ENVIRONMENTAL INVESTIGATION SERVICES

25 June 2015
Ref: E28431Klet-ASS

LAM Consulting Engineers

Attention: Mr Allan Lam

PRELIMINARY ACID SULFATE SOIL ASSESSMENT
PROPOSED MANLY LODGE REDEVELOPMENT
22 VICTORIA PARADE, MANLY, NSW

1 INTRODUCTION

LAM Consulting Engineers ('the client') commissioned Environmental Investigation Services (EIS)[1] to undertake a preliminary acid sulfate soil (ASS) assessment for the proposed Manly Lodge Redevelopment at 22 Victoria Parade, Manly, NSW.

The site is identified as Lot 3 in DP86034. The site location is shown on Figure 1 and the investigation was confined to accessible areas of the site as shown on Figure 2.

The investigation was undertaken generally in accordance with an EIS proposal (Ref: EP9002K) of 18 May 2015 and written acceptance from Allan Lam of LAM Consulting Engineers by email of 25 May 2015.

This report describes the investigation procedures and presents the results of the ASS assessment, together with comments, discussion and recommendations.

A geotechnical investigation was undertaken in conjunction with the ASS assessment by JK Geotechnics[2] and the results are presented in a separate report (Ref. 28431SBrpt, dated 24 June 2015).

1.1 Proposed Development Details

EIS understand that the proposed development will involve the demolition of existing site structures and the construction of a three storey building for hotel/motel accommodation over a single level of basement car parking. The proposed basement will require excavation of up to 3 metres below existing site levels.

[1] Environmental consulting division of Jeffery & Katauskas Pty Ltd (J&K)
[2] Geotechnical consulting division of J&K

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2 INFORMATION ON ACID SULFATE SOILS

2.1 Background

ASS is formed from iron rich alluvial sediments and sulfate (found in seawater) in the presence of sulfate reducing bacteria and plentiful organic matter. These conditions are generally found in mangroves, salt marsh vegetation or tidal areas and at the bottom of coastal rivers and lakes. These soils include those that are producing acid (termed actual ASS) and those that can become acid producing (termed potential ASS or 'PASS'). PASS are naturally occurring soils and sediment that contains iron sulfides (pyrite) which, when exposed to oxygen generate sulfuric acid.

2.2 The ASS Management Advisory Committee (ASSMAC)

The NSW government in 1994 formed the ASSMAC to coordinate a response to ASS issues. In 1998 this group released the Acid Sulfate Soil Manual[3] providing best practice advice for planning, assessment, management, laboratory methods, drainage, groundwater and the preparation of ASS management plans (ASSMP).

In 1997 the Department of Land and Soil Conservation (now part of the Office of Environment and Heritage[4]) developed two series of maps with respect to ASS for use by council and technical staff implementing the ASS Manual 1998:

- ASS Planning Maps – issued to councils and government units; and
- ASS Risk Maps – issued to interested parties.

2.3 The ASS Planning Maps

The ASS planning maps provide an indication of the relative potential for disturbance of ASS to occur at locations within the council area. These maps do not provide an indication of the actual occurrence of ASS at a site or the likely severity of the conditions.

The maps are divided into five classes dependent upon the type of activities/works that if undertaken, may represent an environmental risk through the development of acidic conditions associated with ASS:

Table 2-1: Risk Classes

Risk Class	Description
Class 1	All works.

[3] *Acid Sulfate Soils Manual,* Acid Sulfate Soils Management Advisory Committee (ASSMAC), 1998 (ASS Manual)
[4] http://www.environment.nsw.gov.au/acidsulfatesoil/index.htm

Risk Class	Description
Class 2	All works below existing ground level and works by which the water table is likely to be lowered.
Class 3	Works at depths beyond 1m below existing ground level or works by which the water table is likely to be lowered beyond 1m below existing ground level.
Class 4	Works at depths beyond 2m below existing ground level or works by which the water table is likely to be lowered beyond 2m below existing ground level.
Class 5	Works within 500m of adjacent Class 1,2,3,4 land which are likely to lower the water table below 1m AHD on the adjacent land.

2.4 The ASS Risk Maps

The ASS risk maps provide an indication of the probability of occurrence of PASS at a particular location based on interpretation from geological and soil landscape maps. The maps provide classes based on high probability, low probability, no known occurrence and areas of disturbed terrain (site specific assessment necessary) and the likely depth at which ASS are likely to be encountered.

2.5 Investigation and Laboratory Testing for ASS

The ASS Manual 1998 includes information on assessment of the likelihood of PASS, the need for an ASSMP, and the development of mitigation measures for a proposed development located in PASS risk areas.

The ASS Manual recommends a minimum of 4 sampling locations for a site with an area up to 1ha. For sites greater than 4ha, the manual recommends the use of a reduced density of 2 locations per hectare subject to the proposed development. For lineal investigations, the manual recommends sampling every 50-100m.

The sampling locations should include all areas where significant disturbance of soils will occur and/or areas with a high environmental sensitivity. In some instances a varied sampling plan may be more suitable, particularly for sites less than 1,000m^2 in area.

The depth of investigation should extend to at least 1m beyond the depth of proposed excavation/disturbance or estimated drop in water table height, or to a minimum of 2m below existing ground level, whichever is greatest.

Standard methods for the laboratory analysis of samples are presented in the Australian Standard AS4969-2008/09[5] (part 1 to 14). The principal analytical method is suspension Peroxide Oxidation Combined Acidity and Sulfur (sPOCAS).

The sPOCAS method specified in AS4969-2008/09 supersedes the POCAS method specified in the ASS Manual 1998. When S_{POS} (peroxide oxidisable sulfur) values are close to the action criteria confirmation of the result can be undertaken by the chromium reducible sulfur (S_{CR}) method.

The endpoint for the pH titration in AS4969-2008/09 is pH6.5 as opposed to pH5.5 adopted in the ASS Manual. Therefore the values for Total Actual Acidity (TAA), Total Sulfide Acidity (TSA) and Total Potential Acidity (TPA) will more conservative when analysed using the sPOCAS method specified in AS4969-2008/09.

3 SITE INFORMATION

3.1 Site Description

The site is located on the southern side of Victoria Parade and approximately 50 metres north east of the Victoria Parade and Darley Road junction. The site is situated on the relatively flat low lying topography between Manly Wharf and Manly Beach and has a north western frontage onto Victoria Parade.

At the time of the investigation, the site was occupied by Manly Lodge hotel which comprised a of main two storey rendered building that covered the majority of the site, extending right up to its north east and north west boundaries, with a second one and two storey brick building along the south eastern boundary. The two buildings were separated by a small paved courtyard which was accessed from a paved pathway that ran along the south western boundary.

To the north east of the site was a four storey rendered apartment building with a 2.5m wide concrete driveway running along the common site boundary. Beyond the south western boundary was a three and four storey brick apartment building. A row of 10m tall palm trees ran along this boundary.

