



Preliminary Acid Sulfate Soils Assessment



Econ Environmental Pty Ltd

Proposed SIP and Campus Commons Development

Pymble Ladies' College

20 Avon Road, Pymble NSW 2073

Project No.: ECOE0977-GEO AA Rev03
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1. Introduction

1.1 General

Greywacke Geotechnics (Greywacke) was commissioned by Econ Environmental Pty Ltd to conduct a preliminary acid sulfate soil assessment for a proposed Senior School Building development at **Pymble Ladies College** located at **Avon Road, Pymble NSW 2073**. Based on the information provided, it is understood that the proposed development will include:

- Demolition of the existing Isabel Harrison, Dorothy Knox, John Vicars and Robert Vicars Buildings.
- Tree removal.
- Excavation of the basement level.
- Construction of the new five storey SIP building of RL 145.3m and including:
 - General Learning Spaces.
 - STEM teaching spaces.
 - Senior student facilities.
 - Function spaces.
 - Food and beverage facilities.
 - Associated amenities.
 - Storage and building services.
- 1 car space within the basement (for service vehicles) accessible from the existing rear vehicle service road.
- Minor kerb realignment of the existing access road to the east of the SIP.
- Landscaping on the outdoor terraces and surrounding the building.
- The project also includes the Campus Commons, a significant garden lawn and amphitheatre connecting the SIP precinct to the rest of the campus.

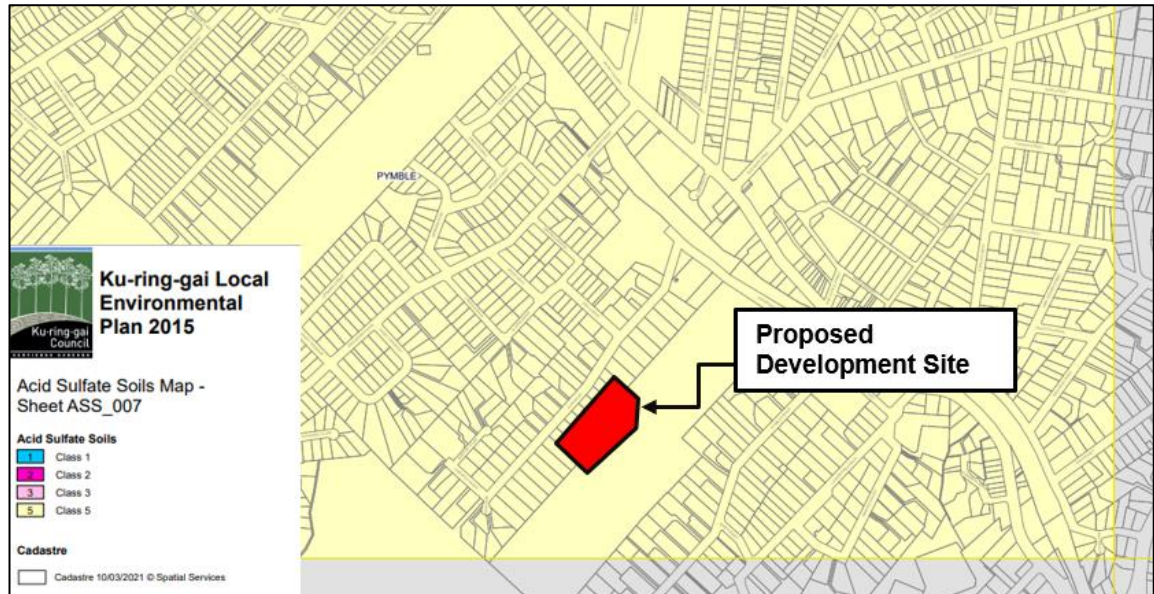
This report may be submitted to the Council to accompany a Development Application (DA) process and it should be read in conjunction with the **Standard Sheets** attached in **Appendix A**, which explain the terms, abbreviations and symbols used, together with interpretation and limitations of this assessment.

Greywacke Geotechnics has been commissioned by Pymble Ladies' College (the College) to prepare this *Preliminary Acid Sulfate Soils Assessment* in accordance with the technical requirements of the Secretary's Environmental Assessment Requirements (SEARs) and in support of the preparation of an Environmental Impact Statement (EIS) and State Significant Development Application (SSD- 79146716) to the Department of Planning, Housing and Infrastructure (DPHI).

1.2 Background and Objective

The Ku-Ring-Gai Local Environmental Plan (LEP) 2015 indicates that the site is located in a **Class 5** (See **Figure 1** below) and a development consent is required for any works identified on the acid sulfate soil planning map. A map excerpt of the Acid Sulfate Soils Map – Sheet ASS_007 is provided in **Figure 1** below.

Figure 1 Acid Sulfate Soils Map Excerpt



Acid sulphate soil is a name given to soils or sediments containing iron sulphides. Iron sulphides are micro-crystalline minerals such as pyrite that have formed naturally in soils where long-term water-logged conditions occur such as estuaries, wetlands, and shallow groundwater in deep sands.

Acid sulfate soils are safe and harmless when not disturbed. However, when exposed to air, through drainage or excavation, the iron sulfides in the soils react with oxygen and water to produce iron compounds and sulfuric acid. This acid can release other substances, including heavy metals, from the soil and into the surrounding environment and waterways. This process turns pyrite into sulfuric acid, which can cause damage to the environment and to buildings, roads, and other structures.

