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Project 35046/2

31October 2002

REPORT ON
ACID SULPHATE SOILS ASSESSMENT
PROPOSED PRAWN FARM
GUTHALUNGRA

1.0 INTRODUCTION

This report presents the results of an acid sulphate soils (ASS) investigation for a proposed prawn farm approximately 5km north of Guthalungra, located between Bowen and Home Hill. The work was carried out for Sinclair Knight Merz (SKM) on behalf of Pacific Reef Fisheries.

A geotechnical investigation was also conducted in parallel and is reported under separate cover (DP Report: 35046/1).

The scope of work performed by Douglas Partners Pty Ltd (DP) comprised a series of backhoe test pits at locations generally distributed throughout the proposed facility, followed by laboratory testing and reporting.

A preliminary investigation of limited extent was carried out by SKM in February 2000 and comprised limited POCAS testing and summary of soil engineering properties. Some of the ASS data from this earlier SKM report is referred herein.

The objective of this present assessment was to perform additional more detailed investigation for the presence of acid sulphate soils, across the entire proposed aquaculture ponds and dams area, and in general accordance with the QASSIT Guidelines (Ref 1).

A layout drawing showing the areal extent of the proposed development was provided by SKM to assist in the investigation.

A draft version of this report was issued on 14 August 2002. There have not been any changes since issue of the draft.

2.0 SITE DESCRIPTION AND PROPOSED FACILITIES

The site is located approximately 5km north of Guthalungra and 58km south east of Home Hill, on a relatively flat coastal plain with some shallow drainage channels or swales. Extensive tidal mud flats were observed bordering on and beyond the northern extremity of the site. Vegetation cover comprised relatively short grasses and scattered trees. The site covers an area of approximately 340ha (refer Drawing 1).

At the time of the investigation, the property was being used for cattle grazing. Several relatively small dams were located near the central western portion of the site (Stage 2 ponds) and a larger dam with cattle yards situated in the south eastern corner (near the proposed office and processing facility).

As indicated on attached Drawing 1 and discussed more fully in Section 4.0 below, the surface terrain was observed to comprise predominantly two main types as follows:

- terrain with a relatively smooth surface (easily traversed);
- terrain with shallow depressions and dried out cattle hoof prints (rough surface).

In addition, two discrete small areas were observed which appeared to differ from the above terrain. They are described as follows:

- A narrow strip of land, approximately 40m to 50m wide, and probably directly underlain by sand, extended northwards from the vicinity of Pit 54 for approximately 300m to 400m. This strip of land contained a group of trees not encountered outside the strip.

- A salt flat tributary of slightly depressed land in the vicinity of Pit 39, drained northward to the salt flats located beyond the northern boundary of the site, and was probably underlain by relatively soft clay.

3.0 GEOLOGY

The Queensland Department of Mines' 1:250,000 Geological Series Ayr Sheet and accompanying Explanatory Notes indicate the site to be underlain by alluvial and deltaic sedimentary deposits, of varying particle size (sand through clay with gravel) and "semi-consolidated in places". Close to and beyond the northern boundary of the site the map indicates coastal mudflats (littoral flats and salt pans) and superficial coastal sand dunes. All sediments are indicated to be of Quaternary age.

The map does not differentiate between the older Pleistocene sediments and more recent Holocene sediments which are both sub-eras of the Quaternary. Published data indicates that only the Holocene aged sediments, and more specifically, coastal and lagoonal deposits, are known to be conducive to the formation of acid sulphate soils.

It is considered probable that only the coastal mud flats are likely to be underlain by acid sulphate soils (ASS). Hence it is unlikely, based on the published data, that ASS will be encountered except along the northern boundary of the site or possible north draining salt flat tributories.

4.0 INVESTIGATION FIELD WORK

4.1 Methods

The field work performed by DP was undertaken between 25 June and 28 June 2002 and comprised the following:

- walkover appraisal by a senior geo-environmental engineer and experienced geo-environmental engineer from Douglas Partners (DP);

- subsurface investigation by 54 backhoe test pits (designated Pits 1 to 54); directed by an experienced geo-environmental engineer from DP who logged the profiles encountered, took soil samples for testing and took groundwater depth measurements; and
- establishment of a field laboratory, operated by the above field geo-environmental engineer, to perform daily ASS screening tests on the samples of soil excavated from the pits.

