Central Coast Council

Preliminary Geotechnical Assessment

Proposed Multistorey Apartment Building Development

23-25 Ashton Avenue, The Entrance NSW

Report No. RGS50080.2 - AC

4 December 2023

REGIONAL GEOTECHNICAL SOLUTIONS

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Manning-Great Lakes
Port Macquarie
Coffs Harbour

RGS50080.2 - AC

4 December 2023

Central Coast Council
PO Box 20
WYONG NSW 2259

Attention: Breelle Varman

Dear Breelle

RE: Proposed Multistorey Apartment Building Development – 23-25 Ashton Avenue, The Entrance NSW

Preliminary Geotechnical Assessment

Regional Geotechnical Solutions Pty Ltd (RGS) has completed preliminary geotechnical investigations and assessment at the site of the proposed multistorey apartment building development that is to be constructed at 23-25 Ashton Avenue, The Entrance NSW. The assessment is required to form a pre-transfer activity assessment prior to ownership transferring from Central Coast Council to Pacific Link Housing (PLH).

The results of the site contamination assessment, which were undertaken in conjunction with the geotechnical assessment are presented in separate reports.

If you have any questions regarding this project, or require any further assistance with this project, please do not hesitate to contact the undersigned.

For and on behalf of **Regional Geotechnical Solutions Pty Ltd**

Prepared by

Louis Davison

Senior Geotechnical Engineer

Reviewed by

Adam Holzhauser

Principal Geotechnical Engineer

Design and Building Practitioner Registration PRE0001152

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1 INTRODUCTION

Regional Geotechnical Solutions Pty Ltd (RGS) has completed a preliminary assessment for the proposed multistorey apartment building development which is to be constructed on the existing council owned land located at 23-25 Ashton Avenue, The Entrance NSW. The assessment is required to form a pre-transfer activity assessment prior to ownership transferring from Central Coast Council to Pacific Link Housing (PLH).

The intrusive investigations and sampling of the site has been undertaken to assess the geotechnical aspects of the site. This report presents the factual data collected from the site, site classification, and Acid Sulfate Soil (ASS) assessment. A detailed geotechnical report will be prepared for PLH which will include recommendations for the proposed development.

A site contamination assessment for the site is presented in a separate report.

The future development will involve a seven storey apartment complex with a portion of two storey townhouses and an on grade carpark. The proposed development is illustrated below.

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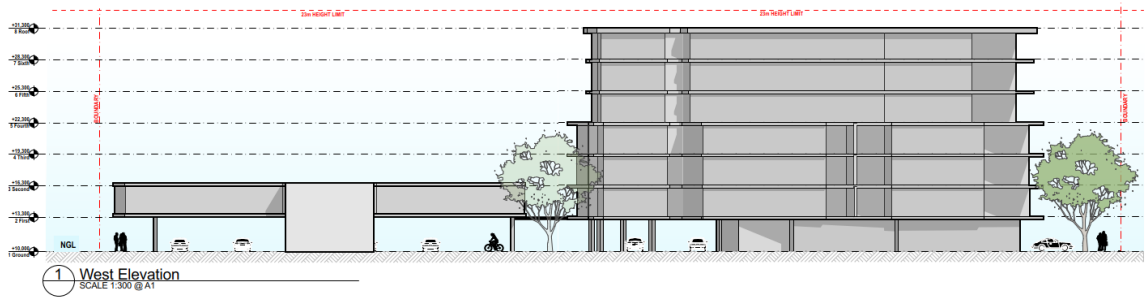

Diagram 1: *Proposed development comprising a seven storey apartment complex and two storey townhouses.*

2 GEOTECHNICAL ASSESSMENT

2.1 Field Work

Field work for the investigation comprised a site walkover assessment and intrusive investigations. The site walkover included observation of relevant surface features on the site and nearby properties and a brief assessment of the condition of nearby structures.

Intrusive investigations included the drilling of four boreholes (BH101 to BH104) with a truck mounted mounted drill rig to depths of up to 4.45m. Standard Penetration Tests (SPTs) were undertaken at approximately 1.5m intervals within each of the boreholes to assess the soil strength profile.

Soil samples were collected at various depths for subsequent laboratory testing.

The field work was undertaken by a Senior Geotechnical Engineer from RGS. Engineering logs of the boreholes are presented in Appendix A. The approximate borehole locations are presented on Figure 1.

2.2 Laboratory Testing

Samples collected during the field work were sent to NATA accredited laboratories for testing. The following testing was undertaken:

- Two (2) no. shrink-swell tests for foundation design and site classification purposes;
- 20 no. acid sulfate screens; and
- 10 no. net acidity and S_{kcl} test suites.

Additional testing undertaken will be presented and discussed in the 'Detailed Geotechnical Report'.

2.3 Site Conditions

2.3.1 Surface Conditions

The site is situated within gently sloping terrain in a near coastal area between Tuggerah Lake and The Entrance Beach. A satellite photograph that shows the location of the site and the site setting is reproduced below.

Diagram 2: *Satellite photograph obtained from Google Earth that illustrates the site location and setting. The site boundaries are outline in red.*

The site is made up of three lots including Lot 24, Lot 36, and Lot 37 DP14230. The southern portion of the site (lot 24) falls to the north at grades of approximately 3°. The northern lotion of the site (Lot 36 & 37) falls to the west at grades of approximately 3°.

The site is currently vacant and sealed with a bitumen hardstand. The seal is in poor condition with various defects including large potholes.

