envirotech
Environmental and Engineering
Consultancy Services

PO Box 3086 East Blaxland NSW 2774
P: 1300 888 324 **F:** 02 8834 0760
W: www.envirotech.com.au
E: info@envirotech.com.au

ACID SULFATE SOILS INVESTIGATION

121 PACIFIC ROAD, PALM BEACH NSW 2108

PREPARED FOR:	Karen, Colin and John Bowers
OUR REFERENCE:	REF-19-8288-A
ISSUE DATE:	29th Aug 2019

CONTROLLED DOCUMENT

DISTRIBUTION & REVISION REGISTER

DISTRIBUTION LIST		
Copy No.	Custodian	Location
1 Original	Daniel Mathew	Envirotech Pty. Ltd (Filed)
2 Soft Copy (PDF, emailed)	Karen, Colin and John Bowers	jane@danielboddam.com

Note: This register identifies the current custodians of controlled copies of the subject document.

DOCUMENT HISTORY		
Document No.	Revision No.	Issue Date
19-8288	A	29/08/2019

AUTHOR	TECHNICAL REVIEWER
	
Charbel Bahi B.Eng. (Civil) Civil Engineer	Ben Hamilton Geotechnical Engineer BSc (Geo.), GradCertEngSci

TABLE OF CONTENTS

1. INTRODUCTION

1.1 General

EnviroTech Pty Ltd was engaged by Karen, Colin and John Bowers to prepare this Acid Sulfate Soils Assessment. This investigation will accompany a development application for proposed residential development.

The study site is Lot 17, 121 Pacific Road, Palm Beach (Figure 1). The site is irregular shaped with an approximate area of 3062 m^2 and is governed by Northern Beaches.

1.2 Objectives

The objective of this Acid Sulfate Soils Assessment is to determine the potential and risk of acid sulfate soils on site in accordance with the NSW Acid Sulfate Soil Management Advisory Committee 1998 "The Acid Sulfate Soils Manual" and determine if an Acid Sulfate Soils Management Plan is required.

1.3 Guidelines

The investigation was conducted in accordance with the NSW Acid Sulfate Soil Management Advisory Committee (ASSMAC) *Acid Sulfate Soil Manual,* 1998.

1.4 Property Identification

The study site is Lot 17, 121 Pacific Road, Palm Beach. It occupies approximately 3062 m^2 of land and is located within a residential area (Figure 1). The property is zoned E4 (Environmental Living)

1.5 Proposed Development

The investigation was conducted as part of DA for a proposed residential dwelling.

Figure 1 Site location map (Six Viewer NSW)

Figure 2 Site location view (Six Viewer NSW)

2. SITE DESCRIPTION

2.1 Site Inspection

A site inspection was carried out on Thursday 1st Aug 2019 which involved a visual assessment of the accessible areas of the site and the excavation and collection of representative soil samples. Details of the findings are presented within the body of this report, as well as an assessment of significance with regards to the findings of the investigation.

2.2 Topography

Undulating to rolling low hills with local relief 20-80 m and slopes of 10-25%. Side slopes with narrow to wide outcropping sandstone rock benches (10-100 m), often forming broken scarps of < 5m.

2.3 Drainage

No groundwater or distinct overland flow paths were noted during the investigation. Stormwater is expected to drain into soils.

2.4 Surrounding land use

The site is located within a residential precinct and bordered by:

- Residential dwelling located in all directions from dwelling
- Palm Beach to the north-east

3. SOIL LANDSCAPE AND ACID SULFATE RISK MAPPING

3.1 Geology and Soils

Hawkesbury Sandstone, which is a medium to coarse-grained quartz sandstone with minor shale and laminite lenses.

Dominant Soil Materials

Loose, coarse sandy loam.

This is loamy sand to sandy loam with loose, apedal single-grained structure and porous sandy fabric. It generally occurs as topsoil.

The colour often becomes lighter with depth and ranges from brownish-black, when organic matter is present, to bleached dull yellow orange. It is often water repellent under native vegetation. The pH ranges from strongly acid pH 4.0 to slightly acid pH 6.0. Small sandstone and platy ironstone fragments, charcoal fragments and roots are common.

Earthy, yellowish-brown clayey sand.

This is commonly yellowish-brown clayey sand with apedal massive structure and porous earthy fabric. It commonly occurs as subsoil over sandstone bedrock. Where it is exposed at the surface it forms hardsetting topsoil.

Texture may increase gradually to a light sandy clay loam with depth. Colour is commonly yellowish-brown and orange mottles are occasionally present with depth. The pH ranges from strongly acid pH 4.0 to slightly acid pH 6.5. Sandstone and ironstone fragments are common and are often concentrated in stone lines in the upper parts of this material. Charcoal fragments are common whilst roots are rare.

Earthy to weakly pedal, yellowish-brown sandy clay loam.

This is commonly a yellowish-brown sandy clay loam to sandy clay with an apedal massive structure and an earthy porous fabric. It usually occurs as subsoil on coarse sandstone.

Texture is commonly sandy clay loam but may increase gradually with depth to sandy clay. Occasionally a weakly pedal structure of sub-angular blocky shaped peds are present. Peds are 73 commonly rough-faced and porous and range in size from 5-20 mm. Colour is commonly yellowish brown. Orange mottles may occur with depth. The pH ranges from strongly acid pH 4.5 to slightly acid pH 6.0. Strongly weathered sandstone fragments are common. Roots and charcoal fragments are rare.

Moderately to strongly pedal, yellowish-brown clay.

This is commonly a yellowish-brown sandy clay or light clay with a moderately to strongly pedal structure and either a smooth or rough faced ped fabric. This material occurs as subsoil on shale bedrock.

Peds ranging in size from 5 mm to 50 mm, are either smooth or rough-faced and are polyhedral to sub-angular blocky. Colour is commonly yellow brown but can vary from dark reddish brown to light grey. Red, orange and grey mottles are occasionally present at depth. The pH ranges from strongly acid pH 4.0 to slightly acid pH 6.0. Shale and ironstone fragments are often present, but charcoal fragments are absent, and roots are rare.

3.2 Acid Sulfate Soils Risk Mapping

The acid sulfate soil risk mapping sourced from the NSW Department of Planning and Environment indicates the site is in a Class 5 acid sulfate soil area (Figure 3).

