade, the pavement should be constructed in accordance with the recommendations of this report and MCC-MoES. In case of discrepancies, clarification should be obtained from Council.

5.5 Drainage

The moisture regime associated with a pavement has a major influence on the performance considering the stiffness/strength of the pavement materials is dependent on the moisture content of the material used. Accordingly, to protect the pavement materials from wetting up and softening, particular care would be required to provide a waterproof seal for the pavement materials, together with adequate surface and sub-surface drainage of the pavement and adjacent areas.

It is recommended that subsoil drainage be installed at, or below subgrade level along both sides of the roads within the development in accordance with Council requirements, at subgrade level with subsoil preferably place in the select layer.

The pavement thickness designs presented above assume drained pavement conditions. The selection, construction and maintenance of appropriate drainage mechanisms will be required for adequate performance.

5.6 Materials

5.6.1 Specifications and Compaction Requirements

Pavement materials and compaction requirements for new pavement construction should conform to Council requirements outlined in MCC-MoES and the following requirements outlined in **Table 10**.

Table 10. Material Specification and Compaction Requirements

Pavement course	Material Specification	Compaction Requirements
Base Course* DGB20 (Class 1 & 2), GMB20 & NGB20-2c MoES (Cl 9.1.2)	Material complying with Council MoES Table 242.3 for the appropriate traffic category	Min 98% Modified (AS 1289 5.2.1)
Subbase Subbase quality crushed rock* (DGS20, DGS40, GMS40, NGS20, NGS40) MoES (Cl 9.1.2)	Material complying with Council MoES	Min 95% Modified (AS1289.5.2.1)
Select Granular material	Minimum min 15% and PI ≤15% (per Council MoES)	Min 98% Modified (AS 1289 5.2.1) or Min 102% Standard (AS 1289 5.1.1)
Subgrade or replacement	Minimum CBR as appropriate for the design option 3% or 5%	Min 95% Modified (AS 1289 5.2.1) or Min 100% Standard (AS 1289 5.1.1)

* NGB and NGS material cannot be used on collector category roads or higher due to higher design traffic. Material should comply with Council MoES Appendix D – Pavement Material Properties for the appropriate traffic category

5.6.2 Wearing Course

Wearing courses should be in accordance with the Council's specifications with reference to TfNSW QA Specifications R116 for Dense Graded Asphalt. A 40mm of AC10" residential mix" has been specified in the draft MoES for residential road types.

The design and construction of wearing courses should be in in consultation with the preferred supplier considering traffic volume and type. All pavement surfaces should be primer sealed prior to the application of the asphaltic concrete ('AC') wearing course. A minimum delay of 14 days is required after the primer seal before placement of the AC wearing course. The delay period on application of the wearing course following primer seal may be altered following discussion with the supplier.

5.6.3 Inspections

The subgrade will require inspection by an experienced geotechnical consultant after boxing out or filling to design subgrade level. The purpose of inspections is to confirm design parameters, assess the suitability of the subgrade to support the pavement, and delineate areas which may require subgrade replacement or remedial treatment prior to construction.

Soaked CBR testing will be required following the completion of bulk earthworks and site regrade activities to confirm the assumed design parameters and appropriate pavement thickness.

All works and materials used in construction should be constructed in accordance with Council Specifications and as specified in this report. Where discrepancies may occur, clarification should be sought from Council.

6 Preliminary Site Classification and Footings

6.1 Preliminary Site Classification

Australian Standard AS 2870-2011 establishes performance requirements and specific designs for common foundation conditions as well as providing guidance on the design of footing systems using engineering principles. Site classes as defined on Table 2.1 and 2.3 of AS 2870 are presented in **Table 11**.

Table 11. General Definition of Site Classes

Site Class	Foundation	Characteristic
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	0 – 20 mm
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes	20 – 40 mm
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes	40 – 60 mm
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes	60 – 75 mm
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes	> 75 mm
A to P	Filled sites (refer to clause 2.4.6 of AS 2870)	-
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.	

Reactive sites are sites consisting of clay soils that swell on wetting and shrink on drying, resulting in ground movements that can damage lightly loaded structures. The amount of ground movement is related to the physical properties of the clay and environmental factors such as climate, vegetation, and watering. A higher probability of damage can occur on reactive sites where abnormal moisture conditions occur, as defined in AS 2870, due to factors such as:

- Presence of trees on the building site or adjacent site, removal of trees prior to or after construction, and the growth of trees too close to a footing. The proximity of mature trees and their effect on foundations should be considered when determining building areas within each allotment (refer to AS 2870).
- Failure to provide adequate site drainage or lack of maintenance of site drainage, failure to repair plumbing leaks and excessive or irregular watering of gardens.
- Unusual moisture conditions caused by removal of structures, ground covers (such as pavements), drains, dams, swimming pools, tanks etc.

Regarding the performance of footings systems, AS 2870 states “footing systems designed and constructed in accordance with this Standard on a normal site (see Clause 1.3.2) that is:

a) not subject to abnormal moisture conditions; and

b) maintained, such that the original site classification remains valid and abnormal moisture conditions do not develop, are expected to usually experience no damage, a low incidence of damage category 1 and an occasional incidence of damage category 2."

Damage categories are defined in Appendix C of AS 2870, which is reproduced in CSIRO Information Sheet BTF 18, Foundation Maintenance and Footing Performance: A Homeowner's Guide attached as **Appendix E – Foundation Maintenance and Footing Performance**.

The laboratory Shrink Swell test result summarised in **Table 6** indicate that the tested natural clay soils are of low to moderate reactivity, with I_{ss} value ranging from 0.3% to 1.8%.

The classification of sites with controlled fill of depths greater than 0.4m (deep fill) comprising of material other than sand would be Class P. An alternative classification may however be given to sites with controlled fill where consideration is made to the potential for movement of the fill and underlying soil based on the moisture conditions at the time of construction and the long-term equilibrium moisture conditions.

Based on the subsurface profiles encountered during the Site inspection and in accordance with the AS 2870-2011; the Site in its existing condition and in the absence of abnormal moisture conditions would likely be classified as detailed in **Table 12**.

Table 12. Anticipated Site Classifications

Waterford, Chisholm NSW	Site Classification
In Existing Condition prior to regrade	**Class P* (reactivity of Class M**, Moderately Reactive)
Following site regrade activities	**Class M**, moderately reactive to **Class H1**, highly reactive
Found uniformly in HW bedrock	**Class S or A**

*it is noted that low bearing capacity was encountered in the majority of the test pits, and the classification assume this will be addressed during regrade activities / bulk earthworks.

A characteristic surface movement (y_s) in the range of 20mm to 40mm has been calculated for the site dependent on the soil profile existing state prior to regrade, using a depth of suction (Hs) change of 2.3m. Following regrade, characteristics surface movement (Ys) is estimated to be in the order of up to 45mm using worst case scenarios as the depth of the cracked zone is considered zero as per AS2870-2011 Clause 2.3.2. Actual site classifications will be dependent on regrade activities including depth to rock and filling depth along with the materials used as fill.

The above site classifications and footing recommendations are for the site conditions present at the time of fieldwork and consequently the site classification may need to be reviewed with consideration of any site works that may be undertaken after the investigation and this report.

Site works may include:

- Changes to the existing soil profile by cutting and filling.
- Landscaping, including trees removed or planted in the general building area; and
- Drainage and watering systems.

Designs and design methods presented in AS 2870-2011 are based on the performance requirement that significant damage can be avoided if site conditions are properly maintained. Performance requirements and foundation maintenance are outlined in Appendix B of AS 2870. The above site classification assumes that the performance requirements as set out in Appendix B of AS 2870 are acceptable and that site foundation maintenance is undertaken to avoid extremes of wetting and drying.

Details on appropriate site and foundation maintenance practices are presented in Appendix B of AS 2870-2011 and in CSIRO Information Sheet BTF 18, Foundation Maintenance and Footing Performance: A Homeowner's Guide. Adherence to the detailing requirement outlined in Section 5 of AS 2870-2011 is essential, Section 5.6. Additional requirements for Classes M, H1, H2 and E sites, including architectural restrictions, plumbing and drainage requirements.

6.2 Footings

All foundations should be designed and constructed in accordance with 2870-2011, Residential Slabs and Footings with reference to site classifications as presented in **Section 6.1**.

All footings should be founded below any topsoil, deleterious soils or uncontrolled fill. All footings for the same structure should be founded on strata of similar stiffness and reactivity to minimise the risk of differential movement and should be confirmed by specific investigation for proposed structures.

