Appendix 2. Channel reports (Component 2).

8.11. Wakool Weir (Downstream) (Site 1)

8.11.1. Location and setting description

This site consisted of pool-riffle-run sequence in a low flow channel approximately 3-5 m in width with steep banks (Figure 8-109). The channel at this site contains submerged logs, sand bars and reeds with water depth ranging from 0.3 – 0.4 m between the upstream and downstream sites. Vegetation on the banks consisted of mixed river red gum and black box woodland with a grassy understorey. Nine profiles were sampled in duplicate. The pH of the channel sediments were predominantly neutral to slightly acidic.

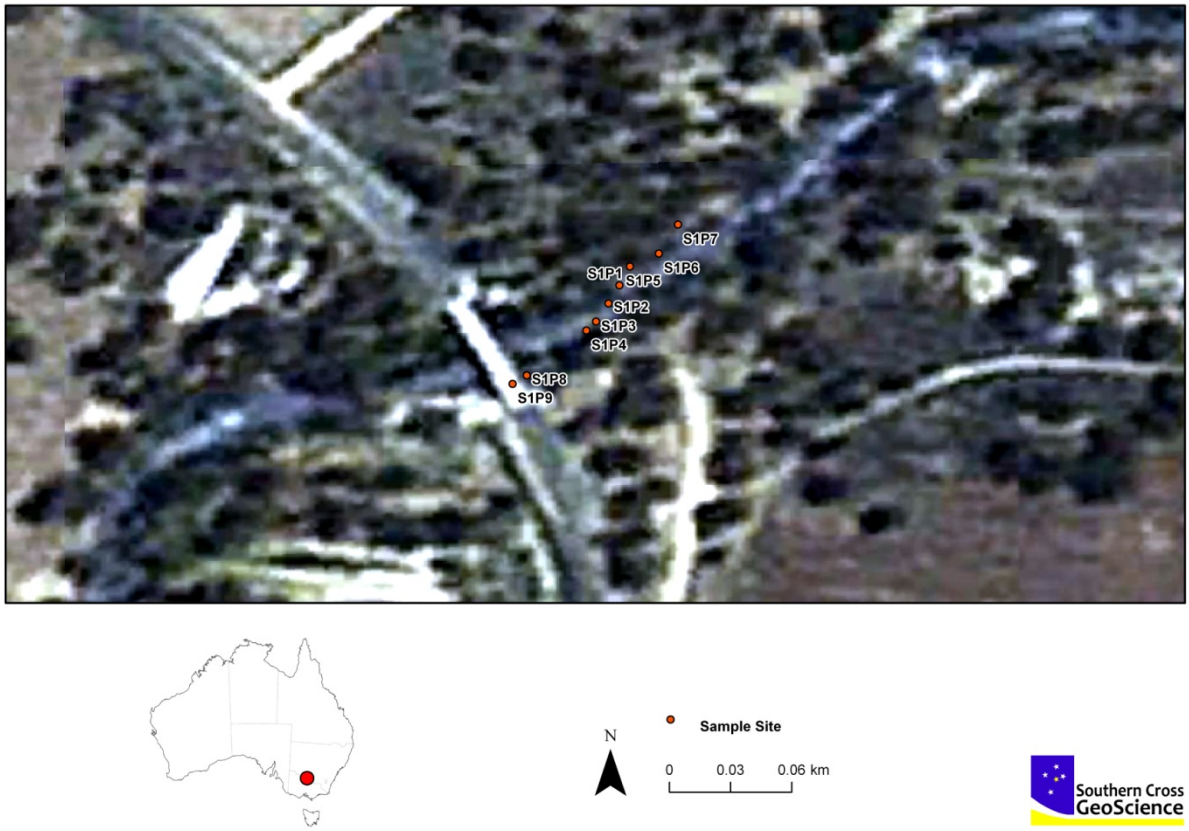

Figure 8-109. Wakool Weir and sample site locations.

8.11.2. Soil profile description and distribution

Nine profiles were described and sampled at the Wakool Weir. The soil subtype and general location description are presented in Table 8-41. Profile description data are presented in Table 8-44.

Table 8-41. Soil identification, subtype and general location description for sites sampled at the Wakool Weir.

Site ID	Easting UTM Zone 55H	Northing UTM Zone 55H	Acid sulfate soil subtype class
WW_1	296182	6069487	Hypersulfidic Subaqueous Soil with Monosulfides
WW_2	296178	6069478	Hypersulfidic Subaqueous Soil with Monosulfides
WW_3	296173	6069469	Hypersulfidic Subaqueous Soil with Monosulfides
WW_4	296169	6069465	Hypersulfidic Subaqueous Soil with Monosulfides
WW_5	296186	6069497	Hypersulfidic Subaqueous Soil
WW_6	296197	6069503	Hypersulfidic Subaqueous Soil with Monosulfides
WW_7	296205	6069517	Hypersulfidic Subaqueous Soil with Monosulfides
WW_8	296146	6069442	Hypersulfidic Subaqueous Soil
WW_9	296140	6069438	Hypersulfidic Subaqueous Soil with Monosulfides

Figure 8-110. Site 1, Wakool Weir (upstream view).

Figure 8-111. Site 1, Wakool Weir (downstream view).

8.11.3. Laboratory data assessment

Soil pH testing (pH_W, pH_{FOX}, pH_{KCl}, $pH_{INCUBATION}$)

The pH data is provided in Table 8-42 and depth profiles of soil pH for all the sites sampled are presented in Figures 8-112 to 8-114. The pH_W values ranged between 5.29 and 6.99. No sulfuric materials (i.e. $pH_W < 4$) were present at Wakool Weir. The pH_{FOX} values ranged between 1.22 and 3.49. The pH_{FOX} results indicate that all the surface soils may have the potential to acidify to pH < 4 as a result of sulfide oxidation. Thirty-six soil materials had a $pH_{FOX} < 2.5$ suggesting that soil acidity problems will emerge when these soils are exposed to air. The S_{CR} data shows 26 of the 40 layers examined contained detectable sulfide (i.e. $S_{CR} \geq 0.01\%$ S). The pH_{KCl} values ranged between 5.11 and 6.77. Fourteen of the sulfidic soil materials (i.e. $S_{CR} \geq 0.01\%$ S) acidified to pH < 4 after at least 8 weeks of incubation. Other acidic soil materials were identified at six of the nine profiles examined, indicating acidity in the soil profile at levels where aluminium may mobilise. Three of the other acidic soils acidified to pH < 4 after at least 8 weeks of incubation.

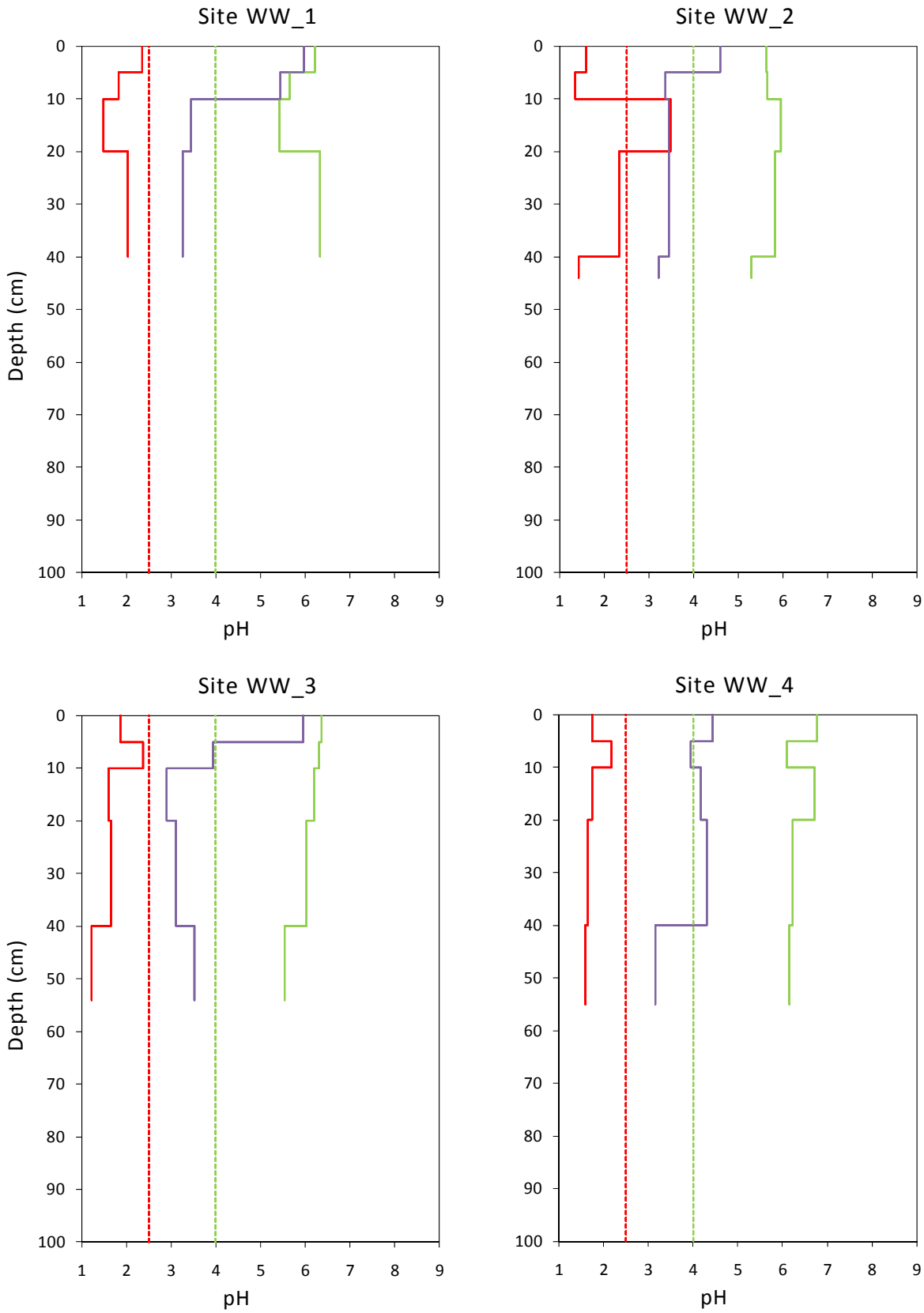

Figure 8-112. Depth profiles of soil pH for sites at the Wakool Weir (WW_1 – WW_4), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

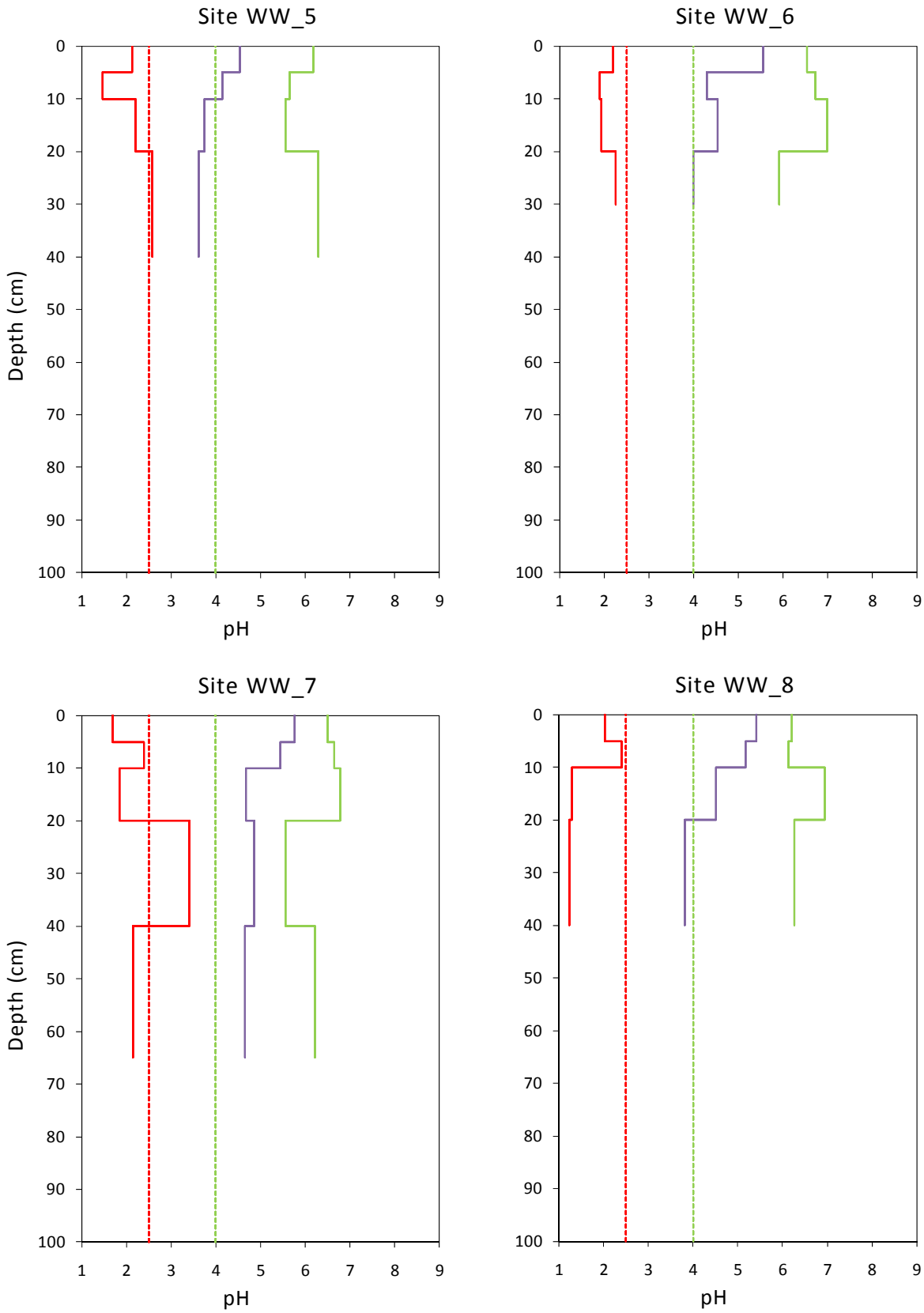

Figure 8-113. Depth profiles of soil pH for sites at the Wakool Weir (WW_5 – WW_8), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

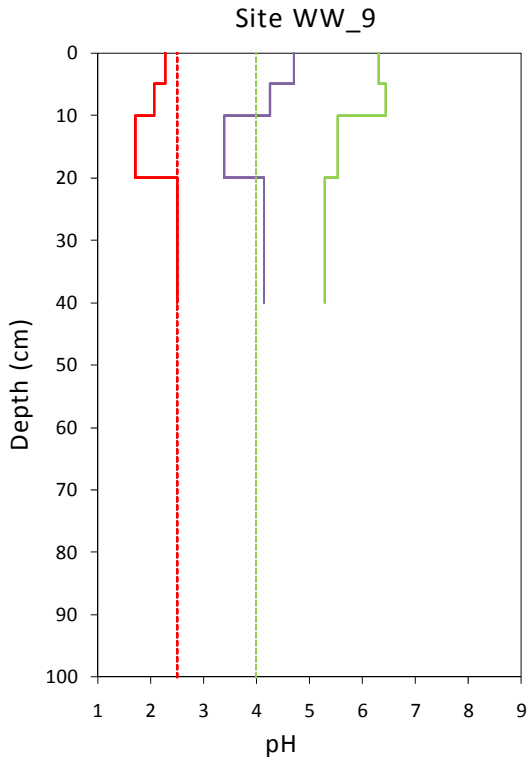

Figure 8-114. Depth profiles of soil pH for sites at the Wakool Weir (WW_9), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

Acid-base accounting

The acid-base accounting data is provided in Table 8-42 and summarised in Figures 8-115 to 8-117.

Chromium reducible sulfur

Chromium reducible sulfur (S_{CR}) values ranged between < 0.01 and 0.15% S_{CR}. Sulfidic soil materials (i.e. S_{CR} ≥ 0.01% S) were identified in all nine soil profiles, with 26 materials of the 40 samples collected equal to or greater than the sulfidic criterion.

Acid volatile sulfide

The acid volatile sulfide (S_{AV}) values ranged between < 0.01 and 0.03% S_{AV}. A total of 11 monosulfidic soil materials (i.e. S_{AV} ≥ 0.01% S) were found in seven of the nine soil profiles examined.

Acid neutralising capacity

The acid neutralising capacity (ANC) ranged between zero and 0.52% $CaCO_3$.

Titratable actual acidity

The titratable actual acidity (TAA) ranged between zero and 28 mole H^+/tonne. A decrease in the TAA with depth was observed in some of the soil profiles (i.e. Sites WW_3, WW_7, WW_8 and WW_9).

Retained acidity

All soil materials had no retained acidity.

Net acidity

Net acidity ranged between -70 and 67 mole H^+/tonne. The 25 hypersulfidic soils had low to moderate net acidities ranging between -48 and 67 mole H^+/tonne.

Water Soluble Sulfate

The water soluble sulfate in the surface soils (i.e. 0-20 cm) ranged between 82 and 687 mg SO_4/kg. The surface soil layers at all nine profiles had a soluble sulfate content exceeding the 100 mg/kg trigger value for MBO formation potential.

Water Data

The surface water data measured in the field are presented in Table 8-43. The field pH of the surface water collected was 6.4, which was slightly below the most relevant ANZECC/ARMCANZ (2000) trigger value for aquatic ecosystems of 6.5. The water data does not indicate that the surface water has been affected by acidification. The SEC value was found to exceed the most relevant ANZECC/ARMCANZ (2000) guideline value.

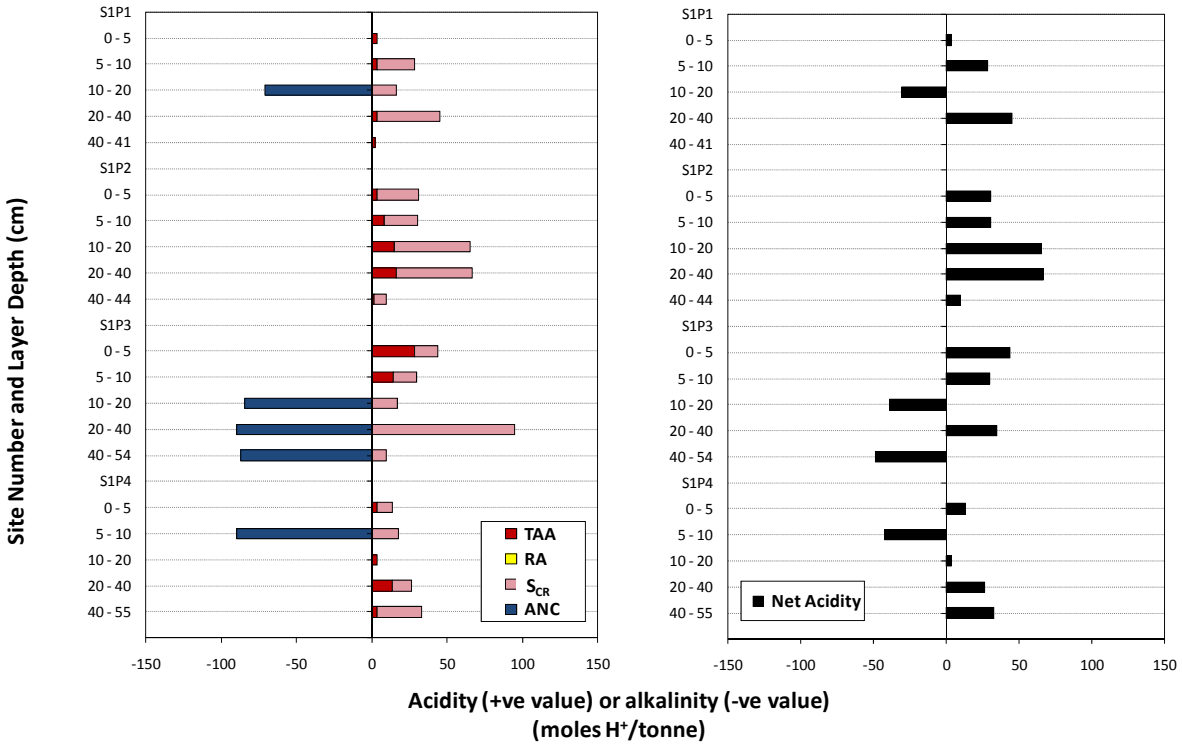

Figure 8-115. Acid-base accounting depth profiles for sites at the Wakool Weir (WW_1 – WW_4). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

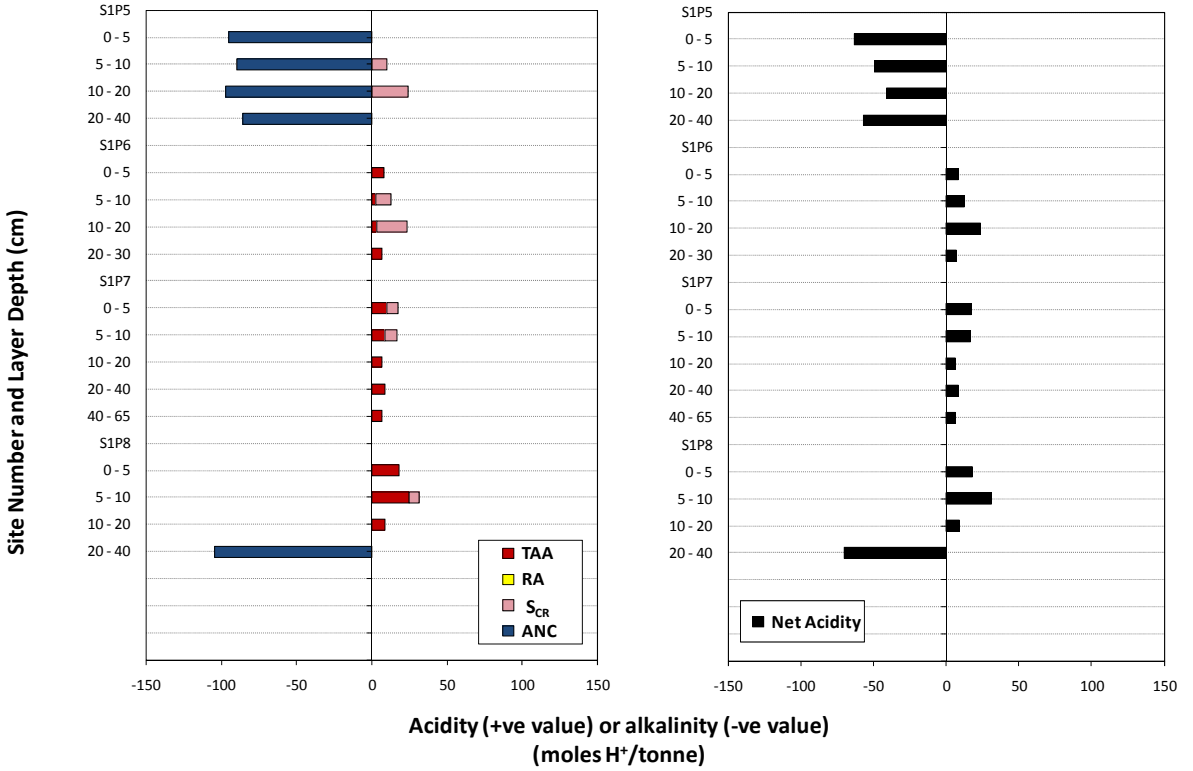

Figure 8-116. Acid-base accounting depth profiles for sites at the Wakool Weir (WW_5 – WW_8). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

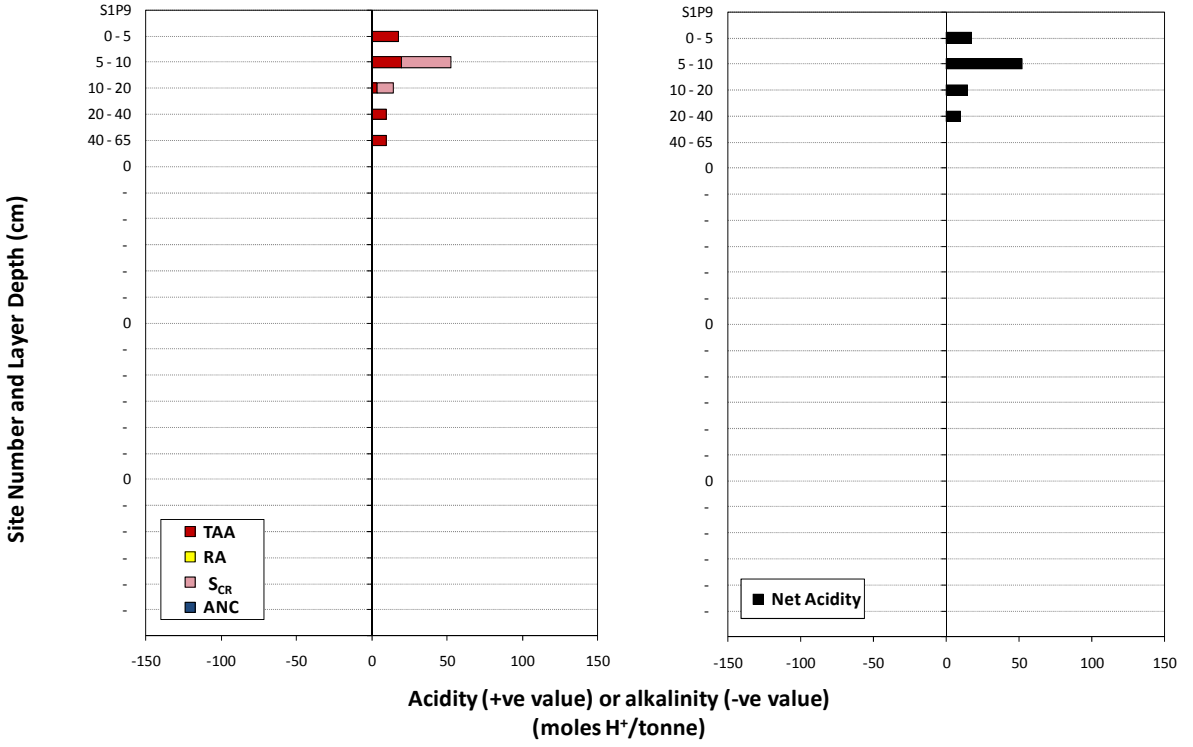

Figure 8-117. Acid-base accounting depth profiles for sites at the Wakool Weir (WW_9). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

8.11.4. Discussion

Acid sulfate soil materials occurred within the soil profile at all nine locations examined at the Wakool Weir. Sulfuric materials were not observed at the Wakool Weir. The presence of reduced inorganic sulfur was identified in all profiles, with a S_{CR} of up to 0.15% S. Hypersulfidic soil materials with low to moderate net acidities (i.e. -48 to 67 mole H^+/tonne) were present in the nine soil profiles examined (one profile also contained a hyposulfidic material). Monosulfidic soil materials were also observed in seven of the sulfidic profiles, with S_{AV} contents of up to 0.03% S. Monosulfidic soil materials (S_{AV} ≤ 0.03% S) were observed in the upper 0-10 cm layers in six profiles. These results indicate that acidity would be produced upon oxidation of the sulfidic materials. All surficial soil materials contained soluble sulfate exceeding the 100 mg/kg trigger value for MBO formation potential. Other acidic soil materials were also observed in six profiles.

Based on the priority ranking criteria adopted by the Scientific Reference Panel of the Murray-Darling Basin Acid Sulfate Soil Risk Assessment Project, there were nine high priority sites based on hypersulfidic material and seven high priority sites based on monosulfidic material. There was one moderate priority site based on the presence of a hyposulfidic material with S_{CR} < 0.10%. In addition, all nine sampling sites had a high priority ranking for Phase 2 detailed assessment based on MBO formation hazard.

The potential hazards posed by acid sulfate soil materials at the Wakool Weir are:

- Acidification hazard: The hypersulfidic materials had low to moderate net acidities (i.e. 63% of layers), indicating that the overall degree of acidification hazard is moderate.

- Deoxygenation hazard: Monosulfidic soil materials (S_{AV} ≤ 0.03% S) observed in the upper 0-10 cm layers in six profiles represent a high deoxygenation hazard. In addition, the soluble sulfate content of surface soil materials at all nine profiles were over the trigger value for MBO formation indicating the possible development of a high deoxygenation hazard at those locations after prolonged wet conditions.

- Metal mobilisation: The moderate acidification hazard indicates that soil acidification may increase the solubility of metals. The presence of monosulfidic materials in upper soil layers and the potential for MBO formation identified in this channel may also result in a high metal release hazard. This would depend on factors such as the potential for MBO formation and the metal loading in the channel. Soil acidity may be sufficient for mobilisation of aluminium.

Summary of key findings for the Wakool Weir:

Soil materials:	Sulfidic soil materials identified included: hypersulfidic (9 profiles), monosulfidic (7 profiles) and hyposulfidic < 0.10% (1 profile). Low to moderate net acidities within channel.
Acid sulfate soil identification:	• Sulfidic materials occurred at various depths and for several sites were found throughout the depth profile. Monosulfides were observed mostly in the upper 20cm of profiles, and in one case from 20-40cm. All sites were subaqueous.
Hazard assessment	• Acidification hazard - moderate level of concern • Deoxygenation hazard - high level of concern • Metal mobilisation hazard - high level of concern

Table 8-42. Laboratory analytical data for acid sulfate soil assessment of Wakool Weir (Site 1).

(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P1_1	0-5		6.21	2.36	5.97*	159.00	6.24	3.63	0.00	0.00	0.00	3.63	0.00	Other Soil Materials
P1_2	5-10		5.65	1.83	5.45*	93.45	6.03	3.45	0.04	0.00	0.00	28.63	0.01	Hypermonosulfidic#
P1_3	10-20		5.42	1.49	3.45*	100.95	6.53	0.00	0.03	0.00	0.36	-30.69	0.00	Hypersulfidic
P1_4	20-40		6.33	2.03	3.25	165.00	6.39	3.79	0.07	0.00	0.00	45.00	0.00	Hypersulfidic
P2_1	0-5		5.64	1.60	4.60*	211.50	6.11	3.70	0.04	0.00	0.00	30.94	0.01	Hypermonosulfidic#
P2_2	5-10		5.65	1.35	3.37	143.70	5.81	8.30	0.04	0.00	0.00	30.70	0.00	Hypersulfidic
P2_3	10-20		5.95	3.49	3.44*	292.50	5.37	15.07	0.08	0.00	0.00	65.05	0.00	Hypersulfidic
P2_4	20-40		5.83	2.33	3.44*	250.50	5.26	16.52	0.08	0.00	0.00	66.95	0.02	Hypermonosulfidic
P2_5	40-44		5.30	1.44	3.22	110.85	6.49	1.55	0.01	0.00	0.00	9.55	0.00	Hypersulfidic
P3_1	0-5		6.37	1.86	5.96	396.00	5.30	28.48	0.02	0.00	0.00	44.06	0.01	Hypermonosulfidic#
P3_2	5-10		6.31	2.37	3.94*	255.00	5.37	14.50	0.02	0.00	0.00	29.77	0.01	Hypermonosulfidic
P3_3	10-20		6.19	1.60	2.90*	178.50	6.54	0.00	0.03	0.00	0.42	-38.91	0.03	Hypermonosulfidic
P3_4	20-40		6.02	1.65	3.10*	79.20	6.75	0.00	0.15	0.00	0.45	34.97	0.00	Hypersulfidic
P3_5	40-54		5.54	1.22	3.53	87.75	6.65	0.00	0.02	0.00	0.44	-48.45	0.00	Hypersulfidic
P4_1	0-5		6.77	1.75	4.44*	147.45	6.10	3.45	0.02	0.00	0.00	13.59	0.00	Hypersulfidic#
P4_2	5-10		6.09	2.17	3.95*	81.75	6.77	0.00	0.03	0.00	0.45	-42.12	0.03	Hypermonosulfidic
P4_3	10-20		6.72	1.74	4.17*	81.90	6.04	3.20	0.00	0.00	0.00	3.20	0.00	Other Acid Soils
P4_4	20-40		6.22	1.64	4.30	78.30	5.46	13.79	0.02	0.00	0.00	26.40	0.00	Hypersulfidic#
P4_5	40-55		6.16	1.59	3.16*	75.60	6.26	3.66	0.05	0.00	0.00	33.00	0.00	Hypersulfidic
P5_1	0-5		6.17	2.13	4.53*	147.30	6.67	0.00	0.00	0.00	0.48	-63.34	0.00	Other Acid Soils
P5_2	5-10		5.66	1.46	4.15*	112.20	6.57	0.00	0.02	0.00	0.45	-49.42	0.00	Hyposulfidic
P5_3	10-20		5.56	2.21	3.75*	87.90	6.76	0.00	0.04	0.00	0.49	-41.21	0.00	Hypersulfidic
P5_4	20-40		6.30	2.59	3.61*	78.30	6.76	0.00	0.00	0.00	0.43	-57.17	0.00	Other Acid Soils
P6_1	0-5		6.54	2.20	5.56*	201.00	5.72	7.98	0.00	0.00	0.00	7.98	n/a	Other Soil Materials
P6_2	5-10		6.73	1.91	4.30*	135.90	6.44	2.51	0.02	0.00	0.00	12.49	n/a	Hypersulfidic#
P6_3	10-20		6.99	1.94	4.54*	108.00	6.26	3.64	0.03	0.00	0.00	23.71	0.01	Hypermonosulfidic#
P6_4	20-30		5.91	2.27	3.99*	57.00	5.80	6.91	0.00	0.00	0.00	6.91	0.00	Other Acid Soils

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). # Classified as hypermonosulfidic/hypersulfidic based on positive net acidity.