Vegetation comprises a tree approximately 5m tall near the centre point of the western boundary and grass along the eastern and western boundaries of the site. There are tall trees on the neighbouring properties to the west.

The northern lots are accessed via Ashton Avenue that comprises a sealed road with curb and gutter, and the southern lot is accessed via Campbell Avenue that also comprises a sealed road with curb and gutter.

The site features are illustrated in the site photographs presented below.

Looking north over Lot 24. The majority of the lot is sealed with grass along the boundaries.

Looking southeast over Lot 36 and 37. The majority of the lot is sealed with grass along the boundaries.

Large pothole located in the existing seal on Lot 24.

Curb and gutter off the entrance to Lot 37.

2.3.2 Subsurface Conditions

The NSW Seamless Geology Map indicates that the site is underlain by coastal sand deposits.

Table 1 provides a summary of the subsurface conditions encountered during the investigation.

Table 1: Summary of Subsurface Conditions.

Material Description	Depth to Base of Material			
	BH101	BH102	BH103	BH104
Fill – Sandy GRAVEL, fine grained gravel, fine to coarse grained sand	0.25	--	0.1	--
Fill – Sandy Gravelly CLAY, medium plasticity, fine grained sand, fine grained, angular gravel	0.5	0.3	--	0.2
Alluvial Soil – Sandy SILT, fine to medium grained sand, soft to stiff	1.4	1.5	0.8	0.8
Residual Soil – Sandy CLAY and Silty CLAY, medium plasticity, stiff to hard	≥ 4.45	≥ 4.2	3.5	2.2
Extremely Weathered Sandstone – Sandy CLAY, medium plasticity, hard / friable	--	- -	≥ 4.15	≥ 4.05*

Note: ≥ Indicates that base of material layer was not encountered.
-- Indicates the material was not encountered
* Practical auger refusal encountered

Groundwater was encountered at a depth of 1.0m in BH101 during the investigations, however, not encountered in any of the other boreholes. Groundwater levels do fluctuate due to inclement weather, tidal influence, seasonal variations or due to reasons that may not have been apparent at the time of the site investigation. Long term groundwater monitoring was not undertaken.

The laboratory results indicate the residual soil has a shrink swell index of between 1.6% and 1.9%.

3 GEOTECHNICAL DISCUSSION AND RECOMMENDATIONS

3.1 Geotechnical Considerations

Bulk earthworks plans for the proposed development have not been provided, however, in consideration of the gently sloping site earthworks are likely to be minor.

The site is underlain by fill that extends to depths of up to 0.8m. There are no records that document the manner of fill placement (i.e., a Level 1 report prepared in accordance with AS3798-2007), therefore in accordance with AS2870-2011 'Residential slabs and footings' the fill is classified as 'uncontrolled fill'. In consideration of this and the presence of soft to firm alluvial soils that extend to depths of up to 1.8m, remove and replace treatments may be considered. Alternatively, a piled foundation system may be considered.

Some foundation treatments will likely be required for the proposed pavement areas.

3.2 Earthworks

3.2.1 General Site Preparation and Site Drainage

Earthwork requirements will vary significantly depending on the proposed development details. Site preparations will generally require stripping of the topsoil and existing uncontrolled fill, root affected material and any soft or disturbed areas. The uncontrolled fill may remain onsite, however, any foundation systems would be required to extend below the depth of the uncontrolled fill layers.

All topsoil and root affected excavated materials should be stockpiled on site where appropriate for later reuse in landscaping areas only or disposed of offsite. These materials are not considered suitable for reuse as engineered fill. Any deleterious or obviously contaminated materials should also be stripped and disposed of in consideration of the comments and recommendations provided in Section 0.

The existing fill and soft to firm alluvial soils may be suitable for reuse as engineered fill, however, significant moisture conditioning will be required in some areas.

Site runoff should be controlled by appropriate measures including silt fencing and the construction of table drains and diversion mounds along the low side of the site. The drains should be directed to discharge in a controlled manner to an approved disposal point.

3.2.2 Excavation Conditions

Based on the supplied drawings deep excavations (e.g., for a basement) are not being considered at this point, as such bulk earthworks are not expected to require excavations beyond stripping of unsuitable material as described above. Some localised deeper excavations may be required for the installation of services.

Excavations of these materials are likely be achievable with small to medium sized excavators. Ripping tynes or rock hammers may be required where deeper excavations into the weathered sandstone profile are required. Groundwater seepage is anticipated to be minor and controllable using conventional gravity drainage to discharge directly into the existing stormwater system or into a sump where it can be pumped into the stormwater system.

Excavation work must be undertaken in accordance with the Safe Work Australia '*Excavation Code of Practice (January 2020)*'

3.2.3 Subgrade Preparation, Fill Placement and Compaction Control

The following general comments and recommendations are provided as a guide for the preparation of filling:

- All root affected material, topsoil, and uncontrolled fill (where excavation is appropriate) should be fully stripped and stockpiled for later reuse for landscaping purposes over the site. Topsoil and root affected materials are not considered suitable for reuse as engineered fill, the uncontrolled fill may be reused as engineered fill but should be assessed by a suitably qualified geotechnical engineer as required;
- Following excavation to an appropriate foundation level, the exposed subgrade materials should be proof rolled to identify any wet, excessively deflecting or other deleterious material. Any such areas should be over-excavated down to a stiff base and backfilled with an approved select fill with similar engineering characteristics to the surrounding soils.