The test pits were located on a general grid of 200m to 500m with occasional additional pits allocated as considered appropriate.

The test pits were set out by the field geo-environmental engineer using a hand-held GPS, based on AMG coordinates supplied by SKM. It should be noted that the coordinates required conversion to the WGS 84 datum, as handheld GPS units are not equipped to process the supplied AMG coordinates. The approximate locations of these pits are indicated on attached Drawing 1.

4.2 Sampling Frequency

Best practice management and identification of ASS is presented in the QASSIT Guidelines (Ref 1). In accordance with QASSIT, initial assessment of the likelihood of ASS occurring can be made using aerial photography, maps and information on geomorphology, soils, height above sea level, land use, hydrology and any soil or water tests previously performed in or around the area.

It follows that the frequency of sampling, as suggested in the QASSIT Guidelines, has been relaxed in this present study, due to the following:

- limited previous geotechnical sampling (including ASS screening tests) performed by SKM prior to this assessment;
- a walkover survey of the terrain was performed by an experienced senior geo-environmental consultant from Douglas Partners prior to commencement of sampling, for validation of published map information.

For this investigation, only 28 of the 54 pits located closest to the tidal flats were sampled for ASS test purposes. Samples were taken at 0.5m depth increments to depths of generally 3m.

4.3 Results

The subsurface conditions encountered in the DP test pits (Pits 1 to 54) are presented in the attached report sheets.

These should be read in conjunction with the general notes preceding them, which explain descriptive terms and classification methods.

4.3.1 Soils

It is considered probable that most of the soils encountered are of alluvial or deltaic flood plain origins, although it is considered possible that soils of lower strength consistency (i.e. relatively more soft) may represent buried coastal or lagoonal deposits. Such coastal deposits may be represented in Pit 39, and the slightly depressed salt flat tributary feature draining northwards from there.

With the exception of Pit 39, where a layer of soft silty clay was encountered, and Pit 54, which was situated within a relatively narrow sandy strip (refer Section 2.0 above), the site can be divided broadly into two generalised profiles, based on near surface conditions as follows:

Shallow Profile 1 – Dark Grey Silty Clays (Rough Surface)

Approximately one half of the pits (22 no) encountered generally very stiff dark grey silty clay from the surface to depths between 0.35m and 1.4m depth (but more frequently between 0.8m to 1.4m depth). The ground surface at and surrounding these locations was generally very uneven, and considered to be highly moisture sensitive. Traversing the terrain underlain by this layer was generally slow, due to the large number of holes either creating by pooling water (previously evaporated/absorbed) or by hoof prints of the cattle grazing across the property, imprinted when the ground was probably moist. The approximate extent of the area underlain by this material is delineated on attached Drawing 1.

Underlying this upper clay was a **Transition Layer** of generally hard sandy/silty clays. These clays were sometimes fissured and usually grey brown/brown grey. This clay layer extended to depths between 0.9m and 3.2m depth (but more frequently 1.7m to 3.2m depth), although it was not apparent in Pits 12 and 51.

Shallow Profile 2 – Brown Grey Sandy / Silty Clay (Relatively Smooth Surface)

The remaining test pits (30 no) generally encountered very stiff to hard grey brown / brown grey slightly sandy to sandy silty clay to depths between 0.3m and 3.1m (but more frequently between 0.3m to 1.2m depth). This clay was commonly fissured and contained trace amounts of fine to coarse gravel sized carbonate nodules.

The upper clay layer was generally underlain by a **Transition Layer** of mottled orange brown slightly sandy to sandy silty clay, grading to clayey sand in places. Weak cementation was regularly observed within the orange brown layer. Some fine to coarse subrounded gravel was observed where the layer graded to clayey sand.

At two locations (Pit 4 and 41) excavation was terminated early due to virtual backhoe refusal on variably cemented gravelly sandy clay/clayey gravelly sand. It is considered that this cementation most probably represents a localised induration process and does not represent underlying bedrock.

