QNRM05524

ACID SULFATE SOILS

OF THE NARROWS AREA,

CENTRAL QUEENSLAND COAST

D J Ross

FITZROY BASIN ASSOCIATION

Natural Heritage Trust
Helping Communities Helping Australia
A Commonwealth Government Initiative

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Natural Resources and Mines

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Department of Natural Resources & Mines
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Summary

Acid sulfate soil mapping has been undertaken at 1:50 000 scale for a relatively undisturbed section of the Central Queensland coast from Friend Point to Connor Creek, The Narrows. The mapping identifies areas of both actual acid sulfate soils and potential acid sulfate soils and their depth of occurrence. Almost all of the land containing acid sulfate soils occurs within the tidal zone with an elevation of less than 5m Australian Height Datum.

Within The Narrows survey area, there are 7,119.6 ha of land mapped with acid sulfate soils. Actual acid sulfate soils total 1,557 ha, and potential acid sulfate soils 5,562.6 ha. A further 1,201.4 ha of land with limited field assessment is likely to contain acid sulfate soils.

Descriptions of the acid sulfate soil map units are presented in this report. Chemical data for selected depth samples are appended. Sample site location is illustrated on the accompanying Sampling Sites map. The distribution of acid sulfate soils is shown on the Acid Sulfate Soils map.

An additional map presenting acid sulfate soil hazard has also been included. This map is an assessment of the acid sulfate soil mapping and chemical data in which land is classified into four classes of acid generation potential. The four classes are very low, low, moderate and high. The distribution of soils with potential for acid generation is shown on the Acid Sulfate Hazard map.

The acid sulfate soils are dominantly clay rich sediments, and saturated with a shallow or perched watertable. Actual acid sulfate soils are greyish brown in colour with pale yellow mottles overlying grey to greenish grey organic-enriched substrate materials. Potential acid sulfate soils are typically greenish grey to dark grey in colour with organic materials.

Ninety-six percent of the area assessed with actual and potential acid sulfate soils has acid sulfate soil layers within 0.5 m depth from the soil surface. Layers of high acid generation potential occur within 0.5m depth from the soil surface over much of the area.

Oxidisable sulfur levels of up to 12.4% and potential acidities to 8,358 mol H^+/t were recorded on an intertidal flat. At slightly higher elevations, the supratidal flats have up to 9.4% oxidisable sulfur and potential acidities to 6,254 mol H^+/t. These levels exceed the highest levels previously recorded for the southern portion of the Central Queensland coast area.

Retained acidity or net acid soluble sulfur levels of up to 1.6% occur in jarosite layers of actual acid sulfate soils. The survey area also contains some tidally affected lands with no acid sulfate soils.

Six piezometers or shallow groundwater monitoring bores were installed at strategic locations in the study area to allow collection of baseline water quality data. Initial field results indicate very low levels of dissolved oxygen, and elevated electrical conductivity readings in all of the standing waters of the bores.

1. Introduction

A mapping project to identify the extent of acid sulfate soils at six coastal locations in Central Queensland has been initiated by the Fitzroy Basin Association, Mackay Whitsunday Natural Resource Management Group, and the Department of Natural Resources and Mines (NR&M) with funding support from the Natural Heritage Trust (NHT). Priority areas for mapping are centred around the Rockhampton and Mackay districts. As well as providing substantial in kind support, NR&M was contracted to assist in identifying areas for mapping, undertake field surveys and to provide laboratory analysis of soil and water samples.

The Narrows survey area is the first of three priority areas to be mapped along the southern Central Queensland coast. It is situated north of Gladstone (Figure 1), and covers the mainland section of the Curtis Coast from Friend Point to Connor Creek. The survey area is named after the relatively narrow tidal passage separating Curtis Island from the mainland and connecting Port Curtis to Keppel Bay. The coastline is largely characterised by mangrove mudflats and saltpans with the occasional low headland of country rock. The survey area is approximately 8,500 ha in area.

Previous sampling of acid sulfate soils along the southern part of the Central Queensland coast (Ross 2002, 2004) had identified acid sulfate soils with high levels of acid generation potential at several locations from Kangaroo Island to Ramsay Crossing in the current survey area. Acid sulfate soil mapping at 1: 50 000 scale has previously been undertaken for the adjoining Gladstone area, south of the current survey area, from Fishermans Landing to Tannum Sands (Ross 2004). This mapping project has been undertaken at the same mapping scale which represents a medium intensity survey with the suitability of the information intended for planning purposes. Map unit description and chemical data from laboratory analyses are presented in this interim report.

Acid sulfate soils (ASS) are soils or sediments containing sulfides (primarily pyrite) or an acid producing layer as the result of the oxidation of sulfides. They commonly occur on low-lying very poorly drained coastal land at elevations less than 5m AHD (Australian Height Datum). Excavating soil or sediment, extracting groundwater or filling land may cause disturbance of acid sulfate soils. When exposed to air, sulfides oxidise to produce sulfuric acid. Disturbed land can release acid, aluminium, iron and heavy metals into drainage waters affecting aquatic plants and animals. Concrete and steel infrastructure including pipes, foundations and bridges are susceptible to acidic corrosion leading to accelerated structural failure (Ahern *et al*. 1988, Powell and Martins 2005). Other potential impacts include the deoxygenation of waterways (Bush *et al*. 2004) and the excess iron stimulating blooms of cyanobacteria such as *Lyngbya majuscula* or fireweed.

Both actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS) occur throughout the survey area. AASS are soils or sediments containing highly acidic soil horizons or layers caused by the oxidation of soil materials that are rich in iron sulfides, primarily pyrite. This oxidation produces hydrogen ions in excess of the sediments capacity to neutralise the acidity, resulting in soils or sediments of pH 4 or less. PASS are soils or sediment containing iron sulfides or sulfidic materials that have not been exposed to air and oxidised. The field pH of these soils or sediment in their undisturbed state is pH 4 or more, and may be neutral or slightly alkaline (Anon 2002).

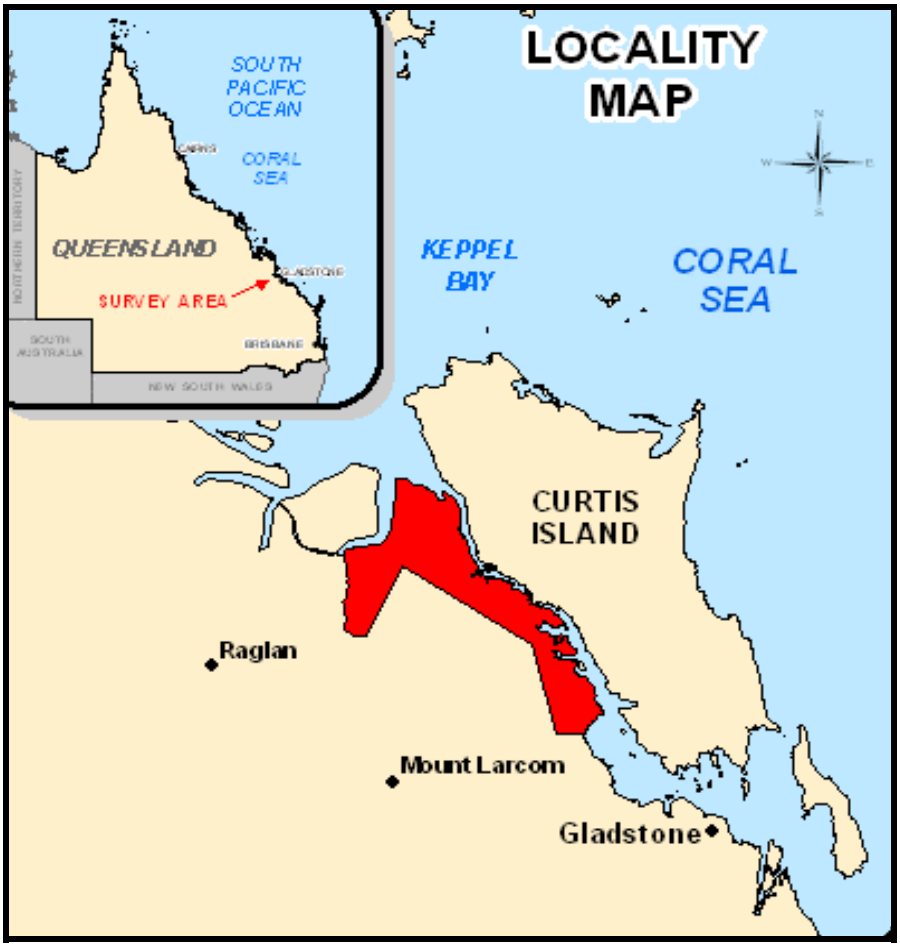

Figure 1. Location of the survey area.

2. Survey Area

The coastline from Friend Point to Connor Creek is relatively undisturbed and consists mainly of mangrove mudflats and saltpans with an occasional low headland of country rock. Mangrove mudflats dominate the southern coastline section from Ramsay Crossing to Kangaroo Island. Marine couch flats and shell ridges are minor in extent. Landward of the tidal zone lies gently sloping alluvial plains, alluvial fans or rises of country rock. Ironbark communities dominate the foreshore area east of the Rundle Range with a marked change to belah communities west of the Rundle Range.

The primary focus of the acid sulfate soil investigation in this survey is the pyritic sediments that were deposited in the Holocene period, that is, during the last 10,000 years. Experience in coastal stratigraphic mapping shows that similar, but much older pyritic sediments of Pleistocene age can occur still in a reduced (anaerobic) state, being buried under either cemented sands or old, consolidated alluvium. They are far less common than the Holocene equivalents, and have been found beneath land whose surface is both above and below 5m AHD. Consolidated pyritic sediments associated with the oil shale deposit of Tertiary age do not form part of this investigation, for example those exposed along Munduran Creek. However they have the same chemical behaviour as acid sulfate soil, and their disturbance should be treated with similar caution.

In geomorphic terms the estuaries along the Curtis Coast represent a series of drowned valleys submerged by rising sea levels (QHED 1994). Filling of the valleys with sediments from both fluvial and marine sources would have occurred during Holocene sea level rise. The landforms present today of predominantly tidal flats of fine sediment indicate low energy deposition of a marine dominated rather than a fluvial dominated depositional regime. Shell ridges at Connor Point and at The Hut provide evidence of minor occurrences of high energy deposition associated with storm events. Sandy flats at the mouth of Targinie and Humpy Creeks have formed from transported granitic materials. Lag gravels occurring on saltpans are derived from eroded terrestrial sediment.

Broad scale geological mapping of the survey area has been undertaken by Donchak and Holmes (1981) and updated by Blake *et al*., Crouch *et al*. (2001). Most of the sulfidic sediments assessed in this investigation occur in Quaternary (Holocene) estuarine mud and sand deposits in mangrove flats and saltpans at elevations <5m AHD. They also occur beneath Chenier ridges, illustrated on earlier geological maps. Landward of the tidal zone, the surface geology of The Narrows Graben includes Quaternary sand, silt, gravel and residual soil along with some outcropping Tertiary conglomerate and sandstone. From Dart Creek to Sandfly, the local country rock consists mainly of Early Carboniferous-Early Permian mudstone, siltstone and felsic volcaniclastic sandstone of an undivided Rockhampton and Berserker Group. The terrestrial sediments to the north are represented as Tertiary-Quaternary sand, mud and gravel, and high level alluvium and colluvium.