Potential for differential movement should be considered due to variation in depth to rock and filling across the Site and articulation incorporated into the design.

6.2.1 High Level Footings

High-level footing alternatives could be expected to comprise slabs on ground with edge beams or pad footings for the support of concentrated loads. Such footings designed in accordance with engineering principles and founded in stiff or better soils (below topsoil, slopewash, uncontrolled fill or other deleterious material may be proportioned on an allowable bearing capacity of 100 kPa.

Where controlled lot filling has been carried out, high-level footing types should be founded below any topsoil onto the stiff or better engineered fill that is placed and compacted in accordance with AS3798-2007.

The founding conditions should be assessed by an experienced geotechnical consultant or experienced engineer to confirm suitable conditions.

6.2.2 Piered Footings

Piered footings are considered as an alternative to deep edge beams or high-level footings and provide an alternate founding solution. It is suggested that bored pier footings, founded in stiff or better natural clay could be proportioned on an end bearing pressure of 150 kPa. Piers founded in weathered sandstone can be apportioned for an allowable bearing capacity of 500kPa and Class S or Class A adopted

All footings should be founded below any topsoil, slopewash, deleterious soils or uncontrolled fill. All footings for the same structure should be founded on strata of similar stiffness and reactivity to minimise the risk of differential movements. Inspection of high level or pier footings excavations should be undertaken to confirm the founding conditions, and the base should be cleared of fall-in prior to the formation of the footings.

7 References

- Austroads AGPT05-19, "Guide to Pavement Technology Part 5: Pavement Evaluation and Treatment Design," Austroads Ltd, October 2019
- Austroads AGPT02-17, "Guide to Pavement Technology Part 2: Pavement Structural Design," Austroads Ltd, 2017.
- eSPADE, Online website of NSW Office of Environment and heritage (www.environment.nsw.gov.au)
- Maitland City Council – Manual of Engineering Standards draft 2025.
- eSPADE, Online website of NSW Office of Environment and heritage (www.environment.nsw.gov.au)
- NearMap, MapBrowser | Nearmap
- Minview, (MinView | Regional NSW | Mining, Exploration and Geoscience)
- NSW Department of Planning and Environment, Resources and Geoscience (www.resourcesandgeoscience.nsw.gov.au)
- Standards Australia, AS1726-2017, "Geotechnical site investigations".
- Standards Australia, AS2159-2009, "Piling – Design & Installation".
- Standards Australia AS2870-2011, "Residential Slabs and Footings".
- Standards Australia AS3798-2007, "Guidelines on Earthworks for Commercial and Residential Structures".
- Standards Australia, HB 160 – Soils Testing, 2006
- TfNSW QA Specification 3051 (Ed 7 Rev 1), "Granular Base and Subbase Materials for Surfaced Road Pavements," Roads and Maritime Services, June 2020.

Appendix A
PHOTOLOG

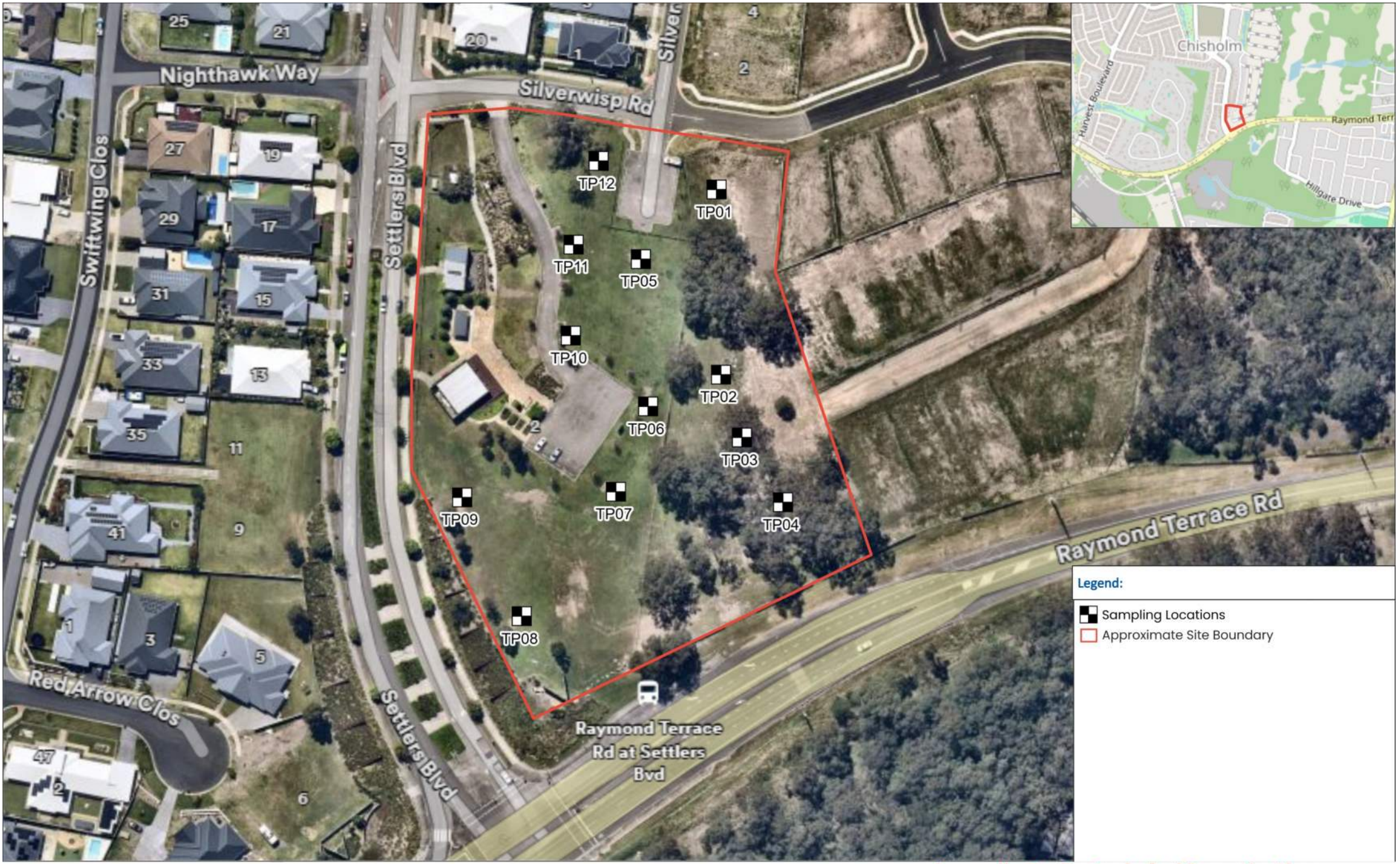
	**Plate 1** **Description:** Site observation, looking south from the central carpark **Date: 27/10/2025**
	**Plate 2** **Description:** Site observation, looking north from the central carpark **Date: 27/10/2025**

	**Plate 3** **Description:** Site observation, looking east adjacent TP10 **Date: 27/10/2025**
	**Plate 4** **Description:** Site observation, looking west from the northern carpark **Date: 27/10/2025**

	**Plate 5** **Description:** Site observation, looking southwest from the northern carpark **Date: 27/10/2025**
	**Plate 6** **Description:** Site observation, looking southeast from the northern carpark **Date: 27/10/2025**

Appendix B

GEOTECHNICAL INVESTIGATION LOCATIONS



EP RISK

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Geotechnical Investigation
Silverwisp Road, Chisholm NSW, Australia

Appendix B - Geotechnical Investigation Locations

Job No: EP4322
Date: 21-10-2025
Version: v1

N

0 25 m 50 m

Approximate Scale Only

Coordinate System: WGS 84
Drawn By: JA Checked By: OP
Scale of regional map not shown
Source: © Department of Finance, Services & Innovation 2018

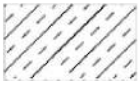
ISO 9001 ISO 45001 ISO 14001

Appendix C
ENGINEERING LOGS

Soil Logging Symbols

CLAYS

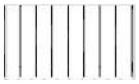

CLAY


silty CLAY

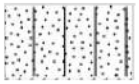

sandy CLAY


gravelly CLAY

SILTS

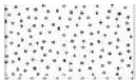

SILT

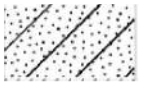

clayey SILT

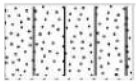

sandy SILT

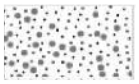

gravelly SILT

SANDS


SAND

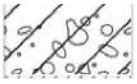

clayey SAND

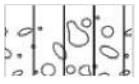

silty SAND

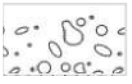

gravelly SAND

GRAVELS


GRAVEL


clayey GRAVEL


silty GRAVEL


sandy GRAVEL

SEDIMENTARY ROCK

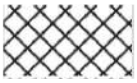

SANDSTONE


SILTSTONE


SHALE


CONGLOMERATE

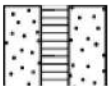
FILL

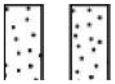

FILL

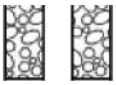

CONCRETE


ASPHALT

GROUNDWATER WELL SYMBOLS

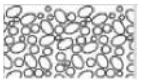

WELL SCREEN


CASING – filter pack


CASING – backfill


CASING – bentonite seal


CASING – grout seal


BACKFILL

OTHER


TOPSOIL – sandy SILT


TOPSOIL – highly organic

Rock Description Explanation Sheet (1 of 2)

Weathering Condition (Degree of Weathering):

The degree of weathering is a continuum from fresh rock to soil. Boundaries between weathering grades may be abrupt or gradational.