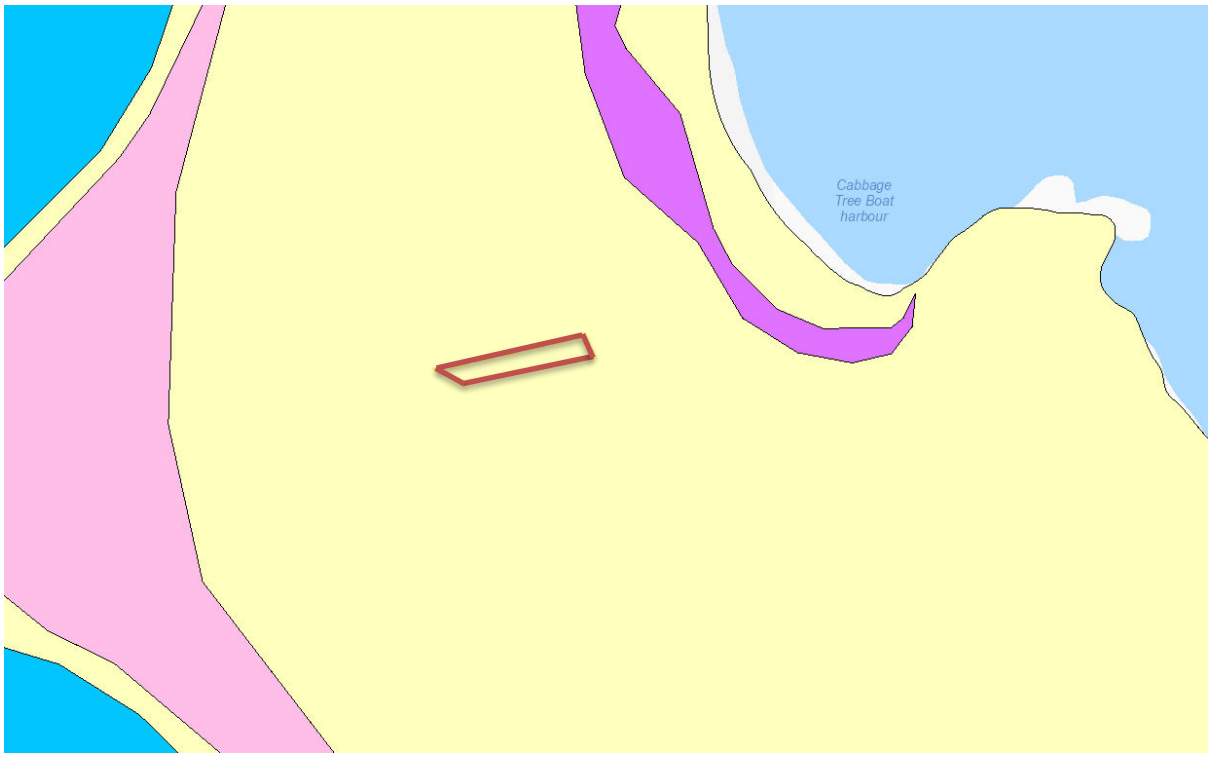

Figure 3 Acid Sulfate Map within site proximity (NSW Planning)

4. BACKGROUND ACID SULFATE SOIL INFORMATION

Acid sulfate soils are the common name given to naturally occurring sediments and soils containing iron sulfides (principally iron sulfide or iron disulfide or their precursors). The exposure of the sulfide in these soils to oxygen by drainage or excavation leads to the generation of sulfuric acid. "Acid Sulfate Soils" include actual acid sulfate soils or potential acid sulfate soils. Actual and potential acid sulfate soils are often found in the same soil profile, with actual acid sulfate soils generally overlying potential acid sulfate soil horizons.

"Actual Acid Sulfate Soils" are soils containing highly acidic soil horizons or layers resulting from the aeration of soil materials that are rich in iron sulfides, primarily sulfide. This oxidation produces hydrogen ions in excess of the sediment's capacity to neutralize the acidity resulting in soils of pH of 4 or less when measured in dry season conditions. These soils can usually be identified by the presence of pale-yellow mottles and coatings of jarosite.

"Potential Acid Sulfate Soils" are soils which contain iron sulfides or sulfidic material which have not been exposed to air and subsequently oxidized. The field pH of these soils in their undisturbed state is pH 4 or more and may be neutral or slightly alkaline. However, they pose a considerable environmental risk when disturbed, as they will become severely acidic when exposed to air and oxidized.

5. SOILS ANALYSIS

5.1 Subsurface Investigation

Two (2) boreholes were drilled in the approximate areas of the proposed structures. Borehole BH01 was drilled in the front of the proposed dwelling (see figure 4). Borehole BH02 was drilled at the back of the proposed dwelling (see figure 4). The boreholes were drilled using a ute-mounted push tube to depths of 2m or prior refusal. The soil strata can be divided into 2 distinct soil layers:

BH01

- 0 – 250mm Topsoil;
- 250 – 850mm Silty Clay
- 850 – 1100mm Clayey Sandstone

BH02

- 0 – 50mm Topsoil;
- 50 – 800mm Silty Clay
- 800 – 900mm Clayey Sandstone

Figure 4 below details the approximate sampling points within the subject site.

Figure 4 Sampling Plan of the site

5.2 Laboratory Analysis

Representative soil samples were collected from each borehole. Samples were sealed in laboratory supplied bags and stored in a freezer in the Envirotech office before being sent to ALS Environmental under chain of custody protocol. Samples were analysed for:

- Suspension Peroxide Oxidation Combined Acidity & Sulfur (SPOCAS);

The results of the analysis are summarised in Table 1 and provided in Appendix 3. Results were compared with '*Action Criteria'* provided in NSW Acid Sulfate Soil Management Advisory Committee (ASSMAC) *Acid Sulfate Soil Manual* (Table 2). Proposed earth works in soil that exceed these action criteria must be accompanied by an Acid Sulfate Soils Management Plan.

6. RESULTS

The SPOCAS results indicate that Potentially Actionable Acid Sulfate soils (PASS) does exist on the subject site.