Two main terms are used when identifying acid sulfate soils are potential acid sulfate soils (PASS) and actual acid sulfate soils (AASS).

Potential acid sulfate soils are soils containing iron sulfides (commonly pyrite) which have the potential to produce sulfuric acid if they are drained or excavated.

Actual acid sulfate soils have already undergone oxidation to produce acid, resulting in a soil pH of less than 4. They also often exhibit yellow and/or red mottling in the soil profile. If these soils still contain sulfides, they have the potential to produce more acid. This assessment was undertaken to assess likelihood of acid sulfate soils being present within the site. It is understood that no previous investigations are known to have been carried out within the site.

This report provides the factual results of the desktop assessment, field investigation, including details of the fieldwork, the geological conditions at the proposed development site and general site observations.

1.3 Guidelines and References

This assessment was conducted in accordance with the *Acid Sulfate Soil Assessment Guidelines* issued by NSW Acid Sulfate Soil Management Advisory Committee (ASSMAC) in August 1998. In addition to the ASSMAC Guideline (1998) and Ku-Ring-Gai Local Environmental Plan (LEP) 2015.

2. Site Setting

2.1 Site Identification Details

The subject site (Lot 11 - 17 in DP7131 and Lot 1 in DP69541) being considered for development is located at **20 Avon Road, Pymble NSW 2073**, approximately 15.5km north-west of Sydney CBD. The location of the site is marked in **Figure 5** found in **Appendix B**.

The site is located within the north-western portion of the school grounds of Pymble Ladies College, which is situated within the upper reaches of a hill within undulating topography. The site is generally positioned within the existing footprint of the Isabel Harrison, Dorothy Knox, John Vicars, Robert Vicars Buildings and its immediate surrounds.

The existing Isabel McKinney Harrison Library comprises a one and two storey split level building, which was assessed to be in good external condition based on a cursory inspection. Surrounding the lower portion of the building is a brick paved courtyard area, which was also in good condition. This paved courtyard is supported by an embankment that slopes down to the northwest at about 22° to 26°.

2.2 Environmental Setting

2.2.1 Topography

Imagery available on the Department of Lands and Spatial Information Exchange website and plans provided by the client show that the site is located at approximate elevations between 116m AHD (Australian Height Datum) and 126m AHD. The site terrain is moderately sloping from down from east to west with slopes up to 14°.

The topography of the surrounding area comprises low rolling and steep hills. Local relief 50–120 m, slopes 5–20%. Convex narrow (20–300 m) ridges and hillcrests grade into moderately inclined sideslopes with narrow concave drainage lines. Moderately inclined slopes of 10–15% are the dominant landform elements.

2.2.2 Regional geology

The Geological Map (Seamless Geology) provided by Department of Primary Industries and Regional Development – NSW Resource online portal shows that the site is primarily underlain by Hawkesbury Sandstone (**Rh**) and contains medium to coarse grained quartz, sandstone with very minor shale and laminite lenses.

A geology map excerpt is provided in **Figure 2** below and the location of the site is marked with a 'black circle with red centre'.

Figure 2 Geology Map Excerpt



3. Preliminary Acid Sulfate Soils Assessment

3.1 General

The New South Wales Acid Sulphate Management Advisory Committee (ASSMAC) recommends that assessment of acid sulphate soils (ASS) or potentially acid sulphate soils at a site is carried out in stages, as described below:

- Step 1 – Check Acid Sulphate Soil map.
- Step 2 – Check if the area meets the geomorphic or site criteria.
- Step 3 – Analyse soil and water indicators.
- Step 4 – Chemical analysis to confirm Acid Sulphate Soil and reaction level (was not required).

3.2 Preliminary Assessment

Step 1

Acid Sulphate Soil Risk Map of the area is provided by the New South Wales Department of Planning, Industry and Environment for public access on the NSW Planning Portal website (<https://www.planningportal.nsw.gov.au/>).

The map indicates that the proposed development site is within an area categorised as **Class 5**, meaning development consent is required for any works within 500 metres of adjacent Class 1, 2, 3 or 4 land which are likely to lower the water table below 1 metre AHD on adjacent Class 1, 2, 3 or 4 land. A map excerpt of the ASS Risk Map is presented in **Figure 4** below. The red shaded area indicates the approximate location of the subject site.

Figure 4 Acid Sulfate Soil Risk Map Excerpt



Action following Step 1

- If the works are in an area identified in the ASS Planning Maps as presenting a risk to the environment, and the works are likely to disturb these soils proceed to Step 3. Step 2 can help confirm if ASS are in the mapped area and identify areas of highest risk.
- **If the works are near to any area mapped as having a risk of acid sulfate soils being present, proceed to Step 2 to confirm that acid sulfate soils are not likely to be present based on geomorphic or site criteria.**

- If the works are not in or near a mapped area, proceed without further consideration of acid sulfate soils.

Step 2

The site is located within **Class 5** of the Acid Sulfate Soils Planning Map and a desktop assessment should be undertaken to check if the location meets the geomorphic or site description criteria. The relevant information regarding the topographic and geomorphic features of the site are provided in *Section 2. Site Setting* above.

