GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

GEOTECHNICAL INVESTIGATION AND ACID SULFATE SOIL ASSESSMENT

FOR

NSW LAND AND HOUSING CORPORATION

97-99 Punchbowl Road, Belfield, New South Wales (BGXU6)

Report No: 21/1264

Project No: 31117/4984D-G

May 2021

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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 97 to 99 Punchbowl Road, Belfield, New South Wales. At the time of writing this report STS were not provided with architectural drawings for the project. The report assumes that the development will typically comprise the construction of single and double storey residential buildings with no basements. Reference to the Strathfield 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,
- Site Classification according to AS2870 (soil reactivity),
- Foundation design parameters including foundation options,
- Exposure classification/soil aggressiveness according to AS2870,
- Foundation design parameters including foundation options,
- Acid Sulphate Soils assessment and need for an Acid Sulphate Management Plan

The investigation was undertaken at the request of Nikola Ristevski via E-mail correspondence on April 1, 2021.

Our scope of work did not include a contamination assessment.

2. NATURE OF THE INVESTIGATION

2.1. Fieldwork

The fieldwork consisted of drilling four (4) boreholes numbered BH1 to BH4 (inclusive), at the locations shown on attached Drawing No. 21/1264**.** Except for BH3, the boreholes were drilled using our track mounted mini Christie rig, owned and operated by STS. ***Because there was no access for the drilling rig, BH3 was drilled using a hand auger.*** Soils 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.

Samples were collected from the boreholes for subsequent laboratory testing.

2.2. Laboratory Testing

In order 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 (SO_4),
- Chloride (Cl)
- Electrical Conductivity (EC), and
- Acid Sulphate Testing (SPOCAS).

Detailed test reports are given in Appendix B.

3. GEOLOGY AND SITE CONDITIONS

The Sydney Geological map at a scale of 1:100,000 shows the site is underlain by Triassic Age Ashfield Shale of the Wianamatta Group. Rocks within this formation comprise shale and laminite.

The site is irregular in shape with an approximate area of 1,132 m^2. 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 falls about 0.5 metres to the north-west.

The site is on the northern corner of the intersection of Punchbowl road and Cecily Street, Belfield. Residential dwellings are on the north western and north eastern sides of the site.

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 and weathered shale. The topsoil is present to depths of 0.3 to 0.4 metres. Stiff becoming very stiff silty clays underlie the topsoil to depths of 1.3 to 1.4 metres. **In BH3, hand auger refusal occurred at a depth of 0.6 metres.** Weathered shale underlies these soils to the depth of auger refusal, 1.7 to 1.85 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.

In order to assist with determining the site classification, two 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, yellow and grey silty clay	3.9
BH4	0.7-0.84	Yellow grey and red silty clay	2.7

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 (H1).*

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

Pad and/or strip footings founded in firm to stiff soils, may be proportioned using an allowable bearing pressure of 100 kPa. The minimum depth of founding must comply with the requirements of AS2870. In order 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. Tree information is attached.

If a higher load carrying capacity is required, piles can be used to transfer the loads to the underlying materials. Piles founded in the very stiff materials may be proportioned using an allowable end bearing pressure of 450 kPa, provided their depth to diameter ratio exceeds a value of 4. An allowable adhesion value of 20 kPa may be adopted below a depth of 0.5 metres. Piles founded in the weathered shale may be proportioned using an allowable end bearing pressure of 700 kPa and an adhesion value of 70 kPa. When piles bear in weathered rock, adhesion in the overlying soils must be ignored.

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	0.3	5.1	20	30	0.058	0.5
S2	BH4	0.4	5.2	40	20	0.061	0.5

The soils on the site consist of sands above and below the ground water table. Therefore, soil conditions A are considered appropriate.

A review of the durability aspects indicates that:

- pH : minimum value of 5.1
- SO_4 : maximum value of 30 mg/kg (ppm) < 5000 ppm
- Cl : maximum value of 40 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 mildly aggressive to concrete and non-aggressive to steel. In accordance with AS2870-2011, the soils are classified as A2.

Reference to DLWC (2002) "Site Investigations for Urban Salinity" indicates that an ECe value of 0.5 dS/m is 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 Strathfield Local Environment Plan (LEP) indicates he site is in an area classified as Class 5 with respect to ASS.

Reference to the Botany Bay (9130S3) 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.