Table 8-42 (continued). Laboratory analytical data for acid sulfate soil assessment of Wakool Weir (Site 1).
(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P7_1	0-5		6.49	1.70	5.77	306.00	5.74	10.24	0.01	0.00	0.00	17.22	0.01	Hypermonosulfidic#
P7_2	5-10		6.65	2.39	5.44*	202.50	5.73	8.39	0.01	0.00	0.00	16.61	0.01	Hypermonosulfidic#
P7_3	10-20		6.79	1.85	4.67*	86.70	5.75	6.41	0.00	0.00	0.00	6.41	0.00	Other Acid Soils
P7_4	20-40		5.55	3.40	4.86	42.45	5.58	8.35	0.00	0.00	0.00	8.35	0.00	Other Acid Soils
P7_5	40-65		6.21	2.14	4.65	36.75	5.57	6.41	0.00	0.00	0.00	6.41	0.00	Other Acid Soils
P8_1	0-5		6.21	2.02	5.42*	310.50	5.41	17.81	0.00	0.00	0.00	17.81	0.00	Other Acid Soils
P8_2	5-10		6.14	2.40	5.18	348.00	5.34	24.65	0.01	0.00	0.00	31.34	0.00	Hypersulfidic#
P8_3	10-20		6.94	1.30	4.51*	238.50	5.95	8.76	0.00	0.00	0.00	8.76	0.00	Other Acid Soils
P8_4	20-40		6.27	1.24	3.81*	98.70	6.52	0.00	0.00	0.00	0.52	-69.77	0.00	Other Acid Soils
P9_1	0-5		6.31	2.28	4.71	405.00	5.45	17.67	0.00	0.00	0.00	17.67	0.00	Other Acid Soils
P9_2	5-10		6.45	2.08	4.25*	687.00	5.19	19.39	0.05	0.00	0.00	52.35	0.03	Hypermonosulfidic#
P9_3	10-20		5.54	1.72	3.39*	172.50	5.11	3.44	0.02	0.00	0.00	14.46	0.00	Hypersulfidic
P9_4	20-40		5.29	2.50	4.14	75.00	5.48	9.62	0.00	0.00	0.00	9.62	0.00	Other Acid Soils

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). # Classified as hypermonosulfidic/hypersulfidic based on positive net acidity.

Table 8-43. Field hydrochemistry data for acid sulfate soil assessment of Wakool Weir (Site 1).

Site ID.	Depth (m)	Specific Electrical Conductivity (µS/cm)	pH
*Lowland River**		*125-2,220*	*6.5-8.0*
WW_9	0.1	4,440	6.36

* ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for relevant parameters (ANZECC/ARMCANZ, 2000).
Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text.

Table 8-44. Profile description data for acid sulfate soil assessment of Wakool Weir (Site 1).

Site and Sample No.	Horizon Depth Range (cm)	Sediment	Organics	Colour	Eh (mV)	pH
P1_1	0-5	SiS	Much, Debris	Sand	-31	6.88
P1_2	5-10	Medium-Coarse Sand	Much, Debris	Sand	-100	6.61
P1_3	10-20	Medium-Coarse Sand	Minor, Debris	Sand	58	6.39
P1_4	20-40	Granular Very Coarse Sand	None	Sand	33	6.1
P2_1	0-5	SiS	Minor, Debris	Sand	-68	6.63
P2_2	5-10	Coarse Sand	Minor, Debris	Sand	-14	6.54
P2_3	10-20	Clayey Medium Sand	None	Sand	-57	6.8
P2_4	20-40	Clayey Medium Sand	None	10YR6/1	-5	6.57
P2_5	40-44	Granular Very Coarse Sand	None	Sand	-198	5.83
P3_1	0-5	SiS	Minor, Debris	Sand	-53	6.18
P3_2	5-10	SiS	Minor, Debris	Sand	-119	6.78
P3_3	10-20	Medium-Coarse Sand	Minor, Debris	Sand	-32	6.46
P3_4	20-40	Medium-Coarse Sand	None	Sand	36	6.3
P3_5	40-54	Very Coarse Sand	None	Sand	137	6.32
P4_1	0-5	Medium-Coarse Sand	Minor, Debris	Sand	-123	6.73
P4_2	5-10	Medium-Coarse Sand	Minor, Debris	Sand	-90	6.49
P4_3	10-20	Medium-Coarse Sand	Minor, Debris	Sand	0	6.58
P4_4	20-40	Medium-Coarse Sand	None	Sand	-28	6.37
P4_5	40-55	Granular Coarse Sand	None	Sand	-60	6.18
P5_1	0-5	Coarse Sand	Minor, Debris	Sand	74	5.74
P5_2	5-10	Coarse Sand	Minor, Debris	Sand	144	5.29
P5_3	10-20	Coarse Sand	None	Sand	213	5.26
P5_4	20-40	Granular Coarse Sand	None	Sand	45	6.07
P6_1	0-5	SiS	Minor, Debris	Sand	-115	6.7
P6_2	5-10	Medium-Coarse Sand	Minor, Debris	Sand	-98	6.47
P6_3	10-20	Coarse Sand	None	Sand	-77	6.58
P6_4	20-30	Clayey Very Coarse Sand	None	Sand	-75	6.43
P7_1	0-5	Silty Sand	Minor, Debris	Sand	-222	6.67
P7_2	5-10	Clayey Sand	Minor, Debris	Sand	-198	6.81
P7_3	10-20	Clayey Medium-Coarse Sand	Minor, Debris	Sand	-102	6.92

Table 8-44 (continued). Profile description data for acid sulfate soil assessment for Component 2, Site 1 (Wakool Weir).

Site and Sample No.	Horizon Depth Range (cm)	Sediment	Organics	Colour	Eh (mV)	pH
P7_4	20-40	Clayey Medium Sand	Minor, Debris	Sand	-50	6.72
P7_5	40-65	Medium Sand (Clayey at base)	None		-56	6.74
P8_1	0-5	Silty Sand	Minor, Debris	Sand	-147	6.89
P8_2	5-10	Silty Sand	Minor, Debris	Sand	-115	6.52
P8_3	10-20	Silty Sand	Minor, Debris	Sand	-138	7.01
P8_4	20-40	Very Coarse Sand	None	Sand	-93	6.57
P9_1	0-5	Silty Sand	Minor, Debris	Sand	-63	6.51
P9_2	5-10	Silty Sand	Minor, Debris	Sand	-255	6.59
P9_3	10-20	Granular Coarse Sand	None	Sand	-175	6.19
P9_4	20-40	Clayey Granular Coarse Sand	None	Sand	-167	6.07
P9_5	40-65				3	6.06

8.12. Genoe Creek Junction (Site 2)

8.12.1. Location and setting description

This site was located upstream of a bend in a low flow channel approximately 25 m wide with steep-sided banks (Figure 8-118). The site contains rocky bars and submerged logs with water depth ranging from 1.7 – 5.0 m. Vegetation on the banks consisted of unhealthy and dead river red gums with a saltbush understorey. Thirteen profiles were sampled in duplicate downstream of the rocky bars. The pH of the channel sediments was predominantly neutral to slightly acidic.

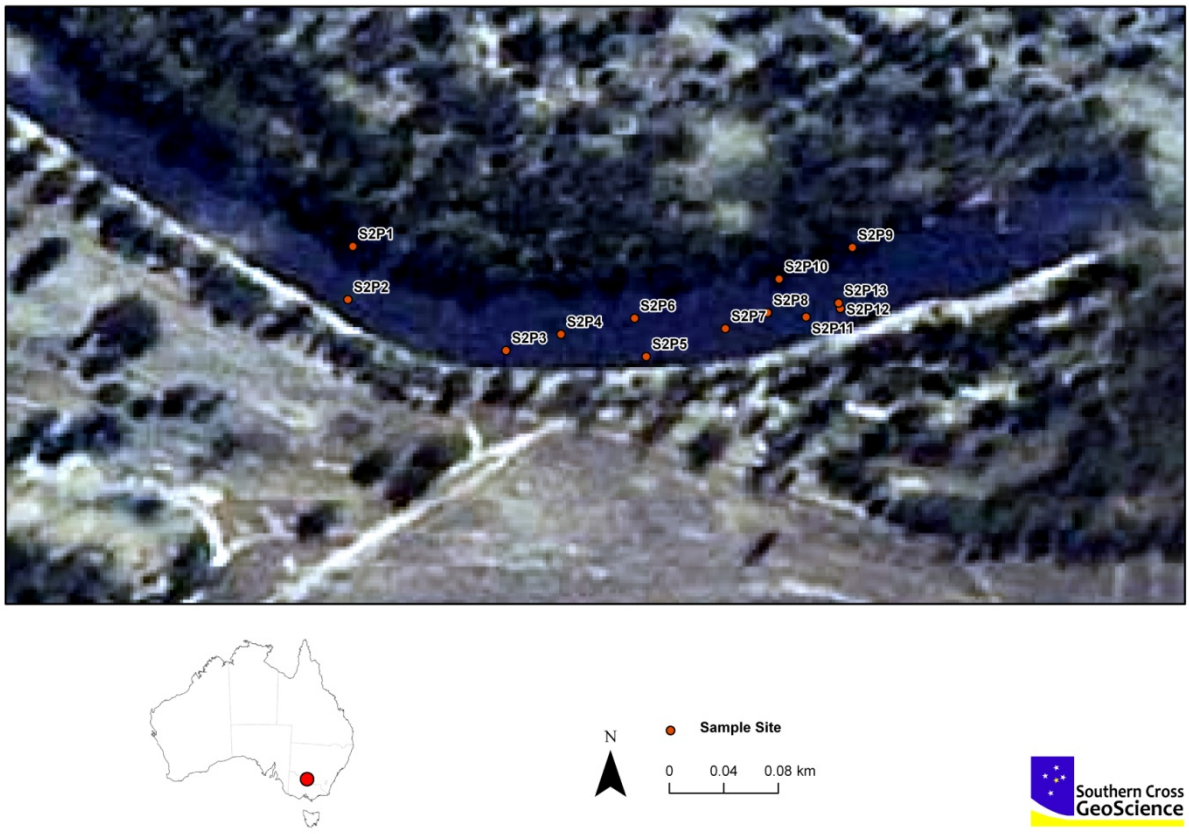

Figure 8-118. Genoe Creek Junction and sample site locations.

8.12.2. Soil profile description and distribution

Thirteen profiles were described and sampled at Genoe Creek Junction. The soil subtype and general location description are presented in Table 8-45. Profile description data are presented in Table 8-48.

Table 8-45. Soil identification, subtype and general location description for sites sampled at Genoe Creek Junction.

Site ID	Easting UTM Zone 54H	Northing UTM Zone 54H	Acid sulfate soil subtype class
GCJ_1	728375	6122205	Hypersulfidic Subaqueous Soil with Monosulfides
GCJ_2	728374	6122178	Hypersulfidic Subaqueous Soil with Monosulfides
GCJ_3	728467	6122209	Hypersulfidic Subaqueous Soil with Monosulfides
GCJ_4	728501	6122220	Hypersulfidic Subaqueous Soil with Monosulfides
GCJ_5	728552	6122203	Hypersulfidic Subaqueous Soil with Monosulfides
GCJ_6	728546	6122231	Hypersulfidic Subaqueous Soil
GCJ_7	728600	6122222	Hypersulfidic Subaqueous Soil with Monosulfides
GCJ_8	728685	6122260	Hypersulfidic Subaqueous Soil with Monosulfides
GCJ_9	728678	6122280	Subaqueous Soil
GCJ_10	728634	6122258	Hypersulfidic Subaqueous Soil with Monosulfides
GCJ_11	728649	6122229	Hypersulfidic Subaqueous Soil with Monosulfides
GCJ_12	728670	6122235	Hypersulfidic Subaqueous Soil with Monosulfides
GCJ_13	728669	6122239	Hypersulfidic Subaqueous Soil with Monosulfides

Figure 8-119. Site 2, Genoe Creek Junction (upstream view).

Figure 8-120. Site 2, Genoe Creek Junction (downstream view).

8.12.3. Laboratory data assessment

Soil pH testing (pH_W, pH_{FOX}, pH_{KCl}, $pH_{INCUBATION}$)

The pH data is provided in Table 8-46 and depth profiles of soil pH for all the sites sampled are presented in Figures 8-121 to 8-124. The pH_W values ranged between 5.03 and 7.89. No sulfuric materials (i.e. $pH_W < 4$) were present at Genoe Creek. The pH_{FOX} values ranged between 1.19 and 5.34. The pH_{FOX} results indicate that many of the surface soil materials examined may have the potential to acidify to pH < 4 as a result of sulfide oxidation. Thirty-two soil materials had a $pH_{FOX} < 2.5$ suggesting that soil acidity problems will emerge when these soils are exposed to air. The S_{CR} data shows 47 of the 56 layers examined contained detectable sulfide (i.e. $S_{CR} \geq 0.01\%$ S). The pH_{KCl} values ranged between 5.63 and 8.16. Thirty-three of the sulfidic soil materials (i.e. $S_{CR} \geq 0.01\%$ S) acidified to pH < 4 after at least 8 weeks of incubation. Other acidic soil materials were identified at five of the 13 profiles examined, indicating acidity in the soil profile at levels where aluminium may mobilise. Six of the other acidic soils acidified to pH < 4 after at least 8 weeks of incubation.

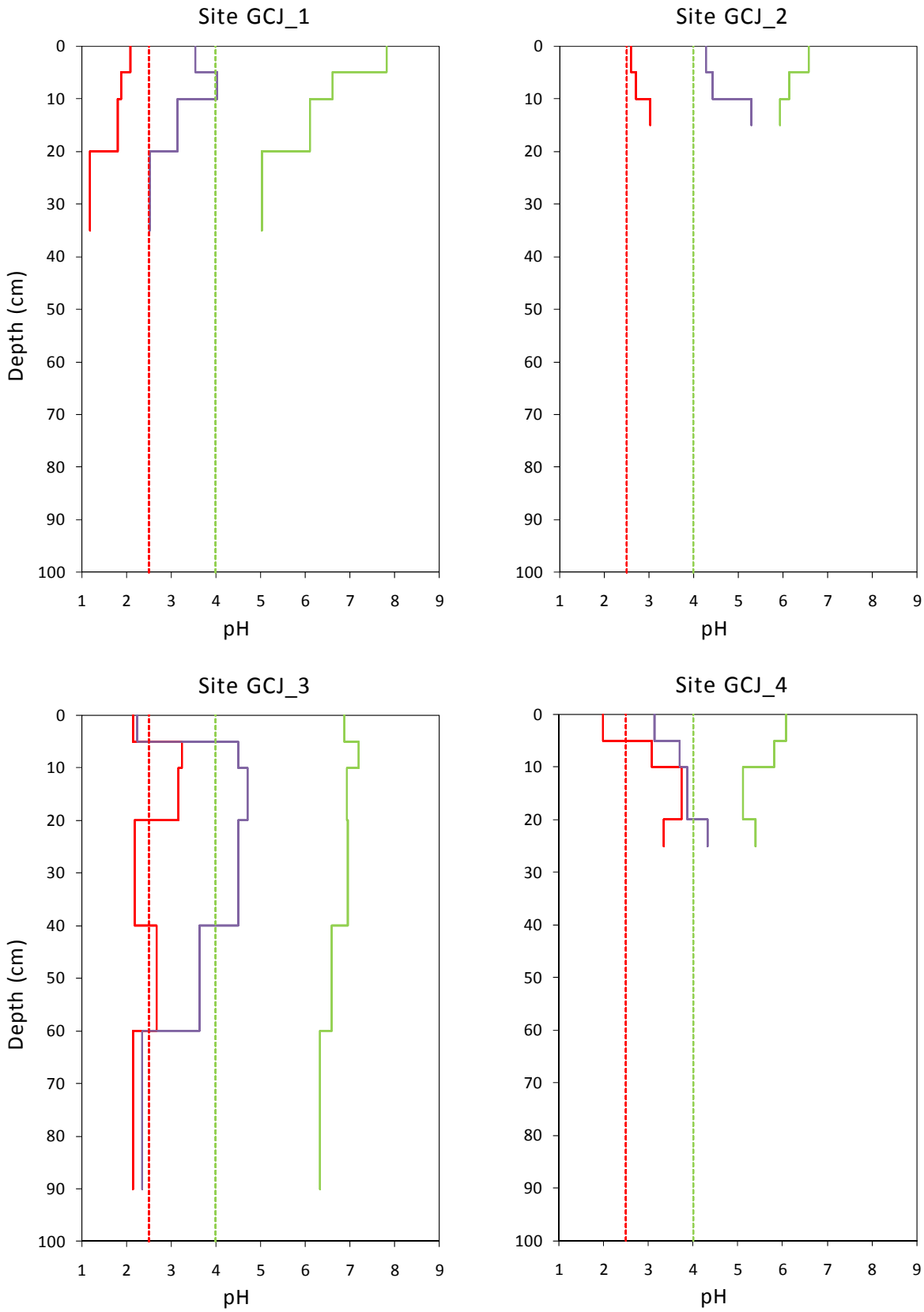

Figure 8-121. Depth profiles of soil pH for sites at Genoe Creek Junction (GCJ_1 – GCJ_4), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

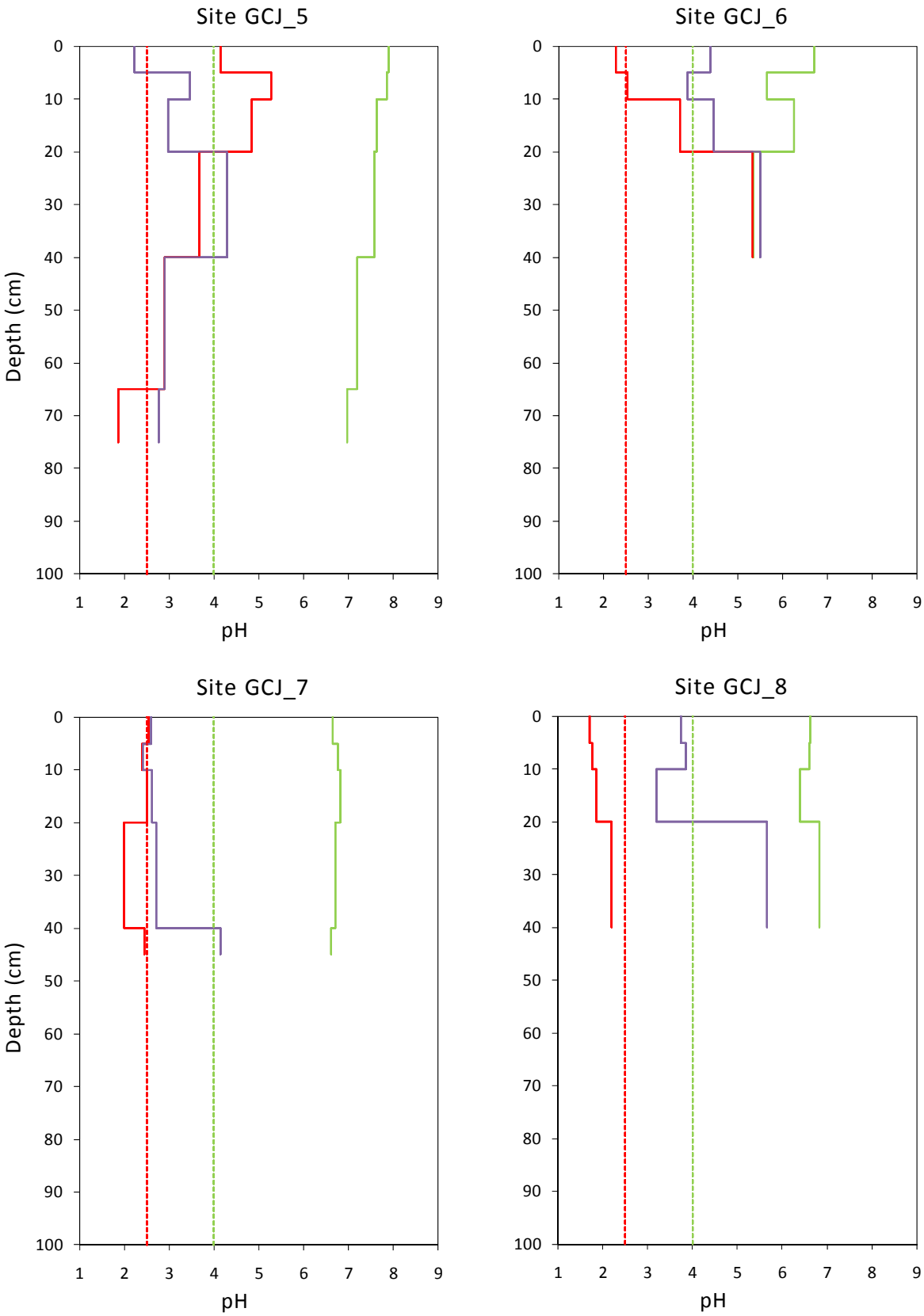

Figure 8-122. Depth profiles of soil pH for sites at Genoe Creek Junction (GCJ_5 – GCJ_8), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

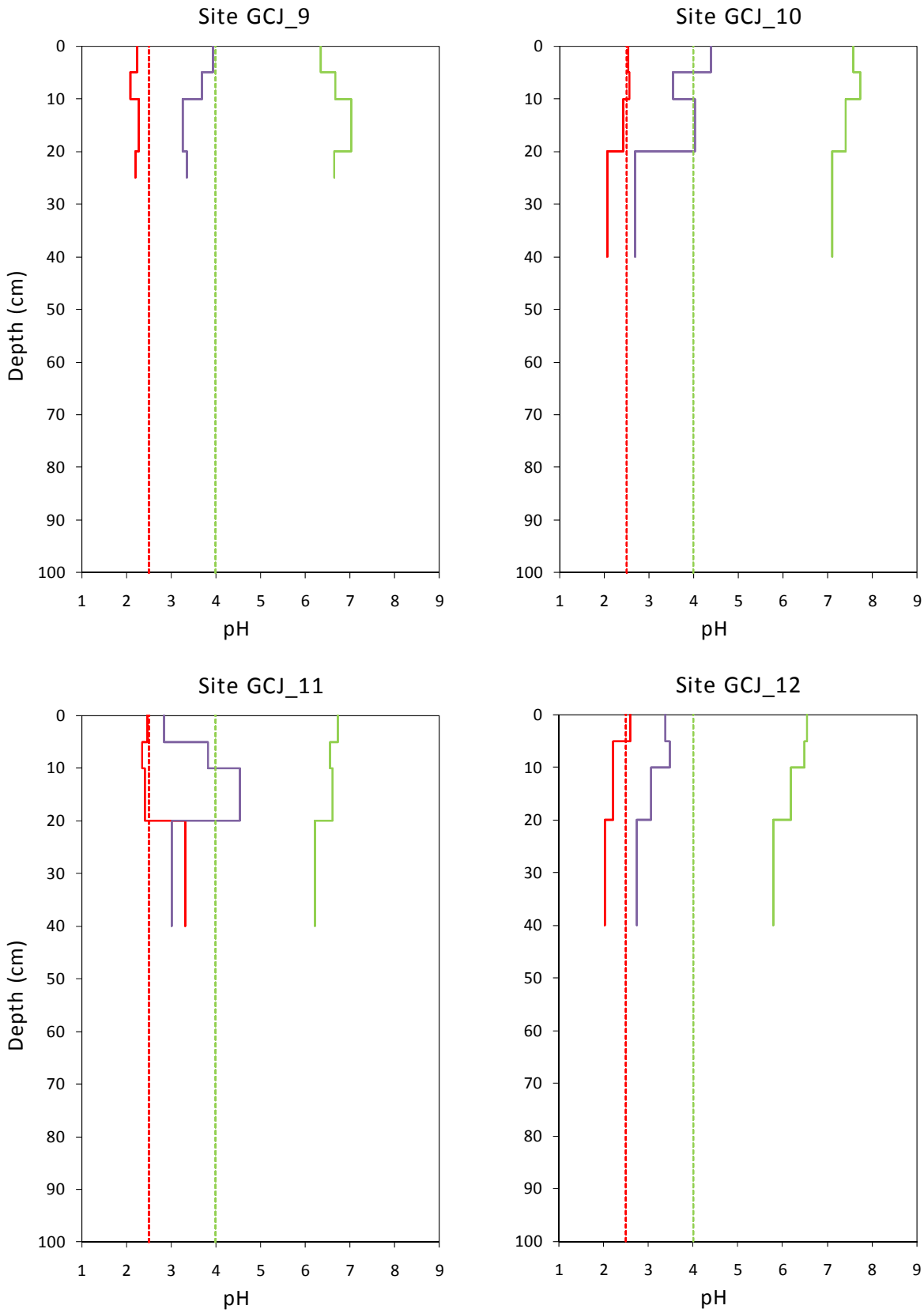

Figure 8-123. Depth profiles of soil pH for sites at Genoe Creek Junction (GCJ_9 – GCJ_12), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

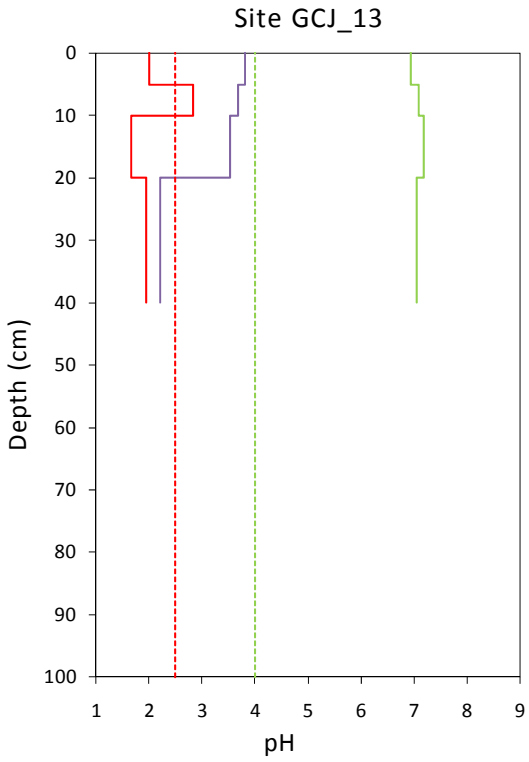

Figure 8-124. Depth profiles of soil pH for sites at Genoe Creek Junction (GCJ_13), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

Acid-base accounting

The acid-base accounting data is provided in Table 8-46 and summarised in Figures 8-125 to 8-127.

Chromium reducible sulfur

Chromium reducible sulfur (S_{CR}) values ranged between < 0.01 and 1.29% S_{CR}. Sulfidic soil materials (i.e. S_{CR} ≥ 0.01% S) were identified in 12 of the 13 soil profiles, with 47 materials of the 56 samples collected equal to or greater than the sulfidic criterion.

Acid volatile sulfide

The acid volatile sulfide (S_{AV}) values ranged between < 0.01 and 1.03% S_{AV}. A total of 39 monosulfidic soil materials (i.e. S_{AV} ≥ 0.01% S) were found in 11 of the 13 soil profiles examined.

Acid neutralising capacity

The acid neutralising capacity (ANC) ranged between zero and 2.64% $CaCO_3$.

Titratable actual acidity

The titratable actual acidity (TAA) ranged between zero and 18 mole H^+/tonne. A slight increase in the TAA with depth was observed in some profiles.

Retained acidity

All soil materials had no retained acidity.

Net acidity

Net acidity ranged between -85 and 590 mole H^+/tonne. The hypersulfidic soils had low to high net acidities ranging between -31 and 590 mole H^+/tonne.

Water Soluble Sulfate

The water soluble sulfate in the surface soils (i.e. 0-20 cm) ranged between 47 and 8,565 mg SO_4/kg. Eleven of the surface soil layers examined had a soluble sulfate content either equal to or exceeding the 100 mg/kg trigger value for MBO formation potential.

Water Data

The surface water data measured in the field are presented in Table 8-47. The field pH of the surface waters collected ranged between 7.3 and 8.1, with only one sample exceeding the most relevant ANZECC/ARMCANZ (2000) trigger value for aquatic ecosystems of 8.0. The water data indicates that the surface water has not been affected by acidification. SEC values were not found to exceed the most relevant ANZECC/ARMCANZ (2000) guideline value.