Rock Material Weathering Classification		
Weathering Grade	**Symbol**	**Definition**
Residual Soil	RS	Soil-like material developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume, but the material has not been significantly transported.
Extremely Weathered Rock	XW	Rock is weathered to such an extent that it has 'soil' properties, i.e. it either disintegrates or can be remoulded in water, but substance fabric and rock structure still recognisable.
Highly Weathered Rock	HW	Strong discolouration is evident throughout the rock mass, often with significant change in the constituent minerals. The intact rock strength is generally much weaker than that of the fresh rock.
Moderately Weathered Rock	MW	Modest discolouration is evident throughout the rock fabric, often with some change in the constituent minerals. The intact rock strength is usually noticeably weaker than that of the fresh rock.
Slightly Weathered Rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh Rock	FR	Rock shows no sign of decomposition or staining.

Notes:

1. Minor variations within broader weathering grade zones will be noted on the engineering borehole logs.
2. Extremely weathered rock is described in terms of soil engineering properties.
3. Weathering may be pervasive throughout the rock mass or may penetrate inwards from discontinuities to some extent.
4. The 'Distinctly Weathered (DW)' class as defined in AS1726-2017 is divided to incorporate HW and MW in the above table. The symbol DW should not be used.

Strength Condition (Intact Rock Strength):

Strength of Rock Material (Based on Point Load Strength Index, corrected to 50mm diameter – $I_{s(50)}$. Field guide used if no tests available. Refer to AS 4133.4.1-2007.			
Term	**Symbol**	**Point Load Index (MPa)** $I_{s(50)}$	**Field Guide to Strength**
Very Low	VL	>0.03 ≤0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 3cm thick can be broken by finger pressure.
Low	L	>0.1 ≤0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	M	>0.3 ≤1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	H	>1 ≤3	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	VH	>3 ≤10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High	EH	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Notes:

1. These terms refer to the strength of the rock material and not to the strength of the rock mass which may be considerably weaker due to the effect of rock defects.
2. Anisotropy of rock material samples may affect the field assessment of strength.
3. Extremely Low Strength ('EL') is now not considered a description of rock strength in line with the updated AS1726-2017 as by definition EL rock should be described in terms of soil properties.

Rock Description Explanation Sheet (2 of 2)

Discontinuity Description: Refer to AS1726-2017, Table A10.

Anisotropic Fabric	
BED	Bedding
FOL	Foliation
LIN	Mineral lineation
Defect Type	
LP	Lamination Parting
Pt	Bedding Parting
FP	Cleavage / Foliation Parting
Jt	Joint
SZ	Sheared Zone
CZ	Crushed Zone
BZ	Broken Zone
HFZ	Highly Fractured Zone
AZ	Alteration Zone
VN	Vein

Roughness (e.g. Planar, Smooth is abbreviated Pln / Sm)		**Class**
Stepped (Stp)	Rough or irregular (R or Irr)	I
	Smooth (Sm)	II
	Slickensided (Sl)	III
Undulating (Un)	Rough (R)	IV
	Smooth (Sm)	V
	Slickensided (Sl)	VI
Planar (Pln)	Rough (R)	VII
	Smooth (Sm)	VIII
	Slickensided (Sl)	IX

Aperture		**Infilling**		
Closed	CD	No visible coating or infill	Clean	Cn
Open	OP	Surfaces discoloured by mineral/s	Stain	St
Filled	FL	Visible mineral or soil infill <1mm	Veneer	Vr
Tight	TI	Visible mineral or soil infill >1mm	Coating	Ct

Other	
Clay	Clay
Fe	Iron
Co	Coal
Carb	Carbonaceous
Sinf	Soil Infill Zone
Qz	Quartz
Ca	Calcite
Chl	Chlorite
Py	Pyrite
Int	Intersecting
Inc	Incipient
DI	Drilling Induced
H	Horizontal
V	Vertical

Note: Describe 'Zones' and 'Coatings' in terms of composition and thickness (mm).

Discontinuity Spacing: On the geotechnical borehole log, a graphical representation of defect spacing vs depth is shown. This representation takes into account all the natural rock defects occurring within a given depth interval, excluding breaks induced by the drilling / handling of core. Refer to AS1726-2017, BS5930-1999.

Defect Spacing			**Bedding Thickness (Sedimentary Rock Stratification)**	
Spacing/Width (mm)	Descriptor	Symbol	Descriptor	Spacing/Width (mm)
			Thinly Laminated	< 6
<20	Extremely Close	EC	Thickly Laminated	6 – 20
20 – 60	Very Close	VC	Very Thinly Bedded	20 – 60
60 – 200	Close	C	Thinly Bedded	60 – 200
200 – 600	Medium	M	Medium Bedded	200 – 600
600 – 2000	Wide	W	Thickly Bedded	600 – 2000
2000 – 6000	Very Wide	VW	Very Thickly Bedded	> 2000
>6000	Extremely Wide	EW		

Defect Spacing in 3D	
Term	**Description**
Blocky	Equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greater than cross section

Defect Persistence
(areal extent)
Trace length of defect given in metres

Symbols: The list below provides an explanation of terms and symbols used on the geotechnical borehole, test pit and penetrometer logs.

Test Results			
PI	Plasticity Index	c'	Effective Cohesion
LL	Liquid Limit	c_u	Undrained Cohesion
LI	Liquidity Index	c'_R	Residual Cohesion
DD	Dry Density	ϕ'	Effective Angle of Internal Friction
WD	Wet Density	ϕ_u	Undrained Angle of Internal Friction
LS	Linear Shrinkage	ϕ'_R	Residual Angle of Internal Friction
MC	Moisture Content	c_v	Coefficient of Consolidation
OC	Organic Content	m_v	Coefficient of Volume Compressibility
WPI	Weighted Plasticity Index	$c_{\alpha\varepsilon}$	Coefficient of Secondary Compression
WLS	Weighted Linear Shrinkage	e	Voids Ratio
DoS	Degree of Saturation	ϕ'_{cv}	Constant Volume Friction Angle
APD	Apparent Particle Density	q_t / q_c	Piezocone Tip Resistance (corrected / uncorrected)
s_u	Undrained Shear Strength	q_d	PANDA Cone Resistance
q_u	Unconfined Compressive Strength	$I_{s(50)}$	Point Load Strength Index
TCR	Total Core Recovery	*RQD*	Rock Quality Designation

Test Symbols	
DCP	Dynamic Cone Penetrometer
SPT	Standard Penetration Test
CPTu	Cone Penetrometer (Piezocone) Test
PANDA	Variable Energy DCP
PP	Pocket Penetrometer Test
U50	Undisturbed Sample 50 mm (nominal diameter)
U100	Undisturbed Sample 100mm (nominal diameter)
UCS	Uniaxial Compressive Strength
Pm	Pressuremeter
FSV	Field Shear Vane
DST	Direct Shear Test
PR	Penetration Rate
PLI	Point Load Index Test (axial)
D	Point Load Test (diametral)
L	Point Load Test (irregular lump)

Groundwater level	Water Inflow	Water Outflow

Test Pit No: TP01

Engineering Log - Test Pit

SHEET 1 OF 1

Client	AVID Residential Estate Pty Ltd C/- ADW Johnson Pty Ltd	Project No.	EP4322
Project	Waterford	Logged By	MC
Location	Settlers Boulevard, Chisholm NSW	Checked By	OP

