APPENDIX B5 – WETLAND DESCRIPTIONS FOR ASSESSMENT OF ACID SULFATE SOIL MATERIALS IN THE LOCK 1 TO WELLINGTON REGION OF THE MURRAY-DARLING BASIN

CONTENTS

71 YARRAMUNDI NORTH (MORGAN'S LAGOON) WETLAND (WETLAND ID. 12726)

71.1 BACKGROUND

Yarramundi North (Morgan's Lagoon) Wetland is situated on the eastern side of the River Murray. The wetland is elongated in shape and it is approximately 1.7 kilometres in length and 500 metres at its widest, and with a total surface area of 100 hectares. The wetland is on the inside of the river curve.

This wetland was studied as part of a separate monitoring investigation of acid sulfate soils, the work and data was presented in the report 'Acid Sulfate Soil Investigations of Vertical and Lateral Changes with Time in five Managed Wetlands Between Lock 1 and Wellington' (Fitzpatrick, Shand, Thomas, Grealish, McClure, Merry and Baker. CSIRO Land and Water Science Report 03/10). Readers are referred to this report for detailed information, and here a summary of the findings are presented.

At the time of field sampling the wetland was dry. Two sites were sampled at the northern end of the wetland, with one site located at low elevation where the surface was friable aggregates (Site MOR3) and the other on the raised edge where the surface was sealed and amongst reeds (Site MOR4). Two sites were sampled and their locations are shown in Figure 71-1.

Figure 71-1. Yarramundi North (Morgan's Lagoon) wetland and site locations.

71.2 DISCUSSION

Acid sulfate soil materials at Yarramundi North (Morgan's Lagoon) Wetland were identified as hypersulfidic in the surface and subsoil layers.

The soils throughout the wetland were dominantly clays with soil cracks extending from the surface to the upper subsoil. In some areas, especially on the margins of the wetland these cracks have been filled with wind-blown sand. Near the up-river inlet there were shallow pockets of surface water and water in the sol cracks were acidic, indicating the potential for hypersulfidic soil materials to react and acidify water when there is contact.

The potential hazards posed by acid sulfate soil materials at the Yarramundi North (Morgan's Lagoon) Wetland are:

- Acidification hazard: Hypersulfidic soil materials were identified in the sampled sites. There is a medium to high level of concern.
- De-oxygenation hazard: No laboratory data was available, but based on judgement and comparison with other similar soils in the area there may be potential for monosulfidic materials to form in the surface layers of soils. Monosulfidic material was observed. There is a high level of concern.
- Metal mobilisation hazard: The medium to high acidification hazard indicates that soil acidification potential may increase the solubility of metals. There is a medium level of concern.

Summary of key findings for Yarramundi North (Morgan's Lagoon) Wetland:

Soil materials:	The soils throughout the wetland were clays in the surface and subsoil layers. The surface and subsoil layers throughout the wetland were hypersulfidic, with a relatively high net acidity. In isolated areas at high elevation the subsoil was hyposulfidic.
Acid sulfate soil identification:	• Hypersulfidic Cracking Clay Soils – occurring throughout the wetland. Dominant (>50%) in extent. • Hyposulfidic Soils – occurring on the margins of the wetland. Isolated (<10%) in extent.
Hazard assessment	• Acidification hazard – medium to high level of concern • De-oxygenation hazard – high level of concern • Metal mobilisation hazard – medium level of concern

72 YARRAMUNDI -NOONAWIRRA WETLAND (WETLAND ID. 12727)

72.1 BACKGROUND

Yarramundi-Noonawirra Wetland is located on the northern side of the River Murray. The wetland is linear in shape, approximately 1300 metres long, and 80 metres at the widest point. The wetland is bounded to the northwest and to the southeast by floodplain. The wetland is connected by a channel to the river at the southern end.

This wetland was studied in 2007/08 as part of a separate monitoring investigation of acid sulfate soils, the work and data was presented in the report 'Acid sulfate soils in subaqueous, waterlogged and drained soil environments of nine wetlands below Blanchetown (Lock 1), South Australia: properties, genesis, risks and management' (Fitzpatrick, Shand, Thomas, Merry, Raven and Simpson, November 2008. Report prepared for South Australian Murray-Darling Basin Natural Resources Management Board. CSIRO Land and Water Science Report 42/08). Readers are referred to this report for detailed information, and here a summary of the findings are presented.

At the time of field sampling the wetland was dry. Sites were located along one transect from the margin into the centre of wetland, with Site NOO1 located near the margin, Site NOO2 in near the centre of the wetland and Site NOO3 located between these two sites. Three sites were sampled in February 2008 and their locations are shown in Figure 72-1.

Figure 72-1. Yarramundi-Noonawirra Wetland and sample site locations.

72.2 DISCUSSION

Acid sulfate soil materials at Yarramundi-Noonawirra Wetland were identified as hypersulfidic or hyposulfidic in the surface and subsoil layers. Hypersulfidic materials occurred near the wetland margins (Sites NOO1 and NOO3) and hyposulfidic material occurred towards the centre of the wetland (Site NOO2).

The soils throughout the wetland were dominantly clays, with wide soil cracks that extended into the subsoil layers, some soil material from the surface had filled the soil cracks.

The potential hazards posed by acid sulfate soil materials at the Yarramundi-Noonawirra Wetland are:

- Acidification hazard: Hypersulfidic and hyposulfidic soil materials occur throughout the wetland. There is a medium to high level of concern.
- De-oxygenation hazard: No data was available, but based on judgement and comparison with other similar soils in the area there may be potential for monosulfidic materials to form in the surface layers of soils, although monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation hazard: The medium to high acidification hazard indicates that soil acidification potential may increase the solubility of metals. There is a medium level of concern.

Summary of key findings for Yarramundi-Noonawirra Wetland:

Soil materials:	The soils throughout the wetland were clays in the surface and subsoil layers, with wide soil cracks into the subsoil.
Acid sulfate soil identification:	• Cracking Clay Soils – occurring throughout the main wetland areas. Co-dominant (>25%) in extent. • Hypersulfidic Cracking Clay Soils – occurring throughout the margins and into the main wetland areas. Co-dominant (>25%) in extent.
Hazard assessment	• Acidification hazard – medium to high level of concern • De-oxygenation hazard – medium level of concern • Metal mobilisation hazard – medium level of concern

73 SOUTH PORTEE WETLAND (WETLAND ID. 12729)

73.1 LOCATION AND SETTING DESCRIPTION

South Portee Wetland (Wetland ID. 12729) is situated on the western side of the River Murray. The wetland is geomorphically categorised as a Murray Gorge basin (Pressey 1986) and is an irregular shape, approximately 1.5 kilometres in length and approximately 750 metres at its widest, with a total surface area of 123 hectares. The wetland is bound to the west by cliff and hill slopes and to the east a floodplain area that separates it from the river. There are water connection channels where the wetland joins with Portee Creek Wetland at the northern end of the wetland and with Yarramundi Creek Wetland at the southern end. At the time when the soil survey was conducted in September 2008, the wetland was dry and there was no surface water. The main wetland area had sealed hard surface with isolated salt tolerant plant species growing, and on the wetland margins there were areas of *Phragmites australis* (Common Reed), and on the elevated floodplain areas there were trees. Three sites were described and sampled and their locations are shown in Figure 73-1.

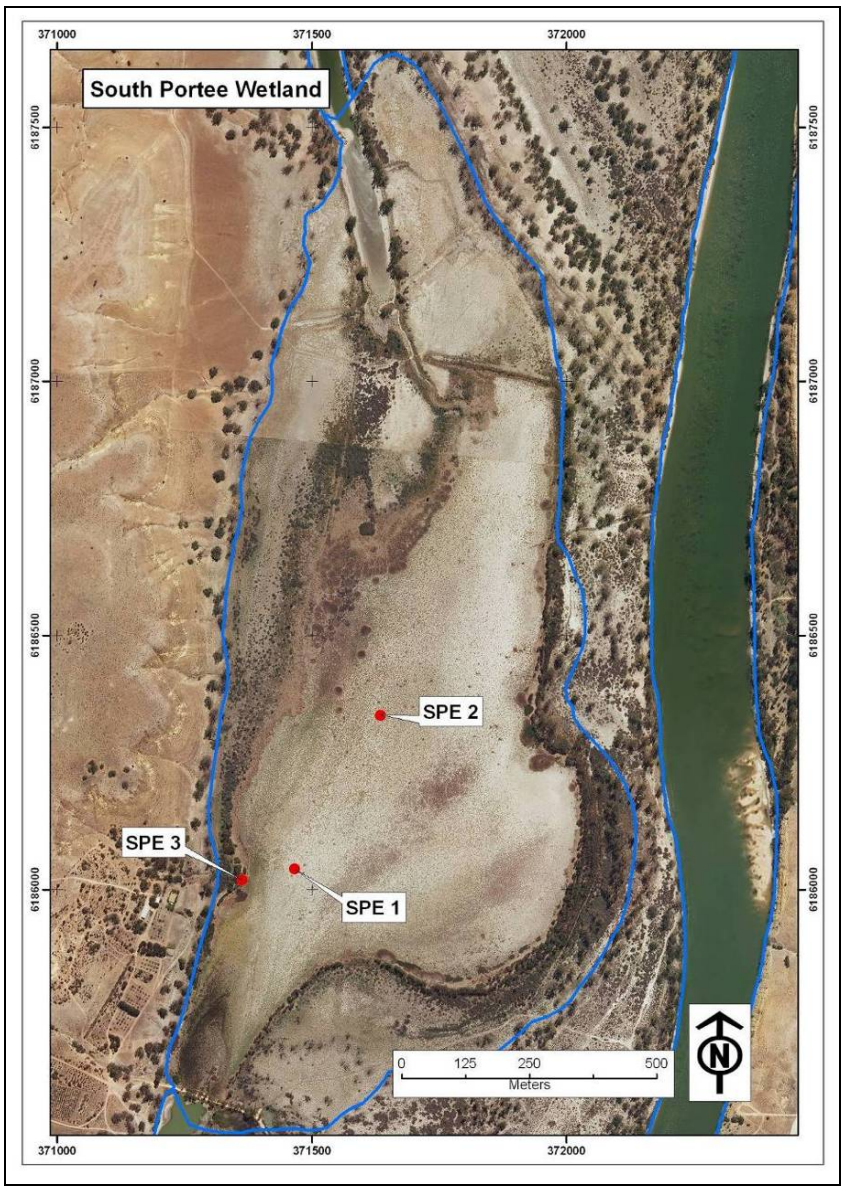

Figure 73-1. South Portee Wetland and sample site locations.

73.2 SOIL PROFILE DESCRIPTION AND DISTRIBUTION

Three sites were described and sampled. The acid sulfate soil subtype class and general landscape description are presented in Table 73-1. Sites were located to form a cross-section through the wetland from the main centre area (SPE1 and SPE2) and the wetland margin (SPE3). The site and soil profile descriptions are presented in Table 73-2 and Table 73-3.

Site SPE1 (Figure 73-2) occurred near the middle of the wetland where there was isolated plants growing on a sealed hard surface. The soil consisted of grey, slightly rigid, clay, over clay that was too dry and hard to dig below 20 centimetres depth.

Site SPE2 (Figure 73-3) occurred in the main area of the wetland where there were isolated plants growing on a sealed hard surface. The soil consisted of grey, slightly rigid, clay, over clay that was too dry and hard to dig below 25 centimetres depth.

Site SPE3 (Figure 73-4) occurred near the wetland margin where *Phragmites australis* (Common Reed) were growing on the surface that was friable. The soil consisted of grey brown, friable, sandy loam, over grey, very firm, clay that became too dry and hard to dig below 50 centimetres depth.

Table 73-1. Site ID, subtype and general landscape description of sites for South Portee Wetland.

Site ID	Easting m zone 54H	Northing m zone 54H	Acid sulfate soil subtype class	General landscape description
SPE1	371467	6186040	Other soil (cracking clay)	Low elevation, near centre of wetland
SPE2	371635	6186342	Other soil (cracking clay)	Low elevation, near centre of wetland
SPE3	371364	6186018	Other soil	High elevation, adjacent to vegetation on wetland margin

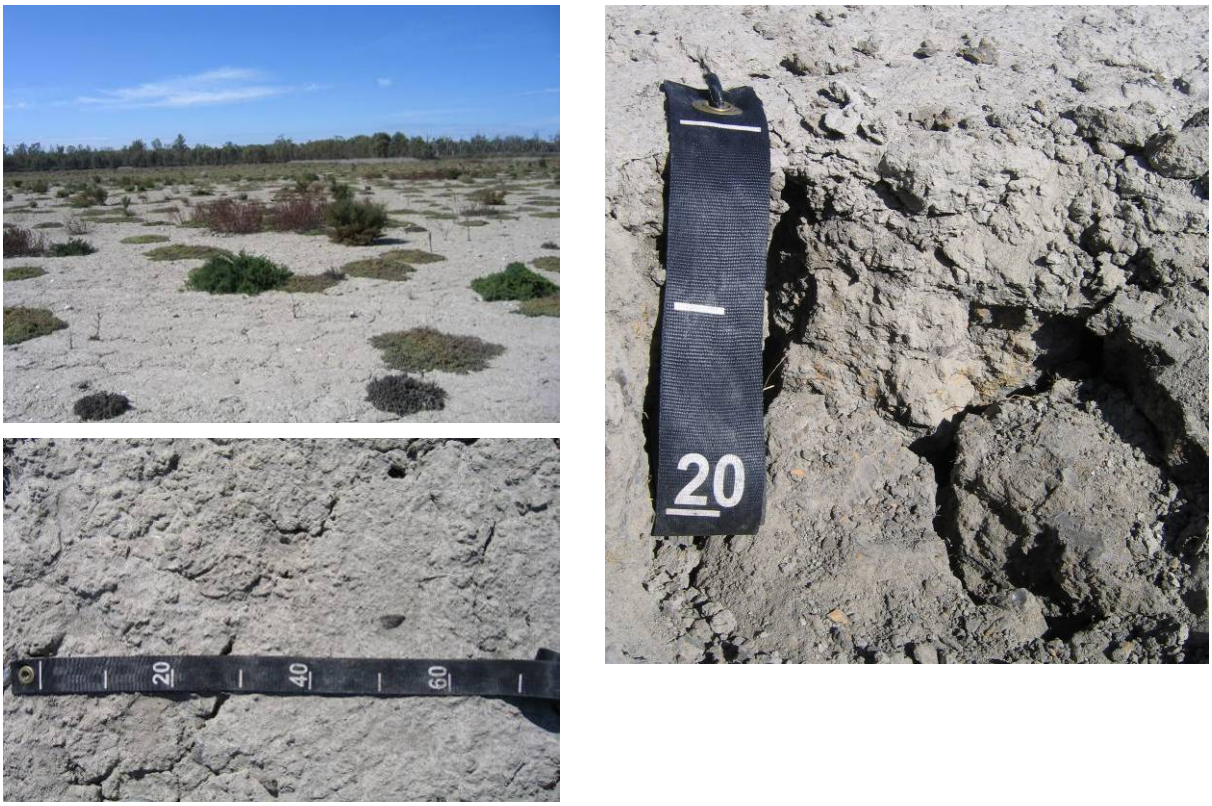

Figure 73-2: Photographs of site SPE1, showing the wetland landscape, the cracking hard sealed surface and the soil profile of slightly rigid clay.

Figure 73-3. Photographs of profile SPE2, showing the wetland landscape with isolated areas of vegetation, and the soil profile of slightly rigid clay.

Figure 73-4. Photographs of profile SPE3, showing the site location in reeds, and the soil profile of friable sandy loam over very firm clay.

73.3 LABORATORY DATA ASSESSMENT

Soil pH testing (pH_W, pH_{OX}, pH_{INC})

The pH data are provided in Table 73-4 and pH profiles are presented in Figure 73-5.

The pH_W data did not identify sulfuric materials with a pH_W <4.

The pH_{INC} data did not identify samples that on incubation declined below the critical value of pH <4. Samples that age to pH_{INC}<4 indicate that these soils potentially would form sulfuric materials as a result of sulfide oxidation.

The pH_{OX} data did not identify samples below the critical value of pH_{OX} <2.5, the threshold value normally used to indicate a high likelihood of sulfuric material forming.

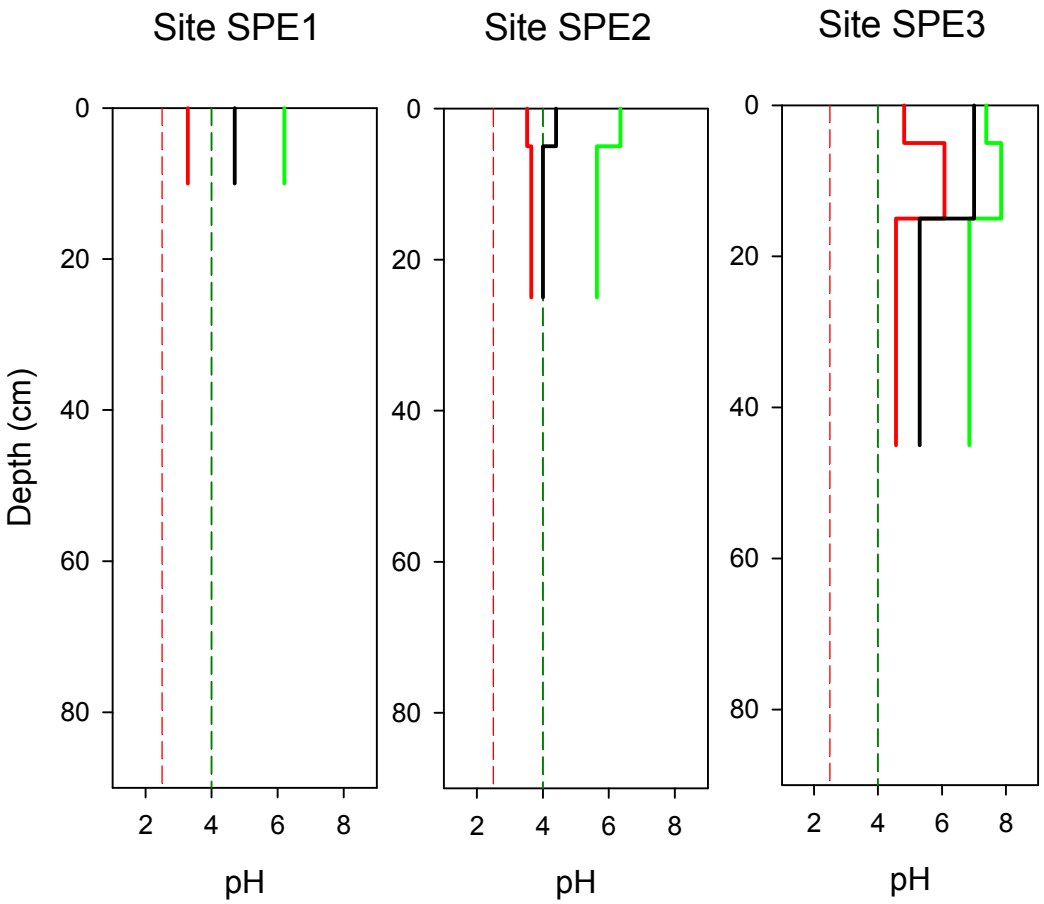

Figure 73-5. Depth profiles of soil pH for South Portee Wetland, showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and ageing pH (pH_{INC} after 28 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

Acid Base Accounting

The acid base accounting data is provided in Table 73-4 and summarised in Figure 73-6.

Chromium reducible sulfur values were below the limit of detection. Sulfidic materials were not detected.

Titratable actual acidity values ranged from 0 to 10.52 mole H^+/tonne.

Analysis of retained acidity was not conducted on any of the samples, as all samples were above the critical value of pH_{KCl} <4.5.

Acid neutralising capacity values ranged from 0 to 3.99 %$CaCO_3$, and were measured in the surface layers of profile SPE3.

Net acidity values ranged from -532 to 3 mole H^+/tonne. Low or negative net acidity values occurred in all layers of the soil profiles.

Water Soluble Sulfate

Water soluble sulfate data values shown in Table 73-4 identified that surface layers were above the critical trigger value of 100 mg/kg SO_4.