The highest astronomical tide (HAT) or predicted tide level, exclusive of extreme levels from storm surge, for the port of Gladstone is 2.27m AHD and 3.05m AHD at Ramsay Crossing, The Narrows (QHED 1994). Accurate elevation data for the sampling sites is not available and contour data indicates most of the Holocene sulfidic sediments (or acid sulfate soils) occur below an elevation of 5m AHD. Spot heights from orthophoto maps and previous sampling from the large supratidal flat at Kangaroo Island indicate the upper level of sulfidic sediment occurrence to be 3.6m AHD. These occur in areas that accommodated marine deposition during former sea level rise.

Recreational fishing in the streams and channels of The Narrows estuary is a significant land use activity. Adjacent lands south of Ramsay Crossing are largely used for grazing cattle on native pastures. These lands contain much of the oil shale bearing Tertiary sediments and rocks of The Narrows Graben. State Forest occupies the section of coastal lowland from the Ramsay Crossing Camping Reserve to Rundle Range where it adjoins the Rundle Range National Park. Valley flats and rises between Gonong and Dart Creeks are used for hardwood forestry for commercial pulp production.

3. Methods

Sites for description and assessment were selected using a free survey technique (Reid 1988) with the aid of 1:25 000 scale colour aerial photographs and orthophoto maps. The accompanying acid sulfate soil map has been compiled at 1:50 000 scale and meets the sampling requirements for medium intensity soil mapping. Areas with actual acid sulfate soils and / or potential acid sulfate soils at various depths are delineated on the map from field observation and interpretation. Acid sulfate soil information collected during a previous reconnaissance survey (Ross 2002) was used in the compilation. The map reference was adopted from the Queensland Acid Sulfate Soil Investigation Team (QASSIT) with minor modification to suit the survey area. Site and soil description follows the Australian Soil and Land Survey Field Handbook (McDonald *et al*. 1990).

Much of the sampling was undertaken using 75mm diameter stainless steel Dormer hand augers. Saturated clays from mangrove flats and saltpans were sampled with a 60mm diameter gouge auger to 1.8m depth or to the depth of hand penetration (Figure 2). Hydraulically driven stainless steel push tubes (75mm diameter) combined with tapered gouge augers (73, 60 and 48mm diameter) and push rods were used to sample sites with clay sediments and suitable vehicle access. Geoprobe percussion coring equipment was employed to sample gravelly to clayey sediments at piezometer sites.

Field pH and Electrical Conductivity (EC) tests were carried out using a WP81 pH-Conductivity meter fitted with an IJ44 pH electrode. Field pH (pH_F) and field pH peroxide (pH_{FOX}) measurements were determined at 0.25m intervals or less to the depth of sampling, in accordance with QASSIT guidelines (Ahern *et al*. 1998). Dissolved Oxygen of piezometer waters was measured using a WP82Y Dissolved Oxygen-Temperature meter fitted with a YSI 5739 field probe. Piezometer installation followed the standards outlined in Minimum Construction Requirements For Water Bores In Australia (Anon 2004).

Following field tests, soil samples for laboratory analysis were selected at each site from the upper depth of occurrence of the acid sulfate soil layer, to confirm the depth category for mapping. The lower depth of occurrence of the ASS layer was also usually sampled at each site. More frequent sampling down the soil profile occurred at Geoprobe cored sites prior to piezometer installation. Samples were placed in a portable refrigerator / freezer and packed frozen for despatch to Brisbane by overnight air express.

Selected soil samples from each site were analysed for peroxide oxidisable sulfur (an estimate of pyrite and other potential sulfur sources of acidity), titratable actual acidity and titratable peroxide acidity using the Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) method (Ahern *et al*. 2004). Laboratory results are given in the Appendix. Forty-one samples with jarosite were analysed for retained acidity by the Net Acid Soluble Sulfur (S_{NAS}) method (Ahern *et al*. 2004).

4. Description of the soil map units

The depth to an actual acid sulfate soil (AASS) layer and/or potential acid sulfate soil (PASS) layer on relatively undisturbed land is shown on the accompanying soil map by an alphanumeric code. The alpha component A refers to an AASS layer, the alpha component S to a PASS layer, while the numerical component (for example 0,1,2 etc) refers to the depth at which these layers occur. The alphanumeric codes are used separately (for example A0) or combined (for example A0S0) where the map unit contains AASS layers overlying PASS layers. Where there is varying depth to an ASS layer within a mapping unit, a forward slash is used, for example S1/S2. The acid sulfate soil map units, of relatively undisturbed land depict varying depths to the acid sulfate soil layer, are coloured using shades of red and are overlain with yellow dots where AASS is present.

Additional information is provided by code for areas of soils with a strongly acid soil layer (pH >4 <5), for example a2LP, and those containing carbonate materials (subscript N). The S_{LA} map unit code indicates ASS in areas where there was limited assessment due to restricted access. The distribution of land where there is a low probability of ASS occurring below an elevation of 5m AHD (LP) is also shown on the map.

There are 7,119.6 ha of acid sulfate soils mapped within the survey area. This area contains approximately 1,557 ha of land with AASS and 5,562.6 ha of land with PASS (Table 1). Limited assessment and landform indicates ASS are likely to occur on a further 1,201.4 ha of land.

4.1 *Actual Acid Sulfate Soils on Relatively Undisturbed Land*

A0S0 (AASS layer and PASS layer within 0.5m depth)

Mapping unit areas with the code A0S0 total 1,452.4 ha in area and represent 93% of the area of actual acid sulfate soils. They occur intermittently along the coastline with the largest areas located in the northern part of the survey area between Deception Creek and Connor Creek. The landform is typically an infrequently inundated supratidal flat (bare saltpan) with patches of samphire on slightly elevated areas or margins (Figure 3).

The soils have a thin brown, structured, medium to heavy clay surface horizon overlying a greyish brown clay subsoil of similar thickness with abundant pale yellow jarosite mottles. The lower unoxidised sulfidic layers are dark grey or greenish grey silty clays. Pre-Holocene or Pleistocene substrate, where present, is a mottled olive grey heavy clay, moist and of very firm strength, with sulfides at the interface. Surface gravel and iron segregations (Figure 4) are soil surface features of areas of relatively narrow saltpan.

The large saltpan extending from Targinie Creek to Kangaroo Island generally has high amounts of organic materials in the potential acid sulfate soil layers with oxidisable sulfur values ranging from 1.5 to 2%. These saturated organic rich sediments of the western portion of the saltpan are likely to have low load bearing strength as they barely support the weight of a person. Oxidisable sulfur levels in the actual acid sulfate soil layers with jarosite range from 0.01 to 0.2%. Retained acidity (Ahern *et al*. 2004) of these layers range from 0.2 to 0.4% pyrite sulfur equivalent.

High to extreme levels of oxidisable sulfur and acid generation potential occur in the A0S0 map units from Phillipies Landing to Ramsay Crossing. The map unit at Phillipies Landing has oxidisable sulfur levels of 2.9 to 4.8% and corresponding Titratable Peroxide Acidities (TPA) of 2,104 to 3,556 moles of hydrogen per tonne of soil (mol H^+/t), below actual acid sulfate soil layers. The levels of oxidisable sulfur in the unit at Teningie Creek range from 5.7 to 6.5% with extreme levels to 9.4% occurring in units between the creek and Ramsay Crossing. Titratable Actual Acidities (TAA) of the jarosite layers range from 17 to 112 mol H^+/t, and retained acidity of 33 to 258 mol H^+/t for the few samples analysed.

The map units located between Ramsay Crossing and The Hut contain variable levels of oxidisable sulfur. Commonly levels are >2% but can range from moderate (0.8%) to very high (7.8%). TAA of the jarosite layers range from 12 to 73 mol H^+/t and retained acidity from 6 to 323 mol H^+/t. Soil depth to underlying hard rock or terrestrial sediment can be moderate (<1m) within these relatively narrow saltpan units.

Extensive areas of saltpan between The Hut and Connor Point generally contain less visible organic materials in the soil profiles and occasionally some very fine shell fragments. Moderate levels of oxidisable sulfur (0.7 to 1.3%) and acid generation potential (563 to 700 mol H^+/t) occur in the PASS layers with a few sites containing higher levels (2.3%, 1567 mol H^+/t). Measured titratable actual acidity levels in layers with jarosite range from zero to 20 mol H^+/t, and retained acidity from zero to 97 mol H^+/t.

The relatively large saltpan unit situated south of The Hut and west of Rundle Range with mostly organic enriched sediments contains higher levels of oxidisable sulfur (1.2 to 3.8%) than between The Hut and Connor Point. An exception was a low level (0.3%) recorded at one site with no visible organic fragments. TAA values of jarosite layers within the map unit are low (<34 mol H^+/t), with retained acidity values significant (176 to 678 mol H^+/t).

The two units located between Dart Creek and Sandfly in the southwest corner of the survey area have oxidisable sulfur levels ranging from 0.97 to 5.2%. Actual acidity (TAA) levels range from zero to 69 mol H^+/t and retained acidity from 6 to 161 mol H^+/t.

A0S0/S0 (Complex of AASS and PASS layers within 0.5m depth)

This single map unit adjoins the Munduran Creek estuary at Ramsay Crossing. The landform is a supratidal flat (bare saltpan) with surface gravel and outwash gravel mounds. The unit is mapped as a soil complex because jarosite was absent in some of the soil profiles examined.

The soils have a brown to dark brown structured sandy medium clay surface horizon overlying a thin greyish brown clay subsoil with orange or pale yellow jarosite mottles. Organic fragments feature in the underlying dark grey silty clays but not the underlying heavy clay substrate. Oxidisable sulfur levels of 3.8 to 8.5% and corresponding peroxide acidities of 2,574 to 6,074 mol H^+/t, occur in the dark grey silty sediments. Lower levels of oxidisable sulfur (1.7 to 2.2%) and peroxide acidity (1,173 to 1,398 mol H^+/t) are associated with the heavy clay substrate. Jarosite layers where present, were not analysed for existing acidity.

Table 1. Area of map units.