Beneath the silty or sandy clay soils described under **'Shallow Profiles 1 and 2'** above, many of the test pits (30 out of the 54 excavated) encountered clayey sand. These **'Deep Profile'** soils, where encountered, were noted below depths of 0.8m to 2.8m (below an average depth of 1.8m).

4.3.2 Groundwater

Groundwater was encountered during excavation between depths of 2.3m to 3.1m in Pits 20, 22, 23, 25, 34, 36 and 37. It should be noted, however, that groundwater depths are affected by climatic conditions and soil permeability and, at this site, probably by tidal influence, and will therefore vary with time.

5.0 ACID SULPHATE SOILS TESTING

Soil testing for actual acid sulphate soils (AASS) and potential acid sulphate soils (PASS) was carried out in accordance with the QASSIT Guidelines (Ref 1).

Initially, all samples (taken at approximately 0.5m depth intervals) were screened on site by measurement of pH after the addition of distilled water (pH_F) and peroxide (pH_{FOX}). This provided an approximate, non quantitative indication of AASS or PASS conditions.

Based on the results of the screening tests, selected samples were transferred to Australian Environmental Laboratories (AEL) where they were subjected to detailed analysis using the Peroxide Oxidation Combined Acidity and Sulphate (POCAS) method. Several samples were also submitted for Sulphur reducible Chromium (S_{Cr}) testing.

The results of the screening tests (pH_F and pH_{FOX}) are presented in Table 5.1 below, along with a summary of the results of POCAS testing. The detailed AEL results are attached.

The results of 34 previous POCAS tests commissioned by SKM in Pits G1 to G13 were reported in February 2000. Only 3 of these results were reported above the detection limits of the laboratory. These 3 results are summarised in Table 5.2 below.

Table 5.1 – Summary of Acid Sulphate Soils Testing, This Investigation

Sample Location	Depth (m)	Screening Tests			POCAS				Chromium Reducible Sulphur Scr (% w/w)	Soil Description
		Natural pH_F	Oxidised pH_{FOX}	Strength of Reaction (0,1,2,3)*	Sulphur S_{POS} (% w/w)	TSA (kg H_2SO_4/ tonne)	TPA (kg H_2SO_4/ tonne)	pH_{OX}		
11	0.5	9.4	8.2	3	-	-	-	-	-	dark grey silty clay
	1.0	8.9	8.1	3F	-	-	-	-	-	light brown sandy silty clay
	1.5	8.6	8.3	3	-	-	-	-	-	light brown slightly sandy silty clay
	2.0	8.4	8.1	3	-	-	-	-	-	light brown slightly sandy silty clay
	2.5	8.6	7.6	3F	-	-	-	-	-	light orange brown clayey sand
	3.0	8.1	7.8	3	<0.005	<0.5	<0.5	6.8	-	light orange brown clayey sand
12	0.5	8.2	5.3	3F	-	-	-	-	-	dark grey silty clay
	1.0	8.0	7.8	3	-	-	-	-	-	light brown clayey sand
	1.5	8.1	6.9	2	0.019	<0.5	<0.5	7.3	-	light brown clayey sand
	2.0	8.1	7.9	3	-	-	-	-	-	light brown clayey sand
	2.5	7.9	7.7	2	-	-	-	-	-	light orange brown gravelly sand
	3.0	8.0	7.7	2	-	-	-	-	-	light orange brown gravelly sand
15	0.5	8.0	6.0	3F	**0.03**	<0.5	<0.5	6.9	-	dark grey silty clay
	1.0	7.9	7.5	3	-	-	-	-	-	dark grey silty clay
	1.5	8.0	8.2	3	-	-	-	-	-	light orange brown sandy silty clay
	2.0	7.7	8.3	3	-	-	-	-	-	light orange brown sandy silty clay
	2.5	7.7	8.2	3	-	-	-	-	-	light orange brown sandy silty clay
	3.0	7.7	8.1	2	-	-	-	-	-	orange brown clayey sand

Legend * '0' denotes no visible bubbling
'3' denotes strong bubbling and effervescence accompanied by escape of gas
'F' denotes frothing as typical of reaction with organic matter
Result in bold indicates action criteria equalled or exceeded for management plan (Ref 1)