3.2 Regional Geology

The geological map of Sydney (1983[6]) indicates the site to be underlain by Quaternary aged deposits of medium to fine-grained marine sands.

3.3 Manly Council Local Environmental Plan (LEP) 2013

A review of the Manly council LEP indicates that the site is located in a Class 4 ASS risk area.

[5] *Analysis of acid sulfate soil – Dried samples – Methods of test, Parts 1 to 14,* Standards Australia, 2008/2009 (AS4969-2008/09)
[6] *1:100,000 Geological Map of Sydney (Series 9130),* Department of Mineral Resources (1983)

3.4 Acid Sulfate Soil (ASS) Risk Map

A review of the ASS risk maps prepared by Department of Land and Water Conservation (1997[7]) indicates that the site is located in an area classed as having 'low risk'.

4 ASSESSMENT CRITERIA

The ASS Manual present 'action criteria' for the interpretation of laboratory results. The 'action criteria' define the need to prepare a management plan and are based on the percentage of oxidisable sulfur (or equivalent Total Potential Acidity [TPA]) for broad categories of soil types. Where disturbance of greater than 1,000 tonnes of ASS is proposed, the action criteria for 'coarse textured soils' apply to all soil types.

4.1 Action Criteria

The following action criteria are presented in the ASS Manual:

Table 4-1: ASS Action Criteria

Category	Description	Criteria
Coarse Textured Soils	Sands to loamy sands	• pH - less than 5; • Total Actual Acidity (TAA)/Total Sulfide Acidity (TSA)/ Total Potential Acidity (TPA) (pH5.5) – greater than 18mol H^+/tonne; and • S_{pos} – greater than 0.03% sulfur oxidisable.
Medium Textured Soils	Sandy loams to light clays	• pH - less than 5; • TAA/TSA/TPA (pH5.5) – greater than 36mol H^+/tonne; and • S_{pos} – greater than 0.06% sulfur oxidisable.
Fine Textured Soils	Medium to heavy clays and silty clays	• pH - less than 5; • TAA/TSA/TPA (pH5.5) – greater than 62mol H^+/tonne; and • S_{pos} – greater than 0.1% sulfur oxidisable.

4.2 Site Specific Action Criteria

The action criteria for coarse textured soils has been adopted for this assessment. This is based on the predominant soil type encountered at the sampling locations (i.e. silty sand) and the proposed excavation works will disturb greater than 1,000 tonnes of soil.

[7] Department of Land and Water Conservation, (1997), *1:25,000 Acid Sulfate Soil Risk Map (Series 9130N2, Ed 2).*

5 INVESTIGATION PROCEDURE

5.1 Subsurface Investigation and Soil Sampling Methods

Field work for this investigation was undertaken on 2 June 2015. Soil samples were obtained from 1 borehole drilled for the JK geotechnical investigation. The sampling locations are shown on the attached Figure 2.

The sample locations were drilled using a track mounted hydraulically operated drill rig equipped with spiral flight augers. Soil samples were obtained from a Standard Penetration Test (SPT) sampler or directly from the auger when conditions did not allow use of the SPT sampler.

Soil samples were obtained at various depths, based on observations made during the field investigation. All samples were placed in plastic bags and sealed with plastic ties with minimal headspace. Each sample was labelled with a unique job number, the sampling location, sampling depth and date. All samples were recorded on the borehole logs attached in the appendices.

The samples were preserved by immediate storage in an insulated sample container with ice. On completion of the fieldwork, the samples were delivered in the insulated sample container to a NATA registered laboratory for analysis under standard COC procedures. Additional samples were frozen and stored pending further analysis.

5.2 Laboratory Analysis

Three selected natural soil samples obtained from the site were analysed for PASS using the sPOCAS analytical methods detailed in AS4969-2008/09. The laboratory testing was undertaken by SGS Alexandria Environmental NSW NATA Accreditation Number – 2562(4354) (ISO/IEC 17025 compliance). Reference should be made to the laboratory reports (Ref: SE140023) attached in the appendices for further information.

6 RESULTS OF THE INVESTIGATION

6.1 Subsurface Conditions

The subsurface conditions encountered generally consisted of concrete pavement to a maximum depth of 0.2m, underlain by fill material to a depth of approximately 0.7m, underlain by sand to the termination depth of the borehole at approximately 6.4m. The fill material typically consisted of silty sand with inclusions of sandstone gravel. Groundwater seepage was encountered at a depth of 4.3m below existing site levels. Reference should be made to the borehole log attached in the appendices for further details.

6.2 Laboratory Results

The soil laboratory results were assessed against the guidelines adopted for the investigation. The results are presented in the attached report tables and summarised below.

Table 6-1: Summary of ASS Results

Analyte	Results Compared to ASS Guidelines
pH_{kcl} and pH_{ox}	The pH_{KCl} results ranged from 7.6 to 10. The results indicate that prior to oxidation the pH values of the soil suspended in potassium chloride solution ranged from neutral to alkaline. Following oxidation, the pH_{ox} results for the samples ranged from 7.0 to 8.9. These results are generally neutral to slightly alkaline. The pH of the samples typically dropped by 0.5 or more units following oxidation.
Acid Trail	TAA, TPA and TSA results were all less than the PQL.
Sulfur Trail	The S_{pos}% results ranged for <0.005% to 0.061%. The majority of the results were above the action criterion of 0.03% as shown on Table A.
Liming Rate	The liming rate required for neutralisation were all less than the PQL.

7 CONCLUSION

The soil samples analysed for this investigation encountered results which indicate potential acid sulfate soils at depths greater than 3 metres. However, these samples have been neutralised by a large quantity of calcium (the source of calcium generally can be associated by the presence of shell fragments). At this stage an ASSMP is not considered necessary for the basement excavation to a depth of 3 metres.

EIS recommend excavated soils for footing and shoring systems should be sampled and analysed for sPOCAS to confirm an ASSMP is not required. As a contingency plan during these works any soils excavated for footings and services the material should be stockpiled and separated by a bund wall or a sediment control fence prior to testing for ASS. Alternatively this material could be placed into skip bins prior to testing.