Map Unit	Map Unit Area (ha)	Percentage of Area Assessed (%)
Actual acid sulfate soils		
A0S0	1452.4	16.92
A0S0/S0	47.2	0.55
$A0S0/S2_N$	17.6	0.21
A0S1	8.7	0.10
A1S2	6.4	0.07
A2	24.7	0.29
Total	**1557.0**	**18.14**
Potential acid sulfate soils		
S0	5389.2	62.78
$S0S1_N/S2$	12.3	0.14
S0/S1	34.9	0.41
S1	18.6	0.22
S1/S2	47.5	0.55
S2	45.3	0.53
S2/S3	14.8	0.17
Total	**5562.6**	**64.8**
Acid sulfate on undisturbed land		
S_{LA}	1201.4	13.99
Low probability ASS land		
a0LP	7.3	0.09
a2LP	43.7	0.51
LP	212.7	2.47
Total	**263.7**	**3.07**
Total area	**8584.7**	**100**

$A0S0/S2_N$ (AASS layer and PASS layer within 0.5m depth overlying PASS with carbonate materials at 1 to 2m depth)

This unit represents a degraded mangrove area at Connor Point (Figure 5), and has an eroded foreshore area adjacent to Keppel Bay (Figure 6). Removal of the mangrove cover on this intertidal flat is likely to be associated with storm events. To date it is the only intertidal flat recorded along the southern Central Queensland coast with a strongly acid soil layer (field pH 3.0).

Figure 2. Gouge auger sampling, supratidal flat, Connor Point.

Figure 3. Typical bare saltpan, A0S0 map unit.

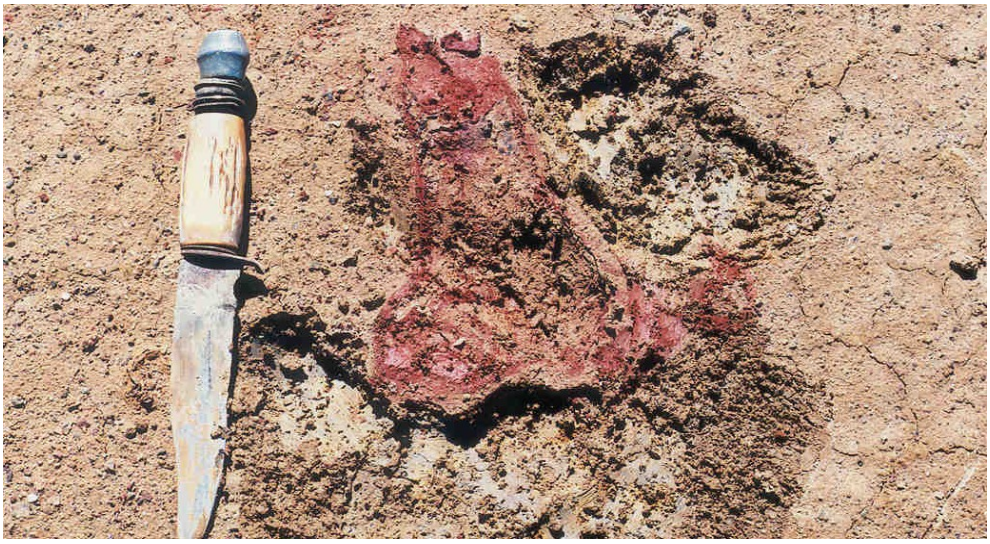

Figure 4. Iron segregation, A0S0 map unit.

The soil profile consists of a strongly acidic, mottled, dark greyish brown clayey surface layer overlying dark grey silty clays with some organic materials and shell fragments. Field estimates of the shell content in the soil profile below 1m depth vary from 20 to 50%. Laboratory results show 1% oxidisable sulfur within 0.5m depth of the soil surface and moderate acid generation potential (530 mol H^+/t). Oxidisable sulfur below 1m depth is 0.79% with no measurable peroxide acidity.

A0S1 (AASS layer within 0.5m depth, PASS layer 0.5 to 1m depth)

The small area between the two rises of country rock on Kangaroo Island, is occupied by tidal flats of varying elevation. A slightly elevated area or supratidal flat (saltpan) represents this unit. The soils are dark brown grading to dark yellowish brown, structured clays with red and orange mottles. A thin grey layer with jarosite overlies layers of dark grey silty clay with organic fragments. Oxidisable sulfur and peroxide acidity in the PASS layer below 0.5m depth range from 1.6% to 2.9% and 850 to 1,432 mol H^+/t respectively.

A1S2 (AASS layer 0.5 to 1m depth, PASS layer 1 to 2m depth)

This small area of extratidal flat occurs in the southeast corner of the survey area. The associated vegetation is narrow-leaved ironbark low woodland (*Eucalyptus crebra*) with isolated clumps of dwarf blue gum (*Eucalyptus tereticornis*) and a ground cover of dominantly marine couch (*Sporobolus virginicus*). The soils are mottled grey medium to heavy clays, strongly acid at shallow depth with a thick layer containing jarosite. Oxidisable sulfur and actual acidity (TAA) in the AASS layers are low (0.3 to 0.8% and 24 to 27 mol H^+/t respectively). Retained acidity in these layers is high (772 mol H^+/t). Oxidisable sulfur and peroxide acidity at 1.8m depth in the PASS layer are 1.9% and 1,360 mol H^+/t respectively. Angular chert gravels occur throughout the soil profiles and substrate.

A2 (AASS layer 1 to 2m depth, no PASS layer)

Part of the gently sloping alluvial plain at the mouth of Telegraph Creek forms this unit. It includes the narrow section of tidal creek, a small swampy area with paperbark tea-tree (*Melaleuca quinquenervia*) and blue gum vegetation. The dominant vegetation of the unit is the tall woodland of narrow-leaved ironbark, Queensland peppermint (*Eucalyptus exserta*) and pink bloodwood (*Corymbia intermedia*) with an understorey of black wattle (*Acacia aulacocarpa*) and quinine tree (*Petalostigma pubescens*).

The soil profile is essentially a loamy brown alluvial soil, overlying a moderately thick (0.5m) reddish brown layer of angular chert gravel, which in turn is underlain by greyish brown marine clay with jarosite (Figure 7). The sediments are strongly acid below 1m depth with negligible oxidisable sulfur values (<0.01 to 0.03%), indicating almost complete oxidation of pyrite in the marine sediment. Titratable actual acidity ranges from 21 to 67 mol H^+/t and peroxide acidity from 16 to 84 mol H^+/t. Retained acidity ranges from 34 to 93 mol H^+/t, and are generally considered low values.

Figure 5. Mangrove degradation, Connor Point.

Figure 6. Shoreline erosion, Connor Point.

Figure 7. Reddish brown gravel layer over marine clay, A2 map unit.

4.2 *Potential Acid Sulfate Soils on Relatively Undisturbed Land*

S0 (PASS layer within 0.5m depth)

The S0 map units are dominant throughout the survey area and occupy most of the seaward margin of the coastal strip except for a few low headlands of country rock. These map units occupy 5,389.2 ha or 96.8% of the area of potential acid sulfate soils. They are mostly associated with frequently inundated intertidal flats (mangrove mudflats), with a few units containing or represented by saltpans (supratidal flats). Closed thickets of the mangrove genus *Rhizophora* and an open margin of *Avicennia* are common throughout the map units (Figure 8).

The soils are either dark grey, grey or greenish grey saturated silty clays with a greyish brown surface horizon. Organic materials occur in the surface layer and underlying silty clay sediments. The potential acid sulfate soil layer can occur in or just below the soil surface layer with a high level of acid generation potential. For example, the 0-0.2m depth sample of site CQA820 contains 3.5% oxidisable sulfur and TPA of 2,312 mol H^+/t.

From Friend Point to Teningie Creek, the levels of oxidisable sulfur are commonly >2% with a range of 1.6 to 5.6% on the shallow intertidal flat at Phillipies Landing. The levels are generally much higher (1.9 to 8.5%) along the coastline between Teningie Creek and Munduran Creek. Extreme levels of oxidisable sulfur are recorded in the embayment between Redcliffe Island and Peppermint Point (8.7 to 12.4%).

The area of intertidal flat from Ramsay Crossing to Telegraph Creek contains levels of oxidisable sulfur ranging from 1.5 to 4.5%. Moderate levels of oxidisable sulfur (<1.5%) generally occur in the S0 map units between The Hut and Connor Point, with occasional very high levels associated with Deception Creek inlet.

South of The Hut to Sandfly, the levels of oxidisable sulfur are generally high (>2%) with a range from 0.3 to 4.6%. Between Sandfly and Dart Creek, the areas of intertidal flat with predominantly mangrove cover contain moderate levels of oxidisable sulfur (<1.6%) with occasional high levels to 3.3%.

S0S1$_N$/S2 (PASS layer 0 to 2m depth, PASS layer 0.5 to 1m depth with carbonate materials)

Potential acid sulfate soils occur in the tidal flats and in the clay sediments underlying chenier ridges (shell ridges) at The Hut. The soils of the tidal flats are grey clays with a brown surface layer. Where present measured peroxide acidity is moderate (500 mol H^+/t) for the level of oxidisable sulfur present (1.2%) indicating some acid neutralising capacity. Shell content in the soil profile increases with depth and below 0.8m there is sufficient carbonate material to neutralise the levels of oxidisable sulfur present (1 to 1.2%).

Mangroves occupy the saltpan margin and a mixture of shrubs the elevated shell ridges (Figure 9). The shell deposits have weak profile development with organic-enriched layers of pale brown and brown shell. Below the shell deposit, there are buried marine clays with very low levels of oxidisable sulfur (0.04%) and no measurable acid generation potential in the upper clay layers. Lower clay layers may contain up to 2% oxidisable sulfur and a titratable potential acidity of 1,176 mol H^+/t.

Figure 8. Mangrove thicket, Connor Point, S0 map unit.

Figure 9. Shell ridge, The Hut.

Figure 10. Sampling shell ridge, Connor Point.

S0/S1 (PASS layer 0 to 1m depth)

The S0/S1 map unit is situated west of Peppermint Point. It is largely represented by a supratidal flat (bare saltpan) but includes the lower section of two tidal creeks with some mangrove cover and gravelly surface deposits. The soils range from coarse sandy clays to medium clays. The greyish brown soil surface layers usually have distinct orange mottles and organic materials are common in the dark grey or greenish grey substrate. High levels of oxidisable sulfur (1.7 to 5.1%) and acid generation potential (1,092 to 3,268 mol H^+/t) are recorded for the unit at depths ranging from 0.3 to 0.8m.

S1 (PASS layer 0.5 to 1m depth)

This unit comprises a relatively small area of supratidal flat (bare saltpan) adjacent to Humphy Creek and the narrow foreshore area at Ramsay Crossing between the two public boat ramps. The soil profile at Humphy Creek is sandy, of moderate depth (1m) and overlies terrestrial heavy clay. It has a moderate level of oxidisable sulfur (0.8%) and acid generation potential (463mol H^+/t). Much higher levels occur in the foreshore area at Ramsay Crossing (1.9 to 3.1%S; 1,363 to 3,062 mol H^+/t).

S1/S2 (PASS layer 0.5 to 2m depth)

These map units are located at Kangaroo Island, Sandfly and Dart Creek. The landform at Kangaroo Island is largely an extratidal flat (marine couch flat) with a low-lying drainage depression and a slightly less elevated area of supratidal flat (saltpan). Elevated gravelly alluvium and a tidal creek occupy much of the unit at Sandfly. Similar gravelly alluvial deposits are associated with the supratidal area of the Dart Creek unit. The more elevated extratidal area at Dart Creek is dominated by marine couch grassland with isolated ironbark communities.