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Table 5.1 (continued) – Summary of Acid Sulphate Soils Testing, This Investigation

Sample Location	Depth (m)	Screening Tests			POCAS				Chromium Reducible Sulphur Scr (% w/w)	Soil Description
		Natural pH_F	Oxidised pH_{FOX}	Strength of Reaction (0,1,2,3)*	Sulphur S_{POS} (% w/w)	TSA (kg H_2SO_4/ tonne)	TPA (kg H_2SO_4/ tonne)	pH_{OX}		
16	0.5	8.3	6.9	3F	-	-	-	-	-	dark grey silty clay
	1.0	8.3	8.0	3	-	-	-	-	-	light brown slightly sandy silty clay
	1.5	8.3	7.9	3	0.02	<0.5	<0.5	6.9	-	light brown slightly sandy silty clay
	2.0	7.9	8.0	3	-	-	-	-	-	light brown slightly sandy silty clay
	2.5	8.0	8.0	3	-	-	-	-	-	light brown slightly sandy silty clay
	3.0	8.1	8.1	2	-	-	-	-	-	orange brown clayey sand
17	0.5	8.1	4.6	3	**0.03**	<0.5	<0.5	6.7	0.014	dark grey silty clay
	1.0	8.2	8.0	3F	-	-	-	-	-	light brown slightly sandy silty clay
	1.5	8.4	7.9	3F	-	-	-	-	-	light brown slightly sandy silty clay
	2.0	8.4	7.2	3	-	-	-	-	-	light brown slightly sandy silty clay
	2.5	8.3	8.1	3	-	-	-	-	-	light brown slightly sandy silty clay
	3.0	8.1	8.0	2	-	-	-	-	-	light brown slightly sandy silty clay
18	0.5	8.3	7.2	3F	-	-	-	-	-	dark brown grey silty clay
	1.0	8.3	7.4	3	0.018	<0.5	<0.5	6.7	-	light grey brown slightly sandy silty clay
	1.5	8.4	7.8	3F	-	-	-	-	-	light grey brown slightly sandy silty clay
	2.0	8.5	8.0	3F	-	-	-	-	-	light grey brown slightly sandy silty clay
	2.5	8.3	7.9	3F	-	-	-	-	-	light grey brown slightly sandy silty clay
	3.0	8.2	8.0	3	-	-	-	-	-	light grey brown sandy clay
19	0.5	7.8	6.3	3F	-	-	-	-	-	dark grey silty clay
	1.0	7.9	6.2	3	0.02	<0.5	<0.5	6.8	-	light brown sandy silty clay
	1.5	8.2	7.7	3	-	-	-	-	-	light brown sandy silty clay
	2.0	8.2	7.5	3	-	-	-	-	-	light brown sandy silty clay
	2.5	8.2	6.9	3	-	-	-	-	-	orange brown sandy silty clay
	3.0	8.3	7.5	3	-	-	-	-	-	orange brown sandy silty clay