Started Excavation	1.9.25	Northing	6371462.00	Slope	90°	Equipment	5T Excavator
Completed Excavation	1.9.25	Easting	372299.00	Bearing	---	Ground Level	

EXCAVATION				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests DCP Results (blows/ 100mm)	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
E	Not Encountered		0		SM	TOPSOIL: Silty SAND: fine to medium grained, brown	M	L	2		TOPSOIL
					CI-CH	Silty CLAY: medium to high plasticity, dark grey, with fine to coarse grained, sub-angular to angular gravel	~PL	St	3	U50	RESIDUAL SOIL
									3		
									3		
									4		
									4		
									4		
									4		
									4		
									3		
			1						4		
									3	B	
					GP	Extremely weathered Sandstone recovered as Sandy GRAVEL, fine to coarse grained, sub-angular to angular, grey, orange/brown, fine to coarse grained sand, with cobbles up to 200mm	D to M				EXTREMELY WEATHERED ROCK DCP:-HB
						Test Pit TP01 Terminated at 1.40 m					Refusal on sandstone
			2								

Remarks:

EP RISK

EP4322

Geotechnical Investigation

TP01

Test Pit No: TP02

Engineering Log - Test Pit

SHEET 1 OF 1

Client	AVID Residential Estate Pty Ltd C/- ADW Johnson Pty Ltd	Project No.	EP4322
Project	Waterford	Logged By	MC
Location	Settlers Boulevard, Chisholm NSW	Checked By	OP

Started Excavation	1.9.25	Northing	6374103.00	Slope	90°	Equipment	5T Excavator
Completed Excavation	1.9.25	Easting	372298.00	Bearing	---	Ground Level	

EXCAVATION				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests DCP Results (blows/ 100mm)	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
E	Not Encountered				SM	TOPSOIL: Silty SAND: fine to medium grained, brown, with coal chitter	M	L	1		TOPSOIL
					CI-CH	Gravelly CLAY: medium to high plasticity, dark grey, fine to coarse grained, sub-angular to angular gravel, with fine to coarse grained sand	~PL	F to St	2 3 3 4	B	RESIDUAL SOIL
					GP	Extremely weathered Sandstone recovered as Sandy GRAVEL, fine to coarse grained, sub-angular to angular, grey, orange/brown, fine to coarse grained sand, with cobbles up to 200mm	D to M				EXTREMELY WEATHERED ROCK DCP:-HB
			1 2			Test Pit TP02 Terminated at 0.60 m					Refusal on sandstone

Remarks:

EP RISK

EP4322

Geotechnical Investigation

TP02

Test Pit No: TP03

Engineering Log - Test Pit

SHEET 1 OF 1

Client	AVID Residential Estate Pty Ltd C/- ADW Johnson Pty Ltd	Project No.	EP4322
Project	Waterford	Logged By	MC
Location	Settlers Boulevard, Chisholm NSW	Checked By	OP

Started Excavation	1.9.25	Northing	6374084.00	Slope	90°	Equipment	5T Excavator
Completed Excavation	1.9.25	Easting	372306.00	Bearing	---	Ground Level	

EXCAVATION				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests DCP Results (blows/ 100mm)	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
E	Not Encountered				SM	TOPSOIL: Silty SAND: fine to medium grained, brown	M	L	1		TOPSOIL
E					CI-CH	Silty CLAY: medium to high plasticity, grey, dark grey	~PL	St to F	3 3 3 2	B B	RESIDUAL SOIL
					GP	Extremely weathered Sandstone recovered as Sandy GRAVEL, fine to coarse grained, sub-angular to angular, grey, orange/brown, fine to coarse grained sand, with cobbles up to 150mm	D to M				EXTREMELY WEATHERED ROCK DCP:-HB
			1 2			Test Pit TP03 Terminated at 0.60 m					Refusal on sandstone

Remarks:

EP RISK

EP4322

Geotechnical Investigation

TP03

Test Pit No: TP04

Engineering Log - Test Pit

SHEET 1 OF 1

Client	AVID Residential Estate Pty Ltd C/- ADW Johnson Pty Ltd	Project No.	EP4322
Project	Waterford	Logged By	MC
Location	Settlers Boulevard, Chisholm NSW	Checked By	OP

Started Excavation	1.9.25	Northing	6374063.00	Slope	90°	Equipment	5T Excavator
Completed Excavation	1.9.25	Easting	372317.00	Bearing	---	Ground Level	

EXCAVATION				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests DCP Results (blows/ 100mm)	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
E	Not Encountered				SM	TOPSOIL: Silty SAND: fine to medium grained, brown	M	L	1		TOPSOIL
					CL-CI	Silty CLAY: low to medium plasticity, grey	~PL	F to St	2 2 3 3	U50	RESIDUAL SOIL
					GP	Extremely weathered Sandstone recovered as Sandy GRAVEL, fine to coarse grained, sub-angular to angular, grey, orange/brown, fine to coarse grained sand, with boulders up to 300mm	D to M		10	B	EXTREMELY WEATHERED ROCK DCP:-HB
			1			Test Pit TP04 Terminated at 0.70 m					Refusal on sandstone
			2								

Remarks:

EP RISK

EP4322

Geotechnical Investigation

TP04

Test Pit No: TP05

Engineering Log - Test Pit

SHEET 1 OF 1

Client	AVID Residential Estate Pty Ltd C/- ADW Johnson Pty Ltd	Project No.	EP4322
Project	Waterford	Logged By	MC
Location	Settlers Boulevard, Chisholm NSW	Checked By	OP

Started Excavation	1.9.25	Northing	6374140.00	Slope	90°	Equipment	5T Excavator
Completed Excavation	1.9.25	Easting	372273.00	Bearing	---	Ground Level	

EXCAVATION				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests DCP Results (blows/ 100mm)	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
E	Not Encountered		0		SM	TOPSOIL: Silty SAND: fine to medium grained, dark brown	M	L	1 1		TOPSOIL
					CI-CH	Silty CLAY: medium to high plasticity, dark grey	~PL	F	2 2 1 2 1 2 2 2 2		RESIDUAL SOIL
			1						2	B	DCP:-HB
					GP	Extremely weathered Sandstone recovered as Sandy GRAVEL, fine to coarse grained, sub-angular to angular, grey, orange/brown, fine to coarse grained sand, with cobbles up to 150mm	D to M			B	EXTREMELY WEATHERED ROCK
						Test Pit TP05 Terminated at 1.40 m					Refusal on sandstone
			2								

Remarks:

EP RISK

EP4322

Geotechnical Investigation

TP05

Test Pit No: TP06

Engineering Log - Test Pit

SHEET 1 OF 1

Client	AVID Residential Estate Pty Ltd C/- ADW Johnson Pty Ltd	Project No.	EP4322
Project	Waterford	Logged By	MC
Location	Settlers Boulevard, Chisholm NSW	Checked By	OP

Started Excavation	1.9.25	Northing	6374089.00	Slope	90°	Equipment	5T Excavator
Completed Excavation	1.9.25	Easting	372274.00	Bearing	---	Ground Level	

EXCAVATION				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests DCP Results (blows/ 100mm)	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
E	Not Encountered				SM	TOPSOIL: Silty SAND: fine to medium grained, dark brown	M	L	1 1		TOPSOIL
					CI-CH	Gravelly CLAY: medium to high plasticity, dark grey, fine to coarse grained, sub-angular to angular gravel, with fine to coarse grained sand	~PL	F and St	1 2 2 2 1 1 1 2 3 3 2 3	B	RESIDUAL SOIL
			1		GP	Extremely weathered Sandstone recovered as Sandy GRAVEL, fine to coarse grained, sub-angular to angular, grey, orange/brown, fine to coarse grained sand, with cobbles up to 200mm	D to M		12	B	EXTREMELY WEATHERED ROCK
						Test Pit TP06 Terminated at 1.50 m			12		DCP:-HB Refusal on sandstone
			2								

Remarks:

EP RISK

EP4322

Geotechnical Investigation

TP06

Test Pit No: TP07

Engineering Log - Test Pit

SHEET 1 OF 1

Client	AVID Residential Estate Pty Ltd C/- ADW Johnson Pty Ltd	Project No.	EP4322
Project	Waterford	Logged By	MC
Location	Settlers Boulevard, Chisholm NSW	Checked By	OP

Started Excavation	1.9.25	Northing	6374063.00	Slope	90°	Equipment	5T Excavator
Completed Excavation	1.9.25	Easting	372261.00	Bearing	---	Ground Level	