8 LIMITATIONS

The report limitations are outlined below:

- EIS accepts no responsibility for any unidentified ASS issues at the site. Any unexpected problems/subsurface features that may be encountered during development works should be inspected by an environmental consultant as soon as possible;
- This report has been prepared based on site conditions which existed at the time of the investigation; scope of work and limitation outlined in the EIS proposal; and terms of contract between EIS and the client (as applicable);
- The conclusions presented in this report are based on investigation of conditions at specific locations, chosen to be as representative as possible under the given circumstances, visual

observations of the site and immediate surrounds and documents reviewed as described in the report;

- Subsurface soil and rock conditions encountered between investigation locations may be found to be different from those expected. Groundwater conditions may also vary, especially after climatic changes;
- The investigation and preparation of this report have been undertaken in accordance with accepted practice for environmental consultants, with reference to applicable environmental regulatory authority and industry standards, guidelines and the assessment criteria outlined in the report;
- Where information has been provided by third parties, EIS has not undertaken any verification process, except where specifically stated in the report;
- EIS accept no responsibility for potentially asbestos containing materials that may exist at the site. These materials may be associated with demolition of pre-1990 constructed buildings or fill material at the site;
- EIS have not and will not make any determination regarding finances associated with the site;
- Additional investigation work may be required in the event of changes to the proposed development or landuse. EIS should be contacted immediately in such circumstances;
- Material considered to be suitable from a geotechnical point of view may be unsatisfactory from a soil contamination viewpoint, and vice versa;
- This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose;
- Copyright in this report is the property of EIS. EIS has used a degree of care, skill and diligence normally exercised by consulting professionals in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report;
- If the client, or any person, provides a copy of this report to any third party, such third party must not rely on this report except with the express written consent of EIS; and
- Any third party who seeks to rely on this report without the express written consent of EIS does so entirely at their own risk and to the fullest extent permitted by law, EIS accepts no liability whatsoever, in respect of any loss or damage suffered by any such third party.

If you have any questions concerning the contents of this letter please do not hesitate to contact us.

Kind Regards

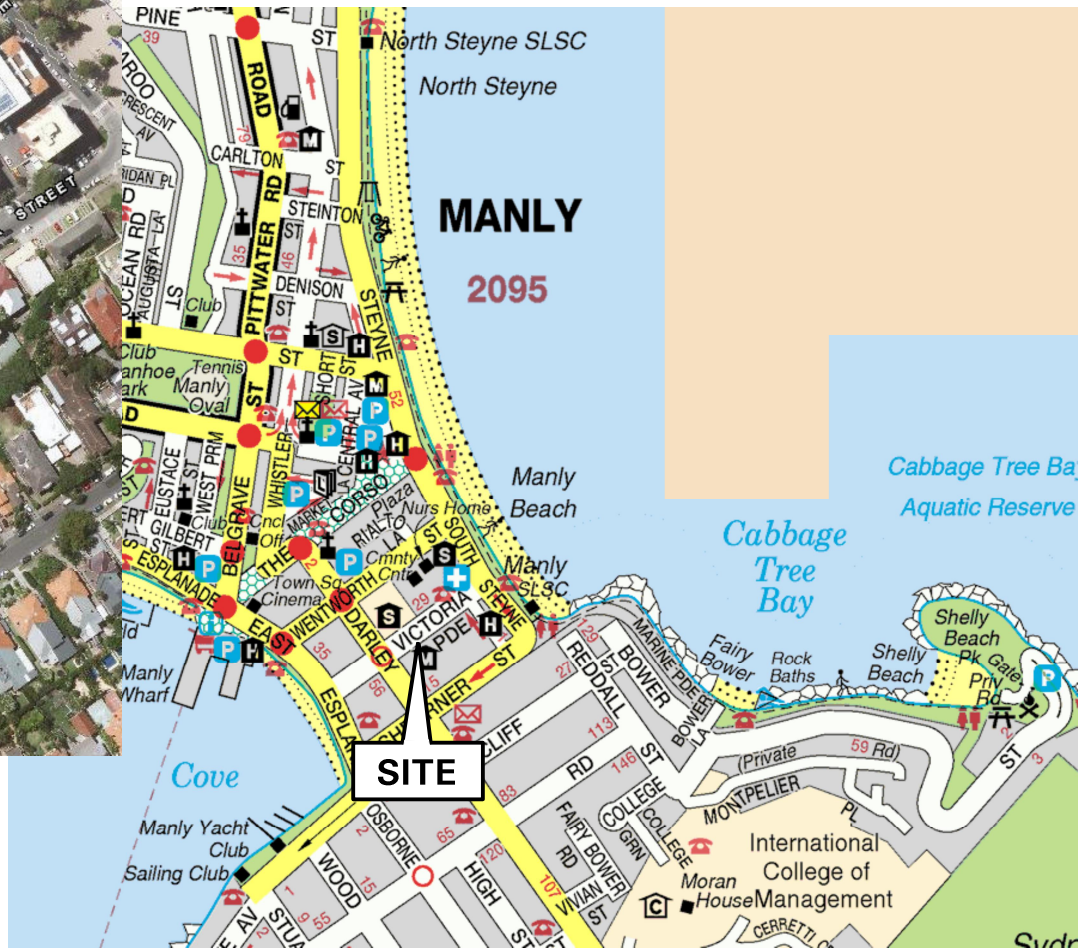
Geoff Fletcher
Environmental Scientist

Vittal Boggaram
Associate Environmental Scientist

Attachments:

1) Report Figures
2) Report Tables
3) Appendices

REPORT FIGURES



NOTES:
Figure has been recreated from UBD on disc (version 7.1) and http://maps.six.nsw.gov.au/.

Figure is not to scale. UBD Map ref: 198 C11

Reference should be made to the report text for a full understanding of this plan.

ENVIRONMENTAL INVESTIGATION SERVICES	Project Number: E28431K	Title: SITE LOCATION PLAN
	Figure: 1	Address: 22 VICTORIA PARADE, MANLY, NSW

PARADE

VICTORIA

No. 22
1&2 STOREY
RENDERED BUILDING
TILE ROOF
"MANLY LODGE"

3
D.P. 86034
SITE AREA
985 m²

BH1 (0.7)

No 18-20
3&4 STOREY
BRICK UNITS
TILE ROOF

No. 22
1&2 STOREY
BRICK
OUTHOUSE
TILE ROOF

S.P. 2217

S.P. 4911

D.P.

RAISED GARDEN

GARBAGE BAY

BRICK GARAGE

BRICK GARAGE

STORAGE

BALCONY

GROUND FLOOR ONLY

FIRST FLOOR ONLY

PAVED

RENDERED WALL

FENCE

CONC. WALL

PALING

TIMBER

METAL LID

AREA

136°16'

136°19'

136°9'

136°53'

226°10'30"

20.265

10.58

18.205

47.585

LEGEND:

- Approximate site boundary
- BH1 (0.2) Borehole location, number and depth of fill (m)
- Approximate proposed basement outline

NOTES:
Figure has been recreated from the JK Geotechnics Figure 1

The borehole locations presented on this plan have been established from site measurements only and should not be construed as survey points. The fill depths include the pavement thickness where pavement was encountered.

Reference should be made to the report text for a full understanding of this plan.