The following site criteria in **Table 1** below was applied in accordance with *Section 2.2 Establish whether acid sulfate soils are present on the site* of the ASSMAC Assessment Guidelines, August 1998 to determine if acid sulfate soils are likely to be present within this site:

Table 1 Site Criteria

Assessment Criteria	Yes / No	Comments
Sediments of recent geological age (Holocene)	No	Hawkesbury Sandstone is part of the middle Triassic period
Soil horizons less than 5 m AHD	No	Site elevation is >116m AHD
Marine or estuarine sediments and tidal lakes	No	See Section 2.2 (including sub-sections)
In coastal wetlands or back swamp areas; waterlogged or scalded areas; interdune swales or coastal sand dunes (if deep excavation or drainage proposed)	No	See Section 2.2 (including sub-sections)
In area where the dominant vegetation is mangroves, reeds, rushes and other swamp-tolerant or marine vegetation such as swamp mahogany (<i>Eucalyptus robusta</i>), paperbark (<i>Melaleuca quinquenervia</i>) and swamp oak (<i>Casuarina glauca</i>)	No	See Section 2.2 (including sub-sections)
In areas identified in geological descriptions or in maps as bearing sulfide minerals, coal deposits or former marine shales/sediments (geological maps and accompanying descriptions may need to be checked)	No	See Section 2.2 (including sub-sections)
Deep older estuarine sediments >10 metres below ground surface, Holocene or Pleistocene age (only an issue if deep excavation or drainage is proposed).	No	See Section 2.2 (including sub-sections)

Action following Step 2

- If the proposal is likely to disturb areas which meet any of the criteria (or are mapped as having a probability of acid sulfate soils being present), soil and water indicators (step 3) should be checked to determine if acid sulfate soils are likely to be present.
- **If activities are proposed in locations which do not meet these geomorphic or site criteria and are not in areas mapped as class 1-4 on the planning maps, proponents can be confident that acid sulfate soils will not be present in the landscape. Soils of older geological age or those not derived from sedimentary deposition can be excluded from further investigation (unless very deep disturbance is proposed).**

The topographic and geomorphic features of the site (refer to Sections 2.2.2 *Topography and Regional Geology* and 2.2.3 *Soil Landscapes* above) indicate that the occurrence of ASS at the proposed development site is **low**. As such, development and construction activities are **unlikely** to be impacted by acid sulfate soil materials.

4. Limitations

This report has been prepared by Greywacke Geotechnics (Greywacke) for Econ Environmental Pty Ltd (Client) and may only be used and relied on by the Client for the purpose agreed between Greywacke and the Client as set out in Section 1.2 of this report.

Greywacke otherwise disclaims responsibility to any person other than the Client arising in connection with this report. Greywacke also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by Greywacke in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. Greywacke has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

Greywacke has prepared this report based on information provided by the Client and others who provided information to Greywacke, which Greywacke has not independently verified or checked beyond the agreed scope of work. Greywacke does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by site conditions, such as the location and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this report. Greywacke does not accept responsibility arising from, or in connection with, any change to the site conditions. Greywacke is also not responsible for updating this report if the site conditions change.

This report should be read in conjunction with the Standard Sheets (contained in Appendix A).

For and On Behalf of
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5. References

1. Geological Seamless Map of NSW, NSW Department of Primary Industries and Regional Development – NSW Resources online portal (<https://minview.geoscience.nsw.gov.au>), 2024;
1. Soil Conservation Service, NSW, Sydney 1:100,000 scale Soil Landscape Series Sheet;
2. New South Wales Acid Sulphate Management Advisory Committee (ASSMAC), *Acid Sulfate Soils Guidelines*, August 1998;
3. Ku-Ring-Gai Local Environmental Plan, 2015, *1:10,000 scale Acid Sulfate Soils Map*, Sheet ASS_007;
4. New South Wales Department of Planning, Industry and Environment, NSW Planning Portal Maps (<https://www.planningportal.nsw.gov.au/>).
5. Google Maps, Map data 2021, www.google.com.au/maps;
6. Department of Lands and Spatial Information Exchange, NSW, Map data 202, <https://maps.six.nsw.gov.au/>;
7. NSW Government Planning, Industry & Environment, web data, Date: 21/02/2024, (<https://www.environment.nsw.gov.au/eSpade2WebApp>);
8. JK Geotechnics, *Report To Pymble Ladies College, On Geotechnical Investigation, For Proposed Senior School Building, At Avon Road, Pymble, NSW, Ref: 34901bcrpt., Date: 19 May 2022.*



APPENDICES



Appendix A – Standard Sheets

GEOTECHNICAL TERMS AND SYMBOLS

The following information is intended to assist in the interpretation of terms and symbols used in geotechnical borehole logs, test pit logs and reports issued by Greywacke Geotechnical Consultants. More detailed information relating to specific test methods is available in the relevant Australian Standards AS1726-2017.