EXCAVATION				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests DCP Results (blows/ 100mm)	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
E	Not Encountered				SM	FILL: Silty SAND: fine to medium grained, dark brown	M	L	2 2		FILL
					CI-CH	Gravelly CLAY: medium to high plasticity, grey, fine to coarse grained, sub-angular to angular gravel, with fine to coarse grained sand	~PL	F and St	2 2 1 2 2 3 3 3 3 2 3		RESIDUAL SOIL
			1		GP	Extremely weathered Sandstone recovered as Sandy GRAVEL, fine to coarse grained, sub-angular to angular, grey, orange/brown, fine to coarse grained sand, with cobbles up to 200mm	D to M		12	B	EXTREMELY WEATHERED ROCK DCP:-HB
						Test Pit TP07 Terminated at 1.40 m					Refusal on sandstone
			2								

Remarks:

EP RISK

EP4322

Geotechnical Investigation

TP07

Test Pit No: TP08

Engineering Log - Test Pit

SHEET 1 OF 1

Client	AVID Residential Estate Pty Ltd C/- ADW Johnson Pty Ltd	Project No.	EP4322
Project	Waterford	Logged By	MC
Location	Settlers Boulevard, Chisholm NSW	Checked By	OP

Started Excavation	1.9.25	Northing	6374027.00	Slope	90°	Equipment	5T Excavator
Completed Excavation	1.9.25	Easting	372232.00	Bearing	---	Ground Level	

EXCAVATION				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests DCP Results (blows/ 100mm)	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
E	Not Encountered				SM	TOPSOIL: Silty SAND: fine to medium grained, brown	D to M	L	1 2	B	TOPSOIL
					GP	Extremely weathered Sandstone recovered as Sandy GRAVEL, fine to coarse grained, sub-angular to angular, grey, orange/brown, fine to coarse grained sand, with boulders up to 400mm			10 12		EXTREMELY WEATHERED ROCK DCP:-HB
			1			Test Pit TP08 Terminated at 0.60 m					Refusal on sandstone
			2								

Remarks:

EP RISK

EP4322

Geotechnical Investigation

TP08

Test Pit No: TP09

Engineering Log - Test Pit

SHEET 1 OF 1

Client	AVID Residential Estate Pty Ltd C/- ADW Johnson Pty Ltd	Project No.	EP4322
Project	Waterford	Logged By	MC
Location	Settlers Boulevard, Chisholm NSW	Checked By	OP

Started Excavation	1.9.25	Northing	6374064.00	Slope	90°	Equipment	5T Excavator
Completed Excavation	1.9.25	Easting	372216.00	Bearing	---	Ground Level	

EXCAVATION				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests DCP Results (blows/ 100mm)	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
E	Not Encountered				SM	TOPSOIL: Silty SAND: fine to medium grained, brown	M	L	1		TOPSOIL
					CI-CH	Gravelly CLAY: medium to high plasticity, dark grey, fine to coarse grained, sub-angular to angular gravel, with fine to coarse grained sand	~PL	F to St	2 3 4 3 3	B U50	RESIDUAL SOIL
					GP	Extremely weathered Sandstone recovered as Sandy GRAVEL, fine to coarse grained, sub-angular to angular, grey, orange/brown, fine to coarse grained sand, with cobbles up to 150mm	D to M		10		EXTREMELY WEATHERED ROCK DCP:-HB
			1			Test Pit TP09 Terminated at 0.80 m					Refusal on sandstone
			2								

Remarks:

EP RISK

EP4322

Geotechnical Investigation

TP09

Test Pit No: TP10

Engineering Log - Test Pit

SHEET 1 OF 1

Client	AVID Residential Estate Pty Ltd C/- ADW Johnson Pty Ltd	Project No.	EP4322
Project	Waterford	Logged By	MC
Location	Settlers Boulevard, Chisholm NSW	Checked By	OP

Started Excavation	1.9.25	Northing	6374119.00	Slope	90°	Equipment	5T Excavator
Completed Excavation	1.9.25	Easting	372251.00	Bearing	---	Ground Level	

EXCAVATION				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests DCP Results (blows/ 100mm)	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
E	Not Encountered				SM	TOPSOIL: Silty SAND: fine to medium grained, brown	M	L	1 2		TOPSOIL
					CI-CH	Gravelly CLAY: medium to high plasticity, dark grey, fine to coarse grained, sub-angular to angular gravel	~PL	St	3 3 4 3 3 3 4 3 3	B U50	RESIDUAL SOIL
			1		GP	Extremely weathered Sandstone recovered as Sandy GRAVEL, fine to coarse grained, sub-angular to angular, grey, orange/brown, fine to coarse grained sand, with cobbles up to 200mm	D to M		13	B	EXTREMELY WEATHERED ROCK DCP:-HB
						Test Pit TP10 Terminated at 1.20 m					Refusal on sandstone
			2								

Remarks:

EP RISK

EP4322

Geotechnical Investigation

TP10

Test Pit No: TP11

Engineering Log - Test Pit

SHEET 1 OF 1

Client	AVID Residential Estate Pty Ltd C/- ADW Johnson Pty Ltd	Project No.	EP4322
Project	Waterford	Logged By	MC
Location	Settlers Boulevard, Chisholm NSW	Checked By	OP

Started Excavation	1.9.25	Northing	6374147.00	Slope	90°	Equipment	5T Excavator
Completed Excavation	1.9.25	Easting	372251.00	Bearing	---	Ground Level	

EXCAVATION				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests DCP Results (blows/ 100mm)	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
E	Not Encountered				SM	TOPSOIL: Silty SAND: fine to medium grained, brown	M	L	2		TOPSOIL
					CI-CH	Gravelly CLAY: medium to high plasticity, dark grey, fine to coarse grained, sub-angular to angular gravel, with fine to medium grained sand	~PL	F to St	1 2 2 1 2 2 3 4 3		RESIDUAL SOIL
			1		GP	Extremely weathered Sandstone recovered as Sandy GRAVEL, fine to coarse grained, sub-angular to angular, grey, orange/brown, fine to coarse grained sand, with cobbles up to 200mm	D to M		12		EXTREMELY WEATHERED ROCK DCP:-HB
						Test Pit TP11 Terminated at 1.20 m					Refusal on sandstone
			2								

Remarks:

EP RISK

EP4322

Geotechnical Investigation

TP11

Test Pit No: TP12

Engineering Log - Test Pit

SHEET 1 OF 1

Client	AVID Residential Estate Pty Ltd C/- ADW Johnson Pty Ltd	Project No.	EP4322
Project	Waterford	Logged By	MC
Location	Settlers Boulevard, Chisholm NSW	Checked By	OP

Started Excavation	1.9.25	Northing	6374173.00	Slope	90°	Equipment	5T Excavator
Completed Excavation	1.9.25	Easting	372257.00	Bearing	---	Ground Level	

EXCAVATION				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests DCP Results (blows/ 100mm)	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
E	Not Encountered				SM	TOPSOIL: Silty SAND: fine to medium grained, brown	M	L	2		TOPSOIL
					CI-CH	Gravelly CLAY: medium to high plasticity, grey, dark grey, fine to coarse grained, sub-angular to angular gravel, with fine to coarse grained sand	~PL	F	2 2 1 2 2		RESIDUAL SOIL
					GP	Extremely weathered Sandstone recovered as Sandy GRAVEL, fine to coarse grained, sub-angular to angular, grey, orange/brown, fine to coarse grained sand, with cobbles up to 200mm	D to M		8 13		EXTREMELY WEATHERED ROCK DCP:-HB
			1			Test Pit TP12 Terminated at 0.90 m					Refusal on sandstone
			2								

Remarks:

EP RISK

EP4322

Geotechnical Investigation

TP12

Appendix D
LABORATORY TEST RESULTS

Material Test Report

Report Number: **NEWC25387-1**
Issue Number: 1
Date Issued: 15/09/2025
Client: EP Risk Management
PO Box 57, Lochinvar NSW 2321
Project Number: NEWC25387
Project Name: EP4322 - Chisholm
Project Location: Chisholm
Client Reference: EP4322 - EP4322
Work Request: 6291
Sample Number: NEWC6291B
Date Sampled: 02/09/2025
Dates Tested: 02/09/2025 - 11/09/2025
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: In accordance with the test method
Site Selection: Selected by Client
Sample Location: **TP04 (0.1 - 0.4m)**

coffey TESTING
Newcastle Laboratory
16 Callistemon Close Warabrook NSW 2304
Phone: (02) 4016 2300
Email: Newcastle Laboratory

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Raphael Kirby-Faust
Geotechnician
Laboratory Accreditation Number: 431

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	30		
Plastic Limit (%)	17		
Plasticity Index (%)	**13**		
Not enough sample for 4 point liquid limit or linear shrink.			