Approximate Scale (m): 0 2 4 6 8 10

ENVIRONMENTAL INVESTIGATION SERVICES

Project Number:	Title:
E28431K	**SAMPLE LOCATION PLAN**
Figure: **2**	Address: **22 VICTORIA PARADE, MANLY, NSW**

REPORT TABLES

TABLE A

SUMMARY OF LABORATORY RESULTS - ACID SULFATE SOILS ANALYSIS (sPOCAS)

		Analysis	pH_{KCL}	TAA	pH_{ox}	TPA	TSA	S_{POS}	S_{Cr}	Liming Rate
				pH 6.5		pH 6.5	pH 6.5	%w/w	%w/w	kg $CaCO_3$/tonne
Action Criteria[1]:		Coarse Textured Soil	pH 5.0	18molH+/ tonne	pH 5.0	18molH+/ tonne	18molH+/ tonne	0.03% w/w	0.03% w/w	
Sample Reference	**Sample Depth (m)**	**Sample Description**		LOW DENSITY RESIDENTIAL						
BH1	0.9-1.0	Sand	7.6	LPQL	7.1	LPQL	LPQL	LPQL	NA	LPQL
BH1	2.9-3.0	Sand	8.9	LPQL	7.0	LPQL	LPQL	LPQL	NA	LPQL
BH1	3.9-4.0	Sand	9.9	LPQL	8.2	LPQL	LPQL	0.034	NA	LPQL
BH1	4.9-5.0	Sand	10.0	LPQL	8.3	LPQL	LPQL	0.058	NA	LPQL
BH1	5.9-6.0	Sand	10.0	LPQL	8.9	LPQL	LPQL	0.061	NA	LPQL
Total Number of Samples			5	5	5	5	5	5	NA	5
Minimum Value			7.6	LPQL	7	LPQL	LPQL	0.034	NA	LPQL
Maximum Value			10.0	LPQL	8.9	LPQL	LPQL	0.061	NA	LPQL

Explanation:

[1] The Action criteria have been adopted from the Acid Sulfate Soil Manual (1998).

Values Exceeding Action Criteria **VALUE**

Abbreviations:

pH_{KCL} : pH of filtered 1:20, 1M KCL extract, shaken overnight

TAA pH 6.5 : Total Actual Acidity in 1M KCL extract titrated to pH6.5

pH_{ox} : pH filtered 1:20 1M KCl after peroxide digestion

TPA : Total Potential Acidity, 1M KCL peroxide digest titrated to pH6.5

TSA: Total Sulfide Acidity

S_{POS}: Peroxide oxidisable Sulfur (SP - SKCL)

Appendix A: Borehole Log

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 1
1/1

Client: LAM CONSULTING ENGINEERS

Project: PROPOSED MANLY LODGE REDEVELOPMENT

Location: 22 VICTORIA PARADE, MANLY, NSW

Job No. 28431SB
Date: 2/6/15

Method: SPIRAL AUGER
JK205

Logged/Checked by: I.S./D.B.

R.L. Surface: ≈ 4.8m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			CONCRETE: 200mm.t				
								-	FILL: Sand, fine to medium grained, brown, trace of sandstone gravel.	M			APPEARS POORLY COMPACTED
					N = 9 4,4,5				FILL: Silty sand, fine to medium grained, dark brown, trace of sandstone gravel and root fibres.				
								SP	SAND: fine grained, light brown, trace of silt.	M	L		
						1			SAND: fine to medium grained, light orange brown, trace of silt.				
					N = 5 2,2,3								
						2							
					N = 6 2,3,3	3							
									SAND: fine to coarse grained, light brown, trace of silt.	W			
					N = 15 3,5,10	4					MD		
									as above, but medium to coarse grained.				
						5							
					N > 20 4,9, 11/100mm	6							
					REFUSAL	7			END OF BOREHOLE AT 6.4m				

EXPLANATORY NOTES – ENVIRONMENTAL LOGS

INTRODUCTION

These notes have been provided to supplement the environmental report with regards to drilling and field logging. Not all notes are necessarily relevant to all reports. Where geotechnical borehole logs are utilised for environmental purpose, reference should also be made to the explanatory notes included in the geotechnical report. Environmental logs are not suitable for geotechnical purposes.

The ground is a product of continuing natural and manmade processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Environmental studies involve gathering and assimilating limited facts about these characteristics and properties in order to understand the ground on a particular site under certain conditions. These conditions are directly relevant only to the ground at the place where, and time when, the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, the SAA Site Investigation Code. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (e.g. sandy clay) as set out below (note that unless stated in the report, the soil classification is based on a qualitative field assessment, not laboratory testing):

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as shown in the following table:

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'Shale' is used to describe thinly bedded to laminated siltstone.

DRILLING OR EXCAVATION METHODS

The following is a brief summary of drilling and excavation methods currently adopted by the Company, and some comments on their use and application. All except test pits and hand auger drilling require the use of a mechanical drilling rig.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descend into the pit. The depth of penetration is limited to approximately 3m for a backhoe and up to 6m for an excavator. Limitations of test pits include problems associated with disturbance and difficulty of reinstatement; and the consequent effects on nearby structures. Care must be taken if construction is to be carried out near test pit locations to either properly re-compact the backfill during construction, or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as fill, hard clay, gravel or ironstone, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and in-situ testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (e.g. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The locations of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" – Test F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of, say, 4, 6 and 7 blows, as: N = 13 (4, 6, 7)
- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as: N>30 (15, 30/40mm)

The results of the test can be related empirically to the engineering properties of the soil. Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test is where the same driving system is used with a solid 60 tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as "Nc" on the borehole logs, together with the number of blows per 150mm penetration.

LOGS

The borehole or test pit logs presented herein are an interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will enable the most reliable assessment, but is not always practicable or possible to justify on economic grounds. In any case, the boreholes or test pits represent only a very small sample of the total subsurface conditions.

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line"

variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

Where groundwater levels are measured in boreholes, there are several potential problems:

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it is left open;
- A localised perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole or 'reverted' chemically if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after stabilising at intervals ranging from several days to perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (e.g. bricks, concrete, plastic, slag/ash, steel etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes

LABORATORY TESTING

Laboratory testing has not been undertaken to confirm the soil classifications and rocks strengths indicated on the environmental logs unless noted in the report.

SITE ANOMALIES

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, EIS should be notified immediately.