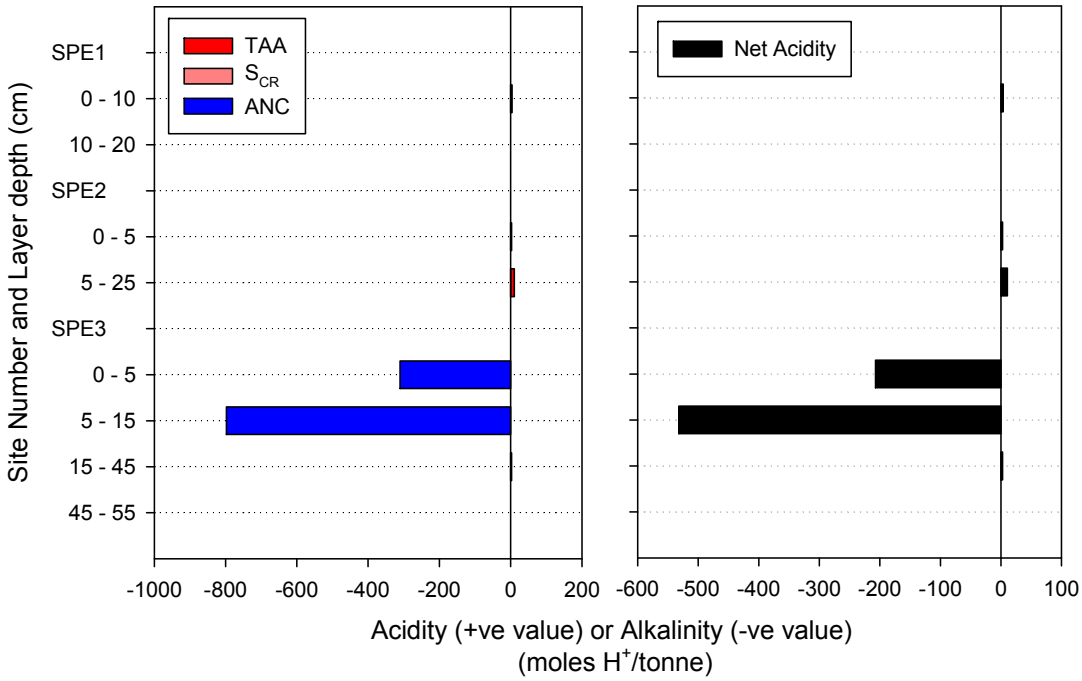

Figure 73-6. Acid base accounting depth profiles for South Portee Wetland. Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

73.4 DISCUSSION

Acid sulfate soil materials at South Portee Wetland were not identified, samples were characterised as other acidic or other soil materials. The acid sulfate soil subtype classes identified were Other Soil (cracking clay) or Other Soil.

The soils throughout the wetland were generally slightly rigid clays, and on the margins the surface layer was friable loamy soil over very firm clays.

Monosulfidic material was not observed but water soluble sulfate data identified that surface layers for the profiles throughout the wetland were in excess of the 100 mg/kg trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at the South Portee Wetland are:

- Acidification hazard: The data identified low or negative net acidity values throughout the profiles, and pH data did not identify potential acidification due to oxidation. There is a low level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated a potential for monosulfidic materials to form in the surface layers of soils, although monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The low acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

Summary of key findings for South Portee Wetland:

Soil materials:	Acid sulfate soil materials were not identified, and all layers were other acidic or other soil materials. The soils throughout were generally slightly rigid clays. Generally profiles had samples with low or negative net acidity values and pH data did not identify potential acidification due to oxidation.
Acid sulfate soil identification:	• Other Soil (cracking clay) – that occurred in the lower elevation main areas of the wetland. Dominant (>50%) in extent. • Other Soil – that occurred on the margins of the wetland. Minor (<25%) in extent.
Hazard assessment	• Acidification hazard – low level of concern. • De-oxygenation hazard – medium level of concern. • Metal mobilisation hazard – low level of concern.

Table 73-2. Site data for South Portee Wetland.

Site Number	Sampled Date	Easting m zone 54H	Northing m zone 54H	Soil Classification	Water depth (+ve) Water table (-ve)	Surface Condition	Earth Cover (Vegetation)	Location Notes
SPE1	05-Sep-08	371467	6186040	Other soil	Not reached	sealed, hard	Bare, few weeds	Low elevation, near centre of wetland
SPE2	05-Sep-08	371635	6186342	Other soil	Not reached	sealed, hard	Bare, few weeds	Low elevation, near centre of wetland
SPE3	05-Sep-08	371364	6186018	Other soil	Not reached	plant material	*Phragmites australis* (Common Reed)	High elevation, adjacent to vegetation on wetland margin

Table 73-3. Soil description data for South Portee Wetland.

Site and Sample Number	Depth Upper (cm)	Depth Lower (cm)	Observation Method (kind)	Soil Colour (Munsell notation)	Texture (class)	Soil Water Status	Mottles Quantity (%)	Mottles Colour	Mottles Location	Structure Type (category)	Consistence (category)	Comments
SPE1.1	0	10	soil pit	2.5Y 7/1	clay	dry	3	10YR 6/8	in matrix	platy	very firm	
SPE1.2	10	20	soil pit	2.5Y 5/1	clay	moist	15	10YR 6/8	in matrix	columnar	slightly rigid	
SPE2.1	0	5	soil pit	2.5Y 7/1	clay	dry	3	10YR 6/8	in matrix	platy	very firm	
SPE2.2	5	25	soil pit	2.5Y 5/1	clay	moist	15	10YR 6/8	in matrix	columnar	slightly rigid	
SPE3.1	0	5	soil pit	10YR 5/3	sandy loam	dry	0			subangular blocky	friable	
SPE3.2	5	15	soil pit	10YR 5/2	sandy loam	dry	3	10YR 6/8	in matrix	subangular blocky	firm	
SPE3.3	15	45	soil pit	2.5Y 5/1	clay	moist	0			massive	very firm	
SPE3.4	45	55	soil pit	2.5Y 5/1	clay	moist	0			massive	very firm	

Table 73-4. Laboratory data for acid sulfate soil assessment of South Portee Wetland.

(red printed values indicate data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
SPE1.1	0 - 10	fine	-	6.20	3.28	4.70	111	5.58	3.80	< 0.01	-	4	other acidic incubation
SPE1.2	10 - 20	fine	-	-	-	-	-	-	-	-	-	-	-
SPE2.1	0 - 5	fine	-	6.35	3.52	4.40	112	5.76	2.63	< 0.01	-	3	other acidic incubation
SPE2.2	5 - 25	fine	-	5.64	3.65	4.00	190	4.91	10.52	< 0.01	-	11	other acidic incubation
SPE3.1	0 - 5	medium	-	7.38	4.82	7.00	661	7.29	-	< 0.01	1.55	-207	other soil material
SPE3.2	5 - 15	medium	-	7.85	6.08	7.00	305	8.04	-	< 0.01	3.99	-532	other soil material
SPE3.3	15 - 45	fine	-	6.85	4.56	5.30	154	6.03	2.63	< 0.01	-	3	other acidic incubation
SPE3.4	45 - 55	fine	-	-	-	-	-	-	-	-	-	-	-

74 PORTEE CREEK WETLAND (WETLAND ID. 12730)

74.1 LOCATION AND SETTING DESCRIPTION

Portee Creek Wetland (Wetland ID. 12730) is situated on the western side of the River Murray. The wetland is geomorphically categorised as a Murray Gorge basin (Pressey 1986) and is a creek with a linear shape, approximately 3.2 kilometres in length and approximately 50 to 100 metres wide, with a total surface area of 18 hectares. The wetland is bounded to the west by hill slopes and to the east by a floodplain area that separates it from Portee Wetland and the river. There are water connection channels at both ends of the wetland as Portee Creek provides a linkage between Moorundie Wetland and South Portee Wetland. At the time when the soil survey was conducted in September 2008, the creek had water in it but the level was low and the surrounding area was a dry sealed soft clay surface with no vegetation, although there were a few isolated areas of reeds and trees growing on the raised bank areas. Two sites were described and sampled and their locations are shown in Figure 74-1.

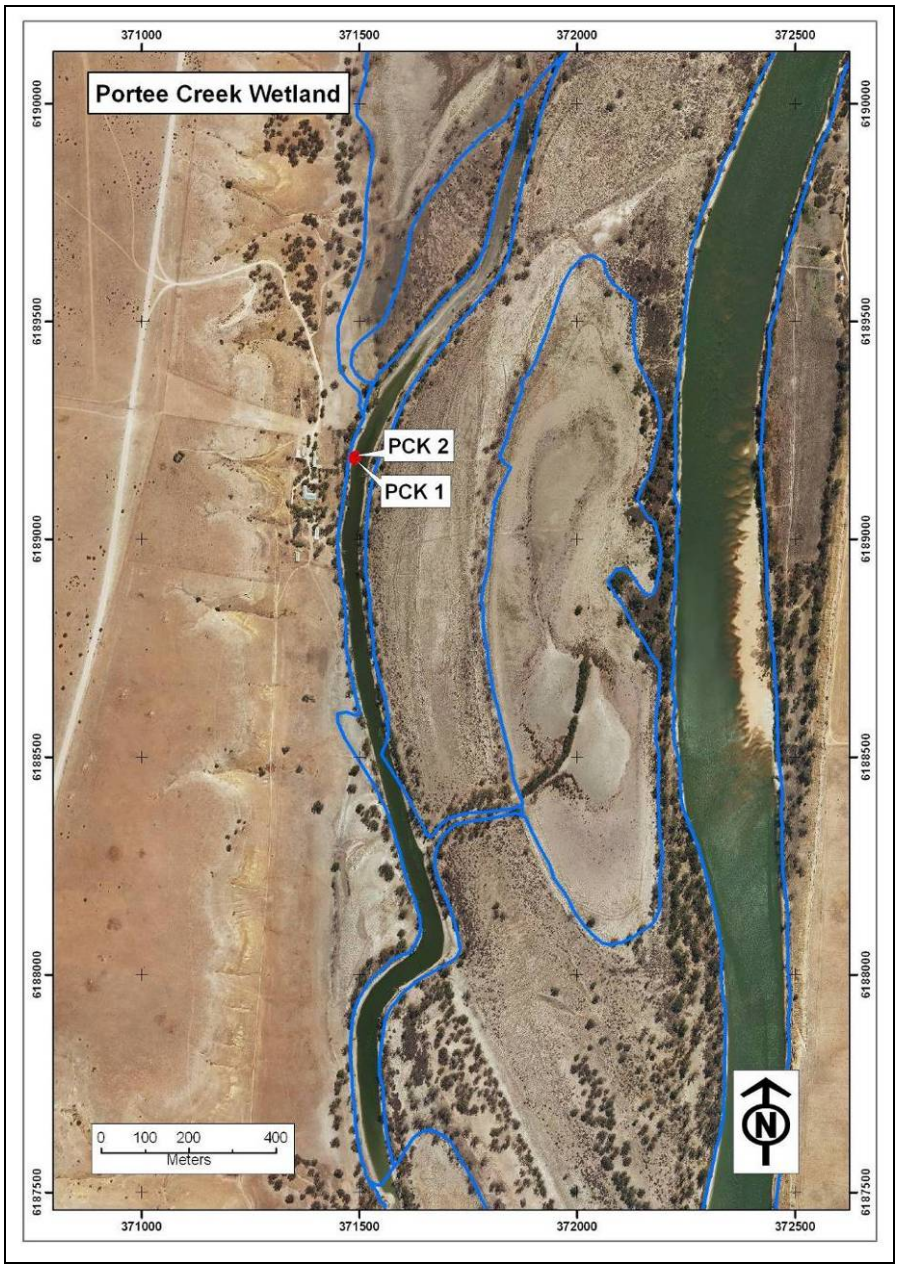

Figure 74-1. Portee Creek Wetland and sample site locations.

74.2 SOIL PROFILE DESCRIPTION AND DISTRIBUTION

Two sites were described and sampled. The acid sulfate soil subtype class and general location description are presented in Table 74-1. The sites were located to characterise the main wetland features that included adjacent to the waters edge (PCK1) and on the surrounding bare surfaced area (PCK2). The site and soil profile descriptions are presented in Table 74-2 and Table 74-3.

Site PCK1 (Figure 74-2) occurred in the water of the creek approximately 2 metres from the water's edge, the water was approximately 20 centimetres deep, and the soil consisted of grey to black, very soft, clay, over olive grey, very firm, clay. Site PCK2 (Figure 74-3) occurred approximately 1 metre above and away from the water's edge, the surface was sealed and soft with salt crystals and there was no plants growing, and the soil consisted of grey, soft, clay, over grey and black, very soft, clay over olive grey, very firm, clay.

Table 74-1. Soil identification, subtype and general location description of sites for Portee Creek Wetland.

Site ID	Easting m zone 54H	Northing m zone 54H	Acid sulfate soil subtype class	General location description
PCK1	371490	6189184	Subaqueous hyposulfidic soil	Low elevation, 2m from waters edge in the water
PCK2	371491	6189189	Hyposulfidic soil	Low elevation, 1m from waters edge

Figure 74-2. Photographs of site PCK1, showing the site location adjacent to the tree branch in the water, viewed across the wetland, and the wetland viewed along the channel.

Figure 74-3. Photograph of site PCK2, showing the site location adjacent and up from the waters edge.

74.3 LABORATORY DATA ASSESSMENT

Soil pH testing (pH_W, pH_{OX}, pH_{INC})

The pH data are provided in Table 74-4 and pH profiles in Figure 74-4.

The pH_W data did not identify sulfuric materials with a pH_W <4.

The pH_{INC} data did not identify samples that on incubation declined below the critical value of pH <4. Samples that age to pH_{INC}<4 indicate that these soils potentially would form sulfuric materials as a result of sulfide oxidation.

The pH_{OX} data did not identify samples below the critical value of pH_{OX} <2.5, the threshold value normally used to indicate a high likelihood of sulfuric material forming.

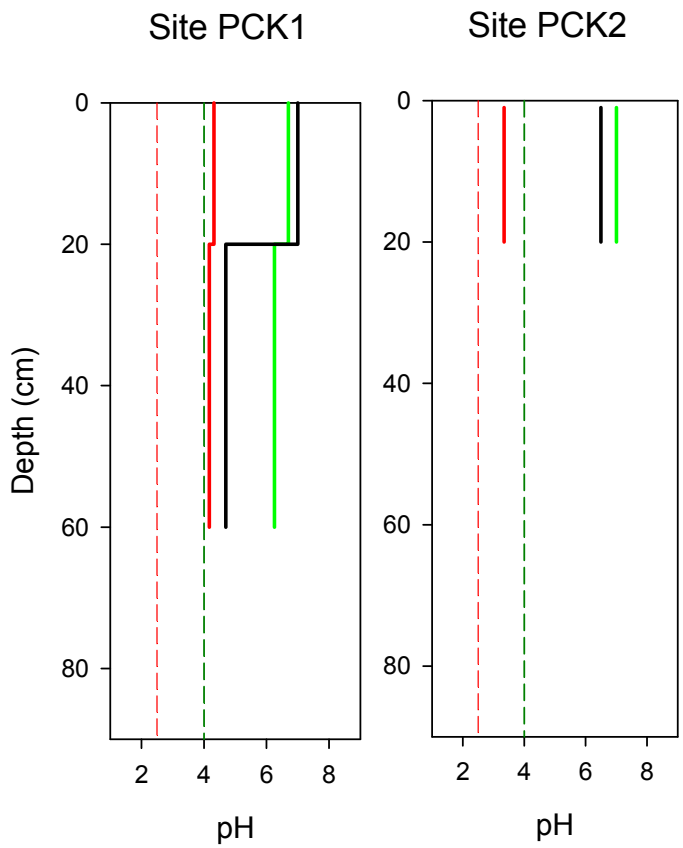

Figure 74-4. Depth profiles of soil pH for Portee Creek Wetland, showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and ageing pH (pH_{INC} after 28 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

Acid Base Accounting

The acid base accounting data is provided in Table 74-4 and summarised in Figure 74-5.

Chromium reducible sulfur values ranged from 0.04 to 0.06 %S_{CR}. Sulfidic materials were detected in all layers of both profiles.

Titratable actual acidity values ranged from 0 to 3.32 mole H^+/tonne.

Analysis of retained acidity was not conducted on any of the samples, as all sample were above the critical value of pH_{KCl} <4.5.

Acid neutralising capacity values ranged from 0 to 2.04 %$CaCO_3$, and were measured in the surface layers of both profiles.

Net acidity values ranged from -231 to 30 mole H^+/tonne. Moderate net acidity value occurred in subsoil of profile PCK1 and negative values occurred in the surface layers of both profiles.

Water Soluble Sulfate

Water soluble sulfate data values shown in Table 74-4 identified that surface layers in all profiles were above the critical trigger value of 100 mg/kg SO_4.

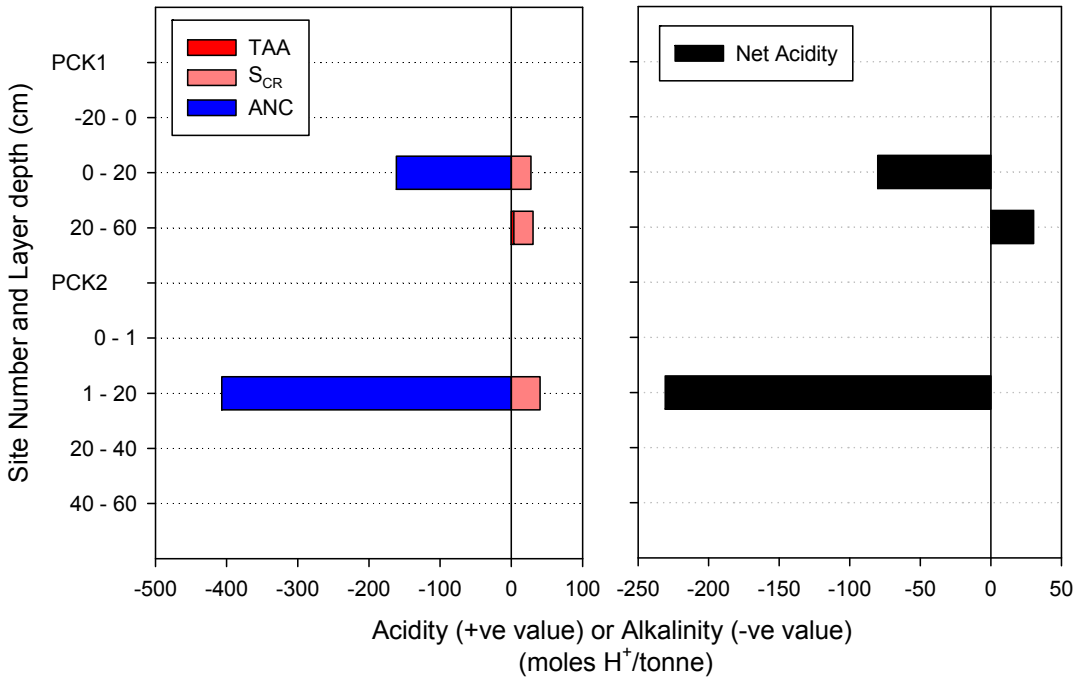

Figure 74-5. Acid base accounting depth profiles for Portee Creek Wetland. Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

74.4 DISCUSSION

Acid sulfate soil materials at Portee Creek Wetland were identified as hyposulfidic in the surface and subsoil layers. The acid sulfate soil subtype classes identified were Subaqueous Hyposulfidic Soil and Hyposulfidic Soil.

The soils throughout the wetland were generally soft and clay textured surface layers over very firm clay subsoil layers.

Monosulfidic material was not observed but water soluble sulfate data identified that surface layers for the profiles throughout the wetland were in excess of the 100 mg/kg trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at the Portee Creek Wetland are:

- Acidification hazard: The data identified moderate net acidity value in one sample, and pH data did not identify potential acidification due to oxidation. There is a low to medium level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated a potential for monosulfidic materials to form in the surface layers of soils, although monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The low to medium acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

Summary of key findings for Portee Creek Wetland:

Soil materials:	Hyposulfidic soil materials were identified in all soil layers. The soils throughout were generally soft clayey surface layers over very firm clay subsoil layers. One sample had a moderate net acidity value and pH data did not identify potential acidification due to oxidation.
Acid sulfate soil identification:	• Subaqueous Hyposulfidic Soil – that occurred in the lower elevation main areas of the wetland below surface water. Sub-dominant (>50%) in extent. • Hyposulfidic Soil – that occurred on the margins of the wetland and main wetland areas where there was no surface water. Sub-dominant (<50%) in extent.
Hazard assessment	• Acidification hazard – low to medium level of concern. • De-oxygenation hazard – medium level of concern. • Metal mobilisation hazard – low level of concern.

Table 74-2. Site data for Portee Creek Wetland.

Site Number	Sampled Date	Easting m zone 54H	Northing m zone 54H	Soil Classification	Water depth (+ve) Water table (-ve)	Surface Condition	Earth Cover (Vegetation)	Location Notes
PCK1	05-Sep-08	371490	6189184	Subaqueous hyposulfidic soil	-20	water	Water	Low elevation, 2m from waters edge
PCK2	05-Sep-08	371491	6189189	Hyposulfidic soil	10	sealed, salt crust	Bare	Low elevation, 1m from waters edge

Table 74-3. Soil description data for Portee Creek Wetland.