At Kangaroo Island the soils range from olive brown to dark grey structured clays. Oxidisable sulfur and acid generation potential in these soils range from low to moderate levels (0.09 to 1.7%; 29 to 922 mol H^+/t TPA). High levels of oxidisable sulfur (1.9 to 2.7%) and acid generation potential (1,150 to 1,750 mol H^+/t) occur in the grey to greenish grey clay sediments of the Sandfly and Dart Creek units.

S2 (PASS layer 1 to 2m depth)

Low narrow shell ridges (chenier ridges) at Connor Point represent this unit (Figure 10). Mangroves grow on the less saline margins and occasionally on the ridges along with a mixture of low shrubs. The shell deposits have similar features to those situated at The Hut with neutral to alkaline organic-enriched layers of shell.

Negligible levels of oxidisable sulfur (<0.01%) occur in the buried upper layers of clay rich sediment. Below 1m depth the levels of oxidisable sulfur range from 1.1 to 1.85% and titratable potential acidities from 632 to 742 mol H^+/t.

4.3 *Acid Sulfate Soil on Relatively Undisturbed Land*

S_{LA} (Limited field assessment and landform indicating ASS)

The S_{LA} map units total 1,201.4ha in area. They represent either intertidal flats with mangrove cover or supratidal flats (saltpans) indicating the presence of acid sulfate soils. No sampling was undertaken along the narrow foreshore area at Kangaroo Island.

Very limited sampling in the southern part of the large map unit extending north from Telegraph Creek to Division Point indicates acid sulfate soils are associated with saltpans and mangrove mudflats. The mangrove mudflat had 1.3% oxidisable sulfur at 0.1m depth increasing to 5.7% below 0.3m depth, with corresponding potential acidities of 804 and 4,365 mol H^+/t. The slightly elevated saltpan had 4.9% oxidisable sulfur at 0.2m depth decreasing to 3.7% below 1m depth, with corresponding potential acidities of 3,518 and 2,470 mol H^+/t.

4.4 *Land with a Low Probability of Acid Sulfate Soil Occurrence*

a0LP (Land predominantly <5m AHD with low probability of ASS occurrence, strongly acid soil layer within 0.5m depth)

This small unit at Phillipies Landing consists of a supratidal flat (bare saltpan) and a narrow drainage depression. The soils are dark brown heavy clays with red mottles, moist and of very firm strength. Field pH of the sub-surface layer is 4.3 to 4.7. The soils have negligible oxidisable sulfur (<0.01%) and acid generation potential (13 mol H^+/t) to the depth sampled (1.7m).

a2LP (Land predominantly <5m AHD with low probability of ASS occurrence, strongly acid soil layer 1 to 2m depth)

Two areas comprise this unit. The area at Humpy Creek is elevated with gum-topped box (*Eucalyptus moluccana*) and surrounded by saltpan and mangroves. The soils are texture contrast with acid (field pH 4.4 to 4.6), mottled greyish brown clay subsoils. Negligible levels of oxidisable sulfur (0.016%) and titratable potential acidity (10 mol H^+/t) are recorded for this area.

The other area, which makes up this unit, is located at Phillipies Landing. It is mainly a supratidal flat with slightly elevated areas supporting either narrow-leaved ironbark or gum-topped box communities. The soils are acid (field pH 4.6 to 4.9), dark greyish brown or yellowish brown heavy clays with no measurable oxidisable sulfur or potential acidity to 2.5m depth.

LP (Land predominantly <5m AHD with low probability of ASS occurrence)

Relatively large areas of *tidally affected* land with a low probability of ASS occurrence are a unique feature of the survey area (Figure 11). Such areas have not been previously recorded for the southern Central Queensland coast (Ross *et al*. 2000, Ross 2002, 2003, 2004).

These areas occur intermittently throughout the survey area from Humpy Creek to Sandfly. The landform is dominantly a supratidal flat (bare saltpan) with a slightly elevated area of

extratidal flat landward. The largest area is situated west of the Rundle Range where it occupies the tidal margin adjacent to belah (*Casuarina cristata*) forest.

Reddish brown gravel is often a characteristic soil surface feature (Figure 12). The soils are slightly acid to neutral, yellowish brown, olive brown or grey non-cracking structure-less heavy clays. Laboratory results for most of the sampling sites indicate negligible levels of oxidisable sulfur and no net acidity to 3m depth or to weathered rock.

Acid sulfate soils were only found in the LP map units in very narrow drainage lines, and were too small to delineate at 1:50 000 scale mapping. These drainage lines were down cut in the past and back-filled with marine sediment. The levels of oxidisable sulfur range from 0.13 to 5.45% and potential acidities from 28 to 3,576 mol H^+/t, at 0.3 to 0.8m depth.

Figure 11. Tidal flat The Hut, LP map unit.

Figure 12. Reddish brown lag gravel, south Rundle Range, LP map unit.

5. Water Quality Monitoring

After the field survey work was completed six piezometers or shallow groundwater monitoring bores were installed to determine the characteristics of the shallow groundwater in this relatively undisturbed landscape. During installation of the six piezometers watertable depth ranged from 0.5 to 1.8m. In future years the piezometers are expected to have adequate water yield for sampling, as the depth to standing water or watertable depth is largely unchanged since installation. Two piezometers are located along Munduran Creek at Ramsay Crossing, two at Telegraph Creek, and one at Gonong and Dart Creeks.

Five piezometers are installed in acid sulfate soils, two of these being actual acid sulfate soils (piezometers C and D). The soil profile at each site has been sampled for a comprehensive chemical analysis to assist in the interpretation of the water quality results. Field testing and water sampling has been undertaken on a monthly basis since October 2005. Field tests are pH, Electrical Conductivity (EC) and Dissolved Oxygen (DO).

Initial field results (Table 2), indicate very low to low dissolved oxygen (2.5 to 10.9% saturation) in the standing waters of the piezometers. Acidic water (field pH 2.9 to 4.6) is associated with the actual acid sulfate soil sites. The waters are brackish or have elevated electrical conductivity readings (24.8 to 68.1 dS/m). Field pH and EC measurements are consistent with interim laboratory measurements.

Table 2. Field measurements of shallow groundwater monitoring bores.

Piezometer	Locality	Date sampled	pH	EC (dS/m)	DO (%sat)
A	Munduran Creek	17-10-05	7.0	52.3	3.5
		21-11-05	6.4	40.1	5.5
		14-12-05	6.4	40.9	5.6
B	Munduran Creek	17-10-05	7.0	32.5	2.5
		21-11-05	6.4	24.8	3.8
		14-12-05	6.3	26.2	3.4
C	Telegraph Creek	17-10-05	4.6	40.6	3.0
		21-11-05	3.6	32.8	6.0
		14-12-05	3.5	35.1	7.0
D	Telegraph Creek	17-10-05	3.8	34.1	10.9
		21-11-05	3.0	27.9	3.6
		14-12-05	2.9	27.3	7.1
E	Gonong Creek	18-10-05	7.1	43.4	3.9
		21-11-05	6.7	31.5	4.3
		14-12-05	6.7	34.0	2.8
F	Dart Creek	18-10-05	6.7	68.1	5.0
		22-11-05	6.4	54.3	3.3
		14-12-05	6.5	53.7	3.6

6. Discussion

The highest level of peroxide oxidisable sulfur (S_{POS}) associated with acid sulfate soils (12.4%), recorded in Queensland to date occurs within the survey area. Although the soil sample is organic enriched, analysis using the chromium reducible sulfur method verified the result with 12.5%. The sampling site is found in the east facing embayment between Redcliffe Island and Peppermint Point, where most of the acid sulfate soil layers within this area have S_{POS} values > 8.7%. The treatment costs for disturbance of such an area are likely to be prohibitive. These extreme levels occur elsewhere throughout the survey area, but are not as extensive in area.

The Narrows survey area contains some acid sulfate soil and landform features not previously recorded for the southern Central Queensland Coast (Ross *et al*. 2000, Ross 2002, 2003, 2004). These include tidally affected land with no acid sulfate soil layer, shell and clay levees along tidal channels, and large iron segregations at the soil surface on saltpans.

Tidal flats where acid sulfate soils are absent are interpreted as eroded terrestrial sediment associated with an encroaching rather than a prograding shoreline. The shell levee found along Connor Creek (Figure 13) is likely to have been formed during storm events. Likewise, the clay levees along channels of the Connor Creek and Deception Creek estuaries, were formed during storm events leaving ponded areas behind the levee. Relatively large iron segregations occurring at the soil surface are likely to be associated with pH change of the strongly acid shallow groundwater, from infrequent inundation by alkaline sea water.

Figure 13. Shell levee, Connor Creek.

Most acid sulfate soils in the survey area occur within the tidal zone. They are permanently wet and have a shallow watertable. They are classified within the Australian Soil Classification (Isbell, 1996) as Hydrosols. Sulfidic Hydrosols and Histic-Sulfidic Hydrosols (potential acid sulfate soils) typically occur on the intertidal or mangrove mudflats. Sulfuric Hydrosols, containing both actual and potential acid sulfate soil layers, are mainly associated with either supratidal flats (saltpans) or slightly elevated marine couch flats (extratidal flats). The soil orders of the soils on the chenier ridges are Rudosols overlying potential acid sulfate soils. Other soil orders in the survey area overlying acid sulfate soils with acid generation potential are Dermosols.

Excluding the chenier plain at The Hut and shell ridges at Connor Point, few sites were found to contain shell or shell fragments within clayey marine sediment to the depth sampled. Those sites with shell are mostly located on intertidal flats at Connor Point and near Kangaroo Island. There is also one site on a supratidal flat (saltpan) north of The Hut with shell fragments in the substrate. Some soil layers from these sites contain sufficient carbonate to be self-neutralising, have no net acidity and would not require treatment if disturbed. Other layers containing shell, with net acidity, would generally require reduced treatment (Dear *et al*. 2002).

The Laboratory Methods Guidelines (Ahern *et al*. 2004) use an acid base accounting approach for predicting Net Acidity from sulfide oxidation of acid sulfate soils. Net acidity is calculated using the following equation:

Net Acidity = Potential Sulfidic Acidity + Existing Acidity – Acid Neutralising Capacity

Where: Existing Acidity = Actual Acidity + Retained; and

Acid Neutralising Capacity (ANC) = measured ANC/Fineness Factor.

During this survey, the 4M HC1 extractable sulfur content was determined on forty-one samples containing jarosite. This analysis enables the calculation of Retained Acidity (S_{NAS}), and is additional to the SPOCAS method. The results are listed in Table 3. S_{NAS} was also determined on an additional 14 selected samples with a field pH > 5.5 and a laboratory pH KCl of < 4.5 (as recommended in the Laboratory Methods Guidelines). For the 14 samples, S_{NAS} was significant in only two samples with retained acidities of 50 and 65 mol H^+/t respectively.

The majority of samples (Table 3) fall in the fine texture category (medium clays to heavy clays) used in acid sulfate soil investigations, and a few from the medium texture category (sandy loams to light clays). All samples contain jarosite and have a field pH of 5.4 or less, before oxidation with hydrogen peroxide. The levels of retained acidity or Net Acid Soluble Sulfur, range from nil to high and appear to be unrelated to soil morphology or soil reaction. The highest levels are from a saltpan east of Connor Creek (Site CQA761), and from a marine couch flat south of Kangaroo Island (Site CQA684).