GRAPHIC LOG SYMBOLS FOR SOIL AND ROCKS

SOIL


FILL


TOPSOIL


CLAY (CL, CH)


SILT (ML, MH)


SAND (SP, SW)


GRAVEL (GP, GW)


SANDY CLAY (CL, CH)


SILTY CLAY (CL, CH)


CLAYEY SAND (SC)


SILTY SAND (SM)


GRAVELLY CLAY (CL, CH)


CLAYEY GRAVEL (GC)


SANDY SILT (ML)


PEAT AND ORGANIC SOILS

ROCK


CONGLOMERATE


SANDSTONE


SHALE


SILTSTONE, MUDSTONE, CLAYSTONE


LIMESTONE


PHYLLITE, SCHIST


TUFF


GRANITE, GABBRO


DOLERITE, DIORITE


BASALT, ANDESITE


QUARTZITE

DEFECTS AND INCLUSIONS


CLAY SEAM


SHEARED OR CRUSHED SEAM


BRECCIATED OR SHATTERED SEAM/ZONE


IRONSTONE GRAVEL


ORGANIC MATERIAL

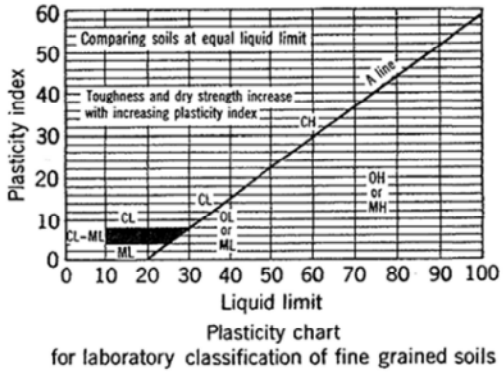
OTHER MATERIALS


CONCRETE


BITUMINOUS CONCRETE, COAL


COLLUVIUM

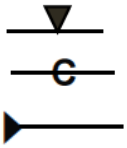
Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights)						Group Symbols [a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils More than half of material is *larger* than 75 μm sieve size[b] (The 75 μm sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	Use grain size curve in identifying the fractions as given under field identification Determine percentages of gravel and sand from grain size curve Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP* More than 12% *GM, GC, SM, SC* 5% to 12% *Borderline* cases requiring use of dual symbols $C_U = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *GW* Atterberg limits below "A" line, or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols Atterberg limits above "A" line, with *PI* greater than 7
			Predominantly one size or a range of sizes with some intermediate sizes missing			*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)			*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)			*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		
	Sands More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes			*SW*	Well graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *SW* Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols Atterberg limits below "A" line with *PI* greater than 7
			Predominantly one size or a range of sizes with some intermediate sizes missing			*SP*	Poorly graded sands, gravelly sands, little or no fines		
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)			*SM*	Silty sands, poorly graded sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)			*SC*	Clayey sands, poorly graded sand-clay mixtures		
Fine-grained soils More than half of material is *smaller* than 75 μm sieve size	Identification Procedures on Fraction Smaller than 380 μm Sieve Size		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)				
	Silts and clays liquid limit less than 50		None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)	
			Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity		
	Silts and clays liquid limit greater than 50		Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays		
			Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity		
Highly Organic Soils			Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils		



Plasticity chart
for laboratory classification of fine grained soils

Note: 1 Soils possessing characteristics of two groups are designated by combinations of group symbols (eg. GW-GC, well graded gravel-sand mixture with clay fines).
2 Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.

LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record		Standing water level. Time delay following completion of drilling may be shown. Extent of borehole collapse shortly after drilling. Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES U50 DB DS ASB ASS SAL	Soil sample taken over depth indicated, for environmental analysis. Undisturbed 50mm diameter tube sample taken over depth indicated. Bulk disturbed sample taken over depth indicated. Small disturbed bag sample taken over depth indicated. Soil sample taken over depth indicated, for asbestos screening. Soil sample taken over depth indicated, for acid sulfate soil analysis. Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual show blows per 150mm penetration. 'R' as noted below.
	N_c = 5 7 3 R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25 PID = 100	Vane shear reading in kPa of Undrained Shear Strength. Photoionisation detector reading in ppm (Soil sample heads pace test).
Moisture (Cohesive Soils) (Cohesionless)	MC > PL MC ≈ PL MC < PL D M W	Moisture content estimated to be greater than plastic limit. Moisture content estimated to be approximately equal to plastic limit. Moisture content estimated to be less than plastic limit. DRY – Runs freely through fingers. MOIST – Does not run freely but no free water visible on soil surface. WET – Free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS S F St VSt H ( )	VERY SOFT – Unconfined compressive strength less than 25kPa SOFT – Unconfined compressive strength 25-5 0kPa FIRM – Unconfined compressive strength 50-1 00kPa STIFF – Unconfined compressive strength 100- 200kPa VERY STIFF – Unconfined compressive strength 200- 400kPa HARD – Unconfined compressive strength greater than 400kPa Bracketed symbol indicates estimated consistency based o n tactile examination or other tests.
Density Index/ Relative Density (Cohesionless Soils)	VL L MD D VD ( )	**Density Index (ID) Range (%)** / **SPT ' N' Value Range (Blows/300mm)** Very Loose <15 / 0-4 Loose 15-35 / 4-10 Medium Dense 35-65 / 10-30 Dense 65-85 / 30-50 Very Dense >85 / >50 Bracketed symbol indicates estimated density based on ease of drilling or other tests.
Hand Penetrometer Readings	300 250	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise
Remarks	'V' bit 'TC' bit T_{60}	Hardened steel 'V' shaped bit. Tungsten carbide wing bit. Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.

LOG SYMBOLS CONTINUED

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining and Geomechanics Abstract Volume 22, No 2, 1985.

TERM	SYMBOL	Is (50) MPa	FIELD GUIDE
Extremely Low:	EL	0.03	Easily remoulded by hand to a material with soil properties.
Very Low:	VL	0.1	May be crumbled in the hand. Sandstone is "sugary" and friable.
Low:	L	0.3	A piece of core 150 mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
Medium Strength:	M	1	A piece of core 150 mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
High:	H	3	A piece of core 150 mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
Very High:	VH	10	A piece of core 150 mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
Extremely High:	EH		A piece of core 150 mm long x 50mm dia. is very difficult to break with h and-held hammer . Rings when struck with a hammer.

ROCK STRENGTH

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to (i.e. relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Iron stained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	

Appendix B: Laboratory Reports and COC Documents

ANALYTICAL REPORT

WORLD RECOGNISED ACCREDITATION

CLIENT DETAILS		LABORATORY DETAILS	
Contact	Geoff Fletcher	Manager	Jon Dicker
Client	Jeffery & Katauskas Pty Ltd	Laboratory	SGS Cairns Environmental
Address	Rear 115 Wicks Road MACQUARIE PARK NSW 2113	Address	Unit 2, 58 Comport St Portsmith QLD 4870
Telephone	(02) 9888 5000	Telephone	+61 07 4035 5111
Facsimile	(02) 9888 5004	Facsimile	+61 07 4035 5122
Email	au.samplereceipt.sydney@sgs.com	Email	AU.Environmental.Cairns@sgs.com
Project	**SE140023 E28431K**	SGS Reference	**CE115585 R1**
Order Number	(Not specified)	Report Number	0000025999
Samples	3	Date Reported	18 Jun 2015
Date Started	05 Jun 2015	Date Received	04 Jun 2015

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(3146)

This report cancels and supersedes the report No.CE 115585-R0. dated 11/06/2015 issued by SGS Environmental Services due to amended sample id (#3).