Site and Sample Number	Depth Upper (cm)	Depth Lower (cm)	Observation Method (kind)	Soil Colour (Munsell notation)	Texture (class)	Soil Water Status	Mottles Quantity (%)	Mottles Colour	Mottles Location	Structure Type (category)	Consistence (category)	Comments
PCK1.0	-20	0	water		water	wet	0					water
PCK1.1	0	20	soil pit	5Y 5/1	clay	wet	0			massive	very soft	low bearing strength
PCK1.2	20	60	push tube	5Y 5/2	sandy clay loam	wet	0			massive	very firm	
PCK2.1	0	1	soil pit	10YR 5/3	sandy clay loam	moist	15	5Y 8/1	in matrix along ped faces	massive	firm	white salt crystals on surface
PCK2.2	1	20	soil pit	5Y 3/1	clay	moist	30	5YR 6/8	in matrix	massive	soft	
PCK2.3	20	40	soil pit	2.5Y 4/1	clay	wet	0			massive	very soft	
PCK2.4	40	60	push tube	5Y 4/2	clay	wet	0			massive	very firm	

Table 74-4. Laboratory data for acid sulfate soil assessment of Portee Creek Wetland.

(red printed values indicate data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
PCK1.0	-20 - 0	water	-	-	-	-	-	-	-	-	-	-	-
PCK1.1	0 - 20	fine	-	6.70	4.32	7.00	288	7.54	-	0.04	0.81	-80	hyposulfidic (S_{CR}<0.10%)
PCK1.2	20 - 60	medium	-	6.25	4.17	4.70	192	6.11	3.32	0.04	-	30	hyposulfidic (S_{CR}<0.10%)
PCK2.1	0 - 1	medium	-	-	-	-	-	-	-	-	-	-	-
PCK2.2	1 - 20	fine	-	7.01	3.35	6.50	819	8.39	-	0.06	2.04	-231	hyposulfidic (S_{CR}<0.10%)
PCK2.3	20 - 40	fine	-	-	-	-	-	-	-	-	-	-	-
PCK2.4	40 - 60	fine	-	-	-	-	-	-	-	-	-	-	-

75 PORTEE WETLAND (WETLAND ID. 12731)

No field survey or assessment conducted at this wetland.

76 MOORUNDIE WETLAND (WETLAND ID. 12722)

76.1 LOCATION AND SETTING DESCRIPTION

Moorundie Wetland (Wetland ID. 12722) is situated on the western side of the River Murray. The wetland is geomorphically categorised as a Murray Gorge basin (Pressey 1986) and is an irregular shape, approximately 4 kilometres in length and 100 to 800 metres wide, with a total surface area of 305 hectares. The wetland is bounded to the west by hill slopes and to the east by floodplain area that separates it from the river. There is a water connection channel to Portee Creek at the southern end of the wetland. At the time when the soil survey was conducted in September 2008, the wetland was dry with no surface water. Isolated vegetation was growing throughout the wetland, *Phragmites australis* (Common Reed) on the margins and trees on the surrounding raised area. Five sites were described and sampled and their locations are shown in Figure 76-1.

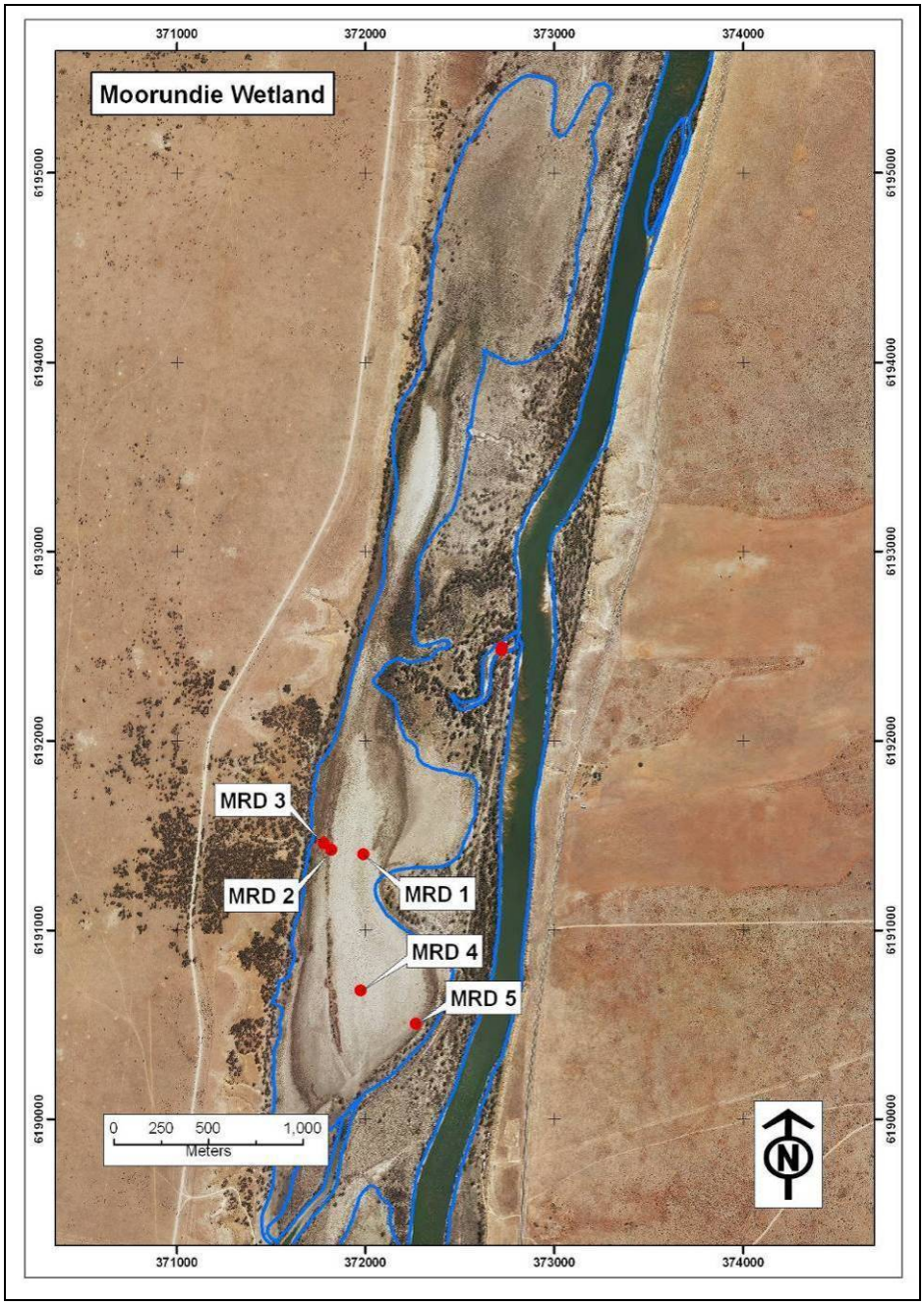

Figure 76-1. Moorundie Wetland and sample site locations.

76.2 SOIL PROFILE DESCRIPTION AND DISTRIBUTION

Five sites were described and sampled. The acid sulfate soil subtype class and general location description are presented in Table 76-1. Sites were located to form a cross-section through the wetland (MRD1, MRD2, and MRD3) and to characterise the main area at the southern end of the wetland (MRD4, MRD5). The site and soil profile descriptions are presented in Table 76-2 and Table 76-3.

Site MRD1 (Figure 76-2) occurred in the middle of the wetland where the surface was sealed and very firm, isolated areas of vegetation were growing. The soil consisted of dark grey, slightly rigid, clay that became too hard to dig.

Site MRD2 (Figure 76-3) occurred on a raised area where *Phragmites australis* (Common Reed) were growing and the surface was sealed. The soil consisted of light grey, very firm, clay, over grey, rigid clay that became too dry and difficult to dig.

Site MRD3 (Figure 76-4) occurred in a dry channel at the base of the hill slope, where the surface was sealed with isolated areas of vegetation growing. The soil consisted of light grey, friable, clay over dark grey, rigid, clay that became too difficult to dig.

Site MRD4 (Figure 76-5) occurred in the middle of the southern end of the wetland where the surface was sealed and friable. The soil consisted of light grey, friable, clay, over dark grey, rigid clay that became too dry and difficult to dig.

Site MRD5 (Figure 76-6) occurred on the elevated margin of the wetland where grasses and weeds were growing. The soil consisted of light grey, friable, clay, over dark grey, rigid clay that became too difficult to dig.

Table 76-1. Soil identification, subtype and general location description of sites for Moorundie Wetland.

Site ID	Easting m zone 54H	Northing m zone 54H	Acid sulfate soil subtype class	General location description
MRD1	371991	6191399	Hyposulfidic soil	Mid elevation
MRD2	371821	6191422	Other soil	High elevation, near edge on cliff side of wetland
MRD3	371780	6191459	Other soil (cracking clay)	Low elevation, in channel
MRD4	371975	6190679	Other soil (cracking clay)	Low elevation, near centre of wetland
MRD5	372269	6190504	Other soil	High elevation, on river side of wetland near trees

Figure 76-2. Photographs of site MRD1, showing the main wetland area with a sealed surface and isolated vegetation clumps, and the soil profile of slightly rigid clay.

Figure 76-3. Photographs of site MRD2, showing the site location adjacent to reeds, the sealed surface, and the soil profile of rigid clay.

Figure 76-4. Photographs of site MRD3, showing the channel area in the wetland, and the soil profile of rigid clay.

Figure 76-5. Photographs of site MRD4, showing the main southern wetland area, and the rigid clay.

Figure 76-6. Photographs of site MRD5 showing the wetland margin where grasses were growing, and the soil profile of rigid clay.

76.3 LABORATORY DATA ASSESSMENT

Soil pH testing (pH_W, pH_{OX}, pH_{INC})

The pH data are provided in Table 76-4 and pH profiles are presented in Figure 76-7.

The pH_W data did not identify sulfuric materials with a pH_W <4.

The pH_{INC} data did not identify samples that on incubation declined below the critical value of pH <4. Samples that age to pH_{INC}<4 indicate that these soils potentially would form sulfuric materials as a result of sulfide oxidation.

The pH_{OX} data did not identify samples below the critical value of pH_{OX} <2.5, the threshold value normally used to indicate a high likelihood of sulfuric material forming.

Acid Base Accounting

The acid base accounting data is provided in Table 76-4 and summarised in Figure 76-8.

Chromium reducible sulfur values ranged from below the limit of detection to 0.01 $\%S_{CR}$. Sulfidic materials were detected at the limit of detection for the subsurface layer in profile MRD1. All other samples were below the limit of detection.

Titratable actual acidity values ranged from 2.45 to 20.11 mole H^+/tonne.

Analysis of retained acidity was not conducted on any of the samples, as all samples were above the critical value of pH_{KCl} <4.5.

Acid neutralising capacity was not detected in any samples.

Net acidity values ranged from 2 to 20 mole H^+/tonne. Moderate net acidity was recorded at the bottom of MRD2 while low net acidity values occurred in all layers of the soil profiles.

Water Soluble Sulfate

Water soluble sulfate data values shown in Table 76-4 identified that surface layers except for profile MRD3 were above the critical trigger value of 100 mg/kg SO_4.

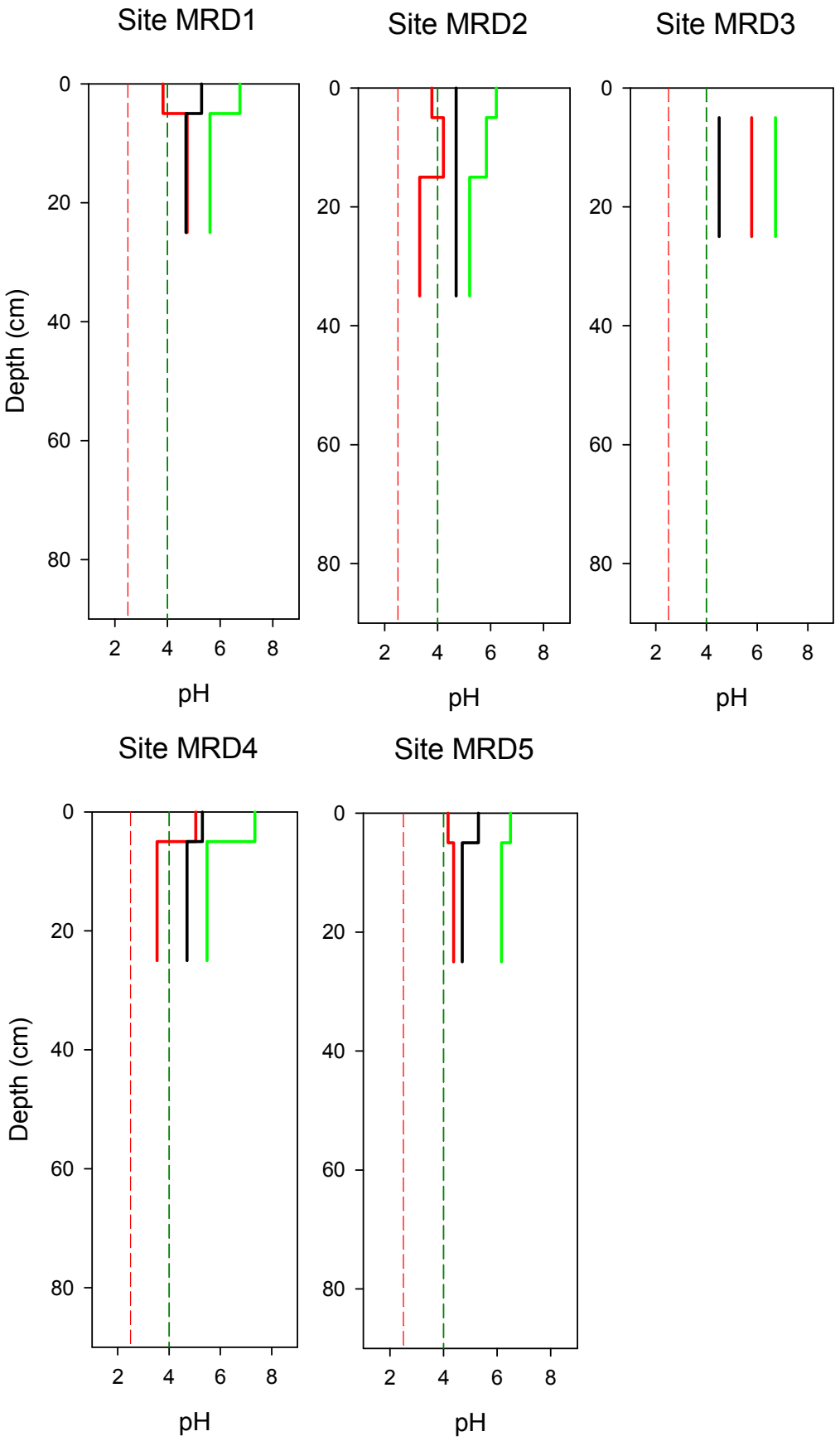

Figure 76-7. Depth profiles of soil pH for Moorundie Wetland, showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and ageing pH (pH_{INC} after 28 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

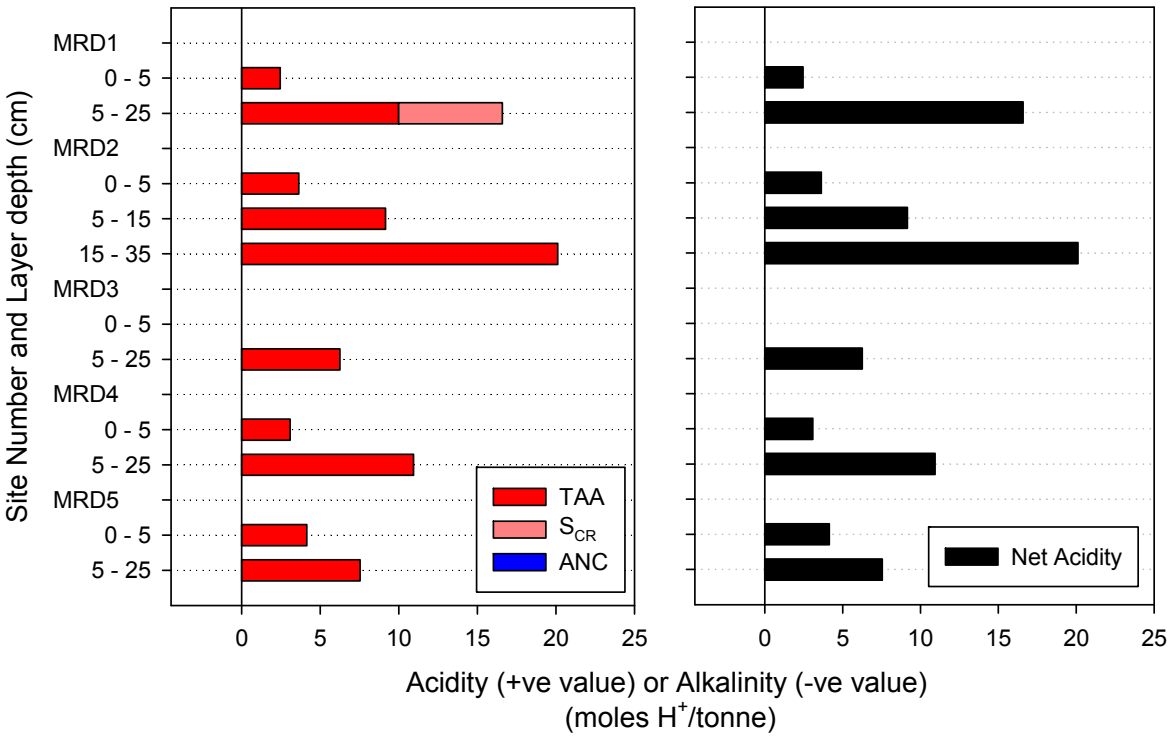

Figure 76-8. Acid base accounting depth profiles for Moorundie Wetland. Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

76.4 DISCUSSION

Acid sulfate soil materials at Moorundie Wetland were identified as hyposulfidic for the subsurface layer of MRD1 but it was at the limit of detection. The rest of the samples were characterised as other acidic soil materials. The acid sulfate soil subtype classes identified were Hyposulfidic Soil, Other Soil and Other Soil (cracking clay).

The soils throughout the wetland were generally friable clay surface layers over rigid clay subsoil layers.

Monosulfidic material was not observed but water soluble sulfate data identified that surface layers for the profiles throughout most of the wetland were in excess of the 100 mg/kg trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at the Moorundie Wetland are:

- Acidification hazard: The data identified moderate or low net acidity values throughout the profiles, and pH data did not identify potential acidification due to oxidation. There is a low to medium level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated a potential for monosulfidic materials to form in the surface layers of soils, although monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The low to medium acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

Summary of key findings for Moorundie Wetland:

Soil materials:	Hyposulfidic soil materials were identified in the subsurface layer of one profile. The soils throughout were generally rigid clays. Generally profiles had samples with moderate or low net acidity values and pH data did not identify potential acidification due to oxidation.
Acid sulfate soil identification:	• Hyposulfidic Soil – that occurred in the lower elevation main areas of the wetland. Co-dominant (>25%) in extent. • Other Soil (cracking clay) – that occurred on the margins and main areas of the wetland. Co-dominant (>25%) in extent. • Other Soil – that occurred on the margins of the wetland. Minor (<25%) in extent.
Hazard assessment	• Acidification hazard – low to medium level of concern. • De-oxygenation hazard – medium level of concern. • Metal mobilisation hazard – low level of concern.

Table 76-2. Site data for Moorundie Wetland.

Site Number	Sampled Date	Easting m zone 54H	Northing m zone 54H	Soil Classification	Water depth (+ve) Water table (-ve)	Surface Condition	Earth Cover (Vegetation)	Location Notes
MRD1	05-Sep-08	371991	6191399	Hypersulfidic soil	Not reached	sealed	Bare, few weeds	Mid elevation
MRD2	05-Sep-08	371821	6191422	Hypersulfidic soil	Not reached	sealed	*Phragmites australis* (Common Reed)	High elevation, near edge on cliff side of wetland
MRD3	05-Sep-08	371780	6191459	Hyposulfidic cracking clay soil	Not reached	sealed, cracking	Bare, few weeds	Low elevation, in channel
MRD4	05-Sep-08	371975	6190679	Sulfuric cracking clay soil	Not reached	sealed, cracking	Bare, few weeds	Low elevation, near centre of wetland
MRD5	05-Sep-08	372269	6190504	Sulfuric soil	Not reached	sealed, loose	grasses, weeds	High elevation, on river side of wetland near trees

Table 76-3. Soil description data for Moorundie Wetland.