The stripped foundation should be observed by a geotechnical engineer to assess appropriate foundation treatment requirements;

- Approved fill (refer below) should be placed in layers not exceeding 300mm loose thickness and be compacted to a minimum dry density ratio of not less than 98% Standard Compaction or 75% density index for cohesionless material (sand). Clay fill is not recommended as discussed below;
- Typically filling below structures should be carried out in accordance with Level 1 inspection and testing as defined in AS3798 – 2007. Fill placed below pavements should be placed under Level 2 conditions; and
- In pavement areas, the upper 300mm of the subgrade materials should be compacted to a minimum density ratio of 100% Standard compaction.

3.2.4 Fill Materials and Offsite Disposal

Materials recommended for use as engineered fill include good quality well graded granular materials (such as DGB20 / DGS40), free of deleterious materials and having a maximum particle size of 200mm, or a locally sourced or site won ripped weathered rock.

Site won alluvial and residual soil may be reused as controlled fill at the site. However, the use of reactive clay soils will result in higher foundation costs due to the shrink-swell potential and subsequent increase in characteristic free surface movement (ys) values.

Where offsite disposal of material, or reuse of material at an alternative site is proposed it should be assessed in accordance with the requirements of the '*Department of Environment and Climate Change NSW Waste Classification* Guidelines *Part 1 Classifying Waste*' (July 2009) and / or the EPA Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014. As a preliminary guide based on the site contamination testing undertaken, the existing upper gravel fill, would likely meet the requirements of the Recovered Aggregate Order 2014, however could not be classified as ENM due to elevated Total Petroleum Hydrocarbon levels. Further testing would be required in order to provide an appropriate classification for these materials. The natural alluvial and residual soils would likely be classified as VENM in most areas, however, the material identified as actual or potential Acid Sulfate Soils as discussed in Section 4 can-not be classified as ENM or VENM and must be disposed of at a licenced landfill facility following treatment if it can not remain onsite.

It is recommended that following topsoil stripping that a Geotechnical Engineer be engaged to assess that the material across the site has not previously been disturbed.

3.3 Footings and Foundation Design Parameters

3.3.1 Site Classification

The site classification presented herein is provided on the basis that the performance expectations of AS2870-2011 are acceptable.

The site is classified as **Class 'P'** in accordance with AS2870-2011 due to the presence of uncontrolled fill and firm soils to depths of up to 1.5m and due to the presence of trees and their potential influence on soil moisture conditions. In accordance with AS2870-2011, Class 'P' sites must be designed based on engineering principles.

An estimate of the characteristic surface movement has been undertaken based on the following:

- Depth of design suction change of H_s=1.5m;

- Crack depth multiplication factor of 0.5;
- Change in suction at design surface level of Δu=1.2;
- Shrink-swell index of 1.9% for the residual soil that extends beyond the depth of suction; and
- Single trees are located closer than half the mature height of the tree from the proposed structure.

Based on the above, a characteristic surface movement of y_s = 20mm is predicted when assessed in accordance with AS2870-2011. Due to the presence of trees the site will be subjected to potential additional surface movement from tree induced suction change. The potential surface movement due to tree-induced suction change (i.e. $y_s + y_t$) is estimated to be 30mm which is equivalent to a Class M site.

Shrink-swell related movements can be affected by alterations to the soil profile by cutting and filling, and by the suction related effects of trees close to the building area. The effects of any such cutting, filling or tree planting should be considered when selecting design values for differential movement across the slab.

Further advice with regard to footing designs is provided below and in the subsequent detailed report.

3.3.2 Foundation Recommendations

Due to the presence of uncontrolled fill and soft to firm soils in the upper 1.5m shallow footings would not be considered appropriate for the site in its current state. As such, a piled foundation system may be considered. Open bored piles or Grout Injected/Continuous Flight Auger (CFA) piles would be considered appropriate.

Further advise relating to foundations will be provided in the detailed geotechnical report.

4 ACID SULFATE SOILS

4.1 Formation of Acid Sulfate Soils

Acid Sulfate Soils (ASS) contain significant concentrations of pyrite which, when exposed to oxygen in the presence of sufficient moisture, oxidises, resulting in the generation of sulfuric acid. Unoxidised pyritic soils are referred to as Potential ASS (PASS). When the soils are exposed, the oxidation of pyrite occurs and sulfuric acids are generated, the soils are said to be Actual ASS (AASS).

4.2 ASS Risk Maps

The Acid Sulfate Soil Risk Mapping of The Entrance area indicates the proposed development is situated approximately 200m west of an area mapped as having a low probability of ASS between a depth of 1m and 3m and within an area of marine and aeolian sand deposits. An extract of the map is reproduced below in Diagram 3.

Diagram 3: *Acid Sulfate Soils Risk map of The Entrance area is reproduced with NSW Government website "Espade v2.2" the lot boundaries are outlined red.*

4.3 Laboratory Testing

Samples collected from the boreholes were transported to a NATA registered laboratory for analysis. ASS screening tests were undertaken on 20 samples. The findings from the screening tests are discussed below.

- The samples revealed pH_F values between 5.19 and 7.64 in distilled water. pH_F less than 4 is an indicator of Actual ASS; and
- The samples revealed pH_{FOX} values between 2.48 and 5.84 in hydrogen peroxide. Values less than 3 can be an indicator of Potential ASS (PASS) but can also be the result of high organic content in the soil.

To provide a more comprehensive assessment, ten samples were submitted for Chromium Reducible Sulphur (CRS) analysis. A summary of the test results is presented in Table 2.