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20	0.5	8.4	6.3	3F	0.016	<0.5	<0.5	6.8	<0.005	dark brown grey silty clay
	1.0	8.6	7.0	3	-	-	-	-	-	light brown sandy silty clay
	1.5	8.7	7.8	3	-	-	-	-	-	light brown sandy silty clay
	2.0	8.5	8.1	2	-	-	-	-	-	light brown sandy silty clay
	2.5	8.3	8.0	2	-	-	-	-	-	light grey silty sand
	3.0	8.1	7.6	3	-	-	-	-	-	light grey silty sand
21	0.5	7.6	5.7	3F	0.024	<0.5	<0.5	9.1	-	grey brown slightly sandy silty clay
	1.0	7.5	6.5	3F	-	-	-	-	-	red brown sandy silty clay
	1.5	7.9	5.9	3F	-	-	-	-	-	red brown clayey sand
	2.0	8.2	5.7	3F	-	-	-	-	-	red brown clayey sand
	2.5	8.1	8.0	3	-	-	-	-	-	red brown silty sand
	3.0	8.2	7.8	3	-	-	-	-	-	red brown silty sand
22	0.5	8.3	5.7	3F	-	-	-	-	-	light yellow brown slightly sandy silty clay
	1.0	8.2	5.9	3F	-	-	-	-	-	light yellow brown slightly sandy silty clay
	1.5	8.1	6.0	3F	-	-	-	-	-	light yellow brown slightly sandy silty clay
	2.0	8.0	7.3	3F	-	-	-	-	-	light yellow brown slightly sandy silty clay
	2.5	8.1	7.3	3F	-	-	-	-	-	light yellow brown slightly sandy silty clay
	3.0	7.8	5.3	2	0.011	<0.5	<0.5	7.4	-	light brown silty sand
23	0.5	8.1	7.9	3F	-	-	-	-	-	light grey silty clay
	1.0	8.3	8.0	3F	-	-	-	-	-	light brown clayey sand
	1.5	8.4	8.1	3F	-	-	-	-	-	light brown clayey sand
	2.0	8.2	7.9	3	<0.005	<0.5	<0.5	7.6	-	light brown clayey sand
	2.5	8.2	8.0	3	-	-	-	-	-	light brown clayey sand
	3.0	8.1	7.9	2	-	-	-	-	-	light brown clayey sand

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24	0.5	8.5	7.6	3F	-	-	-	-	-	dark grey slightly sandy silty clay
	1.0	8.2	7.3	3F	-	-	-	-	-	light brown sandy silty clay
	1.5	8.0	7.4	3F	-	-	-	-	-	light brown sandy silty clay
	2.0	8.0	7.7	3	-	-	-	-	-	light brown sandy silty clay
	2.5	8.1	6.0	3F	0.01	<0.5	<0.5	7.4	-	light brown grey slightly sandy silty clay
	3.0	8.0	6.1	3F	-	-	-	-	-	light brown grey slightly sandy silty clay
25	0.5	7.8	6.6	3	-	-	-	-	-	light brown silty clay
	1.0	8.0	6.2	3F	-	-	-	-	-	orange brown sandy clay
	1.5	8.1	5.3	3	-	-	-	-	-	orange brown sandy clay
	2.0	7.6	4.7	2	-	-	-	-	-	orange brown clayey sand
	2.5	7.6	4.6	1	-	-	-	-	-	orange brown clayey sand
	3.0	7.4	4.5	1	<0.005	<0.5	<0.5	7.3	-	orange brown clayey sand
26	0.5	8.2	6.2	3F	-	-	-	-	-	dark brown grey silty clay
	1.0	8.2	7.5	3F	-	-	-	-	-	light brown sandy clay
	1.5	8.4	8.4	3F	<0.005	<0.5	<0.5	7.1	-	light brown sandy clay
	2.0	8.2	6.1	3F	-	-	-	-	-	light brown sandy clay
	2.5	8.2	7.5	3	-	-	-	-	-	light brown sandy clay
	3.0	8.4	6.1	3F	-	-	-	-	-	orange brown sandy silty clay
27	0.5	6.4	4.7	1	0.013	<0.5	<0.5	7.0	-	dark brown grey silty clay
	1.0	6.7	6.9	3F	-	-	-	-	-	dark brown grey silty clay
	1.5	7.1	7.4	3	-	-	-	-	-	light brown clayey sand
	2.0	7.1	7.9	3	-	-	-	-	-	light brown clayey sand
	2.5	7.4	5.6	3	-	-	-	-	-	light brown clayey sand
	3.0	7.3	6.1	3	-	-	-	-	-	light brown clayey sand