Table 1: Results of SPOCAS Analysis

Bore_ Depth/mm	Net Acidity (Sulfur Units) %S	Net Acidity (Acidity Units) mole H+/t	Liming Rate Kg $CaCO_3$/t	Texture	Potential ASS
1_300	0.04	27	2	Silty Clay	No
2_200	0.11	68	5	Topsoil	Yes
2_500	0.14	87	6	Silty Clay	Yes
2_800	0.14	88	7	Silty Clay	Yes

Table 2: Action Criteria based on ASS soil analysis for three broad texture categories (ASSMAC, 1998)

Type of Material		**Action Criteria 1-1000 tonnes disturbed**		**Action Criteria 1000 tonnes disturbed**	
Texture range. McDonald Et al.(1990)	**Approx. clay Content** (%<0.002mm)	**Sulfur trail** %S oxidisable (oven-dry basis) eg, S_{tos} or S_{pos}	**Acid trail** Mol H^+ / tonne (oven-dry basis) eg, TPA or TSA	**Sulfur trail** %S oxidisable (oven-dry basis) eg, S_{tos} or S_{pos}	**Acid trail** Mol H^+ / tonne (oven-dry basis) eg, TPA or TSA
Coarse Texture Sands to loamy sands	≤ 5	0.03	18	0.03	18
Medium Texture Sandy Loams to light clays	5 - 40	0.06	36	0.03	18
Fine Texture Medium to heavy clays and silty clays	≥ 40	0.1	62	0.03	18

Table 3: Exposure Classification for Concrete in Sulphate Soils (AS2870:2011)

Exposure conditions			Exposure classification	
Sulfates (expressed as SO_4) *		Ph	Soil conditions A	Soil conditions B
In soil ppm	In groundwater ppm			
< 5000	< 1000	> 5.5	A2	A1
5000 - 10000	1000 - 3000	4.5 – 5.5	B1	A2
10000 - 20000	3000 – 10000	4 – 4.5	B2	B1
> 20000	> 10000	< 4	C2	B2

* Approximately 100 ppm SO_4 = 80 ppm SO_3
\+ Soil conditions A – high permeability soils (e.g. Sands and gravels) that are in groundwater
\+ Soil conditions B – low permeability soils (e.g. Silts and clays) or all soils above groundwater

With reference to the aggressivity of the acid sulphate soils and the pH laboratory results the soil exposure classification for the subject allotment is B1.

7. CONCLUSION

The SPOCAS results indicate that Potentially Actionable Acid Sulfate soils (PASS) does exist on the subject site. As such the below management plan is to be implemented during any stages of underlying soil disturbance during the construction phase.

All construction methods within AS2870:2011 for B1 exposure soils is to be adhered to.

8. ACID SULFATE SOILS MANAGEMENT PLAN

As per the recommendations within this assessment, an Acid Sulfate Soils Management Plan has been prepared for the proposed development.

8.1 Principles

Where acid sulfate soil materials (actual or potential) are present on a site, it is recommended that, where practicable, the material should not be disturbed. Sites that contain acid sulfate soil materials need to be managed to avoid adverse environmental impact and risk to human health. If the preliminary assessment has established the presence of actual or potential acid sulfate soil materials, consideration will need to be given to appropriate management measures to mitigate potential impacts.

Where disturbance of the acid sulfate soil material is unavoidable, the main objective of acid sulfate soil material management is to prevent or minimise the potential for on- and off-site impacts, using the most cost-effective and environmentally sustainable methods. The suitability of management measures will depend on the nature and location of the acid sulfate soil materials.

Common management approaches:

1. Determine presence of acid sulfate soil materials

Characterize proposed development sites for acid sulfate properties.

2. Minimise disturbance or drainage of acid sulfate soil materials

   It may be appropriate to select an alternative non-acid sulfate soil site rather than undertake remediation of impacts caused by disturbance of acid sulfate soil materials. If an alternative site is not feasible, works can be designed to minimise the need for excavation or disturbance of acid sulfate soil materials by:

   a. undertaking shallow excavations and drainage measures;
   b. avoiding lowering of groundwater levels that may result in exposure of soils;
   c. covering the surface with clean soil if acid sulfate soil materials are close to the surface;
   d. the use of screw or push piles and bearers and joists rather than slab-on-ground.

3. Prevent oxidation

   This may include staging the project to prevent oxidation and placing potential acid sulfate soil materials into an anaerobic environment, usually below the water table.

4. Minimise oxidation rate and isolate higher risk materials from exposure

   This may include covering with soil or water to reduce oxygen availability and control of water movement or controlling bacteria or other limiting factors (e.g. alkalinity) by either physical or chemical means to reduce the oxidation rate.

5. Contain and treat acid drainage to minimise risk of significant off-site impacts

   Typically, this would involve installing a leachate collection and treatment system.

6. Provide an agent to neutralise acid as it is produced

   This would involve mixing the acid sulfate soil material with an excess of lime.

7. Separate acid sulfate soil material

   This may include use of mechanical separation, such as sluicing or hydro cyclone to separate acid sulfate fines from non-acidic sulfate material, followed by treatment or disposal of acid sulfate fines in an anaerobic environment.

8. Hasten oxidation and collection and treatment of acid sulfate leachate

   This involves spreading the acid sulfate soil material in a thin layer over an impermeable area to achieve a high level of oxidation. Rainfall or irrigation leaches the soil and the leachate is then collected and treated.

9. Manage stockpiled materials

   Stockpiled acid sulfate soil material needs to be managed to ensure no adverse environmental impacts occur. This should include:

   a. minimizing the quantity and duration of storage;
   b. minimizing the surface area that can be oxidized;
   c. covering the soil to minimise infiltration;
   d. stormwater control measures; and
   e. controlling erosion and collection/treatment of runoff.

8.2 Preparation

1. Designated locations for stockpiles are to be established prior to the commencement of excavations;
2. An adequate source of liming agent is to be readily available;
3. All necessary bunding is to be established prior to the breaking of ground on site.

8.3 Neutralizing Acid Sulfate Soils and Method

8.3.1 Type

1. All the disturbed and excavated soils are to be separated and treated;
2. Appropriate quantities of neutralizing agents (lime) should be incorporated with all the ASS materials that are to be left above ground, or disposed of by any means;
3. The agents are applied to neutralize any acid that may have been or will be produced because of aeration;
4. Thorough mixing with neutralizing agent is a necessary requirement for this option.