Table 2: Summary of ASS CRS Test Results

Test location	Depth (m)	Texture	Action Criteria[1] (mol H^+ / t)	Actual Acidity – TAA (mol H^+ / t)	Potential Sulfidic Acidity – CRS (mol H^+ / t)	KCL-Extractable Sulfur (mol H+/t)	Net Acidity (mol H^+ / t)
BH101	0.9 – 1.0	Coarse	18	12	4	1	16
BH101	1.9 – 2.0	Fine	62	41	6	6	47
BH101	2.9 – 3.0	Fine	62	41	0	**415**	41
BH102	0.9 – 1.0	Medium	36	33	9	3	**43**
BH102	1.4 – 1.5	Fine	62	30	5	15	35
BH102	1.9 – 2.0	Fine	62	18	0	6	18
BH103	0.9 – 1.0	Fine	62	14	5	1	19
BH103	2.9 – 3.0	Fine	62	8	0	3	8
BH104	0.9 – 1.0	Fine	62	6	0	3	6
BH104	1.9 – 2.0	Fine	62	1	0	0	1

NOTE:

1. *Action criteria is based on less than 1000 tonnes of soil being disturbed*
2. *Values in **Bold** exceed the action criteria.*

4.4 Analysis of ASS Results

The results of the analysis were compared against the action criteria as presented in Table 5.4 of the Water Quality Australia *National Acid Sulfate Soils Guidance National acid sulfate soils sampling and identification methods manual June 2018.*

The assessment is based on less than 1,000 tonnes of soil disturbance. Table 5.4 indicates that for less than 1,000 tonnes of soil disturbance the following action criteria are applicable:

- Fine grained soil - ≥ 62 mol/tonne net acidity.
- Medium grained soil - ≥ 36 mol/tonne net acidity.
- Coarse grained soil - ≥ 18 mol/tonne net acidity.

The laboratory test results presented in Table 8 indicate:

- The net acidity in the samples tested from BH101 to BH104 is below the adopted action criteria except for sample BH102 - 0.9 to 1.0m;
- KCL-extractable sulfur was present in sample BH101 2.9 to 3.0m at a level well above the adopted action criteria indicting high levels of sulfuric acidity;

- Sulfuric acidity is present in nine of the ten samples tested, but net acidity is below the adopted action criteria for the respective grain size apart from sample BH102 - 0.9 to 1.0m;

The results have been evaluated against volume and grain size-based thresholds, considering volumes of less than 1,000 tonnes disturbance based on the assumption that disturbance would be limited to excavation of piles and service trenches. If greater volumes are expected, the results must be reassessed.

4.5 Conclusions Regarding Acid Sulfate Soils

Due to the presence of sulfuric acidity and BH102 - 0.9 to 1.0m being PASS an Acid Sulfate Soils Management Plan (ASSMP) is required for the proposed works where these soils will be impacted.

The management plan should be prepared once details of the proposed development are known.

5 LIMITATIONS

This report comprises the results of an investigation carried out for a specific purpose and client as defined in the document. The report should not be used by other parties or for purposes or projects other than those assumed and stated within the report, as it may not contain adequate or appropriate information for applications other than those assumed or advised at the time of its preparation. The contents of the report are for the sole use of the client and no responsibility or liability will be accepted to any third party. The report should not be reproduced either in part or in full, without the express permission of Regional Geotechnical Solutions Pty Ltd.

Geotechnical site investigation is based on data collection, judgment, experience, and opinion. By its nature, it is less exact than other engineering disciplines. The findings presented in this report and used as the basis for the recommendations presented herein were obtained using normal, industry accepted geotechnical design practises and standards. To our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

The recommended depth and properties of any soil, rock, groundwater, or other material referred to in this report is an engineering estimate based on the information available at the time of its writing. The estimate is influenced and limited by the fieldwork method and testing carried out in the site investigation, and other relevant information as has been made available. In cases where information has been provided to Regional Geotechnical Solutions for the purposes of preparing this report it has been assumed that the information is accurate and appropriate for such use. No responsibility is accepted by Regional Geotechnical Solutions for inaccuracies within any data supplied by others.

If site conditions encountered during construction vary significantly from those discussed in this report, Regional Geotechnical Solutions Pty Ltd should be contacted for further advice.

This report alone should not be used by contractors as the basis for preparation of tender documents or project estimates. Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

For and on behalf of **Regional Geotechnical Solutions Pty Ltd**

Prepared by

Louis Davison

Senior Geotechnical Engineer

Reviewed by

Adam Holzhauser

Principal Geotechnical Engineer

Design and Building Practitioner Registration PRE0001152

Figures

REGIONAL GEOTECHNICAL SOLUTIONS	**Client:**	Central Coast Council	Job No. RGS50080.2
	Project:	Proposed Multistorey Apartment Building Development 23-25 Ashton Avenue, The Entrance	Drawn By: LD Scale: NTS Date: 5-Dec-23
	Title:	Site Layout Plan	Drawing No. **Figure 1**

Appendix A

Results of Field Investigations

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH101

CLIENT:	Central Coast Council	**PAGE:**	1 of 1
PROJECT NAME:	Proposed Multi-Storey Apartment Building Development	**JOB NO:**	RGS50080.2
SITE LOCATION:	23-25 Ashton Avenue, The Entrance	**LOGGED BY:**	LD
TEST LOCATION:	Refer to Figure 1	**DATE:**	8/11/23