Soil Descriptions and Classification

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726:2017 'Geotechnical Site Investigations'. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Soil types are described according to the predominating particle size and behaviour as set out below:

Particle size definitions (Refer to AS1726-2017, Table 1)

Fraction	Components	Subdivision	Size ¹ (mm)
Oversize	Boulders (Bo)		> 200
	Cobbles (Co)		63 - 200
Coarse grained soils	Gravel (Gr)	Coarse (cGr)	19 - 63
		Medium (mGr)	6.7 - 19
		Fine (fGr)	2.36 - 6.7
	Sand (Sa)	Coarse (cSa)	0.6 - 2.36
		Medium (mSa)	0.21 - 0.6
		Fine (fSa)	0.075 - 0.21
Fine grained soils	Silt (Si)		0.002 - 0.075
	Clay (Cly)		< 0.002

Note: 1. Corresponding (approximately) to standard sieve sizes

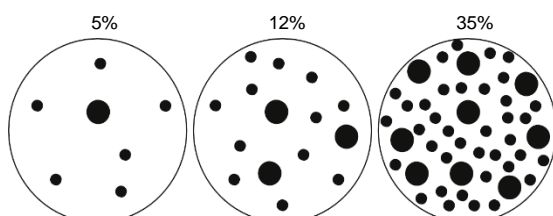
Descriptive terms for accessory (secondary and minor) soil components (Refer to AS 1726:2017, Table 2)

Designation of components	In coarse grained soils				In fine grained soils	
	% Fines	Terminology	% Accessory coarse fraction	Terminology	% Sand/ gravel	Terminology
Minor	≤ 5	Add 'trace clay/silt' to description, as applicable	≤ 15	Add 'trace sand/gravel' to description, as applicable	≤ 15	Use 'trace'
	> 5, ≤ 12	Add 'with clay/silt' to description, as applicable	> 15, ≤ 30	Add 'with sand/gravel' to description, as applicable	> 15, ≤ 30	Add 'with sand/gravel' to description, as applicable
Secondary	> 12	Prefix soil name as 'silty' or 'clayey', as applicable	> 30	Prefix soil name as 'sandy' or 'gravelly', as applicable	> 30	Prefix soil name with 'sandy' or 'gravelly', as applicable

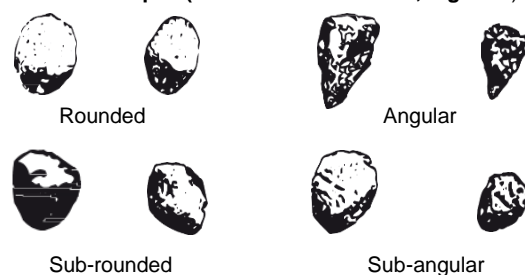
Descriptive Terms for Plasticity (Refer to AS 1726:2017, Table 6)

Descriptive term	Range of liquid limit for silt	Range of liquid limit for clay
Non-plastic	Not applicable	Not applicable
Low plasticity	≤ 50	≤ 35
Medium plasticity	Not applicable	> 35 and ≤ 50
High plasticity	> 50	> 50

Percentages of grains (after AS 1726:2017, Figure 3)



Particle shapes (Refer to AS 1726:2017, Figure 4)



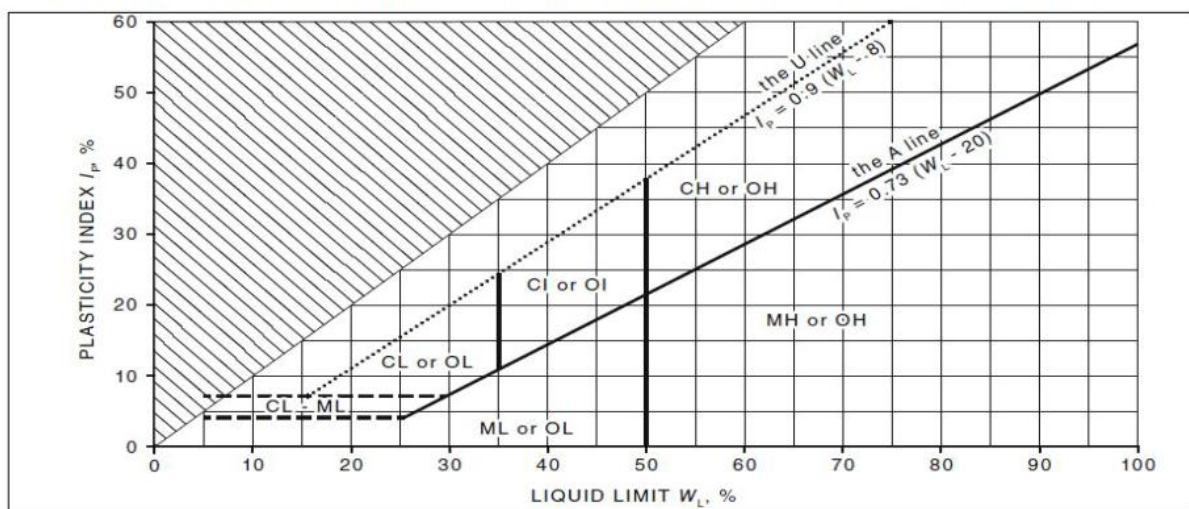
Classification of coarse grained soils (Refer to AS 1726:2017, Table 9)

Major divisions	Group symbol	Typical names	Field classification of sand and gravel	Laboratory classification		
Coarse grained soil (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL > 50% of coarse fraction is larger than 2.36mm	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 4$ $1 < C_c < 3$
		GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	Fines behave as silt
		GC	Gravel-clay mixtures and gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	Fines behave as clay
	SAND > 50% of coarse fraction is smaller than 2.36mm	SW	Sand and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 6$ $1 < C_c < 3$
		SP	Sand and gravel-sand mixtures, little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		SM	Sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	NA
		SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12%, fines are clayey	