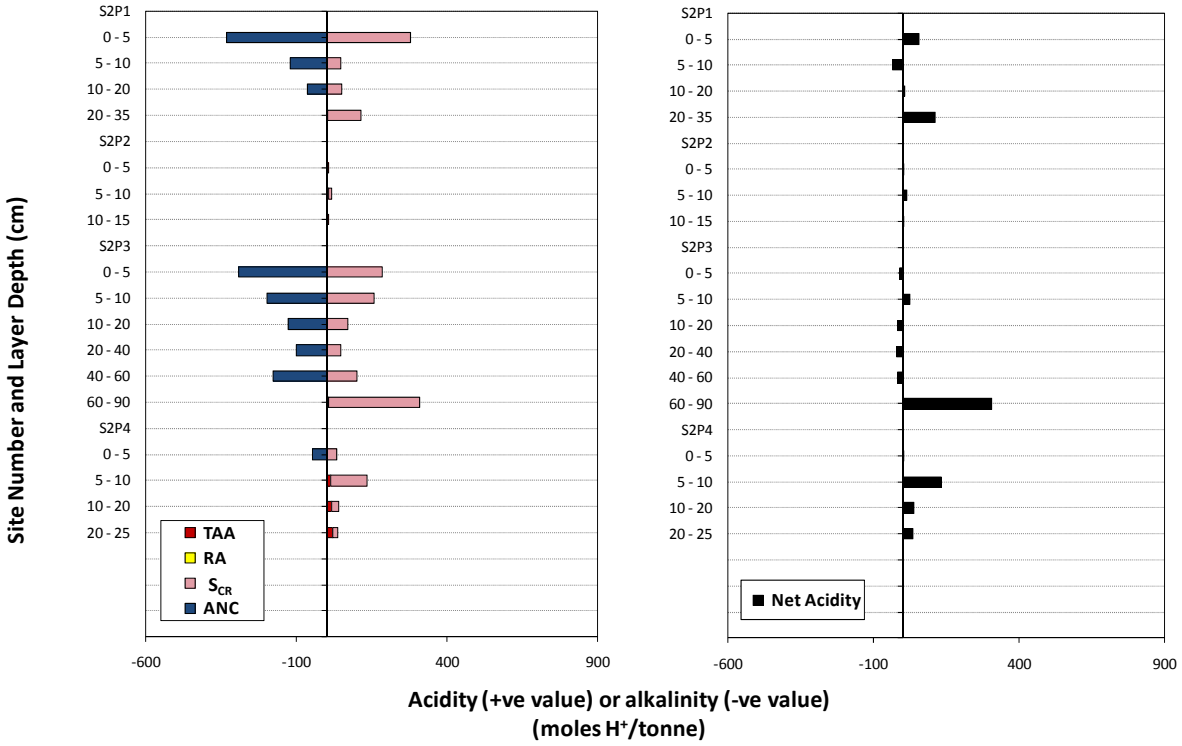

Figure 8-125. Acid-base accounting depth profiles for sites at Genoe Creek Junction (GCJ_1 – GCJ_4). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

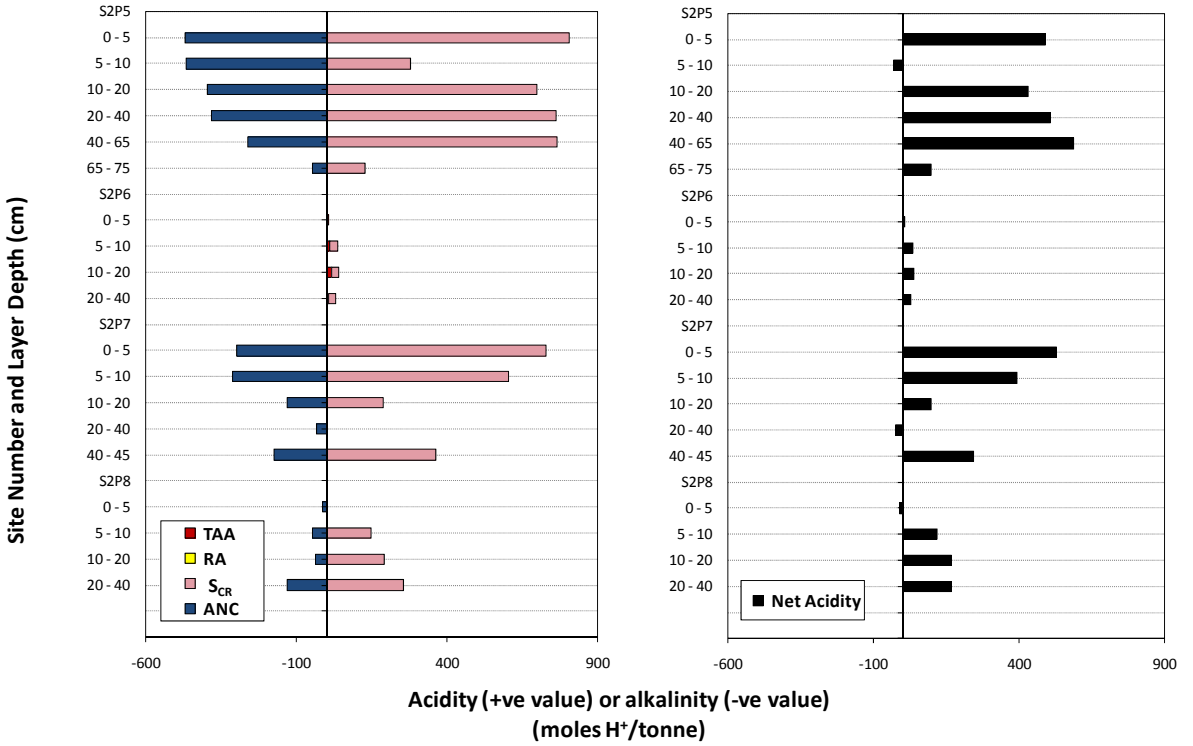

Figure 8-126. Acid-base accounting depth profiles for sites at Genoe Creek Junction (GCJ_5 – GCJ_8). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

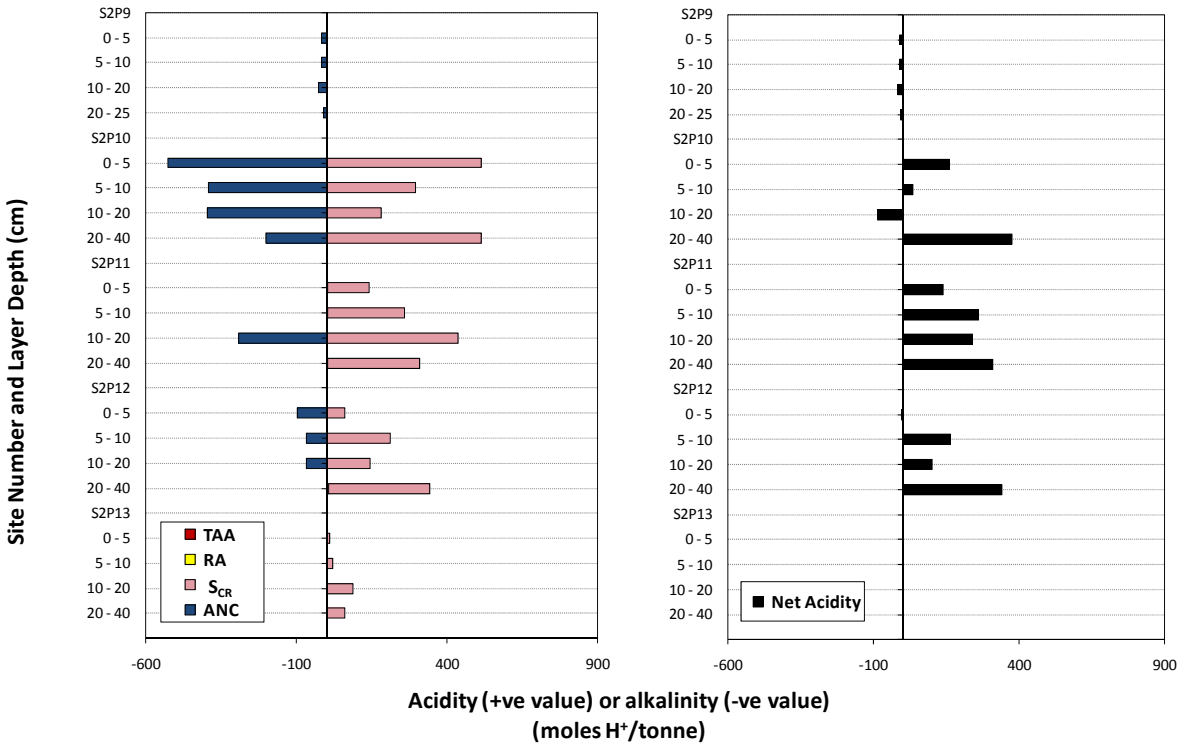

Figure 8-127. Acid-base accounting depth profiles for sites at Genoe Creek Junction (GCJ_9 – GCJ_13). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

8.12.4. Discussion

Acid sulfate soil materials occurred within the soil profile at 12 of the 13 sites examined at Genoe Creek Junction. Sulfuric materials were not observed at Genoe Creek Junction. The presence of reduced inorganic sulfur was identified in 12 profiles (i.e. all except GCJ 9), with a S_{CR} of up to 1.29% S. Hypersulfidic soil materials with low to high net acidities (i.e. -31 - 590 mole H^+/tonne) were present in 12 of the 13 soil profiles examined (three profiles also contained a hyposulfidic material). Monosulfidic soil materials were also observed in 11 of the sulfidic profiles, with S_{AV} contents of up to 1.03% S. Monosulfidic soil materials were observed in the upper 0-10 cm layers in all 11 profiles and often occurred throughout the soil profile. These results indicate that acidity would be produced upon oxidation of the sulfidic materials. Eleven surficial soil materials contained soluble sulfate exceeding the 100 mg/kg trigger value for MBO formation potential. Other acidic soil materials were also observed in five profiles.

Based on the priority ranking criteria adopted by the Scientific Reference Panel of the Murray-Darling Basin Acid Sulfate Soil Risk Assessment Project, there were 12 high priority sites based on hypersulfidic material, two high priority sites based on hyposulfidic material (S_{CR} ≥ 0.10%) and 11 high priority sites based on monosulfidic material. There were two moderate priority sites based on the presence of hyposulfidic material with S_{CR} < 0.10%. In addition, 11 sampling sites had a high priority ranking for Phase 2 detailed assessment based on MBO formation hazard.

The potential hazards posed by acid sulfate soil materials at Genoe Creek Junction are:

- Acidification hazard: At least 22 hypersulfidic materials had high net acidities (i.e. 39% of layers) indicating that the overall degree of acidification hazard is high.

- Deoxygenation hazard: Monosulfidic soil materials (S_{AV} ≤ 1.03% S) observed in the upper 0-10 cm layers at 11 sites represent a high deoxygenation hazard. In addition, the soluble sulfate content of surface soil materials at 11 sites were over the trigger value for MBO formation indicating the possible development of a high deoxygenation hazard at those locations after prolonged wet conditions.

- Metal mobilisation: The high acidification hazard indicates that soil acidification may increase the solubility of metals. The presence of monosulfidic materials in upper soil layers and the potential for MBO formation identified in this channel may also result in a high metal release hazard. This would depend on factors such as the potential for MBO formation and the metal loading in the channel. Soil acidity may be sufficient for mobilisation of aluminium.

Summary of key findings for Genoe Creek Junction:

Soil materials:	Sulfidic soil materials identified included: hypersulfidic (12 profiles), monosulfidic (11 profiles), hyposulfidic ≥ 0.10% (2 profiles) and hyposulfidic < 0.10% (2 profiles). Other acidic soil materials observed in the remaining 1 profile. Low to high net acidities within channel, with several hypersulfidic materials having high net acidities.
Acid sulfate soil identification:	• Sulfidic materials occurred at various depths and for several sites were found throughout the depth profile. Similarly, monosulfides were commonly found at all depths. All sites were subaqueous.
Hazard assessment	• Acidification hazard - high level of concern • Deoxygenation hazard - high level of concern • Metal mobilisation hazard - high level of concern

Table 8-46. Laboratory analytical data for acid sulfate soil assessment of Genoe Creek Junction (Site 2).

(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P1_1	0-5		7.82	2.10	3.55*	699.00	6.51	0.00	0.45	0.00	1.67	57.15	0.24	Hypermonosulfidic
P1_2	5-10		6.61	1.88	4.04*	511.50	6.65	0.00	0.07	0.00	0.60	-33.51	0.06	Hypomonosulfidic
P1_3	10-20		6.10	1.80	3.14*	561.00	6.53	0.00	0.08	0.00	0.31	6.75	0.03	Hypermonosulfidic
P1_4	20-35		5.03	1.19	2.52*	684.00	6.32	4.38	0.17	0.00	0.00	113.13	0.02	Hypermonosulfidic
P2_1	0-5		6.58	2.61	4.28*	186.00	6.35	5.55	0.00	0.00	0.00	5.55	0.00	Other Acid Soils
P2_2	5-10		6.15	2.72	4.42*	154.50	6.05	6.64	0.01	0.00	0.00	15.10	0.01	Hypermonosulfidic#
P2_3	10-15		5.94	3.04	5.30	73.95	6.07	5.14	0.00	0.00	0.00	5.14	0.00	Other Acid Soils
P3_1	0-5		6.88	2.15	2.24*	2985.00	7.68	0.00	0.29	0.00	1.46	-11.14	0.25	Hypermonosulfidic
P3_2	5-10		7.20	3.24	4.50*	1800.00	7.29	0.00	0.25	0.00	1.00	23.79	0.23	Hypermonosulfidic#
P3_3	10-20		6.94	3.16	4.71	1144.50	7.07	0.00	0.11	0.00	0.64	-16.48	0.10	Hypomonosulfidic
P3_4	20-40		6.95	2.19	4.50*	907.50	7.07	0.00	0.08	0.00	0.50	-18.68	0.05	Hypomonosulfidic
P3_5	40-60		6.60	2.68	3.64*	2040.00	6.73	0.00	0.16	0.00	0.89	-17.93	0.05	Hypermonosulfidic
P3_6	60-90		6.33	2.15	2.35*	2595.00	6.27	5.43	0.48	0.00	0.00	307.06	0.05	Hypermonosulfidic
P4_1	0-5		6.08	1.99	3.14	162.00	6.60	0.00	0.05	0.00	0.24	1.32	0.00	Hypersulfidic
P4_2	5-10		5.82	3.08	3.71*	294.00	5.78	12.95	0.19	0.00	0.00	134.23	0.06	Hypermonosulfidic
P4_3	10-20		n/a	n/a	3.87	47.25	5.82	16.21	0.04	0.00	0.00	38.94	0.00	Hypersulfidic#
P4_4	20-25		5.39	3.34	4.32*	43.50	5.63	18.41	0.03	0.00	0.00	36.76	0.00	Hypersulfidic#
P5_1	0-5		7.89	4.15	2.23*	1089.00	7.96	0.00	1.29	0.00	2.36	491.84	0.86	Hypermonosulfidic
P5_2	5-10		7.86	5.27	3.47*	8565.00	8.16	0.00	0.45	0.00	2.33	-31.42	0.20	Hypermonosulfidic
P5_3	10-20		7.63	4.85	2.97*	n/a	7.87	0.00	1.12	0.00	1.98	433.40	0.83	Hypermonosulfidic
P5_4	20-40		7.58	3.68	4.30*	2535.00	7.71	0.00	1.22	0.00	1.92	507.57	0.87	Hypermonosulfidic#
P5_5	40-65		7.19	2.91	2.90*	6420.00	7.22	0.00	1.23	0.00	1.31	589.84	0.92	Hypermonosulfidic
P5_6	65-75		6.96	1.86	2.77*	792.00	7.15	0.00	0.20	0.00	0.23	96.35	0.00	Hypersulfidic
P6_1	0-5		6.71	2.29	4.39*	253.50	6.27	7.12	0.00	0.00	0.00	7.12	0.00	Other Acid Soils
P6_2	5-10		5.66	2.54	3.89*	122.10	6.14	9.83	0.04	0.00	0.00	36.26	0.00	Hypersulfidic
P6_3	10-20		6.25	3.71	4.47*	180.00	5.80	14.98	0.04	0.00	0.00	39.60	0.00	Hypersulfidic#
P6_4	20-40		5.36	5.34	5.51	202.50	5.89	7.63	0.03	0.00	0.00	29.12	0.00	Hypersulfidic#

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). # Classified as hypermonosulfidic/hypersulfidic based on positive net acidity.

Table 8-46 (continued). Laboratory analytical data for acid sulfate soil assessment of Genoe Creek Junction (Site 2).

(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P7_1	0-5		6.64	2.54	2.60*	4440.00	7.22	0.00	1.17	0.00	1.50	528.56	1.03	Hypermonosulfidic
P7_2	5-10		6.76	2.40	2.42*	5175.00	7.07	0.00	0.97	0.00	1.57	393.44	0.68	Hypermonosulfidic
P7_3	10-20		6.81	2.51	2.61*	2985.00	6.95	0.00	0.30	0.00	0.66	99.21	0.26	Hypermonosulfidic
P7_4	20-40		6.70	2.00	2.71*	990.00	7.07	0.00	0.00	0.00	0.17	-22.51	0.00	Other Acid Soils
P7_5	40-45		6.62	2.44	4.14*	2700.00	6.81	0.00	0.58	0.00	0.87	245.25	0.54	Hypermonosulfidic#
P8_1	0-5		6.62	1.70	3.74	88.20	6.89	0.00	0.00	0.00	0.07	-9.39	0.00	Other Acid Soils
P8_2	5-10		6.60	1.77	3.86	292.50	6.72	0.00	0.24	0.00	0.24	117.23	0.11	Hypermonosulfidic
P8_3	10-20		6.39	1.86	3.20*	363.00	6.58	0.00	0.31	0.00	0.18	167.56	0.24	Hypermonosulfidic
P8_4	20-40		6.83	2.20	5.67*	277.50	6.61	0.00	0.41	0.00	0.66	166.05	0.00	Hypersulfidic#
P9_1	0-5		6.34	2.24	3.93*	54.00	6.79	0.00	0.00	0.00	0.08	-10.38	0.00	Other Acid Soils
P9_2	5-10		6.66	2.09	3.70*	56.25	6.83	0.00	0.00	0.00	0.08	-11.16	0.00	Other Acid Soils
P9_3	10-20		7.02	2.28	3.26*	58.95	6.78	0.00	0.00	0.00	0.14	-18.40	0.00	Other Acid Soils
P9_4	20-25		6.64	2.20	3.35*	64.95	6.66	0.00	0.00	0.00	0.05	-6.52	0.00	Other Acid Soils
P10_1	0-5		7.57	2.55	4.39*	4080.00	7.23	0.00	0.82	0.00	2.64	162.26	0.76	Hypermonosulfidic#
P10_2	5-10		7.73	2.57	3.54*	n/a	7.57	0.00	0.47	0.00	1.96	34.70	0.32	Hypermonosulfidic
P10_3	10-20		7.40	2.44	4.04*	2655.00	7.25	0.00	0.29	0.00	1.99	-84.84	0.14	Hypomonosulfidic
P10_4	20-40		7.10	2.07	2.69*	4260.00	7.09	0.00	0.82	0.00	1.02	377.48	0.32	Hypermonosulfidic
P11_1	0-5		6.73	2.46	2.84*	6375.00	6.49	2.48	0.22	0.00	0.00	140.02	0.22	Hypermonosulfidic
P11_2	5-10		6.56	2.36	3.83*	4605.00	6.46	3.71	0.41	0.00	0.00	259.79	0.39	Hypermonosulfidic
P11_3	10-20		6.62	2.42	4.53*	3690.00	6.51	0.00	0.70	0.00	1.47	241.87	0.62	Hypermonosulfidic#
P11_4	20-40		6.21	3.32	3.01*	2715.00	6.48	2.37	0.49	0.00	0.00	308.71	0.46	Hypermonosulfidic
P12_1	0-5		6.55	2.60	3.38*	939.00	6.78	0.00	0.10	0.00	0.49	-4.29	0.10	Hypermonosulfidic
P12_2	5-10		6.49	2.22	3.48*	963.00	6.85	0.00	0.34	0.00	0.34	165.07	0.24	Hypermonosulfidic
P12_3	10-20		6.18	2.21	3.06*	1269.00	6.50	0.00	0.23	0.00	0.34	100.28	0.08	Hypermonosulfidic
P12_4	20-40		5.80	2.02	2.75*	837.00	6.39	4.90	0.54	0.00	0.00	342.22	0.12	Hypermonosulfidic
P13_1	0-5		6.93	2.01	3.82*	n/a	n/a	n/a	0.01	n/a	n/a	n/a	0.01	Hypermonosulfidic
P13_2	5-10		7.09	2.84	3.69*	n/a	n/a	n/a	0.03	n/a	n/a	n/a	0.03	Hypermonosulfidic
P13_3	10-20		7.19	1.66	3.53*	n/a	n/a	n/a	0.14	n/a	n/a	n/a	0.03	Hypermonosulfidic
P13_4	20-40		7.05	1.95	2.22	n/a	n/a	n/a	0.09	n/a	n/a	n/a	0.02	Hypermonosulfidic

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). # Classified as hypermonosulfidic/hypersulfidic based on positive net acidity.

Table 8-47. Field hydrochemistry data for acid sulfate soil assessment of Genoe Creek Junction (Site 2).

Site ID.	Depth (m)	Specific Electrical Conductivity (µS/cm)	pH
*Lowland River**		*125-2,220*	*6.5-8.0*
GCJ_1	0.1	714	7.73
GCJ _1	1.5	706	7.56
GCJ _1	2.0	709	7.48
GCJ _10	0.1	682	8.12
GCJ _10	1.1	711	7.75
GCJ _10	2.0	739	7.33

* ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for relevant parameters (ANZECC/ARMCANZ, 2000).
Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text.

Table 8-48. Profile description data for acid sulfate soil assessment of Genoe Creek Junction (Site 2).

Site and Sample No.	Horizon Depth Range (cm)	Sediment	Organics	Colour	Eh (mV)	pH
P1_1	0-5	Mud	Much, Debris	10YR2/1	-74	6.59
P1_2	5-10	Muddy Sand	Much, Debris	10YR2/1	-99	6.52
P1_3	10-20	Medium Sand	Much, Debris	10YR2/1	-300	6.22
P1_4	20-35	Medium Sand	None	Sand	-144	6.92
P2_1	0-5	Muddy Sand	Much Debris	10YR2/1	-161	6.93
P2_2	5-10	Muddy Sand	Much Debris	10YR2/1	-44	6.64
P2_3	10-15	Muddy Sand	Much Debris	Sand	-73	6.53
P3_1	0-5	Mud	Much, Debris	Sand	-102	6.82
P3_2	5-10	Mud	Much, Debris	Sand	-126	6.71
P3_3	10-20	Muddy Sand	Some	Sand	-123	6.64
P3_4	20-40	Medium Sand	Some	Sand	-112	6.67
P3_5	40-60	Medium Sand	Some	Sand	-132	6.51
P3_6	60-90	Clayey Medium Sand	Some	Sand	-103	6.29
P4_1	0-5	Muddy Medium Sand	Much, Debris	Sand	-106	6.83
P4_2	5-10	Fine to Medium Sand	Some	Sand	-104	6.72
P4_3	10-20	Clayey Medium Sand	Some	Sand	-122	6.51
P4_4	20-25	Clayey Medium Sand	None	Sand	-83	6.21
P5_1	0-5	Mud	Much, Debris	10YR2/1	-101	6.74
P5_2	5-10	Mud	Much, Debris	10YR2/1	-109	6.76
P5_3	10-20	Mud	Much, Debris	10YR2/1	-100	6.79
P5_4	20-40	Mud	Much, Debris	10YR2/1	-115	6.56
P5_5	40-65	Mud	Much, Debris	10YR2/1	-109	6.49
P5_6	65-75	Very Coarse Sand	Much, Debris		-65	6.65
P6_1	0-5	Muddy Sand	Much, Debris	10YR2/1	-86	6.88
P6_2	5-10	Clayey Fine Sand	Some	10YR6/1	-105	6.67
P6_3	10-20	Clayey Fine Sand	Some	10YR6/1	-120	6.53
P6_4	20-40	Clayey Fine Sand (Gley)	None	10YR6/1	-76	6.27
P7_1	0-5	Mud	Some	10YR2/1	-66	6.51
P7_2	5-10	Mud	Some	10YR2/1	-81	6.52
P7_3	10-20	Mud	Some	10YR2/1	-82	6.49

Table 8-48 (continued). Profile description data for acid sulfate soil assessment of Genoe Creek Junction (Site 2).

Site and Sample No.	Horizon Depth Range (cm)	Sediment	Organics	Colour	Eh (mV)	pH
P7_4	20-40	Medium-Coarse Sand (Muddy)	Some	10YR2/1	-69	6.5
P7_5	40-45	Medium-Coarse Sand (Muddy)	Some	10YR2/1	-132	6.49
P8_1	0-5	Very Coarse Sand	Much, Debris	Sand	-49	6.8
P8_2	5-10	Very Coarse Sand	Much, Debris	Sand	-86	6.85
P8_3	10-20	Very Coarse Sand	Much, Debris	Sand	-76	6.5
P8_4	20-40	Very Coarse Silty Sand	Much, Debris	Sand	-41	6.49
P9_1	0-5	Coarse Sand	None	Sand	84	6.67
P9_2	5-10	Coarse Sand	Much, Debris	Sand	93	6.4
P9_3	10-20	Coarse Sand	Much, Debris	Sand	52	6.81
P9_4	20-25	Coarse Sand	Much, Debris	Sand	96	7.06
P10_1	0-5	Mud	Some	10YR2/1	117	7.15
P10_2	5-10	Mud	Some	10YR2/1	117	7.2
P10_3	10-20	Mud	Some	10YR2/1	118	6.92
P10_4	20-40	Muddy Sand	Some	10YR2/1	141	6.76
P11_1	0-5	Mud	Some	10YR2/1	-132	6.73
P11_2	5-10	Mud	Some	10YR2/1	-164	6.58
P11_3	10-20	Mud	Some	10YR2/1	-161	6.67
P11_4	20-40	Sandy Mud	Some	10YR2/1	-230	6.51
P12_1	0-5	Mud	Some	10YR2/1	-168	6.62
P12_2	5-10	Sandy Mud	Some	10YR2/1	-154	6.56
P12_3	10-20	Sandy Mud	Some	10YR2/1	-121	6.44
P12_4	20-40	Sandy Mud	Some	10YR2/1	-169	6.42
P13_1	0-5	Mud	Some	10YR2/1	-134	7.11
P13_2	5-10	Medium Sand Mud	Some	Sand	-196	7.14
P13_3	10-20	Medium Sand	None	Sand	-140	6.93
P13_4	20-40	Medium Sand	None	Sand	-113	6.88

8.13. Mallan Bridge (Downstream) (Site 3)

8.13.1. Location and setting description

This site was located upstream of a bend in a low flow channel approximately 20 – 30 m wide with steep-sided banks (Figure 8-128). The channel at this site contains submerged logs and reeds with water depth ranging from 0.6 – 2.0 m. Vegetation on the banks consisted of tall river red gum woodland along the banks and mixed black box and river red gum woodland with saltbush and lignum understorey on the floodplain. Twelve profiles were sampled in duplicate. The pH of the channel sediments were predominantly neutral to slightly acidic.

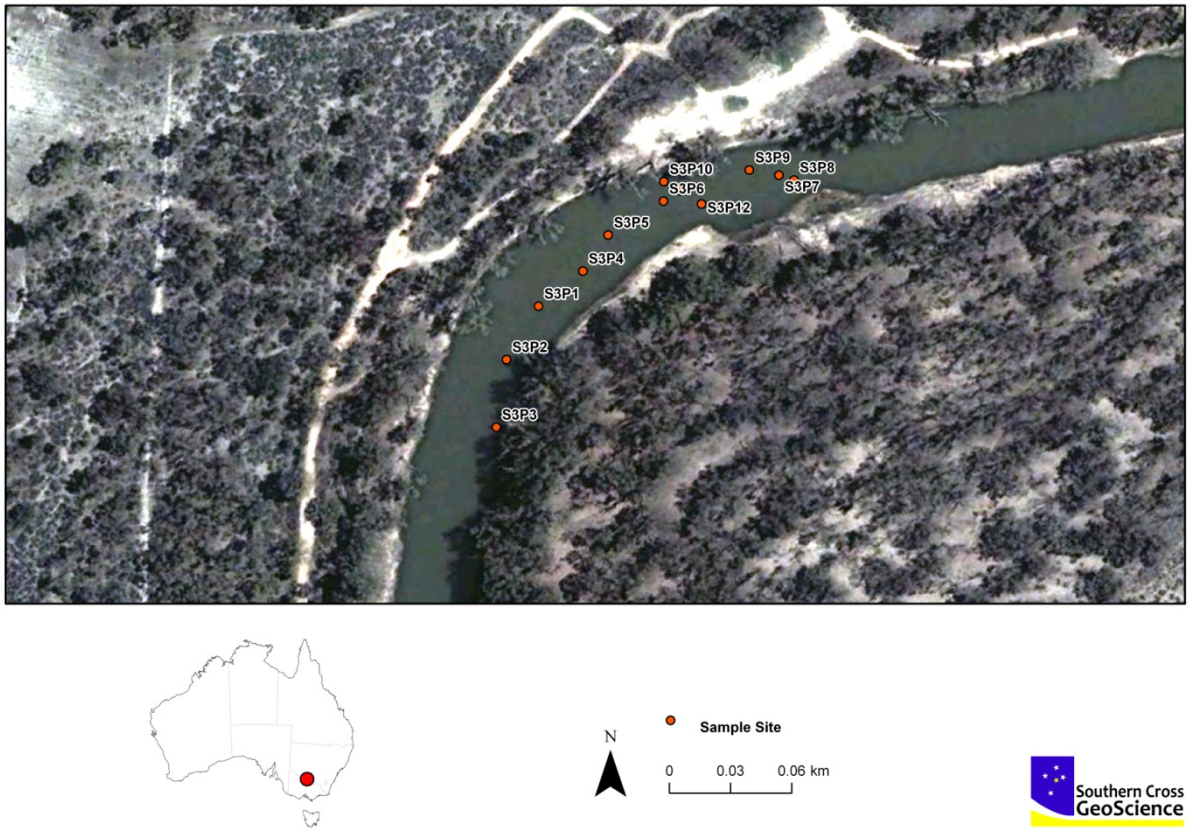

Figure 8-128. Mallan Bridge and sample site locations.

8.13.2. Soil profile description and distribution

Twelve profiles were described and sampled at Mallan Bridge. The soil subtype and general location description are presented in Table 8-49. Profile description data are presented in Table 8-52.

Table 8-49. Soil identification, subtype and general location description for sites sampled at Mallan Bridge.

Site ID	Easting UTM Zone 54H	Northing UTM Zone 54H	Acid sulfate soil subtype class
MB_1	744336	6109094	Hypersulfidic Subaqueous Soil with Monosulfides
MB_2	744322	6109068	Hypersulfidic Subaqueous Soil with Monosulfides
MB_3	744324	6109035	Hypersulfidic Subaqueous Soil with Monosulfides
MB_4	744354	6109111	Hypersulfidic Subaqueous Soil with Monosulfides
MB_5	744365	6109128	Subaqueous Soil
MB_6	744387	6109144	Subaqueous Soil
MB_7	744434	6109156	Hypersulfidic Subaqueous Soil
MB_8	744440	6109153	Subaqueous Soil
MB_9	744422	6109158	Subaqueous Soil
MB_10	744388	6109154	Hypersulfidic Subaqueous Soil with Monosulfides
MB_11	744394	6109149	Subaqueous Soil
MB_12	744403	6109142	Hypersulfidic Subaqueous Soil

Figure 8-129. Site 3, Mallan Bridge (upstream view).

Figure 8-130. Site 3, Mallan Bridge (downstream view).

8.13.3. Laboratory data assessment

Soil pH testing (pH_W, pH_{FOX}, pH_{KCl}, $pH_{INCUBATION}$)

The pH data is provided in Table 8-50 and depth profiles of soil pH for all the sites sampled are presented in Figures 8-131 to 8-133. The pH_W values ranged between 6.00 and 8.08. No sulfuric materials (i.e. $pH_W < 4$) were present at Mallan Bridge. The pH_{FOX} values ranged between 1.13 and 3.92. The pH_{FOX} results indicate that all the surface soils may have the potential to acidify to pH < 4 as a result of sulfide oxidation. Twenty-seven soil materials had a $pH_{FOX} < 2.5$ suggesting that soil acidity problems will emerge when these soils are exposed to air. The S_{CR} data shows only 22 of the 50 layers examined contained detectable sulfide (i.e. $S_{CR} \geq 0.01\%$ S). The pH_{KCl} values ranged between 5.13 and 7.41. Eighteen of the sulfidic soil materials (i.e. $S_{CR} \geq 0.01\%$ S) acidified to pH < 4 after at least 8 weeks of incubation. Other acidic soil materials were identified in nine of the 12 profiles examined, indicating acidity in the soil profile at levels where aluminium may mobilise. Sixteen of the other acidic soils acidified to pH < 4 after at least 8 weeks of incubation.