SIGNATORIES

Anthony Nilsson
Operations Manager

Jon Dicker
Manager Northern QLD

Jon Scott
Inorganic Chemist / Asbestos Team lea

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	CE115585.001 Soil 02 Jun 2015 BH1 0.9-1.0	CE115585.002 Soil 02 Jun 2015 BH1 2.9-3.0	CE115585.003 Soil 02 Jun 2015 BH1 5.9-6.0
Moisture Content Method: AN002 Tested: 4/6/2015						
% Moisture	%	0.5		**2.4**	**1.8**	**32**
TAA (Titratable Actual Acidity) Method: AN219 Tested: 11/6/2015						
pH KCl	pH Units	-		**7.6**	**8.9**	**10.0**
Titratable Actual Acidity	kg H2SO4/T	0.25		<0.25	<0.25	<0.25
Titratable Actual Acidity (TAA) moles H+/tonne	moles H+/T	5		<5	<5	<5
Titratable Actual Acidity (TAA) S%w/w	%w/w S	0.01		<0.01	<0.01	<0.01
Sulphur (SKCl)	%w/w	0.005		<0.005	<0.005	<0.005
Calcium (CaKCl)	%w/w	0.005		**0.042**	**0.056**	**0.29**
Magnesium (MgKCl)	%w/w	0.005		<0.005	<0.005	**0.030**
TPA (Titratable Peroxide Acidity) Method: AN218 Tested: 11/6/2015						
Peroxide pH (pH Ox)	pH Units	-		**7.1**	**7.0**	**8.9**
TPA as kg H_2SO_4/tonne	kg H2SO4/T	0.25		<0.25	<0.25	<0.25
TPA as moles H+/tonne	moles H+/T	5		<5	<5	<5
TPA as S % W/W	%w/w S	0.01		<0.01	<0.01	<0.01
Titratable Sulfidic Acidity as moles H+/tonne	moles H+/T	5		<5	<5	<5
Titratable Sulfidic Acidity as kg H_2SO_4/tonne	kg H2SO4/T	0.25		<0.25	<0.25	<0.25
Titratable Sulfidic Acidity as S % W/W	%w/w S	0.01		<0.01	<0.01	<0.01
ANCE as % $CaCO_3$	% CaCO3	0.01		**0.20**	**0.13**	**14**
ANCE as moles H+/tonne	moles H+/T	5		**40**	**25**	**2730**
ANCE as S % W/W	%w/w S	0.01		**0.06**	**0.04**	**4.4**
Peroxide Oxidisable Sulphur (Spos)	%w/w	0.005		<0.005	<0.005	**0.061**
Peroxide Oxidisable Sulphur as moles H+/tonne	moles H+/T	5		<5	<5	**38**
Sulphur (Sp)	%w/w	0.005		<0.005	<0.005	**0.061**
Calcium (Cap)	%w/w	0.005		**0.046**	**0.061**	**8.3**
Reacted Calcium (CaA)	%w/w	0.005		<0.005	<0.005	**8.0**
Reacted Calcium (CaA)	moles H+/T	5		<5	<5	**4000**
Magnesium (Mgp)	%w/w	0.005		<0.005	<0.005	**0.48**
Reacted Magnesium (MgA)	%w/w	0.005		<0.005	<0.005	**0.45**
Reacted Magnesium (MgA)	moles H+/T	5		<5	<5	**370**
Net Acid Soluble Sulphur as % w/w	%w/w	0.005		-	-	-
Net Acid Soluble Sulphur as moles H+/tonne	moles H+/T	5		-	-	-

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name CE115585.001 Soil 02 Jun 2015 BH1 0.9-1.0	CE115585.002 Soil 02 Jun 2015 BH1 2.9-3.0	CE115585.003 Soil 02 Jun 2015 BH1 5.9-6.0
SPOCAS Net Acidity Calculations Method: AN220 Tested: 11/6/2015					
s-Net Acidity	%w/w S	0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H+/T	5	<5	<5	<5
Liming Rate	kg CaCO3/T	0.1	<0.1	<0.1	<0.1
Verification s-Net Acidity	%w/w S	-20	NA	NA	**-2.9**
a-Net Acidity without ANCE	moles H+/T	5	<5	<5	**38**
Liming Rate without ANCE	kg CaCO3/T	0.1	<0.1	<0.1	**2.8**

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

TAA (Titratable Actual Acidity) **Method: ME-(AU)-[ENV]AN219**

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
pH KCl	LB027070	pH Units	-	6.3	2%	101%
Titratable Actual Acidity	LB027070	kg H2SO4/T	0.25	<0.25	18%	NA
Titratable Actual Acidity (TAA) moles H+/tonne	LB027070	moles H+/T	5	<5	18%	92%
Titratable Actual Acidity (TAA) S%w/w	LB027070	%w/w S	0.01	<0.01	18%	92%
Sulphur (SKCl)	LB027070	%w/w	0.005	<0.005	0%	98%
Calcium (CaKCl)	LB027070	%w/w	0.005	<0.005	3%	113%
Magnesium (MgKCl)	LB027070	%w/w	0.005	<0.005	3%	99%

TPA (Titratable Peroxide Acidity) **Method: ME-(AU)-[ENV]AN218**

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Peroxide pH (pH Ox)	LB027068	pH Units	-	7.1	4%	91%
TPA as kg H_2SO_4/tonne	LB027068	kg H2SO4/T	0.25	<0.25	0%	107%
TPA as moles H+/tonne	LB027068	moles H+/T	5	<5	0%	107%
TPA as S % W/W	LB027068	%w/w S	0.01	<0.01	0%	107%
ANCE as % $CaCO_3$	LB027068	% CaCO3	0.01	<0.01	0%	
ANCE as moles H+/tonne	LB027068	moles H+/T	5	<5	0%	
ANCE as S % W/W	LB027068	%w/w S	0.01	<0.01	0%	
Sulphur (Sp)	LB027068	%w/w	0.005	<0.005	7%	
Calcium (Cap)	LB027068	%w/w	0.005	<0.005	3%	
Magnesium (Mgp)	LB027068	%w/w	0.005	<0.005	2%	

METHOD SUMMARY

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN004	Soils, sediments and sludges are pulverised using an LM2 ringmill. The dry sample is pulverised to a particle size of >90% passing through a -75µm sieve.
AN218	Soil samples are subjected to extreme oxidising conditions using hydrogen peroxide. Continuous application of heat and peroxide ensure all sulphide is converted to sulphuric acid. Excess peroxide is broken down by a copper catalyst prior to titration for acidity. Calcium, magnesium, and sulphur are determined by ICP-OES. Also included is a carbonate modification step which, depending on pH after the initial oxidation, gives a measure of ANC.
AN219	Dried pulped sample is extracted for 4 hours in a 1 M KCl solution. The ratio of sample to solution is 1:40. The extract is titrated for acidity. Calcium, magnesium, and sulphur are determined by ICP-AES.
AN220	SPOCAS Suite: Scheme for the calculation of net acidities and liming rates using a Fineness Factor of 1.5.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	This analysis is not covered by the scope of accreditation.	QFH	QC result is above the upper tolerance
**	Indicative data, theoretical holding time exceeded.	QFL	QC result is below the lower tolerance
^	Performed by outside laboratory.	-	The sample was not analysed for this analyte
		NVL	Not Validated