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

Geomorphological Indicator Type	Indicator of ASS	Site Presence of Feature
	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 20 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
	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 (Eucalyptus rudis) (Eucalyptus robusta), paperbarks (Melaleucaspp.) and casuarinas (Casuarina spp.).	Not observed

In order to assess the significance of the PASS, the following field methodology was conducted;

- Drilling of four boreholes, BH1 to BH4 (inclusive), to a maximum depth of 1.85 metres below existing ground level (approximately RL 18.0 m AHD);
- Sampling for laboratory analyses was carried out in BH2 and BH3 at depths of 0.5 and 1.0 metre 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. Due to the subsurface conditions present on site, we assume that the development will be founded on piles. STS estimates that <1000m^3 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.

As only clayey soils were 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 Sand Soils

Analysis	Unit	LOR	ASS1 BH1 @ 0.5 m	ASS2 BH1 @ 1.0 m	ASS3 BH4 @ 0.4 m	Action Criteria[1] <1000 tonnes disturbed
pH before Oxidation	NA	0.1	4.3	4.2	4.2	-
pH after Oxidation	NA	0.1	4.2	4.7	4.5	<3 (high risk)
S (POS)	%	0.02	<0.02	<0.02	<0.02	0.1
TPA	Mole/tonne	2	192	151	181	62
TSA	Mole/tonne	2	79	34	47	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.

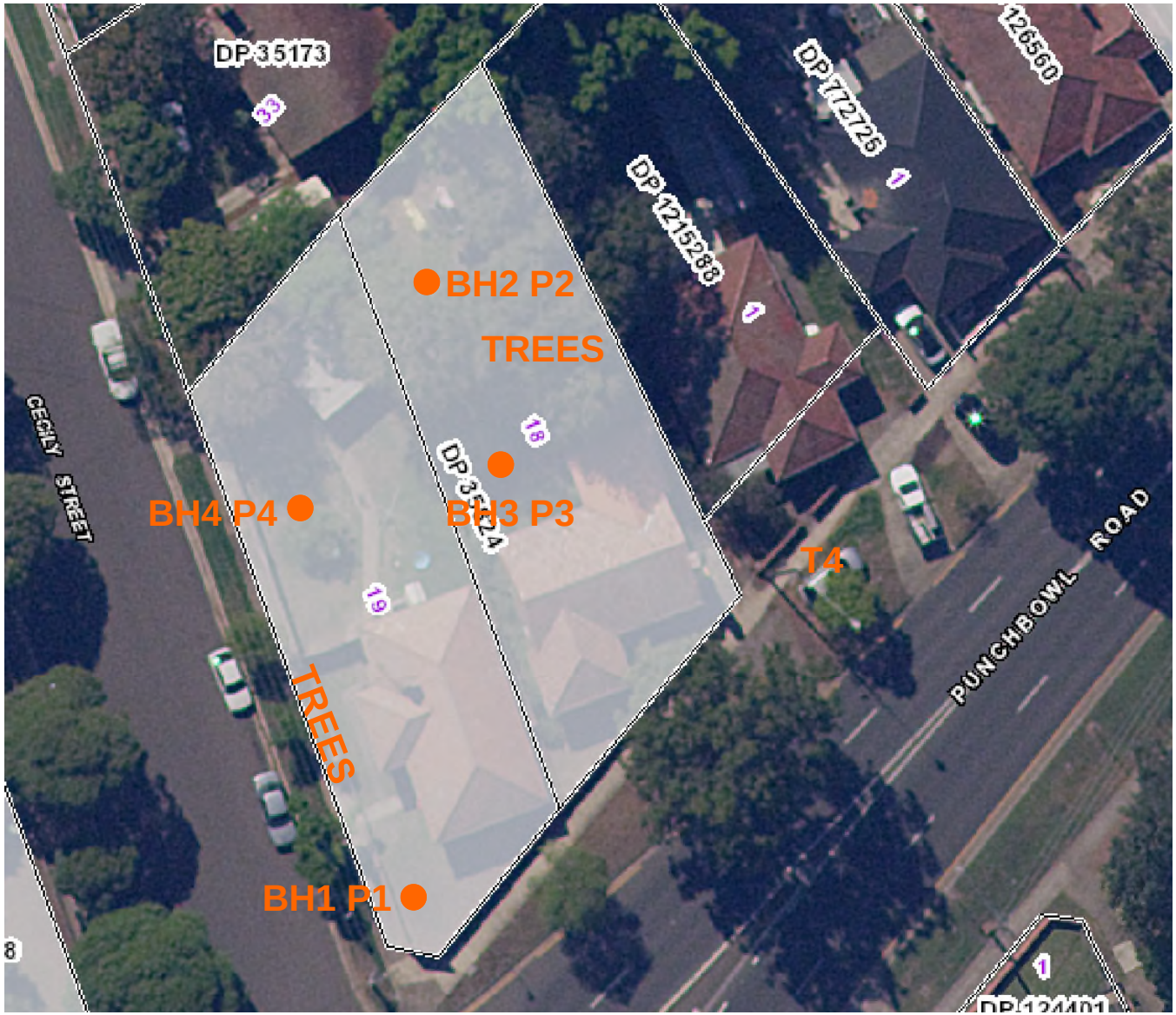
Since there is minimal proposed bulk excavation together with absence of PASS and the fact that dewatering will not be required, an Acid Sulfate Management Plan will not be required.