Legend

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28	0.5	6.8	7.1	3F	-	-	-	-	-	light brown grey silty clay
	1.0	7.6	7.8	2	-	-	-	-	-	light brown grey silty clay
	1.5	7.8	7.8	3	-	-	-	-	-	light brown grey silty clay
	2.0	8.0	7.5	3	-	-	-	-	-	light brown grey silty clay
	2.5	8.1	7.5	3	-	-	-	-	-	light brown grey silty clay
	3.0	8.3	7.1	3	-	-	-	-	-	light brown grey silty clay
29	0.5	8.3	6.9	3F	-	-	-	-	-	dark brown silty clay
	1.0	8.3	7.9	3	-	-	-	-	-	light orange brown clayey silt
	1.5	8.5	8.3	3	-	-	-	-	-	light orange brown clayey silt
	2.0	8.8	8.6	3+	-	-	-	-	-	light brown clayey sand
	2.5	8.7	6.2	2	<0.005	<0.5	<0.5	7.2	-	light brown clayey sand
	3.0	8.8	8.0	2	-	-	-	-	-	light grey clayey sand
30	0.5	8.6	7.8	3	-	-	-	-	-	brown grey silty clay
	1.0	8.8	8.3	3	-	-	-	-	-	brown sandy silty clay
	1.5	8.9	8.3	3	-	-	-	-	-	brown sandy silty clay
	2.0	8.9	6.8	2	-	-	-	-	-	light brown sandy silty clay
	2.5	8.7	6.4	2	<0.005	<0.5	<0.5	7.2	-	light grey brown clayey sand
	3.0	8.6	7.9	3	-	-	-	-	-	light grey brown clayey sand
31	0.5	7.9	4.5	3F	0.017	<0.5	<0.5	6.9	-	dark brown grey silty clay
	1.0	7.4	5.9	3F	-	-	-	-	-	dark brown grey silty clay
	1.5	7.8	6.5	3F	-	-	-	-	-	light grey sandy silty clay
	2.0	8.3	7.4	3	-	-	-	-	-	light grey sandy silty clay
	2.5	8.2	7.5	3	-	-	-	-	-	light grey sandy silty clay
	3.0	8.1	7.5	3F	-	-	-	-	-	light grey sandy silty clay

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32	0.5	9.0	7.4	3F	-	-	-	-	-	dark brown grey silty clay
	1.0	9.3	6.9	2	-	-	-	-	-	light brown clayey sand
	1.5	8.9	8.7	3	<0.005	<0.5	<0.5	6.8	-	dark grey brown silty clay
	2.0	9.4	8.6	3F	-	-	-	-	-	dark grey brown silty clay
	2.5	9.2	8.8	3	-	-	-	-	-	dark grey brown silty clay
	3.0	9.1	8.9	3	-	-	-	-	-	dark grey brown silty clay
33	0.5	7.8	4.6	1	0.012	<0.5	<0.5	6.9	<0.005	dark grey silty clay
	1.0	7.8	7.3	2F	-	-	-	-	-	dark grey silty clay
	1.5	8.1	7.9	3	-	-	-	-	-	light brown sandy silty clay
	2.0	8.4	8.0	3	-	-	-	-	-	light brown sandy silty clay
	2.5	8.1	8.0	3	-	-	-	-	-	light brown sandy silty clay
	3.0	8.1	7.6	3	-	-	-	-	-	light grey brown gravelly clayey sand
34	0.5	8.2	7.8	3F	-	-	-	-	-	light grey gravelly sandy silty clay
	1.0	8.3	5.9	1	-	-	-	-	-	light grey gravelly clayey sand
	1.5	8.1	5.7	3	-	-	-	-	-	light grey gravelly clayey sand
	2.0	7.7	5.8	2	-	-	-	-	-	light grey gravelly clayey sand
	2.5	7.7	5.6	3	<0.005	<0.5	<0.5	6.8	-	light grey gravelly clayey sand
	3.0	7.6	6.1	2	-	-	-	-	-	light grey gravelly clayey sand
35	0.5	8.1	7.1	3F	-	-	-	-	-	dark grey silty clay
	1.0	7.1	7.7	3	-	-	-	-	-	dark grey silty clay
	1.5	7.3	7.6	3	-	-	-	-	-	light brown silty clay
	2.0	8.6	8.2	3	-	-	-	-	-	light brown silty clay
	2.5	8.5	8.0	3	-	-	-	-	-	brown grey silty clay
	3.0	8.8	8.6	3	-	-	-	-	-	brown grey silty clay

Legend — * *'0' denotes no visible bubbling*
'3' denotes strong bubbling and effervescence accompanied by escape of gas
'F' denotes frothing as typical of reaction with organic matter
Result in bold indicates action criteria equalled or exceeded for management plan (Ref 1)