Site and Sample Number	Depth Upper (cm)	Depth Lower (cm)	Observation Method (kind)	Soil Colour (Munsell notation)	Texture (class)	Soil Water Status	Mottles Quantity (%)	Mottles Colour	Mottles Location	Structure Type (category)	Consistence (category)	Comments
MRD1.1	0	5	soil pit	10YR 6/2	clay	dry	0			platy	very firm	
MRD1.2	5	25	soil pit	2.5Y 4/1	clay	moist	3	5YR 6/8	in matrix adjacent to pores	columnar	slightly rigid	too hard to dig below this layer
MRD2.1	0	5	soil pit	10YR 6/2	clay	dry	0			platy	very firm	
MRD2.2	5	15	soil pit	2.5Y 4/1	clay	moist	0			subangular blocky	rigid	
MRD2.3	15	35	soil pit	2.5Y 4/1	clay	moist	3	5YR 6/8	in matrix adjacent to pores	columnar	rigid	too hard to dig below this layer
MRD3.1	0	5	soil pit	10YR 6/2	clay	dry	3	10YR 6/8	in matrix	platy	friable	
MRD3.2	5	25	soil pit	2.5Y 4/1	clay	moist	0			subangular blocky	rigid	too hard to dig below this layer
MRD4.1	0	5	soil pit	10YR 6/2	clay	dry	3	10YR 6/8	in matrix	subangular blocky	friable	
MRD4.2	5	25	soil pit	2.5Y 4/1	clay	moist	0			subangular blocky	rigid	too hard to dig below this layer
MRD5.1	0	5	soil pit	10YR 5/1	clay	dry	0			angular blocky	friable	
MRD5.2	5	25	soil pit	10YR 5/1	clay	moist	3	10YR 6/8	in matrix	subangular blocky	rigid	too hard to dig below this layer

Table 76-4. Laboratory data for acid sulfate soil assessment of Moorundie Wetland.

(red printed values indicate data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
MRD1.1	0 - 5	fine	-	6.75	3.83	5.30	223	6.11	2.45	< 0.01	-	2	other acidic incubation
MRD1.2	5 - 25	fine	-	5.61	4.75	4.70	730	5.03	9.99	0.01	-	17	hyposulfidic (S_{CR}<0.10%)
MRD2.1	0 - 5	fine	-	6.22	3.78	4.70	248	5.68	3.63	< 0.01	-	4	other acidic incubation
MRD2.2	5 - 15	fine	-	5.84	4.22	4.70	372	5.21	9.16	< 0.01	-	9	other acidic incubation
MRD2.3	15 - 35	fine	-	5.21	3.32	4.70	498	4.51	20.11	< 0.01	-	20	other acidic incubation
MRD3.1	0 - 5	fine	-	-	-	-	-	-	-	-	-	-	-
MRD3.2	5 - 25	fine	-	6.72	5.78	4.50	71	5.58	6.26	< 0.01	-	6	other acidic incubation
MRD4.1	0 - 5	fine	-	7.35	5.04	5.30	257	5.88	3.08	< 0.01	-	3	other acidic incubation
MRD4.2	5 - 25	fine	-	5.48	3.53	4.70	426	5.03	10.94	< 0.01	-	11	other acidic incubation
MRD5.1	0 - 5	fine	-	6.50	4.17	5.30	260	5.78	4.14	< 0.01	-	4	other acidic incubation
MRD5.2	5 - 25	fine	-	6.16	4.38	4.70	238	5.35	7.54	< 0.01	-	8	other acidic incubation

77 MOORUNDIE CREEK WETLAND (WETLAND ID. 12021)

77.1 LOCATION AND SETTING DESCRIPTION

Moorundie Creek Wetland (Wetland ID. 12021) is situated on the western side of the River Murray. The wetland is geomorphically categorised as a lentic channel (Pressey 1986) and is a small creek with a thin sinuous to somewhat linear shape, approximately 0.5 kilometres in length and approximately 50 metres wide, with a total surface area of 2 hectares. The creek is cut down into the floodplain and is bounded by the surrounding slopes. There is a water connection channel with the river at the eastern end. At the time when the soil survey was conducted in September 2008, the wetland was dry and there was no surface water. There was no vegetation growing in the wetland and on the margin slopes there were isolated areas of *Phragmites australis* (Common Reed). Two sites were described and sampled and their locations are shown in Figure 77-1.

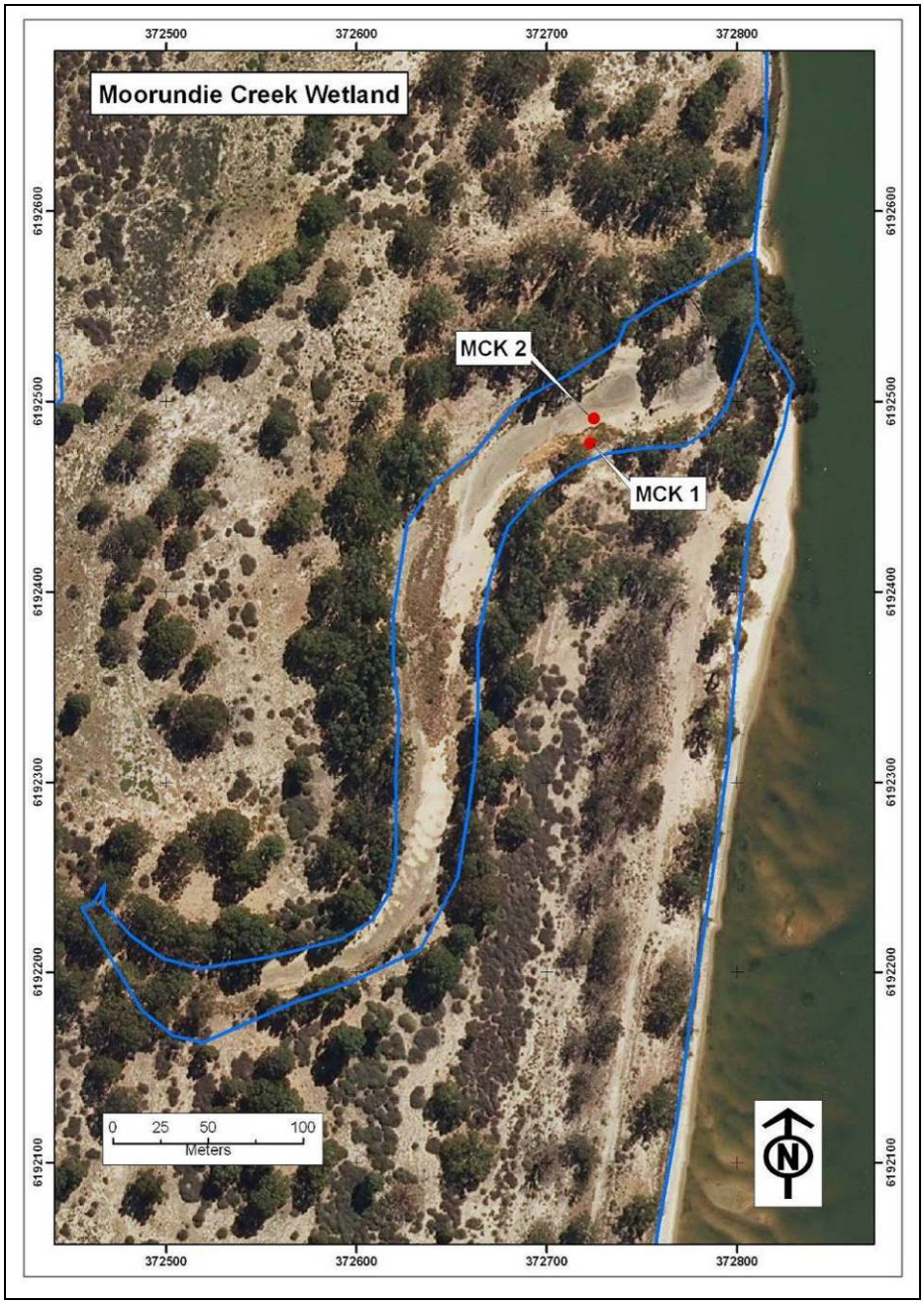

Figure 77-1. Moorundie Creek Wetland and sample site locations.

77.2 SOIL PROFILE DESCRIPTION AND DISTRIBUTION

Two sites were described and sampled. The acid sulfate soil subtype class and general location description are presented in Table 77-1. Sites were located to characterise the low elevation main wetland area (MCK1) and the surrounding higher elevation margin area (MCK2). The site and soil profile descriptions are presented in Table 77-2 and Table 77-3.

Site MCK1 (Figure 77-2) occurred near the middle of the dry creek where the surface was cracking and no vegetation was growing. The soil consisted of dark grey, slightly rigid, clay over grey, rigid clay that became too hard to dig.

Site MCK2 (Figure 77-3) occurred on the raised slope margins where *Phragmites australis* (Common Reed) were growing. The soil consisted of light brown, loose, sandy loam, over grey, very firm clay that became too hard to dig.

Table 77-1. Soil identification, subtype and general location description of sites for Moorundie Creek Wetland.

Site ID	Easting m zone 54H	Northing m zone 54H	Acid sulfate soil subtype class	General location description
MCK1	372723	6192478	Hyposulfidic soil (cracking clay)	Low elevation, near the middle of the wetland
MCK2	372725	6192491	Other soil	High elevation, amongst reeds

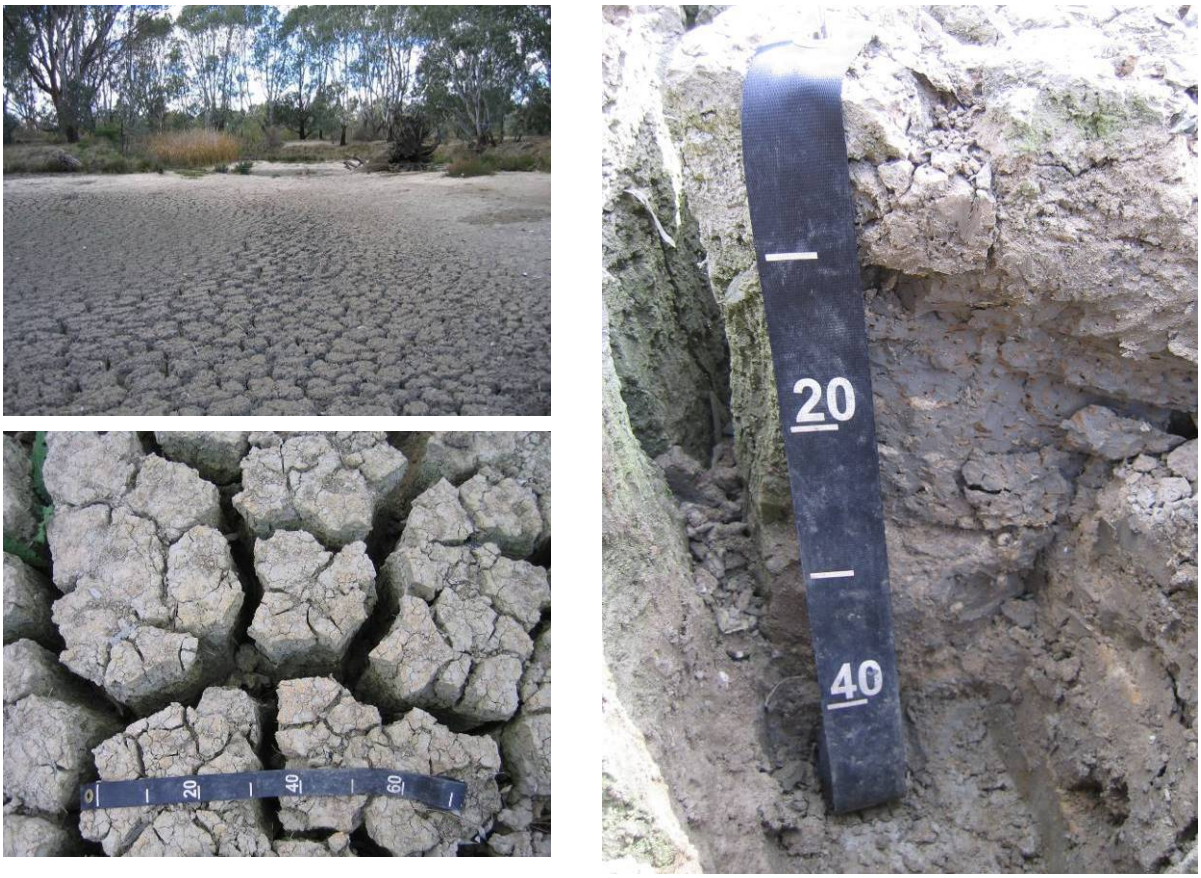

Figure 77-2. Photographs of site MCK1, showing the main wetland area with a cracking surface, large columnar structure, and the soil profile of rigid, columnar, clay.

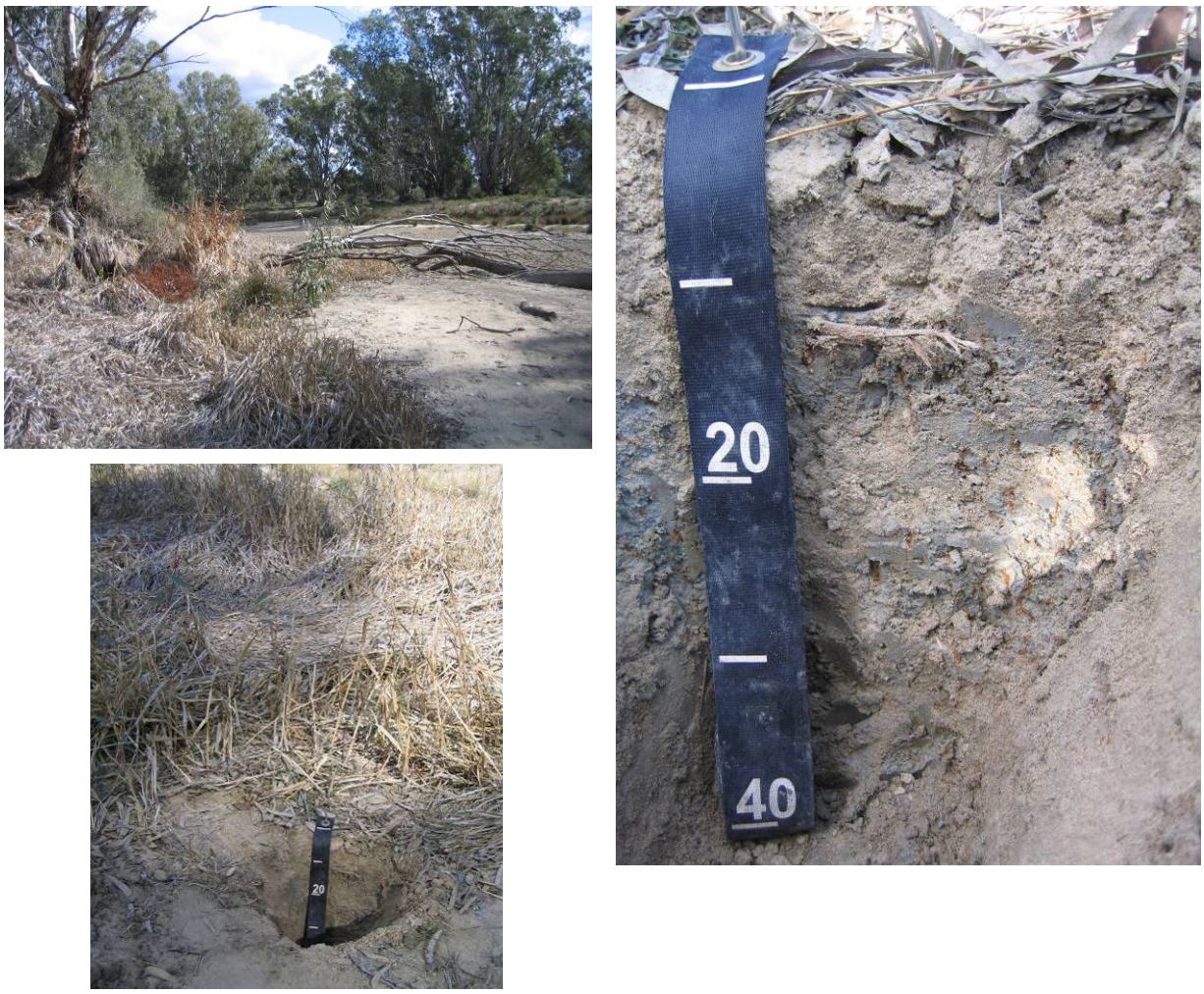

Figure 77-3. Photographs of site MCK2, showing the landscape of the wetland margin, the site location amongst reeds, and the soil profile of loose sandy loam, over very firm clay.

77.3 LABORATORY DATA ASSESSMENT

Soil pH testing (pH_W, pH_{OX}, pH_{INC})

The pH data are provided in Table 77-4 and pH profiles are presented in Figure 77-4.

The pH_W data did not identify sulfuric materials with a pH_W <4.

The pH_{INC} data did not identify samples that on incubation declined below the critical value of pH <4. Samples that age to pH_{INC}<4 indicate that these soils potentially would form sulfuric materials as a result of sulfide oxidation.

The pH_{OX} data for the surface layer of profile MCK2 identified samples below the critical value of pH_{OX} <2.5, the threshold value normally used to indicate a high likelihood of sulfuric material forming. All other samples were above the critical value.

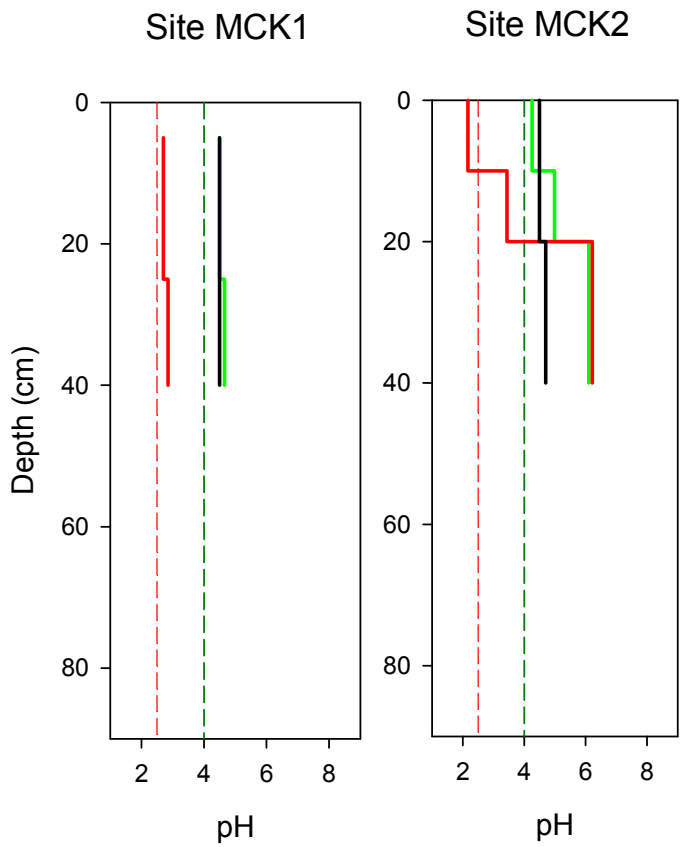

Figure 77-4. Depth profiles of soil pH for Moorundie Creek Wetland, showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and ageing pH (pH_{INC} after 28 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

Acid Base Accounting

Acid base accounting data is provided in Table 77-4 and summarised in Figure 77-5.

Chromium reducible sulfur values ranged from below the limit of detection to 0.01 $\%S_{CR}$. Sulfidic materials were detected at the limit of detection in a subsoil layer of profile MCK2.

Titratable actual acidity values ranged from 7.5 to 34.51 mole H^+/tonne.

Analysis of retained acidity was not conducted on any of the samples, however retained acidity may be present in upper layers of both profiles that were below the critical value of pH_{KCl} <4.5.

Acid neutralising capacity was not detected.

Net acidity values ranged from 7 to 35 mole H^+/tonne. Moderate net acidities were recorded in all but the lower layers of MCK2.

Water Soluble Sulfate

Water soluble sulfate data values shown in Table 77-4 identified that surface layers for both profiles were above the trigger value of 100 mg/kg SO_4.