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.

Laurie Ihnativ
Senior Geotechnical Engineer
STS Geotechnics Pty Limited



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STS Geotechnics Pty. Ltd.	Scale: Unknown	Date: April 2021
Client: NSW LAND & HOUSING CORPORATION		
GEOTECHNICAL INVESTIGATION **97-99 PUNCHBOWL ROAD, BELFIELD** **BOREHOLE AND PENETROMETER LOCATIONS**	Project No. 31117/4984D-G	Drawing No: 21/1264

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Tree Heights and Type

Project: 97-99 Punchbowl Road, Belfield — Project No. / STS No.: 31117/4984D-G

Client: NSW Land & Housing Corporation — Technician: TS

Tree No.	Canopy Radius (m)	Distance from Tree Along Ground (m)	Uphill / Level / Downhill	Height of Tree (m)	Native (Y / N)	Growing/Mature
TREES	5 - 8			12 - 14	Y	M
T4	2			3	N	M
TREES	2 - 6			3 - 12	Y	M

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

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: NSW Land & Housing Corporation	Project: 31117/4984D-G	**BOREHOLE NO.: BH 1**
Project: 97-99 Punchbowl Road, Belfield	Date : April 19, 2021	Sheet 1 of 1
Location: Refer to Drawing No. 21/1264	Logged: TS Checked By: LWI	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S1 @ 0.3 m		TOPSOIL; SILTY CLAY: brown, low plasticity	CL	STIFF TO VERY STIFF	M
	ASS1 @ 0.5 m U50 0.6-0.75 m	0.5	SILTY CLAY: red brown with some grey, medium plasticity, trace of ironstone gravel	CL	STIFF TO VERY STIFF VERY STIFF	M
	ASS2 @ 1.0 m	1.0	SILTY CLAY: light grey with some orange brown, medium plasticity	CL	VERY STIFF	D-M
		1.5	WEATHERED SHALE: grey/brown		EXTREMELY LOW STRENGTH	D
		2.0	AUGER REFUSAL AT 1.7 M ON WEATHERED SHALE			
		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

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS

Equipment: Mini Christie

Hole Diameter (mm): 100

Angle from Vertical (°):

Drill Bit: Spiral

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: NSW Land & Housing Corporation	Project: 31117/4984D-G	**BOREHOLE NO.: BH 2**
Project: 97-99 Punchbowl Road, Belfield	Date : April 19, 2021	Sheet 1 of 1
Location: Refer to Drawing No. 21/1264	Logged: TS Checked By: LWI	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL: SILTY CLAY: brown, low plasticity	CL	STIFF	M
		0.5	SILTY CLAY: red brown with some grey, medium plasticity, trace of ironstone gravel	CL	STIFF VERY STIFF	M
		1.0	SILTY CLAY: light grey with some orange brown, medium plasticity	CL	VERY STIFF	M
		1.5	WEATHERED SHALE: grey/brown		EXTREMELY LOW STRENGTH	D
		2.0	AUGER REFUSAL AT 1.85 M ON WEATHERED SHALE			
		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

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS

Equipment: Mini Christie

Hole Diameter (mm): 100

Angle from Vertical (°):