Material Test Report

Report Number: **NEWC25387-1**
Issue Number: 1
Date Issued: 15/09/2025
Client: EP Risk Management
PO Box 57, Lochinvar NSW 2321
Project Number: NEWC25387
Project Name: EP4322 - Chisholm
Project Location: Chisholm
Client Reference: EP4322 - EP4322
Work Request: 6291
Sample Number: NEWC6291D
Date Sampled: 02/09/2025
Dates Tested: 02/09/2025 - 12/09/2025
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: In accordance with the test method
Site Selection: Selected by Client
Sample Location: **TP10 (0.12 - 1.0m)**

Newcastle Laboratory
16 Callistemon Close Warabrook NSW 2304
Phone: (02) 4016 2300
Email: Newcastle Laboratory

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Raphael Kirby-Faust
Geotechnician
Laboratory Accreditation Number: 431

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	42		
Plastic Limit (%)	22		
Plasticity Index (%)	**20**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**9.5**		
Cracking Crumbling Curling	Curling		

Material Test Report

Report Number: **NEWC25387-1**
Issue Number: 1
Date Issued: 15/09/2025
Client: EP Risk Management
PO Box 57, Lochinvar NSW 2321
Project Number: NEWC25387
Project Name: EP4322 - Chisholm
Project Location: Chisholm
Client Reference: EP4322 - EP4322
Work Request: 6291
Dates Tested: 02/09/2025 - 05/09/2025
Location: Test Pit Material Evaluation - Chisholm

coffey TESTING
Newcastle Laboratory
16 Callistemon Close Warabrook NSW 2304
Phone: (02) 4016 2300
Email: Newcastle Laboratory

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Raphael Kirby-Faust
Geotechnician
Laboratory Accreditation Number: 431

Shrink Swell Index AS 1289 7.1.1 & 2.1.1					
Sample Number	NEWC6291A	NEWC6291B	NEWC6291C	NEWC6291D	
Date Sampled	02/09/2025	02/09/2025	02/09/2025	02/09/2025	
Date Tested	03/09/2025	05/09/2025	05/09/2025	05/09/2025	
Material Source	**	**	**	**	
Sample Location	TP01 (0.1 - 1.0m)	TP04 (0.1 - 0.4m)	TP09 (0.1 - 0.5m)	TP10 (0.12 - 1.0m)	
Inert Material Estimate (%)	0	0	2	0	
Pocket Penetrometer before (kPa)	480	500	220	150	
Pocket Penetrometer after (kPa)	360	450	180	110	
Shrinkage Moisture Content (%)	26.3	18.0	21.1	23.1	
Shrinkage (%)	**3.0**	**0.6**	**2.8**	**3.2**	
Swell Moisture Content Before (%)	25.1	17.2	22.5	21.4	
Swell Moisture Content After (%)	28.9	21.5	30.7	26.3	
Swell (%)	**0.0**	**-0.1**	**0.6**	**-0.2**	
Shrink Swell Index Iss (%)	**1.7**	**0.3**	**1.7**	**1.8**	
Visual Description	sandy CLAY (brown)	sandy CLAY (brown)	Sandy CLAY (mottle)	sandy CLAY with some rock (brown)	
Cracking	MC	MC	SC	SC	
Crumbling	No	No	No	No	
Remarks	**	**	**	**	

Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.
Cracking Terminology: UC Uncracked, SC Slightly Cracked, MC Moderately Cracked, HC Highly Cracked, FR Fragmented.
NATA Accreditation does not cover the performance of pocket penetrometer readings.

Material Test Report

Report Number: **NEWC25387-2**
Issue Number: 1
Date Issued: 26/09/2025
Client: EP Risk Management
PO Box 57, Lochinvar NSW 2321
Project: NEWC25387 - EP4322 - Chisholm
Project Location: Chisholm
Client Reference: EP4322
Work Request: 6294
Dates Tested: 02/09/2025 - 08/09/2025
Location: Test Pit Material Evaluation - Chisholm

coffey TESTING
Newcastle Laboratory
16 Callistemon Close Warabrook NSW 2304
Phone: (02) 4016 2300
Email: Newcastle Laboratory

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Raphael Kirby-Faust
Geotechnician
Laboratory Accreditation Number: 431

Determination of Point Load (AS 4133.4.1)										
Sample #	Specimen	Depth	Location	Test Type	I_s (Mpa)	$I_{s(50)}$ (Mpa)	$I_{s(50)}$ Min	$I_{s(50)}$ Max	Rock Type	Moisture Condition
NEWC6294A	**	**	TP01 (1.0 - 1.3m)	Irregular	0.32	0.33	**	**	**	Natural
NEWC6294A	2	**	TP01 (1.0 - 1.3m)	Irregular	0.31	0.36	**	**	**	Natural
NEWC6294A	3	**	TP01 (1.0 - 1.3m)	Irregular	0.29	0.34	**	**	**	Natural
NEWC6294A	4	**	TP01 (1.0 - 1.3m)	Irregular	0.33	0.41	**	**	**	Natural
NEWC6294A	5	**	TP01 (1.0 - 1.3m)	Irregular	0.31	0.38	**	**	**	Natural
NEWC6294B	**	**	TP02 (0.3 - 0.6m)	Irregular	0.71	0.87	**	**	**	Natural
NEWC6294B	2	**	TP02 (0.3 - 0.6m)	Irregular	1.4	1.7	**	**	**	Natural
NEWC6294B	3	**	TP02 (0.3 - 0.6m)	Irregular	1.1	1.3	**	**	**	Natural
NEWC6294B	4	**	TP02 (0.3 - 0.6m)	Irregular	0.89	1.1	**	**	**	Natural
NEWC6294B	5	**	TP02 (0.3 - 0.6m)	Irregular	0.79	0.97	**	**	**	Natural
NEWC6294C	**	**	TP03 (0.4 - 0.6m)	Irregular	0.46	0.52	**	**	**	Natural
NEWC6294C	2	**	TP03 (0.4 - 0.6m)	Irregular	0.49	0.55	**	**	**	Natural
NEWC6294C	3	**	TP03 (0.4 - 0.6m)	Irregular	0.96	1.2	**	**	**	Natural
NEWC6294C	4	**	TP03 (0.4 - 0.6m)	Irregular	0.66	0.82	**	**	**	Natural
NEWC6294C	5	**	TP03 (0.4 - 0.6m)	Irregular	0.46	0.55	**	**	**	Natural
NEWC6294D	**	**	TP04 (0.4 - 0.7m)	Irregular	0.87	0.99	**	**	**	Natural
NEWC6294D	2	**	TP04 (0.4 - 0.7m)	Irregular	0.68	0.77	**	**	**	Natural
NEWC6294D	3	**	TP04 (0.4 - 0.7m)	Irregular	0.48	0.54	**	**	**	Natural
NEWC6294D	4	**	TP04 (0.4 - 0.7m)	Irregular	0.93	0.95	**	**	**	Natural
NEWC6294D	5	**	TP04 (0.4 - 0.7m)	Irregular	0.20	0.28	**	**	**	Natural