Table 3. Retained acidity for selected samples with jarosite.

Site No	Depth (m)	Texture[1] Category	Field pH [2]	S_{NAS} [3] (%)	s-S_{NAS} [4] (%)	a-S_{NAS} [5] (mol H^+/ t)
CQA682	0.1-0.3	Fine	3.8	0.351	0.263	164
CQA683	0.1-0.3	Fine	3.9	0.581	0.435	272
CQA684	0.8-1.0	Fine	3.3	1.650	1.237	772
CQA691	0.2-0.3	Fine	3.7	0.023	0.017	11
CQA693	0.1-0.3	Medium	2.9	0.676	0.507	316
CQA706	0.1-0.3	Fine	3.8	0.012	0.009	6
CQA710	0.2-0.3	Medium	2.9	0.014	0.010	7
CQA713	0.2-0.3	Medium	3.6	0.580	0.435	271
CQA716	0.2-0.4	Medium	3.6	0.316	0.237	148
CQA718	0.1-0.3	Medium	2.9	0.690	0.517	323
CQA719	0.1-0.3	Medium	2.6	0.273	0.204	128
CQA722	0.1-0.3	Fine	3.4	0.366	0.274	171
CQA724	0.02-0.2	Fine	2.9	1.180	0.885	414
CQA728	0.1-0.2	Medium	3.4	0.344	0.258	161
CQA733	0.1-0.3	Medium	3.4	0.012	0.009	6
CQA761	0.1-0.3	Fine	3.2	1.450	1.087	678
CQA764	0.1-0.3	Fine	4.0	<0.005	0	0
CQA766	0.15-0.3	Fine	3.5	<0.005	0	0
CQA767	0.1-0.3	Fine	5.1	<0.005	0	0
CQA768	0.1-0.3	Fine	3.9	0.029	0.021	10
CQA769	0.2-0.4	Fine	5.4	0.007	0.005	2
CQA773	0.2-0.4	Fine	3.9	0.060	0.045	21
CQA775	0.2-0.4	Fine	3.4	<0.005	0	0
CQA776	0.4-0.6	Fine	3.2	0.195	0.146	91
CQA776	0.8-1.0	Fine	3.1	0.471	0.353	220
CQA777	1.5-1.7	Fine	2.6	0.111	0.083	52
CQA781	0.2-0.4	Medium	3.6	0.221	0.166	103
CQA785	0.2-0.3	Medium	3.3	0.201	0.151	94
CQA791	0.1-0.3	Fine	3.8	0.564	0.423	264
CQA792	0.2-0.4	Medium	3.7	0.376	0.282	176
CQA805	0.5-0.7	Fine	3.0	0.310	0.232	145
CQA805	0.8-1.0	Fine	2.9	0.161	0.121	75
CQA807	0.2-0.4	Medium	3.5	0.066	0.049	31
CQA812	0.1-0.3	Medium	3.8	0.208	0.156	97
CQA819	0.2-0.4	Fine	3.7	0.071	0.053	33
CQA828	0.2-0.3	Medium	2.6	0.551	0.413	258
CQA846	0.8-1.0	Medium	4.1	0.027	0.020	12
CQA846	1.1-1.3	Fine	4.6	0.094	0.070	44
CQA847	1.2-1.4	Medium	4.0	0.073	0.055	34
CQA847	1.8-2.0	Fine	4.0	0.266	0.199	93
CQA847	2.2-2.4	Fine	3.8	0.110	0.082	38

[1] Ahern *et al*. (1998).
[2] Field pH before oxidation.
[3] Net acid soluble Sulfur (Ahern *et al*. 2004).
[4] Equivalent % pyrite Sulfur.
[5] Equivalent acidity units.

For this survey, net acidity (moles H^+/tonne) is calculated as follows and the results are listed in the Appendix:

pH KC1 ≥ 6.5, Net Acidity = 623.7 x S_{POS} – (332.7 x CaA – 548.4 x MgA);

pH KCl < 6.5, Net Acidity = 623.7 x S_{POS} + TAA + (467.8 x S_{NAS});

pH KCl < 6.5, Net Acidity = 623.7 x S_{POS} + TAA.

Calculated Net Acidity is generally less than the measured Titratable Peroxide Acidity (TPA) and in some samples the difference is quite substantial. For example, site CQA564 0.2 – 0.4m depth sample (Appendix) has measured TPA of 877 mol H^+/t greater than the calculated Net Acidity for sulfide oxidation. The complexity of acid sulfate soil chemistry, and reasons why acidity measured by titration methods are not consistent with acidity predicted from sulfur analysis, are outlined in the Acid Sulfate Soil Laboratory Methods Guidelines (Ahern *et al.* 2004). These differences are possibly due to organic matter and organic acidity effects, as acid sulfate soils in the nearby Gladstone area are known to also have a high organic carbon content (2 to 9%). Because the measured TPA values indicated a higher risk of acid and iron contamination if disturbed, these were used in the description of the map units and not Net Acidity terminology.

The accompanying acid sulfate soils map is essentially a map of *depth* to the acid sulfate soil layers. An indication of risk, depending on the type and extent of disturbance, can be inferred from the depth to an actual acid sulfate soil and/or potential acid sulfate soil layer. For example, draining land with actual and potential acid sulfate soil layers at very shallow depth (<0.5m), within the A0S0 mapping units would be considered a high risk activity. However, there is no indication of the level of sulfides, actual acidity or acid generation potential provided at 1:50 000 scale of mapping. Mapping units with the same depth code can contain quite variable levels of sulfides, existing and potential acidity and consequently varying levels of risk.

Acid sulfate soil risk maps which predict the distribution of acid sulfate soils, based on an assessment of the geomorphic environment, have been produced for coastal areas of New South Wales (Flewin *et al.* 1996). The maps identify the areas at risk and likely depth to the occurrence of acid sulfate soils. Three risk classes are used (High, Low and No Known Occurrence) and these can be related to land use activities that may expose acid sulfate soils, creating an environmental risk. Unlike risk maps, hazard maps are based on more objective criteria with limited interpretation.

The potential acid generation of particular areas of land is illustrated on the accompanying acid sulfate soil *hazard* map. Four classes of acid generation potential are used (Very Low, Low, Moderate and High) based on the concentration of sulfides (peroxide oxidisable sulfur content, S_{POS}) and corresponding acid generation potential (titratable peroxide acidity, TPA) or Net Acidity. The criteria used to establish the classes (Table 4) is the same as that used for the adjacent Gladstone area.

Table 4. Acid sulfate hazard classes.

Class	Criteria
Very Low	S_{POS} < 0.03% and TPA = 18 to 80 mol H^+/t S_{POS} > 0.03% and TPA = 0 to <18 mol H^+/t Low probability areas
Low	S_{POS} > 0.03% and TPA ≥ 18 to < 200 mol H^+/t
Moderate	S_{POS} > 0.35% and TPA ≥ 200 to < 1000 mol H^+/t Net Acidity ≥ 200 to <1000 mol H^+/t
High	S_{POS} > 1.5% and TPA > 1000 mol H^+/t Net Acidity > 1000 mol H^+/t

Depth to the acid sulfate soil layer is not used in the class criteria because the higher concentrations of sulfides and acid generation potential mostly occur at shallow depth and are associated with clayey sediments. Lower concentrations of sulfides and lower acid generation potential generally occur at greater depth and are often associated with sandy sediments. For convenience of use, the depth to the acid sulfate soil layer with significant potential acidity has been placed on the mapping units of the hazard map. The hazard map should be read in conjunction with the accompanying acid sulfate soil map.

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APPENDIX

Chemical data for samples at selected depths

ABBREVIATIONS

S_{POS} Peroxide oxidisable sulfur

TAA Titratable actual acidity

TPA Titratable peroxide acidity

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
522	0.3-0.5	Phillipies	Supratidal	4.851	105	3556	3130
	1.0-1.2	Landing	Flat	1.838	0	1204	1146
523	0.3-0.5	Phillipies	Intertidal Flat	5.696	82	4108	3635
	0.8-0.9	Landing		0.367	0	186	229
524	0.3-0.5	Phillipies Landing	Intertidal Flat	5.154	53	3530	3268
525	1.5-1.7	Ramsay Crossing	Extratidal Flat	0.013	0	0	0
526	1.5-1.6	Ramsay Crossing	Extratidal Flat	<0.01	0	0	0
527	0.3-0.5	Ramsay	Intertidal Flat	2.600	43	1708	1165
	0.8-1.0	Crossing		3.360	45	2221	2141
	1.1-1.3			0.430	0	174	248
528	0.7-0.9	Ramsay Crossing	Supratidal Flat	0.097	0	0	36
537	0.5-0.7	Ramsay Crossing	Supratidal Flat	1.960	76	1328	1292
538	0.1-0.3	Ramsay	Intertidal Flat	1.530	45	1097	999
	0.8-1.0	Crossing		4.110	122	2981	2685
539	0.3-0.5	Ramsay	Intertidal Flat	1.190	0	714	742
	1.6-1.8	Crossing		1.060	10	665	671
540	0.3-0.5	Ramsay	Intertidal Flat	1.920	46	1363	1244
	0.8-1.9	Crossing		2.900	112	2342	1921
	1.6-1.8			3.130	45	2062	1997
541	0.1-0.3	Ramsay	Supratidal	0.017	18	22	29
	0.3-0.5	Crossing	Flat	0.078	0	26	49
559	0.3-0.5	Munduran	Supratidal	1.800	39	1246	1162
	1.5-1.7		Flat	1.550	17	993	984
560	0.4-0.6	Munduran	Supratidal	3.810	58	2574	2434
	0.8-1.0		Flat	3.230	70	2200	2085
	1.4-1.6			1.770	20	1173	1124
561	0.2-0.4	Munduran	Intertidal Flat	1.100	25	760	711
	0.8-1.0			0.876	0	537	551
562	0.6-0.8	Munduran	Supratidal	4.880	157	3636	3201
	1.3-1.5		Flat	5.600	68	3624	3561
563	0.4-0.6	Munduran	Supratidal	8.610	181	6026	5551
	0.9-1.1		Flat	2.610	0	1722	1632
564	0.2-0.4	Munduran	Intertidal Flat	8.440	227	6368	5491
	0.8-1.0			5.710	133	4120	3694
	1.3-1.5			8.770	120	5780	5590
565	0.3-0.5	Munduran	Intertidal Flat	3.240	34	2164	2055
	1.2-1.4			1.630	10	1051	1027
566	0.4-0.6	Munduran	Supratidal	5.710	112	3940	3673
	0.8-1.0		Flat	6.010	132	4124	3880
	1.3-1.5			6.540	113	4474	4129
567	0.2-0.4	Munduran	Intertidal Flat	2.380	67	1698	1551
	0.6-0.8			1.220	0	724	735
675	0.3-0.5	Friend	Supratidal	1.601	39	1045	1037
	1.3-1.5	Point	Flat	1.987	102	1342	1341
676	0.2-0.4	Friend	Supratidal	2.980	132	2148	1991
	0.8-1.0	Point	Flat	1.856	50	1210	1207
	1.6-1.8			2.140	0	1300	1335