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

SAMPLE RECEIPT ADVICE

SE140023

CLIENT DETAILS

Contact	Geoff Fletcher
Client	Jeffery & Katauskas Pty Ltd
Address	Rear 115 Wicks Road MACQUARIE PARK NSW 2113
Telephone	(02) 9888 5000
Facsimile	(02) 9888 5004
Email	gfletcher@jkgroup.net.au
Project	**E284831K**
Order Number	(Not specified)
Samples	3

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
Samples Received	Tue 2/6/2015
Report Due	Thu 11/6/2015
SGS Reference	**SE140023**

SUBMISSION DETAILS

This is to confirm that 3 samples were received on Tuesday 2/6/2015. Results are expected to be ready by Thursday 11/6/2015. Please quote SGS reference SE140023 when making enquiries. Refer below for details relating to sample integrity upon receipt.

Sample counts by matrix	3 Soils	Type of documentation received	COC
Date documentation received	2/6/2015	Samples received in good order	Yes
Samples received without headspace	**No**	Sample temperature upon receipt	2.6°C
Sample container provider	SGS	Turnaround time requested	Standard
Samples received in correct containers	Yes	Sufficient sample for analysis	Yes
Sample cooling method	Ice	Samples clearly labelled	Yes
Complete documentation received	Yes	Number of eskies/boxes received	

Samples will be held for one month for water samples and two months for soil samples from date of report, unless otherwise instructed.

COMMENTS

SPOCAS subcontracted to SGS Cairns, 2/58 Comport St, Portsmith QLD 4870, NATA Accreditation Number: 2562, Site Number: 3146.
Samples received at SGS on 2/6/15@5:30pm. Samples were not registered until the next working day.
3 samples have been placed on hold as no tests have been assigned for them by the client. These samples will not be processed.

SAMPLE RECEIPT ADVICE

SE140023

CLIENT DETAILS

Client Jeffery & Katauskas Pty Ltd

Project E284831K

SUMMARY OF ANALYSIS

No.	Sample ID	Sample Subcontracted
001	BH1 0.9-1.0	1
002	BH1 2.9-3.0	1
003	BH1 5.9-6.0	1

The above table represents SGS Environmental Services' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

ANALYTICAL REPORT

WORLD RECOGNISED ACCREDITATION

CLIENT DETAILS		LABORATORY DETAILS	
Contact	Geoff Fletcher	Manager	Jon Dicker
Client	Jeffery & Katauskas Pty Ltd	Laboratory	SGS Cairns Environmental
Address	Rear 115 Wicks Road MACQUARIE PARK NSW 2113	Address	Unit 2, 58 Comport St Portsmith QLD 4870
Telephone	(02) 9888 5000	Telephone	+61 07 4035 5111
Facsimile	(02) 9888 5004	Facsimile	+61 07 4035 5122
Email	au.samplereceipt.sydney@sgs.com	Email	AU.Environmental.Cairns@sgs.com
Project	**E28431K**	SGS Reference	**CE115829 R0**
Order Number	**SE140023A**	Report Number	0000026122
Samples	2	Date Reported	23 Jun 2015
Date Started	19 Jun 2015	Date Received	18 Jun 2015

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(3146)

SIGNATORIES

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Jon Dicker
Manager Northern QLD

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name CE115829.001 Soil 02 Jun 2015 BH1 3.9-4.0	CE115829.002 Soil 02 Jun 2015 BH1 4.9-5.0
Moisture Content Method: AN002 Tested: 18/6/2015				
% Moisture	%	0.5	**19**	**28**
TAA (Titratable Actual Acidity) Method: AN219 Tested: 22/6/2015				
pH KCl	pH Units	-	**9.9**	**10.0**
Titratable Actual Acidity	kg H2SO4/T	0.25	<0.25	<0.25
Titratable Actual Acidity (TAA) moles H+/tonne	moles H+/T	5	<5	<5
Titratable Actual Acidity (TAA) S%w/w	%w/w S	0.01	<0.01	<0.01
Sulphur (SKCl)	%w/w	0.005	**0.007**	**0.006**
Calcium (CaKCl)	%w/w	0.005	**0.29**	**0.31**
Magnesium (MgKCl)	%w/w	0.005	**0.019**	**0.028**
TPA (Titratable Peroxide Acidity) Method: AN218 Tested: 22/6/2015				
Peroxide pH (pH Ox)	pH Units	-	**8.2**	**8.3**
TPA as kg H_2SO_4/tonne	kg H2SO4/T	0.25	<0.25	<0.25
TPA as moles H+/tonne	moles H+/T	5	<5	<5
TPA as S % W/W	%w/w S	0.01	<0.01	<0.01
Titratable Sulfidic Acidity as moles H+/tonne	moles H+/T	5	<5	<5
Titratable Sulfidic Acidity as kg H_2SO_4/tonne	kg H2SO4/T	0.25	<0.25	<0.25
Titratable Sulfidic Acidity as S % W/W	%w/w S	0.01	<0.01	<0.01
ANCE as % $CaCO_3$	% CaCO3	0.01	**11**	**18**
ANCE as moles H+/tonne	moles H+/T	5	**2200**	**3500**
ANCE as S % W/W	%w/w S	0.01	**3.5**	**5.6**
Peroxide Oxidisable Sulphur (Spos)	%w/w	0.005	**0.034**	**0.058**
Peroxide Oxidisable Sulphur as moles H+/tonne	moles H+/T	5	**21**	**36**
Sulphur (Sp)	%w/w	0.005	**0.042**	**0.063**
Calcium (Cap)	%w/w	0.005	**5.2**	**8.5**
Reacted Calcium (CaA)	%w/w	0.005	**4.9**	**8.2**
Reacted Calcium (CaA)	moles H+/T	5	**2400**	**4100**
Magnesium (Mgp)	%w/w	0.005	**0.13**	**0.25**
Reacted Magnesium (MgA)	%w/w	0.005	**0.11**	**0.22**
Reacted Magnesium (MgA)	moles H+/T	5	**92**	**180**
Net Acid Soluble Sulphur as % w/w	%w/w	0.005	-	-
Net Acid Soluble Sulphur as moles H+/tonne	moles H+/T	5	-	-