8.3.2 Monitoring

1. Regular monitoring should be carried during the period of works at the end of each day of excavation (only required once if excavation works are completed within one day and the stockpiled materials tested at the end of the day);
2. Monitoring should be run after neutralization procedures to establish the effectiveness of the treatment and prior to any disposal.

8.3.3 Treatment

1. The recommended material for treatment is medium-fine agricultural lime (aglime) which is slightly alkaline and of low solubility;
2. The aglime should be fine ground (at least < 1 mm) calcium carbonate or calcite (limestone or marble). Coarse-grained calcite is not recommended, as one of the products of the neutralization reaction is gypsum which has low solubility and may not mix appropriately;
3. Aglime purity should preferably be 90% or better. Based on the volume required lower grade materials are not recommended as the economical trade off would not justify the potential change in outcome;
4. When estimating lime requirements, a safety factor of at least 1.5 should be applied to allow for inefficient mixing of the lime and its low reactivity;
5. The following in the suggested liming rate indicated by the NATA accredited laboratory, 9Kg per $CaCO_3$/t.
6. Aglime is to be readily available on site;
7. All excavated and disturbed material extending beneath the proposed subgrade preparation are to be lined with limestone or marble;

8. An impervious appropriately bunded area incorporating provision for the collection and treatment of the leachate from the oxidation of the sulfidic material (should such leachate occur) must be provided;
9. Prior to excavations, weather should be checked, and excavation works should not be undertaken unless a continuous forecast of 5 days does not indicate the chance of moderate to heavy rain;
10. All excavations are to be covered once treated to protect against unforeseen weather events.

8.3.4 Method

1. The proposed method for treating of the ASS involves spreading out acid sulfate soils in thin layers (0.15- 0.3 m) over a thin bed of lime (within the impervious appropriately bunded area), air drying and mechanically breaking up clods as drying proceeds;
2. When soil is sufficiently dry, lime is applied and thoroughly mixed;
3. The material is then compacted prior to treatment of the next layer;
4. Effective drying and mixing of lime with clay is often difficult. In addition, the sulfide distribution in some soils can be highly variable making the treatment programming difficult.
5. The drying rate is very dependent on the temperature and in cooler climates the methods may be too slow to be practicable;
6. The advantage of this method is that although some oxidation occurs during the drying phase, the presence of an excess quantity of lime tends to prevent extreme acidity developing in the soil.

8.3.5 Stockpiled materials

The following recommendations outline the best practice methods for the stockpiling of Acid Sulfate Soils and are to be applied;

1. Stockpiles of acid sulphate soils should be located in settings that ensure minimal environmental impact from any acidic leachate produced. The design of stockpile(s) should:
    a. Establish leachate collection and treatment systems including an impervious pad on which to place the stockpile;
    b. Minimise the surface area exposed to oxidation - consider using some form of artificial capping if storage is for longer than a few weeks;
    c. Minimise the amount of infiltration of water - consider using some form of artificial capping.
2. All stockpiles should be bunded and leachate collection and treatment systems should be installed. If an impervious pad has not been established under the stockpile, as a precautionary measure, an apron of fine lime should be applied when stockpiling materials for any length of time.

8.3.6 Disposal off-site and Contingency Planning

1. Once treatment has been applied and or testing has confirmed the materials do not, or no longer meet the definition of Actual Acid Sulfate Soils the materials are to be disposed of to

an appropriately licensed landfill facility with an accompanying Waste Analysis Classification Report;

2. The waste classification assessment is to be conducted in accordance with *NSW DECCW Waster Classification Guidelines 2008*. The guidelines (Part 4) states ASS cannot be treated as virgin excavated natural materials (VENM) and that potential and actual ASS must be treated (neutralized) prior to acceptance by a landfill operator;
3. In the event that liming treatment is unsuccessful and or site restraints, timing restraints or unforeseen circumstances prevent the materials being treated on site the materials are to be sent to Licensed Landfill Facility which is licensed to receive this classification of waste;
4. Any ASS material requiring transport should be loaded directly into sealed trucks and transported. The base of the truck containment should be lined with a layer of lime. The condition of the lime layer should be visually checked regularly, and lime should be replenished if necessary;
5. All vehicles must be covered to prove the loss of ASS material during transport. Wheels and external surfaces of trucks should be cleaned prior to leaving site.

8.4 Water and Leachate Monitoring, Treatment and Discharge

1. If water is observed within the excavation it must be directed into a water tank or similar storage vessel utilizing pumps or other such appropriate methods. This may be in the form of either direct pumping of water and carting away or storage on site;
2. In the instance that the water is to be disposed of into stormwater or sewer, it will need to be inspected for signs of concern (e.g. discoloration, visible oil sheen etc.) and tested for pH and Total Suspended Solids (TSS) prior to disposal (refer Urban Stormwater Blue Book);
3. In the unexpected event that onsite stockpiles produce leachates, the water will require '*finishing*' prior to discharge to correct the acidity. A calcium hydroxide solution may be used for rapid neutralization;
4. As previously mentioned, soils are to be tested prior to disposal offsite and will require field pH and peroxide pH testing before disposal. See Table 1 for summary of monitoring requirements.

Table 1: Monitoring Requirements

Material	Test	Frequency	Target Level
Stored water (both leachate and groundwater)	pH	Daily, following rain events and non-work periods	pH 6.5 – 8.5 on average and not less than 5.5 for anyone reading
Leachate to be disposed of	pH and TSS	Daily	pH 6.5-8.5
Soil to be disposed offsite	Standard suite for waste analysis, field pH, Peroxide pH	End of each day of excavation (prior to disposal)	pH 6.0 – 12.0 No change in colour, no effervesce, no release of sulfurous odor, no depression in pH below field pH

8.5 Bunding Requirements

1. AS 4452B-1997 defines a bund as an impervious embankment of earth, or a wall of brick, stone, concrete or other suitable material, which may form part or all of the perimeter of a compound that provides a barrier to retain liquid. Since the bund is the main part of a spill containment system, the whole system (or bunded area) is colloquially referred to within industry as the '*bund*';
2. The bund is designed to contain spillages and leaks from liquids used, stored or processed above-ground, and to facilitate clean-up operations.
3. A bund consists of:
    a. An impervious bund walls or embankment surrounding the facility or tanks;
    b. An impervious floor within the bunded area;
    c. Any joints in the floor or the wall, or between the floor and the wall;
    d. Any associated facilities designed to remove liquids safely from the bunded area without polluting the environment.