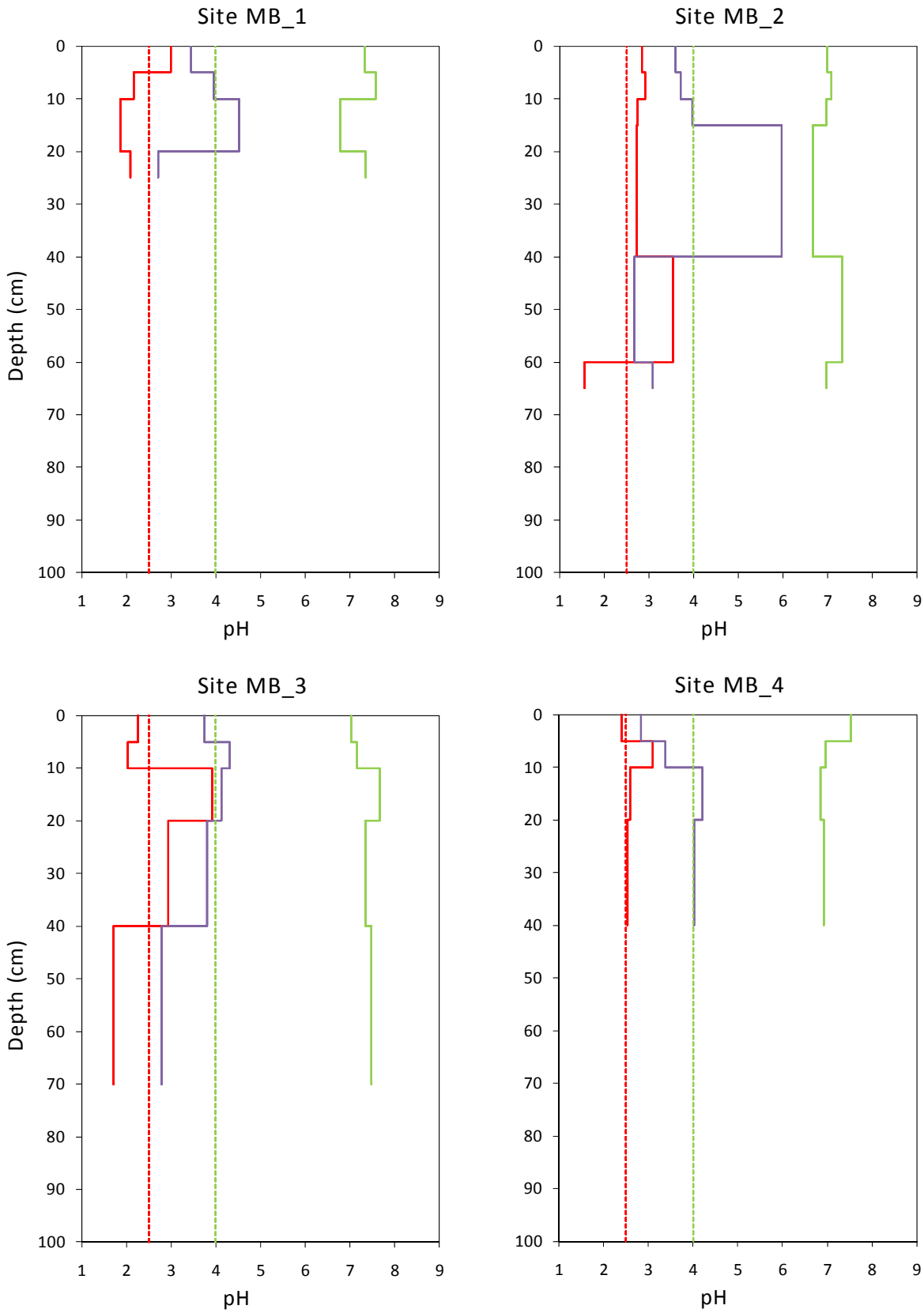

Figure 8-131. Depth profiles of soil pH for sites at Mallan Bridge (MB_1 – MB_4), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

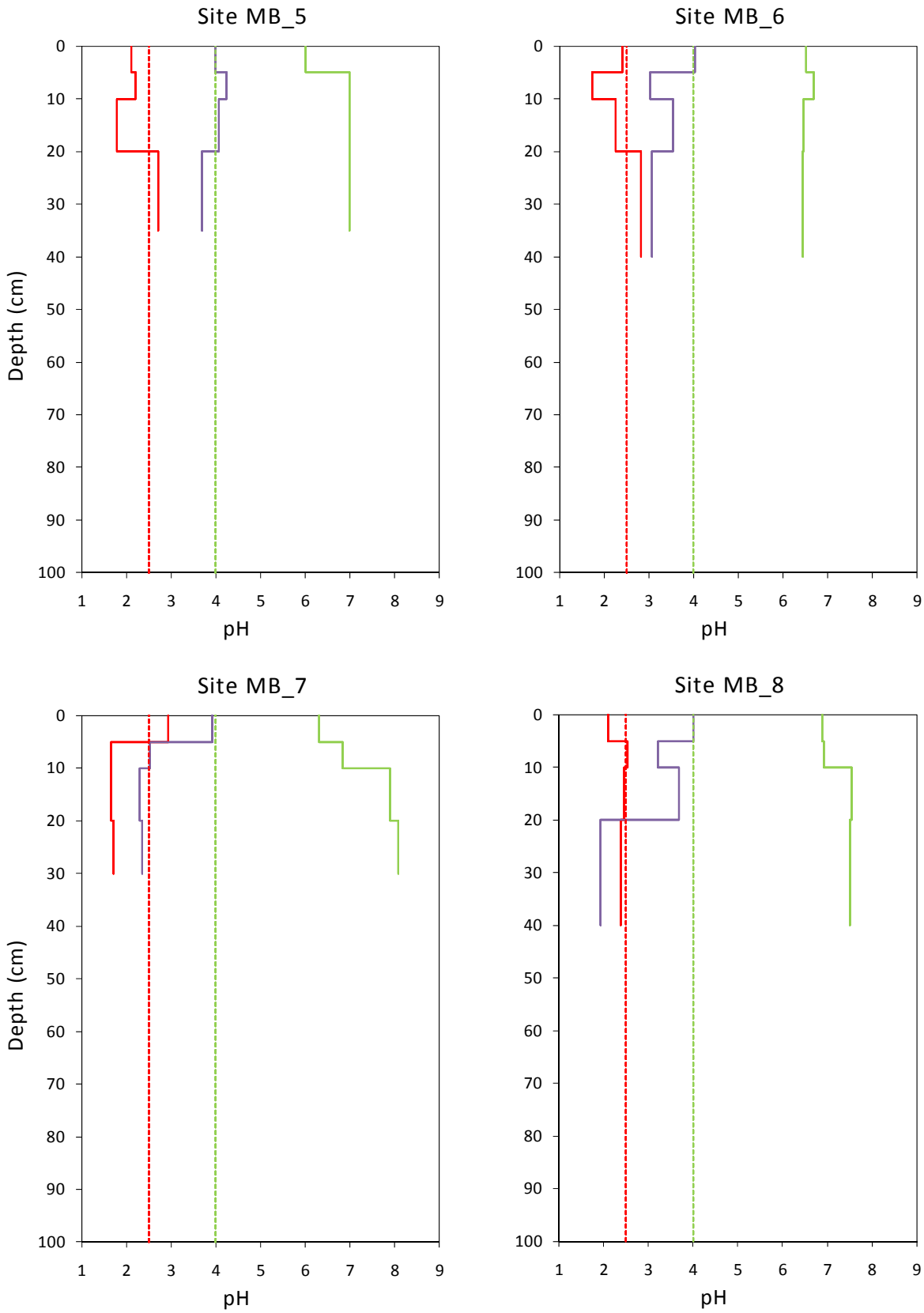

Figure 8-132. Depth profiles of soil pH for sites at Mallan Bridge (MB_5 – MB_8), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

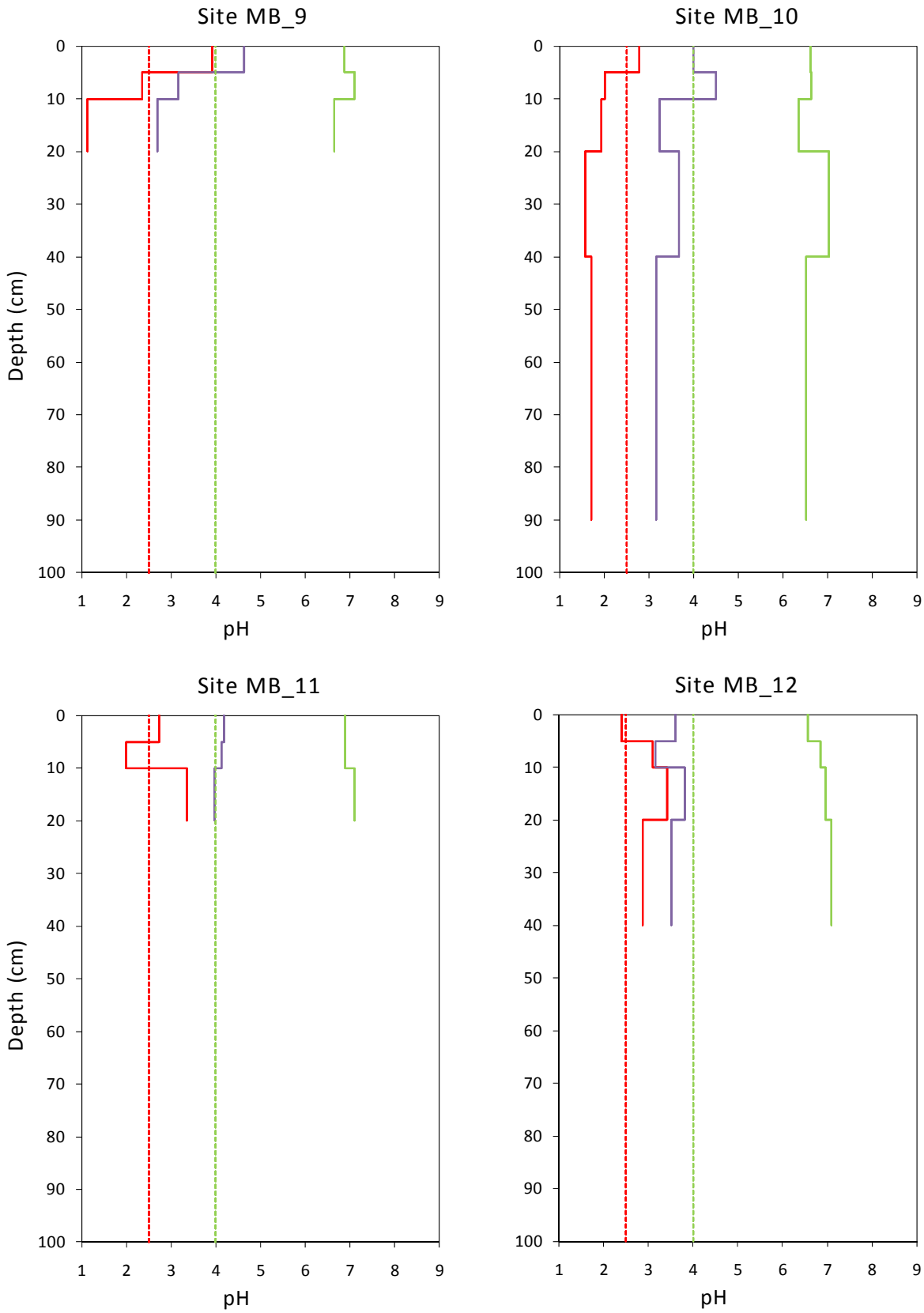

Figure 8-133. Depth profiles of soil pH for sites at Mallan Bridge (MB_9 – MB_12), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

Acid-base accounting

The acid-base accounting data is provided in Table 8-50 and summarised in Figures 8-134 to 8-136.

Chromium reducible sulfur

Chromium reducible sulfur (S_{CR}) values ranged between < 0.01 and 0.78% S_{CR}. Sulfidic soil materials (i.e. S_{CR} ≥ 0.01% S) were identified in seven of the 12 soil profiles, with 22 materials of the 50 samples collected equal to or greater than the sulfidic criterion.

Acid volatile sulfide

The acid volatile sulfide (S_{AV}) values ranged between < 0.01 and 0.72% S_{AV}. A total of 15 monosulfidic soil materials (i.e. S_{AV} ≥ 0.01% S) were found in five of the 12 soil profiles examined.

Acid neutralising capacity

The acid neutralising capacity (ANC) ranged between zero and 1.36% $CaCO_3$.

Titratable actual acidity

The titratable actual acidity (TAA) ranged between zero and 23 mole H^+/tonne. A decrease in the TAA with depth was observed in some profiles.

Retained acidity

All soil materials had no retained acidity.

Net acidity

Net acidity ranged between -32 and 503 mole H^+/tonne. The 22 hypersulfidic soils had low to high net acidities ranging between 11 and 503 mole H^+/tonne.

Water Soluble Sulfate

The water soluble sulfate in the surface soils (i.e. 0-20 cm) ranged between 45 and 2,100 mg SO_4/kg. The surface soil layers at ten of the 12 examined had a soluble sulfate content exceeding the 100 mg/kg trigger value for MBO formation potential.

Water Data

The surface water data measured in the field are presented in Table 8-51. The field pH of the surface waters collected ranged between 7.1 and 7.4, with no samples outside the most relevant ANZECC/ARMCANZ (2000) trigger values for aquatic ecosystems. The water data indicates that the surface water has not been affected by acidification. SEC values were not found to exceed the most relevant ANZECC/ARMCANZ (2000) guideline value.

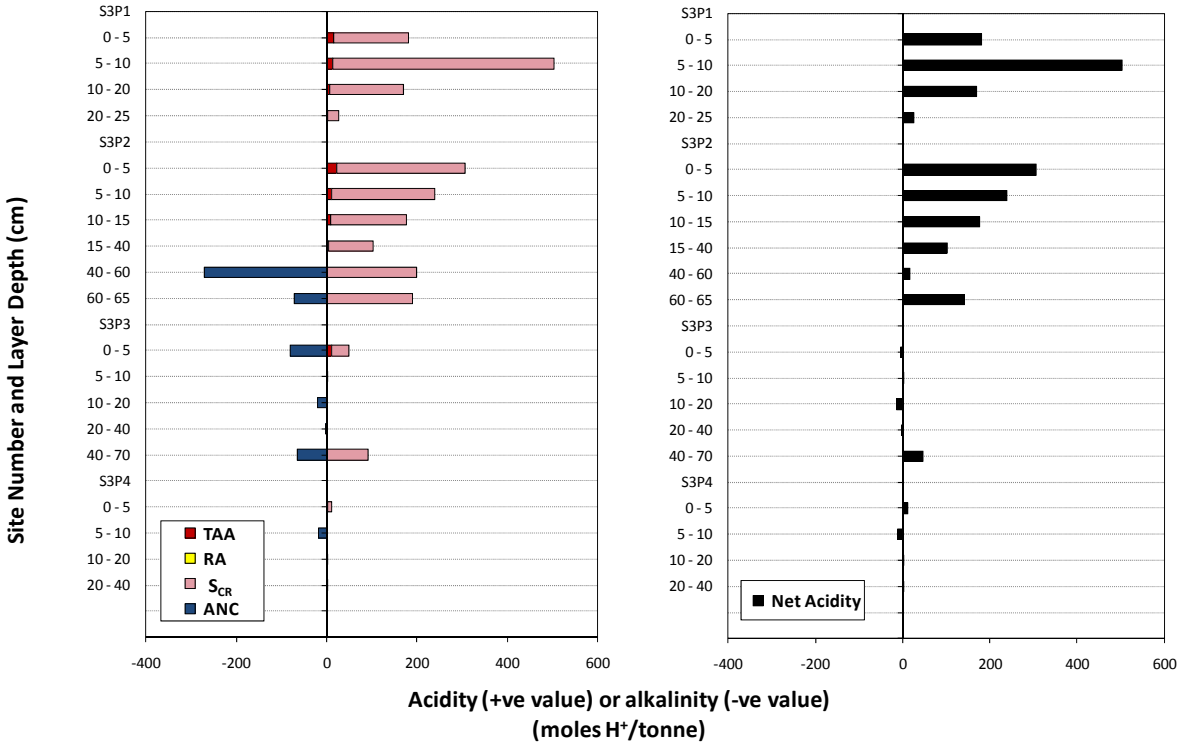

Figure 8-134. Acid-base accounting depth profiles for sites at Mallan Bridge (MB_1 – MB_4). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

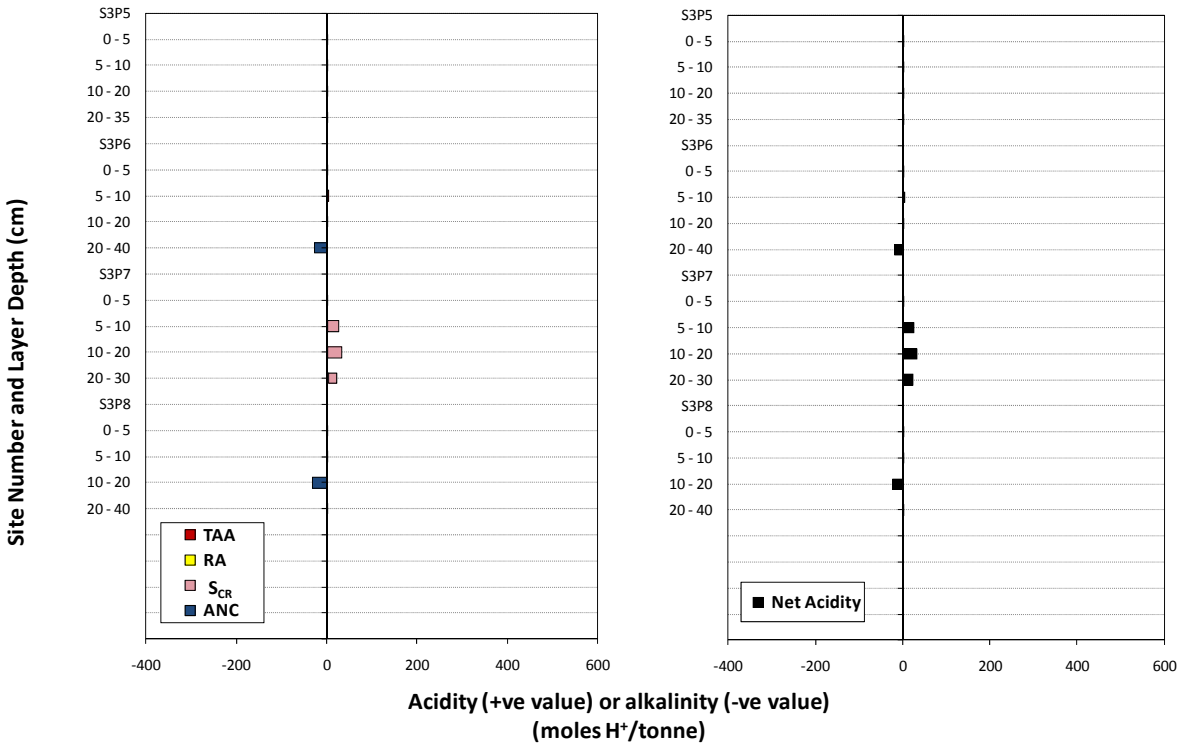

Figure 8-135. Acid-base accounting depth profiles for sites at Mallan Bridge (MB_5 – MB_8). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

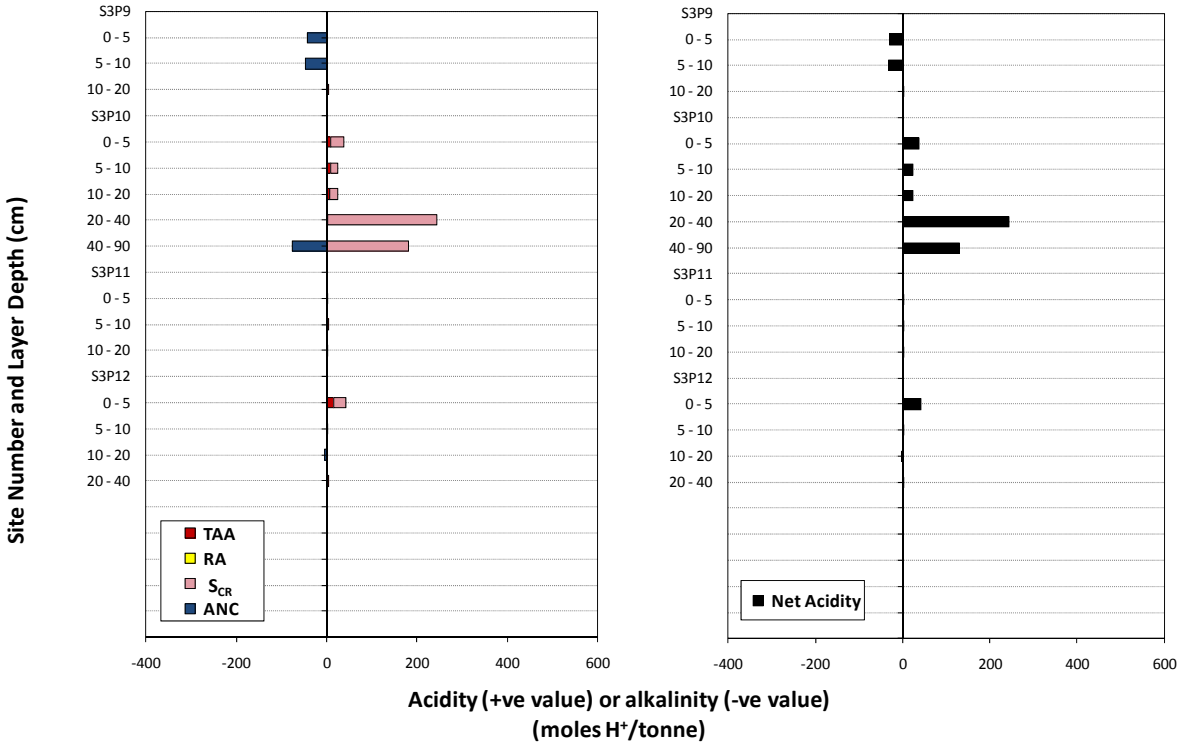

Figure 8-136. Acid-base accounting depth profiles for sites at Mallan Bridge (MB_9 – MB_12). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

8.13.4. Discussion

Acid sulfate soil materials occurred within the soil profile at seven of the 12 sites examined at Mallan Bridge. Sulfuric materials were not observed at Mallan Bridge. The presence of reduced inorganic sulfur was identified at seven sites, and throughout the profile at three sites (i.e. MB_1, MB_2 and MB_10), with a S_{CR} of up to 0.78% S. Hypersulfidic soil materials with low to high net acidities (i.e. 11 - 503 mole H^+/tonne) were present in seven of the 12 soil profiles examined. Monosulfidic soil materials were also observed in five of the sulfidic profiles, with S_{AV} contents of up to 0.72% S. Monosulfidic soil materials (S_{AV} ≤ 0.72% S) were observed in the upper 0-10 cm layers in the five profiles. These results indicate that acidity would be produced upon oxidation of the sulfidic materials. The surficial soil materials in ten profiles contained soluble sulfate exceeding the 100 mg/kg trigger value for MBO formation potential. Other acidic soil materials were also observed in nine profiles.

Based on the priority ranking criteria adopted by the Scientific Reference Panel of the Murray-Darling Basin Acid Sulfate Soil Risk Assessment Project, there were seven high priority sites based on hypersulfidic material and five high priority sites based on monosulfidic material. Ten sampling sites had a high priority ranking for Phase 2 detailed assessment based on MBO formation hazard.

The potential hazards posed by acid sulfate soil materials at the Mallan Bridge sites are:

- Acidification hazard: While low-moderate net acidities were dominant in this channel, several hypermonosulfidic materials had high net acidities (i.e. 20% of layers), indicating that the overall degree of acidification hazard is high.

- Deoxygenation hazard: Monosulfidic soil materials (S_{AV} ≤ 0.72% S) observed in the upper 0-10 cm layers at five sites represent a high deoxygenation hazard. In addition, the soluble sulfate content of surface soil materials at ten sites were over the trigger value for MBO formation indicating the possible development of a high deoxygenation hazard at those locations after prolonged wet conditions.

- Metal mobilisation: The high acidification hazard indicates that soil acidification may increase the solubility of metals. The presence of monosulfidic materials in upper soil layers and the potential for MBO formation identified in this channel may also result in a high metal release hazard. This would depend on factors such as the potential for MBO formation and the metal loading in the channel. Soil acidity may be sufficient for mobilisation of aluminium.

Summary of key findings for Mallan Bridge:

Soil materials:	Sulfidic soil materials identified included: hypersulfidic (7 profiles), and monosulfidic (5 profiles). Other acidic materials identified at the remaining 5 profiles. Low-moderate net acidities dominant within channel, although several hypermonosulfidic soil materials had high net acidities.
Acid sulfate soil identification:	• Sulfidic and monosulfidic materials were recorded at all depths, and at some sites were found throughout the depth profile. All sites were subaqueous.
Hazard assessment	• Acidification hazard - high level of concern • Deoxygenation hazard - high level of concern • Metal mobilisation hazard - high level of concern

Table 8-50. Laboratory analytical data for acid sulfate soil assessment of Mallan Bridge (Site 3).

(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P1_1	0-5		7.32	2.99	3.45	1860.00	5.70	14.56	0.27	0.00	0.00	181.21	0.24	Hypermonosulfidic
P1_2	5-10		7.58	2.17	3.96*	2100.00	6.04	13.94	0.78	0.00	0.00	502.87	0.72	Hypermonosulfidic
P1_3	10-20		6.79	1.86	4.52	496.50	6.12	6.34	0.26	0.00	0.00	169.21	0.23	Hypermonosulfidic#
P1_4	20-35		7.35	2.10	2.71	330.00	6.26	2.58	0.04	0.00	0.00	26.14	0.02	Hypermonosulfidic
P2_1	0-5		6.99	2.85	3.59	1303.50	5.46	22.73	0.46	0.00	0.00	306.68	0.38	Hypermonosulfidic
P2_2	5-10		7.08	2.92	3.71*	1575.00	5.86	11.33	0.37	0.00	0.00	239.10	0.34	Hypermonosulfidic
P2_3	10-15		6.97	2.75	3.97	771.00	5.95	9.01	0.27	0.00	0.00	176.16	0.20	Hypermonosulfidic
P2_4	15-40		6.67	2.73	5.98*	165.00	6.27	3.20	0.16	0.00	0.00	102.06	0.13	Hypermonosulfidic#
P2_5	40-60		7.33	3.55	2.68*	627.00	7.32	0.00	0.32	0.00	1.36	17.38	0.07	Hypermonosulfidic
P2_6	60-65		6.97	1.56	3.09*	396.00	7.02	0.00	0.30	0.00	0.36	141.20	0.01	Hypermonosulfidic
P3_1	0-5		7.02	2.26	3.74*	615.00	5.87	11.83	0.06	0.00	0.00	38.14	0.04	Hypermonosulfidic
P3_2	5-10		7.16	2.04	4.32	113.25	6.19	2.38	0.00	0.00	0.00	2.38	0.00	Other Acid Soils
P3_3	10-20		7.67	3.91	4.12*	53.10	6.56	0.00	0.00	0.00	0.10	-13.29	0.00	Other Acid Soils
P3_4	20-40		7.34	2.94	3.80*	40.05	6.97	0.00	0.00	0.00	0.01	-1.30	0.00	Other Acid Soils
P3_5	40-70		7.48	1.72	2.78	153.00	7.41	0.00	0.15	0.00	0.33	46.87	0.00	Hypersulfidic
P4_1	0-5		7.53	2.41	2.83	102.15	6.24	2.46	0.01	0.00	0.00	11.29	0.01	Hypermonosulfidic
P4_2	5-10		6.97	3.10	3.39*	61.65	6.70	0.00	0.00	0.00	0.09	-11.77	0.00	Other Acid Soils
P4_3	10-20		6.84	2.59	4.22	68.70	6.31	2.86	0.00	0.00	0.00	2.86	0.00	Other Acid Soils
P4_4	20-40		6.93	2.54	4.03	64.50	6.23	2.66	0.00	0.00	0.00	2.66	0.00	Other Acid Soils
P5_1	0-5		6.00	2.11	4.00*	74.85	6.32	3.12	0.00	0.00	0.00	3.12	0.00	Other Acid Soils
P5_2	5-10		6.99	2.21	4.23*	98.85	6.33	2.32	0.00	0.00	0.00	2.32	0.00	Other Acid Soils
P5_3	10-20		6.99	1.79	4.06	111.15	6.04	3.12	0.00	0.00	0.00	3.12	0.00	Other Acid Soils
P5_4	20-35		6.98	2.72	3.69	71.55	6.34	2.14	0.00	0.00	0.00	2.14	0.00	Other Acid Soils
P6_1	0-5		6.51	2.42	4.03*	95.85	6.44	1.92	0.00	0.00	0.00	1.92	0.00	Other Acid Soils
P6_2	5-10		6.68	1.73	3.04	117.75	5.91	4.30	0.00	0.00	0.00	4.30	0.00	Other Acid Soils
P6_3	10-20		6.46	2.27	3.54*	76.80	6.07	2.64	0.00	0.00	0.00	2.64	0.00	Other Acid Soils
P6_4	20-40		6.45	2.82	3.08*	69.30	6.64	0.00	0.00	0.00	0.13	-17.35	0.00	Other Acid Soils

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). # Classified as hypermonosulfidic based on positive net acidity.

Table 8-50 (continued). Laboratory analytical data for acid sulfate soil assessment of Mallan Bridge (Site 3).

(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P7_1	0-5		6.31	2.93	3.92*	64.65	6.23	2.55	0.00	0.00	0.00	2.55	0.00	Other Acid Soils
P7_2	5-10		6.84	1.65	2.53	94.95	6.09	2.21	0.04	0.00	0.00	25.72	0.00	Hypersulfidic
P7_3	10-20		7.90	1.66	2.30	98.55	6.37	1.92	0.05	0.00	0.00	33.95	0.00	Hypersulfidic
P7_4	20-30		8.08	1.72	2.36	103.20	6.19	3.59	0.03	0.00	0.00	22.95	0.00	Hypersulfidic
P8_1	0-5		6.89	2.10	4.01	118.20	5.83	2.92	0.00	0.00	0.00	2.92	0.00	Other Acid Soils
P8_2	5-10		6.92	2.54	3.21	80.55	6.17	1.94	0.00	0.00	0.00	1.94	0.00	Other Acid Soils
P8_3	10-20		7.55	2.46	3.69	64.95	6.61	0.00	0.00	0.00	0.16	-21.79	0.00	Other Acid Soils
P8_4	20-40		7.50	2.39	1.94	166.50	6.28	1.55	0.00	0.00	0.00	1.55	0.00	Other Acid Soils
P9_1	0-5		6.87	3.92	4.63*	57.00	6.68	0.00	0.00	0.00	0.22	-28.79	0.00	Other Acid Soils
P9_2	5-10		7.11	2.36	3.17*	90.75	6.61	0.00	0.00	0.00	0.24	-32.22	0.00	Other Acid Soils
P9_3	10-20		6.64	1.13	2.69	133.65	5.53	3.91	0.00	0.00	0.00	3.91	0.00	Other Acid Soils
P10_1	0-5		6.62	2.78	4.00*	306.00	5.55	9.82	0.05	0.00	0.00	38.46	0.02	Hypermonosulfidic#
P10_2	5-10		6.63	2.02	4.50	184.50	5.66	9.00	0.02	0.00	0.00	23.76	0.00	Hypersulfidic#
P10_3	10-20		6.35	1.95	3.25*	166.50	5.79	6.35	0.03	0.00	0.00	24.33	0.00	Hypersulfidic
P10_4	20-40		7.03	1.58	3.68*	220.50	6.47	1.86	0.39	0.00	0.00	244.50	0.02	Hypermonosulfidic
P10_5	40-50		n/a	n/a	3.17*	271.50	6.60	0.00	0.29	0.00	0.39	129.60	0.02	Hypermonosulfidic
P11_1	0-5		6.90	2.73	4.18*	52.95	6.41	2.11	0.00	0.00	0.00	2.11	0.00	Other Acid Soils
P11_2	5-10		6.90	1.99	4.12*	77.40	6.31	3.36	0.00	0.00	0.00	3.36	0.00	Other Acid Soils
P11_3	10-20		7.10	3.35	3.98	45.00	6.36	2.35	0.00	0.00	0.00	2.35	0.00	Other Acid Soils
P12_1	0-5		6.56	2.40	3.61	156.00	5.13	14.80	0.05	0.00	0.00	42.89	0.00	Hypersulfidic
P12_2	5-10		6.85	3.10	3.16	48.60	6.31	2.72	0.00	0.00	0.00	2.72	0.00	Other Acid Soils
P12_3	10-20		6.97	3.42	3.81	52.65	6.62	0.00	0.00	0.00	0.02	-2.87	0.00	Other Acid Soils
P12_4	20-40		7.10	2.88	3.52*	136.35	6.16	3.18	0.00	0.00	0.00	3.18	0.00	Other Acid Soils

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). # Classified as hypermonosulfidic/hypersulfidic based on positive net acidity.

Table 8-51. Field hydrochemistry data for acid sulfate soil assessment of Mallan Bridge (Site 3).

Site ID.	Depth (m)	Specific Electrical Conductivity (µS/cm)	pH
*Lowland River**		*125-2,220*	*6.5-8.0*
MB_3	0.1	732	7.23
MB_3	1.3	726	7.22
MB_3	2.3	725	7.11
MB_8	0.1	1,180	7.41
MB_8	0.4	1,184	7.37
MB_8	0.8	1,183	7.16

* ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for relevant parameters (ANZECC/ARMCANZ, 2000).
Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text.

Table 8-52. Profile description data for acid sulfate soil assessment of Mallan Bridge (Site 3).

Site and Sample No.	Horizon Depth Range (cm)	Sediment	Organics	Colour	Eh (mV)	pH
P1_1	0-5	Mud	Much Debris	10YR2/1	-70	7.15
P1_2	5-10	Mud	Much Debris	10YR2/1	-123	7.25
P1_3	10-20	Mud	Much Debris	10YR2/1	-145	7.33
P1_4	20-35	Granular Very Coarse Sand	None	Sand	-83	7.32
P2_1	0-5	Mud	Much Debris	10YR2/1	-157	7.41
P2_2	5-10	Mud	Much Debris	10YR2/1	-168	6.80
P2_3	10-15	Mud	Some	10YR2/1	-139	6.81
P2_4	15-40	Mud	Some	10YR2/1	-126	6.91
P2_5	40-60	Fine Sandy Silt	None	Sand		
P2_6	60-65	Gc-Very Coarse Sand	None	Sand	-139	7.03
P3_1	0-5	Mud	Some, Debris	10YR2/1	-139	7.19
P3_2	5-10	Very Coarse Sand	None	Sand	-135	6.91
P3_3	10-20	Very Coarse Sand	None	Sand	-60	6.91
P3_4	20-40	Very Coarse Sand	None	Sand	-46	6.82
P3_5	40-70	Coarse-Very Coarse Sand	None	Sand	-84	7.53
P4_1	0-5	Very Coarse Sand	None	Sand	-155	7.66
P4_2	5-10	Coarse Sand	None	Sand	-86	7.22
P4_3	10-20	Coarse Sand	None	Sand	-167	7.47
P4_4	20-40	Very Coarse Sand	None	Sand		
P5_1	0-5	Very Coarse Sand	None	Sand	4	6.55
P5_2	5-10	Coarse Sand	None	Sand	-128	7.13
P5_3	10-20	Granular Very Coarse Sand	None	Sand	-34	7.15
P5_4	20-35	Granular Very Coarse Sand	None	Sand	-14	7.26
P6_1	0-5	Coarse Sand	None	Sand	62	6.53
P6_2	5-10	Coarse Sand	None	Sand	50	6.61
P6_3	10-20	Coarse Sand	None	Sand	-55	6.59
P6_4	20-40	Coarse Sand	None	Sand		
P7_1	0-5	Coarse Sand	None	Sand	166	6.52
P7_2	5-10	Coarse Sand	None	Sand	130	6.83
P7_3	10-20	Coarse Sand	None	Sand	83	7.07

Table 8-52 (continued). Profile description data for acid sulfate soil assessment of Mallan Bridge (Site 3).