Notes:

- Where the grading is determined from laboratory tests, it is defined by coefficients of curvature C_c and uniformity C_u derived from the particle size distribution curve, as specified in AS1726:2017, Clause 6.1.4.11
- For fines contents between 5% and 12%, the soil shall be given a dual classification comprising the two group symbols separated by a dash, e.g. for a gravel with between 5% and 12% silt fines, the classification is GP-GM
- Soils that are dominated by boulders, cobbles or peat (Pt) are described separately and are not classified

Modified Casagrande chart for classifying silts and clays according to their behaviour (Refer to AS 1726:2017, Figure 5)



Note: The U line is an approximate upper bound for most natural soils. Data which plot above the U line may represent unusual / problem soil behaviour, or unreliable data and should be considered carefully.

Classification of fine grained soils (Refer to AS 1726:2017, Table 10)

Major divisions	Group symbol	Typical names	Field classification of silt and clay			Laboratory classification % < 0.075mm	
			Dry strength	Dilatancy	Toughness		
Fine grained soil (more than 95% of soil excluding oversize fraction is less than 0.075mm)	SILT and CLAY (low to medium plasticity)	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity	None to low	Slow to rapid	Low	Below A line
		CL, CI	Inorganic clay of low plasticity to medium plasticity, gravelly clay and sandy clay	Medium to high	None to slow	Medium	Above A line
		OL	Organic silt	Low to medium	Slow	Low	Below A line
	SILT and CLAY (high plasticity)	MH	Inorganic silt	Low to medium	None to slow	Low to medium	Below A line
		CH	Inorganic clay of high plasticity	High to very high	None	High	Above A line
		OH	Organic clay of medium to high plasticity, organic silt	Medium to high	None to very slow	Low to medium	Below A line
	Highly organic soil	Pt	Peat, highly organic soil	–	–	–	–

Terms for coarse grained particle sizes (Refer to AS1726:2017, Claus 6.1.4.11)

Term	Description
Well Graded	Having good representation of all particle sizes from the largest to the smallest.
Poorly Graded	One or more intermediate sizes poorly represented
Gap Graded	With one or more intermediate sizes absent
Uniformly Graded	Essentially of one size

Soil and rock colour terms and abbreviations (Refer to AS 1726:2017, Clauses 6.1.5, 6.2.3.3)

Term	Abbreviation	Modifier	Abbreviation
Black	bk	Pale	pl
White	wh		
Grey	gy		
Red	rd	Dard	dk
Brown	br		
Orange	or		
Yellow	yl	Mottled	mtd
Purple	pu		
Green	gr		
Blue	bl		

Moisture condition of soil (Refer to AS 1726:2017, Claus 6.1.7)

Course Grained Soil	
Term	Field appearance and feel
Dry	Non-cohesive and free running
Moist	Feels cool, darkened in colour - tends to stick together
Wet	Feels cool, darkened in colour - tends to stick together, free water forms when handling
Fine Grained Soil	
Description	Relative to the plastic limit (or liquid limit for soils with higher moisture contents)
Moist, dry of plastic limit	Hard and friable and powdery (or 'w < PL')
Moist, near plastic limit	Soils can be moulded at a moisture content approximately equal to the plastic limit (or 'w ≈ PL')
Moist, wet of plastic limit	Soils usually weakened and free water forms on hands when handling (or 'w > PL')
Wet, near liquid limit	(or 'w ≈ LL')
Wet, wet of liquid limit	(or 'w > LL')

Cementation of soils (Refer to AS 1726:2017, Claus 6.1.7)

Term	Definition
Weakly cemented	Easily disaggregated by hand in air or water
Moderately cemented	Effort is required to disaggregate by hand in air or water

Consistency terms for cohesive soils (Refer to AS 1726:2017, Table 11)

Consistency ¹	Field guide to consistency	Indicative undrained shear strength s_u (kPa) ²	Approximate range of SPT N values
Very Soft (VS)	Exudes between the fingers when squeezed in hand	≤ 12	0 - 2
Soft (S)	Can be moulded by light finger pressure	> 12 and ≤ 25	2 - 4
Firm (F)	Can be moulded by strong finger pressure	> 25 and ≤ 50	4 - 8
Stiff (St)	Cannot be moulded by fingers	> 50 and ≤ 100	8 - 15
Very Stiff (VSt)	Can be indented thumb nail	> 100 and ≤ 200	15 - 30
Hard (H)	Can be indented with difficulty by thumb nail	> 200	> 30
Friable (Fr)	Can be easily crumbed or broken into small pieces by hand	-	-

Notes:

- Consistency is affected by the moisture content of the soil at the time of measurement
- Often $s_u = q_u / 2$ (where q_u is the unconfined compressive strength, Foundation Analysis and Design, 5th ed., J.E. Bowles, 1997)

Relative density of non-cohesive soils (Refer to AS1726:2017, Table 12)

Term	Density Index %	Approximate range of SPT N values
Very Loose (VL)	≤ 15	0 - 4
Loose (L)	> 15 and ≤ 35	4 - 10
Medium Dense (MD)	> 35 and ≤ 65	10 - 30
Dense (D)	> 65 and ≤ 85	30 - 50
Very Dense (VD)	> 85	> 50