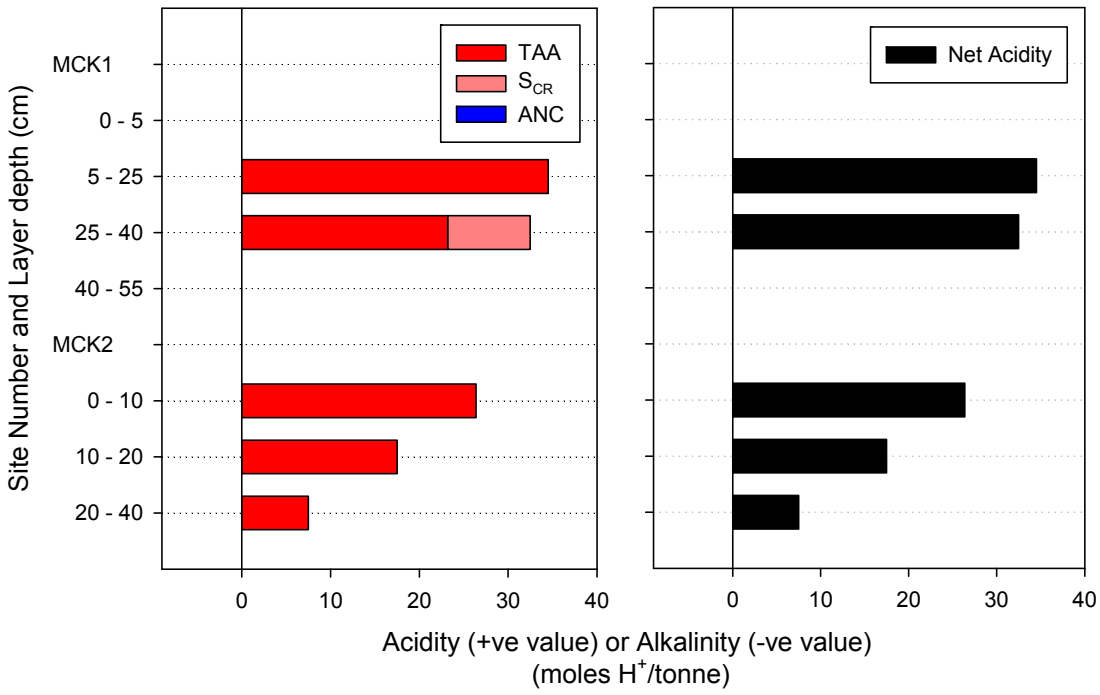

Figure 77-5. Acid base accounting depth profiles for Moorundie Creek Wetland. Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

77.4 DISCUSSION

Acid sulfate soil materials at Moorundie Creek Wetland were identified as hyposulfidic for the subsoil layer of profile MCK1, the rest of the samples were characterised as other acidic soil materials. The acid sulfate soil subtype classes identified were Hyposulfidic Soil (cracking clay) and Other Soil.

The soils throughout the main area of the wetland were generally rigid clays with columnar structure in the upper layers, and on the wetland margins the surface soil layers where loamy over very firm blocky clays.

Monosulfidic material was not observed but water soluble sulfate data identified that surface layers for the profiles throughout the wetland were in excess of the 100 mg/kg trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at the Moorundie Creek Wetland are:

- Acidification hazard: The data identified moderate or low net acidity values throughout both profiles, and pH_{OX} data identified potential acidification due to oxidation in one surface layer. There is a medium level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated a potential for monosulfidic materials to form in the surface layers of soils, although monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The medium acidification hazard indicates that soil acidification potential may increase the solubility of metals. There is a medium level of concern.

Summary of key findings for Moorundie Creek Wetland:

Soil materials:	Hyposulfidic soil materials were identified in one subsoil layer in the main wetland area. The soils throughout were generally rigid clays with columnar structure in the upper layers, and on the wetland margins the surface soil layers where loamy over very firm blocky clays. Generally both profiles had samples with moderate or low net acidity values and pH_{OX} data identified potential acidification due to oxidation in one sample.
Acid sulfate soil identification:	• Hyposulfidic Soil (cracking clay) – that occurred in the lower elevation main areas of the wetland. Dominant (>50%) in extent. • Other Soil – that occurred on the margins of the wetland. Minor (<25%) in extent.
Hazard assessment	• Acidification hazard – medium level of concern. • De-oxygenation hazard – medium level of concern. • Metal mobilisation hazard – medium level of concern.

Table 77-2. Site data for Moorundie Creek Wetland.

Site Number	Sampled Date	Easting m zone 54H	Northing m zone 54H	Soil Classification	Water depth (+ve) Water table (-ve)	Surface Condition	Earth Cover (Vegetation)	Location Notes
MCK1	05-Sep-08	372723	6192478	Hyposulfidic cracking clay soil	Not reached	cracking	Bare	Low elevation, near the middle of the wetland
MCK2	05-Sep-08	372725	6192491	Other soil	Not reached	sealed	*Phragmites australis* (Common Reed)	High elevation, amongst reeds

Table 77-3. Soil description data for Moorundie Creek Wetland.

Site and Sample Number	Depth Upper (cm)	Depth Lower (cm)	Observation Method (kind)	Soil Colour (Munsell notation)	Texture (class)	Soil Water Status	Mottles Quantity (%)	Mottles Colour	Mottles Location	Structure Type (category)	Consistence (category)	Comments
MCK1.1	0	5	soil pit	10YR 6/2	clay	dry	5	2.5YR 5/8	in matrix	platy	slightly rigid	
MCK1.2	5	25	soil pit	2.5Y 4/1	clay	moist	3	5YR 6/8	in matrix	columnar	rigid	
MCK1.3	25	40	soil pit	2.5Y 4/1	clay	moist	10	5YR 6/8	in matrix adjacent to pores	columnar	rigid	
MCK1.4	40	55	soil pit	2.5Y 6/1	clay	moist	10	5YR 6/8	in matrix adjacent to pores	massive	very firm	too hard to dig below this layer
MCK2.1	0	10	soil pit	10YR 6/2	sandy loam	dry	0			granular	loose	
MCK2.2	10	20	soil pit	2.5Y 4/1	clay	moist	10	5YR 6/8	in matrix adjacent to pores	subangular blocky	very firm	
MCK2.3	20	40	soil pit	2.5Y 4/1	clay	moist	10	5YR 6/8	in matrix adjacent to pores	massive	very firm	too hard to dig below this layer

Table 77-4. Laboratory data for acid sulfate soil assessment of Moorundie Creek Wetland.

(red printed values indicate data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
MCK1.1	0 - 5	fine	-	-	-	-	-	-	-	-	-	-	-
MCK1.2	5 - 25	fine	-	4.50	2.70	4.50	1224	4.24	34.51	< 0.01	-	35	other acidic
MCK1.3	25 - 40	fine	-	4.66	2.85	4.50	1410	4.44	23.22	0.01	-	32	hyposulfidic (S_{CR}<0.10%)
MCK1.4	40 - 55	fine	-	-	-	-	-	-	-	-	-	-	-
MCK2.1	0 - 10	medium	-	4.26	2.17	4.50	388	4.14	26.39	< 0.01	-	26	other acidic
MCK2.2	10 - 20	fine	-	4.99	3.44	4.50	410	4.39	17.49	< 0.01	-	17	other acidic
MCK2.3	20 - 40	fine	-	6.10	6.22	4.70	282	5.26	7.50	< 0.01	-	7	other acidic incubation

78 BLANCHETOWN FLAT WETLAND (WETLAND ID. 12239)

78.1 LOCATION AND SETTING DESCRIPTION

Blanchetown Flat Wetland (Wetland ID. 12239) is situated on the western side of the River Murray, and down river from Lock 1 and the town of Blanchetown. The wetland geomorphically categorised as a miscellaneous floodplain depression (Pressey 1986) and is an irregular shape. It is approximately 600 metres in length and 100 to 200 metres wide, with a total surface area of 15 hectares. The wetland is bounded by floodplain. There are no obvious water connection channels with the river. At the time when the soil survey was conducted in September 2008, the wetland was dry. Isolated vegetation was growing throughout the wetland with *Phragmites australis* (Common Reed) and trees growing on the surrounding raised areas of the wetland margin. Two sites were described and sampled and their locations are shown in Figure 78-1.

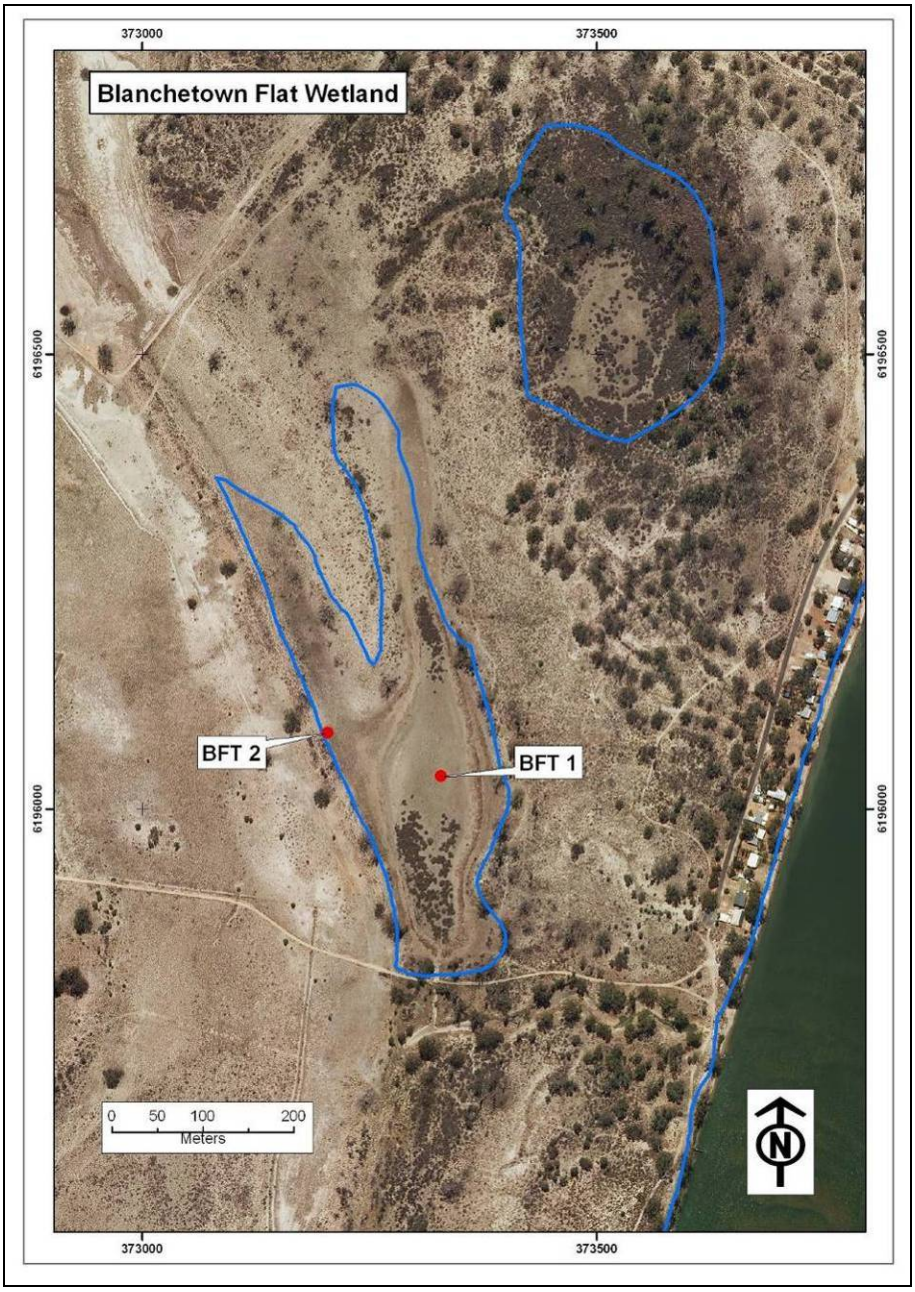

Figure 78-1. Blanchetown Flat Wetland and sample site locations.

78.2 SOIL PROFILE DESCRIPTION AND DISTRIBUTION

Two sites were described and sampled. The acid sulfate soil subtype class and general location description are presented in Table 78-1. The sites were located to characterise the main wetland area (BFT1) and the sloped margin area (BFT2). The site and soil profile descriptions are presented in Table 78-2 and Table 78-3.

Site BFT1 (Figure 78-2) occurred in the middle of the wetland at the lowest elevation where the surface was friable aggregates with isolated areas of grasses and weeds growing. The soil consisted of grey, very firm, clay that became too hard to dig.

Site BFT2 (Figure 78-3) occurred on the raised slope margins where the surface was sealed and grasses and weed s were growing. The soil consisted of brown, friable, sandy loam, over brown grey, very firm, clay that became too difficult to dig.

Table 78-1. Soil identification, subtype and general location description of sites for Blanchetown Flat Wetland.

Site ID	Easting m zone 54H	Northing m zone 54H	Acid sulfate soil subtype class	General location description
BFT1	373329	6196036	Other soil	Low elevation, near middle of wetland
BFT2	373204	6196084	Other soil	High elevation, on wetland margin

Figure 78-2. Photographs of site BFT1, showing the landscape of the main wetland area, and the soil profile of friable, granular structured clay, over very firm, blocky, clay.

Figure 78-3. Photographs of the soil profile BFT2, showing the wetland margin at a high elevation, and the soil profile of friable, sandy loam to approximately 25 centimetres over very firm clay.

78.3 LABORATORY DATA ASSESSMENT

Soil pH testing (pH_W, pH_{OX}, pH_{INC})

The pH data are provided in Table 78-4 and pH profiles are presented in Figure 78-4.

The pH_W data did not identify sulfuric materials with a pH_W <4.

The pH_{INC} data did not identify samples that on incubation declined below the critical value of pH <4. Samples that age to pH_{INC}<4 indicate that these soils potentially would form sulfuric materials as a result of sulfide oxidation.

The pH_{OX} data did not identify samples below the critical value of pH_{OX} <2.5, the threshold value normally used to indicate a high likelihood of sulfuric material forming.

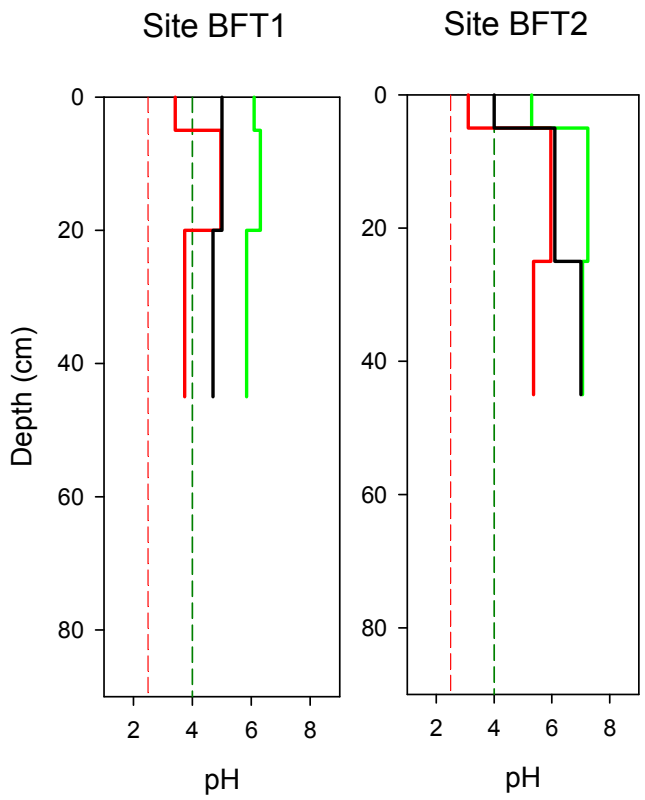

Figure 78-4. Depth profiles of soil pH for Blanchetown Flat Wetland, showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and ageing pH (pH_{INC} after 28 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

Acid Base Accounting

The acid base accounting data is provided in Table 78-4 and summarised in Figure 78-5.

Chromium reducible sulfur values were all below the limit of detection. Sulfidic materials were not detected in any of the soil layers sampled.

Titratable actual acidity values ranged from 0 to 8.41 mole H^+/tonne.

Analysis of retained acidity was not conducted on any of the samples, as all samples were above the critical value of pH_{KCl} <4.5.

Acid neutralising capacity values ranged from 0 to 0.49 %$CaCO_3$, and were measured in the subsoil layers of profile BFT2.

Net acidity values ranged from -65 to 8 mole H^+/tonne. Low net acidity values occurred in all layers of of profile BFT1 and the surface layer of profile BFT2. Negative net acidity values occurred in the sub surface layers of profile BFT2.

Water Soluble Sulfate

Water soluble sulfate data values shown in Table 78-4 identified that surface layers were above the critical trigger value of 100 mg/kg SO_4.

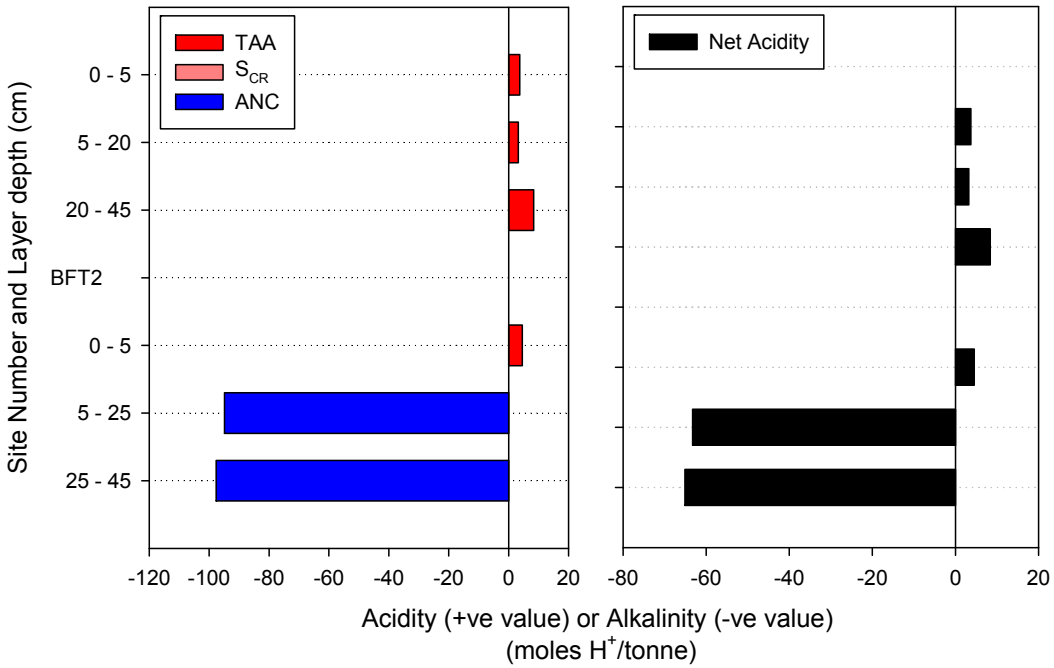

Figure 78-5. Acid base accounting depth profiles for Blanchetown Flat Wetland. Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

78.4 DISCUSSION

Acid sulfate soil materials at Blanchetown Flat Wetland were not identified, samples were characterised as other acidic or other soil materials. The acid sulfate soil subtype classes identified were Other Soil.

The soils throughout the main wetland area were generally very firm clays and on the wetland margins there was a friable loamy surface layer, over very firm clays.

Monosulfidic material was not observed but water soluble sulfate data identified that surface layers for the profiles throughout the wetland were in excess of the 100 mg/kg trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at the Blanchetown Flat Wetland are:

- Acidification hazard: The data identified low or negative net acidity values throughout both profiles, and pH data did not identify potential acidification due to oxidation. There is a low level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated a potential for monosulfidic materials to form in the surface layers of soils, although monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The low acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

Summary of key findings for Blanchetown Flat Wetland:

Soil materials:	Acid sulfate soil materials were not identified. Most soil layers were characterised as other acidic or other soil materials. The soils throughout the main wetland area were generally very firm clays and on the wetland margins there was a friable loamy surface layer, over very firm clays. Both profiles had samples with low or negative net acidity values and pH data did not identify potential acidification due to oxidation.
Acid sulfate soil identification:	• Other Soil – that occurred throughout the wetland. Dominant (>50%) in extent.
Hazard assessment	• Acidification hazard – low level of concern. • De-oxygenation hazard – medium level of concern. • Metal mobilisation hazard – low level of concern.

Table 78-2. Site data for Blanchetown Flat Wetland.

Site Number	Sampled Date	Easting m zone 54H	Northing m zone 54H	Soil Classification	Water depth (+ve) Water table (-ve)	Surface Condition	Earth Cover (Vegetation)	Location Notes
BFT1	06-Sep-08	373329	6196036	Other soil	Not reached	crumbling, aggregates	weeds	Low elevation, near middle of wetland
BFT2	06-Sep-08	373204	6196084	Other soil	Not reached	sealed	weeds	High elevation, on wetland margin

Table 78-3. Soil description data for Blanchetown Flat Wetland.

Site and Sample Number	Depth Upper (cm)	Depth Lower (cm)	Observation Method (kind)	Soil Colour (Munsell notation)	Texture (class)	Soil Water Status	Mottles Quantity (%)	Mottles Colour	Mottles Location	Structure Type (category)	Consistence (category)	Comments
BFT1.1	0	5	soil pit	10YR 5/1	clay	moist	3	5YR 6/8	in matrix	granular	friable	
BFT1.2	5	20	soil pit	10YR 4/1	clay	moist	3	5YR 6/8	in matrix	subangular blocky	very firm	
BFT1.3	20	45	soil pit	10YR 4/1	clay	moist	0			subangular blocky	very firm	too hard to dig below this layer
BFT2.1	0	5	soil pit	10YR 6/2	sandy loam	moist	0			subangular blocky	friable	
BFT2.2	5	25	soil pit	10YR 5/3	sandy loam	moist	0			massive	friable	
BFT2.3	25	45	soil pit	10YR 5/2	clay	moist	3	5Y 5/3	in matrix	massive	very firm	too hard to dig below this layer

Table 78-4. Laboratory data for acid sulfate soil assessment of Blanchetown Flat Wetland.