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
677	0.0-0.2	Friend	Intertidal Flat	1.588	22	1014	1012
	0.8-1.0	Point		2.083	47	1408	1346
681	0.2-0.4	Friend	Supratidal	<0.01	0	0	0
	0.4-0.6	Point	Flat	0.827	0	544	516
	0.8-1.0			1.060	27	744	688
	1.6-1.8			1.100	33	744	719
682	0.1-0.3	Friend	Supratidal	0.200	16	130	305
	0.3-0.5	Point	Flat	1.580	62	1172	1047
	0.8-1.0			1.660	77	1190	1112
	1.6-1.8			1.470	18	991	935
683	0.1-0.3	Friend	Supratidal	0.245	20	180	445
	0.3-0.5	Point	Flat	1.960	97	1478	1319
	0.8-1.0			1.910	81	1378	1272
	1.6-1.8			1.910	89	1410	1280
684	0.8-1.0	Friend	Extratidal	0.031	24	53	816
	1.3-1.5	Point	Flat	0.088	27	116	82
	1.8-2.0			1.990	64	1360	1305
685	0.8-1.0	Friend	Extratidal	<0.01	0	0	0
	1.3-1.5	Point	Flat	0.013	13	17	21
	1.8-2.0			<0.01	0	0	0
686	0.2-0.4	Munduran	Tidal Creek	1.040	15	675	664
	0.8-1.0	Creek		1.240	34	842	807
	1.3-1.5			1.770	44	1164	1148
	1.8-2.0			1.430	0	863	892
687	0.8-1.0	Munduran	Stream	0.014	52	71	61
	1.1-1.3	Creek	Channel	0.021	0	0	13
	1.5-1.7			0.096	0	15	60
688	0.3-0.5	Munduran	Back	0.013	63	43	71
	0.8-1.0	Creek	Channel	0.010	25	25	31
	1.3-1.5			0.013	14	13	22
689	0.1-0.3	Ramsay	Supratidal	0.047	0	0	29
	0.3-0.5	Crossing	Flat	4.530	135	3130	2960
	0.8-1.0			7.830	144	5512	5028
	1.3-1.5			1.280	0	772	784
690	0.3-0.5	Ramsay	Intertidal Flat	6.600	165	4648	4281
	0.8-1.0	Crossing		6.440	192	4588	4209
	1.3-1.5			3.490	35	2250	2212
	1.6-1.8			2.960	42	1924	1888
691	0.2-0.3	Ramsay	Supratidal	0.198	24	149	158
	0.3-0.5	Crossing	Flat	0.805	59	547	561
	0.8-1.0			0.374	0	109	168
692	0.2-0.4	Ramsay	Intertidal Flat	4.550	122	3094	2960
	0.8-1.0	Crossing		3.210	125	2246	2127
	1.3-1.5			3.100	28	2040	1961
	1.6-1.8			2.590	50	1742	1665
693	0.1-0.3	Ramsay	Supratidal	0.419	73	337	651
	0.3-0.5	Crossing	Flat	2.710	135	1952	1825
	0.8-1.0			1.430	19	884	911
694	0.3-0.5	Ramsay	Intertidal Flat	1.040	28	666	677
	0.8-1.0	Crossing		2.620	69	1814	1703
	1.3-1.5			1.420	18	936	904
	1.6-1.8			2.210	10	1426	1388

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
695	0.0-0.2	Phillipies	Intertidal Flat	1.040	13	715	662
	0.3-0.5	Landing		4.660	130	3076	3036
	1.0-1.2			2.900	99	2026	1908
696	0.3-0.5	Phillipies	Supratidal	0.015	0	0	0
	0.6-0.8	Landing	Flat	<0.01	0	0	0
	1.3-1.5			<0.01	0	0	0
697	0.3-0.5	Phillipies	Supratidal	<0.01	0	0	0
	1.5-1.7	Landing	Flat	<0.01	13	0	13
698	0.3-0.5	Phillipies	Supratidal	<0.01	0	0	0
	0.8-1.0	Landing	Flat	0.804	26	463	527
699	0.8-1.0	Phillipies	Extratidal	0.016	0	0	10
	1.8-2.0	Landing	Flat	<0.01	0	0	0
700	0.3-0.5	Phillipies	Supratidal	0.383	0	172	239
	0.8-1.0	Landing	Flat	0.409	0	188	255
	1.6-1.8			0.458	0	210	286
701	0.8-1.0	Phillipies	Extratidal	<0.01	0	0	0
	2.5-2.7	Landing	Flat	<0.01	0	0	0
702	0.3-0.5	Phillipies	Supratidal	<0.01	0	0	0
	0.6-0.8	Landing	Flat	<0.01	0	0	0
703	0.6-0.8	Phillipies	Stream	0.358	0	189	223
	1.3-1.5	Landing	Channel	0.163	0	0	102
704	0.2-0.4	Telegraph	Intertidal Flat	1.540	0	804	960
	0.8-1.0	Creek		2.240	27	1460	1424
	1.6-1.8			0.941	0	490	587
705	0.2-0.4	Telegraph	Supratidal	1.490	83	1047	1012
	0.8-1.0	Creek	Flat	2.650	112	1822	1765
	1.6-1.8			2.310	85	1566	1526
706	0.1-0.3	Telegraph	Supratidal	0.297	22	162	213
	0.3-0.5	Creek	Flat	2.280	64	1638	1486
	0.8-1.0			4.620	101	3162	2982
	1.6-1.8			4.790	107	3378	3095
707	0.1-0.3	Telegraph	Intertidal Flat	1.310	21	804	838
	0.3-0.5	Creek		5.760	177	4365	3770
	1.2-1.4			0.748	0	360	467
708	0.2-0.4	Telegraph	Supratidal	2.410	109	1861	1612
	0.5-0.7	Creek	Flat	0.731	0	349	435
709	0.1-0.3	Deception	Intertidal Flat	2.200	45	1577	1417
	0.8-1.0	Creek		7.070	172	5129	4582
	1.1-1.3			5.480	177	3848	3595
710	0.2-0.3	Deception	Supratidal	0.170	30	87	142
	0.3-0.5	Creek	Flat	2.460	82	1648	1616
711	0.2-0.4	Gonong	Intertidal Flat	1.030	14	640	656
	0.8-1.0	Creek		2.340	51	1711	1510
	1.2-1.4			1.000	0	568	624
712	0.4-0.6	Sandfly	Intertidal Flat	0.519	0	242	324
	0.8-1.0			2.620	71	1826	1705
	1.6-1.8			4.120	94	2694	2664
713	0.2-0.3	Connor	Supratidal	0.393	24	208	540
	0.3-0.5	Creek	Flat	3.720	117	2678	2437
	0.8-1.0			3.890	97	2767	2523
	1.3-1.5			2.160	27	1316	1374

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
714	0.3-0.5	Deception	Supratidal	5.290	135	3828	3434
	1.0-1.2	Creek	Flat	4.460	99	2929	2881
715	0.2-0.4	Deception	Intertidal	9.010	198	6548	5818
	0.8-1.0	Creek	Flat	6.910	145	4731	4455
	1.4-1.6			1.310	17	834	834
716	0.2-0.4	Deception	Supratidal	0.685	66	443	493
	0.4-0.6	Creek	Flat	2.330	100	1748	1568
	0.8-1.0			2.010	44	1303	1298
	1.3-1.5			1.920	0	1136	1198
717	0.0-0.1	Deception	Extratidal	0.010	0	0	0
	0.5-0.7	Creek	Flat	<0.01	0	0	0
718	0.1-0.3	Deception	Supratidal	0.075	12	0	382
	0.3-0.5	Creek	Flat	3.500	45	2212	2228
	1.0-1.2			1.460	32	832	943
719	0.1-0.3	Deception	Supratidal	0.260	44	146	334
	0.3-0.5	Creek	Flat	4.070	107	2736	2645
	0.8-1.0			6.090	126	4028	3924
720	0.3-0.5	Deception	Intertidal	5.760	125	4068	3718
	0.7-0.9	Creek	Flat	1.130	0	541	687
	1.2-1.4			4.940	84	3260	3165
721	0.25-0.35	Deception	Supratidal	2.750	79	1756	1840
	0.8-1.0	Creek	Flat	3.390	39	2074	2153
	1.3-1.5			1.820	0	1008	1135
722	0.1-0.3	Connor	Supratidal	0.181	20	38	304
	0.3-0.5	Creek	Flat	2.490	64	1632	1617
	1.1-1.3			2.550	19	1704	1609
	1.6-1.8			2.200	22	1348	1394
723	0.35-0.5	The Hut	Intertidal	1.450	0	502	785
	0.8-1.0		Flat	1.230	0	0	0
	1.6-1.8			1.170	0	0	0
724	0.02-0.2	The Hut	Supratidal	0.113	20	24	655
	0.2-0.4		Flat	2.440	84	1602	1606
	0.8-1.0			1.200	52	716	800
	1.6-1.8			2.270	30	1376	1446
725	0.5-0.7	Deception	Intertidal	0.160	0	0	100
	0.8-1.0	Creek	Flat	0.488	0	188	304
	1.6-1.8			1.960	0	1104	1222
726	0.3-0.5	Connor	Intertidal	6.170	105	4512	3992
	0.8-1.0	Creek	Flat	3.660	41	2300	2324
	1.6-1.8			3.130	43	1970	1995
727	0.4-0.6	Gonong	Intertidal	1.220	36	778	797
	0.8-1.0	Creek	Flat	2.180	20	1312	1380
	1.5-1.7			1.660	35	894	1070
728	0.1-0.2	Connor	Supratidal	1.200	69	750	978
	0.3-0.5	Creek	Flat	3.590	122	2410	2361
	0.8-1.0			4.230	123	2794	2761
	1.2-1.4			5.230	91	3420	3353
729	0.3-0.5	Connor	Supratidal	1.970	25	1190	1254
	0.8-1.0	Creek	Flat	3.270	68	2108	2155
	1.3-1.5			2.380	53	1506	1537