Table 5.1 (continued) – Summary of Acid Sulphate Soils Testing, This Investigation

Sample Location	Depth (m)	Screening Tests			POCAS				Chromium Reducible Sulphur Scr (% w/w)	Soil Description
		Natural pH_F	Oxidised pH_{FOX}	Strength of Reaction (0,1,2,3)*	Sulphur S_{POS} (% w/w)	TSA (kg H_2SO_4/ tonne)	TPA (kg H_2SO_4/ tonne)	pH_{OX}		
36	0.5	8.5	8.2	3F	-	-	-	-	-	grey silty clay
	1.0	8.5	7.2	2	-	-	-	-	-	grey silty clay
	1.5	8.3	6.6	3	-	-	-	-	-	light grey silty sandy clay
	2.0	8.7	6.1	3	<0.005	<0.5	<0.5	7.0	-	light grey silty sandy clay
	2.5	8.8	5.9	2	-	-	-	-	-	light grey clayey sand
	3.0	7.9	6.6	2	-	-	-	-	-	light grey clayey sand
37	0.5	8.1	7.8	3	-	-	-	-	-	light brown grey silty clay
	1.0	8.2	8.1	3	-	-	-	-	-	light brown grey silty clay
	1.5	8.8	7.4	3	-	-	-	-	-	light brown grey silty clay
	2.0	8.2	6.3	1	-	-	-	-	-	light grey clayey sand
	2.5	8.5	5.9	1	0.011	<0.5	<0.5	6.9	-	light grey clayey sand
	3.0	8.4	7.5	3	-	-	-	-	-	light grey clayey sand
38	0.5	8.6	7.0	3F	-	-	-	-	-	brown clayey silt
	1.0	8.5	6.8	3	-	-	-	-	-	brown clayey silt
	1.5	8.3	8.0	3F	-	-	-	-	-	grey brown silty clay
	2.0	8.5	6.4	2	-	-	-	-	-	light grey silty clay
	2.5	8.2	7.9	2	-	-	-	-	-	light grey silty clay
	3.0	8.1	8.4	3	-	-	-	-	-	light grey silty clay
39	0.5	7.0	4.8	1	-	-	-	-	-	light grey silty clay
	1.0	4.8	3.1	1	-	-	-	-	-	dark grey sandy silty clay
	1.5	5.1	3.8	3F	-	-	-	-	-	light brown clayey sand
	2.0	8.7	1.2	3	**0.2**	<0.5	<0.5	3.5	-	grey silty clay
	2.5	8.9	7.3	3	-	-	-	-	-	grey silty clay
	3.0	8.4	1.6	3	**0.94**	<0.5	<0.5	2.0	-	grey silty clay

Legend * *'0' denotes no visible bubbling*
'3' denotes strong bubbling and effervescence accompanied by escape of gas
'F' denotes frothing as typical of reaction with organic matter
Result in bold indicates action criteria equalled or exceeded for management plan (Ref 1)

Table 5.2 – Summary of Acid Sulphate Soils Tests, as Commissioned by SKM (February 2000), and above the Detection Limits of the Laboratory

Test Pit	Depth (m)	Sulphur S_{POS} (% w/w)	TSA[2] (($kg\ H_2SO_4$ per tonne)	TPA[2] ($kg\ H_2SO_4$ per tonne)	Description[1]
G1C	2.1	**0.26**	**6.8**	**6.8**	grey, wet, sand, grit
G2C	1.7	**0.57**	**13.9**	**13.9**	grey, wet, silty sand
G8A	0.3	<0.02	0.2	0.2	loose sandy topsoil, slightly clay
G13A	0.5	<0.02	0.8	0.8	light brown sandy clay

Note:
1. *Soil descriptions were made by SKM staff.*
2. *Results were originally quoted by SKM in mol H+/tonne and have been converted to kg H_2SO_4/tonne for overall consistency.*
3. *Results in bold indicate action criteria equalled or exceeded for management plan (Ref 1).*

6.0 COMMENTS

6.1 Criteria for Evaluation of Test Data

The criteria on which the results of screening tests (pH_F and pH_{FOX}) were assessed as indicative of possible actual acid sulphate soils (AASS) or potential acid sulphate soils (PASS) were based on the QASSIT Guidelines (Ref 1) as follows:

- pH_F <4 indicates oxidation has occurred in the past and that AASS is present. The screening test results were all above pH 7 with the exception of Pit 39 (pH_F = 4.8 at 1.0m depth);
- pH_{FOX} <3, plus a pH_{FOX} reading at least one pH unit below pH_F, plus a strong reaction with peroxide. This condition was only encountered in Pit 39 at similar depths of 2.0m and 3.0m.