(red printed values indicate data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
BFT1.1	0 - 5	fine	-	6.10	3.42	5.00	360	5.85	3.72	< 0.01	-	4	other acidic incubation
BFT1.2	5 - 20	fine	-	6.31	4.97	5.00	331	5.80	3.26	< 0.01	-	3	other acidic incubation
BFT1.3	20 - 45	fine	-	5.84	3.74	4.70	427	5.49	8.41	< 0.01	-	8	other acidic incubation
BFT2.1	0 - 5	medium	-	5.30	3.11	4.00	172	5.74	4.58	< 0.01	-	5	other acidic incubation
BFT2.2	5 - 25	medium	-	7.24	5.96	6.10	183	7.41	-	< 0.01	0.47	-63	other soil material
BFT2.3	25 - 45	fine	-	7.06	5.37	7.00	631	6.90	-	< 0.01	0.49	-65	other soil material

79 ARLUNGA WETLAND (WETLAND ID. 12010)

79.1 LOCATION AND SETTING DESCRIPTION

Arlunga Wetland (Wetland ID. 12010) is situated on the western side of the River Murray, up river and adjacent to the town of Blanchetown and Lock 1. The wetland is geomorphically categorised as a Murray Gorge basin (Pressey 1986) and is elongated in shape, approximately 4 kilometres in length and approximately 600 metres at its widest, with a total surface area of 166 hectares. The wetland is bounded to the west by hill slopes and to the east by a spit that separates it from the river. There is a wide water connection channel with the river at the down-river end. At the time when the soil survey was conducted in October 2008, there was water in the wetland. Isolated areas of *Phragmites australis* (Common Reed) vegetation and trees were growing on the wetland margins. Two sites were described and sampled and their locations are shown in Figure 79-1.

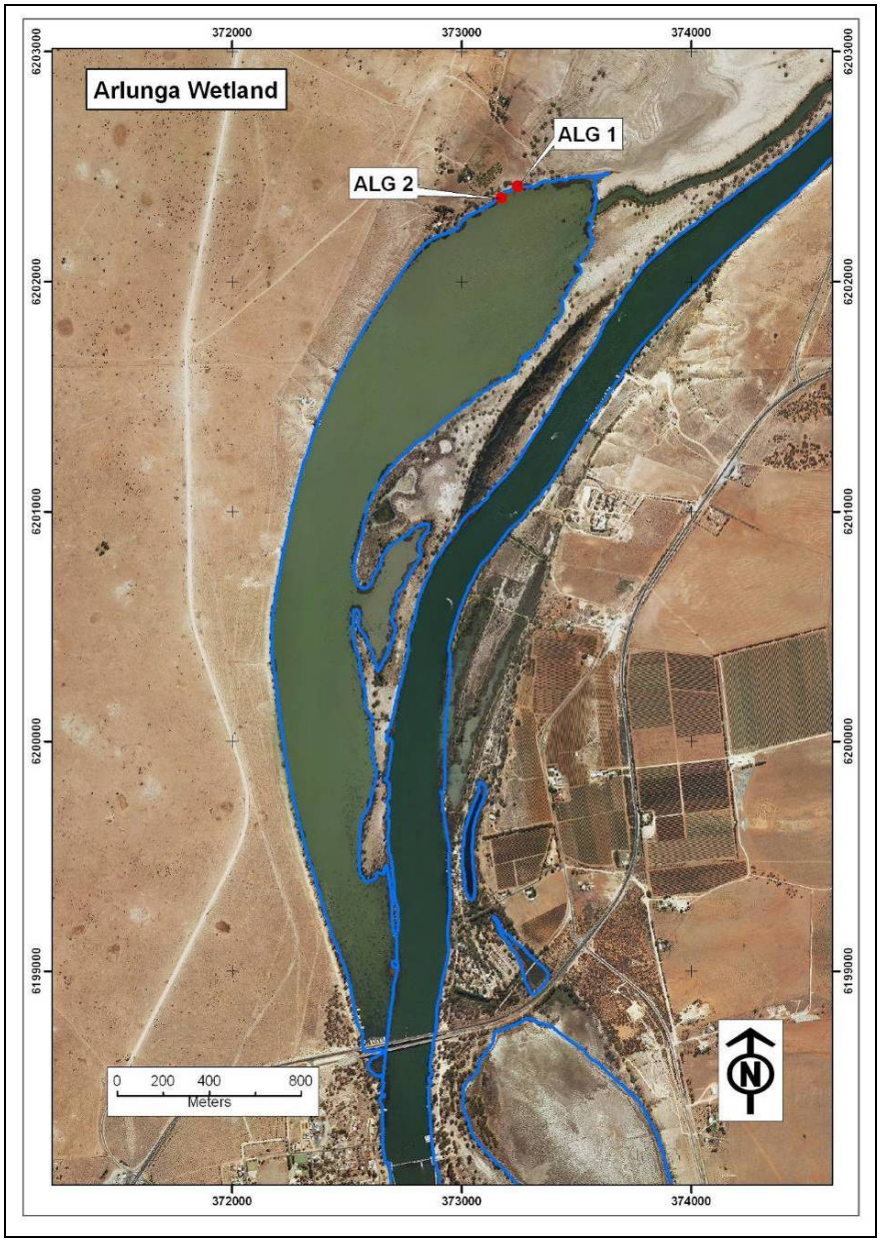

Figure 79-1. Arlunga Wetland and sample site locations.

79.2 SOIL PROFILE DESCRIPTION AND DISTRIBUTION

Two sites were described and sampled. The acid sulfate soil subtype class and general location description are presented in Table 79-1. The sites were located at the northern end of the wetland in open water (ALG1) and amongst *Phragmites australis* (Common Reed) in water (ALG2). The site and soil descriptions are presented in Table 79-2 and Table 79-3.

Site ALG1 (Figure 79-2) occurred in open water that was 30 centimetres deep. The soil consisted of olive grey, very firm, clay.

Site ALG2 (Figure 79-3) occurred amongst an isolated area of *Phragmites australis* (Common Reed) vegetation in water that was 35 centimetres deep, and the soil consisted of black, very soft, peat, over black, very firm, clay loam.

Table 79-1. Soil identification, subtype and general location description of sites for Arlunga Wetland.

Site ID	Easting m zone 54H	Northing m zone 54H	Acid sulfate soil subtype class	General location description
ALG1	373244	6202413	Subaqueous other soil	Low elevation, 5m into water from waters edge
ALG2	373173	6202364	Subaqueous hyposulfidic soil	Low elevation, 3m from waters edge amongst *Phragmites australis* (Common Reed)

Figure 79-2. Photographs of site ALG1, showing the wetland margin, and the site location in open water marked by the auger handle.

Figure 79-3. Photographs of site ALG2, showing the wetland margin and the site located adjacent to reeds, and the soil profile of very soft peat to approximately 5 centimetres over very firm clay loam.

79.3 LABORATORY DATA ASSESSMENT

Soil pH testing (pH_W, pH_{OX}, pH_{INC})

The pH data are provided in Table 79-4 and pH profiles are presented in Figure 79-4.

The pH_W data did not identify sulfuric materials with a pH_W <4.

The pH_{INC} data did not identify samples that on incubation declined below the critical value of pH <4. Samples that age to pH_{INC}<4 indicate that these soils potentially would form sulfuric materials as a result of sulfide oxidation.

The pH_{OX} data did not identify samples below the critical value of pH_{OX} <2.5, the threshold value normally used to indicate a high likelihood of sulfuric material forming.

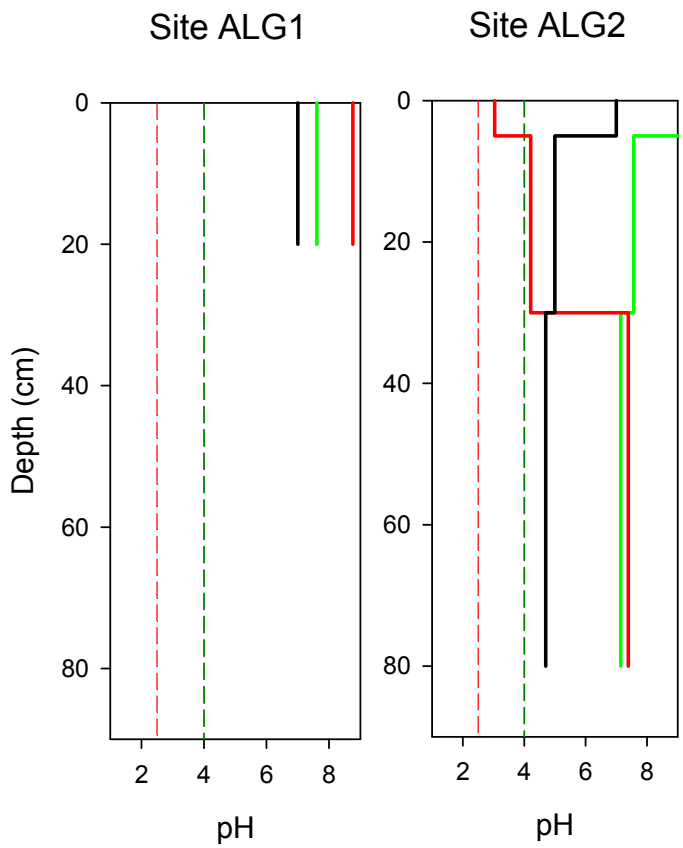

Figure 79-4. Depth profiles of soil pH for Arlunga Wetland, showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and ageing pH (pH_{INC} after 28 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

Acid Base Accounting

Acid base accounting data is provided in Table 79-4 and summarised in Figure 79-5.

Chromium reducible sulfur values ranged from below the limit of detection to 0.18 $\%S_{CR}$. Sulfidic materials were detected in the surface layer of profile ALG2

Titratable actual acidity values ranged from 0 to 1.72 mole H^+/tonne.

Analysis of retained acidity was not conducted on any of the samples, as all samples were above the critical value of pH_{KCl} <4.5.

Acid neutralising capacity values ranged from 0 to 19.97 $\%CaCO_3$, and were measured in the surface layers of both profiles.

Net acidity values ranged from -2661 to 2 mole H^+/tonne. Negative net acidity values occurred in most layers of both profiles and a low value occurred in the subsoil of ALG2.

Water Soluble Sulfate

Water soluble sulfate data values shown in Table 79-4 identified that surface layers in profile ALG2 were above the critical trigger value of 100 mg/kg SO_4.

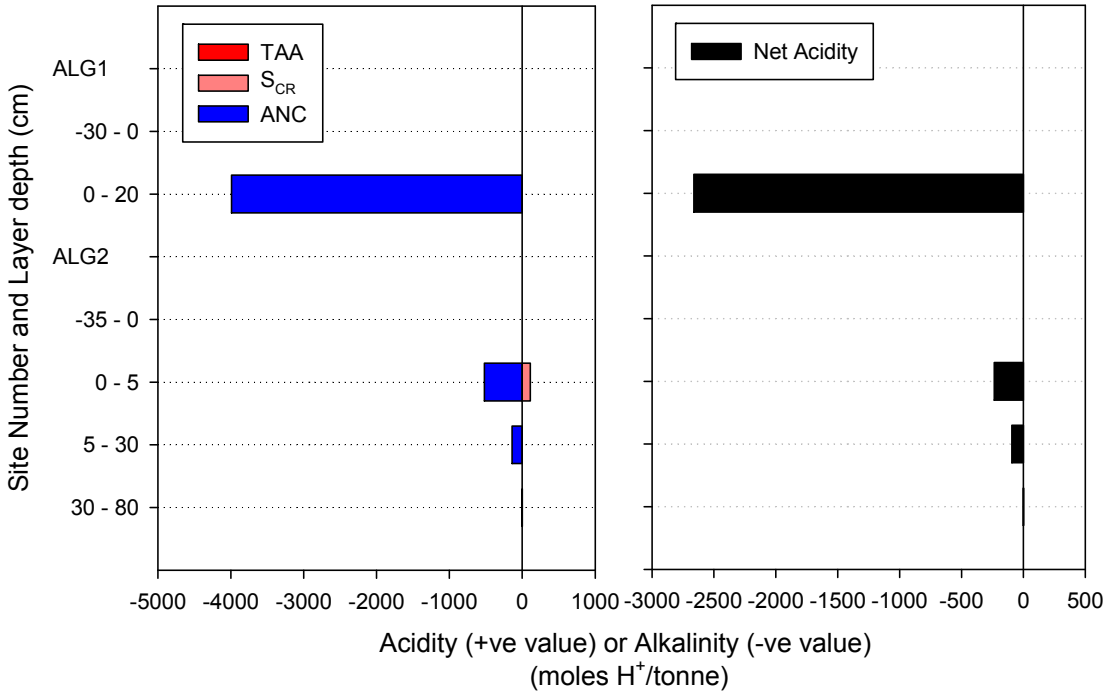

Figure 79-5. Acid base accounting depth profiles for Arlunga Wetland. Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

79.4 DISCUSSION

Acid sulfate soil materials at Arlunga Wetland were identified as hyposulfidic for the surface layer of profile ALG2 while the rest of the samples were characterised as other acidic or other soil materials. The acid sulfate soil subtype classes identified were Subaqueous Hyposulfidic Soil and Subaqueous Other Soil.

The soils throughout the wetland were generally very firm clays and on the margins amongst reeds there was a surface layer of soft peat.

Monosulfidic material was not observed but water soluble sulfate data identified that surface layers for the profiles on the margins of the wetland were in excess of the 100 mg/kg trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at the Arlunga Wetland are:

- Acidification hazard: The data identified negative or low net acidity values throughout both profiles, and pH data did not identify potential acidification due to oxidation. There is a low level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated a potential for monosulfidic materials to form in the surface layers of soils, although monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The low acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

Summary of key findings for Arlunga Wetland:

Soil materials:	Hyposulfidic soil materials were identified in the surface layer near the wetland margin amongst reeds. The soils were generally very firm clays and on the margins amongst reeds there was a surface layer of soft peat. Generally both profiles had samples with negative or low net acidity values and pH data did not identify potential acidification due to oxidation.
Acid sulfate soil identification:	• Subaqueous Other Soil – that occurred in the lower elevation below water main areas of the wetland. Dominant (>50%) in extent. • Subaqueous Hyposulfidic Soil – that occurred below water on the margins of the wetland. Minor (25%) in extent.
Hazard assessment	• Acidification hazard – low level of concern. • De-oxygenation hazard – medium level of concern. • Metal mobilisation hazard – low level of concern.

Table 79-2. Site data for Arlunga Wetland.

Site Number	Sampled Date	Easting m zone 54H	Northing m zone 54H	Soil Classification	Water depth (+ve) Water table (-ve)	Surface Condition	Earth Cover (Vegetation)	Location Notes
ALG1	22-Oct-08	373244	6202413	Subaqueous other soil	-30	water	Water	Low elevation, 5m into water from waters edge
ALG2	22-Oct-08	373173	6202364	Subaqueous hyposulfidic soil	-35	water	Water	Low elevation, 3m from waters edge amongst *Phragmites australis* (Common Reed)

Table 79-3. Soil description data for Arlunga Wetland.

Site and Sample Number	Depth Upper (cm)	Depth Lower (cm)	Observation Method (kind)	Soil Colour (Munsell notation)	Texture (class)	Soil Water Status	Mottles Quantity (%)	Mottles Colour	Mottles Location	Structure Type (category)	Consistence (category)	Comments
ALG1.0	-30	0	water		water	wet	0					water sample collected
ALG1.1	0	20	soil pit	5Y 6/3	clay	wet	0			subangular blocky	very firm	gravel at boundary
ALG2.0	-35	0	water		water	wet	0					water sample collected
ALG2.1	0	5	soil pit	5Y 5/1	peat	wet	0			massive	very soft	sulfurous odour, gravel at boundary
ALG2.2	5	30	soil pit	5Y 3/1	sandy clay loam	wet	0			massive	very firm	
ALG2.3	30	80	push tube	5Y 3/2	clay loam	wet	0			massive	very firm	below this layer is an olive clay

Table 79-4. Laboratory data for acid sulfate soil assessment of Arlunga Wetland.

(red printed values indicate data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
ALG1.0	-30 - 0	water	-	-	-	-	-	-	-	-	-	-	-
ALG1.1	0 - 20	fine	0.32	7.61	8.76	7.00	47	8.86	0.00	< 0.01	19.97	-2661	other soil material
ALG2.0	-35 - 0	water	-	-	-	-	-	-	-	-	-	-	-
ALG2.1	0 - 5	medium	0.18	9.08	3.04	7.00	830	8.06	0.00	0.18	2.59	-235	hyposulfidic (S_{CR}≥0.10%)
ALG2.2	5 - 30	medium	0.30	7.57	4.21	5.00	225	8.07	0.00	< 0.01	0.70	-93	other acidic incubation
ALG2.3	30 - 80	medium	0.23	7.15	7.39	4.70	116	6.40	1.72	< 0.01	-	2	other acidic incubation

80 BRENDA PARK WETLAND (WETLAND ID. 12304)

80.1 LOCATION AND SETTING DESCRIPTION

Brenda Park Wetland (Wetland ID. 12304) is situated on the western side of the River Murray, up river from the town of Blanchetown and Lock 1. The wetland is geomorphically categorised as a lentic channel (Pressey 1986) and is irregular in shape, approximately 2.5 kilometres in length and approximately 500 metres wide, with a total surface area of 98 hectares. The wetland is bound to the west by a cliff and hill slope and to the east by a raised floodplain area approximately 500 metres wide. There is a water connection channel at the southern end. At the time when the soil survey was conducted in October 2008, the wetland was dry. Isolated areas of vegetation were growing throughout and *Phragmites australis* (Common Reed) and trees were growing on the higher wetland margin areas. Seven sites were described and sampled and their locations are shown in Figure 80-1.

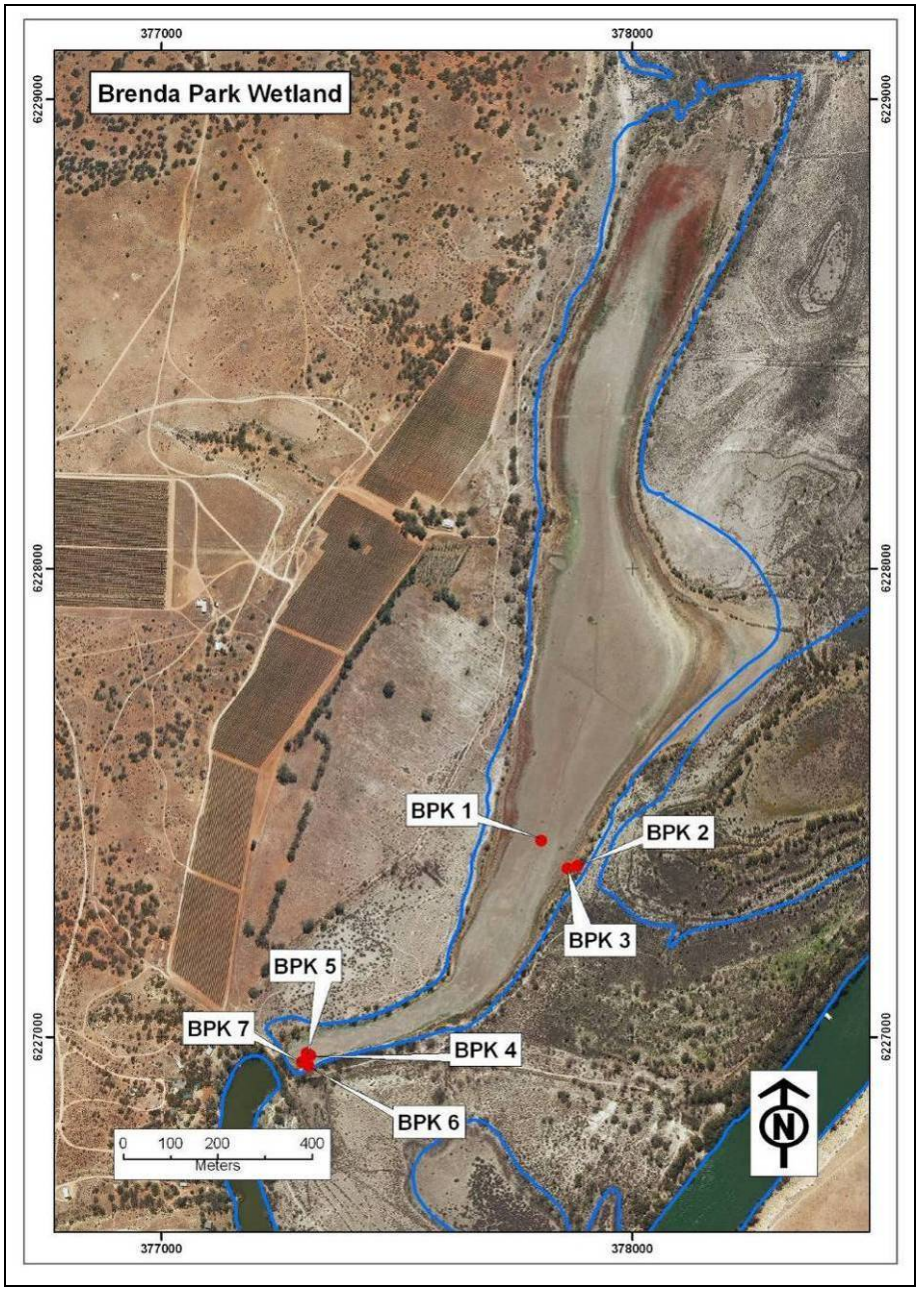

Figure 80-1. Brenda Park Wetland and sample site locations.