DRILL TYPE: Truck Mounted **EASTING:** **SURFACE RL:**

BOREHOLE DIAMETER: **INCLINATION:** 90° **NORTHING:** **DATUM:** AHD

Drilling and Sampling					Material description and profile information						Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY		Test Type	Result	Structure and additional observations
AD/T		0.30m 0.40m ES				GP	0.01m **BITUMEN**	D					WEARING SURFACE
						CI	0.25m **FILL:** Sandy GRAVEL, fine grained, grey, fine to coarse grained sand, with some clay, medium plasticity	M < w_P					FILL
						ML	0.50m **FILL:** Sandy CLAY, medium plasticity, orange-brown, fine grained sand, with some gravel, fine to medium grained, angular	M > w_P	S - F				ALLUVIUM
		0.90m 1.00m ES SPT 2,2,0 N=2		1.0			**Sandy SILT:** Low plasticity, black, fine to medium grained sand						
		1.40m 1.50m 1.45m ES				CI	1.40m **Sandy CLAY:** Medium plasticity, grey, fine to medium grained sand		F - St		HP	100	RESIDUAL
				2.0		CH	2.00m **Silty CLAY:** Medium to high plasticity, pale grey, pale brown, with some sand, fine to medium grained	M < w_P	St - VSt		HP	250	
		2.50m SPT 2,5,6 N=11									HP	200	
		2.95m		3.0									
						CI	3.60m **Silty CLAY:** Medium plasticity, red-brown, with a trace of sand, fine grained		H				
		4.00m SPT 7,10,11 N=21		4.0							HP	550	
							4.45m				HP	>600	
		4.45m					Hole Terminated at 4.45 m						
				5.0									

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH102

CLIENT:	Central Coast Council	**PAGE:**	1 of 1
PROJECT NAME:	Proposed Multi-Storey Apartment Building Development	**JOB NO:**	RGS50080.2
SITE LOCATION:	23-25 Ashton Avenue, The Entrance	**LOGGED BY:**	LD
TEST LOCATION:	Refer to Figure 1	**DATE:**	8/11/23

DRILL TYPE: Truck Mounted **EASTING:** **SURFACE RL:**

BOREHOLE DIAMETER: **INCLINATION:** 90° **NORTHING:** **DATUM:** AHD

Drilling and Sampling					Material description and profile information						Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY		Test Type	Result	Structure and additional observations
AD/T	Not Encountered	0.90m 1.00m ES SPT 1,2,2 N=4 1.50m 1.45m U 1.80m 2.00m 2.10m ES 2.50m SPT 2,3,6 N=9 2.95m 3.00m ES 4.00m SPT 18,25/50mm N=R 4.20m		1.0 2.0 3.0 4.0 5.0		CI	**FILL:** Sandy Gravelly CLAY, medium plasticity, fine to medium grained sand, with gravel, fine grained, angular						FILL
					0.30m	ML	**Sandy SILT:** Low plasticity, black	M > w_P	F				ALLUVIUM
					1.10m	CI	**Silty CLAY:** Medium plasticity, grey, pale brown		F - St		HP HP	120 110	
					1.50m	CH	**Silty CLAY:** Medium to high plasticity, pale grey, pale brown, with a trace of sand, fine grained	M < w_P	St				RESIDUAL
									St - VSt		HP HP	220 300	
					3.40m	CI	**Sandy CLAY:** Medium plasticity, grey, orange-brown		H / Fr		HP	>600	
					4.20m		Hole Terminated at 4.20 m						

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH103

CLIENT:	Central Coast Council	**PAGE:**	1 of 1
PROJECT NAME:	Proposed Multi-Storey Apartment Building Development	**JOB NO:**	RGS50080.2
SITE LOCATION:	23-25 Ashton Avenue, The Entrance	**LOGGED BY:**	LD
TEST LOCATION:	Refer to Figure 1	**DATE:**	8/11/23

DRILL TYPE: Truck Mounted **EASTING:** **SURFACE RL:**

BOREHOLE DIAMETER: **INCLINATION:** 90° **NORTHING:** **DATUM:** AHD

Drilling and Sampling					Material description and profile information						Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY		Test Type	Result	Structure and additional observations
AD/T	Not Encountered	0.10m 0.20m ES				CI ML	0.10m **FILL:** Sandy Gravelly CLAY, medium plasticity, pale brown, fine to coarse grained sand, fine grained angular gravel **Sandy Clayey SILT:** Low plasticity, black	M > w_P	F				FILL ALLUVIUM
		1.00m SPT 3,3,6 N=9 1.45m		1.0		CH	0.80m **Silty CLAY:** Medium to high plasticity, pale grey, red-brown, pale brown		St - VSt		HP HP	190 270	RESIDUAL
		2.00m 2.10m ES		2.0									
		2.50m SPT 10,18,17 N=35 2.95m		3.0		CI	2.40m **Sandy CLAY:** Medium plasticity, orange-brown, grey	M < w_P	H / Fr		HP	>600	
		4.00m SPT 25 N=R 4.15m		4.0		CI	3.50m **Sandy CLAY:** Medium plasticity, grey						EXTREMELY WEATHERED SANDSTONE
				5.0			4.15m Hole Terminated at 4.15 m						

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - BOREHOLE

REGIONAL GEOTECHNICAL SOLUTIONS

BOREHOLE NO: BH104

CLIENT:	Central Coast Council	**PAGE:**	1 of 1
PROJECT NAME:	Proposed Multi-Storey Apartment Building Development	**JOB NO:**	RGS50080.2
SITE LOCATION:	23-25 Ashton Avenue, The Entrance	**LOGGED BY:**	LD
TEST LOCATION:	Refer to Figure 1	**DATE:**	8/11/23