Determination of Point Load (AS 4133.4.1)										
NEWC6294E	**	**	TP05 (1.2 - 1.4m)	Irregular	1.2	1.5	**	**	**	Natural
NEWC6294E	2	**	TP05 (1.2 - 1.4m)	Irregular	2.0	2.3	**	**	**	Natural
NEWC6294E	3	**	TP05 (1.2 - 1.4m)	Irregular	3.7	3.5	**	**	**	Natural
NEWC6294E	4	**	TP05 (1.2 - 1.4m)	Irregular	2.5	2.5	**	**	**	Natural
NEWC6294E	5	**	TP05 (1.2 - 1.4m)	Irregular	1.5	2.0	**	**	**	Natural
NEWC6294F	**	**	TP06 (1.3 - 1.5m)	Irregular	0.33	0.37	**	**	**	Natural
NEWC6294F	2	**	TP06 (1.3 - 1.5m)	Irregular	0.48	0.53	**	**	**	Natural
NEWC6294F	3	**	TP06 (1.3 - 1.5m)	Irregular	0.44	0.52	**	**	**	Natural
NEWC6294F	4	**	TP06 (1.3 - 1.5m)	Irregular	0.59	0.72	**	**	**	Natural
NEWC6294F	5	**	TP06 (1.3 - 1.5m)	Irregular	0.44	0.52	**	**	**	Natural
NEWC6294G	**	**	TP07 (1.2 - 1.4m)	Irregular	0.35	0.40	**	**	**	Natural
NEWC6294G	2	**	TP07 (1.2 - 1.4m)	Irregular	1.3	1.3	**	**	**	Natural
NEWC6294G	3	**	TP07 (1.2 - 1.4m)	Irregular	0.63	0.68	**	**	**	Natural
NEWC6294G	4	**	TP07 (1.2 - 1.4m)	Irregular	1.0	1.3	**	**	**	Natural
NEWC6294G	5	**	TP07 (1.2 - 1.4m)	Irregular	1.3	1.3	**	**	**	Natural
NEWC6294H	**	**	TP08 (0.15 - 0.6m)	Irregular	0.29	0.37	**	**	**	Natural
NEWC6294H	2	**	TP08 (0.15 - 0.6m)	Irregular	0.42	0.51	**	**	**	Natural
NEWC6294H	3	**	TP08 (0.15 - 0.6m)	Irregular	0.45	0.49	**	**	**	Natural
NEWC6294H	4	**	TP08 (0.15 - 0.6m)	Irregular	0.59	0.66	**	**	**	Natural
NEWC6294H	5	**	TP08 (0.15 - 0.6m)	Irregular	0.54	0.56	**	**	**	Natural
NEWC6294I	**	**	TP10 (1.0 - 1.2m)	Irregular	2.6	2.7	**	**	**	Natural
NEWC6294I	2	**	TP10 (1.0 - 1.2m)	Irregular	1.5	1.7	**	**	**	Natural
NEWC6294I	3	**	TP10 (1.0 - 1.2m)	Irregular	0.82	1.1	**	**	**	Natural
NEWC6294I	4	**	TP10 (1.0 - 1.2m)	Irregular	0.36	0.43	**	**	**	Natural
NEWC6294I	5	**	TP10 (1.0 - 1.2m)	Irregular	0.56	0.78	**	**	**	Natural

Material Test Report

Report Number:	**NEWC25387-3**
Issue Number:	1
Date Issued:	26/09/2025
Client:	EP Risk Management
	PO Box 57, Lochinvar NSW 2321
Project Number:	NEWC25387
Project Name:	EP4322 - Chisholm
Project Location:	Chisholm
Client Reference:	EP4322
Work Request:	6295
Sample Number:	NEWC6295A
Date Sampled:	01/09/2025
Dates Tested:	02/09/2025 - 12/09/2025
Sampling Method:	Sampled by Client
	The results apply to the sample as received
Preparation Method:	In accordance with the test method
Site Selection:	Selected by Client
Sample Location:	**TP03 (0.1 - 0.4m)**

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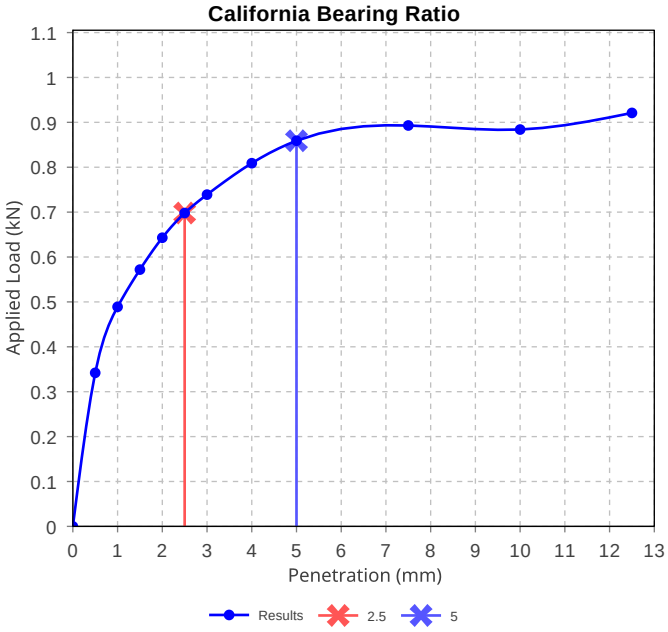
Approved Signatory: Raphael Kirby-Faust
Geotechnician
Laboratory Accreditation Number: 431

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	46		
Plastic Limit (%)	19		
Plasticity Index (%)	**27**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**13.0**		
Cracking Crumbling Curling	Curling		

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	AS1289 3.2.1 & 3.3.1		
Maximum Dry Density (t/m^3)	1.48		
Optimum Moisture Content (%)	26.0		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	97.5		
Dry Density after Soaking (t/m^3)	1.48		
Field Moisture Content (%)	24.9		
Moisture Content at Placement (%)	25.3		
Moisture Content Top 30mm (%)	27.3		
Moisture Content Rest of Sample (%)	27.7		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours (h)	71.1		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	1.4		



Material Test Report

Report Number: **NEWC25387-3**
Issue Number: 1
Date Issued: 26/09/2025
Client: EP Risk Management
PO Box 57, Lochinvar NSW 2321
Project Number: NEWC25387
Project Name: EP4322 - Chisholm
Project Location: Chisholm
Client Reference: EP4322
Work Request: 6295
Sample Number: NEWC6295B
Date Sampled: 01/09/2025
Dates Tested: 02/09/2025 - 12/09/2025
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: In accordance with the test method
Site Selection: Selected by Client
Sample Location: **TP05 (1.0 - 1.2m)**

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Approved Signatory: Raphael Kirby-Faust
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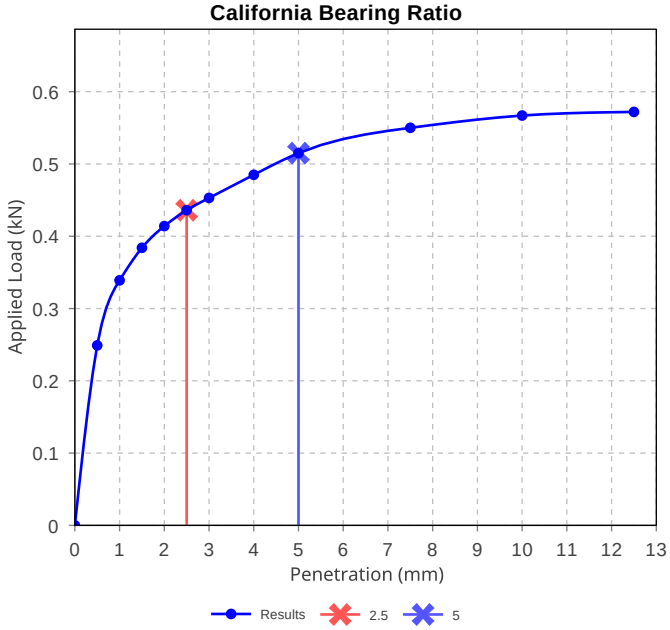
Laboratory Accreditation Number: 431

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	69		
Plastic Limit (%)	19		
Plasticity Index (%)	**50**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**18.0**		
Cracking Crumbling Curling	Curling		

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**3.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	AS1289 3.2.1 & 3.3.1		
Maximum Dry Density (t/m^3)	1.36		
Optimum Moisture Content (%)	33.0		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	97.0		
Dry Density after Soaking (t/m^3)	1.36		
Field Moisture Content (%)	31.7		
Moisture Content at Placement (%)	31.9		
Moisture Content Top 30mm (%)	35.2		
Moisture Content Rest of Sample (%)	33.3		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours (h)	71.4		
Swell (%)	1.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	3.9		

California Bearing Ratio



Particle Size Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
100 mm	**100**			0		
75 mm	**97**			3		
53 mm	**97**			0		
37.5 mm	**96**			0		
26.5 mm	**95**			1		
19 mm	**95**			0		
13.2 mm	**95**			0		
9.5 mm	**95**			0		
6.7 mm	**95**			0		
4.75 mm	**94**			0		
2.36 mm	**93**			1		
1.18 mm	**92**			1		
0.6 mm	**91**			1		
0.425 mm	**90**			1		
0.3 mm	**90**			1		
0.15 mm	**90**			0		
0.075 mm	**86**			4		

Material Test Report

Report Number: **NEWC25387-3**
Issue Number: 1
Date Issued: 26/09/2025
Client: EP Risk Management
PO Box 57, Lochinvar NSW 2321
Project Number: NEWC25387
Project Name: EP4322 - Chisholm
Project Location: Chisholm
Client Reference: EP4322
Work Request: 6295
Sample Number: NEWC6295C
Date Sampled: 01/09/2025
Dates Tested: 02/09/2025 - 12/09/2025
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: In accordance with the test method
Site Selection: Selected by Client
Sample Location: **TP06 (0.9 - 1.3m)**

