

GEOTECHNICAL INVESTIGATION AND ACID SULFATE SOIL ASSESSMENT

FOR

NSW LAND AND HOUSING CORPORATION

6-12 Peters Avenue, Wallsend, New South Wales

Report No: 21/2033

Project No: 31248/5224D-G

July 2021

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DRAWING NO. 21/2033 – BOREHOLE AND PENETROMETER LOCATIONS

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1. INTRODUCTION

This report presents the results of a combined Geotechnical Investigation and Acid Sulfate Soil (ASS) assessment carried out by STS Geotechnics Pty Limited (STS) for a proposed new residential development to be constructed at 6-12 Peters Avenue, Wallsend, NSW. At the time of writing this report STS were not provided with architectural drawings for the project. The report has been written assuming that the development will typically comprise the construction of single and double storey residential buildings with no basements. Reference to the Newcastle LEP shows the site is located within a Class 5 Acid Sulfate Soils area and therefore Council requires an assessment to be undertaken.

The purpose of the investigation was to provide information on:

- Site conditions and regional geology,
- Subsurface conditions including groundwater levels (if encountered),
- Site Classification according to AS2870 (soil reactivity),
- Foundation design parameters including foundation options,
- Exposure classification/soil aggressiveness according to AS2870,
- Acid Sulphate Soils assessment and need for an Acid Sulphate Management Plan

The investigation was undertaken at the request of Andrew Stacey of NSW land & Housing Corporation and in accordance with STS proposal P21-233 dated 27 May, 2021.

Our scope of work did not include a contamination assessment.

2. NATURE OF THE INVESTIGATION

2.1. Fieldwork

The fieldwork consisted of drilling six (6) boreholes numbered BH1 to BH6 (inclusive), at the locations shown on attached Drawing No. 21/2033. Boreholes BH1, BH3, BH4 and BH5 were drilled using our ute-mounted Edson RP70 drilling rig, owned, and operated by STS. BH2 and BH6 were drilled using hand auger equipment because there was no access for the drilling rig. Soil strengths were assessed by carrying out a Dynamic Cone Penetrometer (DCP) test adjacent to each borehole location.

Drilling operations were undertaken by one of STS's senior technical officers who also logged the subsurface conditions encountered.

Representative soil samples were collected from the boreholes for subsequent laboratory testing.

2.2. Laboratory Testing

To determine the site classification and to assess the soils for their aggressiveness, selected representative soil samples were tested to determine the following:

- Shrink swell Index,
- pH,
- Sulphate content (SO₄),
- Chloride (Cl)
- Electrical Conductivity (EC), and
- Acid Sulphate Testing (SPOCAS).

Detailed test reports are given in Appendix B.

3. GEOLOGY AND SITE CONDITIONS

The Newcastle geological map at a scale of 1:250,000 shows the site is underlain by Permian Age Newcastle Coal Measures. Rocks within this formation typically comprise conglomerate, sandstone, tuff, shale and coal. The site is located close to the boundary of Quaternary Age gravel, sand, silt, clay, “Waterloo Rock” marine and freshwater deposits.

The site is trapezoidal in shape with an approximate area of 2,633 m². At the time of the fieldwork, the site was occupied by existing single storey residential dwellings with surrounding concrete driveways, grass, trees, and shrubs. The ground surface fall approximately 3 meters to the east.

The site is bound by Peters Avenue to the east, vacant land to the west, and residential dwellings to the north and south.

4. SUBSURFACE CONDITIONS

When assessing the subsurface conditions across a site from a limited number of boreholes, there is the possibility that variations may occur between test locations. The data derived from the site investigation programme are extrapolated across the site to form a geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour regarding the proposed development. The actual condition at the site may differ from those inferred, since no subsurface exploration programme, no matter how comprehensive, can reveal all subsurface details and anomalies, particularly on a site such as this where there has been previous development.

The subsurface conditions generally consist of topsoil overlying silty clays. The topsoil is present to depths of 0.3 to 0.4 metres. In BH1, BH3, BH4 and BH5, stiff, becoming very stiff with depth, natural silty clays underlie the topsoils to the depth of drilling, 3.0 metres. In BH2 and BH6 the very stiff clays could not be penetrated beyond the depth of hand auger refusal, 0.8 to 0.9 metres.

The subsurface conditions observed are recorded on the borehole logs given in Appendix A. An explanation of the terms used on the logs is also given in Appendix A. Notes relating to geotechnical reports are also attached.

Groundwater was not observed during drilling works.

5. GEOTECHNICAL DISCUSSION

5.1. Site Classification (AS2870)

The classification has been prepared in accordance with the guidelines set out in the “Residential Slabs and Footings” Code, AS2870 – 2011.

To assist with determining the site classification, three shrink/swell tests were carried out on representative samples retrieved from the site. The detailed test report is attached and summarised below:

Location	Depth (m)	Material Description	Shrink/Swell Index (% per ΔpF)
BH1	0.6-0.8	Red - brown, some light grey, silty clay	2.7
BH4	0.6-0.8	Orange - brown, some light grey, silty clay	5.3
BH5	0.5-0.7	Orange - brown, some light grey, silty clay	4.6

Because there are trees and existing dwellings present, abnormal moisture conditions (AMC) prevail at the site. (Refer to Section 1.3.3 of AS2870).

Because of the AMC present, the site is classified a *Problem Site (P)*. Provided the recommendations given below are adopted the site may be reclassified *Highly Reactive (H2)*.

Foundation design and construction consistent with this classification shall be adopted as specified in the above referenced standard and in accordance with the following design details.

5.2. Foundation Design Parameters

We do not recommend founding any structural loads within the topsoil material.

Pad and/or strip footings founded in the natural, stiff silty clays, may be proportioned using an allowable bearing pressure of 100 kPa. The minimum depth of founding must comply with the requirements of AS2870. To overcome the presence of trees, the foundations should be designed in accordance with the procedures given in Appendices H and CH of AS2870-2011.