DRILL TYPE: Truck Mounted **EASTING:** **SURFACE RL:**

BOREHOLE DIAMETER: **INCLINATION:** 90° **NORTHING:** **DATUM:** AHD

Drilling and Sampling					Material description and profile information						Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY		Test Type	Result	Structure and additional observations
AD/T	Not Encountered	0.20m				CI	**FILL:** Sandy Gravelly CLAY, medium plasticity, pale brown, fine to coarse grained sand, fine grained angular gravel	D					FILL
		0.30m ES				ML	**Sandy Clayey SILT:** Low plasticity, black, fine to medium grained sand	M > w_P	F				ALLUVIUM
		0.50m											
		B											
		0.90m											
		1.00m		1.0		CI	**Silty CLAY:** Medium plasticity, grey, red-brown, pale brown, with a trace of sand, fine grained	M < w_P	St - VSt				RESIDUAL
		SPT 3,3,6 N=9									HP	300	
											HP	220	
		1.45m											
		2.00m		2.0									
		2.10m ES											
		2.50m				CI	**Sandy CLAY:** Medium plasticity, orange-brown		H / Fr				EXTREMELY WEATHERED SANDSTONE
		SPT 10,18,17 N=35											SPT bouncing froom first blow
		2.95m		3.0									
		4.00m		4.0		CI	**Sandy CLAY:** Medium plasticity, pale grey						EXTREMELY TO HIGHLY WEATHERED SANDSTONE
		SPT 25 N=R					Hole Terminated at 4.00 m Refusal						SPT instantly bouncing at 4.0m
		4.15m		5.0									

LEGEND:

Water

- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes

- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
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Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Appendix B

Laboratory Results

Material Test Report

Qualtest LABORATORY (NSW) PTY LTD
Newcastle Laboratory
2 Murray Dwyer Circuit Mayfield West NSW 2304
Phone: (02) 4968 4468
Email: brentcullen@qualtest.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA WORLD RECOGNISED ACCREDITATION

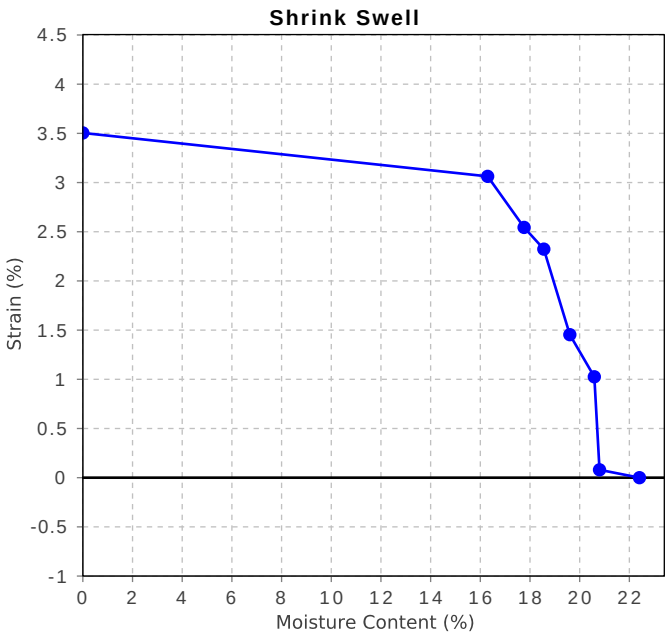
Approved Signatory: Brent Cullen
Engineering Geologist
NATA Accredited Laboratory Number: 18686

Report Number:	**MNC16P-0001-20**
Issue Number:	1
Date Issued:	27/11/2023
Client:	Regional Geotechnical Solutions Pty Ltd
	44 Bent Street, Wingham NSW 2429
Project Number:	MNC16P-0001
Project Name:	Various Testing
Project Location:	The Entrance, NSW
Client Reference:	RGS50080.1
Work Request:	547
Sample Number:	NEW23S-547B
Date Sampled:	10/11/2023
Dates Tested:	13/11/2023 - 14/11/2023
Sampling Method:	Sampled by Client
	The results apply to the sample as received
Sample Location:	**BH102 - (1.5 - 1.8m)**
Material:	Insitu
Material Source:	On-Site

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**1.9**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**3.5**
Estimated % by volume of significant inert inclusions	1
Cracking	Moderately Cracked
Crumbling	No
Moisture Content (%)	22.4

Swell Test	
Initial Pocket Penetrometer (kPa)	200
Final Pocket Penetrometer (kPa)	190
Initial Moisture Content (%)	23.3
Final Moisture Content (%)	20.8
Swell (%)	**-0.1**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

Qualtest LABORATORY (NSW) PTY LTD
Newcastle Laboratory
2 Murray Dwyer Circuit Mayfield West NSW 2304
Phone: (02) 4968 4468
Email: brentcullen@qualtest.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA WORLD RECOGNISED ACCREDITATION