80.2 SOIL PROFILE DESCRIPTION AND DISTRIBUTION

Seven sites were described and sampled. The acid sulfate soil subtype class and general location description are presented in Table 80-1. Three sites were located near the middle of the wetland to form a cross-section (BPK1, BPK2, BPK3), and four sites were located at the southern end of the wetland near the connection channel (BPK4, BPK5, BPK6, BPK7). The site and soil profile descriptions are presented in Table 80-2 and Table 80-3.

Site BPK1 (Figure 80-2) occurred in the middle of the wetland at the lowest elevation where the surface was a friable aggregate with isolated areas of grasses and weeds growing. The soil consisted of grey, loose, clay, over grey, very firm, clay with brown mottles on ped faces.

Site BPK2 (Figure 80-3) occurred on a raised area where reeds were growing. The soil consisted of brown grey, hard, clay, over dark grey, extremely firm, clay that became too difficult to dig.

Site BPK3 (Figure 80-4) occurred on a raised area that was probably an old shore line near the wetland margin where gum trees were growing. The soil consisted of grey, hard, clay that became too dry and hard to dig.

Site BPK4 (Figure 80-5) occurred at the southern end of the wetland in the low channel inlet next to a small area of surface water. The soil consisted of thin, black, very soft, clay loam, over a dark grey, very soft, clay.

Site BPK5 (Figure 80-5) occurred the southern end of the wetland in the channel inlet where there was surface water 10 centimetres deep, and the soil consisted of thin, black, very soft, clay loam, over a dark grey, very soft, clay. This profile was not sampled as the materials appeared similar to the nearby profile BPK4 and it was assumed that these would have the same soil characteristics except for this profile occurred below surface water at the time of sampling and most likely would dry like BPK4.

Site BPK6 (Figure 80-6) occurred at the southern end of the wetland at a high elevation area that formed the wetland margin where gum trees were growing. The soil consisted of light brown firm, sandy loam with red brown mottles in the matrix that became too dry and sandy to dig with depth.

Site BPK7 occurred at the southern end of the wetland between sites BPK4 and BPK6 where there was an old shore line. Surface salts only were collected from this site, a soil description was not made and soil samples were not collected.

Table 80-1. Soil identification, subtype and general location description of sites for Brenda Park Wetland.

Site ID	Easting m zone 54H	Northing m zone 54H	Acid sulfate soil subtype class	General location description
BPK1	377807	6227419	Other soil	Low elevation, near centre of wetland
BPK2	377884	6227365	Other soil	High elevation, next to wetland margin
BPK3	377863	6227359	Other soil	Mid elevation, probably an old shoreline
BPK4	377316	6226960	Hyposulfidic soil	Low elevation, next to surface water
BPK5	377309	6226965	Subaqueous Hyposulfidic soil	Low elevation, in water
BPK6	377313	6226938	Other soil	High elevation, next to wetland margin
BPK7	377299	6226946	Other soil	Mid elevation

Figure 80-2. Photographs of site BPK1, showing the main wetland area with no vegetation growing, and the soil profile of loose aggregates over very firm clay.

Figure 80-3. Photographs of site BPK2, showing the landscape of the wetland margin, and the soil profile of hard, blocky structured clay

Figure 80-4. Photographs of site BPK3, showing the wetland margin that was probably an old shoreline, and the soil profile of hard clay.

Figure 80-5. Photographs of site BPK4 and site BPK5 was located in the surface water area as seen in the background, showing the wetland area with some surface water, and the soil profile of black, very soft, clay.

Figure 80-6. Photographs of site BPK6, showing the wetland margin, and the soil profile of friable sandy loam over firm clay.

80.3 LABORATORY DATA ASSESSMENT

Soil pH testing (pH_W, pH_{OX}, pH_{INC})

The pH data are provided in Table 80-4 and pH profiles are presented in Figure 80-7.

The pH_W data did not identify sulfuric materials with a pH_W <4.

The pH_{INC} data for subsoil layers of profile BPK1 identified samples that on incubation declined below the critical value of pH <4. Samples that age to pH_{INC}<4 indicate that these soils potentially would form sulfuric materials as a result of sulfide oxidation. All other samples were above the critical value.

The pH_{OX} data did not identify samples below the critical value of pH_{OX} <2.5, the threshold value normally used to indicate a high likelihood of sulfuric material forming.

Acid Base Accounting

Acid base accounting data is provided in Table 80-4 and summarised in Figure 80-8.

Chromium reducible sulfur values ranged from below the limit of detection to 0.64 $\%S_{CR}$. Sulfidic materials were detected in all layers of profile BPK4.

Titratable actual acidity values ranged from 0 to 17.89 mole H^+/tonne.

Analysis of retained acidity was not conducted on any of the samples, as all samples were above the critical value of pH_{KCl} <4.5.

Acid neutralising capacity values ranged from 0 to 2.86 $\%CaCO_3$, and were measured in the subsoil layers of profiles BPK2 and BPK4.

Net acidity values ranged from -218 to 207 mole H^+/tonne. Moderate and high net acidity values occurred in profile BPK4, and all other samples had negative or low values.

Water Soluble Sulfate

Water soluble sulfate data values shown in Table 80-4 identified that surface layers were above the critical trigger value of 100 mg/kg SO_4.

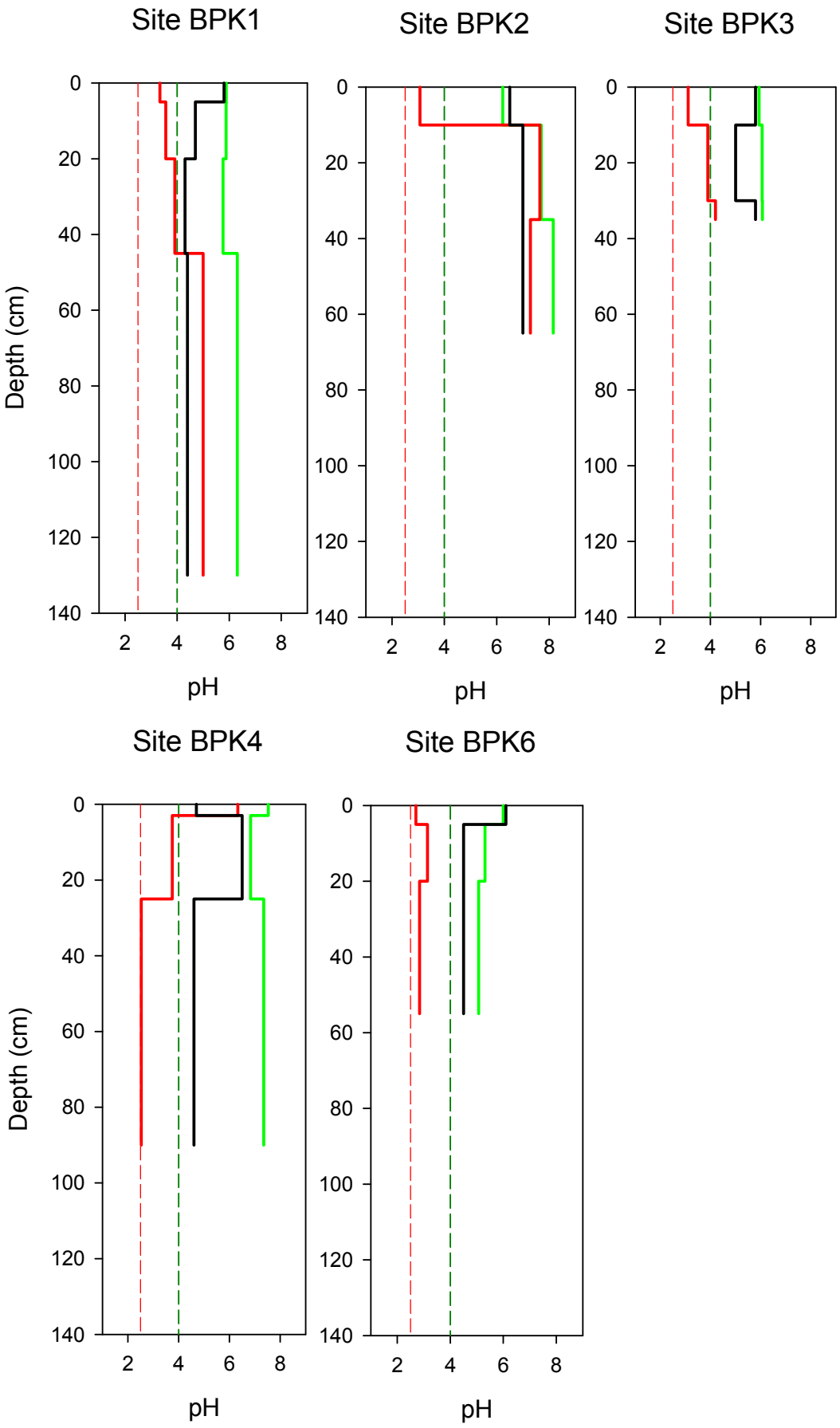

Figure 80-7. Depth profiles of soil pH for Brenda Park Wetland, showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and ageing pH (pH_{INC} after 28 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

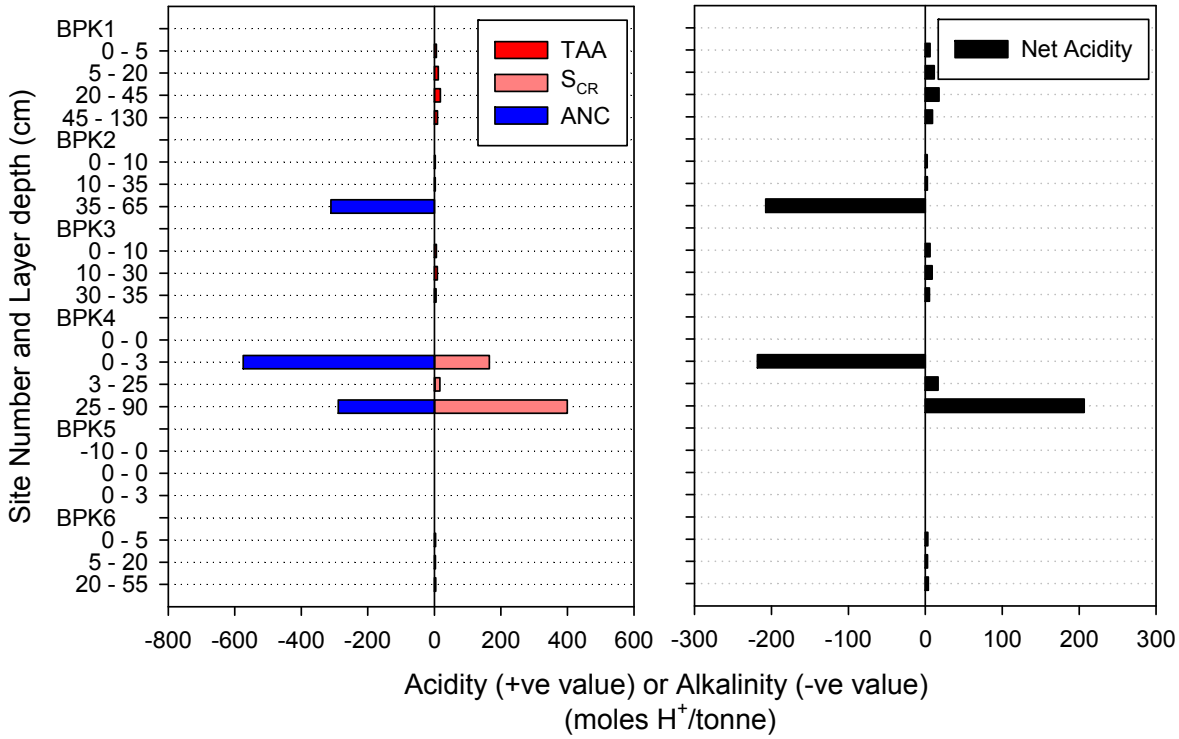

Figure 80-8. Acid base accounting depth profiles for Brenda Park Wetland. Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

80.4 DISCUSSION

Acid sulfate soil materials at Brenda Park Wetland were identified as hyposulfidic for profile BPK4 and probably profile BPK5, the rest of the samples were characterised as other acidic or other soil materials. The acid sulfate soil subtype classes identified were Subaqueous Hyposulfidic Soil, Hyposulfidic Soil, and Other Soil.

The soils throughout the wetland were generally hard clays, and near the surface water areas at the southern end of the wetland they were very soft clay loams over clay.

Monosulfidic material was not observed but water soluble sulfate data identified that surface layers for the profiles throughout the wetland were in excess of the 100 mg/kg trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at the Brenda Park Wetland are:

- Acidification hazard: The data identified moderate or high net acidity values in one profile and the remainder were generally low values, and pH data identified potential acidification due to oxidation in one profile. There is a medium level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated a potential for monosulfidic materials to form in the surface layers of soils, although monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The medium acidification hazard indicates that soil acidification potential may increase the solubility of metals. There is a medium level of concern.

Summary of key findings for Brenda Park Wetland:

Soil materials:	Hyposulfidic soil materials were identified in one profile, and the rest of the soil layers were characterised as other acidic or other soil materials. The soils throughout were generally firm clays and where there was surface water at the southern end of the wetland they were very soft clays. Moderate and high net acidity values occurred in one profile and pH data identified potential acidification due to oxidation in one profile.
Acid sulfate soil identification:	• Other Soil – that occurred in the lower elevation main areas and on the margins of the wetland. Dominant (>50%) in extent. • Hyposulfidic Soil – that occurred low elevation areas at the southern end of the wetland. Isolated (<10%) in extent. • Subaqueous Hyposulfidic Soil – that occurred in the low elevation areas at the southern end of the wetland. Isolated (<10%) in extent.
Hazard assessment	• Acidification hazard – medium level of concern. • De-oxygenation hazard – medium level of concern. • Metal mobilisation hazard – medium level of concern.

Table 80-2. Site data for Brenda Park Wetland.

Site Number	Sampled Date	Easting m zone 54H	Northing m zone 54H	Soil Classification	Water depth (+ve) Water table (-ve)	Surface Condition	Earth Cover (Vegetation)	Location Notes
BPK1	22-Oct-08	377807	6227419	Other soil	70	crumbling	Bare	Low elevation, near centre of wetland
BPK2	22-Oct-08	377884	6227365	Other soil	Not reached	plant material	reeds	High elevation, next to wetland margin
BPK3	22-Oct-08	377863	6227359	Other soil (cracking clay)	Not reached	cracking, weak, crumbling	gums	Mid elevation, probably an old shoreline
BPK4	22-Oct-08	377316	6226960	Hyposulfidic soil	5	sealed, soft	Bare	Low elevation, next to surface water
BPK5	22-Oct-08	377309	6226965	Subaqueous other soil	-10	water	Water	Low elevation, in water
BPK6	22-Oct-08	377313	6226938	Other soil	Not reached	soft, some salt crystals	gums	High elevation, next to wetland margin
BPK7	22-Oct-08	377299	6226946	Other soil	Not reached	soft, salt crystals	Bare	Mid elevation

Table 80-3. Soil description data for Brenda Park Wetland.

Site and Sample Number	Depth Upper (cm)	Depth Lower (cm)	Observation Method (kind)	Soil Colour (Munsell notation)	Texture (class)	Soil Water Status	Mottles Quantity (%)	Mottles Colour	Mottles Location	Structure Type (category)	Consistence (category)	Comments
BPK1.1	0	5	soil pit	2.5Y 6/1	clay loam	dry	0			angular blocky	loose	some salts on aggregate surfaces
BPK1.2	5	20	soil pit	2.5Y 4/1	clay	moist	5	7.5YR 5/8	in matrix	subangular blocky	firm	
BPK1.3	20	45	soil pit	2.5Y 4/1	clay	moist	5	7.5YR 5/8	in matrix	subangular blocky	very firm	sticky clay
BPK1.4	45	130	push tube	2.5Y 4/2	clay	moist	5	7.5YR 5/8	in matrix	massive	very firm	
BPK2.1	0	10	soil pit	2.5Y 5/2	clay	dry	3	7.5YR 5/8	in matrix	angular blocky	hard	
BPK2.2	10	35	soil pit	2.5Y 5/1	clay	dry	5	7.5YR 5/8	in matrix	angular blocky	hard	
BPK2.3	35	65	push tube	2.5Y 4/1	clay	moist	5	7.5YR 5/8	in matrix	angular blocky	extremely firm	too hard to dig below this layer

Site and Sample Number	Depth Upper (cm)	Depth Lower (cm)	Observation Method (kind)	Soil Colour (Munsell notation)	Texture (class)	Soil Water Status	Mottles Quantity (%)	Mottles Colour	Mottles Location	Structure Type (category)	Consistence (category)	Comments
BPK3.1	0	10	soil pit	2.5Y 6/2	clay	dry	3	10YR 6/8	in matrix	angular blocky	hard	
BPK3.2	10	30	soil pit	2.5Y 5/2	clay	dry	25	10YR 6/8	in matrix along ped faces	columnar	hard	
BPK3.3	30	35	soil pit	2.5Y 5/2	clay	dry	35	10YR 6/8	in matrix	columnar	extremely hard	too hard to dig below this layer
BPK4.0	0	0.5	soil pit	10YR 7/2	clay	moist	0			SALTS	friable	a skin of clay and white salts
BPK4.1	0	3	soil pit	5Y 4/1	clay loam	moist	0			massive	very soft	low bearing strength
BPK4.2	3	25	soil pit	5Y 4/1	clay	wet	15	7.5YR 6/8	in matrix along ped faces	subangular blocky	firm	
BPK4.3	25	90	soil pit	5Y 4/1	clay	wet	0			massive	very soft	low bearing strength
BPK5.0	-10	0	water		water	wet	0					
BPK5.1	0	0	soil pit	10YR 5/3		wet	0			massive	very soft	brown algae skin
BPK5.2	0	3	soil pit		clay loam	wet	0			massive	very soft	layers for this profile same as for those of BPK4 10m away
BPK6.1	0	5	soil pit	2.5Y 6/4	sandy loam	moist	0			single grain	friable	
BPK6.2	5	20	soil pit	2.5Y 6/4	sandy loam	moist	25	10YR 6/8	in matrix	single grain	firm	
BPK6.3	20	55	soil pit	2.5Y 5/3	sandy clay loam	moist	10	10YR 6/8	in matrix	single grain	firm	too hard to auger below this layer due to packed sand
BPK7.0	0	0	soil pit	2.5Y 8/1	SALTS	dry	0					surface salts

Table 80-4. Laboratory data for acid sulfate soil assessment of Brenda Park Wetland.