9. CONTINGENCY PLANNING

The hire of a chemical spill kit suitable to the scale of works, i.e. up to 1 m^3 of chemical spill should be retained on site to be utilized in the event that the above management strategies fail or are temporarily unavailable. Members of staff are to be aware of the location and how to use the spill kit prior to commencing works.

10. LIMITATIONS

The information contained within this report have been prepared exclusively for the client. Envirotech have prepared the report to address the risk associated with scale of the works. The report has been prepared with a degree of care and skill ordinarily exercised in similar investigations by reputable members of the environmental industry in Australia. No other warranty, expressed or implied, is made or intended. This report is to be read in its entirety including attachments and appendices and should not read in individual sections.

A third party should not rely upon the information prior to making an assessment that the scope of work conducted meets their specific needs. Envirotech cannot be held liable for third party reliance on this document.

Envirotech's professional opinions are based upon its professional judgment, experience, training and results from analytical data. In some cases, further testing and analysis may be required, thus producing different results and/or opinions. Envirotech Pty Ltd has limited its investigation to the scope agreed upon with its client.

11. REFERENCES

- *Acid Sulfate Soils, Planning Guidelines,* 1998.
- *Acid Sulfate Soils, Assessment Guidelines,* 1998.
- *Acid Sulfate Soil Manual,* 1998.

12. APPENDIX 1: ALS SOIL LABORATORY RESULTS

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1924809**	Page	: 1 of 4
Client	: **ENVIROTECH PTY. LTD.**	Laboratory	: Environmental Division Sydney
Contact	: BEN HAMILTON	Contact	: Customer Services ES
Address	: Level1/1/23 Rowood Rd, Prospect 2148	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 121 Pacific Road, Palm Beach	Date Samples Received	: 06-Aug-2019 15:30
Order number	: 828819	Date Analysis Commenced	: 12-Aug-2019
C-O-C number	: ----	Issue Date	: 23-Aug-2019 11:04
Sampler	: BEN HAMILTON		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 4		
No. of samples analysed	: 4		

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. 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*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by 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)			Client sample ID	BH01 0.3m	BH02 0.2m	BH02 0.5m	BH02 0.8m	----
			Client sampling date / time	01-Aug-2019 00:00	01-Aug-2019 00:00	01-Aug-2019 00:00	01-Aug-2019 00:00	----
Compound	CAS Number	LOR	Unit	ES1924809-001	ES1924809-002	ES1924809-003	ES1924809-004	--------
				Result	Result	Result	Result	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.5**	**4.5**	**4.3**	**4.2**	----
pH OX (23B)	----	0.1	pH Unit	**3.0**	**4.4**	**4.1**	**4.1**	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**8**	**55**	**87**	**88**	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**137**	**81**	**112**	**105**	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	**129**	**26**	**26**	**17**	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.020	% pyrite S	<0.020	**0.089**	**0.139**	**0.142**	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.020	% pyrite S	**0.220**	**0.130**	**0.180**	**0.169**	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.020	% pyrite S	**0.207**	**0.041**	**0.041**	**0.027**	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.020	% S	<0.020	<0.020	<0.020	<0.020	----
Peroxide Sulfur (23De)	----	0.020	% S	**0.031**	**0.020**	<0.020	<0.020	----
Peroxide Oxidisable Sulfur (23E)	----	0.020	% S	**0.031**	**0.020**	<0.020	<0.020	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	**19**	**13**	<10	<10	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.020	% Ca	**0.189**	**0.046**	<0.020	<0.020	----
Peroxide Calcium (23Wh)	----	0.020	% Ca	**0.210**	**0.064**	<0.020	<0.020	----
Acid Reacted Calcium (23X)	----	0.020	% Ca	**0.021**	<0.020	<0.020	<0.020	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	**11**	<10	<10	<10	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.020	% S	<0.020	<0.020	<0.020	<0.020	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.020	% Mg	**0.039**	**0.052**	**0.042**	**0.029**	----
Peroxide Magnesium (23Tm)	----	0.020	% Mg	**0.040**	**0.052**	**0.042**	**0.031**	----
Acid Reacted Magnesium (23U)	----	0.020	% Mg	<0.020	<0.020	<0.020	<0.020	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	<10	<10	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.020	% S	<0.020	<0.020	<0.020	<0.020	----
EA029-G: Retained Acidity								
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	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH01 0.3m	BH02 0.2m	BH02 0.5m	BH02 0.8m	----
				Client sampling date / time	01-Aug-2019 00:00	01-Aug-2019 00:00	01-Aug-2019 00:00	01-Aug-2019 00:00	----
Compound	CAS Number	LOR	Unit		ES1924809-001	ES1924809-002	ES1924809-003	ES1924809-004	--------
					Result	Result	Result	Result	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		**1.5**	**1.5**	**1.5**	**1.5**	**----**
Net Acidity (sulfur units)	----	0.02	% S		**0.04**	**0.11**	**0.14**	**0.14**	**----**
Net Acidity (acidity units)	----	10	mole H+ / t		**27**	**68**	**87**	**88**	**----**
Liming Rate	----	1	kg CaCO3/t		**2**	**5**	**6**	**7**	**----**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		**0.04**	**0.11**	**0.14**	**0.14**	**----**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		**27**	**68**	**87**	**88**	**----**
Liming Rate excluding ANC	----	1	kg CaCO3/t		**2**	**5**	**6**	**7**	**----**

QUALITY CONTROL REPORT

Work Order	: **ES1924809**	Page	: 1 of 6
Client	: **ENVIROTECH PTY. LTD.**	Laboratory	: Environmental Division Sydney
Contact	: BEN HAMILTON	Contact	: Customer Services ES
Address	: Level1/1/23 Rowood Rd, Prospect 2148	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 121 Pacific Road, Palm Beach	Date Samples Received	: 06-Aug-2019
Order number	: 828819	Date Analysis Commenced	: 12-Aug-2019
C-O-C number	: ----	Issue Date	: 23-Aug-2019
Sampler	: BEN HAMILTON		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 4		
No. of samples analysed	: 4		