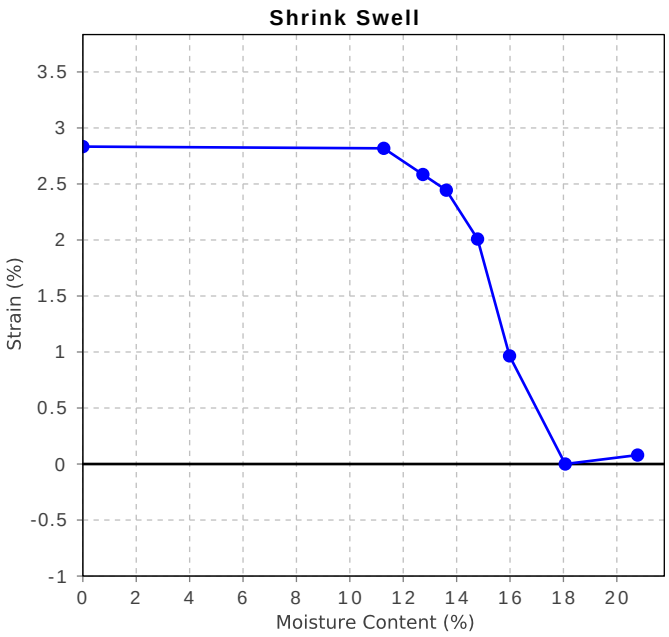
Approved Signatory: Brent Cullen
Engineering Geologist
NATA Accredited Laboratory Number: 18686

Report Number:	**MNC16P-0001-20**
Issue Number:	1
Date Issued:	27/11/2023
Client:	Regional Geotechnical Solutions Pty Ltd
	44 Bent Street, Wingham NSW 2429
Project Number:	MNC16P-0001
Project Name:	Various Testing
Project Location:	The Entrance, NSW
Client Reference:	RGS50080.1
Work Request:	547
Sample Number:	NEW23S-547D
Date Sampled:	10/11/2023
Dates Tested:	13/11/2023 - 14/11/2023
Sampling Method:	Sampled by Client
	The results apply to the sample as received
Sample Location:	**BH202 - (1.0 - 1.3m)**
Material:	Insitu
Material Source:	On-Site

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**1.6**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**2.8**
Estimated % by volume of significant inert inclusions	1
Cracking	Moderately Cracked
Crumbling	No
Moisture Content (%)	18.1

Swell Test	
Initial Pocket Penetrometer (kPa)	250
Final Pocket Penetrometer (kPa)	170
Initial Moisture Content (%)	17.6
Final Moisture Content (%)	20.8
Swell (%)	**-0.1**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



RESULTS OF ACID SULFATE SOIL ANALYSIS

20 samples supplied by Regional Geotechnical Solutions Pty Ltd on 13/11/2023. Lab Job No. P7508.
Analysis requested by Louis Davidson. Your Job: RGS50080.2 20 Samples.

1/21 Cook Drive COFFS HARBOUR NSW 2450

Sample Identification	EAL Lab Code	Texture	Moisture Content		pH_F and pH_{FOX}				KCl-extractable sulfur (S_{KCl})		Potential Sulfidic Acidity (Chromium Reducible Sulfur - CRS)		pH_{KCl}	Actual Acidity (Titratable Actual Acidity - TAA)	Retained Acidity		Non-treated soil: Acid Neutralising Capacity (ANC_{BT})		Non-treated soil: Net Acidity	Lime Calculation
			(% moisture of total wet weight)	(g moisture / g of oven dry soil)	pH_F	pH_{FOX}	pH change	Reaction	(% S_{KCl})	(equiv. mol H^+/t)	(% S_{Cr})	(mol H^+/t)		(mol H^+/t)	(%S_{NAS})	(mol H^+/t)	(% $CaCO_3$)	(mol H^+/t)	(mol H^+/t)	(kg $CaCO_3$/t DW)
Method Info.		**	**		*(In-house method S21)*				**		*(In-house method S20)*		*(In-house method 16b)*		**		*(In-house method ST4)*		**	**
BH 101 0.9 - 1.0	*P7508/1*	Coarse	11.1	0.12	6.05	2.71	-3.34	Medium	0.001	1	0.006	4	5.65	12	..	..	..	..	16	1
BH 101 1.4 -1.5	*P7508/2*	Medium	15.4	0.18	5.73	4.20	-1.53	Low	..	..	..	..	..	..	..	..	..	..	..	..
BH 101 1.9 - 2.0	*P7508/3*	Fine	17.5	0.21	5.28	3.18	-2.10	Medium	0.010	6	0.010	6	4.85	41	..	..	..	..	47	4
BH 101 2.4 - 2.5	*P7508/4*	Fine	20.5	0.26	5.50	4.19	-1.31	High	..	..	..	..	..	..	..	..	..	..	..	..
BH 101 2.9 - 3.0	*P7508/5*	Fine	32.3	0.48	5.60	4.27	-1.33	High	0.665	415	<0.005	0	4.81	41	..	..	..	..	41	3
BH 102 0.9 - 1.0	*P7508/6*	Medium	14.0	0.16	5.19	2.48	-2.71	Medium	0.004	3	0.015	9	5.08	33	..	..	..	..	43	3
BH 102 1.4 -1.5	*P7508/7*	Fine	23.7	0.31	5.51	3.75	-1.76	Medium	0.023	15	0.008	5	5.10	30	..	..	..	..	35	3
BH 102 1.9 - 2.0	*P7508/8*	Fine	18.8	0.23	5.91	3.29	-2.62	Medium	0.010	6	<0.005	0	5.40	18	..	..	..	..	18	1
BH 102 2.4 - 2.5	*P7508/9*	Fine	29.5	0.42	5.82	4.63	-1.20	Medium	..	..	..	..	..	..	..	..	..	..	..	..
BH 102 2.9 - 3.0	*P7508/10*	Fine	20.7	0.26	5.95	4.77	-1.18	Low	..	..	..	..	..	..	..	..	..	..	..	..
BH 103 0.9 - 1.0	*P7508/11*	Fine	19.1	0.24	5.77	2.77	-3.00	High	0.002	1	0.008	5	5.53	14	..	..	..	..	19	1
BH 103 1.4 - 1.5	*P7508/12*	Fine	22.3	0.29	5.89	4.45	-1.44	Medium	..	..	..	..	..	..	..	..	..	..	..	..
BH 103 1.9 - 2.0	*P7508/13*	Medium	16.5	0.20	6.15	4.56	-1.59	Medium	..	..	..	..	..	..	..	..	..	..	..	..
BH 103 2.4 - 2.5	*P7508/14*	Fine	28.1	0.39	6.99	5.39	-1.60	Low	..	..	..	..	..	..	..	..	..	..	..	..
BH 103 2.9 - 3.0	*P7508/15*	Fine	14.0	0.16	6.54	5.32	-1.22	Medium	0.004	3	<0.005	0	5.76	8	..	..	..	..	8	1
BH 104 0.9 - 1.0	*P7508/16*	Fine	25.2	0.34	6.71	4.96	-1.75	Low	0.005	3	<0.005	0	5.93	6	..	..	..	..	6	0
BH 104 1.4 - 1.5	*P7508/17*	Fine	31.2	0.45	6.80	5.45	-1.35	Medium	..	..	..	..	..	..	..	..	..	..	..	..
BH 104 1.9 - 2.0	*P7508/18*	Fine	17.5	0.21	7.64	5.76	-1.88	Low	0.000	0	<0.005	0	6.46	1	..	..	..	..	1	0
BH 104 2.4 - 2.5	*P7508/19*	Fine	17.3	0.21	7.63	5.84	-1.79	Low	..	..	..	..	..	..	..	..	..	..	..	..
BH 104 2.9 - 3.0	*P7508/20*	Fine	12.8	0.15	7.37	5.75	-1.62	Low	..	..	..	..	..	..	..	..	..	..	..	..