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name CE115829.001 Soil 02 Jun 2015 BH1 3.9-4.0	CE115829.002 Soil 02 Jun 2015 BH1 4.9-5.0
SPOCAS Net Acidity Calculations Method: AN220 Tested: -				
s-Net Acidity	%w/w S	0.01	<0.01	<0.01
a-Net Acidity	moles H+/T	5	<5	<5
Liming Rate	kg CaCO3/T	0.1	<0.1	<0.1
Verification s-Net Acidity	%w/w S	-20	**-2.3**	**-3.7**
a-Net Acidity without ANCE	moles H+/T	5	**21**	**36**
Liming Rate without ANCE	kg CaCO3/T	0.1	**1.6**	**2.7**

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

TAA (Titratable Actual Acidity) Method: ME-(AU)-[ENV]AN219

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
pH KCl	LB027363	pH Units	-	5.6	1%	101%
Titratable Actual Acidity	LB027363	kg H2SO4/T	0.25	<0.25	0%	NA
Titratable Actual Acidity (TAA) moles H+/tonne	LB027363	moles H+/T	5	<5	0%	92%
Titratable Actual Acidity (TAA) S%w/w	LB027363	%w/w S	0.01	<0.01	0%	92%
Sulphur (SKCl)	LB027363	%w/w	0.005	<0.005	3%	
Calcium (CaKCl)	LB027363	%w/w	0.005	<0.005	7%	
Magnesium (MgKCl)	LB027363	%w/w	0.005	<0.005	7%	

TPA (Titratable Peroxide Acidity) Method: ME-(AU)-[ENV]AN218

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Peroxide pH (pH Ox)	LB027362	pH Units	-	6.2	0%	96%
TPA as kg H_2SO_4/tonne	LB027362	kg H2SO4/T	0.25	<0.25	0%	110%
TPA as moles H+/tonne	LB027362	moles H+/T	5	<5	0%	110%
TPA as S % W/W	LB027362	%w/w S	0.01	<0.01	0%	110%
ANCE as % $CaCO_3$	LB027362	% CaCO3	0.01	<0.01	2%	
ANCE as moles H+/tonne	LB027362	moles H+/T	5	<5	2%	
ANCE as S % W/W	LB027362	%w/w S	0.01	<0.01	2%	
Sulphur (Sp)	LB027362	%w/w	0.005	<0.005	4%	
Calcium (Cap)	LB027362	%w/w	0.005	<0.005	4%	
Magnesium (Mgp)	LB027362	%w/w	0.005	<0.005	14%	

METHOD SUMMARY

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN004	Soils, sediments and sludges are pulverised using an LM2 ringmill. The dry sample is pulverised to a particle size of >90% passing through a -75µm sieve.
AN218	Soil samples are subjected to extreme oxidising conditions using hydrogen peroxide. Continuous application of heat and peroxide ensure all sulphide is converted to sulphuric acid. Excess peroxide is broken down by a copper catalyst prior to titration for acidity. Calcium, magnesium, and sulphur are determined by ICP-OES. Also included is a carbonate modification step which, depending on pH after the initial oxidation, gives a measure of ANC.
AN219	Dried pulped sample is extracted for 4 hours in a 1 M KCl solution. The ratio of sample to solution is 1:40. The extract is titrated for acidity. Calcium, magnesium, and sulphur are determined by ICP-AES.
AN220	SPOCAS Suite: Scheme for the calculation of net acidities and liming rates using a Fineness Factor of 1.5.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	This analysis is not covered by the scope of accreditation.	QFH	QC result is above the upper tolerance
**	Indicative data, theoretical holding time exceeded.	QFL	QC result is below the lower tolerance
^	Performed by outside laboratory.	-	The sample was not analysed for this analyte
		NVL	Not Validated

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

SAMPLE RECEIPT ADVICE

SE140023A

CLIENT DETAILS

Contact	Geoff Fletcher
Client	Jeffery & Katauskas Pty Ltd
Address	Rear 115 Wicks Road MACQUARIE PARK NSW 2113
Telephone	(02) 9888 5000
Facsimile	(02) 9888 5004
Email	gfletcher@jkgroup.net.au
Project	**E284831K - Additional Analysis**
Order Number	(Not specified)
Samples	5

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
Samples Received	Tue 2/6/2015
Report Due	Wed 24/6/2015
SGS Reference	**SE140023A**

SUBMISSION DETAILS

This is to confirm that 5 samples were received on Tuesday 2/6/2015. Results are expected to be ready by Wednesday 24/6/2015. Please quote SGS reference SE140023A when making enquiries. Refer below for details relating to sample integrity upon receipt.

Sample counts by matrix	2 Soils	Type of documentation received	Email
Date documentation received	17/6/15@10:16AM	Samples received in good order	Yes
Samples received without headspace	**No**	Sample temperature upon receipt	2.6°C
Sample container provider	SGS	Turnaround time requested	Standard
Samples received in correct containers	Yes	Sufficient sample for analysis	Yes
Sample cooling method	Ice	Samples clearly labelled	Yes
Complete documentation received	Yes	Number of eskies/boxes received	

Samples will be held for one month for water samples and two months for soil samples from date of report, unless otherwise instructed.

COMMENTS

SPOCAS subcontracted to SGS Cairns, 2/58 Comport St, Portsmith QLD 4870, NATA Accreditation Number: 2562, Site Number: 3146.

SAMPLE RECEIPT ADVICE

SE140023A

CLIENT DETAILS

Client Jeffery & Katauskas Pty Ltd

Project E284831K - Additional Analysis

SUMMARY OF ANALYSIS

No.	Sample ID	Sample Subcontracted
004	BH1 3.9-4.0m	1
005	BH1 4.9-5.0m	1

The above table represents SGS Environmental Services' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

Blackman, Daniel (Sydney)

From: Geoff Fletcher [GFletcher@jkgroup.net.au]
Sent: Wednesday, 17 June 2015 10:16 AM
To: AU.Environmental.Sydney (Sydney)
Subject: RE: Report Job SE140023, your reference E284831K, order number

Importance: High

Hi Trent,

Could we please schedule some additional sPOCAS testing on the following two samples on hold:
E28431K BH1 3.9-4.0m; and
E28431K BH1 4.9-5.0m.

Also the lab report has listed the wrong sample depth for sample 3 ID. Depth should be 5.9-6.0 not 2.9-6.0m

-----Original Message-----
From: AU.Environmental.Sydney@SGS.com [mailto:AU.Environm
Sent: Thursday, 11 June 2015 8:07 PM
To: Geoff Fletcher
Subject: Report Job SE140023, your reference E284831K, order number

Dear Geoff,

Please find attached the report for SGS job SE140023, your reference E284831K, order number .

-IMPORTANT INFORMATION ABOUT YOUR REPORT-
To align with NEPM 1999 (2013), SGS Environmental has changed the way Silica Gel Clean-up of TRH extracts is reported. TPH Silica Gel has now become TRH - Silica. NEPM 1999(2013) seeks to clarify TRH and TPH in Schedule B3, 10.2.7.

If you have any questions or concerns, please don't hesitate to contact your SGS Client Services representative.

Regards,
Huong Crawford