If a higher load carrying capacity is required, piers founded in very stiff silty clay materials may be proportioned using an allowable end bearing pressure of 300 kPa, provided their depth to diameter ratio exceeds a value of 4. An allowable adhesion value of 20 kPa may be adopted for the portion of the shaft below a depth of 0.5 metres and within the very stiff clays.

In order to ensure the bearing values given can be achieved, care should be taken to ensure the base of the excavations is free of all loose material prior to concreting. To this end, it is recommended that all excavations be concreted as soon as possible, preferably immediately after excavating, cleaning, inspecting and approval. Pier excavations should not be left open overnight. The possibility of groundwater inflow needs to be considered when drilling the piers and pouring concrete.

The site is considered suitable for slab on ground construction provided due regard is given to the ground surface slope.

During foundation construction, should the subsurface conditions vary to those inferred in this report, a suitably experienced geotechnical engineer should review the design and recommendations given above to determine if any alterations are required.

5.3. Soil Aggressiveness

The aggressiveness or erosion potential of an environment in building materials, particularly concrete and steel is dependent on the levels of soil pH and the types of salts present, generally sulfates and chlorides. To determine the degree of aggressiveness, the test values obtained are compared to Tables 6.4.2 (C) and 6.5.2 (C) in AS2159 – 2009 Piling – Design and Installation.

The test results are summarised in Table 5.1.

Table 5.1 – Soil Aggressiveness Summary Table

Sample No.	Location	Depth (m)	pH	Chloride (mg/kg)	Sulfate (mg/kg)	Electrical Conductivity (dS/m)	
						EC _{1:5}	EC _e
S1	BH1	0.4	6.4	<50	10	0.046	0.5
S2	BH4	0.4	6.9	<50	20	0.051	0.5
S3	BH5	0.4	6.2	80	20	0.032	0.3

The soils on the site consist of cohesive soils above the ground water table. Therefore, soil conditions B are considered appropriate.

A review of the durability aspects indicates that:

- pH : minimum value of 6.2
- SO₄ : maximum value of 20 mg/kg (ppm) < 5000 ppm
- Cl : maximum value of 80 mg/kg (ppm) < 5000 ppm
- EC_e : maximum value of 0.5 dS/m

In accordance with AS2159-2009, the exposure classification for the onsite soils is non-aggressive to both steel and concrete. In accordance with AS2870-2011, the soils are classified as A1.

Reference to DLWC (2002) "Site Investigations for Urban Salinity" indicates that EC_e values of 0.3 to 0.5 dS/m are consistent with the presence of non-saline soils.

6. ACID SULFATE SOIL ASSESSMENT

6.1. Introduction

ASS is the common name given to sediments and soils containing iron sulfides which, when exposed to oxygen generate sulfuric acid. Natural processes formed most acid sulfate sediments when certain conditions existed in the Holocene geological period (the last 10,000 years). Formation conditions require the presence of iron-rich sediments, sulfate (usually from seawater), removal of reaction products such as bicarbonate, the presence of sulfate reducing bacteria. It should be noted that these conditions exist in mangroves, salt marsh vegetation or tidal areas, and at the bottom of coastal rivers and lakes.

The relatively specific conditions under which acid sulfate soils are formed usually limit their occurrence to low lying parts of coastal floodplains, rivers, and creeks. This includes areas with saline or brackish water such as deltas, coastal flats, back swamps and seasonal or permanent freshwater swamps that were formerly brackish. Due to flooding and stormwater erosion, these sulfidic sediments may continue to be re-distributed through the sands and sediments of the

estuarine floodplain region. Sulfidic sediment may be found at any depth in suitable coastal sediments – usually beneath the water table.

Any lowering in the water table that uncovers potential ASS will result in their aeration and the exposure of iron sulfide sediments to oxygen. The lowering in the water table can occur naturally due to seasonal fluctuations and drought or any human intervention, when carrying out any excavations during site development. Potential ASS can also be exposed to air during physical disturbance with the material at the disturbance face, as well as the extracted material, both potentially being oxidised. The oxidation of iron sulfide sediments in potential ASS results in ASS soils.

Successful management of areas with ASS is possible but must consider the specific nature of the site and the environmental consequences of development. While it is preferable that sites exhibiting acid sulfate characteristics are not disturbed, management techniques have been devised to minimise and manage impacts in certain circumstances.

When works involving the disturbance of soil or the change of groundwater levels are proposed in coastal areas, a preliminary assessment should be undertaken to determine whether potential acid sulfate soils (PASS) are present and if the proposed works are likely to disturb these soils.

6.2. Presence of PASS

The Newcastle Local Environmental Plan (LEP) indicates the site is in an area classified as Class 5.

Reference to the Wallsend (923S23) ASS Risk Map indicates the property is within an area of ‘no known occurrence’. The Risk Map describes effects of works in the area as follows: *‘Land management activities not likely to be affected by acid sulfate soil materials’*.

6.3. Assessment

A geomorphological assessment for PASS was undertaken by a review of available geomorphic mapping and aerial photography (Google Earth and SIX Maps (<https://maps.six.nsw.gov.au/>)) to identify, interpret, and compare features against site geomorphic characteristics (sediment, landscape and vegetation) noted in Tables 2.1 and 4.1 of NASSG 2018a that indicate typical locations of PASS. The typical PASS features and results of review are presented in Table 6.1.

To assess the significance of the PASS, the following field methodology was conducted.

- Laboratory testing was carried out on samples taken from BH3 at depths of 0.6, 1.7 and 2.5 metres below existing ground level.
- Three samples were sent to a NATA accredited laboratory for Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) testing.

We have assumed that there will be little to no bulk excavation carried out on the site other than excavation for piling. STS estimates that <1000m³ of material will be removed for the proposed development.