Drill Bit: Spiral

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: NSW Land & Housing Corporation	Project: 31117/4984D-G	**BOREHOLE NO.: BH 3**
Project: 97-99 Punchbowl Road, Belfield	Date : April 19, 2021	
Location: Refer to Drawing No. 21/1264	Logged: TS Checked By: LWI	Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL: SILTY CLAY: brown, low plasticity	CL	STIFF TO VERY STIFF	M
		0.5	SILTY CLAY: red brown with some grey, medium plasticity, trace of ironstone gravel	CL	STIFF TO VERY STIFF	D-M
			HAND AUGER REFUSAL AT 0.6 M		VERY STIFF	
		1.0				
		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

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS

Equipment: Hand Auger

Hole Diameter (mm): 100

Angle from Vertical (°):

Drill Bit: Spiral

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GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: NSW Land & Housing Corporation	Project: 31117/4984D-G	**BOREHOLE NO.: BH 4**
Project: 97-99 Punchbowl Road, Belfield	Date : April 19, 2021	Sheet 1 of 1
Location: Refer to Drawing No. 21/1264	Logged: TS Checked By: LWI	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL: SILTY CLAY: brown, low plasticity	CL	FIRM TO STIFF	M
	S2 @ 0.4 m ASS3 @ 0.4 m U50 0.7-0.84 m	0.5	SILTY CLAY: red brown with some grey, medium plasticity	CL	VERY STIFF	M
		1.0	SILTY CLAY: light grey with some orange brown, medium plasticity	CL	VERY STIFF	D-M
		1.5	WEATHERED SHALE: grey		EXTREMELY LOW STRENGTH	D
		2.0	AUGER REFUSAL AT 1.7 M ON WEATHERES SHALE			
		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: Mini Christie

Hole Diameter (mm): 100

Angle from Vertical (°):

Drill Bit: Spiral

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

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Dynamic Cone Penetrometer Test Report

Project: 97-99 PUNCHBOWL ROAD, BELFIELD
Client: NSW LAND & HOUSING CORPORATION
Address: 31-39 Macquarie Street, Parramatta
Test Method: AS 1289.6.3.2

Project No.: 31117/4984D-G
Report No.: 21/1264
Report Date: 23/04/2021
Page: 1 of 1

NATA
Accredited for compliance with ISO/IEC 17025 - Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards
NATA Accreditation Number 2750

Site No.	P1	P2	P3	P4		
Location	Refer to Drawing No. 21/1264	Refer to Drawing No. 21/1264	Refer to Drawing No. 21/1264	Refer to Drawing No. 21/1264		
Date Tested	19/4/2021	19/4/2021	19/4/2021	19/4/2021		
Starting Level	Surface Level	Surface Level	Surface Level	Surface Level		
Depth (m)	Penetration Resistance (blows / 150mm)					
0.00 - 0.15	6	4	5	4		
0.15 - 0.30	8	5	5	3		
0.30 - 0.45	7	5	6	8		
0.45 - 0.60	7	6	8	8		
0.60 - 0.75	6	7	8	8		
0.75 - 0.90	9	7	7	6		
0.90 - 1.05	11	8	9	8		
1.05 - 1.20	10	7	11	10		
1.20 - 1.35	22	12	22	22		
1.35 - 1.50	Refusal	22	Refusal	Refusal		
1.50 - 1.65		Refusal				
1.65 - 1.80						
1.80 - 1.95						
1.95 - 2.10						
2.10 - 2.25						
2.25 - 2.40						
2.40 - 2.55						
2.55 - 2.70						
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 **S**oil 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 indicted 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

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

Shrink Swell Index Report

Project: 97 PUNCHBOWL ROAD, BELFIELD — Project No.: 31117
Client: NSW LAND & HOUSING CORPORATION — Report No.: 21/1238
Address: Level 2, 31-39 Macquarie Street, Parramatta 2150 — Report Date: 22/04/2021
Test Method: AS1289.7.1.1 — Page: 1 OF 1

Sampling Procedure: AS 1289.1.3.1 Clause 3.1.3.2 - Thin Walled Sampler

STS / Sample No.		4984D-L/1					
Sample Location		Borehole 1 Refer to Drawing					
Material Description		Silty Gravelly Clay, red/yellow/grey					
Depth (m)		0.6 - 0.75					
Sample Date		16/04/2021					
Shrink	Moisture Content (%)	28.0					
	Soil Crumbling	Nil					
	Extent of Cracking	Fine Cracks					
	Strain (%)	4.7					
Swell	Moisture Content Initial (%)	29.1					
	Moisture Content Final (%)	33.8					
	Strain (%)	4.8					
Inert Inclusions (%)		<20					
Shrink Swell Index (%)		**3.9**					

Remarks:

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards
NATA Accreditation Number 2750

Approved Signatory.....