Note: The moisture content may influence the inferred relative density

Soil Origin

Geological and anthropogenic origins of soils (Refer to AS 1726:2017, Claus 6.1.9)

Description	Definition
FILL	Any material which has been placed by anthropogenic processes. 'FILL' should be emphasised on logs by the use of BLOCK LETTERS
TOPSOIL	Mantle of surface and/or near surface soil often defined by high levels of organic matter. 'TOPSOIL' should be emphasised on logs by the use of BLOCK LETTERS
Extremely weathered material	Formed directly from <i>in situ</i> weathering of geological formations. Although of soil strength it retains the structure and/or fabric of the parent rock material
Residual soil	Formed directly from <i>in situ</i> weathering of geological formations. No longer retaining any visual structure or fabric of the parent soil or rock material
Alluvial soil	Deposited by streams and rivers
Estuarine soil	Deposited in coastal estuaries, and including sediments carried by inflowing rivers and streams, and tidal currents
Marine soil	Deposited in a marine environment
Lacustrine soil	Deposited in freshwater lakes
Aeolian soil	Carried and deposited by wind
Colluvial soil	Soil and rock debris transported down slopes by gravity, with or without the assistance of flowing water and generally deposited in gullies or at the base of slopes. Formed from landslides.
Slopewash	Thinner and more widespread colluvial deposits that accumulate gradually over longer geological timeframes than colluvial soils from landslides

Note: Soils should be assigned to a stratigraphic unit. Where there is doubt, the terms 'possibly' or 'probably shall be used

Definitions of FILL types (Refer to AS1726:2017, Claus 6.1.11 and Appendix D)

FILL type	Definition
Controlled	Fill placed in accordance with AS 3798 or other controlled method, as demonstrated by construction documentation
Uncontrolled FILL	Fill for which no construction documentation is available

Typical characteristics and descriptive terms for FILL materials (Refer to AS 1726:2017, Table 14, and Claus 6.1.11)

Some typical characteristics of FILL	
Uncontrolled / non-engineered fill may settle variably, have poor bearing capacity	
Very distinct changes in soil profile, unusually variable range of colours	
Presence of foreign objects such as glass, plastic, slag	
Buried organic matter	
'Cloddiness' of clay soil indicating previous disturbance by excavation	
Generalised terms	Typical descriptions
Organic matter	Fibrous peat
	Charcoal
	Wood fragments
	Roots (greater than 2mm diameter)
	Root fibres (less than 2mm diameter)
	Night soil, putrescible waste
Artificial materials	Oil, bitumen
	Masonry, concrete rubble, fibrous plaster, plasterboard, asbestos, fibre cement
	Timber pieces, wood shavings, sawdust, leather
	Iron filings, drums, steel bars, steel scrap
	Slag, chitter, ash, tailings
	Rubber tyres, bottles, broken glass

ROCK DESCRIPTION

Refer to AS 1726-2017 for the description and classification of rock material composition, including:

- (a) Rock type
- (b) Grain size
- (c) Texture and fabric
- (d) Colour (describe as per soil).

The condition of a rock material refers to its weathering characteristics, strength characteristics and rock mass properties. Refer to AS 1726-2017.

Classification of material weathering (Refer to AS1726:2017, Table 20)

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

Notes:

1. The term 'Extremely Weathered rock' is misleading as the material has soil properties. The word 'rock' should be replaced with the name of the original rock in lower case or the word 'material', e.g. Extremely Weathered granite or Extremely Weathered material. Residual soil and Extremely Weathered material should be described using soil descriptive terms

2. A 'specific rockmass unit (RMU)' may be defined as a significant zone (generally of > 1m length downhole in a borehole) dominated by one rock type with one dominant weathering grade, for example 'GRANITE (MW)'. RMU's may locally contain lesser zones of other materials or weathering grades, including seams, veins, dykes etc.

Rock material strength classification (Refer to AS1726:2017, Table 19)

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

Notes:

- Material with strength less than 'Very Low' shall be described using soil characteristics. The presence of an original rock structure, fabric or texture should be noted if relevant
- The method for measuring the uniaxial compressive strength shall be in accordance with AS4133.4.2.1
- The method for measuring the point load strength index shall be in accordance with AS4133.4.1
- Any correlation between UCS and $I_{s(50)}$ implied in the above Table shall not be relied upon for design purposes without supporting evidence

ROCK DEFECTS

Rock defect angle of incidence¹ (un-orientated drill core)

Angle of incidence (group range) ²	Descriptor
0° - 15°	sub horizontal
15° - 30°	gentle
30° - 45°	moderate
45° - 60°	steep
60° - 75°	very steep
75° - 90°	sub vertical

Note:

- Angle measured between defect and the normal to the core-axis (the horizontal plane for vertical boreholes).
- For a specific rockmass unit (RMU), defects may be grouped according to the above ranges (or to more narrow ranges where appropriate).