The laboratory results are summarised in Table 6.3 and 6.4, with the full test results available in Appendix B. The test results were compared to action criteria for 1-1000 tonnes of potential ASS disturbed material, as referenced in NSW Acid Sulfate Soil Management Advisory Committee, Acid Sulfate Soil Manual (ASSMAC,1998) summarised in Table 6.2.

The action criteria trigger needed to prepare an ASSMP and are based on the percentage of oxidisable sulphur (or equivalent TPA and TSA) for broad categories of soil types. Works in soils that exceed these action criteria must prepare a management plan and obtain development consent.

Table 6.1 PASS Features and results of review

Geomorphological Indicator Type	Indicator of ASS	Site Presence of Feature
Sediment characteristics	Sediments of recent geological age (Holocene)	Not observed
	Marine or estuarine sediments	Not observed
	Iron sulfide minerals, former marine or shales and sediments, coal deposits, and mineral sand deposits	Not observed
	Deep estuarine sediments >10m below ground surface, Holocene or Pleistocene age (only if deep excavation or drainage is proposed)	Not observed
	Areas known to contain peat or a build-up of organic material.	No peat observed
Landscape characteristics	Land with elevation less than 5 m AHD	Minimum ground RL onsite is approximately 9 m AHD (from google earth)
	Areas where the highest known water table level is within 3 m of the surface.	Water table not encountered
	Waterlogged or scalded area	Not observed

Geomorphological Indicator Type	Indicator of ASS	Site Presence of Feature
	Tidal lakes	Not observed
	Coastal wetlands or back swamp areas	Not observed
	Interdune swales or coastal sand dunes (if deep excavation or drainage is proposed)	Deep excavation or drainage not proposed
	Any areas (including inland areas) where a combination of all the following factors exist: organic matter, iron minerals, waterlogged conditions or high water table, and sulfidic minerals.	Not observed
Vegetation characteristic	Areas where the dominant vegetation is mangroves, reeds, rushes and other vegetation associated with areas of shallow water tables such as flooded gums (<i>Eucalyptus rudis</i>) (<i>Eucalyptus robusta</i>), paperbarks (<i>Melaleuca</i> spp.) and casuarinas (<i>Casuarina</i> spp.).	Not observed

As only clay soils are encountered in all boreholes, the fine texture (FT) criteria are considered the most appropriate and have been adopted for this assessment.

Table 6.2 – ASS Action Criteria

Type of material		Action Criteria if 1-1000 tonnes ASS disturbed	
Texture Range (McDonald et al 1990)	Approx. clay content (%<0.02mm)	Sulphur Trail %S oxidisable (oven dry basis) eg S _{TOS} or S _{POS}	Acid Trail Mol H ⁺ /tonne (oven dry basis) eg TPA or TSA _s
Coarse Texture (CT) Sands to loamy sands	≥5	0.03	18
Medium Texture (MT) Sandy loams to light clays	5-50	0.06	36
Fine Texture (FT) Medium to heavy clays and silty clays	≥40	0.1	62

Table 6.3 – SPOCAS Test Results Summary for clay soils

Analysis	Unit	LOR	ASS1 BH3 @ 0.6 m	ASS2 BH3 @ 1.7 m	ASS3 BH3 @ 2.5 m	Action Criteria ¹ <1000 tonnes disturbed
pH before Oxidation	NA	0.1	3.9	4.2	4.3	-
pH after Oxidation	NA	0.1	4.3	5.2	5.5	<3 (high risk)
S (POS)	%	0.02	<0.02	<0.02	<0.02	0.1
TPA	Mole/tonne	2	174	62	43	62
TSA	Mole/tonne	2	110	17	13	62

1 = ASSMAC (1998)

Action Criteria Exceeded

Some of the TPA and TSA concentrations exceed the action criteria. However, the S(POS) concentrations indicate the absence of sulphur. Since the site does not meet the criteria for the presence of ASS, the TPA and TPS concentrations recorded are assessed to be due to some other cause than the presence of PASS.

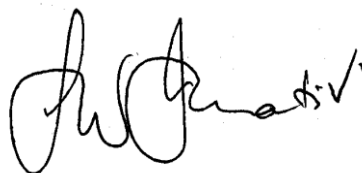
Since there is minimal proposed bulk excavation together with absence of PASS and the fact that dewatering will not be required, an Acid Sulfate Management Plan will not be required.

7. FINAL COMMENTS

During construction, should the subsurface conditions vary from those inferred above, we would be contacted to determine if any changes should be made to our recommendations. The exposed bearing surfaces for footings should be inspected by a geotechnical engineer to ensure the allowable pressure given has been achieved.



Slaiman Shirzai
Geotechnical Engineer
STS Geotechnics Pty Limited



Laurie Ihnativ
Senior Geotechnical Engineer
STS Geotechnics Pty Limited



STS Geotechnics Pty. Ltd.

Scale: Unknown

Date: July 2021

Client: NSW LAND & HOUSING CORPORATION

GEOTECHNICAL INVESTIGATION
6-12 PETERS AVENUE, WALLSEND
BOREHOLE AND PENETROMETER LOCATIONS

Project No.
31248/5224D-G

Drawing No: 21/2033

NOTES RELATING TO GEOTECHNICAL REPORTS

Introduction

These notes have been provided to outline the methodology and limitations inherent in geotechnical reporting. The issues discussed are not relevant to all reports and further advice should be sought if there are any queries regarding any advice or report.

When copies of reports are made, they should be reproduced in full.

Geotechnical Reports

Geotechnical reports are prepared by qualified personnel on the information supplied or obtained and are based on current engineering standards of interpretation and analysis.