Site and Sample No.	Horizon Depth Range (cm)	Sediment	Organics	Colour	Eh (mV)	pH
P7_4	20-30	Coarse Sand	None	Sand	97	7.03
P8_1	0-5	Muddy Sand	Some	10YR2/1, 10YR6/1	-54	6.57
P8_2	5-10	Very Coarse Sand	None	Sand	-33	6.38
P8_3	10-20	Coarse Sand	None	Sand	-30	6.77
P8_4	20-40	ClCoarse Sand	None	Sand		
P9_1	0-5	Coarse Sand	None	Sand	81	6.38
P9_2	5-10	Very Coarse Sand	None	Sand	31	6.56
P9_3	10-20	Very Coarse Sand	None	Sand	63	6.69
P10_1	0-5	Muddy Fine to Medium Sand	Some	Sand	-13	6.21
P10_2	5-10	Medium Sand	Some	Sand	-41	6.31
P10_3	10-20	Medium Sand	Some	Sand	-44	6.19
P10_4	20-40	Medium Sand	None	Sand	-10	6.11
P10_5	40-50	Clayey Sand	None	10YR6/1	-48	6.16
P11_1	0-5	Coarse Sand	None	Sand	35	6.54
P11_2	5-10	Very Coarse Sand	None	Sand	25	6.44
P11_3	10-20	Very Coarse Sand	None	Sand	55	6.57
P12_1	0-5	Coarse Sand	None	Sand	-53	6.35
P12_2	5-10	Very Coarse Sand	None	Sand	-54	6.46
P12_3	10-20	Very Coarse Sand	None	Sand	-29	6.36
P12_4	20-40	Mud	None	Sand	4	6.47

8.14. Gee Gee Bridge (Downstream) (Site 4)

8.14.1. Location and setting description

This site consisted of a low flow channel approximately 10 – 15 m wide with sandy, steep sided banks (Figure 8-137). The channel at this site contains reeds and submerged logs with water depth ranging from 0.4 – 2.5 m between the upstream and downstream sites. Vegetation on the banks consisted of tall river red gum woodland with cherry ballart and native grass understorey. Thirteen profiles were sampled in duplicate. The pH of the channel sediments were predominantly neutral to slightly acidic.

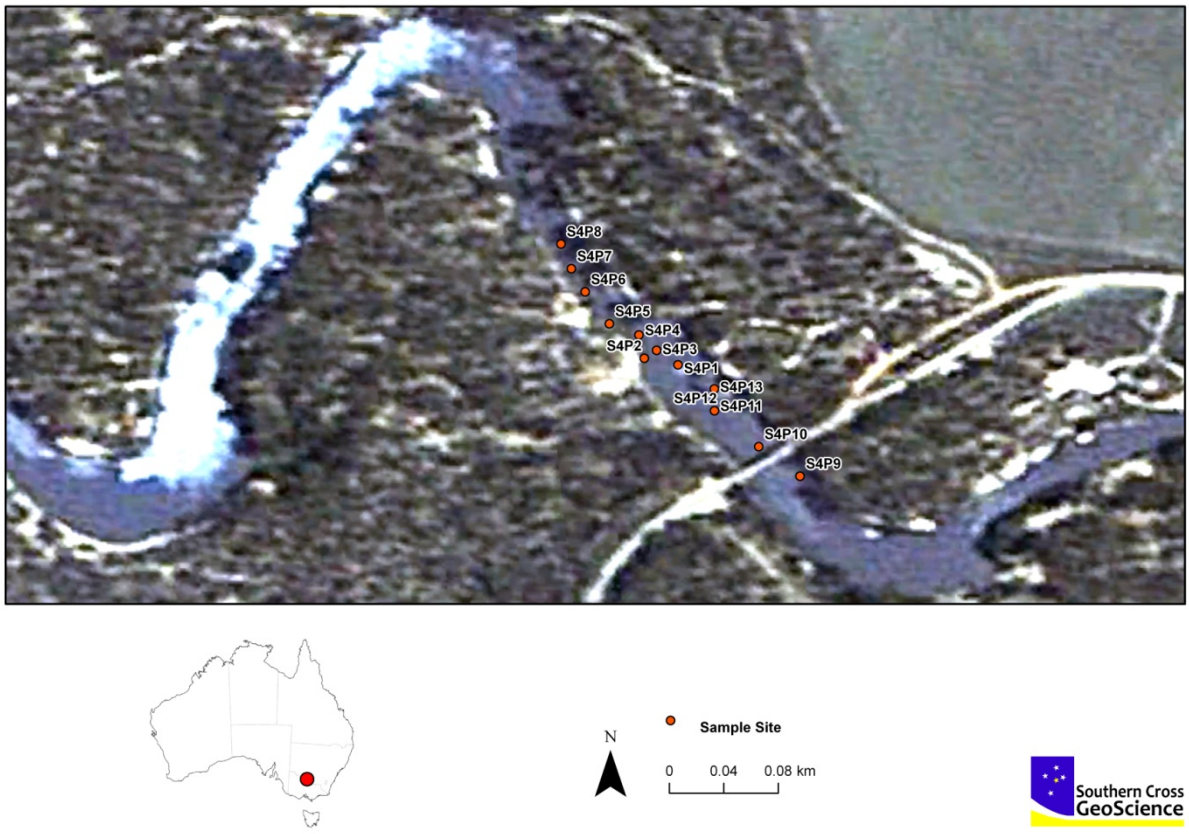

Figure 8-137. Gee Gee Bridge and sample site locations.

8.14.2. Soil profile description and distribution

Thirteen profiles were described and sampled at Gee Gee Bridge. The soil subtype and general location description are presented in Table 8-53. Profile description data are presented in Table 8-56.

Table 8-53. Soil identification, subtype and general location description for sites sampled at Gee Gee Bridge.

Site ID	Easting UTM Zone 54H	Northing UTM Zone 54H	Acid sulfate soil subtype class
GGB_1	766065	6086568	Subaqueous Soil
GGB_2	766045	6086573	Hypersulfidic Subaqueous Soil
GGB_3	766053	6086579	Subaqueous Soil
GGB_4	766043	6086591	Subaqueous Soil
GGB_5	766025	6086599	Subaqueous Soil
GGB_6	766011	6086623	Subaqueous Soil
GGB_7	766003	6086640	Hypersulfidic Subaqueous Soil with Monosulfides
GGB_8	765998	6086659	Hypersulfidic Subaqueous Soil with Monosulfides
GGB_9	766136	6086484	Hypersulfidic Subaqueous Soil
GGB_10	766112	6086506	Subaqueous Soil
GGB_11	766086	6086534	Subaqueous Soil
GGB_12	766086	6086534	Subaqueous Soil
GGB_13	766087	6086550	Subaqueous Soil

Figure 8-138. Site 4, Gee Gee Bridge (upstream view).

Figure 8-139. Site 4, Gee Gee Bridge (downstream view).

8.14.3. Laboratory data assessment

Soil pH testing (pH_W, pH_{FOX}, pH_{KCl}, $pH_{INCUBATION}$)

The pH data is provided in Table 8-54 and depth profiles of soil pH for all the sites sampled are presented in Figures 8-140 to 8-143. The pH_W values ranged between 4.61 and 6.84. No sulfuric materials (i.e. pH_W < 4) were present at Gee Gee Bridge. The pH_{FOX} values ranged between 1.37 and 3.94. The pH_{FOX} results indicate that all the surface soils may have the potential to acidify to pH < 4 as a result of sulfide oxidation. Twenty-two soil materials had a pH_{FOX} < 2.5 suggesting that soil acidity problems will emerge when these soils are exposed to air. The S_{CR} data shows only four of the 52 layers examined contained detectable sulfide (i.e. S_{CR} ≥ 0.01% S). The pH_{KCl} values ranged between 4.51 and 6.64. One of the sulfidic soil materials (i.e. S_{CR} ≥ 0.01% S) acidified to pH < 4 after at least 8 weeks of incubation. Other acidic soil materials were identified in the 13 profiles examined, indicating acidity in the soil profile at levels where aluminium may mobilise. Seven of the other acidic soils acidified to pH < 4 after at least 8 weeks of incubation.

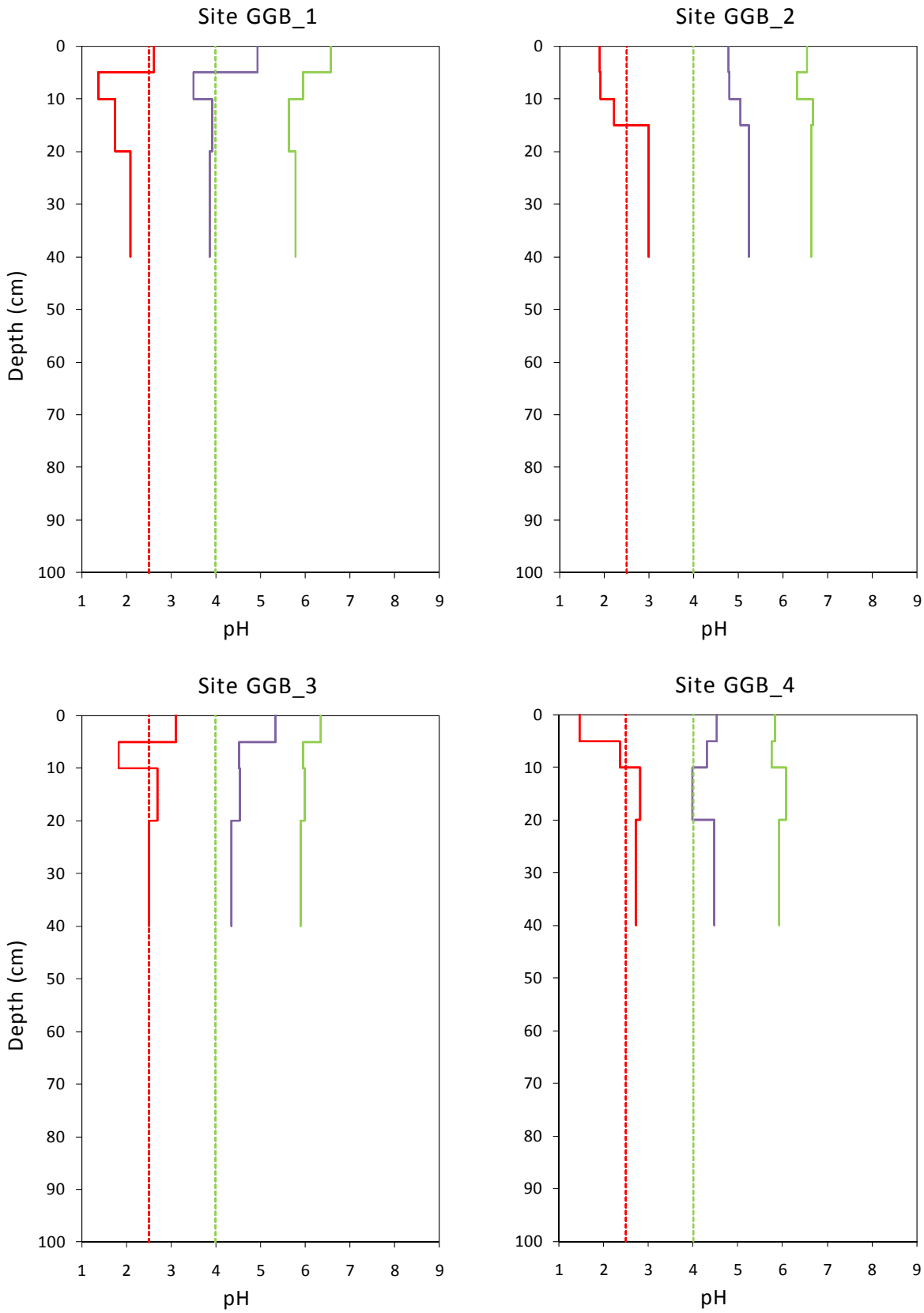

Figure 8-140. Depth profiles of soil pH for sites at Gee Gee Bridge (GGB_1 – GGB_4), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

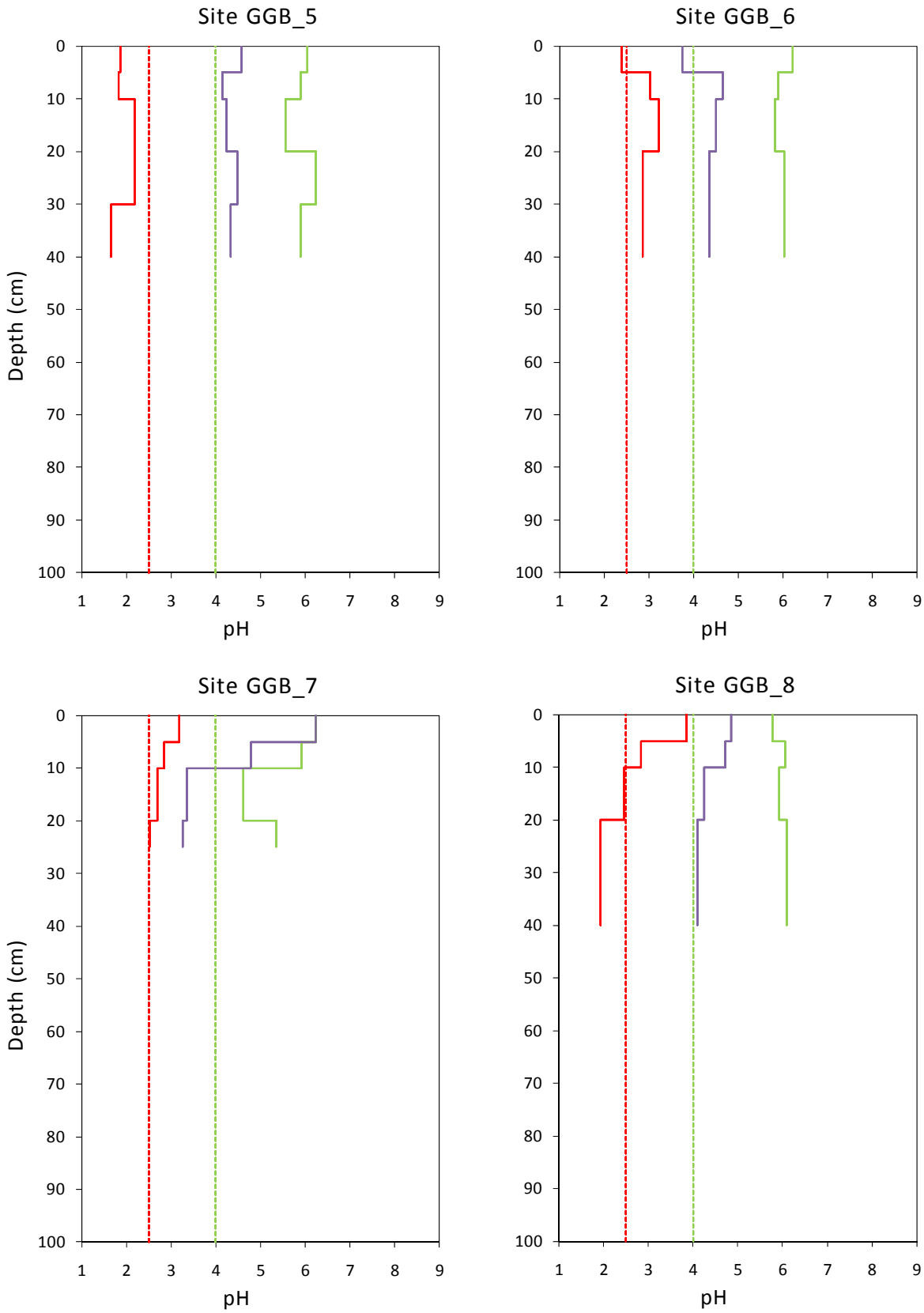

Figure 8-141. Depth profiles of soil pH for sites at Gee Gee Bridge (GGB_5 – GGB_8), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

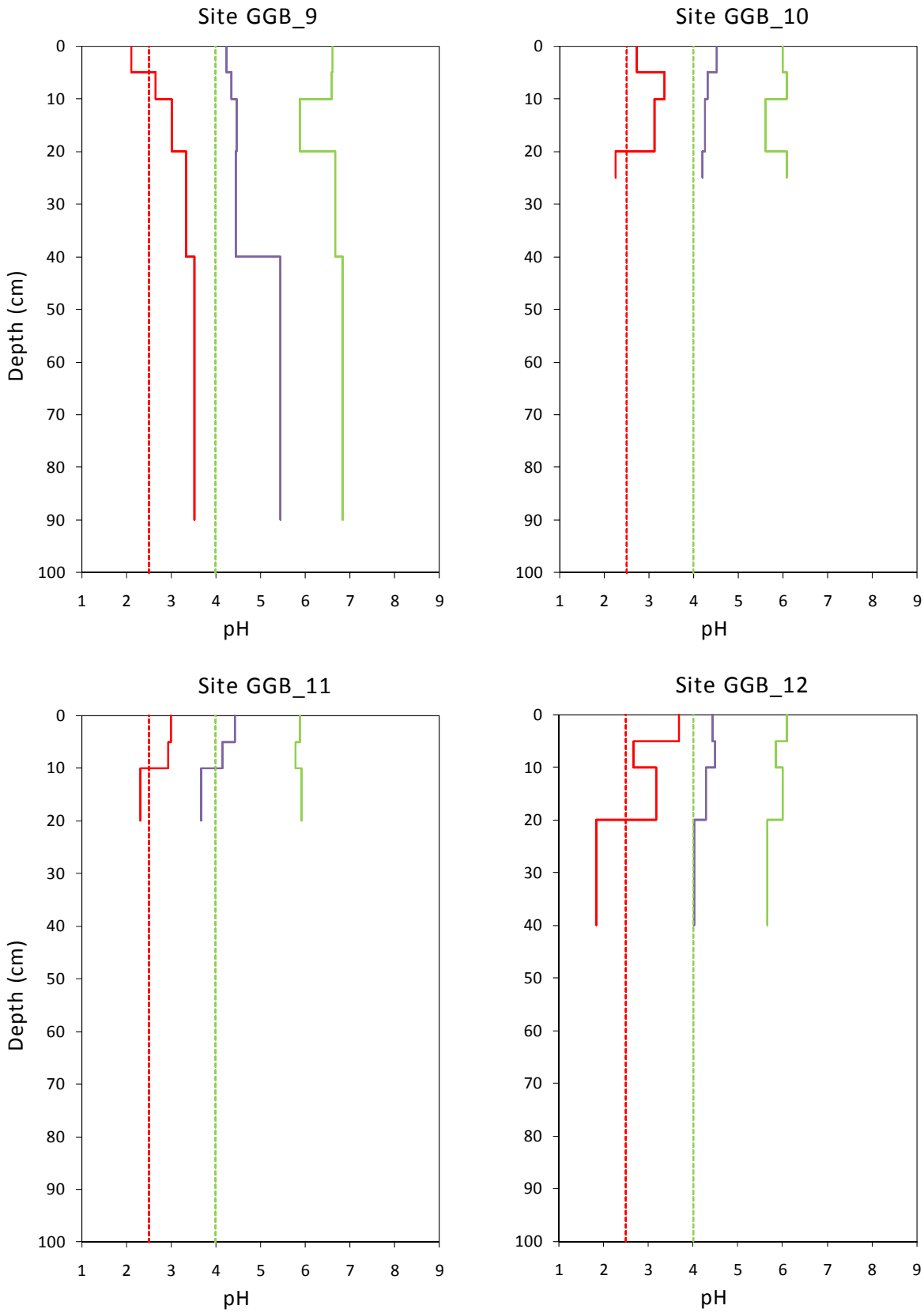

Figure 8-142. Depth profiles of soil pH for sites at Gee Gee Bridge (GGB_9 – GGB_12), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

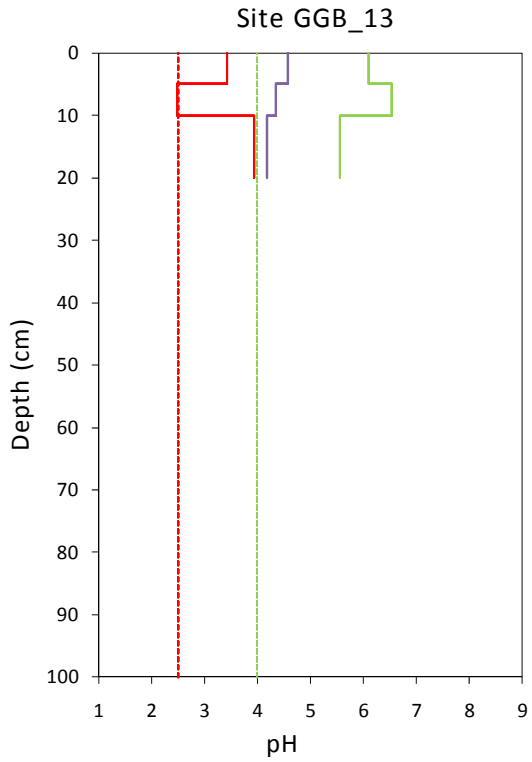

Figure 8-143. Depth profiles of soil pH for sites at Gee Gee Bridge (GGB_13), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

Acid-base accounting

The acid-base accounting data is provided in Table 8-54 and summarised in Figures 8-144 to 8-146.

Chromium reducible sulfur

Chromium reducible sulfur (S_{CR}) values ranged between < 0.01 and 0.02% S_{CR}. Sulfidic soil materials (i.e. S_{CR} ≥ 0.01% S) were identified in four of the 13 soil profiles, with only four materials of the 52 samples collected equal to or greater than the sulfidic criterion.

Acid volatile sulfide

The acid volatile sulfide (S_{AV}) values ranged between < 0.01 and 0.02% S_{AV}. A total of two monosulfidic soil materials (i.e. S_{AV} ≥ 0.01% S) were found in two of the 13 soil profiles examined.

Acid neutralising capacity

The acid neutralising capacity (ANC) ranged between zero and 0.14% $CaCO_3$.

Titratable actual acidity

The titratable actual acidity (TAA) ranged between zero and 62 mole H^+/tonne. The TAA trend with depth varied between profiles.

Retained acidity

All soil materials had no retained acidity.

Net acidity

Net acidity ranged between -18 and 62 mole H^+/tonne. The four hypersulfidic soils had low to moderate net acidities ranging between 11 and 52 mole H^+/tonne.

Water Soluble Sulfate

The water soluble sulfate in the surface soils (i.e. 0-20 cm) ranged between 20 and 159 mg SO_4/kg. The surface soil layers in two of the 13 profiles examined had a soluble sulfate content exceeding the 100 mg/kg trigger value for MBO formation potential.

Water Data

The surface water data measured in the field are presented in Table 8-55. The field pH of the surface waters collected ranged between 6.5 and 6.6, with no samples outside the most relevant ANZECC/ARMCANZ (2000) trigger values for aquatic ecosystems. The water data indicates that the surface water has not been affected by acidification. SEC values were not found to exceed the most relevant ANZECC/ARMCANZ (2000) guideline value.

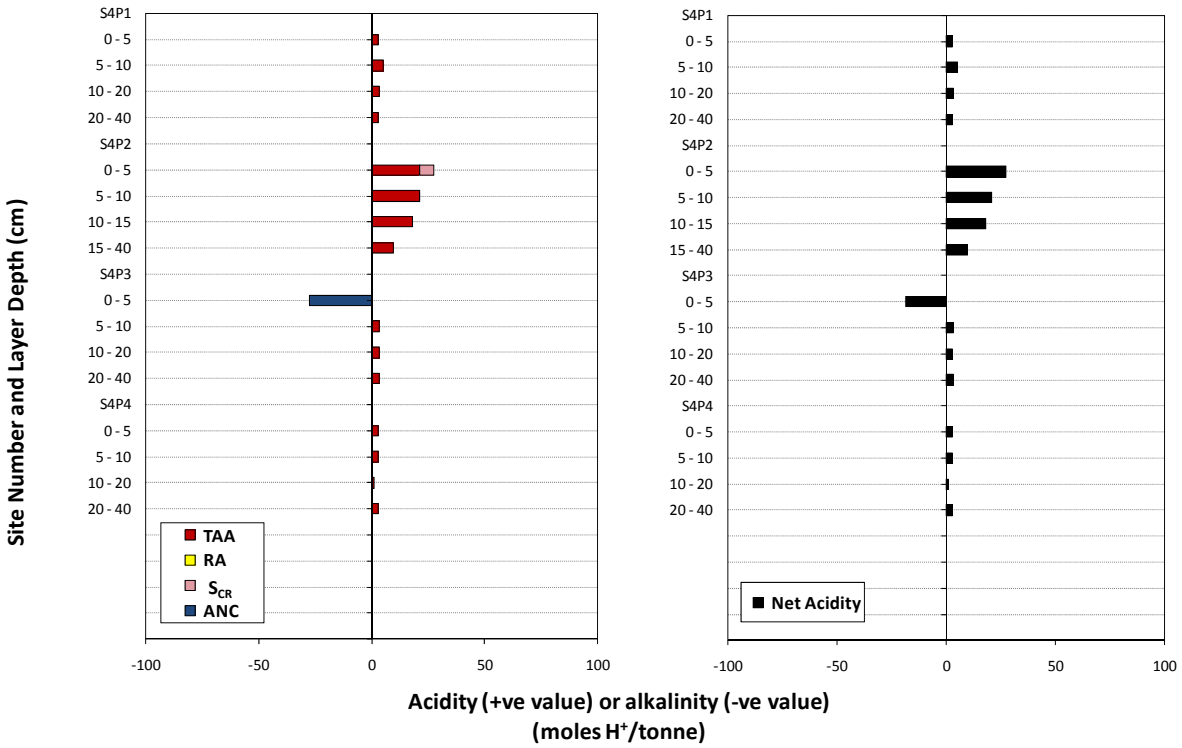

Figure 8-144. Acid-base accounting depth profiles for sites at Gee Gee Bridge (GGB_1 – GGB_4). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

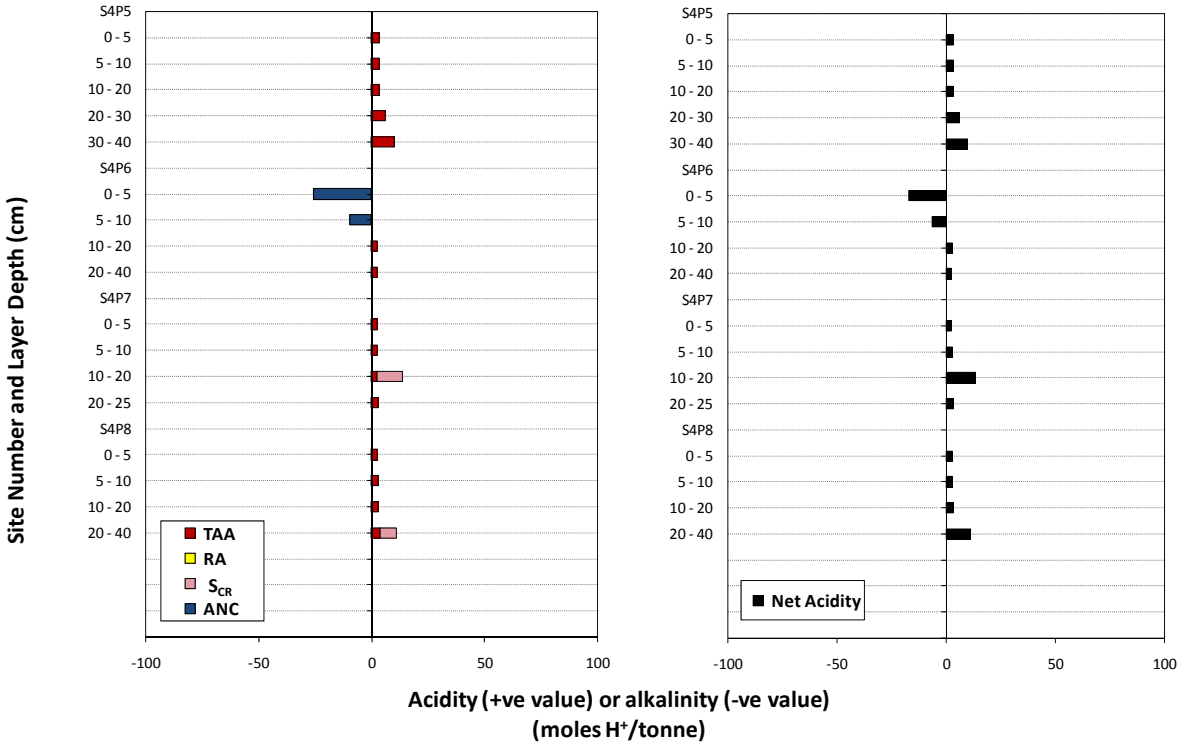

Figure 8-145. Acid-base accounting depth profiles for sites at Gee Gee Bridge (GGB_5 – GGB_8). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

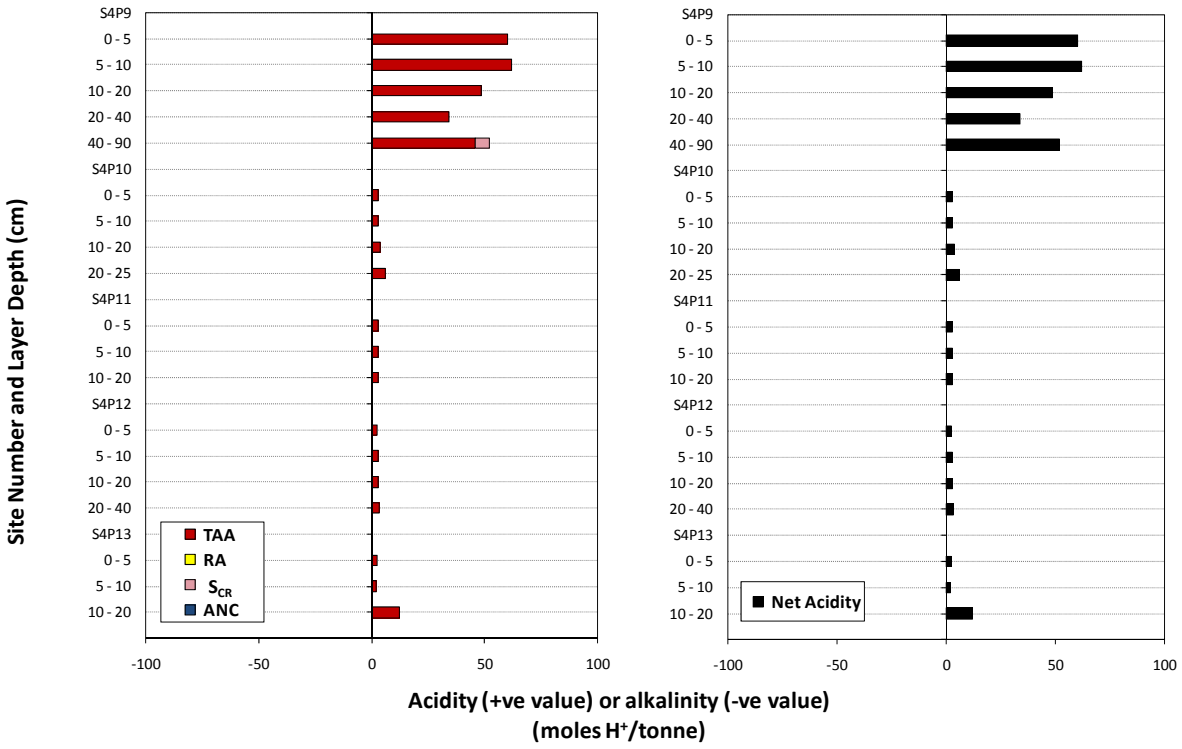

Figure 8-146. Acid-base accounting depth profiles for sites at Gee Gee Bridge (GGB_9 – GGB_13). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

8.14.4. Discussion

Acid sulfate soil materials occurred within the soil profile at four of the 13 sites examined at Gee Gee Bridge. Sulfuric materials were not observed at Gee Gee Bridge. The presence of reduced inorganic sulfur was identified in four profiles, with a S_{CR} of up to 0.02% S. Hypersulfidic soil materials with low to moderate net acidities (i.e. 11 - 52 mole H^+/tonne) were present in four profiles. Monosulfidic soil materials were also observed in the subsoils (i.e. below a depth of 20 cm) at two of the sulfidic sites, with S_{AV} contents of up to 0.02%. These results indicate that some acidity would be produced upon oxidation of the sulfidic materials. The surficial soil materials at two sites contained soluble sulfate exceeding the 100 mg/kg trigger value for MBO formation potential. Other acidic soil materials were also observed at all 13 sites.

Based on the priority ranking criteria adopted by the Scientific Reference Panel of the Murray-Darling Basin Acid Sulfate Soil Risk Assessment Project, there were four high priority sites based on hypersulfidic material and two high priority sites based on monosulfidic material. Two sampling sites had a high priority ranking for Phase 2 detailed assessment based on MBO formation hazard.

The potential hazards posed by acid sulfate soil materials at the Gee Gee Bridge sites are:

- Acidification hazard: Low net acidities were dominant in this channel, and with only two hypersulfidic materials (S_{CR} ≤ 0.02% S) having moderate net acidities (i.e. 4% of layers), the overall degree of acidification hazard is low.

- Deoxygenation hazard: Monosulfidic soil materials (S_{AV} ≤ 0.02% S) were observed at a depth of greater than 10 cm which would represent a low deoxygenation hazard. However, the soluble sulfate content of surface soil materials at two sites were over the trigger value for MBO formation indicating the possible development of a high deoxygenation hazard at those locations after prolonged wet conditions.

- Metal mobilisation: The low acidification hazard indicates that soil acidification is not likely to increase the solubility of metals. However, the potential for MBO formation identified in this channel may result in a low to moderate metal release hazard depending on factors such as the potential for MBO formation and the metal loading in this system. Soil acidity may be sufficient for mobilisation of aluminium.