The above criteria were used to select samples for quantitative laboratory analysis of AAS by POCAS tests. A few chromium reducible sulphur (S_{cr}) tests were also conducted. In addition samples with the lowest pH_F in each test pit were generally selected for POCAS.

The action criteria on which the presence of ASS was made from POCAS test results and which trigger a requirement for a site management plan were also based on QASSIT (Ref 1) as follows:

- recorded level of 0.03% oxidisable sulphur (S_{pos} or S_{cr}) by dry weight; or
- 0.9kg of acid per tonne of soil (TPA or TSA) which is the equivalent of 18 moles of acid per tonne of soil).

6.2 Presence of ASS

The results of the field screening and laboratory tests performed to date indicate that neither AASS nor PASS are likely to be encountered across the majority of the proposed pond and dam developments. This is in agreement with the geology of the area (refer Section 3.0 above) which suggests that only the coastal mud flats and salt pan terrain north of the subject site is of Holocene age and hence conducive to the presence of ASS.

The main exception to this is the low lying area draining northwards in the vicinity of Pit 39. This is described in Section 2.0 and 4.3.1 as a tributary of the salt flats beyond the northern boundary of the site. The strongest indicators of PASS were found below 2m depth in Pit 39. The test results exceeded the trigger values for application of an acid sulphate soils management plan (ASSMP). Calculations indicate 10kg to 50kg of lime is required per tonne of soil for neutralisation if this area is to be disturbed. This includes a factor of safety of 1.5.

The earlier POCAS tests commissioned by SKM (February 2000) indicated the results of samples from Pits G1 and G2, located close to the west bank of the Elliott River, to be in excess of ASSMP trigger values. Calculations indicate 10kg and 20kg lime per tonne of soil for neutralisation. It is understood, however, that this area (G1 and G2) is located outside the proposed development.

More marginal results were obtained at the locations of Pits 15 and 17 where the sulphur trail results (S_{pos}) at shallow depth (0.5m) were both equal to the trigger values for ASSMP. Here, it should be noted that frothing occurred in one of the samples during screening (Pit 15 at 0.5m) which is indicative of organic content. Although no frothing was encountered in the other sample (Pit 17 at 0.5m), the additional S_{cr} result was much lower (0.014%) than the S_{pos} result (0.03%). It should be noted that the chromium reducible sulphur test (S_{cr}) is described in ASSMAC (Ref 2) as being "not measurably affected by sulphur in organic matter". It follows that the S_{pos} tests for those shallow samples may be falsely high due to the probable presence of sulphur in organic matter.

6.3 Additional Work

Based on the above, it is suggested that additional work of minor extent be performed to define the extent of ASS (if any) in the vicinity of Pits 15 and 17 and to confirm that PASS conditions in the vicinity of Pit 39 are confined to the drainage channel connecting to the salt flats to the north.

As the pipeline routes, which are to cross the salt flats north east of Pit 17, have not yet been investigated, it is suggested that the additional investigation of Pit 15, 17 and 39 areas, outlined above, be performed at the same time.

DOUGLAS PARTNERS PTY LTD Reviewed By:

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Reference:

1. Ahern, CR, Ahern, MR, and Powell, B, "Guidelines for Sampling and Analysis of Lowland Acid Sulphate Soils (ASS) in Queensland 1998," QASSIT, Department of Natural Resources, Resource Sciences Centre, Indooroopilly, October 1998.

2. Stone, Y, Ahearn, CR and Blunden, B, "Acid Sulphate Soils Manual 1998", Acid Sulphate Soil Management Advisory Committee, Wollongbar, NSW, 26 August 1998.