Information may be gained from limited subsurface testing, surface observations, previous work and is supplemented by knowledge of the local geology and experience of the range of properties that may be exhibited by the materials present. For this reason, geotechnical reports should be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Where the report has been prepared for a specific purpose (eg. design of a three-storey building), the information and interpretation may not be appropriate if the design is changed (eg. a twenty storey building). In such cases, the report and the sufficiency of the existing work should be reviewed by STS Geotechnics Pty Limited in the light of the new proposal.

Every care is taken with the report content, however, it is not always possible to anticipate or assume responsibility for the following conditions:

- Unexpected variations in ground conditions. The potential for this depends on the amount of investigative work undertaken.
- Changes in policy or interpretation by statutory authorities.
- The actions of contractors responding to commercial pressures.

If these occur, STS Geotechnics Pty Limited would be pleased to resolve the matter through further investigation, analysis or advice.

Unforeseen Conditions

Should conditions encountered on site differ markedly from those anticipated from the information contained in the report, STS

Geotechnics Pty Limited should be notified immediately. Early identification of site anomalies generally results in any problems being more readily resolved and allows re-interpretation and assessment of the implications for future work.

Subsurface Information

Logs of a borehole, recovered core, test pit, excavated face or cone penetration test are an engineering and/or geological interpretation of the subsurface conditions. The reliability of the logged information depends on the drilling/testing method, sampling and/or observation spacings and the ground conditions. It is not always possible or economic to obtain continuous high quality data. It should also be recognised that the volume or material observed or tested is only a fraction of the total subsurface profile.

Interpretation of subsurface information and application to design and construction must take into consideration the spacing of the test locations, the frequency of observations and testing, and the possibility that geological boundaries may vary between observation points.

Groundwater observations and measurements outside of specially designed and constructed piezometers should be treated with care for the following reasons:

- In low permeability soils groundwater may not seep into an excavation or bore in the short time it is left open.
- A localised perched water table may not represent the true water table.
- Groundwater levels vary according to rainfall events or season.
- Some drilling and testing procedures mask or prevent groundwater inflow.

The installation of piezometers and long term monitoring of groundwater levels may be required to adequately identify groundwater conditions.

Supply of Geotechnical Information or Tendering Purposes

It is recommended tenderers are provided with as much geological and geotechnical information that is available and that where there are uncertainties regarding the ground conditions, prospective tenders should be provided with comments discussing the range of likely conditions in addition to the investigation data.

APPENDIX A – BOREHOLE LOGS AND EXPLANATION SHEETS

Client: NSW Land & Housing Corporation		Project / STS No. 31248/5224D-G		BOREHOLE NO.: BH 1		
Project: 6-12 Peters Avenue, Wallsend		Date: July 2, 2021				
Location: Refer to Drawing No. 21/2033		Logged: TS Checked By: SS		Sheet 1 of 1		
W A T E R L E V E	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E
	S1 @ 0.4 m		TOPSOIL: SILTY CLAY: brown, low plasticity	CL	-	M
	U50	0.5	SILTY CLAY: red brown, some light grey, medium to high plasticity, trace of ironstone gravel	CL/CH	STIFF	M
		1.0				
		1.5				
		2.0	SILTY CLAY: pale grey, some orange brown, medium plasticity	CL	VERY STIFF	D-M
		2.5				
			BOREHOLE DISCONTINUED AT 3.0 M			
D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT) S - jar sample				Contractor: STS Equipment: Edson RP70 Hole Diameter (mm): 100 Angle from Vertical (°): 0 Drill Bit: Spiral		
NOTES: See explanation sheets for meaning of all descriptive terms and symbols						

Client: NSW Land & Housing Corporation		Project / STS No. 31248/5224D-G		BOREHOLE NO.: BH 2		
Project: 6-12 Peters Avenue, Wallsend		Date: July 2, 2021				
Location: Refer to Drawing No. 21/2033		Logged: TS Checked By: SS		Sheet 1 of 1		
W A T E R L E	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E
			TOPSOIL: SILTY CLAY: brown, low plasticity	CL	-	M
		0.5	SILTY CLAY: orange brown, some light grey, medium plasticity, trace of gravel	CL	STIFF	M
		1.0	HAND AUGER REFUSAL AT 0.9 M			
		1.5				
		2.0				
		2.5				
D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT) S - jar sample				Contractor: STS Equipment: Hand Auger Hole Diameter (mm): 100		
NOTES: See explanation sheets for meaning of all descriptive terms and symbols				Angle from Vertical (°): 0 Drill Bit: Spiral		

Client: NSW Land & Housing Corporation		Project / STS No. 31248/5224D-G		BOREHOLE NO.: BH 3		
Project: 6-12 Peters Avenue, Wallsend		Date: July 2, 2021				
Location: Refer to Drawing No. 21/2033		Logged: TS Checked By: SS		Sheet 1 of 1		
W A T E R L E V E L	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E
			TOPSOIL: SILTY CLAY: brown, low plasticity	CL	-	M
	ASS1 @ 0.6 m	0.5	SILTY CLAY: orange brown, some light grey, medium plasticity, trace of gravel	CL	STIFF	M
	ASS2 @ 1.7 m	1.5	SILTY CLAY: light grey, some orange brown, medium plasticity	CL	VERY STIFF	D-M
	ASS3 @ 2.5 m	2.5	SILTY CLAY: orange brown, some light grey, medium plasticity, trace of ironstone gravel	CL	VERY STIFF	D-M
			BOREHOLE DISCONTINUED AT 3.0 M			
D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT) S - jar sample				Contractor: STS Equipment: Edson RP70 Hole Diameter (mm): 100 Angle from Vertical (°): 0 Drill Bit: Spiral		
NOTES: See explanation sheets for meaning of all descriptive terms and symbols						