Summary of key findings for Gee Gee Bridge:

Soil materials:	Sulfidic soil materials identified included: hypersulfidic (4 profiles) and monosulfidic (2 profiles). Other acidic soil materials observed at the remaining 9 profiles. Low net acidities dominant within channel, although 2 hypersulfidic soil materials had moderate net acidities.
Acid sulfate soil identification:	• Sulfidic materials were recorded in one surface layer and three sub-surface layers. Monosulfides were found in two materials, at depths of 10-20cm and 40-90cm. All sites were subaqueous.
Hazard assessment	• Acidification hazard - low level of concern • Deoxygenation hazard - high level of concern • Metal mobilisation hazard – low to moderate level of concern

Table 8-54. Laboratory analytical data for acid sulfate soil assessment of Gee Gee Bridge (Site 4).

(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P1_1	0-5		6.58	2.62	4.94	43.20	6.39	2.85	0.00	0.00	0.00	2.85	0.00	Other Acid Soils
P1_2	5-10		5.95	1.37	3.50	49.80	5.62	5.19	0.00	0.00	0.00	5.19	0.00	Other Acid Soils
P1_3	10-20		5.63	1.75	3.91	42.30	5.85	3.45	0.00	0.00	0.00	3.45	0.00	Other Acid Soils
P1_4	20-40		5.79	2.10	3.87	37.20	5.95	2.95	0.00	0.00	0.00	2.95	0.00	Other Acid Soils
P2_1	0-5		6.53	1.90	4.79	103.80	5.41	20.96	0.01	0.00	0.00	27.36	0.00	Hypersulfidic[#]
P2_2	5-10		6.32	1.92	4.80	113.70	5.32	20.95	0.00	0.00	0.00	20.95	0.00	Other Acid Soils
P2_3	10-15		6.67	2.22	5.05*	106.50	5.30	18.13	0.00	0.00	0.00	18.13	0.00	Other Acid Soils
P2_4	15-40		6.63	3.00	5.23	54.30	5.49	9.60	0.00	0.00	0.00	9.60	0.00	Other Acid Soils
P3_1	0-5		6.34	3.10	5.33*	28.05	6.53	0.00	0.00	0.00	0.14	-18.43	0.00	Other Acid Soils
P3_2	5-10		5.96	1.83	4.52	61.50	5.74	3.20	0.00	0.00	0.00	3.20	0.00	Other Acid Soils
P3_3	10-20		5.99	2.69	4.53	29.10	6.12	3.02	0.00	0.00	0.00	3.02	0.00	Other Acid Soils
P3_4	20-40		5.90	2.50	4.36	36.30	5.78	3.17	0.00	0.00	0.00	3.17	0.00	Other Acid Soils
P4_1	0-5		5.84	1.47	4.54*	37.05	6.34	2.58	0.00	0.00	0.00	2.58	0.00	Other Acid Soils
P4_2	5-10		5.75	2.37	4.30	43.35	6.32	2.73	0.00	0.00	0.00	2.73	0.00	Other Acid Soils
P4_3	10-20		6.08	2.82	3.99	42.75	6.44	0.96	0.00	0.00	0.00	0.96	0.00	Other Acid Soils
P4_4	20-40		5.92	2.72	4.47	39.60	6.17	2.89	0.00	0.00	0.00	2.89	0.00	Other Acid Soils
P5_1	0-5		6.05	1.86	4.58*	40.50	5.92	3.18	0.00	0.00	0.00	3.18	0.00	Other Acid Soils
P5_2	5-10		5.89	1.83	4.15*	37.05	5.97	3.20	0.00	0.00	0.00	3.20	0.00	Other Acid Soils
P5_3	10-20		5.55	2.19	4.23	47.10	5.83	3.20	0.00	0.00	0.00	3.20	0.00	Other Acid Soils
P5_4	20-30		6.23	2.18	4.49	63.15	5.68	6.03	0.00	0.00	0.00	6.03	0.00	Other Acid Soils
P5_5	30-40		5.90	1.65	4.33	70.20	5.45	9.87	0.00	0.00	0.00	9.87	0.00	Other Acid Soils
P6_1	0-5		6.21	2.40	3.75	30.30	6.57	0.00	0.00	0.00	0.13	-17.19	0.00	Other Acid Soils
P6_2	5-10		5.90	3.03	4.65	39.30	6.64	0.00	0.00	0.00	0.05	-6.31	0.00	Other Acid Soils
P6_3	10-20		5.82	3.23	4.51	36.00	6.37	2.56	0.00	0.00	0.00	2.56	0.00	Other Acid Soils
P6_4	20-40		6.02	2.87	4.35	32.85	6.39	2.45	0.00	0.00	0.00	2.45	0.00	Other Acid Soils
P7_1	0-5		6.23	3.19	6.23	25.50	6.30	2.54	0.00	0.00	0.00	2.54	0.00	Other Soil Materials
P7_2	5-10		5.91	2.85	4.79	31.50	6.14	2.57	0.00	0.00	0.00	2.57	0.00	Other Acid Soils
P7_3	10-20		4.61	2.70	3.35	36.00	5.94	2.65	0.02	0.00	0.00	13.62	0.02	Hypermonosulfidic
P7_4	20-25		5.35	2.53	3.25	29.70	6.23	3.12	0.00	0.00	0.00	3.12	0.00	Other Acid Soils

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). [#] Classified as hypersulfidic based on positive net acidity.

Table 8-54 (continued). Laboratory analytical data for acid sulfate soil assessment of Gee Gee Bridge (Site 4).

(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P8_1	0-5		5.77	3.86	4.85*	20.25	6.28	2.55	0.00	0.00	0.00	2.55	0.00	Other Acid Soils
P8_2	5-10		6.06	2.83	4.71	29.85	5.92	2.93	0.00	0.00	0.00	2.93	0.00	Other Acid Soils
P8_3	10-20		5.93	2.46	4.25	36.15	5.57	3.01	0.00	0.00	0.00	3.01	0.00	Other Acid Soils
P8_4	20-40		6.10	1.94	4.10	53.40	5.50	3.63	0.01	0.00	0.00	11.03	0.01	Hypermonosulfidic#
P9_1	0-5		6.61	2.11	4.24*	159.00	4.58	60.22	0.00	0.00	0.00	60.22	0.00	Other Acid Soils
P9_2	5-10		6.59	2.66	4.36*	150.00	4.51	62.06	0.00	0.00	0.00	62.06	0.00	Other Acid Soils
P9_3	10-20		5.87	3.02	4.46*	142.35	4.56	48.67	0.00	0.00	0.00	48.67	0.00	Other Acid Soils
P9_4	20-40		6.67	3.33	4.44*	129.90	4.84	33.96	0.00	0.00	0.00	33.96	0.00	Other Acid Soils
P9_5	40-90		6.84	3.53	5.45*	211.50	4.60	45.89	0.01	0.00	0.00	52.15	0.00	Hypersulfidic#
P10_1	0-5		6.00	2.73	4.52*	31.95	6.01	2.93	0.00	0.00	0.00	2.93	0.00	Other Acid Soils
P10_2	5-10		6.09	3.35	4.31	28.80	6.01	2.59	0.00	0.00	0.00	2.59	0.00	Other Acid Soils
P10_3	10-20		5.61	3.13	4.25	28.80	5.73	3.59	0.00	0.00	0.00	3.59	0.00	Other Acid Soils
P10_4	20-25		6.08	2.27	4.20	40.05	5.27	6.10	0.00	0.00	0.00	6.10	0.00	Other Acid Soils
P11_1	0-5		5.87	3.00	4.43*	30.60	6.19	2.72	0.00	0.00	0.00	2.72	0.00	Other Acid Soils
P11_2	5-10		5.78	2.94	4.14*	36.15	5.92	2.93	0.00	0.00	0.00	2.93	0.00	Other Acid Soils
P11_3	10-20		5.91	2.31	3.67*	94.95	5.97	2.93	0.00	0.00	0.00	2.93	0.00	Other Acid Soils
P12_1	0-5		6.10	3.68	4.44*	24.60	6.28	2.45	0.00	0.00	0.00	2.45	0.00	Other Acid Soils
P12_2	5-10		5.85	2.66	4.50*	37.20	5.83	2.69	0.00	0.00	0.00	2.69	0.00	Other Acid Soils
P12_3	10-20		6.00	3.17	4.28*	33.60	5.91	2.62	0.00	0.00	0.00	2.62	0.00	Other Acid Soils
P12_4	20-40		5.67	1.83	4.03*	37.05	5.70	3.17	0.00	0.00	0.00	3.17	0.00	Other Acid Soils
P13_1	0-5		6.11	3.42	4.57*	26.55	6.29	2.35	0.00	0.00	0.00	2.35	0.00	Other Acid Soils
P13_2	5-10		6.54	2.49	4.36*	30.00	6.21	1.96	0.00	0.00	0.00	1.96	0.00	Other Acid Soils
P13_3	10-20		5.56	3.94	4.19	41.40	4.97	12.14	0.00	0.00	0.00	12.14	0.00	Other Acid Soils

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). # Classified as hypermonosulfidic/hypersulfidic based on positive net acidity.

Table 8-55. Field hydrochemistry data for acid sulfate soil assessment of Gee Gee Bridge (Site 4).

Site ID.	Depth (m)	Specific Electrical Conductivity (µS/cm)	pH
*Lowland River**		*125-2,220*	*6.5-8.0*
GGB_8	0.1	101.2	6.54
GGB_9	0.1	100.8	6.57

* ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for relevant parameters (ANZECC/ARMCANZ, 2000).
Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text.

Table 8-56. Profile description data for acid sulfate soil assessment of Gee Gee Bridge (Site 4).

Site and Sample No.	Horizon Depth Range (cm)	Sediment	Organics	Colour	Eh (mV)	pH
P1_1	0-5	Granular Very Coarse Sand	Some, Debris	Sand	152	6.71
P1_2	5-10	Granular Very Coarse Sand	Some, Debris	Sand	53	6.51
P1_3	10-20	Granular Very Coarse Sand	Much, Debris	Sand	127	6.38
P1_4	20-40	Granular Very Coarse Sand	Much, Debris	Sand	42	6.52
P2_1	0-5	Medium Sand	Some	Sand	-79	6.84
P2_2	5-10	Medium Sand	Some	Sand	-95	6.86
P2_3	10-15	Medium Sand	Some	Sand	-121	6.67
P2_4	15-40	Medium Sand (Gley)	Some	2.5Y4/3	-60	6.91
P3_1	0-5	Coarse to Very Coarse Sand	Some	Sand	186	6.74
P3_2	5-10	Coarse to Very Coarse Sand	Some	Sand	114	6.64
P3_3	10-20	Coarse to Very Coarse Sand	Some	Sand	109	6.60
P3_4	20-40	Coarse to Very Coarse Sand	Some	Sand	154	6.46
P4_1	0-5	Coarse to Very Coarse Sand	None	Sand	71	6.59
P4_2	5-10	Coarse to Very Coarse Sand (reducing)	Some	10YR6/1	121	6.35
P4_3	10-20	Coarse to Very Coarse Sand (reducing)	Some	10YR6/1	25	6.45
P4_4	20-40	Coarse to Very Coarse Sand	None	Sand	3	6.63
P5_1	0-5	Coarse Sand	Some	Sand	-66	6.84
P5_2	5-10	Coarse Sand	Some	Sand	-35	6.43
P5_3	10-20	Coarse to Very Coarse Sand	Some	Sand	26	6.44
P5_4	20-30	Silty Coarse Sand	Some, Debris	Sand	-36	6.62
P5_5	30-40	Coarse to Very Coarse Sand	Some, Debris	Sand	99	6.53
P6_1	0-5	Coarse to Very Coarse Sand	None	Sand	139	6.68
P6_2	5-10	Very Coarse Sand	None	Sand	91	6.95
P6_3	10-20	Very Coarse Sand	None	Sand	96	6.21
P6_4	20-40	Very Coarse Sand	None	Sand	186	6.48
P7_1	0-5	Very Coarse Sand	Some	Sand	187	6.18
P7_2	5-10	Very Coarse Sand	Some	Sand	119	6.22
P7_3	10-20	Very Coarse Sand (reducing)	Some	10YR6/1	182	6.62
P7_4	20-25	Very Coarse Sand (reducing)	Some	10YR6/1	171	6.41
P8_1	0-5	Granular Very Coarse Sand	Some	Sand	255	6.51

Table 8-56 (continued). Profile description data for acid sulfate soil assessment of Gee Gee Bridge (Site 4).

Site and Sample No.	Horizon Depth Range (cm)	Sediment	Organics	Colour	Eh (mV)	pH
P8_2	5-10	Granular Very Coarse Sand	Some	Sand	217	6.4
P8_3	10-20	Coarse Sand (reducing)	None	10YR6/1	159	6.79
P8_4	20-40	Coarse Sand (reducing)	None	10YR6/1	104	6.76
P9_1	0-5	Mud	Some	10YR2/1	-77	6.56
P9_2	5-10	Mud	Some	10YR2/1	-99	6.56
P9_3	10-20	Mud	Some	10YR2/1	-119	6.61
P9_4	20-40	Mud	Some	10YR2/1	-105	6.6
P9_5	40-90	Mud	Some	10YR2/1	-88	6.51
P10_1	0-5	Coarse Sand (reducing)	Some	10YR6/1	7	6.54
P10_2	5-10	Coarse Sand (reducing)	Some	10YR6/1	-39	6.89
P10_3	10-20	Very Coarse Sand (reducing)	None	10YR6/1	-52	6.68
P10_4	20-25	Very Coarse Sand (reducing)	None	10YR6/1	-46	6.77
P11_1	0-5	Very Coarse Sand	Some	Sand'	34	6.7
P11_2	5-10	Very Coarse Sand (reducing)	Some	10YR6/1	-18	6.76
P11_3	10-20	Very Coarse Sand (reducing)	Some	10YR6/1	-38	6.6
P12_1	0-5	Coarse Sand	Some	Sand	7	6.43
P12_2	5-10	Very Coarse Sand	Some	Sand	-24	7.15
P12_3	10-20	Very Coarse Sand (reducing)	Some	10YR6/1	-9	6.81
P12_4	20-40	Very Coarse Sand (reducing)	Some	10YR6/1	0	6.79
P13_1	0-5	Very Coarse Sand	Some	Sand	56	6.93
P13_2	5-10	Very Coarse Sand	Some	Sand	129	6.67
P13_3	10-20	Coarse Sand (Clay)	None	10YR6/1	10	6.42

8.15. Yarrakool Creek Junction (Site 5)

8.15.1. Location and setting description

This site was located on a straight reach of the river in a low flow channel approximately 20 m wide with steep-sided banks (Figure 8-147). The channel contains reeds and submerged logs with water depth ranging from 0.9 – 2.0 m. Vegetation on the banks consisted of unhealthy or dead river red gums and black box with lignum and saltbush understorey. Twelve profiles were sampled in duplicate. The pH of the channel sediments was slightly acidic.

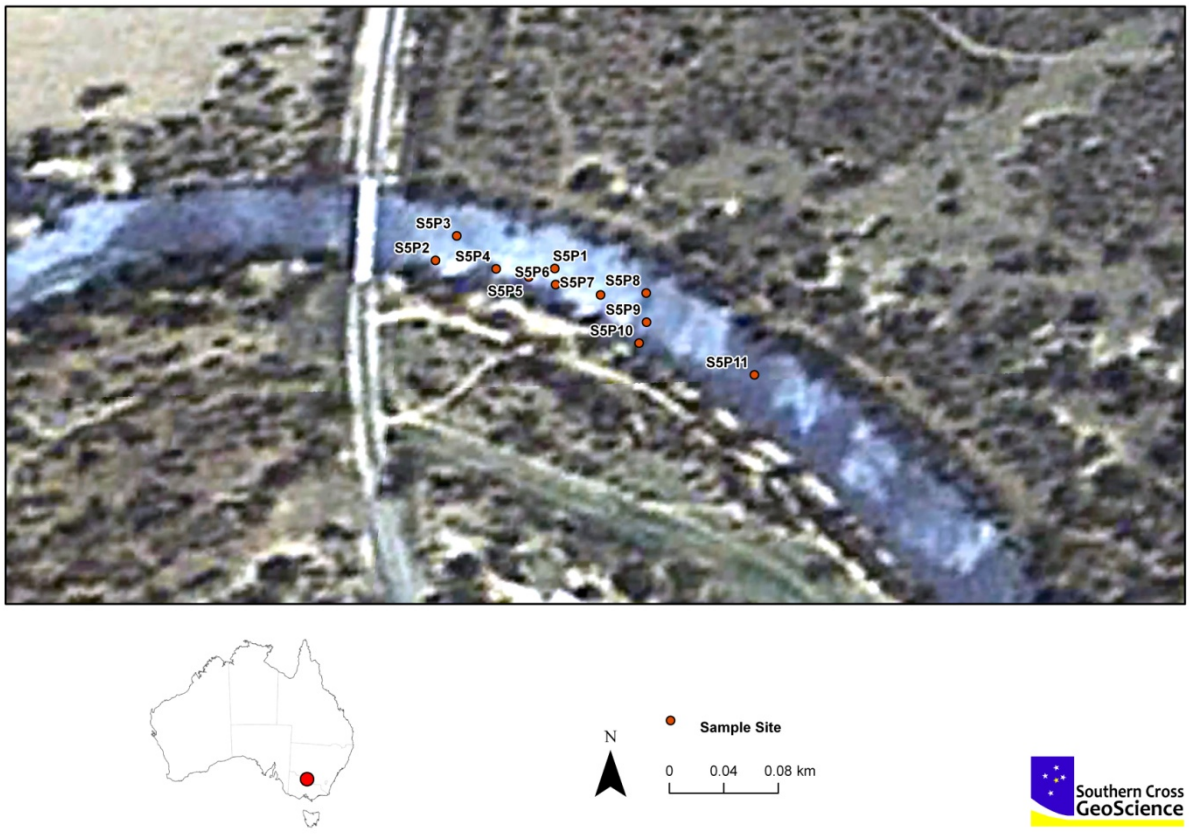

Figure 8-147. Yarrakool Creek Junction and sample site locations.

8.15.2. Soil profile description and distribution

Twelve profiles were described and sampled at Yarrakool Creek Junction. The soil subtype and general location description are presented in Table 8-57. Profile description data are presented in Table 8-60.

Table 8-57. Soil identification, subtype and general location description for sites sampled at Yarrakool Creek Junction.

Site ID	Easting UTM Zone 55H	Northing UTM Zone 55H	Acid sulfate soil subtype class
YCJ_1	269132	6068968	Subaqueous Soil
YCJ_2	269061	6068972	Hypersulfidic Subaqueous Soil
YCJ_3	269073	6068990	Hypersulfidic Subaqueous Soil
YCJ_4	269097	6068966	Hypersulfidic Subaqueous Soil
YCJ_5	269117	6068961	Hypersulfidic Subaqueous Soil
YCJ_6	269133	6068956	Hypersulfidic Subaqueous Soil with Monosulfides
YCJ_7	269160	6068949	Subaqueous Soil
YCJ_8	269188	6068951	Subaqueous Soil
YCJ_9	269188	6068930	Subaqueous Soil
YCJ_10	269184	6068914	Hypersulfidic Subaqueous Soil
YCJ_11	269254	6068893	Hypersulfidic Subaqueous Soil
YCJ_12	269229	6068900	Hypersulfidic Subaqueous Soil

Figure 8-148. Site 5, Yarrakool Creek Junction (upstream view).

Figure 8-149. Site 5, Yarrakool Creek Junction (downstream view).

8.15.3. Laboratory data assessment

Soil pH testing (pH_W, pH_{FOX}, pH_{KCl}, $pH_{INCUBATION}$)

The pH data is provided in Table 8-58 and depth profiles of soil pH for all the sites sampled are presented in Figures 8-150 to 8-152. The pH_W values ranged between 4.97 and 6.57. No sulfuric materials (i.e. $pH_W < 4$) were present at Yarrakool Creek Junction. The pH_{FOX} values ranged between 1.63 and 3.12. The pH_{FOX} results indicate that all the surface soils may have the potential to acidify to pH < 4 as a result of sulfide oxidation. Forty-nine soil materials had a $pH_{FOX} < 2.5$ suggesting that soil acidity problems will emerge when these soils are exposed to air. The S_{CR} data shows only 22 of the 60 layers examined contained detectable sulfide (i.e. $S_{CR} \geq 0.01\%$ S). The pH_{KCl} values ranged between 4.05 and 4.79. One of the sulfidic soil materials (i.e. $S_{CR} \geq 0.01\%$ S) acidified to pH < 4 after at least 8 weeks of incubation. Other acidic soil materials were identified in 11 of the 12 profiles examined, indicating acidity in the soil profile at levels where aluminium may mobilise. Three of the other acidic soils acidified to pH < 4 after at least 8 weeks of incubation.

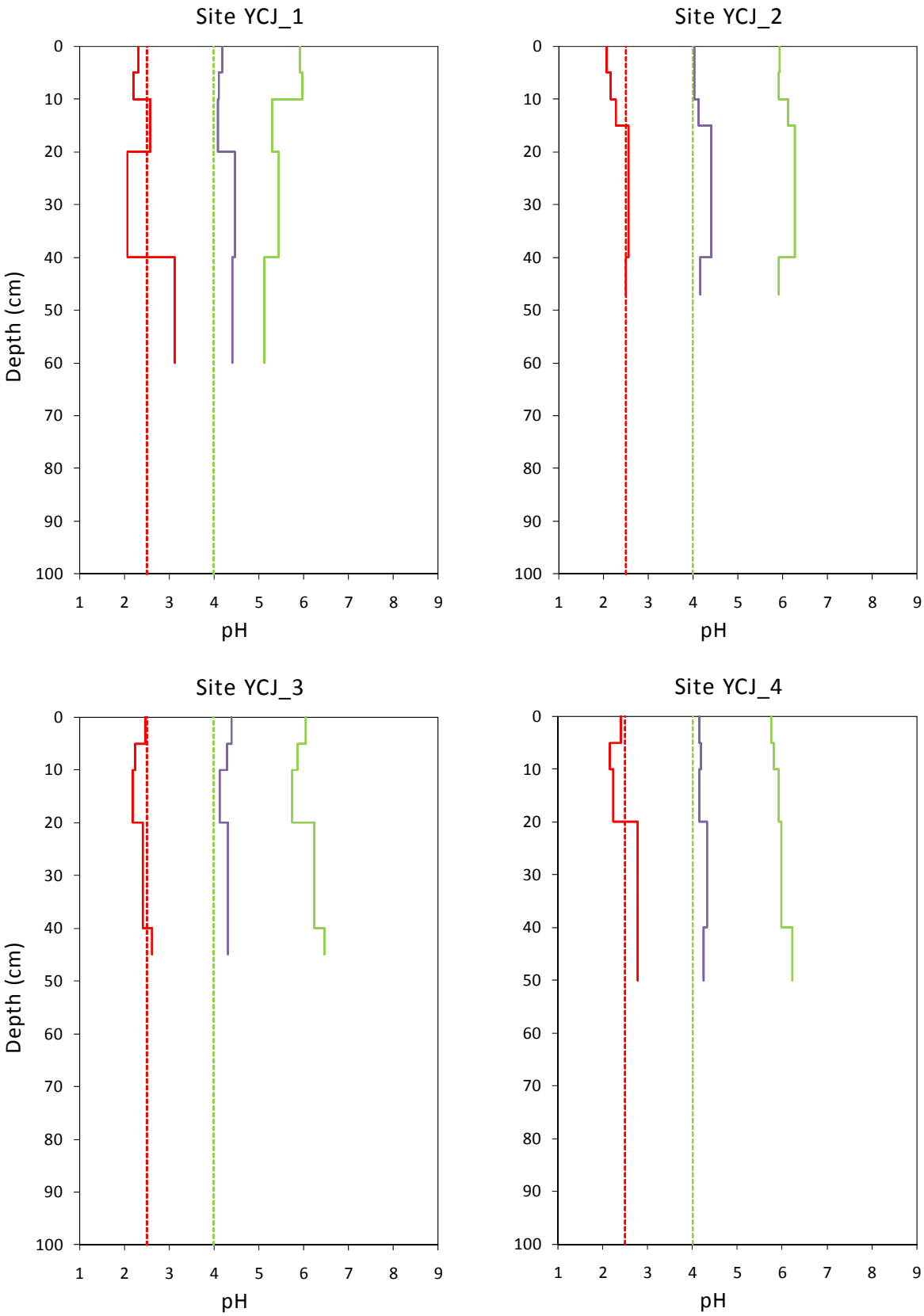

Figure 8-150. Depth profiles of soil pH for sites at Yarrakool Creek Junction (YCJ_1 – YCJ_4), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

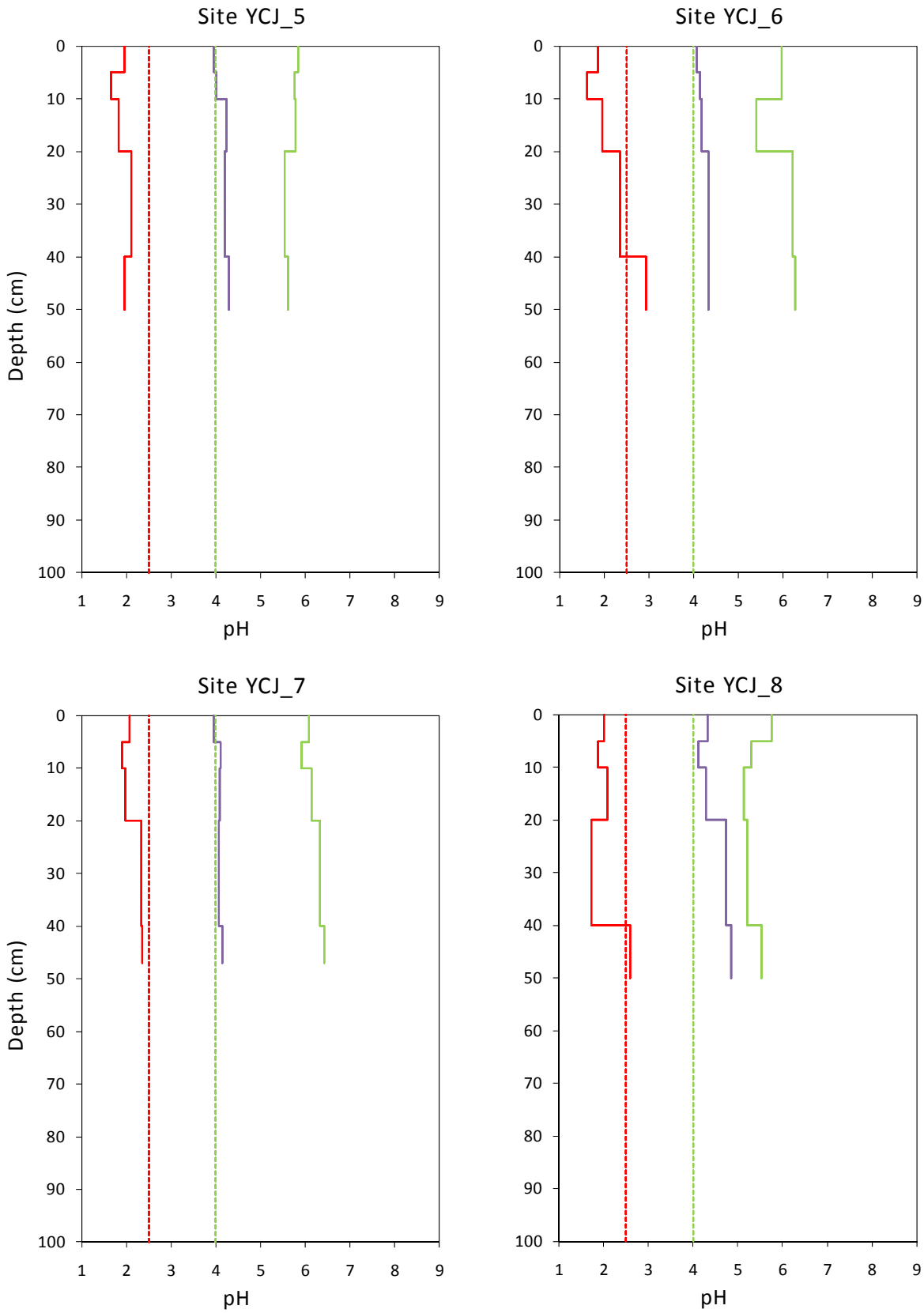

Figure 8-151. Depth profiles of soil pH for sites at Yarrakool Creek Junction (YCJ_5 – YCJ_8), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

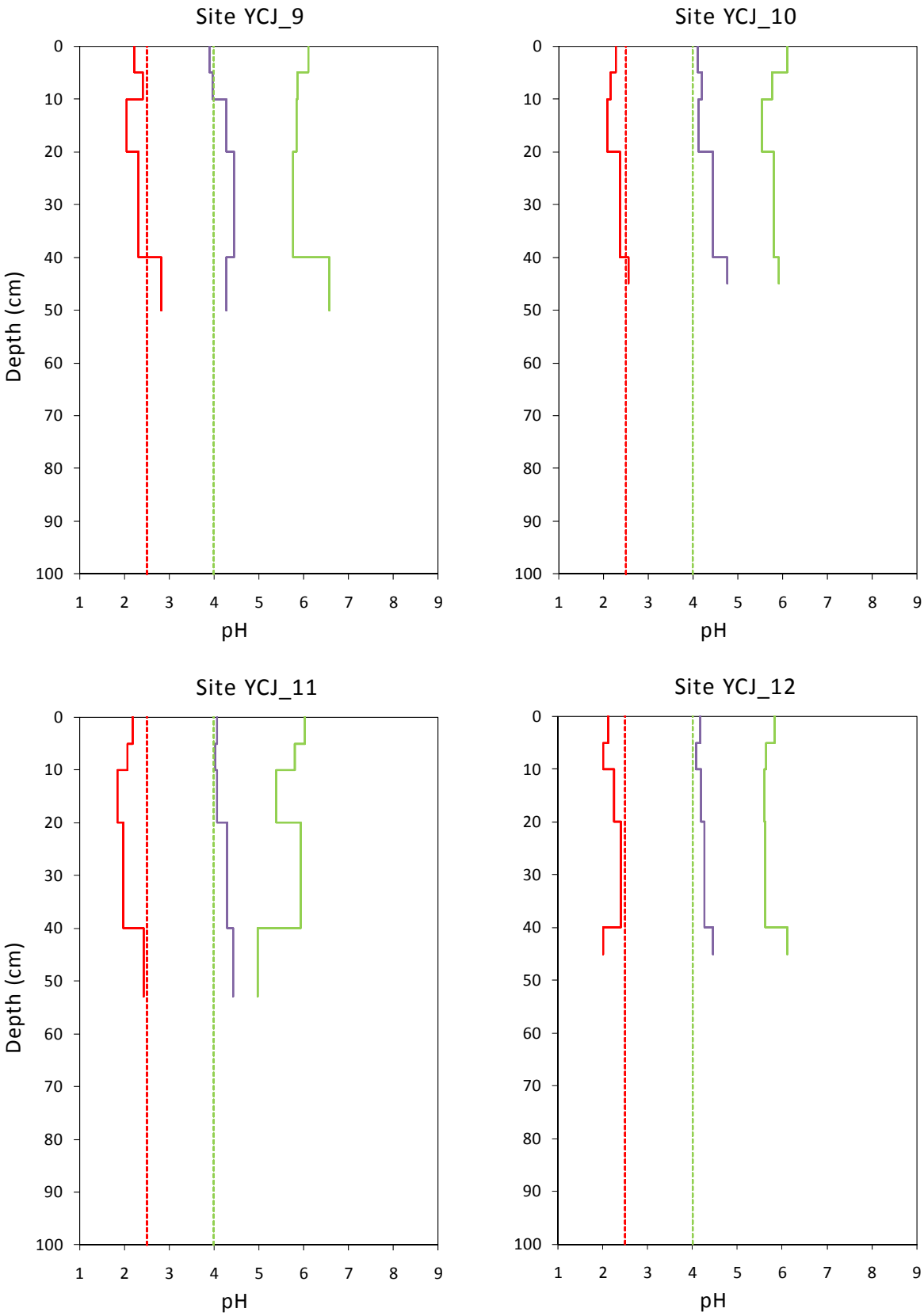

Figure 8-152. Depth profiles of soil pH for sites at Yarrakool Creek Junction (YCJ_9 – YCJ_12), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

Acid-base accounting

The acid-base accounting data is provided in Table 8-58 and summarised in Figures 8-153 to 8-155.

Chromium reducible sulfur

Chromium reducible sulfur (S_{CR}) values ranged between < 0.01 and 0.02% S_{CR}. Sulfidic soil materials (i.e. S_{CR} ≥ 0.01% S) were identified in eight of the 12 soil profiles, with 22 materials of the 60 samples collected equal to or greater than the sulfidic criterion.

Acid volatile sulfide

The acid volatile sulfide (S_{AV}) values ranged between < 0.01 and 0.01% S_{AV}. Only one monosulfidic soil material (i.e. S_{AV} ≥ 0.01% S) was found in one of the 12 soil profiles examined.

Acid neutralising capacity

All soil materials had no acid neutralising capacity (ANC).