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
730	0.9-1.1	Dart Creek	Extratidal	<0.01	0	0	0
	1.4-1.6		Flat	0.633	0	236	395
	1.8-2.0			2.460	179	1750	1713
731	0.4-0.6	Dart Creek	Supratidal	0.013	0	0	0
	0.8-1.0		Flat	1.600	30	998	1028
	1.3-1.5			2.690	59	1698	1737
732	0.2-0.4	Dart Creek	Intertidal	1.400	18	834	891
	0.8-1.0		Flat	2.280	74	1466	1551
	1.6-1.8			1.540	10	927	970
733	0.1-0.3	Connor	Supratidal	0.165	15	57	123
	0.3-0.5	Creek	Flat	1.050	14	624	669
	0.8-1.0			0.974	0	382	444
	1.6-1.8			1.790	37	1026	1153
734	0.4-0.6	Connor	Supratidal	<0.01	0	0	0
	0.8-1.0	Creek	Flat	0.792	0	481	494
	1.1-1.3			1.380	0	894	861
735	0.2-0.4	Connor	Intertidal	1.160	14	721	737
	0.8-1.0	Creek	Flat	1.670	11	1028	1053
	1.6-1.8			1.330	0	811	830
736	0.3-0.5	Connor	Intertidal	0.467	0	170	291
	0.8-1.0	Creek	Flat	0.888	12	488	566
	1.6-1.8			0.237	0	58	137
737	0.3-0.5	Connor	Supratidal	1.140	16	640	727
	0.8-1.0	Creek	Flat	1.380	0	802	861
	1.6-1.8			1.320	0	740	823
738	0.1-0.3	Connor	Supratidal	0.559	47	372	396
	0.3-0.5	Creek	Flat	2.590	69	1753	1684
	0.8-1.0			3.110	58	2065	1998
739	0.3-0.5	Connor	Intertidal	1.180	0	644	736
	0.8-1.0	Creek	Flat	1.500	11	858	947
	1.6-1.8			4.610	77	2976	3022
740	0.8-1.0	Gonong	Extratidal	0.049	0	0	25
	1.2-1.4	Creek	Flat	1.170	20	652	750
	1.8-2.0			1.350	36	806	880
741	0.8-1.0	Gonong	Extratidal	0.017	0	0	0
	1.8-2.0	Creek	Flat	<0.01	0	0	0
	2.3-2.5			0.049	0	0	18
742	1.0-1.2	Gonong	Tidal	0.493	0	222	307
	1.3-1.5	Creek	Creek	0.975	13	514	621
	1.8-2.0			0.172	0	54	107
743	0.5-0.7	Gonong	Intertidal	3.340	89	2156	2172
	1.0-1.2	Creek	Flat	1.500	11	822	947
	1.6-1.8			1.850	10	1068	1164
744	0.3-0.5	Connor	Supratidal	4.320	82	2758	2766
	0.8-1.0	Creek	Flat	2.940	27	1788	1861
	1.6-1.8			1.700	0	922	1060
745	0.3-0.5	Connor	Intertidal	2.620	67	1638	1701
	0.8-1.0	Creek	Flat	0.619	0	244	386
	1.6-1.8			0.834	0	396	520
746	0.2-0.4	Connor	Supratidal	<0.01	0	0	0
	0.8-1.0	Creek	Flat	<0.01	0	12	0
	1.6-1.8			<0.01	0	18	0

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
747	0.3-0.5	Connor	Intertidal Flat	2.990	31	1842	1896
	0.8-1.0	Creek		4.020	56	2470	2563
	1.6-1.8			2.040	0	1076	1272
748	0.6-0.8	Connor	Tidal Creek	0.025	0	0	0
	1.0-1.2	Creek		1.970	0	1150	1229
	1.6-1.8			1.240	0	638	773
749	0.2-0.4	Connor	Supratidal	0.010	0	0	0
	0.8-1.0	Creek	Flat	0.045	0	0	11
	1.3-1.5			0.284	0	0	92
750	0.3-0.5	Connor	Extratidal	<0.01	0	0	0
	0.8-1.0	Creek	Flat	<0.01	0	0	0
	1.8-2.0			<0.01	0	0	0
751	0.3-0.5	Connor	Drainage	0.011	0	0	0
	0.8-1.0	Creek	Depression	0.134	0	28	73
752	0.3-0.5	Connor	Intertidal	0.281	0	112	175
	0.8-1.0	Creek	Creek	1.380	19	824	880
	1.6-1.8			2.080	19	1282	1316
753	0.2-0.4	Connor	Supratidal	0.016	0	0	10
	0.6-0.8	Creek	Flat	<0.01	0	0	0
754	0.2-0.4	Connor	Intertidal Flat	1.680	24	980	1072
	0.8-1.0	Creek		4.040	98	2878	2618
	1.6-1.8			4.820	95	3282	3101
755	0.4-0.6	Connor	Supratidal	2.770	64	1824	1792
	0.8-1.0	Creek	Flat	1.820	0	1044	1135
	1.6-1.8			2.010	0	1190	1254
756	0.3-0.5	Connor	Drainage	5.450	96	3576	3495
	0.8-1.0	Creek	Depression	4.990	70	3132	3182
757	0.1-0.3	Connor	Supratidal	<0.01	0	0	0
	0.6-0.8	Creek	Flat	<0.01	0	0	0
758	0.2-0.4	Connor	Intertidal Flat	1.360	0	652	861
	0.8-1.0	Creek		1.380	0	636	861
	1.6-1.8			1.320	0	572	823
759	0.3-0.5	Connor	Intertidal Flat	1.800	0	1132	1123
	0.8-1.0	Creek		1.970	0	1042	1229
	1.6-1.8			1.790	0	888	1116
760	0.4-0.6	Connor	Intertidal Flat	0.310	24	19	139
	0.8-1.0	Creek		0.250	39	34	156
	1.4-1.6			0.150	0	0	29
761	0.1-0.3	Connor	Supratidal	0.140	0	0	766
	0.8-1.0	Creek	Flat	3.460	54	2106	2212
	1.2-1.4			2.090	33	1208	1337
762	0.8-1.0	Connor	Supratidal	<0.01	0	0	0
	1.3-1.5	Creek	Flat	<0.01	0	0	0
763	0.2-0.4	Connor	Intertidal Flat	2.220	16	1244	1401
	0.8-1.0	Creek		2.490	43	1458	1600
	1.6-1.8			3.780	26	2306	2384
764	0.1-0.3	Connor	Supratidal	0.330	0	130	206
	0.3-0.5	Creek	Flat	1.240	12	634	785
	0.8-1.0			1.130	0	528	705
	1.6-1.8			1.890	64	1108	1243

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
765	0.3-0.5	Connor	Intertidal Flat	1.280	0	612	777
	0.8-1.0	Creek		1.790	0	920	1116
	1.6-1.8			1.720	0	888	1073
766	0.15-0.3	Connor	Supratidal	0.080	10	33	60
	0.3-0.5	Creek	Flat	0.740	10	370	472
	0.8-1.0			0.410	0	110	246
	1.6-1.8			0.180	0	0	70
767	0.1-0.3	Connor	Supratidal	0.030	0	0	19
	0.3-0.5	Creek	Flat	0.910	16	470	584
	0.8-1.0			1.980	47	1154	1282
	1.6-1.8			1.600	0	844	998
768	0.1-0.3	Connor	Supratidal	0.340	0	129	212
	0.3-0.5	Creek	Flat	1.510	58	888	1000
	0.8-1.0			2.050	49	1232	1332
	1.6-1.8			1.110	0	546	670
769	0.2-0.4	Connor	Supratidal	0.020	0	0	0
	0.4-0.6	Creek	Flat	1.340	0	721	836
	0.8-1.0			1.370	0	730	854
	1.6-1.8			0.890	10	438	565
770	0.3-0.5	The Hut	Supratidal	4.240	43	2564	2687
	0.7-0.9		Flat	2.280	10	1222	1422
771	0.8-1.0	The Hut	Chenier Plain	0.040	0	0	0
	1.3-1.5			1.980	58	1176	1300
772	0.3-0.5	Connor	Intertidal Flat	1.640	17	882	1040
	0.8-1.0	Creek		2.350	53	1420	1524
	1.6-1.8			3.180	71	1954	2066
773	0.2-0.4	Deception	Supratidal	0.070	10	26	54
	0.4-0.6	Creek	Flat	0.260	0	78	162
	0.8-1.0			0.320	0	88	200
	1.6-1.8			0.940	0	334	537
774	0.1-0.3	Deception	Intertidal Flat	0.590	0	204	368
	0.8-1.0	Creek		1.070	0	506	667
	1.6-1.8			0.980	0	442	611
775	0.2-0.4	Deception	Supratidal	0.030	0	15	19
	0.4-0.6	Creek	Flat	0.480	0	202	299
	0.8-1.0			1.600	12	874	1010
	1.6-1.8			1.270	0	612	792
776	0.4-0.6	Telegraph	Extratidal	<0.01	27	11	118
	0.8-1.0	Creek	Flat	0.020	35	11	268
	1.6-1.8			1.170	33	764	763
777	0.8-1.0	Telegraph	Plain	0.010	67	16	73
	1.5-1.7	Creek		0.020	60	24	124
	1.8-2.0			0.010	26	23	32
778	1.8-2.0	Telegraph	Plain	<0.01	0	0	0
	2.8-3.0	Creek		<0.01	0	0	0
779	0.8-1.0	Telegraph	Plain	<0.01	0	0	0
	1.8-2.0	Creek		<0.01	0	0	0
780	0.0-0.1	Telegraph	Drainage	0.050	121	53	152
	0.8-1.0	Creek	Depression	0.010	42	14	48
781	0.2-0.4	Telegraph	Supratidal	<0.01	0	0	103
	0.7-0.9	Creek	Flat	<0.01	0	0	0
	1.1-1.3			<0.01	10	0	10

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
782	0.8-1.0	Telegraph	Extratidal	<0.01	0	0	0
	1.6-1.8	Creek	Flat	<0.01	0	0	0
783	0.8-1.0	Phillipies	Plain	<0.01	0	0	0
	1.5-1.7	Landing		<0.01	0	0	0
	2.3-2.5			<0.01	0	0	0
784	0.3-0.5	Phillipies	Drainage	<0.01	0	0	0
	0.8-1.0	Landing	Depression	<0.01	0	0	0
785	0.2-0.3	Phillipies	Supratidal	0.520	10	226	428
	0.3-0.5	Landing	Flat	2.940	98	1956	1932
	0.8-1.0			3.920	67	2500	2512
	1.4-1.6			0.520	0	222	324
786	0.3-0.5	Connor	Supratidal	0.010	0	0	0
	0.8-1.0	Point	Flat	0.900	0	324	490
	1.6-1.8			0.740	0	0	174
787	0.3-0.5	Connor	Intertidal Flat	0.340	0	30	169
	0.8-1.0	Creek		1.040	0	500	649
	1.4-1.6			0.650	0	230	405
788	0.3-0.5	Connor	Intertidal Flat	0.450	0	56	234
	0.8-1.0	Creek		1.360	0	734	848
	1.6-1.8			0.920	0	416	533
789	0.3-0.5	Connor	Intertidal Flat	0.110	0	0	51
	0.8-1.0	Creek		1.180	0	640	736
	1.6-1.8			1.770	13	1036	1117
790	0.3-0.5	Connor	Drainage	<0.01	0	0	0
	0.8-1.0	Creek	Depression	<0.01	0	0	0
	1.8-2.0			<0.01	0	0	0
	2.8-3.0			<0.01	0	0	0
791	0.1-0.3	Connor	Supratidal	1.560	34	1052	1271
	0.3-0.5	Creek	Flat	2.520	79	1668	1651
	0.8-1.0			3.480	62	2234	2232
	1.6-1.8			1.630	48	1004	1065
792	0.2-0.4	Connor	Supratidal	0.270	0	78	344
	0.4-0.6	Creek	Flat	0.310	0	106	193
	0.8-1.0			0.230	0	24	125
	1.4-1.6			0.750	0	0	468
793	0.4-0.6	Sandfly	Supratidal	1.100	0	546	686
	0.8-1.0		Flat	2.220	21	1326	1406
	1.6-1.8			3.540	50	2304	2258
794	0.2-0.4	Sandfly	Intertidal Flat	0.600	0	124	374
	0.8-1.0			4.670	112	3166	3025
	1.6-1.8			1.460	0	794	911
795	0.45-0.6	Sandfly	Supratidal	1.760	44	1154	1142
	0.8-1.0		Flat	2.410	27	1512	1530
	1.6-1.8			1.280	0	692	798
796	0.3-0.5	Sandfly	Creek Bank	1.550	0	966	967
	0.6-0.8			0.330	0	93	193
797	0.8-1.0	Connor	Beach Ridge	<0.01	0	0	0
	1.2-1.4	Point		1.180	0	632	736
	1.5-1.7			1.330	0	742	830
798	0.4-0.6	Connor	Supratidal	0.950	0	304	593
	0.8-1.0	Point	Flat	1.580	0	980	985
	1.3-1.5			1.250	13	776	793