Client: NSW Land & Housing Corporation		Project / STS No. 31248/5224D-G		BOREHOLE NO.: BH 4		
Project: 6-12 Peters Avenue, Wallsend		Date: July 2, 2021				
Location: Refer to Drawing No. 21/2033		Logged: TS Checked By: SS		Sheet 1 of 1		
W A T T A B E R L E	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E
	S4 @ 0.4 m		TOPSOIL: SILTY CLAY: brown, low plasticity	CL	-	M
		0.5	SILTY CLAY: orange brown, some light grey, medium plasticity, trace of gravel	CL	STIFF	M
	U50					
		1.0				
		1.5				
		2.0	SILTY CLAY: light grey, some orange brown, medium plasticity	CL	VERY STIFF	D-M
		2.5				
			BOREHOLE DISCONTINUED AT 3.0 M			
D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT) S - jar sample				Contractor: STS Equipment: Edson RP70 Hole Diameter (mm): 100 Angle from Vertical (°): 0 Drill Bit: Spiral		
NOTES: See explanation sheets for meaning of all descriptive terms and symbols						

Client: NSW Land & Housing Corporation		Project / STS No. 31248/5224D-G		BOREHOLE NO.: BH 5		
Project: 6-12 Peters Avenue, Wallsend		Date: July 2, 2021				
Location: Refer to Drawing No. 21/2033		Logged: TS Checked By: SS		Sheet 1 of 1		
W A T T A E B R L E	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E
	U50		TOPSOIL: SILTY CLAY: brown, low plasticity	CL	-	M
		0.5	SILTY CLAY: orange brown, some light grey, medium plasticity, trace of gravel	CL	STIFF	D-M
		1.0				
		1.5				
		2.0				
		2.5	SILTY CLAY: light grey, some orange brown, medium plasticity	CL	VERY STIFF	D-M
			BOREHOLE DISCONTINUED AT 3.0 M			
D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT) S - jar sample				Contractor: STS Equipment: Edson RP70 Hole Diameter (mm): 100 Angle from Vertical (°): 0 Drill Bit: Spiral		
NOTES: See explanation sheets for meaning of all descriptive terms and symbols						

Form: I1-2

Dynamic Cone Penetrometer Test Report

Project: 6-12 PETERS AVENUE, WALLSEND

Project No.: 31248/5224D-G

Client: NSW LAND & HOUSING CORPORATION

Report No.: 21/2033

Address: 31-39 Macquarie Street, Parramatta

Report Date: 5/07/2021

Test Method: AS 1289.6.3.2

Page: 1 of 1

Site No.	P1	P2	P3	P4	P5	P6
Location	Refer to Drawing No. 21/2033	Refer to Drawing No. 21/2033	Refer to Drawing No. 21/2033	Refer to Drawing No. 21/2033	Refer to Drawing No. 21/2033	Refer to Drawing No. 21/2033
Date Tested	2/7/2021	2/7/2021	2/7/2021	2/7/2021	2/7/2021	2/7/2021
Starting Level	Surface Level	Surface Level	Surface Level	Surface Level	Surface Level	Surface Level
Depth (m)	Penetration Resistance (blows / 150mm)					
0.00 - 0.15	4	2	4	3	4	3
0.15 - 0.30	2	4	3	4	2	2
0.30 - 0.45	2	6	3	4	3	4
0.45 - 0.60	3	6	4	6	4	6
0.60 - 0.75	4	5	4	4	4	5
0.75 - 0.90	3	4	3	5	5	5
0.90 - 1.05	5	6	6	5	6	6
1.05 - 1.20	5	6	6	6	8	8
1.20 - 1.35	6	6	7	8	7	7
1.35 - 1.50	4	5	7	7	7	7
1.50 - 1.65	5	9	8	7	9	6
1.65 - 1.80	5	7	7	9	9	8
1.80 - 1.95	7	8	9	10	10	11
1.95 - 2.10	7	13	10	13	11	14
2.10 - 2.25	8	22/D	13	11	12	22/D
2.25 - 2.40	9		15	10	22/D	
2.40 - 2.55	11		22/D	22/D		
2.55 - 2.70	22/D					
2.70 - 2.85						
2.85 - 3.00						
3.00 - 3.15						
3.15 - 3.30						
3.30 - 3.45						
3.45 - 3.60						
3.60 - 3.75						

Remarks: * Pre drilled prior to testing



Approved Signatory.....

Technician: TS

Orlando Mendoza - Laboratory Manager

E1. CLASSIFICATION OF SOILS

E1.1 Soil Classification and the Unified System

An assessment of the site conditions usually includes an appraisal of the data available by combining values of engineering properties obtained by the site investigation with descriptions, from visual observation of the materials present on site.

The system used by STS Geotechnics Pty Ltd (STS) in the identification of soil is the Unified Soil Classification system (USC) which was developed by the US Army Corps of Engineers during World War II and has since gained international acceptance and has been adopted in its metricated form by the Standards Association of Australia.

The Australian Site Investigation Code (AS1726-1981, Appendix D) recommends that the description of a soil includes the USC group symbols which are an integral component of the system.

The soil description should contain the following information in order:

Soil composition

- SOIL NAME and USC classification symbol (IN BLOCK LETTERS)
- plasticity or particle characteristics
- colour
- secondary and minor constituents (name estimated proportion, plasticity or particle characteristics, colour)

Soil condition

- moisture condition
- consistency or density index

Soil structure

- structure (zoning, defects, cementing)

Soil origin

interpretation based on observation eg FILL, TOPSOIL, RESIDUAL, ALLUVIUM.

E1.2 Soil Composition

- (a) Soil Name and Classification Symbol

The USC system is summarised in Figure E1.2.1. The primary division separates soil types on the basis of particle size into:

- Coarse grained soils - more than 50% of the material less than 60 mm is larger than 0.06 mm (60 µm).
- Fine grained soils - more than 50% of the material less than 60 mm is smaller than 0.06 mm (60 µm).

Initial classification is by particle size as shown in Table E1.2.1. Further classification of fine grained soils is based on plasticity.