(red printed values indicate data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
BPK1.1	0 - 5	medium	11,850	5.89	3.34	5.80	2442	5.88	6.17	< 0.01	-	6	other soil material
BPK1.2	5 - 20	fine	560	5.88	3.56	4.70	559	5.16	11.80	< 0.01	-	12	other acidic incubation
BPK1.3	20 - 45	fine	760	5.76	3.91	4.30	358	4.93	17.89	< 0.01	-	18	other acidic incubation
BPK1.4	45 - 130	fine	1,280	6.31	5.00	4.40	533	5.27	9.39	< 0.01	-	9	other acidic incubation
BPK2.1	0 - 10	fine	1,220	6.23	3.07	6.50	747	5.96	2.58	< 0.01	-	3	other soil material
BPK2.2	10 - 35	fine	990	7.70	7.65	7.00	237	6.25	2.66	< 0.01	-	3	other soil material
BPK2.3	35 - 65	fine	430	8.16	7.29	7.00	158	7.97	0.00	< 0.01	1.56	-207	other soil material
BPK3.1	0 - 10	fine	5,480	5.94	3.11	5.80	1338	5.79	6.17	< 0.01	-	6	other soil material
BPK3.2	10 - 30	fine	590	6.06	3.90	5.00	127	5.46	8.86	< 0.01	-	9	other acidic incubation
BPK3.3	30 - 35	fine	690	6.07	4.20	5.80	199	5.62	5.43	< 0.01	-	5	other soil material
BPK4.0	0 - 0.5	fine	-	-	-	-	-	-	-	-	-	-	salts
BPK4.1	0 - 3	medium	13,330	7.53	6.33	4.70	4143	8.20	0.00	0.26	2.88	-218	hyposulfidic (S_{CR}≥0.10%)
BPK4.2	3 - 25	fine	1,970	6.83	3.75	6.50	2235	6.41	2.39	0.02	-	17	hyposulfidic (S_{CR}<0.10%)
BPK4.3	25 - 90	fine	1,930	7.35	2.53	4.60	1438	7.66	0.00	0.64	1.45	207	hyposulfidic (S_{CR}≥0.10%)
BPK5.0	-10 - 0	water	-	-	-	-	-	-	-	-	-	-	-
BPK5.1	0 - 0	fine	-	-	-	-	-	-	-	-	-	-	-
BPK5.2	0 - 3	medium	-	-	-	-	-	-	-	-	-	-	-
BPK6.1	0 - 5	medium	8,160	6.00	2.70	6.10	2307	6.20	3.47	< 0.01	-	3	other soil material
BPK6.2	5 - 20	medium	1,710	5.31	3.14	4.50	225	5.94	3.02	< 0.01	-	3	other acidic incubation
BPK6.3	20 - 55	medium	3,410	5.07	2.84	4.50	1210	5.37	4.10	< 0.01	-	4	other acidic incubation
BPK7.0	0 - 0	salt	-	-	-	-	-	-	-	-	-	-	-

81 MORGAN CONSERVATION PARK WETLAND (WETLAND ID. 12277, 12286)

81.1 LOCATION AND SETTING DESCRIPTION

Morgan Conservation Park Wetland (Wetland ID. 12277, 12286) is situated on the eastern side of the River Murray, across the river from the town of Morgan. The wetland is geomorphically categorised as a Murray Gorge basin (Pressey 1986) and is formed by two irregular shapes that are separated by a raised road on a causeway with culverts connecting the two sections. The wetland is approximately 1.7 kilometres in length and up to 500 metres at the widest, with a total surface area of 100 hectares. The wetland is bound by a raised floodplain area that separates it from the river and surrounding farmland. At the time when the soil survey was conducted in October 2008, the wetland was dry. Isolated areas of vegetation were growing throughout the wetland and on the raised margin areas there were isolated areas of *Phragmites australis* (Common Reed) and trees. Four sites were described and sampled and their locations are shown in Figure 81-1.

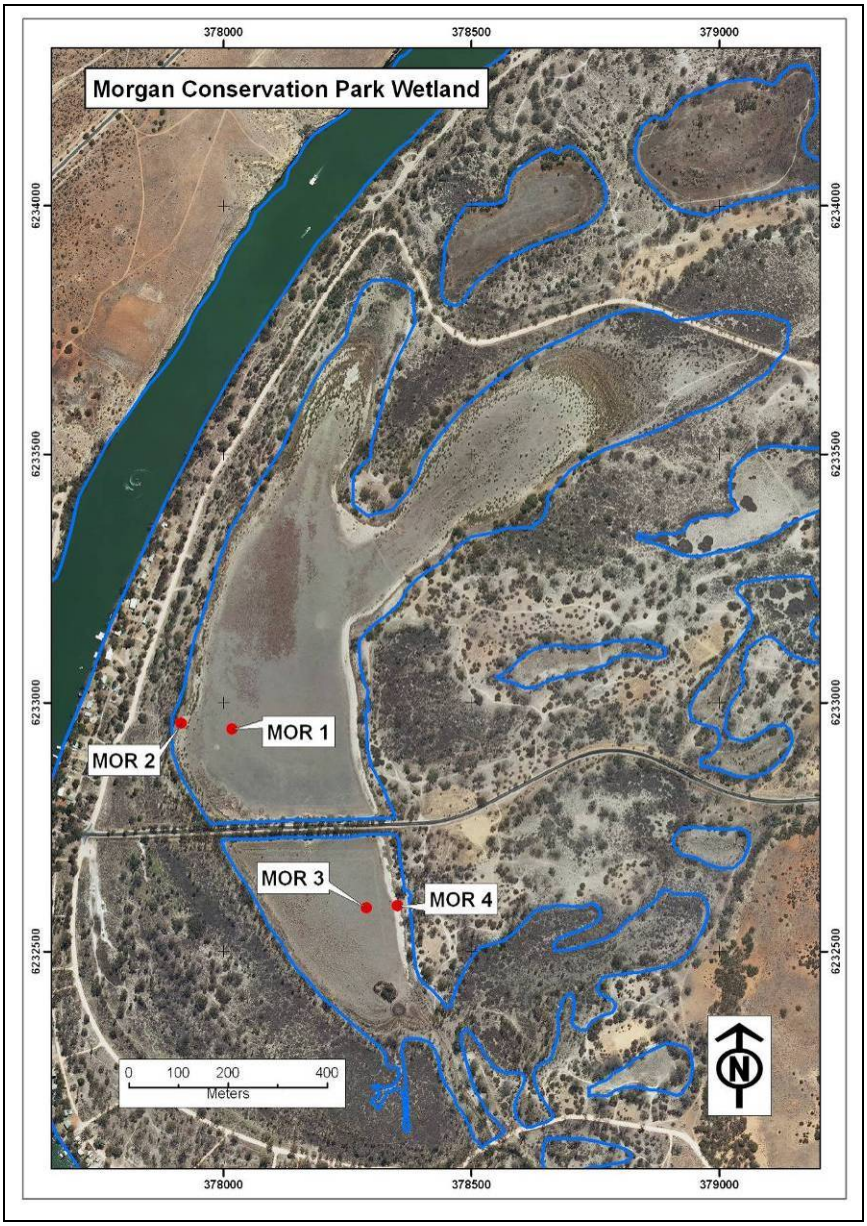

Figure 81-1. Morgan Conservation Park Wetland and sample site locations.

81.2 SOIL PROFILE DESCRIPTION AND DISTRIBUTION

Four sites were described and sampled. The acid sulfate soil subtype class and general location description are presented in Table 80-1. Two sites were located in the northern section (MOR1 and MOR2) and two in the smaller southern section (MOR3 and MOR4). The site and soil profile descriptions are presented in Table 80-2 and Table 80-3.

Site MOR1 (Figure 81-2) occurred in the middle of the wetland at the lowest elevation where the surface was friable aggregates with isolated area of grasses and weeds growing. The soil consisted of dark grey, loose, clay, over dark grey, firm clay with brown mottles in the matrix and below this it was too dry and hard to dig.

Site MOR2 (Figure 81-3) occurred on a raised area of the wetland margin where *Phragmites australis* (Common Reed) were growing and the surface was sealed and hard. The soil consisted of grey, loose clay loam aggregates, over grey, extremely hard, clay that became too difficult to dig.

Site MOR3 (Figure 81-4) occurred in the middle of the wetland at the lowest elevation where the surface was friable aggregates with isolated areas of grasses and weeds were growing. The soil consisted of grey, extremely hard, clay that became too hard to dig.

Site MOR4 (Figure 81-5) occurred on a raised area on the wetland margins where the surface was sealed and *Phragmites australis* (Common Reed) were growing. The soil consisted of grey, hard, sandy clay loam with organic matter and clay lenses, over white, loose, sand.

Table 81-1. Soil identification, subtype and general location description of sites for Morgan Conservation Park Wetland.

Site ID	Easting m zone 54H	Northing m zone 54H	Acid sulfate soil subtype class	General location description
MOR1	378018	6232947	Other soil	Low elevation, about 500m from causeway
MOR2	377916	6232959	Other soil	High elevation, on edge of reeds and vegetation
MOR3	378289	6232587	Other soil	Low elevation, about 400m from causeway
MOR4	378352	6232592	Other soil	High elevation, on sand slope between wetland and wetland margin

Figure 81-2. Photographs of site MOR1, showing the main wetland area, and the soil profile of firm clay with brown mottles in the soil matrix.

Figure 81-3. Photographs of site MOR2, showing the landscape of the wetland margin where reeds were growing, and the soil profile of extremely firm clay.

Figure 81-4. Photographs of site MOR3, showing the main wetland area, and the soil profile of extremely hard clay.

Figure 81-5. Photographs of site MOR4, showing the wetland margin in the foreground where there was sandy soil moving across the main wetland area from the margin, and the soil profile of loose sand.

81.3 LABORATORY DATA ASSESSMENT

Soil pH testing (pH_W, pH_{OX}, pH_{INC})

The pH data are provided in Table 80-4 and pH profiles are presented in Figure 81-6.

The pH_W data did not identify sulfuric materials with a pH_W <4.

The pH_{INC} data did not identify samples that on incubation declined below the critical value of pH <4. Samples that age to pH_{INC}<4 indicate that these soils potentially would form sulfuric materials as a result of sulfide oxidation.

The pH_{OX} data did not identify samples below the critical value of pH_{OX} <2.5, the threshold value normally used to indicate a high likelihood of sulfuric material forming.

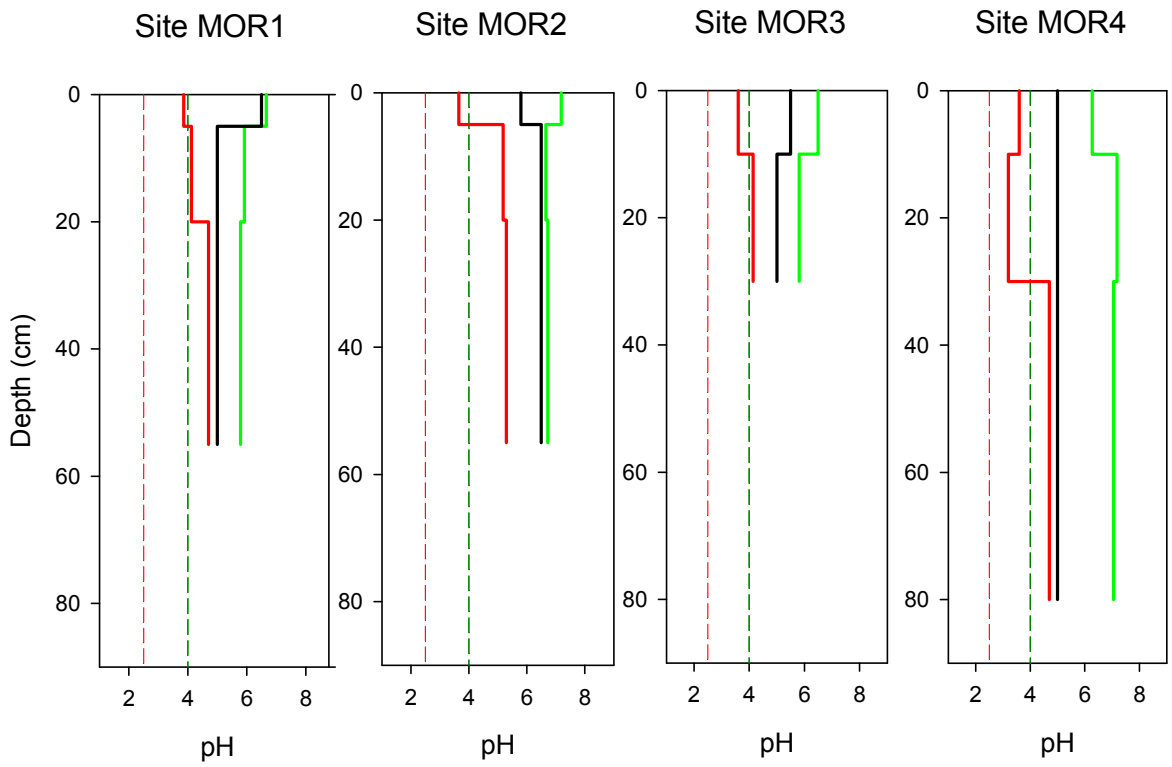

Figure 81-6. Depth profiles of soil pH for Morgan Conservation Park Wetland, showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and ageing pH (pH_{INC} after 28 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

Acid Base Accounting

Acid base accounting data is provided in Table 80-4 and summarised in Figure 81-7.

Chromium reducible sulfur values were all below the limit of detection. Sulfidic materials were not detected in any of the soil layers.

Titratable actual acidity values ranged from 0 to 13.95 mole H^+/tonne.

Analysis of retained acidity was not conducted on any of the samples, as all samples were above the critical value of pH_{KCl} <4.5.

Acid neutralising capacity values ranged from 0 to 0.50 %$CaCO_3$, and were measured in one surface layer of profile MOR2.

Net acidity values ranged from -67 to 14 mole H^+/tonne. Low net acidity values occurred in all layers of the soil profiles, except for the surface layer of MOR2 that had a negative value.

Water Soluble Sulfate

Water soluble sulfate data values shown in Table 80-4 identified that surface layers were above the critical trigger value of 100 mg/kg SO_4.

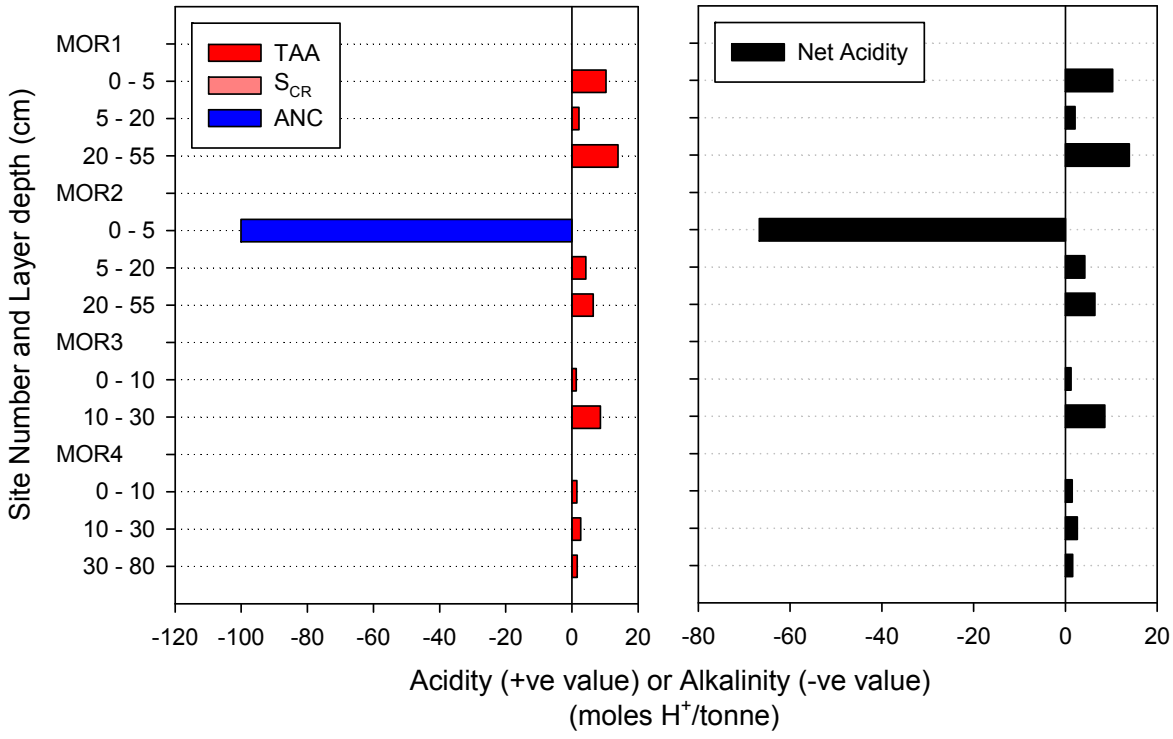

Figure 81-7. Acid base accounting depth profiles for Morgan Conservation Park Wetland. Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

81.4 DISCUSSION

Acid sulfate soil materials at Morgan Conservation Park Wetland were not identified, all samples were characterised as other acidic or other soil materials. The acid sulfate soil subtype class identified was Other Soil.

The soils throughout the wetland were generally firm, clays, and on the margins the surface layers were sandy or loamy.

Monosulfidic material was not observed but water soluble sulfate data identified that surface layers for the profiles throughout the wetland were in excess of the 100 mg/kg trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at the Morgan Conservation Park Wetland are:

- Acidification hazard: The data identified low net acidity values throughout both profiles, and pH data did not identify potential acidification due to oxidation. There is a low level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated a potential for monosulfidic materials to form in the surface layers of soils, although monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The low acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

Summary of key findings for Morgan Conservation Park Wetland:

Soil materials:	Acid sulfate soil materials were not identified, all samples were characterised as other acidic or other soil materials. The soils were generally firm, clays. Generally all profiles had samples with low net acidity values and pH data did not identify potential acidification due to oxidation.
Acid sulfate soil identification:	• Other Soil – that occurred throughout the wetland. Dominant (>50%) in extent.
Hazard assessment	• Acidification hazard – low level of concern. • De-oxygenation hazard – medium level of concern. • Metal mobilisation hazard – low level of concern.

Table 81-2. Site data for Morgan Conservation Park Wetland.

Site Number	Sampled Date	Easting m zone 54H	Northing m zone 54H	Soil Classification	Water depth (+ve) Water table (-ve)	Surface Condition	Earth Cover (Vegetation)	Location Notes
MOR1	22-Oct-08	378018	6232947	Other soil	Not reached	crumbling	weed	Low elevation, about 500m from causeway
MOR2	22-Oct-08	377916	6232959	Other soil	Not reached	sealed, hard	*Phragmites australis* (Common Reed)	High elevation, on edge of reeds and vegetation
MOR3	22-Oct-08	378289	6232587	Other soil	Not reached	crumbling	weeds	Low elevation, about 400m from causeway
MOR4	22-Oct-08	378352	6232592	Other soil	Not reached	sealed, sandy	*Phragmites australis* (Common Reed)	High elevation, on sand slope between wetland and wetland margin

Table 81-3. Soil description data for Morgan Conservation Park Wetland.

Site and Sample Number	Depth Upper (cm)	Depth Lower (cm)	Observation Method (kind)	Soil Colour (Munsell notation)	Texture (class)	Soil Water Status	Mottles Quantity (%)	Mottles Colour	Mottles Location	Structure Type (category)	Consistence (category)	Comments
MOR1.1	0	5	soil pit	2.5Y 5/1	clay loam	dry	0			granular	loose	
MOR1.2	5	20	soil pit	2.5Y 4/1	clay	moist	2	10YR 6/8	in matrix	subangular blocky	firm	
MOR1.3	20	55	soil pit	2.5Y 4/1	clay	moist	25	10YR 6/8	in matrix	massive	firm	too hard to dig below this layer
MOR2.1	0	5	soil pit	2.5Y 6/2	clay loam	dry	0			single grain	loose	
MOR2.2	5	20	soil pit	2.5Y 6/2	clay	dry	5	10YR 6/8	in matrix adjacent to pores	angular blocky	extremely hard	
MOR2.3	20	55	soil pit	2.5Y 5/2	clay loam	moist	10	10YR 6/8	in matrix	angular blocky	extremely firm	too hard to dig below this layer
MOR3.1	0	10	soil pit	2.5Y 5/2	clay	dry	30	7.5YR 6/8	in matrix	granular	loose	
MOR3.2	10	30	soil pit	2.5Y 5/2	clay	dry	5	5YR 6/8	in matrix	columnar	extremely hard	too hard to dig below this layer
MOR4.1	0	10	soil pit	2.5Y 7/1	loamy sand	dry	0			single grain	loose	
MOR4.2	10	30	soil pit	2.5Y 7/1	sandy clay loam	dry	0			subangular blocky	hard	mix of organic matter and clay lenses in sand
MOR4.3	30	80	soil pit	2.5Y 7/1	sand	moist	0			single grain	loose	

Table 81-4. Laboratory data for acid sulfate soil assessment of Morgan Conservation Park Wetland.

(red printed values indicate data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
MOR1.1	0 - 5	medium	4,040	6.66	3.86	6.50	419	5.36	10.31	< 0.01	-	10	other soil material
MOR1.2	5 - 20	fine	2,230	5.92	4.12	5.00	577	6.48	2.12	< 0.01	-	2	other acidic incubation
MOR1.3	20 - 55	fine	2,800	5.79	4.70	5.00	464	4.99	13.95	< 0.01	-	14	other acidic incubation
MOR2.1	0 - 5	medium	570	7.19	3.65	5.80	63	6.53	0.00	< 0.01	0.50	-67	other soil material
MOR2.2	5 - 20	fine	2,710	6.66	5.18	6.50	352	6.02	4.22	< 0.01	-	4	other soil material
MOR2.3	20 - 55	fine	4,290	6.72	5.29	6.50	781	5.85	6.41	< 0.01	-	6	other soil material
MOR3.1	0 - 10	medium	1,030	6.49	3.60	5.50	325	5.93	1.26	< 0.01	-	1	other soil material
MOR3.2	10 - 30	fine	1,000	5.81	4.14	5.00	280	5.39	8.60	< 0.01	-	9	other acidic incubation
MOR4.1	0 - 10	coarse	530	6.27	3.60	5.00	41	6.33	1.48	< 0.01	-	1	other acidic incubation
MOR4.2	10 - 30	medium	870	7.18	3.20	5.00	236	5.86	2.62	< 0.01	-	3	other acidic incubation
MOR4.3	30 - 80	coarse	45,500	7.05	4.70	5.00	19	6.35	1.58	< 0.01	-	2	other acidic incubation

Contact Us
Phone: 1300 363 400
+61 3 9545 2176
Email: enquiries@csiro.au
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