Detailed rock defect spacing description (Refer to ISO14689:2017(E) and BS5930:1999)

Defect Spacing Descriptors ¹			Rock Fabric Thickness Descriptors ² (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

Notes:

- Rock defects are termed as 'discontinuities' in ISO14689:2017(E) and BS5930:1999. A distinction is drawn in BS5930:1999 between 'mechanical discontinuities', which are already open and present in the rock, and 'integral discontinuities', which are built-in potential planes of weakness. Rock fabrics are essentially integral discontinuities, either distinct or indistinct depending on the extent of their effect on intact rock strength
- The terms 'laminated' and 'bedded' are rock fabric descriptors applicable to sedimentary rock. For igneous and metamorphic rock fabrics, use the above listed defect spacing descriptors
- The above listed defect spacing descriptors should be used to define the frequency of defects, i.e. the spacing between successive defects, (or the mean defect spacing for zones of relatively broken rock); Alternatively, defect frequency should be measured by the 'Fracture Index', which is the number of defects per metre of core (AS1726:2017, Claus 6.2.9.3)

Rock defect surface description (Refer to AS1726:2017, Claus 6.2.5.4)

Surface Roughness	Abbreviation	Definition	Surface Shape ¹	Abbreviation	Definition
Very rough	VRo	Many large surface irregularities (amplitude generally more than 1 mm). Feels like, or coarser than very coarse sand paper.	Planar	Pln	The defect does not vary in orientation
Rough	Ro	Many small surface irregularities (amplitude generally less than 1 mm). Feels like fine to coarse sand paper.	Curved	Cvd	The defect has a gradual change in orientation
Smooth	Sm	Smooth to touch. Few or no surface irregularities.	Undulating	Und	The defect has a wavy surface
Polished	Po	Shiny smooth surface.	Stepped	Stp	The defect has one or more well defined steps
Slickensided	Sl	Grooved or striated surface, usually polished.	Irregular	Irr	The defect has many sharp changes of orientation

Notes:

1. Although the surface roughness of defects can be described at all scales of observation, the overall shape of the defect surface can usually be observed only at medium and large scale. For example, a defect which appears planar in a 50 mm diameter drill core may be described as curved, undulating or stepped when observed in outcrop where more of the defect is visible.
2. At the medium scale of observation (100mm to 1m), description of the roughness of the surface shall be enhanced by description of the shape of the defect surface using the terms in the above Table, and as illustrated in AS1726:2017, Figure 7
3. For medium scale (100mm to 1m) and large scale (1m to 10m) exposures, defect wavelength and amplitude of asperities should be measured appropriately in (mm) or (m) as per AS1726:2017, Figure 8. Surface roughness may be alternatively characterised by the joint roughness coefficient (JRC), using the profiles provided in AS1726:2017, Figure 9
4. For large scale exposures, measurements of defect waviness for may be made as per AS1726:2017, Figure 10

Rock defect aperture and infill descriptors (Refer to AS1726:2017 Claus 6.2.5.2 and Claus 6.2.5.5)

Defect Aperture			Defect Infill		
Term	Abbreviation	Definition	Term	Abbreviation	Definition
Open ¹	OP	Defects with visible aperture, with or without infill	Clean	Cn	No visible coating
Filled	FL	Open defects with infill of less than 1mm thickness	Stained	Stn	No visible coating, but surfaces are discoloured
Tight	TI	Defects with no appreciable aperture or measurable asperity	Veneer	Vr	A visible coating of soil or mineral, too thin to measure; may be patchy
Healed ²	HD	Tight defects that have been re-cemented by minerals such as calcite and chlorite	Coating ³	Ct	A visible, measureable coating of up to 1mm thickness

Notes:

1. Aperture of open defects shall be measured in millimetres
2. Healed defects generally possess some tensile strength across the defect surface, but the re-cemented strength is less than that of the rockmass
3. Where possible the mineralogy of the infill shall be identified. Soil material thicker than 1mm shall be described using defect terms (for example, infilled seam). Rock material thicker than 1mm shall be described as veins

Groundwater symbols

Symbol	Definition
31/01/2020	Standing groundwater level on the date shown
	Water inflow
	Water outflow

GEOLOGICAL MAPPING

Geological mapping symbols (Refer to AS1726:2017, Figure E1)

Mapping symbols for geological boundaries and structures			
		Observed geological boundary, position known	
		Observed geological boundary, position approximate	
		Geological boundary, interpreted or inferred	
		Fault zone or shear zone	
		Unconformity	
\angle_{25} Bedding	\angle_{25} Cleavage	25° Plunge of fold ¹	Anticline, F1
\angle_{25} Foliation	\angle_{25} Joint	25° Plunge of lineation on plane	Syncline, F2

Notes: Order and type of fold indicated with appropriate symbol

GRAPHICAL SYMBOLS

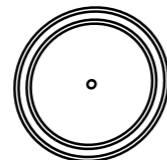
<p>CLAYS</p> <ul style="list-style-type: none"> CLAY Silty CLAY Sandy CLAY Gravelly CLAY 	<p>SILTS</p> <ul style="list-style-type: none"> Organic SILT SILT Clayey SILT Sandy SILT Gravelly SILT 	<p>SANDS</p> <ul style="list-style-type: none"> SAND Clayey SAND Silty SAND Gravelly SAND 	<p>GRAVELS</p> <ul style="list-style-type: none"> GRAVEL Clayey GRAVEL Silty GRAVEL Sandy GRAVEL COBBLES & BOULDERS
<p>SEDIMENTARY ROCK</p> <ul style="list-style-type: none"> CONGLOMERATE BRECCIA SANDSTONE SILTSTONE SHALE MUDSTONE / CLAYSTONE COAL 	<p>METAMORPHIC ROCK</p> <ul style="list-style-type: none"> SLATE / PHYLLITE / SCHIST GNEISS QUARTZITE <p>IGNEOUS ROCK</p> <ul style="list-style-type: none"> GRANITE BASALT TUFF 	<p>MISCELLANEOUS</p> <ul style="list-style-type: none"> FILL TOPSOIL CONCRETE ASPHALT CORE LOSS PAVEMENT GRAVEL PAVEMENT (Natural Gravels) PAVEMENT (Crushed Rock) 	