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
799	0.3-0.5	Connor Point	Intertidal Flat	0.480	0	108	293
	0.8-1.0			2.970	0	1822	1852
	1.6-1.8			1.260	0	518	786
800	1.5-1.7	Connor Point	Beach Ridge	1.850	0	683	1097
801	0.2-0.4	Connor Point	Intertidal Flat	1.000	0	530	624
	0.7-0.9			0.920	0	95	477
	1.6-1.8			0.790	0	0	117
802	0.4-0.6	Connor Point	Supratidal Flat	0.790	0	422	493
	0.8-1.0			0.820	0	460	511
	1.6-1.8			0.830	0	0	342
803	0.2-0.4	Connor Point	Supratidal Flat	<0.01	0	0	0
	0.4-0.6			0.770	39	517	519
	0.8-1.0			0.950	0	382	593
	1.2-1.4			0.920	0	34	553
804	0.2-0.4	Ramsay Crossing	Intertidal Flat	2.270	29	1452	1445
	0.8-1.0			4.140	17	2632	2599
	1.6-1.8			5.470	0	3398	3412
805	0.5-0.7	Deception Creek	Extratidal Flat	0.040	20	45	190
	0.8-1.0			0.030	23	51	117
	1.0-1.2			1.340	44	870	880
	1.6-1.8			2.440	49	1546	1571
806	0.3-0.5	Deception Creek	Intertidal Flat	0.330	0	138	206
	0.8-1.0			0.370	0	152	231
	1.6-1.8			2.170	13	1312	1366
807	0.2-0.4	Deception Creek	Supratidal Flat	0.550	72	378	446
	0.5-0.7			5.270	112	3704	3399
	0.8-1.0			5.560	135	3930	3603
	1.6-1.8			5.630	91	3862	3602
808	0.3-0.5	Deception Creek	Extratidal Flat	<0.01	0	0	0
	0.7-0.9			<0.01	0	0	0
809	0.1-0.2	Deception Creek	Supratidal Flat	0.010	0	0	0
	0.3-0.5			2.380	58	1576	1542
	0.8-1.0			2.420	95	1656	1604
	1.6-1.8			1.320	73	912	896
810	0.3-0.5	Deception Creek	Intertidal Flat	0.830	0	481	518
	0.8-1.0			2.140	24	1374	1359
	1.6-1.8			6.750	74	4614	4284
811	0.3-0.5	Deception Creek	Intertidal Flat	0.930	48	651	628
	0.8-1.0			0.930	55	655	635
	1.6-1.8			0.870	0	492	543
812	0.1-0.3	Deception Creek	Supratidal Flat	0.030	0	15	116
	0.3-0.5			0.790	58	563	551
	0.8-1.0			0.530	58	397	388
	1.6-1.8			0.330	33	237	239
813	0.4-0.6	Deception Creek	Intertidal Flat	1.540	28	952	988
	0.8-1.0			0.810	0	402	505
	1.5-1.8			1.670	0	539	979
814	0.3-0.5	Deception Creek	Supratidal Flat	0.540	20	309	357
	0.8-1.0			0.970	49	1244	1277
	1.5-1.8			3.000	84	1930	1955

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
815	0.0-0.2	Deception	Intertidal Flat	0.370	0	27	231
	0.3-0.5	Creek		1.550	0	828	967
	0.8-1.0			1.500	0	830	935
	1.5-1.8			1.380	0	760	861
816	0.2-0.4	Deception	Supratidal	4.910	98	3518	3160
	0.8-1.0	Creek	Flat	3.790	38	2470	2401
	1.6-1.8			2.350	49	1560	1514
817	0.3-0.5	Munduran	Tidal Creek	2.300	0	1426	1434
	0.8-1.0			2.510	0	1552	1565
	1.5-1.8			5.160	0	3268	3218
818	0.6-0.8	Munduran	Supratidal	1.700	15	1092	1075
	1.0-1.2		Flat	1.400	14	882	887
	1.5-1.8			2.180	0	1342	1359
819	0.2-0.4	Munduran	Supratidal	0.960	17	578	615
	0.4-0.6		Flat	8.230	64	5432	5197
	0.8-1.0			2.430	36	1440	1551
820	0.0-0.2	Munduran	Intertidal Flat	3.510	34	2312	2223
	0.8-1.0			12.400	54	8358	7787
	1.5-1.8			5.950	49	3902	3760
821	0.3-0.5	Munduran	Intertidal Flat	1.650	0	1004	1029
	0.8-1.0			10.500	58	7086	6606
	1.5-1.8			6.630	52	4448	4187
822	0.4-0.6	Munduran	Supratidal	5.350	64	3684	3400
	0.8-1.0		Flat	6.510	84	4494	4144
	1.5-1.7			5.300	46	3386	3351
823	0.2-0.4	Munduran	Intertidal Flat	3.570	36	2406	2262
	0.8-1.0			8.760	76	6008	5539
	1.5-1.8			7.150	77	4724	4536
824	0.2-0.4	Munduran	Supratidal	0.100	0	12	62
	0.8-1.0		Flat	1.980	29	1282	1263
	1.5-1.8			1.800	29	1186	1151
825	0.3-0.5	Munduran	Tidal Creek	1.010	0	418	629
	0.7-0.9			0.270	0	0	168
826	0.2-0.4	Munduran	Supratidal	8.540	128	6074	5454
	0.8-1.0		Flat	6.120	88	4312	3905
	1.6-1.8			2.240	0	1398	1397
827	0.3-0.5	Munduran	Intertidal Flat	4.090	90	2822	2640
	0.8-1.0			6.620	111	4666	4239
	1.5-1.8			4.110	28	2652	2591
828	0.2-0.3	Munduran	Supratidal	0.320	36	250	235
	0.3-0.5		Flat	9.080	89	6300	5752
	0.8-1.0			9.440	68	6254	5955
	1.4-1.6			3.240	29	2032	3116
829	0.3-0.5	Munduran	Intertidal Flat	6.930	85	4798	4407
	0.8-1.0			8.570	89	5930	5434
	1.5-1.8			4.950	61	3340	3176
830	0.2-0.4	Munduran	Intertidal Flat	4.470	81	3202	2868
	0.8-1.0			3.800	44	2512	2414
	1.4-1.6			1.500	0	882	935
831	0.2-0.4	Munduran	Intertidal Flat	2.410	22	1476	1525
	0.8-1.0			5.380	64	3764	3419
	1.5-1.8			4.520	39	3024	2858

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA Mol H^+/t	Net Acidity mol H^+/t
832	0.4-0.6	Munduran	Supratidal	4.300	43	2998	2724
	0.8-1.0		Flat	3.380	50	2362	2158
	1.5-1.7			2.970	50	1958	1902
833	0.0-0.2	Munduran	Intertidal Flat	0.910	0	582	567
	0.2-0.4			2.130	29	1484	1357
834	0.0-0.2	Munduran	Intertidal Flat	1.960	12	1262	1234
	0.8-1.0			1.340	17	916	852
	1.2-1.4			1.510	0	920	941
835	0.1-0.3	Munduran	Intertidal Flat	1.200	16	772	764
	0.8-1.0			3.040	19	1990	1915
	1.2-1.45			2.330	0	1482	1453
836	0.0-0.2	Munduran	Intertidal Flat	1.690	10	1116	1064
	0.3-0.5			2.400	24	1586	1520
	0.8-1.0			4.490	33	2992	2833
837	0.3-0.5	Munduran	Supratidal	8.620	78	5702	5454
	0.8-1.0		Flat	9.210	82	6176	5826
	1.3-1.5			1.920	0	1194	1197
838	0.2-0.4	Phillipies	Supratidal	2.980	74	2104	1932
	0.8-1.0	Landing	Flat	2.120	37	1384	1359
	1.2-1.4			2.830	0	1682	1765
839	0.2-0.4	Phillipies	Intertidal Flat	2.520	0	1632	1571
	0.8-1.0	Landing		3.200	18	2058	2013
	1.6-1.8			1.770	0	1128	1103
840	0.2-0.4	Scrubby	Intertidal Flat	3.360	54	2222	2149
	0.8-1.0	Creek		3.620	35	2360	2292
	1.4-1.6			2.560	37	1730	1633
841	0.1-0.3	Phillipies	Intertidal Flat	1.840	0	1162	1147
	0.8-1.0	Landing		1.820	0	1142	1135
	1.6-1.8			2.140	0	1310	1334
842	0.3-0.5	Deception	Intertidal Flat	1.590	0	1012	991
	0.8-1.0	Creek		5.610	87	3934	3498
	1.6-1.8			0.640	0	178	399
843	0.1-0.3	Deception	Intertidal Flat	3.680	33	2494	2328
	0.8-1.0	Creek		8.140	64	5422	5140
	1.0-1.1			4.640	0	2932	2781
844	0.8-1.0	Munduran Creek	Extratidal Flat	0.010	0	0	6
845	0.8-1.0	Munduran Creek	Back Channel	1.810	17	1210	1146
846	0.4-0.6	Telegraph	Extratidal	0.010	15	33	21
	0.8-1.0	Creek	Flat	<0.01	0	18	18
	1.1-1.3			0.010	17	45	67
	1.4-1.6			0.070	15	146	59
847	1.2-1.4	Telegraph	Alluvial	<0.01	21	38	60
	1.8-2.0	Creek	Plain	0.010	37	75	135
	2.2-2.4			0.030	38	84	95
848	1.2-1.4	Gonong	Extratidal	1.530	0	967	954
	1.6-1.8	Creek	Flat	4.100	0	2601	2557
849	1.0-1.2	Dart	Extratidal	1.300	0	794	810
	1.5-1.7	Creek	Flat	1.930	0	1238	1203
	2.0-2.2			2.260	12	1488	1421
	2.3-2.5			2.410	25	1548	1522