Titratable actual acidity

The titratable actual acidity (TAA) ranged between 15 and 62 mole H^+/tonne. A decrease in TAA with depth was usually observed.

Retained acidity

Retained acidity was detected in a total of 51 layers from all 12 profiles, ranging between zero and 5 mole H^+/tonne.

Net acidity

Net acidity ranged between 15 and 72 mole H^+/tonne. The 22 hypersulfidic soils had moderate net acidities ranging between 33 and 72 mole H^+/tonne.

Water Soluble Sulfate

The water soluble sulfate in the surface soils (i.e. 0-20 cm) ranged between 49 and 137 mg SO_4/kg. The surface soil layers at ten of the 12 profiles examined had a soluble sulfate content either equal to or exceeding the 100 mg/kg trigger value for MBO formation potential.

Water Data

The surface water data measured in the field are presented in Table 8-59. The field pH of the surface waters collected ranged between 7.0 and 8.3, with one sample exceeding the most relevant ANZECC/ARMCANZ (2000) trigger value for aquatic ecosystems of 8.0. The water data indicates that the surface water has not been affected by acidification. SEC values were not found to exceed the most relevant ANZECC/ARMCANZ (2000) guideline value.

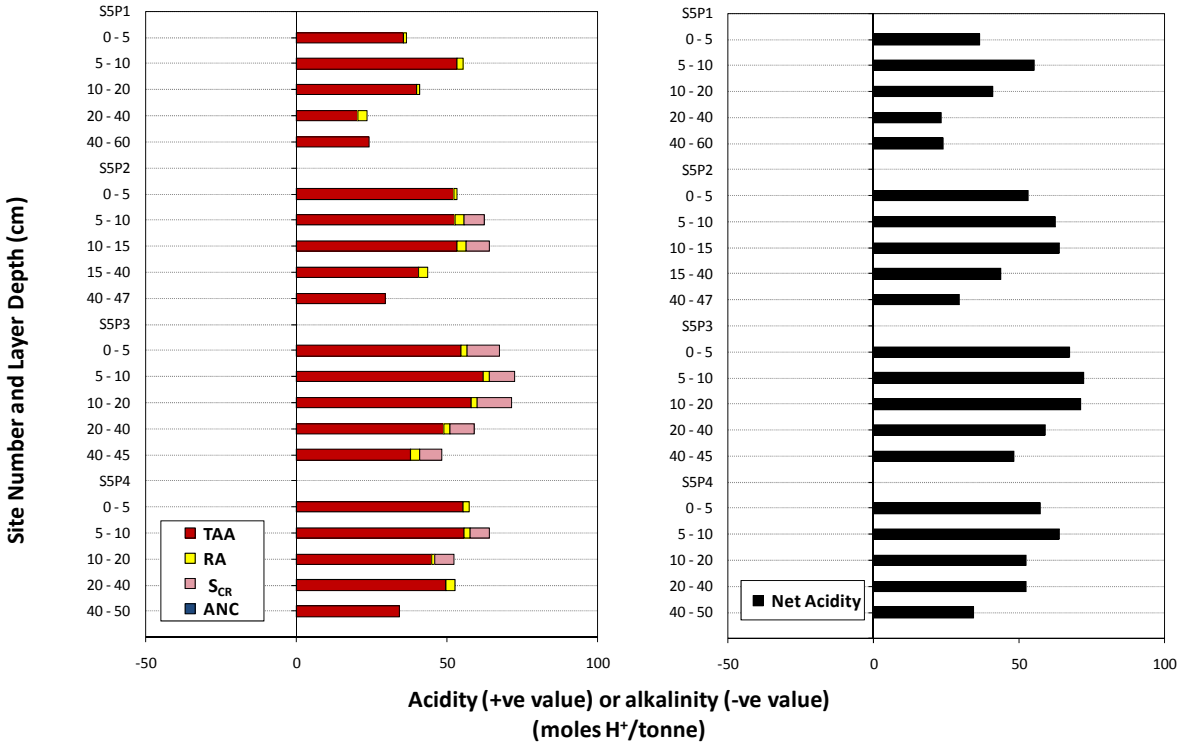

Figure 8-153. Acid-base accounting depth profiles for sites Yarrakool Creek Junction (YCJ_1 – YCJ_4). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

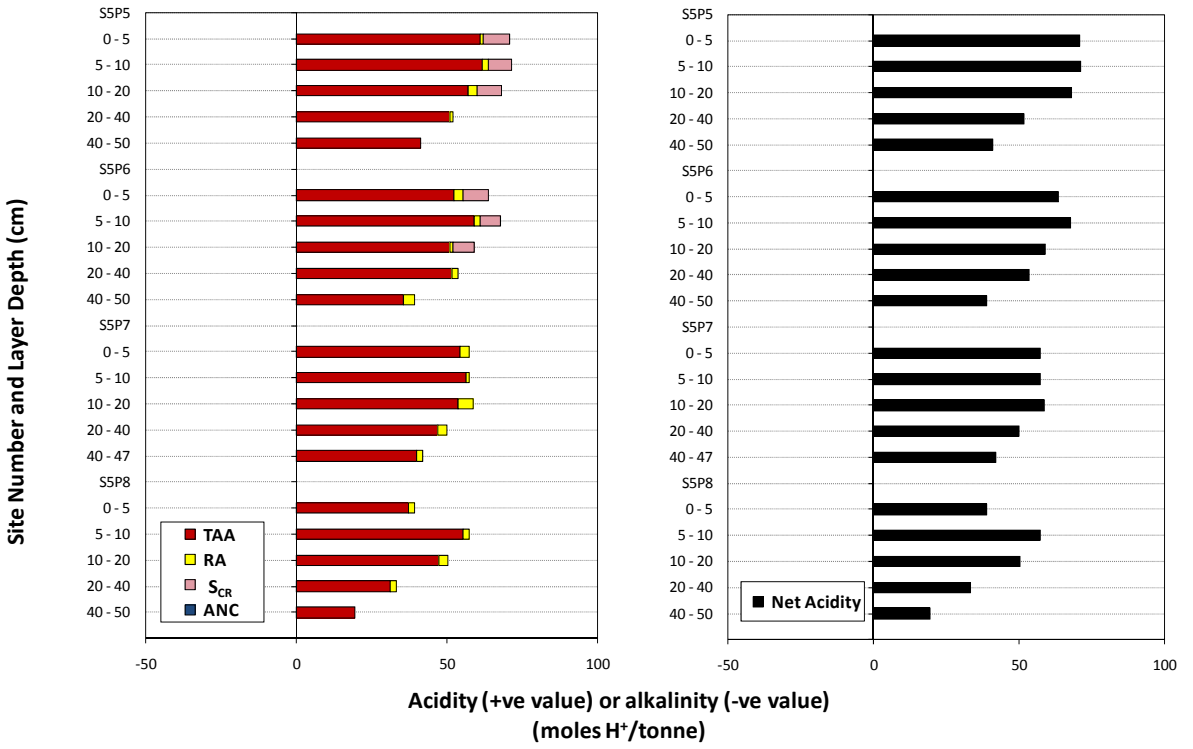

Figure 8-154. Acid-base accounting depth profiles for sites Yarrakool Creek Junction (YCJ_5 – YCJ_8). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

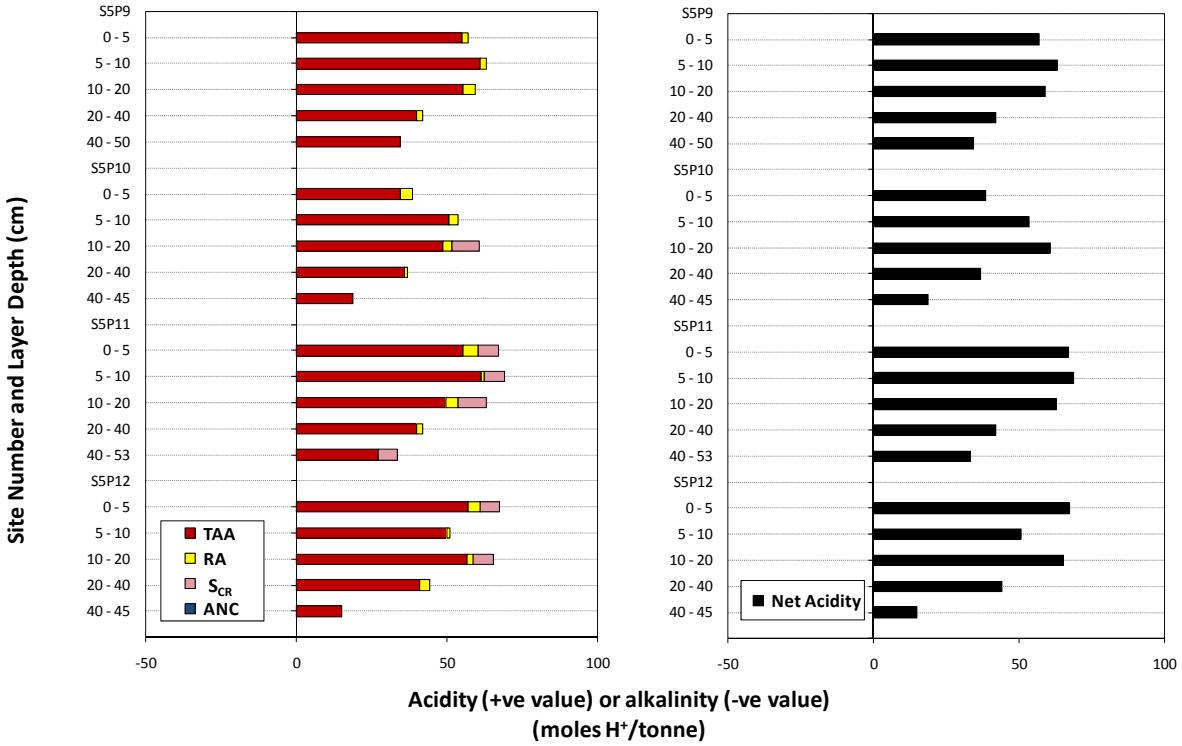

Figure 8-155. Acid-base accounting depth profiles for sites Yarrakool Creek Junction (YCJ_9 – YCJ_12). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

8.15.4. Discussion

Acid sulfate soil materials occurred within the soil profile at eight of the 12 sites examined at Yarrakool Creek Junction. Sulfuric materials were not observed at Yarrakool Creek Junction. Hypersulfidic soil materials with S_{CR} contents of up to 0.02% S were present at the eight sites. These sulfidic soil materials had low to moderate net acidities (i.e. 33 - 72 mole H^+/tonne). A monosulfidic soil material was observed in the upper 0-5 cm layer at one site, with an S_{AV} content of 0.01% S. These results indicate that acidity would be produced upon oxidation of the sulfidic materials. All surficial soil materials at ten sites contained soluble sulfate either equal to or exceeding the 100 mg/kg trigger value for MBO formation potential. Other acidic soil materials were also observed at 11 sites.

Based on the priority ranking criteria adopted by the Scientific Reference Panel of the Murray-Darling Basin Acid Sulfate Soil Risk Assessment Project, there were eight high priority sites based on hypersulfidic material. Ten sampling sites had a high priority ranking for Phase 2 detailed assessment based on MBO formation hazard.

The potential hazards posed by acid sulfate soil materials at the Yarrakool Creek Junction sites are:

- Acidification hazard: Moderate net acidities were dominant in this channel, and all hypersulfidic materials had moderate net acidities (i.e. 37 % of layers), indicating that the overall degree of acidification hazard is moderate.

- Deoxygenation hazard: A monosulfidic soil material (S_{AV} = 0.01% S) observed in the upper 0-5 cm layer at one site represent a high deoxygenation hazard. In addition, the soluble sulfate content of surface soil materials at ten sites were over the trigger

value for MBO formation indicating the possible development of a high deoxygenation hazard at those locations after prolonged wet conditions.

- Metal mobilisation: The moderate acidification hazard indicates that soil acidification may increase the solubility of metals. The presence of a monosulfidic material in an upper soil layer and the potential for MBO formation identified in parts of this channel may also result in a high metal release hazard. This would depend on factors such as the potential for MBO formation and the metal loading in the channel. Soil acidity may be sufficient for mobilisation of aluminium at all sites.

Summary of key findings for Yarrakool Creek Junction:

Soil materials:	Sulfidic soil materials identified included: hypersulfidic (8 profiles) and monosulfidic (1 profile). Other acidic soil materials observed in the remaining 4 profiles. Moderate net acidities dominant within this channel.
Acid sulfate soil identification:	• Sulfidic materials were recorded at various depths, and from across the full depth profile at one site. Only one monosulfidic material was recorded, in a surface layer. All sites were subaqueous.
Hazard assessment	• Acidification hazard - moderate level of concern • Deoxygenation hazard - high level of concern • Metal mobilisation hazard - high level of concern

Table 8-58. Laboratory analytical data for acid sulfate soil assessment of Yarrakool Creek Junction (Site 5).

(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P1_1	0-5		5.91	2.31	4.18*	77.40	4.11	35.49	0.00	1.00	0.00	36.49	0.00	Other Acid Soils
P1_2	5-10		5.97	2.20	4.10*	96.15	4.05	53.32	0.00	2.00	0.00	55.32	0.00	Other Acid Soils
P1_3	10-20		5.29	2.58	4.09	88.80	4.05	39.93	0.00	1.00	0.00	40.93	0.00	Other Acid Soils
P1_4	20-40		5.44	2.07	4.47	72.30	4.44	20.43	0.00	3.00	0.00	23.43	0.00	Other Acid Soils
P1_5	40-60		5.13	3.12	4.41	63.30	4.58	23.96	0.00	0.00	0.00	23.96	0.00	Other Acid Soils
P2_1	0-5		5.93	2.07	4.03*	116.40	4.15	52.21	0.00	1.00	0.00	53.21	0.00	Other Acid Soils
P2_2	5-10		5.91	2.17	4.04	100.35	4.08	52.65	0.01	3.00	0.00	62.52	0.00	Hypersulfidic#
P2_3	10-15		6.13	2.29	4.12	108.60	4.10	53.29	0.01	3.00	0.00	63.97	0.00	Hypersulfidic#
P2_4	15-40		6.27	2.56	4.40	87.90	4.32	40.65	0.00	3.00	0.00	43.65	0.00	Other Acid Soils
P2_5	40-47		5.91	2.51	4.17	97.65	4.54	29.54	0.00	0.00	0.00	29.54	0.00	Other Acid Soils
P3_1	0-5		6.05	2.46	4.38*	136.65	4.22	54.49	0.02	2.00	0.00	67.32	0.00	Hypersulfidic#
P3_2	5-10		5.85	2.25	4.29*	109.80	4.08	61.90	0.01	2.00	0.00	72.40	0.00	Hypersulfidic#
P3_3	10-20		5.74	2.19	4.13	120.60	4.14	57.95	0.02	2.00	0.00	71.35	0.00	Hypersulfidic#
P3_4	20-40		6.24	2.42	4.32	123.45	4.27	48.86	0.01	2.00	0.00	58.93	0.00	Hypersulfidic#
P3_5	40-45		6.46	2.61	4.31	116.85	4.42	37.98	0.01	3.00	0.00	48.41	0.00	Hypersulfidic#
P4_1	0-5		5.75	2.41	4.16*	120.90	4.22	55.44	0.00	2.00	0.00	57.44	0.00	Other Acid Soils
P4_2	5-10		5.82	2.15	4.19*	114.75	4.15	55.74	0.01	2.00	0.00	64.11	0.00	Hypersulfidic#
P4_3	10-20		5.92	2.24	4.16	104.25	4.19	44.91	0.01	1.00	0.00	52.39	0.00	Hypersulfidic#
P4_4	20-40		5.98	2.78	4.33	129.90	4.24	49.62	0.00	3.00	0.00	52.62	0.00	Other Acid Soils
P4_5	40-45		6.22	2.78	4.24*	119.25	4.50	34.24	0.00	0.00	0.00	34.24	0.00	Other Acid Soils
P5_1	0-5		5.83	1.95	3.96*	50.10	4.14	60.96	0.01	1.00	0.00	70.79	0.00	Hypersulfidic
P5_2	5-10		5.77	1.66	4.02*	106.35	4.13	61.56	0.01	2.00	0.00	71.32	0.00	Hypersulfidic#
P5_3	10-20		5.78	1.83	4.23	112.80	4.18	56.96	0.01	3.00	0.00	68.09	0.00	Hypersulfidic#
P5_4	20-40		5.54	2.11	4.20	119.40	4.28	50.89	0.00	1.00	0.00	51.89	0.00	Other Acid Soils
P5_5	40-50		5.62	1.95	4.29*	109.80	4.45	41.13	0.00	0.00	0.00	41.13	0.00	Other Acid Soils

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). # Classified as hypersulfidic based on positive net acidity.

Table 8-58 (continued). Laboratory analytical data for acid sulfate soil assessment of Yarrakool Creek Junction (Site 5).

(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P6_1	0-5		5.98	1.86	4.07*	52.20	4.18	52.32	0.01	3.00	0.00	63.60	0.01	Hypermonosulfidic
P6_2	5-10		5.98	1.63	4.14*	103.95	4.17	59.00	0.01	2.00	0.00	67.75	0.00	Hypersulfidic#
P6_3	10-20		5.40	1.96	4.18	106.05	4.17	51.10	0.01	1.00	0.00	59.15	0.00	Hypersulfidic#
P6_4	20-40		6.22	2.35	4.34	104.25	4.24	51.56	0.00	2.00	0.00	53.56	0.00	Other Acid Soils
P6_5	40-50		6.27	2.94	4.34*	154.50	4.42	35.55	0.00	3.50	0.00	39.05	0.00	Other Acid Soils
P7_1	0-5		6.09	2.08	3.96*	108.90	4.18	54.46	0.00	3.00	0.00	57.46	0.00	Other Acid Soils
P7_2	5-10		5.91	1.90	4.11*	124.20	4.15	56.26	0.00	1.00	0.00	57.26	0.00	Other Acid Soils
P7_3	10-20		6.14	1.97	4.09*	124.95	4.18	53.78	0.00	5.00	0.00	58.78	0.00	Other Acid Soils
P7_4	20-40		6.32	2.34	4.07*	104.85	4.27	47.02	0.00	3.00	0.00	50.02	0.00	Other Acid Soils
P7_5	40-47		6.42	2.36	4.15*	94.20	4.43	39.92	0.00	2.00	0.00	41.92	0.00	Other Acid Soils
P8_1	0-5		5.75	2.01	4.33*	80.40	4.19	37.08	0.00	2.00	0.00	39.08	0.00	Other Acid Soils
P8_2	5-10		5.31	1.87	4.11*	85.35	4.07	55.37	0.00	2.00	0.00	57.37	0.00	Other Acid Soils
P8_3	10-20		5.13	2.09	4.28*	97.35	4.07	47.37	0.00	3.00	0.00	50.37	0.00	Other Acid Soils
P8_4	20-40		5.21	1.72	4.74*	97.20	4.31	31.29	0.00	2.00	0.00	33.29	0.00	Other Acid Soils
P8_5	40-50		5.52	2.60	4.85	68.25	4.79	19.50	0.00	0.00	0.00	19.50	0.00	Other Acid Soils
P9_1	0-5		6.10	2.22	3.90*	48.90	4.24	55.05	0.00	2.00	0.00	57.05	0.00	Other Acid Soils
P9_2	5-10		5.86	2.42	3.97*	103.05	4.15	61.12	0.00	2.00	0.00	63.12	0.00	Other Acid Soils
P9_3	10-20		5.84	2.06	4.27*	109.95	4.20	55.22	0.00	4.00	0.00	59.22	0.00	Other Acid Soils
P9_4	20-40		5.77	2.31	4.45*	106.95	4.33	39.97	0.00	2.00	0.00	41.97	0.00	Other Acid Soils
P9_5	40-50		6.57	2.83	4.27*	99.45	4.56	34.53	0.00	0.00	0.00	34.53	0.00	Other Acid Soils
P10_1	0-5		6.10	2.28	4.10	97.35	4.37	34.61	0.00	4.00	0.00	38.61	0.00	Other Acid Soils
P10_2	5-10		5.76	2.16	4.21*	103.65	4.23	50.53	0.00	3.00	0.00	53.53	0.00	Other Acid Soils
P10_3	10-20		5.54	2.09	4.12	92.85	4.20	48.61	0.01	3.00	0.00	60.67	0.00	Hypersulfidic#
P10_4	20-40		5.80	2.37	4.44*	72.60	4.38	35.74	0.00	1.00	0.00	36.74	0.00	Other Acid Soils
P10_5	40-45		5.91	2.57	4.77	69.90	4.77	18.77	0.00	0.00	0.00	18.77	0.00	Other Acid Soils

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). # Classified as hypersulfidic based on positive net acidity.

Table 8-58 (continued). Laboratory analytical data for acid sulfate soil assessment of Yarrakool Creek Junction (Site 5).

(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P11_1	0-5		6.02	2.18	4.07*	96.15	4.21	55.47	0.01	5.00	0.00	67.14	0.00	Hypersulfidic#
P11_2	5-10		5.80	2.07	4.03*	108.00	4.14	61.53	0.01	1.00	0.00	68.93	0.00	Hypersulfidic#
P11_3	10-20		5.39	1.85	4.07	106.05	4.17	49.48	0.02	4.00	0.00	63.03	0.00	Hypersulfidic#
P11_4	20-40		5.93	1.97	4.29	90.15	4.30	39.98	0.00	2.00	0.00	41.98	0.00	Other Acid Soils
P11_5	40-53		4.97	2.43	4.43*	79.05	4.53	27.16	0.01	0.00	0.00	33.43	0.00	Hypersulfidic#
P12_1	0-5		5.84	2.12	4.17*	95.70	4.19	56.92	0.01	4.00	0.00	67.47	0.00	Hypersulfidic#
P12_2	5-10		5.65	2.00	4.08*	103.20	4.16	49.83	0.00	1.00	0.00	50.83	0.00	Other Acid Soils
P12_3	10-20		5.60	2.25	4.19*	112.95	4.17	56.54	0.01	2.00	0.00	65.27	0.00	Hypersulfidic#
P12_4	20-40		5.62	2.40	4.26*	105.00	4.34	40.74	0.00	3.50	0.00	44.24	0.00	Other Acid Soils
P12_5	40-45		6.12	2.00	4.45	63.15	4.56	14.98	0.00	0.00	0.00	14.98	0.00	Other Acid Soils

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). # Classified as hypersulfidic based on positive net acidity.

Table 8-59. Field hydrochemistry data for acid sulfate soil assessment of Yarrakool Creek Junction (Site 5).

Site ID.	Depth (m)	Specific Electrical Conductivity (µS/cm)	pH
*Lowland River**		*125-2,220*	*6.5-8.0*
YCJ_3	0.1	185.1	8.25
YCJ_3	1.0	183.9	7.56
YCJ_3	1.8	184.3	7.44
YCJ_11	0.1	189.0	7.88
YCJ_11	0.7	188.0	7.58
YCJ_11	1.2	185.6	7.00

* ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for relevant parameters (ANZECC/ARMCANZ, 2000).
Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text.

Table 8-60. Profile description data for acid sulfate soil assessment of Yarrakool Creek Junction (Site 5).

Site and Sample No.	Horizon Depth Range (cm)	Sediment	Organics	Colour	Eh (mV)	pH
P1_1	0-5	Medium Sand	Minor	10YR5/3	67	5.77
P1_2	5-10	Medium Sandy Clay	Minor	10YR5/1	52	6.07
P1_3	10-20	Medium Sandy Clay	None	10YR5/1	15	6.04
P1_4	20-40	Medium to Coarse Sandy Clay	None	10YR5/1	65	5.72
P1_5	40-60	Medium to Coarse Sandy Clay	None	10YR5/1	44	5.99
P2_1	0-5	Silty Clay	None	10YR5/1	15	6.03
P2_2	5-10	Silty Clay	None	10YR5/1	88	5.98
P2_3	10-15	Silty Clay	None	10YR5/1	83	5.99
P2_4	15-40	Silty Clay	None	10YR5/1	102	6.10
P2_5	40-47	Silty Clay	None	10YR5/1	110	5.95
P3_1	0-5	Fine Sandy Clay	None	10YR5/1	242	6.04
P3_2	5-10	Fine Sandy Clay	None	10YR5/1	263	6.02
P3_3	10-20	Fine Sandy Clay	None	10YR5/1	83	5.89
P3_4	20-40	Fine Sandy Clay	None	10YR5/1	62	5.94
P3_5	40-45	Fine Sandy Clay	None	10YR5/1	52	5.95
P4_1	0-5	Silty Clay	None	10YR5/1	217	6.05
P4_2	5-10	Silty Clay	None	10YR5/1	114	5.77
P4_3	10-20	Fine Sandy Clay	None	10YR5/1	88	5.95
P4_4	20-40	Fine Sandy Clay	None	10YR5/1	56	6.16
P4_5	40-45	Fine Sandy Clay	None	10YR5/1	100	6.00
P5_1	0-5	Fine Sandy Clay	None	10YR5/1	58	5.95
P5_2	5-10	Fine Sandy Clay	None	10YR5/1	86	5.88
P5_3	10-20	Fine Sandy Clay	None	10YR5/1	113	5.92
P5_4	20-40	Medium Sandy Clay	None	10YR5/1	87	5.83
P5_5	40-50	Medium Sandy Clay	None	10YR5/1	18	5.65
P6_1	0-5	Silty Clay	None	10YR5/1	15	5.82
P6_2	5-10	Silty Clay	None	10YR5/1	68	5.82
P6_3	10-20	Silty Clay	None	10YR5/1	112	5.80
P6_4	20-40	Silty Clay	None	10YR5/1	76	6.02
P6_5	40-50	Silty Clay	None	10YR5/1	93	5.81

Table 8-60 (continued). Profile description data for acid sulfate soil assessment of Yarrakool Creek Junction (Site 5).

Site and Sample No.	Horizon Depth Range (cm)	Sediment	Organics	Colour	Eh (mV)	pH
P7_1	0-5	Silty Clay	None	10YR5/1	66	6.00
P7_2	5-10	Silty Clay	None	10YR5/1	113	5.89
P7_3	10-20	Silty Clay	None	10YR5/1	74	5.99
P7_4	20-40	Silty Clay	None	10YR5/1	120	5.85
P7_5	40-47	Silty Clay	None	10YR5/1	120	5.92
P8_1	0-5	Silty Clay	None	10YR5/3	91	5.91
P8_2	5-10	Silty Clay	None	10YR5/3	84	5.35
P8_3	10-20	Silty Medium Sand	None	10YR5/1	95	5.83
P8_4	20-40	Silty Medium Sand	None	10YR5/1	81	5.95
P8_5	40-50	Silty Medium Sand	None	10YR5/1	110	5.89
P9_1	0-5	Silty Medium Sand	None	10YR5/3	28	5.86
P9_2	5-10	Medium Sandy Clay	None	10YR5/1	81	5.71
P9_3	10-20	Medium Sandy Clay	None	10YR5/1	101	5.85
P9_4	20-40	Medium Sandy Clay	None	10YR5/1	61	5.97
P9_5	40-50	Medium Sandy Clay	None	10YR5/1	80	5.59
P10_1	0-5	Silty Medium Sand	None	10YR5/3	158	5.89
P10_2	5-10	Medium Sandy Clay	None	10YR5/1	83	5.89
P10_3	10-20	Medium Sandy Clay	None	10YR5/1	107	5.75
P10_4	20-40	Medium Sandy Clay	None	10YR5/1	37	5.95
P10_5	40-45	Medium Sandy Clay	None	10YR5/1	-8	6.06
P11_1	0-5	Silty Medium Sand	None	10YR5/3	5	5.84
P11_2	5-10	Medium Sandy Clay	None	10YR5/3	89	5.50
P11_3	10-20	Medium Sandy Clay	None	10YR5/1	103	5.81
P11_4	20-40	Medium Sandy Clay	None	10YR5/1	92	5.87
P11_5	40-53	Medium Sandy Clay	None	10YR5/1	120	5.94
P12_1	0-5	Medium Sandy Clay	None	10YR5/1	38	5.86
P12_2	5-10	Medium Sandy Clay	None	10YR5/1	113	5.81
P12_3	10-20	Medium Sandy Clay	None	10YR5/1	125	5.75
P12_4	20-40	Medium Sandy Clay	None	10YR5/1	200	5.88

8.16. Kyalite Boat Ramp (Site 6)

8.16.1. Location and setting description

This site was located upstream of a bend in a flowing channel approximately 30 m wide (Figure 8-156). Water depth ranges from 1.0 – 3.5 m. Vegetation on the banks consisted of river red gums with a saltbush understorey. Twelve profiles were sampled in duplicate. The pH of the channel sediments were predominantly neutral to slightly acidic.

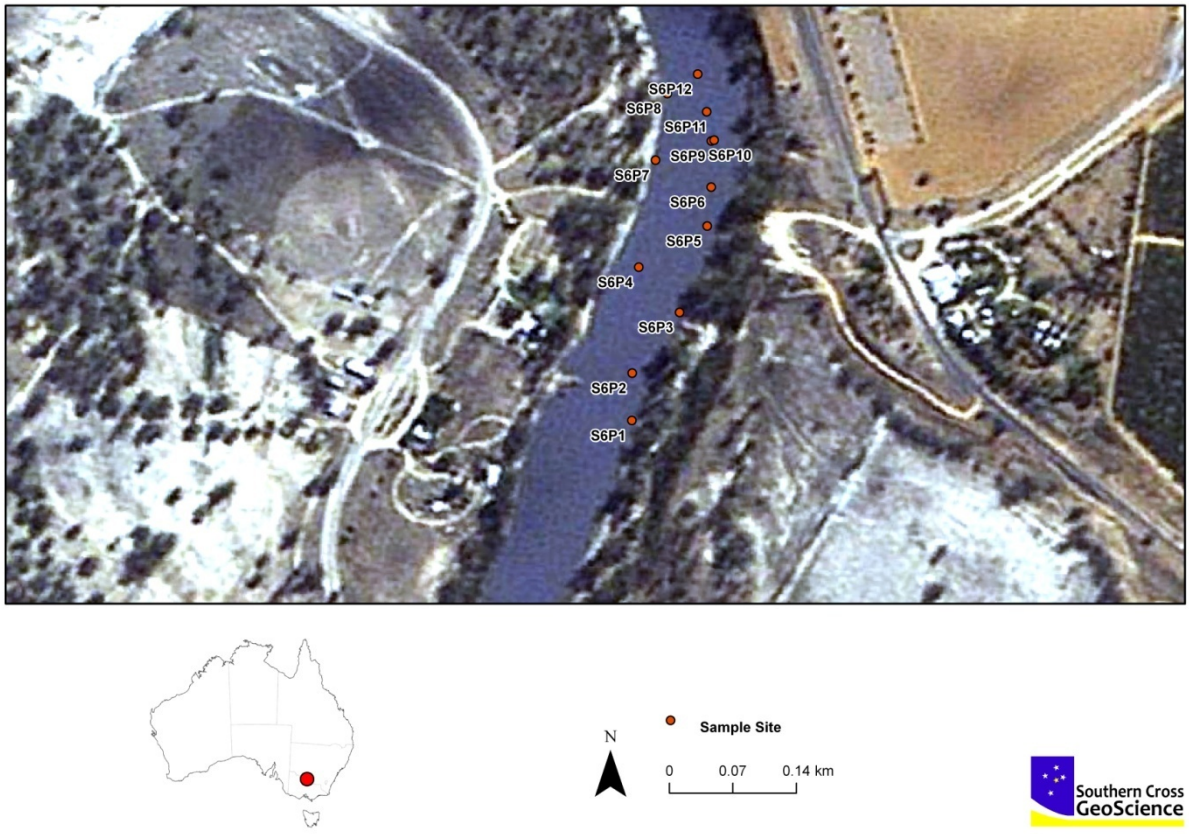

Figure 8-156. Kyalite Boat Ramp and sample site locations.

8.16.2. Soil profile description and distribution

Twelve profiles were described and sampled at Kyalite Boat Ramp. The soil subtype and general location description are presented in Table 8-61. Profile description data are presented in Table 8-64.

Table 8-61. Soil identification, subtype and general location description for sites sampled at Kyalite Boat Ramp.

Site ID	Easting UTM Zone 54H	Northing UTM Zone 54H	Acid sulfate soil subtype class
KBR_1	726493	6129477	Subaqueous Soil
KBR_2	726481	6129529	Subaqueous Soil
KBR_3	726532	6129595	Hypersulfidic Subaqueous Soil with Monosulfides
KBR_4	726490	6129645	Hypersulfidic Subaqueous Soil
KBR_5	726553	6129689	Hypersulfidic Subaqueous Soil
KBR_6	726557	6129732	Hypersulfidic Subaqueous Soil
KBR_7	726508	6129763	Hypersulfidic Subaqueous Soil with Monosulfides
KBR_8	726488	6129835	Subaqueous Soil
KBR_9	726559	6129783	Hypersulfidic Subaqueous Soil with Monosulfides
KBR_10	726561	6129783	Subaqueous Soil
KBR_11	726555	6129815	Hypersulfidic Subaqueous Soil
KBR_12	726548	6129857	Hypersulfidic Subaqueous Soil with Monosulfides

Figure 8-157. Site 6, Kyalite Boat Ramp (upstream view).