Technician: DH

Orlando Mendoza - Laboratory Manager

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

Shrink Swell Index Report

Project: 99 PUNCHBOWL ROAD, BELFIELD — Project No.: 31117
Client: NSW LAND & HOUSING CORPORATION — Report No.: 21/1239
Address: Level 2, 31-39 Macquarie Street, Parramatta 2150 — Report Date: 22/04/2021
Test Method: AS1289.7.1.1 — Page: 1 OF 1

Sampling Procedure: AS 1289.1.3.1 Clause 3.1.3.2 - Thin Walled Sampler

STS / Sample No.		4984D-L/1					
Sample Location		Borehole 4 Refer to Drawing					
Material Description		Silty Clay, yellow/grey/red , trace gravel					
Depth (m)		0.7 - 0.84					
Sample Date		19/04/2021					
Shrink	Moisture Content (%)	26.3					
	Soil Crumbling	Nil					
	Extent of Cracking	Fine Cracks					
	Strain (%)	4.2					
Swell	Moisture Content Initial (%)	24.7					
	Moisture Content Final (%)	26.3					
	Strain (%)	1.4					
Inert Inclusions (%)		<5					
Shrink Swell Index (%)		**2.7**					

Remarks:

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards
NATA Accreditation Number 2750

Approved Signatory.....

Technician: DH

Orlando Mendoza - Laboratory Manager

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2114549**	Page	: 1 of 6
Client	: **STS Geotechnics**	Laboratory	: Environmental Division Sydney
Contact	: ENQUIRES STS	Contact	: Customer Services ES
Address	: Unit 14/1 Cowpasture Place Wetherill Park 2164	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 31116/31117	Date Samples Received	: 20-Apr-2021 14:45
Order number	: E-2021-0128	Date Analysis Commenced	: 26-Apr-2021
C-O-C number	: ----	Issue Date	: 30-Apr-2021 11:39
Sampler	: ----		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 10		
No. of samples analysed	: 10		

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
Franco Lentini	LCMS Coordinator	Sydney Inorganics, Smithfield, NSW
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.