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. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

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*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by 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

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
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
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA029-A: pH Measurements (QC Lot: 2519201)									
ES1924810-002	Anonymous	EA029: pH KCl (23A)	----	0.1	pH Unit	5.5	5.5	0.00	0% - 20%
		EA029: pH OX (23B)	----	0.1	pH Unit	4.5	4.5	0.00	0% - 20%
EM1912469-001	Anonymous	EA029: pH KCl (23A)	----	0.1	pH Unit	10.7	10.7	0.00	0% - 20%
		EA029: pH OX (23B)	----	0.1	pH Unit	8.3	8.4	1.20	0% - 20%
EA029-B: Acidity Trail (QC Lot: 2519201)									
ES1924810-002	Anonymous	EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.020	<0.020	0.00	No Limit
		EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.020	<0.020	0.00	No Limit
		EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.020	<0.020	0.00	No Limit
		EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	4	4	0.00	No Limit
		EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	0.00	No Limit
		EA029: Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	0.00	No Limit
EM1912469-001	Anonymous	EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.020	<0.020	0.00	No Limit
		EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.020	<0.020	0.00	No Limit
		EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.020	<0.020	0.00	No Limit
		EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.00	No Limit
		EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	0.00	No Limit
		EA029: Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	0.00	No Limit
EA029-C: Sulfur Trail (QC Lot: 2519201)									
ES1924810-002	Anonymous	EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.020	<0.020	0.00	No Limit
		EA029: Peroxide Sulfur (23De)	----	0.02	% S	<0.020	<0.020	0.00	No Limit
		EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.020	<0.020	0.00	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA029-C: Sulfur Trail (QC Lot: 2519201) - continued									
ES1924810-002	Anonymous	EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	0.00	No Limit
EM1912469-001	Anonymous	EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	0.260	0.259	0.00	0% - 50%
		EA029: Peroxide Sulfur (23De)	----	0.02	% S	0.347	0.364	4.58	0% - 50%
		EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	0.088	0.104	17.5	No Limit
		EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	55	65	17.5	No Limit
EA029-D: Calcium Values (QC Lot: 2519201)									
ES1924810-002	Anonymous	EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	0.041	0.043	4.94	No Limit
		EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	0.050	0.050	0.00	No Limit
		EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.020	<0.020	0.00	No Limit
		EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.020	<0.020	0.00	No Limit
		EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	0.00	No Limit
EM1912469-001	Anonymous	EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	0.700	0.692	1.18	0% - 20%
		EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	1.80	1.89	4.83	0% - 20%
		EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	1.10	1.20	8.48	0% - 20%
		EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	0.880	0.958	8.48	0% - 20%
		EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	549	597	8.48	0% - 20%
EA029-E: Magnesium Values (QC Lot: 2519201)									
ES1924810-002	Anonymous	EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.020	<0.020	0.00	No Limit
		EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.020	<0.020	0.00	No Limit
		EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.020	<0.020	0.00	No Limit
		EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.020	<0.020	0.00	No Limit
		EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	0.00	No Limit
EM1912469-001	Anonymous	EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.020	<0.020	0.00	No Limit
		EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	0.108	0.113	4.40	No Limit
		EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	0.108	0.113	4.40	No Limit
		EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	0.143	0.149	4.40	No Limit
		EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	89	93	4.40	No Limit
EA029-H: Acid Base Accounting (QC Lot: 2519201)									
ES1924810-002	Anonymous	EA029: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.00	No Limit
		EA029: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.00	No Limit
		EA029: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.00	No Limit
		EA029: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.00	No Limit
		EA029: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.00	No Limit
		EA029: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.00	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA029-H: Acid Base Accounting (QC Lot: 2519201) - continued									
ES1924810-002	Anonymous	EA029: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	0.00	No Limit
EM1912469-001	Anonymous	EA029: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.00	No Limit
		EA029: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.00	No Limit
		EA029: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.09	0.10	17.5	No Limit
		EA029: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.00	No Limit
		EA029: Liming Rate excluding ANC	----	1	kg CaCO3/t	4	5	0.00	No Limit
		EA029: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.00	No Limit
		EA029: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	55	65	17.5	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA029-A: pH Measurements (QCLot: 2519201)								
EA029: pH KCl (23A)	----	0.1	pH Unit	<0.1	4.5 pH Unit	102	70	130
EA029: pH OX (23B)	----	0.1	pH Unit	<0.1	4.5 pH Unit	95.6	70	130
EA029-B: Acidity Trail (QCLot: 2519201)								
EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	24.6 mole H+ / t	82.8	70	130
EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	29.1 mole H+ / t	105	70	130
EA029: Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	----	----	----	----
EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.020	----	----	----	----
EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.020	----	----	----	----
EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.020	----	----	----	----
EA029-C: Sulfur Trail (QCLot: 2519201)								
EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.020	0.052 % S	110	70	130
EA029: Peroxide Sulfur (23De)	----	0.02	% S	<0.020	0.145 % S	120	70	130
EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.020	----	----	----	----
EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	----	----	----	----
EA029-D: Calcium Values (QCLot: 2519201)								
EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.020	0.151 % Ca	75.1	70	130
EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.020	0.296 % Ca	73.2	70	130
EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.020	----	----	----	----
EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.020	----	----	----	----
EA029-E: Magnesium Values (QCLot: 2519201)								
EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.020	0.176 % Mg	122	70	130
EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.020	0.175 % Mg	129	70	130
EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.020	----	----	----	----
EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.020	----	----	----	----
EA029-G: Retained Acidity (QCLot: 2519201)								
EA029: Net Acid Soluble Sulfur (20Je)	----	0.02	% S	<0.020	----	----	----	----
EA029: acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.020	----	----	----	----
EA029: HCl Extractable Sulfur (20Be)	----	0.02	% S	<0.020	0.027 % S	93.3	70	130
EA029-H: Acid Base Accounting (QCLot: 2519201)								
EA029: ANC Fineness Factor	----	0.5	-	<0.5	----	----	----	----