NOTES:

1. All analysis is reported on a dry weight (DW) basis, unless wet weight (WW) is specified.
2. Samples are dried and ground immediately upon arrival (unless supplied dried and ground).
3. Analytical procedures are sourced from Sullivan L, Ward N, Toppler N and Lancaster G. 2018. National acid sulfate soils guidance: national acid sulfate soils identification and laboratory methods manual, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.
4. The Acid Base Accounting Equation, where Acid Neutralising Capacity has not been corroborated by other data, is Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity (Eq. 3.2; Sullivan et al. 2018 - full reference above).
5. The Acid Base Accounting Equation for post-limed soil materials is Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity - (post treatment Acid Neutralising Capacity - initial Acid Neutralising Capacity) (Eq. 3.3; Sullivan et al. 2018 - full reference above).
   While the Acid Neutralising Capacity of a soil material may not be included in the Net Acidity calculation (Note 4), it must be measured to give an Initial Acid Neutralising Capacity if verification testing is planned post-liming.
   The Inital Acid Neutralising Capacity must be provided by the client to enable EAL to produce Verification Net Acidity and Liming calculations for post-limed soil materials.
6. The Acid Base Accounting Equation, where Acid Neutralising Capacity has been corroborated by other data, is Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity - Acid Neutralising Capacity (Eq. 3.1; Sullivan et al. 2018 - full reference above).
7. The lime calculation includes a Safety Factor of 1.5 as a safety margin for acid neutralisation (Sullivan et al. 2018). This is only applied to positive values. An increased Safety Factor may be required in some cases.
8. Retained Acidity is required when the pHKCl < 4.5 or where jarosite has been visually observed.
9. A negative Net Acidity result indicates an excess acid neutralising capacity.
10. If insufficient mixing occurs during intial sampling, or during post-liming, or both: the Potential Sulfidic Acidity may be greater in the post-limed sample than in the intial sample; the post-liming Acid Neutralising Capacity may be lower in the post-limed sample than in the intial sample.
11. **An acid sulfate soil management plan is triggered by Net Acidity results greater than the texture dependent criterion: coarse texture ≥ 0.03% S or 18 mol H+/t; medium texture ≥ 0.06% S or 36 mol H+/t; fine texture ≥ 0.1% S or 62 mol H+/t) (Table 1.1; Sullivan et al. 2018 – full reference a**
12. For projects that disturb > 1000 t of soil material, the coarse trigger of ≥ 0.03% S or ≥ 18 mol H+/t must be applied in accordance with Sullivan et al. (2018) (full reference above).
13. Acid sulfate soil texture triggers can be related to NCST (2009) textures: coarse and peats = sands to loamy sands; medium = clayey sand to light clays; fine = light medium to heavy clays (Sullivan et al. 2018 - full reference above).
14. Bulk density is required to convert liming rates to soil volume based results. Field bulk density rings can be submitted to EAL for bulk density determination.
15. A negative Net Acidity result indicates an excess acid neutralising capacity.
16. '..' is reported where a test is either not requested or not required. Where pHKCl is < 4.5 or > 6.5, zero is reported for SNAS and ANC in Net Acidity calculations, respectively.
17. Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.
18. ** NATA accreditation does not cover the performance of this service.
19. Analysis conducted between sample arrival date and reporting date.
20. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer SCU.edu.au/eal/t&cs or on request).
21. Results relate to the samples tested.
22. This final report was issued on 17/11/2023 and replaces the previous report issued on 15/11/2023. Net acidity for selected samples is now included.

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WORLD RECOGNISED ACCREDITATION
Accreditation No. 14960
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checked: .....
Graham Lancaster
Laboratory Manager