TABLE E1.2.1 - CLASSIFICATION BY PARTICLE SIZE

NAME	SUB-DIVISION	SIZE
Clay (1)		< 2 µm
Silt (2)		2 µm to 60 µm
Sand	Fine Medium Coarse	60 µm to 200 µm 200 µm to 600 µm 600 µm to 2 mm
Gravel (3)	Fine Medium Coarse	2 mm to 6 mm 6 mm to 20 mm 20 mm to 60 mm
Cobbles (3)		60 mm to 200 mm
Boulders (3)		> 200 mm

Where a soil contains an appropriate amount of secondary material, the name includes each of the secondary components (greater than 12%) in increasing order of significance, eg sandy silty clay.

Minor components of a soil are included in the description by means of the terms “some” and “trace” as defined in Table E1.2.2.

TABLE E1.2.2 - MINOR SOIL COMPONENTS

TERM	DESCRIPTION	APPROXIMATE PROPORTION (%)
Trace	presence just detectable, little or no influence on soil properties	0-5
Some	presence easily detectable, little influence on soil properties	5-12

The USC group symbols should be included with each soil description as shown in Table E1.2.3

TABLE E1.2.3 - SOIL GROUP SYMBOLS

SOIL TYPE	PREFIX
Gravel	G
Sand	S
Silt	M
Clay	C
Organic	O
Peat	Pt

The group symbols are combined with qualifiers which indicate grading, plasticity or secondary components as shown on Table E1.2.4

TABLE E1.2.4 - SOIL GROUP QUALIFIERS

SUBGROUP	SUFFIX
Well graded	W
Poorly Graded	P
Silty	M
Clayey	C
Liquid Limit <50% - low to medium plasticity	L
Liquid Limit >50% - medium to high plasticity	H

(b) Grading

“Well graded”	Good representation of all particle sizes from the largest to the smallest.
“Poorly graded”	One or more intermediate sizes poorly represented
“Gap graded”	One or more intermediate sizes absent
“Uniformly graded”	Essentially single size material.

(c) Particle shape and texture

The shape and surface texture of the coarse grained particles should be described.

Angularity may be expressed as “rounded”, “sub-rounded”, “sub-angular” or “angular”.

Particle **form** can be “equidimensional”, “flat” or “elongate”.

Surface texture can be “glassy”, “smooth”, “rough”, “pitted” or “striated”.

(d) Colour

The colour of the soil should be described in the moist condition using simple terms such as:

Black	White	Grey	Red
Brown	Orange	Yellow	Green
Blue			

These may be modified as necessary by “light” or “dark”. Borderline colours may be described as a combination of two colours, eg red-brown.

For soils that contain more than one colour terms such as:

- Speckled Very small (<10 mm dia) patches
- Mottled Irregular
- Blotched Large irregular (>75 mm dia)
- Streaked Randomly oriented streaks

(e) Minor Components

Secondary and minor components should be individually described in a similar manner to the dominant component.

E1.3 Soil Condition

(a) Moisture

Soil moisture condition is described as “dry”, “moist” or “wet”.

The moisture categories are defined as:

Dry (D) - Little or no moisture evident. Soils are running. Moist (M) - Darkened in colour with cool feel. Granular soil particles tend to adhere. No free water evident upon remoulding of cohesive soils.

In addition the moisture content of cohesive soils can be estimated in relation to their liquid or plastic limit.

(b) Consistency

Estimates of the consistency of a clay or silt soil may be made from manual examination, hand penetrometer test, SPT results or from laboratory tests to determine undrained shear or unconfined compressive strengths. The classification of consistency is defined in Table E1.3.1.

TABLE E1.3.1 - CONSISTENCY OF FINE-GRAINED SOILS

TERM	UNCONFINED STRENGTH (kPa)	FIELD IDENTIFICATION
Very Soft	<25	Easily penetrated by fist. Sample exudes between fingers when squeezed in the fist.
Soft	25 - 50	Easily moulded in fingers. Easily penetrated 50 mm by thumb.
Firm	50 - 100	Can be moulded by strong pressure in the fingers. Penetrated only with great effort.
Stiff	100 - 200	Cannot be moulded in fingers. Indented by thumb but penetrated only with great effort.
Very Stiff	200 - 400	Very tough. Difficult to cut with knife. Readily indented with thumb nail.
Hard	>400	Brittle, can just be scratched with thumb nail. Tends to break into fragments.

Unconfined compressive strength as derived by a hand penetrometer can be taken as approximately double the undrained shear strength ($q_u = 2 c_u$).

(c) Density Index

The insitu density index of granular soils can be assessed from the results of SPT or cone penetrometer tests. Density index should not be estimated visually.

TABLE E1.3.2 - DENSITY OF GRANULAR SOILS

TERM	SPT N VALUE	STATIC CONE VALUE q_c (MPa)	DENSITY INDEX (%)
Very Loose	0 - 3	0 - 2	0 - 15
Loose	3 - 8	2 - 5	15 - 35
Medium Dense	8 - 25	5 - 15	35 - 65
Dense	25 - 42	15 - 20	65 - 85
Very Dense	>42	>20	>85

E1.4 Soil Structure

(a) Zoning

A sample may consist of several zones differing in colour, grain size or other properties. Terms to classify these zones are:

Layer - continuous across exposure or sample

Lens - discontinuous with lenticular shape

Pocket - irregular inclusion

Each zone should be described, their distinguishing features, and the nature of the interzone boundaries.

(b) Defects

Defects which are present in the sample can include:

- fissures
- roots (containing organic matter)
- tubes (hollow)
- casts (infilled)

Defects should be described giving details of dimensions and frequency. Fissure orientation, planarity, surface condition and infilling should be noted. If there is a tendency to break into blocks, block dimensions should be recorded

E1.5 Soil Origin

Information which may be interpretative but which may contribute to the usefulness of the material description should be included. The most common interpreted feature is the origin of the soil. The assessment of the probable origin is based on the soil material description, soil structure and its relationship to other soil and rock materials.