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EA029-H: Acid Base Accounting (QCLot: 2519201) - continued								
EA029: Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
EA029: Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	----	----	----
EA029: Liming Rate	----	1	kg CaCO3/t	<1	----	----	----	----
EA029: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
EA029: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	----	----	----	----
EA029: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	----	----	----	----

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) or Matrix Spike Duplicate (MSD) Results are required to be reported.**

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1924809**	Page	: 1 of 5
Client	: **ENVIROTECH PTY. LTD.**	Laboratory	: Environmental Division Sydney
Contact	: BEN HAMILTON	Telephone	: +61-2-8784 8555
Project	: 121 Pacific Road, Palm Beach	Date Samples Received	: 06-Aug-2019
Site	: ----	Issue Date	: 23-Aug-2019
Sampler	: BEN HAMILTON	No. of samples received	: 4
Order number	: 828819	No. of samples analysed	: 4

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method / Container / Client Sample ID(s)		Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA029-A: pH Measurements							
Snap Lock Bag - frozen on receipt							
BH01 0.3m,	BH02 0.2m,	12-Aug-2019	02-Aug-2019	**10**	----	----	----
BH02 0.5m,	BH02 0.8m						
EA029-B: Acidity Trail							
Snap Lock Bag - frozen on receipt							
BH01 0.3m,	BH02 0.2m,	12-Aug-2019	02-Aug-2019	**10**	----	----	----
BH02 0.5m,	BH02 0.8m						
EA029-C: Sulfur Trail							
Snap Lock Bag - frozen on receipt							
BH01 0.3m,	BH02 0.2m,	12-Aug-2019	02-Aug-2019	**10**	----	----	----
BH02 0.5m,	BH02 0.8m						
EA029-D: Calcium Values							
Snap Lock Bag - frozen on receipt							
BH01 0.3m,	BH02 0.2m,	12-Aug-2019	02-Aug-2019	**10**	----	----	----
BH02 0.5m,	BH02 0.8m						
EA029-E: Magnesium Values							
Snap Lock Bag - frozen on receipt							
BH01 0.3m,	BH02 0.2m,	12-Aug-2019	02-Aug-2019	**10**	----	----	----
BH02 0.5m,	BH02 0.8m						
EA029-F: Excess Acid Neutralising Capacity							
Snap Lock Bag - frozen on receipt							
BH01 0.3m,	BH02 0.2m,	12-Aug-2019	02-Aug-2019	**10**	----	----	----
BH02 0.5m,	BH02 0.8m						
EA029-G: Retained Acidity							
Snap Lock Bag - frozen on receipt							
BH01 0.3m,	BH02 0.2m,	12-Aug-2019	02-Aug-2019	**10**	----	----	----
BH02 0.5m,	BH02 0.8m						
EA029-H: Acid Base Accounting							
Snap Lock Bag - frozen on receipt							
BH01 0.3m,	BH02 0.2m,	12-Aug-2019	02-Aug-2019	**10**	----	----	----
BH02 0.5m,	BH02 0.8m						

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-A: pH Measurements							
Snap Lock Bag - frozen on receipt (EA029)							
BH01 0.3m, BH02 0.2m, BH02 0.5m, BH02 0.8m	**01-Aug-2019**	**12-Aug-2019**	02-Aug-2019	×	**13-Aug-2019**	10-Nov-2019	✓
EA029-B: Acidity Trail							
Snap Lock Bag - frozen on receipt (EA029)							
BH01 0.3m, BH02 0.2m, BH02 0.5m, BH02 0.8m	**01-Aug-2019**	**12-Aug-2019**	02-Aug-2019	×	**13-Aug-2019**	10-Nov-2019	✓
EA029-C: Sulfur Trail							
Snap Lock Bag - frozen on receipt (EA029)							
BH01 0.3m, BH02 0.2m, BH02 0.5m, BH02 0.8m	**01-Aug-2019**	**12-Aug-2019**	02-Aug-2019	×	**13-Aug-2019**	10-Nov-2019	✓
EA029-D: Calcium Values							
Snap Lock Bag - frozen on receipt (EA029)							
BH01 0.3m, BH02 0.2m, BH02 0.5m, BH02 0.8m	**01-Aug-2019**	**12-Aug-2019**	02-Aug-2019	×	**13-Aug-2019**	10-Nov-2019	✓
EA029-E: Magnesium Values							
Snap Lock Bag - frozen on receipt (EA029)							
BH01 0.3m, BH02 0.2m, BH02 0.5m, BH02 0.8m	**01-Aug-2019**	**12-Aug-2019**	02-Aug-2019	×	**13-Aug-2019**	10-Nov-2019	✓
EA029-F: Excess Acid Neutralising Capacity							
Snap Lock Bag - frozen on receipt (EA029)							
BH01 0.3m, BH02 0.2m, BH02 0.5m, BH02 0.8m	**01-Aug-2019**	**12-Aug-2019**	02-Aug-2019	×	**13-Aug-2019**	10-Nov-2019	✓
EA029-G: Retained Acidity							
Snap Lock Bag - frozen on receipt (EA029)							
BH01 0.3m, BH02 0.2m, BH02 0.5m, BH02 0.8m	**01-Aug-2019**	**12-Aug-2019**	02-Aug-2019	×	**13-Aug-2019**	10-Nov-2019	✓
EA029-H: Acid Base Accounting							
Snap Lock Bag - frozen on receipt (EA029)							
BH01 0.3m, BH02 0.2m, BH02 0.5m, BH02 0.8m	**01-Aug-2019**	**12-Aug-2019**	02-Aug-2019	×	**13-Aug-2019**	10-Nov-2019	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	SOIL	In house: Referenced to Ahern et al 2004 - a suspension peroxide oxidation method following the 'sulfur trail' by determining the level of 1M KCL extractable sulfur and the sulfur level after oxidation of soil sulphides. The 'acidity trail' is followed by measurement of TAA, TPA and TSA. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.