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Approved Signatory: Raphael Kirby-Faust
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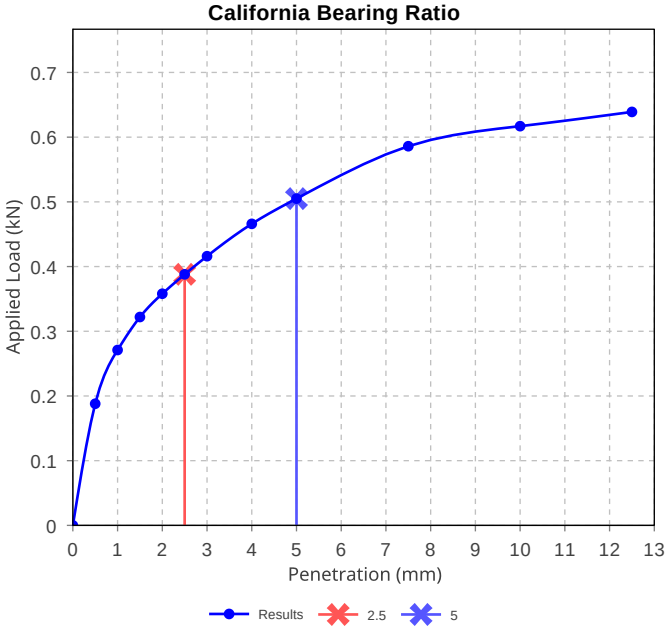
Laboratory Accreditation Number: 431

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	53		
Plastic Limit (%)	22		
Plasticity Index (%)	**31**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**14.0**		
Cracking Crumbling Curling	Curling		

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**3.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	AS1289 3.2.1 & 3.3.1		
Maximum Dry Density (t/m^3)	1.48		
Optimum Moisture Content (%)	27.0		
Laboratory Density Ratio (%)	101.0		
Laboratory Moisture Ratio (%)	99.5		
Dry Density after Soaking (t/m^3)	1.48		
Field Moisture Content (%)	28.8		
Moisture Content at Placement (%)	26.7		
Moisture Content Top 30mm (%)	30.6		
Moisture Content Rest of Sample (%)	28.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours (h)	72.8		
Swell (%)	1.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		

California Bearing Ratio



Material Test Report

Report Number: **NEWC25387-3**
Issue Number: 1
Date Issued: 26/09/2025
Client: EP Risk Management
PO Box 57, Lochinvar NSW 2321
Project Number: NEWC25387
Project Name: EP4322 - Chisholm
Project Location: Chisholm
Client Reference: EP4322
Work Request: 6295
Sample Number: NEWC6295D
Date Sampled: 01/09/2025
Dates Tested: 02/09/2025 - 08/09/2025
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: In accordance with the test method
Site Selection: Selected by Client
Sample Location: **TP09 (0.1 - 0.5)**

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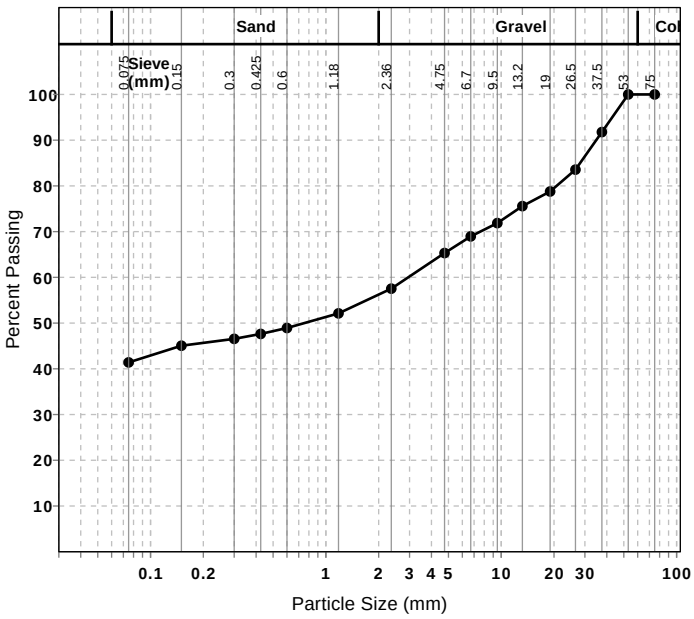
Approved Signatory: Raphael Kirby-Faust
Geotechnician
Laboratory Accreditation Number: 431

Particle Size Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
75 mm	**100**			0		
53 mm	**100**			0		
37.5 mm	**92**			8		
26.5 mm	**84**			8		
19 mm	**79**			5		
13.2 mm	**76**			3		
9.5 mm	**72**			4		
6.7 mm	**69**			3		
4.75 mm	**65**			4		
2.36 mm	**58**			8		
1.18 mm	**52**			5		
0.6 mm	**49**			3		
0.425 mm	**48**			1		
0.3 mm	**47**			1		
0.15 mm	**45**			1		
0.075 mm	**41**			4		

Particle Size Distribution



Appendix E

FOUNDATION MAINTENANCE AND FOOTING PERFORMANCE

Foundation Maintenance and Footing Performance:
A Homeowner's Guide

CSIRO

BTF 18
replaces
Information
Sheet 10/91

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 homeowner 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.

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

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. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

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 are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

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). 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.

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 with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

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.
- 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. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins 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).

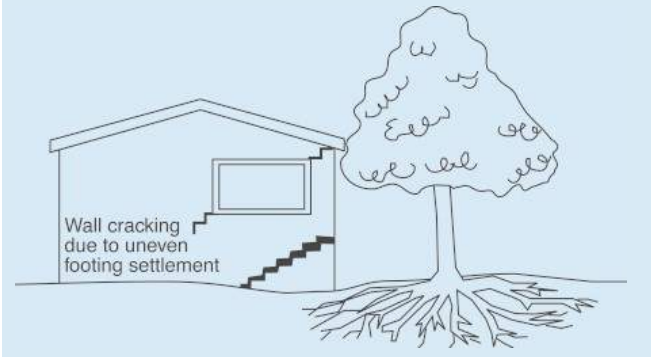
Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

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.

Trees can cause shrinkage and damage



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 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 cause 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. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 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/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 is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

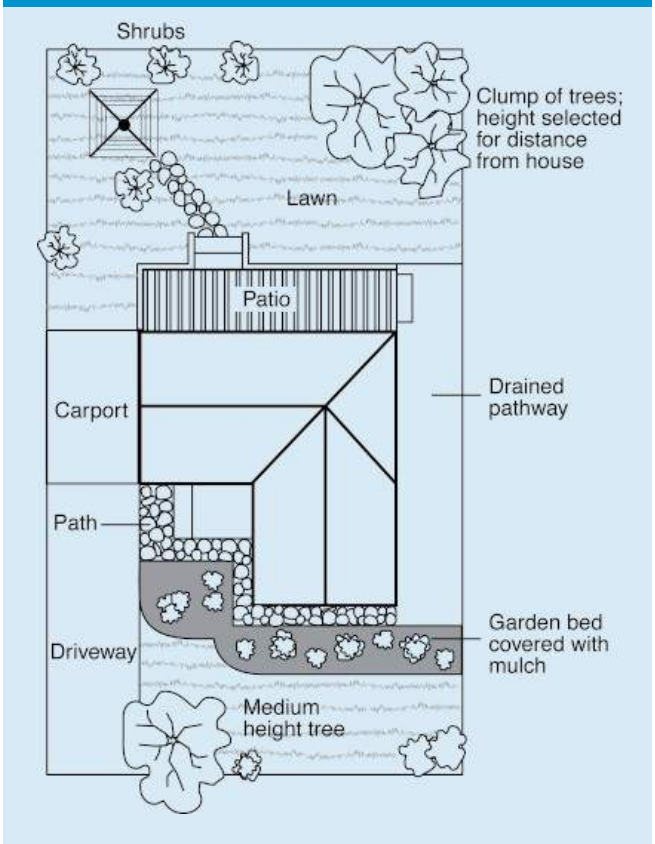
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

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

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
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
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 depend on number of cracks	4

Gardens for a reactive site



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 from it (see BTF 19).

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.

Warning: Although this Building Technology File 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.
- 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. For information on plant roots and drains, see Building Technology File 17.

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 homeowner 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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