Common terms used are:

“Residual Soil” - Material which appears to have been derived by weathering from the underlying rock. There is no evidence of transport.

“Colluvium” - Material which appears to have been transported from its original location. The method of movement is usually the combination of gravity and erosion.

“Landslide Debris” - An extreme form of colluvium where the soil has been transported by mass movement. The material is obviously distributed and contains distinct defects related to the slope failure.

“Alluvium” - Material which has been transported essentially by water. usually associated with former stream activity.

“Fill” - Material which has been transported and placed by man. This can range from natural soils which have been

placed in a controlled manner in engineering construction to dumped waste material. A description of the constituents should include an assessment of the method of placement.

E1.6 Fine Grained Soils

The physical properties of fine grained soils are dominated by silts and clays.

The definition of clay and silt soils is governed by their Atterberg Limits. Clay soils are characterised by the properties of cohesion and plasticity with cohesion defines as the ability to deform without rupture. Silts exhibit cohesion but have low plasticity or are non-plastic.

The field characteristics of clay soils include:

- dry lumps have appreciable dry strength and cannot be powdered
- volume changes occur with moisture content variation
- feels smooth when moist with a greasy appearance when cut.

The field characteristics of silt soils include:

- dry lumps have negligible dry strength and can be powdered easily
- dilatancy - an increase in volume due to shearing - is indicated by the presence of a shiny film of water after a hand sample is shaken. The water disappears upon remoulding. Very fine grained sands may also exhibit dilatancy.
- low plasticity index
- feels gritty to the teeth

E1.7 Organic Soils

Organic soils are distinguished from other soils by their appreciable content of vegetable matter, usually derived from plant remains.

The soil usually has a distinctive smell and low bulk density.

The USC system uses the symbol Pt for partly decomposed organic material. The O symbol is combined with suffixes “O” or “H” depending on plasticity.

Where roots or root fibres are present their frequency and the depth to which they are encountered should be recorded. The presence of roots or root fibres does not necessarily mean the material is an “organic material” by classification.

Coal and lignite should be described as such and not simply as organic matter.

APPENDIX B – LABORATORY TEST RESULTS

Shrink Swell Index Report

Project: 6-12 PETERS AVENUE, WALLSEND

Client: **NSW LAND & HOUSING CORPORATION**

Address: 31-39 Macquarie Street, Parramatta

Test Method: AS1289.7.1.1

Project No.: 31248

Report No.: 21/2066

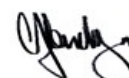
Report Date: 8/07/2021

Page: 1 OF 1

Sampling Procedure: AS 1289.1.3.1 Clause 3.1.3.2 - Thin Walled Sampler

STS / Sample No.		5224D-L/1	5224D-L/2	5224D-L/3			
Sample Location		Borehole 1 Refer to Drawing No. 21/2033	Borehole 4 Refer to Drawing No. 21/2033	Borehole 5 Refer to Drawing No. 21/2033			
Material Description		Silty Clay, orange/red grey/yellow brown	Silty Clay, orange grey	Silty Clay, orange grey			
Depth (m)		0.6 - 0.8	0.7 - 0.9	0.5 - 0.7			
Sample Date		2/07/2021	2/07/2021	2/07/2021			
Shrink	Moisture Content (%)	31.9	31.7	35.4			
	Soil Crumbling	Nil	Nil	Nil			
	Extent of Cracking	Open Cracks	Nil	Nil			
	Strain (%)	4.2	7.0	7.8			
Swell	Moisture Content Initial (%)	33.6	25.3	29.9			
	Moisture Content Final (%)	36.3	28.9	30.5			
	Strain (%)	1.4	5.0	0.8			
Inert Inclusions (%)		<10	<10	<10			
Shrink Swell Index (%)		2.7	5.3	4.6			

Remarks:



Approved Signatory.....

Technician: DH

Orlando Mendoza - Laboratory Manager

CERTIFICATE OF ANALYSIS

Work Order : **ES2124669**
Client : **STS Geotechnics**
Contact : **ENQUIRES STS**
Address : Unit 14/1 Cowpasture Place
 Wetherill Park 2164
Telephone : ----
Project : 31248/5224D-R
Order number : E-2021-0230
C-O-C number : ----
Sampler : ----
Site : ----
Quote number : EN/222
No. of samples received : 6
No. of samples analysed : 6

Page : 1 of 6
Laboratory : Environmental Division Sydney
Contact : Customer Services ES
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone : +61-2-8784 8555
Date Samples Received : 05-Jul-2021 12:35
Date Analysis Commenced : 08-Jul-2021
Issue Date : 13-Jul-2021 17:39



Accreditation No. 825
 Accredited for compliance with
 ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW



General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

Ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- ED045G: LOR raised for Chloride on samples 1 and 2 due to sample matrix.
- ASS: EA029 (SPOCAS): Excess ANC not required because pH OX less than 6.5.
- ASS: EA029 (SPOCAS): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO₃) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from kg/t dry weight to kg/m³ in-situ soil, multiply reported results x wet bulk density of soil in t/m³.