Preparation Methods	Method	Matrix	Method Descriptions
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **ES1924809**

Client	: **ENVIROTECH PTY. LTD.**	Laboratory	: Environmental Division Sydney
Contact	: BEN HAMILTON	Contact	: Customer Services ES
Address	: Level1/1/23 Rowood Rd, Prospect 2148	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: ben@envirotech.com.au	E-mail	: ALSEnviro.Sydney@ALSGlobal.com
Telephone	: ----	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: 121 Pacific Road, Palm Beach	Page	: 1 of 3
Order number	: 828819	Quote number	: ES2018ENVTECH0001 (EN/222)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: BEN HAMILTON		

Dates

Date Samples Received	: 06-Aug-2019 15:30	Issue Date	: 06-Aug-2019
Client Requested Due Date	: 15-Aug-2019	Scheduled Reporting Date	: **15-Aug-2019**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Not Available
No. of coolers/boxes	: 1	Temperature	: 2.6'C - Ice Bricks present
Receipt Detail	: ESKY	No. of samples received / analysed	: 4 / 4

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- SPOCAS Analysis to be conducted by ALS Brisbane.
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months ± 1 week) from receipt of samples.
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Suspension Peroxide Oxidation-Combined Acidity and Sulphate : EA029		
BH01 0.3m	- Snap Lock Bag - frozen on receipt	- Snap Lock Bag - frozen
BH02 0.2m	- Snap Lock Bag - frozen on receipt	- Snap Lock Bag - frozen
BH02 0.5m	- Snap Lock Bag - frozen on receipt	- Snap Lock Bag - frozen
BH02 0.8m	- Snap Lock Bag - frozen on receipt	- Snap Lock Bag - frozen

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **SOIL**

Laboratory sample ID	Client sampling date / time	Client sample ID	SOIL - EA029 SPOCAS
ES1924809-001	01-Aug-2019 00:00	BH01 0.3m	✓
ES1924809-002	01-Aug-2019 00:00	BH02 0.2m	✓
ES1924809-003	01-Aug-2019 00:00	BH02 0.5m	✓
ES1924809-004	01-Aug-2019 00:00	BH02 0.8m	✓

Proactive Holding Time Report

The following table summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory.

Matrix: **SOIL** Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Client Sample ID(s)	Container	Due for extraction	Due for analysis	Samples Received		Instructions Received	
				Date	Evaluation	Date	Evaluation
EA029: Suspension Peroxide Oxidation-Combined Acidity and Sulphate							
BH01 0.3m	Snap Lock Bag - frozen on recei	02-Aug-2019	31-Oct-2019	06-Aug-2019	✘	----	----
BH02 0.2m	Snap Lock Bag - frozen on recei	02-Aug-2019	31-Oct-2019	06-Aug-2019	✘	----	----
BH02 0.5m	Snap Lock Bag - frozen on recei	02-Aug-2019	31-Oct-2019	06-Aug-2019	✘	----	----
BH02 0.8m	Snap Lock Bag - frozen on recei	02-Aug-2019	31-Oct-2019	06-Aug-2019	✘	----	----

Requested Deliverables

ACCURATE ACCOUNTS		
- A4 - AU Tax Invoice (INV)	Email	accurateaccounts@bigpond.com
BEN HAMILTON		
- *AU Certificate of Analysis - NATA (COA)	Email	ben@envirotech.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	ben@envirotech.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	ben@envirotech.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	ben@envirotech.com.au
- A4 - AU Tax Invoice (INV)	Email	ben@envirotech.com.au
- Chain of Custody (CoC) (COC)	Email	ben@envirotech.com.au
- EDI Format - ENMRG (ENMRG)	Email	ben@envirotech.com.au
- EDI Format - ESDAT (ESDAT)	Email	ben@envirotech.com.au
INFO		
- *AU Certificate of Analysis - NATA (COA)	Email	info@envirotech.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	info@envirotech.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	info@envirotech.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	info@envirotech.com.au
- Chain of Custody (CoC) (COC)	Email	info@envirotech.com.au
- EDI Format - ENMRG (ENMRG)	Email	info@envirotech.com.au
- EDI Format - ESDAT (ESDAT)	Email	info@envirotech.com.au
Jack Hinchliffe		
- *AU Certificate of Analysis - NATA (COA)	Email	jack@envirotech.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	jack@envirotech.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	jack@envirotech.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	jack@envirotech.com.au
- A4 - AU Tax Invoice (INV)	Email	jack@envirotech.com.au
- Chain of Custody (CoC) (COC)	Email	jack@envirotech.com.au
- EDI Format - ENMRG (ENMRG)	Email	jack@envirotech.com.au
- EDI Format - ESDAT (ESDAT)	Email	jack@envirotech.com.au

15/8/19

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5800 E: gladstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 24 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304 Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com

NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com

PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

TOWNSVILLE 14-16 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: Envirotech PTY LTD	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☐ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: Prospect		☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes / No / N/A
PROJECT: 121 Pacific Road, Palm Beach	**ALS QUOTE NO.:**	**COC SEQUENCE NUMBER (Circle)**	Free ice / frozen ice bricks present upon receipt? Yes / No / N/A
ORDER NUMBER: 828819		COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: 26 °C
PROJECT MANAGER: Daniel Mathew	**CONTACT PH:** 029896 1568	OF: 1 2 3 4 5 6 7	Other comments:
SAMPLER: Ben Hamilton	**SAMPLER MOBILE:**	**RELINQUISHED BY:**	**RECEIVED BY:**
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**	*Ben Hamilton*	DATE/TIME: 6/8/19 1730
Email Reports to (will default to PM if no other addresses are listed): ben@envirotech.com.au		DATE/TIME: 06/08/2019	**RELINQUISHED BY:** / DATE/TIME:
Email Invoice to (will default to PM if no other addresses are listed): accurateaccounts@bigpond.com			**RECEIVED BY:** / DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL CONTAINERS	SPOCAS								Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	BH01 0.3m	1/08/2019	S		1	√								
2	BH02 0.2m	1/08/2019	S		1	√								
3	BH02 0.5m	1/08/2019	S		1	√								
4	BH02 0.8m	1/08/2019	S		1	√								
				TOTAL	4	4								

Subcon / Forward Lab / Split WO

Lab / Analysis: ~~ALS Brisbane~~

Organised By / Date: 12-4 Spocase

Relinquished By / Date:

Connote / Courier:

WO No: ES1924809

Attached By PO / Internal Sheet:

Environmental Division Sydney

Work Order Reference

ES1924809

Telephone : + 61-2-8784 8555

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.