Frequently used symbols in geotechnical engineering

Symbol	Definition	Symbol	Definition
AASS	Actual acid sulfate soil	PASS	Potential acid sulfate soil
BH	Bore hole	PI or I_P	Plasticity index
BS	Bulk distrusted sample	PL or w_p	Plastic Limit
c	Cohesion of a soil	PS	Piston sample
c'	Effective cohesion	PP	Pocket Penetrometer Test
c_v	Coefficient of consolidation	PQ	85mm diameter drill core (double tube wireline)
C_c	Coefficient of curvature	PQ3	83.1mm diameter drill core (triple tube wireline)
C_u	Coefficient of uniformity	q	Overburden pressure
CPT	Cone Penetration Test	q'	Effective overburden pressure
CPTu	Cone Penetration Test with pore pressure measurement (piezocone)	q_c	Cone resistance
D_{10}	Grain sizes for which 10% of the soil grains are smaller	q_d	VEDCP (PANDA) cone resistance
D_{30}	Grain sizes for which 30% of the soil grains are smaller	q_u	Unconfined compressive strength
D_{60}	Grain sizes for which 60% of the soil grains are smaller	Q	Wet density
DS	Disturbed sample (small)	Q_d	Dry density
DCP	Dynamic Cone Penetrometer Test	ρ_w	Full penetration over any 150mm interval is achieved by SPT rod weight only
DMT	Flat Plate Dilatometer Test	R_D	Dry density ratio
e	Void ratio	RMU	Significant zone dominated by one rock type with one dominant weathering grade
E	Young's modulus (ratio of axial stress to axial strain)	RQD _(per CR)	Rock quality designation (ratio calculated per length of core run)
E_s	Modulus of elasticity	RQD _(per RMU)	Rock quality designation (ratio calculated per length of specific rock mass unit)
ES	Environmental Sample	s_u	Shear strength of a soil, (often $s_u = q_u / 2$)
ECN	Emerson Class Number	S	Degree of saturation
f_s	Cone skin friction	SPT	Standard Penetration Test
F_R	Cone friction ratio	TP	Test pit
FVS	Field Vane Shear Test	TCR	Total core recovery (%)
GSL	Ground surface level	u	Pore water pressure
hb	No measurable penetration, or the SPT hammer is bouncing for five consecutive blow	u_c	Pore water pressure measured at the tip of a piezocone (CPTu)
hw	Full penetration over any 150mm interval is achieved by SPT hammer and rod weight only	UCS	Uniaxial compressive strength test
HQ	63.5mm diameter drill core(double tube wireline)	U50	Undisturbed 50mm diameter tube sample
HQ3	61.1mm diameter drill core(triple tube wireline)	U75	Undisturbed 75mm diameter tube sample
I_D	Density index (cohesionless soil)	U100	Undisturbed 100mm diameter tube sample
I_{s50}	Point load strength index	VC	Vibro core
$I_{s50(A)}$	Axial point load strength index	VEDCP	Variable Energy Cone Penetration Test (PANDA)
$I_{s50(D)}$	Diametral point load strength index	w	Moisture content of a soil
$I_{s50(L)}$	Irregular (lump) point load strength index	w_o	Optimum moisture content (OMC)
k	Coefficient of permeability	WS	Water sample
K	Ratio of lateral to vertical stress	WLS	Weighted linear shrinkage
K_a	Active earth pressure	WPI	Weighted plasticity index
K_p	Passive earth pressure	z	Depth of interest from ground surface level (GSL)
LL or W_L	Liquid Limit %	Greek symbol	Definition
LS	Linear Shrinkage	γ	Unit weight of material
m_v	Coefficient of volume decrease	γ'	Effective unit weight of material
MDD	Maximum dry density	ϵ	Strain
n	Porosity	ν	Poisson's ratio
N	SPT Penetration Resistance, (blows per final 300mm penetration)	ρ	Density
N_p	DCP Penetration Resistance, (blows per 300mm penetration, depth recorded at centre of interval)	σ	Pressure or stress
NQ	47.6mm diameter drill core (double tube wireline)	σ'	Effective pressure or stress
NQ3	45.1mm diameter drill core (triple tube wireline)	τ	Shear stress
NMLC	51.9 mm diameter drill core (triple tube wireline)	ϕ	Angle of internal friction
OCR	Overconsolidation ratio	ϕ'	Effective angle of internal friction



Appendix B – Figures



LEGEND

Site Location

Borehole Locations

DCP/PSP Test Locations

Client: Econ Environmental Pty Ltd
Project: Proposed Senior School Building
Location: Avon Road, Pymble NSW 2073

Job Number: ECOE0977 - GEO AA

Revision: A

Drawn: N/A

Date: 24-Mar-25

Figure 3



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