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	31248/S1	31248/S2	31248/S3	31248/ASS1	31248/ASS2
Sampling date / time				02-Jul-2021 00:00	02-Jul-2021 00:00	02-Jul-2021 00:00	02-Jul-2021 00:00	02-Jul-2021 00:00	
Compound	CAS Number	LOR	Unit	ES2124669-001	ES2124669-002	ES2124669-003	ES2124669-004	ES2124669-005	
				Result	Result	Result	Result	Result	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	6.4	6.9	6.2	----	----	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	46	51	32	----	----	
EA029-A: pH Measurements									
pH KCl (23A)	----	0.1	pH Unit	----	----	----	3.9	4.2	
pH OX (23B)	----	0.1	pH Unit	----	----	----	4.3	5.2	
EA029-B: Acidity Trail									
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	64	45	
Titrateable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	174	62	
Titrateable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	110	17	
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.020	% pyrite S	----	----	----	0.103	0.072	
sulfidic - Titrateable Peroxide Acidity (s-23G)	----	0.020	% pyrite S	----	----	----	0.279	0.099	
sulfidic - Titrateable Sulfidic Acidity (s-23H)	----	0.020	% pyrite S	----	----	----	0.176	0.027	
EA029-C: Sulfur Trail									
KCl Extractable Sulfur (23Ce)	----	0.020	% S	----	----	----	<0.020	<0.020	
Peroxide Sulfur (23De)	----	0.020	% S	----	----	----	<0.020	<0.020	
Peroxide Oxidisable Sulfur (23E)	----	0.020	% S	----	----	----	<0.020	<0.020	
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	----	----	<10	<10	
EA029-D: Calcium Values									
KCl Extractable Calcium (23Vh)	----	0.020	% Ca	----	----	----	0.027	<0.020	
Peroxide Calcium (23Wh)	----	0.020	% Ca	----	----	----	0.027	<0.020	
Acid Reacted Calcium (23X)	----	0.020	% Ca	----	----	----	<0.020	<0.020	
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	----	----	<10	<10	
sulfidic - Acid Reacted Calcium (s-23X)	----	0.020	% S	----	----	----	<0.020	<0.020	
EA029-E: Magnesium Values									
KCl Extractable Magnesium (23Sm)	----	0.020	% Mg	----	----	----	0.069	0.102	
Peroxide Magnesium (23Tm)	----	0.020	% Mg	----	----	----	0.069	0.102	
Acid Reacted Magnesium (23U)	----	0.020	% Mg	----	----	----	<0.020	<0.020	
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	----	----	<10	<10	
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.020	% S	----	----	----	<0.020	<0.020	
EA029-G: Retained Acidity									



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	31248/S1	31248/S2	31248/S3	31248/ASS1	31248/ASS2
Sampling date / time					02-Jul-2021 00:00	02-Jul-2021 00:00	02-Jul-2021 00:00	02-Jul-2021 00:00	02-Jul-2021 00:00
Compound	CAS Number	LOR	Unit		ES2124669-001	ES2124669-002	ES2124669-003	ES2124669-004	ES2124669-005
				Result	Result	Result	Result	Result	Result
EA029-G: Retained Acidity - Continued									
HCl Extractable Sulfur (20Be)	----	0.020	% S	----	----	----	----	<0.020	<0.020
Net Acid Soluble Sulfur (20Je)	----	0.020	% S	----	----	----	----	<0.020	<0.020
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	----	----	----	<10	<10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.020	% pyrite S	----	----	----	----	<0.020	<0.020
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-	----	----	----	----	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	----	0.10	0.07
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	----	64	45
Liming Rate	----	1	kg CaCO3/t	----	----	----	----	5	3
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	----	----	0.10	0.07
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	----	----	64	45
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	----	----	5	3
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%	20.8	21.1	21.7	----	----	----
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg	10	20	20	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg	<50	<50	80	----	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)		Sample ID		31248/ASS3	----	----	----	----
		Sampling date / time		02-Jul-2021 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	ES2124669-006	-----	-----	-----	-----
				Result	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	4.3	----	----	----	----
pH OX (23B)	----	0.1	pH Unit	5.5	----	----	----	----
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	30	----	----	----	----
Titrateable Peroxide Acidity (23G)	----	2	mole H+ / t	43	----	----	----	----
Titrateable Sulfidic Acidity (23H)	----	2	mole H+ / t	13	----	----	----	----
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.020	% pyrite S	0.048	----	----	----	----
sulfidic - Titrateable Peroxide Acidity (s-23G)	----	0.020	% pyrite S	0.069	----	----	----	----
sulfidic - Titrateable Sulfidic Acidity (s-23H)	----	0.020	% pyrite S	0.020	----	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.020	% S	<0.020	----	----	----	----
Peroxide Sulfur (23De)	----	0.020	% S	<0.020	----	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.020	% S	<0.020	----	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	----	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.020	% Ca	<0.020	----	----	----	----
Peroxide Calcium (23Wh)	----	0.020	% Ca	<0.020	----	----	----	----
Acid Reacted Calcium (23X)	----	0.020	% Ca	<0.020	----	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	----	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.020	% S	<0.020	----	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.020	% Mg	0.110	----	----	----	----
Peroxide Magnesium (23Tm)	----	0.020	% Mg	0.110	----	----	----	----
Acid Reacted Magnesium (23U)	----	0.020	% Mg	<0.020	----	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	----	----	----	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.020	% S	<0.020	----	----	----	----
EA029-G: Retained Acidity								
HCl Extractable Sulfur (20Be)	----	0.020	% S	<0.020	----	----	----	----
Net Acid Soluble Sulfur (20Je)	----	0.020	% S	<0.020	----	----	----	----
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	----	----	----	----
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.020	% pyrite S	<0.020	----	----	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	31248/ASS3	----	----	----	----
			Sampling date / time	02-Jul-2021 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	ES2124669-006	-----	-----	-----	-----
				Result	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	0.05	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	30	----	----	----	----
Liming Rate	----	1	kg CaCO3/t	2	----	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.05	----	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	30	----	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	2	----	----	----	----

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(SOIL) EA029-D: Calcium Values

(SOIL) EA029-E: Magnesium Values

(SOIL) EA029-F: Excess Acid Neutralising Capacity

(SOIL) EA029-H: Acid Base Accounting

(SOIL) EA029-G: Retained Acidity

(SOIL) EA029-A: pH Measurements

(SOIL) EA029-C: Sulfur Trail

(SOIL) EA029-B: Acidity Trail