- 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 ($CaCO_3$) 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.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	31116/S1	31116/S2	31116/ASS/BH1/1.0	31116/ASS/BH3/0.5	31116/ASS/BH3/1.0
			Sampling date / time	19-Apr-2021 00:00	19-Apr-2021 00:00	19-Apr-2021 00:00	19-Apr-2021 00:00	19-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	ES2114549-001	ES2114549-002	ES2114549-003	ES2114549-004	ES2114549-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.4	5.2	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	29	48	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	4.1	4.4	4.3
pH OX (23B)	----	0.1	pH Unit	----	----	4.2	4.3	4.0
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	140	77	115
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	205	143	198
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	65	66	83
sulfidic - Titratable Actual Acidity (s-23F)	----	0.020	% pyrite S	----	----	0.224	0.123	0.185
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.020	% pyrite S	----	----	0.329	0.230	0.318
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.020	% pyrite S	----	----	0.105	0.107	0.132
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.020	% S	----	----	<0.020	<0.020	0.027
Peroxide Sulfur (23De)	----	0.020	% S	----	----	<0.020	0.020	0.040
Peroxide Oxidisable Sulfur (23E)	----	0.020	% S	----	----	<0.020	<0.020	<0.020
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	----	<10	<10	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.020	% Ca	----	----	0.081	0.074	0.092
Peroxide Calcium (23Wh)	----	0.020	% Ca	----	----	0.083	0.069	0.091
Acid Reacted Calcium (23X)	----	0.020	% Ca	----	----	<0.020	<0.020	<0.020
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	----	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.020	% S	----	----	<0.020	<0.020	<0.020
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.020	% Mg	----	----	0.028	0.024	0.047
Peroxide Magnesium (23Tm)	----	0.020	% Mg	----	----	0.028	0.023	0.046
Acid Reacted Magnesium (23U)	----	0.020	% Mg	----	----	<0.020	<0.020	<0.020
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	----	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.020	% S	----	----	<0.020	<0.020	<0.020
EA029-G: Retained Acidity								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	31116/S1	31116/S2	31116/ASS/BH1/1.0	31116/ASS/BH3/0.5	31116/ASS/BH3/1.0
				Sampling date / time	19-Apr-2021 00:00	19-Apr-2021 00:00	19-Apr-2021 00:00	19-Apr-2021 00:00	19-Apr-2021 00:00
Compound	CAS Number	LOR	Unit		ES2114549-001	ES2114549-002	ES2114549-003	ES2114549-004	ES2114549-005
					Result	Result	Result	Result	Result
EA029-G: Retained Acidity - Continued									
HCl Extractable Sulfur (20Be)	----	0.020	% S		----	----	<0.020	<0.020	0.031
Net Acid Soluble Sulfur (20Je)	----	0.020	% S		----	----	<0.020	<0.020	<0.020
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t		----	----	<10	<10	<10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.020	% pyrite S		----	----	<0.020	<0.020	<0.020
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	----	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S		----	----	0.24	0.15	0.20
Net Acidity (acidity units)	----	10	mole H+ / t		----	----	149	91	126
Liming Rate	----	1	kg CaCO3/t		----	----	11	7	9
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	----	0.24	0.15	0.20
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	----	149	91	126
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	----	11	7	9
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		19.2	19.5	----	----	----
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		10	20	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg		40	50	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	31117/S1	31117/S2	31117/ASS/BH1/0.5	31116/ASS/BH1/1.0	31116/ASS/BH4/0.4
			Sampling date / time	19-Apr-2021 00:00	19-Apr-2021 00:00	19-Apr-2021 00:00	19-Apr-2021 00:00	19-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	ES2114549-006	ES2114549-007	ES2114549-008	ES2114549-009	ES2114549-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.1**	**5.2**	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**58**	**51**	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	**4.3**	**4.2**	**4.2**
pH OX (23B)	----	0.1	pH Unit	----	----	**4.2**	**4.7**	**4.3**
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	**114**	**117**	**134**
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	**192**	**151**	**181**
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	**79**	**34**	**47**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.020	% pyrite S	----	----	**0.182**	**0.187**	**0.216**
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.020	% pyrite S	----	----	**0.308**	**0.242**	**0.291**
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.020	% pyrite S	----	----	**0.126**	**0.055**	**0.075**
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.020	% S	----	----	**0.021**	<0.020	<0.020
Peroxide Sulfur (23De)	----	0.020	% S	----	----	**0.030**	<0.020	<0.020
Peroxide Oxidisable Sulfur (23E)	----	0.020	% S	----	----	<0.020	<0.020	<0.020
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	----	<10	<10	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.020	% Ca	----	----	**0.033**	<0.020	**0.086**
Peroxide Calcium (23Wh)	----	0.020	% Ca	----	----	**0.033**	<0.020	**0.070**
Acid Reacted Calcium (23X)	----	0.020	% Ca	----	----	<0.020	<0.020	<0.020
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	----	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.020	% S	----	----	<0.020	<0.020	<0.020
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.020	% Mg	----	----	**0.077**	**0.066**	**0.057**
Peroxide Magnesium (23Tm)	----	0.020	% Mg	----	----	**0.078**	**0.065**	**0.047**
Acid Reacted Magnesium (23U)	----	0.020	% Mg	----	----	<0.020	<0.020	<0.020
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	----	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.020	% S	----	----	<0.020	<0.020	<0.020
EA029-G: Retained Acidity								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	31117/S1	31117/S2	31117/ASS/BH1/0.5	31116/ASS/BH1/1.0	31116/ASS/BH4/0.4
			Sampling date / time	19-Apr-2021 00:00	19-Apr-2021 00:00	19-Apr-2021 00:00	19-Apr-2021 00:00	19-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	ES2114549-006	ES2114549-007	ES2114549-008	ES2114549-009	ES2114549-010
				Result	Result	Result	Result	Result
EA029-G: Retained Acidity - Continued								
HCl Extractable Sulfur (20Be)	----	0.020	% S	----	----	0.022	<0.020	<0.020
Net Acid Soluble Sulfur (20Je)	----	0.020	% S	----	----	<0.020	<0.020	<0.020
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	----	<10	<10	<10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.020	% pyrite S	----	----	<0.020	<0.020	<0.020
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	----	----	0.19	0.19	0.22
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	120	120	138
Liming Rate	----	1	kg CaCO3/t	----	----	9	9	10
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	0.19	0.19	0.22
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	120	120	138
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	9	9	10
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	19.4	20.2	----	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	30	20	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	20	40	----	----	----

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