Figure 8-158. Site 6, Kyalite Boat Ramp (downstream view).

8.16.3. Laboratory data assessment

Soil pH testing (pH_W, pH_{FOX}, pH_{KCl}, $pH_{INCUBATION}$)

The pH data is provided in Table 8-62 and depth profiles of soil pH for all the sites sampled are presented in Figures 8-159 to 8-161. The pH_W values ranged between 5.44 and 7.37. No sulfuric materials (i.e. $pH_W < 4$) were present at Kyalite Boat Ramp. The pH_{FOX} values ranged between 1.40 and 5.89. The pH_{FOX} results indicate that all of the surface soils may have the potential to acidify to pH < 4 as a result of sulfide oxidation. Thirty-four soil materials had a $pH_{FOX} < 2.5$ suggesting that soil acidity problems will emerge when these soils are exposed to air. The S_{CR} data shows only 23 of the 60 layers examined contained detectable sulfide (i.e. $S_{CR} \geq 0.01\%$ S). The pH_{KCl} values ranged between 3.93 and 8.57. None of the sulfidic soil materials (i.e. $S_{CR} \geq 0.01\%$ S) acidified to pH < 4 after at least 8 weeks of incubation. Other acidic soil materials were identified in 11 of the 12 profiles examined, indicating acidity in the soil profile at levels where aluminium may mobilise.

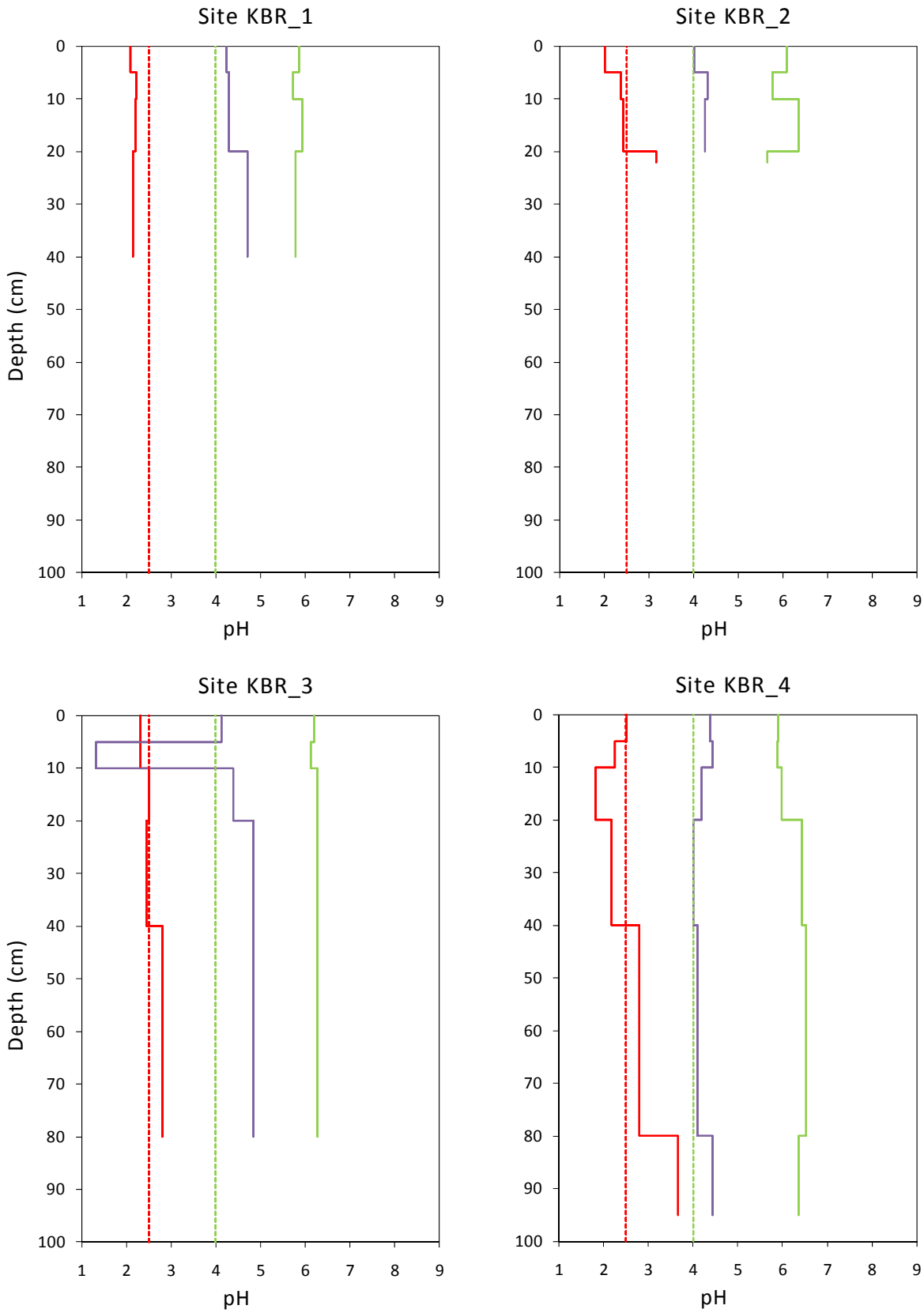

Figure 8-159. Depth profiles of soil pH for sites at Kyalite Boat Ramp (KBR_1 to KBR_4), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

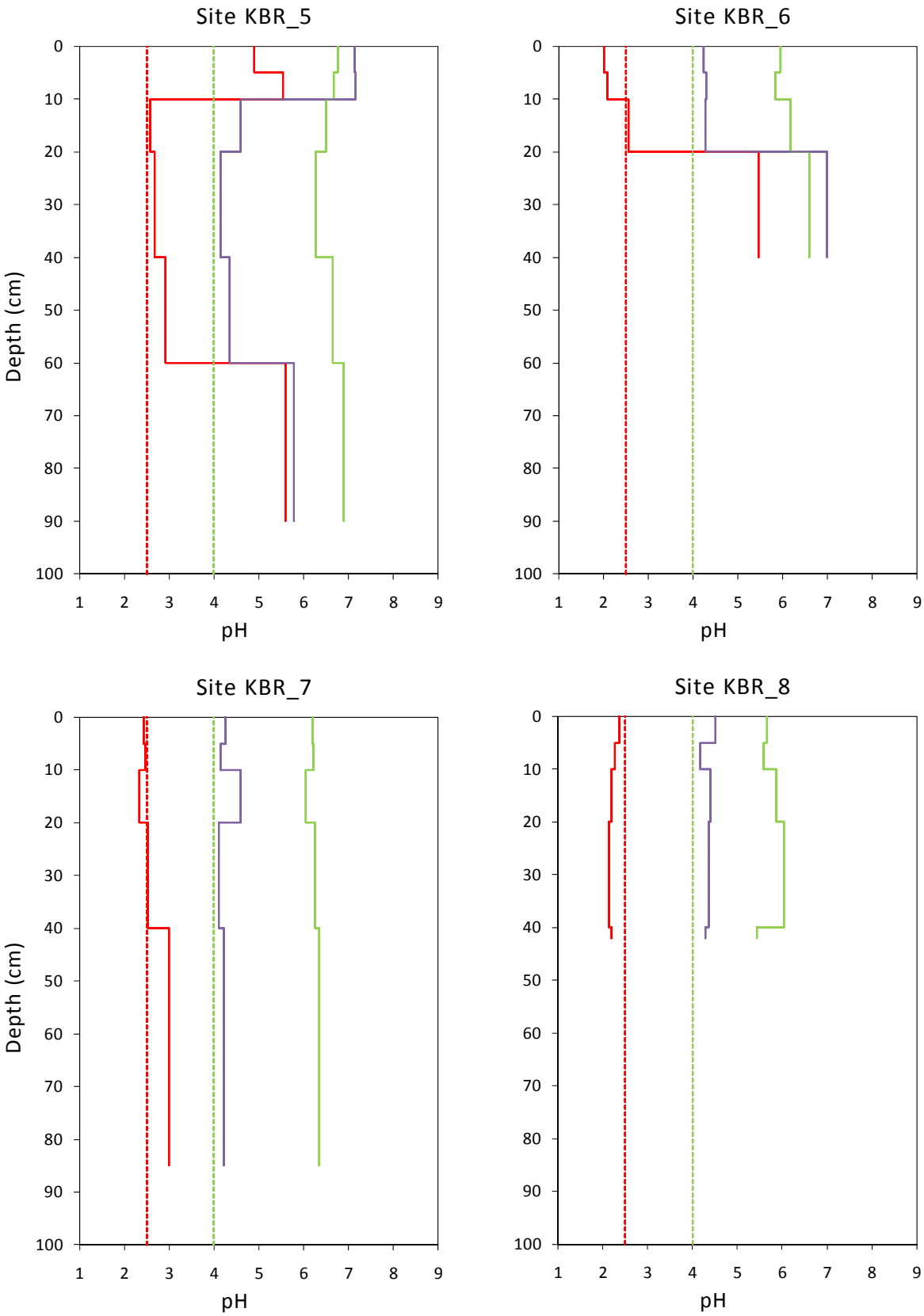

Figure 8-160. Depth profiles of soil pH for sites at Kyalite Boat Ramp (KBR_5 to KBR_8), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

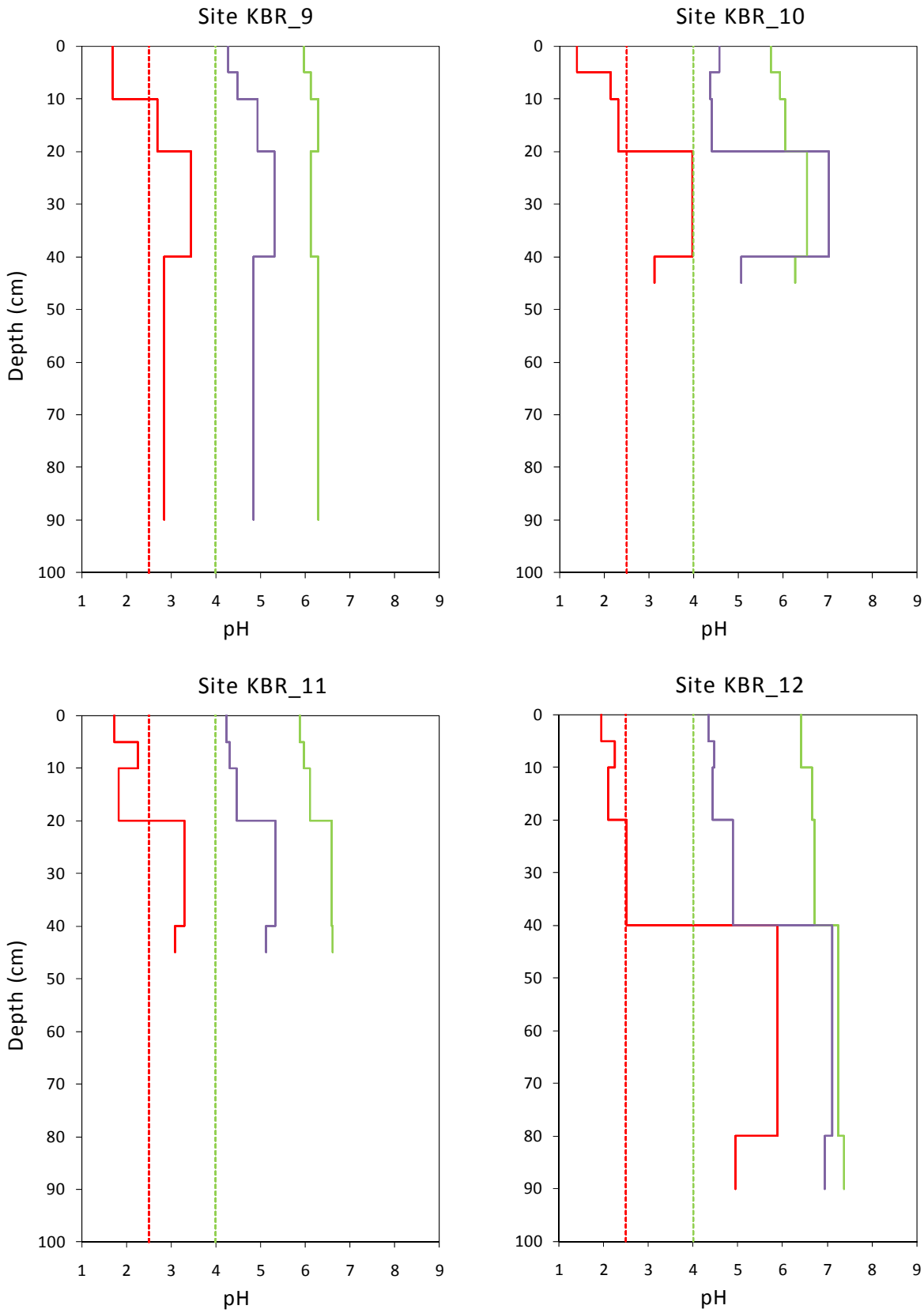

Figure 8-161. Depth profiles of soil pH for sites at Kyalite Boat Ramp (KBR_9 to KBR_12), showing soil pH (pH_W as green line), peroxide treated pH (pH_{FOX} as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical pH_W and $pH_{incubation}$ value of 4 (green dashed line) and critical pH_{FOX} value of 2.5 (red dashed line).

Acid-base accounting

The acid-base accounting data is provided in Table 8-62 and summarised in Figures 8-162 to 8-164.

Chromium reducible sulfur

Chromium reducible sulfur (S_{CR}) values ranged between < 0.01 and 0.17% S_{CR}. Sulfidic soil materials (i.e. S_{CR} ≥ 0.01% S) were identified in eight of the 12 soil profiles, with 23 materials of the 60 samples collected equal to or greater than the sulfidic criterion.

Acid volatile sulfide

The acid volatile sulfide (S_{AV}) values ranged between < 0.01 and 0.05% S_{AV}. A total of seven monosulfidic soil materials (i.e. S_{AV} ≥ 0.01% S) were found in four of the 12 soil profiles examined.

Acid neutralising capacity

The acid neutralising capacity (ANC) ranged between zero and 5.18% $CaCO_3$.

Titratable actual acidity

The titratable actual acidity (TAA) ranged between zero and 75 mole H^+/tonne. A decrease in TAA with depth was often observed,

Retained acidity

Retained acidity was detected in 12 layers, ranging between zero and 4 mole H^+/tonne.

Net acidity

Net acidity ranged between -690 and 113 mole H^+/tonne. The 20 hypersulfidic soils had low to high net acidities ranging between 10 and 113 mole H^+/tonne.

Water Soluble Sulfate

The water soluble sulfate in the surface soils (i.e. 0-20 cm) ranged between 33 and 249 mg SO_4/kg. The surface soil layers in 10 of the 12 profiles examined had a soluble sulfate content exceeding the 100 mg/kg trigger value for MBO formation potential.

Water Data

The surface water data measured in the field are presented in Table 8-63. The field pH of the surface waters collected ranged between 7.6 and 7.9, with no samples outside the most relevant ANZECC/ARMCANZ (2000) trigger values for aquatic ecosystems. The water data indicates that the surface water has not been affected by acidification. SEC values were not found to exceed the most relevant ANZECC/ARMCANZ (2000) guideline value.

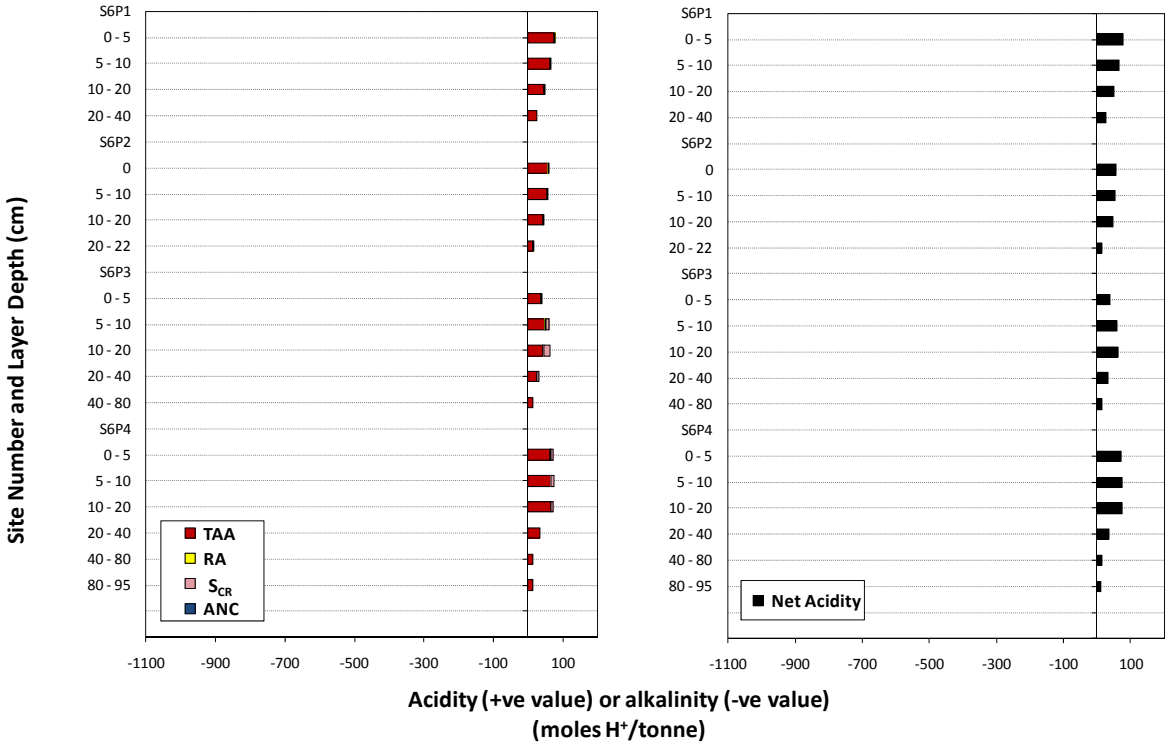

Figure 8-162. Acid-base accounting depth profiles for sites at Kyalite Boat Ramp (KBR_1 to KBR_4). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

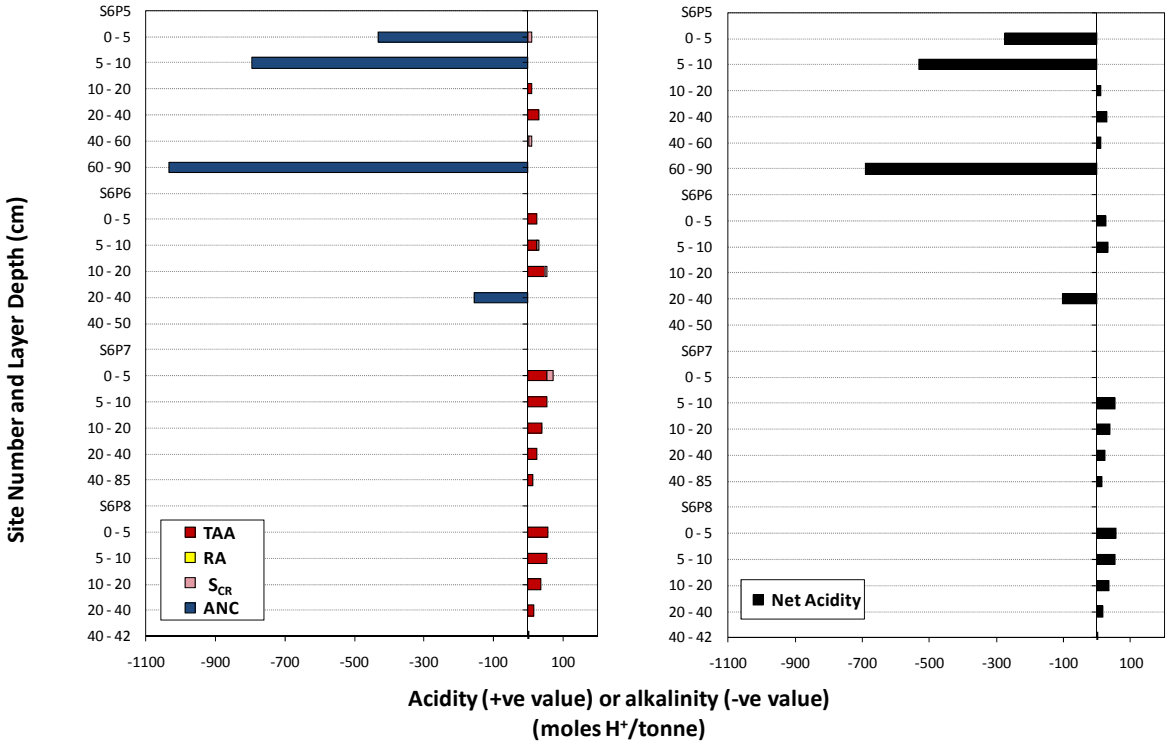

Figure 8-163. Acid-base accounting depth profiles for sites at Kyalite Boat Ramp (KBR_5 to KBR_8). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

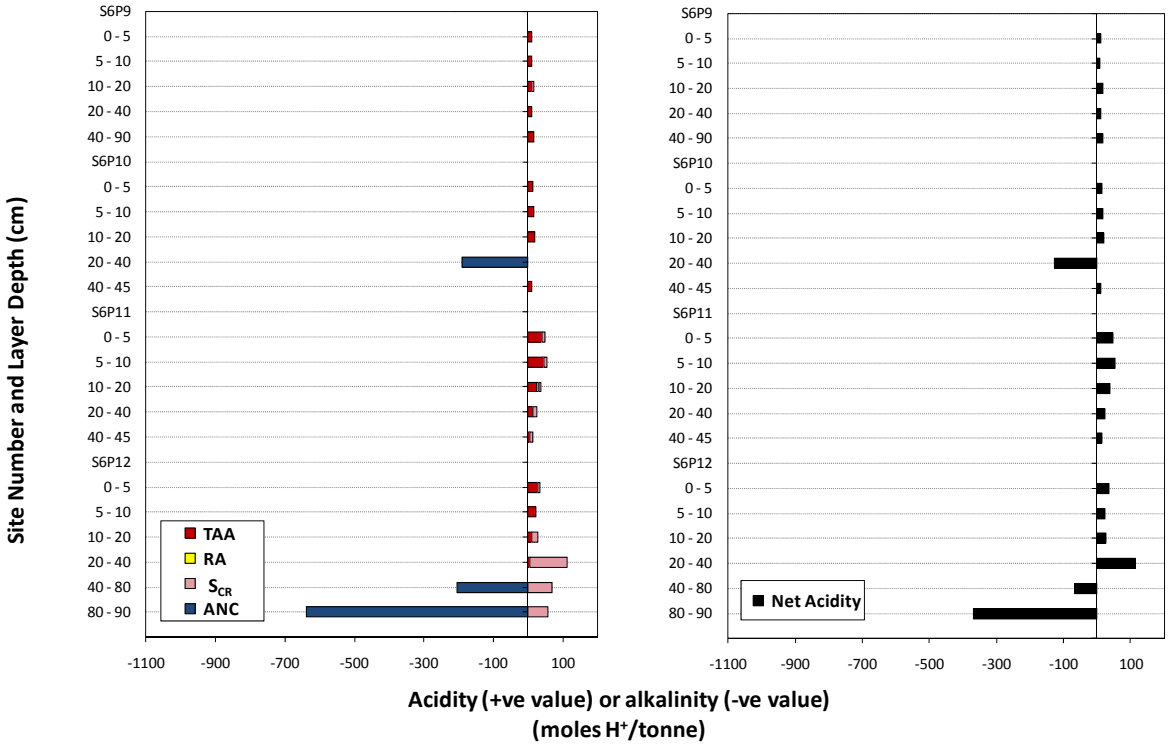

Figure 8-164. Acid-base accounting depth profiles for sites at Kyalite Boat Ramp (KBR_9 to KBR_12). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.

8.16.4. Discussion

Acid sulfate soil materials occurred within the soil profile at eight of the 12 sites examined at Kyalite Boat Ramp. Sulfuric materials were not observed at Kyalite Boat Ramp. The presence of reduced inorganic sulfur was identified at eight sites, with a S_{CR} of up to 0.17% S. Hypersulfidic soil materials with low to high net acidities (i.e. 10 to 113 mole H^+/tonne) were present in the eight soil profiles examined (two profiles also contained hyposulfidic material). Monosulfidic soil materials were also observed in four of the sulfidic profiles, with S_{AV} contents of up to 0.05% S. Monosulfidic soil materials (S_{AV} ≤ 0.02% S) were observed in the upper 0-10 cm layers in two profiles. These results indicate that acidity would be produced upon oxidation of the sulfidic materials. The surficial soil materials at ten sites contained soluble sulfate exceeding the 100 mg/kg trigger value for MBO formation potential. Other acidic soil materials were also observed at 11 sites.

Based on the priority ranking criteria adopted by the Scientific Reference Panel of the Murray-Darling Basin Acid Sulfate Soil Risk Assessment Project, there were eight high priority sites based on hypersulfidic material, one high priority site based on hyposulfidic material (S_{CR} ≥ 0.10%) and four high priority sites based on monosulfidic material. There was also one moderate priority site based on the presence of hyposulfidic material with S_{CR} < 0.10%. In addition, ten sampling sites had a high priority ranking for Phase 2 detailed assessment based on MBO formation hazard.

The potential hazards posed by acid sulfate soil materials at the Kyalite Boat Ramp sites are:

- Acidification hazard: Low-moderate net acidities were dominant in this channel, and only one hypersulfidic material had a high net acidity (i.e. 2% of layers), indicating that the overall degree of acidification hazard is moderate.

- Deoxygenation hazard: Monosulfidic soil materials (S_{AV} ≤ 0.02% S) observed in the upper 0-10 cm layers at two sites represent a high deoxygenation hazard. In addition, the soluble sulfate content of surface soil materials at ten sites were over the trigger value for MBO formation indicating the possible development of a high deoxygenation hazard at those locations after prolonged wet conditions.

- Metal mobilisation: The moderate acidification hazard indicates that soil acidification may increase the solubility of metals. The presence of monosulfidic materials in upper soil layers and the potential for MBO formation identified in parts of this channel may also result in a high metal release hazard. This would depend on factors such as the potential for MBO formation and the metal loading in the channel. Soil acidity may be sufficient for mobilisation of aluminium.

Summary of key findings for Kyalite Boat Ramp:

Soil materials:	Sulfidic soil materials identified included: hypersulfidic (8 profiles), monosulfidic (4 profiles), hyposulfidic ≥ 0.10% (1 profile) and hyposulfidic < 0.10% (1 profile). Low-moderate net acidities dominant within channel, although 1 hypersulfidic soil material had a high net acidity.
Acid sulfate soil identification:	• Sulfidic materials were observed at varying depths, and at two sites occurred throughout the depth profile. Monosulfides were found at four sites, at varying depths. All sites were subaqueous.
Hazard assessment	• Acidification hazard - moderate level of concern • Deoxygenation hazard - high level of concern • Metal mobilisation hazard - high level of concern

Table 8-62. Laboratory analytical data for acid sulfate soil assessment of Kyalite Boat Ramp (Site 6).

(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P1_1	0-5		5.86	2.09	4.23*	102.60	4.04	74.86	0.00	4.00	0.00	78.86	0.00	Other Acid Soils
P1_2	5-10		5.72	2.23	4.29*	118.95	4.03	62.19	0.00	3.00	0.00	65.19	0.00	Other Acid Soils
P1_3	10-20		5.93	2.21	4.29*	94.35	4.17	46.99	0.00	3.00	0.00	49.99	0.00	Other Acid Soils
P1_4	20-40		5.79	2.14	4.71*	111.75	4.52	26.72	0.00	0.00	0.00	26.72	0.00	Other Acid Soils
P2_1	0-5		6.09	2.02	4.02*	82.50	3.98	55.95	0.00	1.00	0.00	56.95	0.00	Other Acid Soils
P2_2	5-10		5.76	2.38	4.32*	88.35	3.96	53.33	0.00	1.00	0.00	54.33	0.00	Other Acid Soils
P2_3	10-20		6.34	2.43	4.25*	97.50	4.18	42.91	0.00	3.00	0.00	45.91	0.00	Other Acid Soils
P2_4	20-22		5.66	3.17	n/a	49.20	4.39	13.54	0.00	2.00	0.00	15.54	0.00	Other Acid Soils#
P3_1	0-5		6.20	2.32	4.13*	111.45	4.41	36.92	0.00	2.00	0.00	38.92	0.00	Other Acid Soils
P3_2	5-10		6.13	2.31	4.32*	n/a	4.26	47.91	0.01	3.00	0.00	59.87	0.01	Hypermonosulfidic#
P3_3	10-20		6.27	2.51	4.39*	249.00	4.30	42.04	0.03	4.00	0.00	63.73	0.02	Hypermonosulfidic#
P3_4	20-40		6.28	2.45	4.84*	95.10	4.69	23.99	0.01	0.00	0.00	30.93	0.00	Hypersulfidic
P3_5	40-80		6.28	2.80	4.84*	96.00	4.94	14.82	0.00	0.00	0.00	14.82	0.00	Other Acid Soils
P4_1	0-5		5.90	2.52	4.38*	49.65	4.00	61.91	0.01	3.00	0.00	71.69	0.00	Hypersulfidic#
P4_2	5-10		5.89	2.25	4.44*	51.60	4.05	65.37	0.01	0.00	0.00	73.63	0.00	Hypersulfidic#
P4_3	10-20		5.98	1.82	4.19	111.75	4.08	66.04	0.01	0.00	0.00	73.08	0.00	Hypersulfidic#
P4_4	20-40		6.44	2.17	4.00*	144.30	4.42	34.05	0.00	0.00	0.00	34.05	0.00	Other Acid Soils
P4_5	40-80		6.52	2.80	4.10*	112.80	5.03	13.44	0.00	0.00	0.00	13.44	0.00	Other Acid Soils
P4_6	80-95		6.36	3.66	4.44*	114.15	5.09	12.35	0.00	0.00	0.00	12.35	0.00	Other Acid Soils
P5_1	0-5		6.76	4.89	7.14	120.75	7.69	0.00	0.02	0.00	2.16	-275.78	0.00	Hyposulfidic
P5_2	5-10		6.67	5.53	7.16	130.05	7.94	0.00	0.00	0.00	3.99	-530.98	0.00	Other Soil Materials
P5_3	10-20		6.50	2.59	4.60*	96.45	5.43	9.81	0.00	0.00	0.00	9.81	0.00	Other Acid Soils
P5_4	20-40		6.28	2.67	4.14*	105.00	4.51	30.52	0.00	0.00	0.00	30.52	0.00	Other Acid Soils
P5_5	40-60		6.65	2.92	4.36*	108.00	6.10	3.41	0.01	0.00	0.00	10.48	0.00	Hypersulfidic#
P5_6	60-90		6.89	5.60	5.78*	143.25	8.34	0.00	0.00	0.00	5.18	-689.74	0.00	Other Soil Materials

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). # Classified as hypersulfidic based on positive net acidity.

Table 8-62 (continued). Laboratory analytical data for acid sulfate soil assessment of Kyalite Boat Ramp (Site 6).

(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P6_1	0-5		5.95	2.02	4.23*	106.50	4.44	25.42	0.00	0.00	0.00	25.42	0.00	Other Acid Soils
P6_2	5-10		5.84	2.09	4.30*	94.20	4.28	24.61	0.01	0.00	0.00	31.45	0.00	Hypersulfidic#
P6_3	10-20		6.17	2.57	4.28*	90.60	4.14	48.09	0.01	n/a	0.00	≥ 55.56	0.00	Hypersulfidic#
P6_4	20-40		6.59	5.46	6.98	105.00	7.13	0.00	0.00	0.00	0.78	-103.93	0.00	Other Soil Materials
P7_1	0-5		6.19	2.43	4.26	n/a	4.22	53.38	0.03	n/a	0.00	≥ 70.52	0.02	Hypermonosulfidic#
P7_2	5-10		6.21	2.47	4.15	n/a	4.12	53.80	0.00	0.00	0.00	53.80	0.00	Other Acid Soils
P7_3	10-20		6.05	2.33	4.60*	102.00	4.22	39.66	0.00	0.00	0.00	39.66	0.00	Other Acid Soils
P7_4	20-40		6.26	2.53	4.10*	114.30	4.61	24.34	0.00	0.00	0.00	24.34	0.00	Other Acid Soils
P7_5	40-85		6.34	3.00	4.22*	107.25	5.09	14.57	0.00	0.00	0.00	14.57	0.00	Other Acid Soils
P8_1	0-5		5.67	2.37	4.51*	39.90	3.93	56.50	0.00	0.00	0.00	56.50	0.00	Other Acid Soils
P8_2	5-10		5.58	2.27	4.18	96.90	3.98	53.18	0.00	0.00	0.00	53.18	0.00	Other Acid Soils
P8_3	10-20		5.87	2.20	4.39	84.75	4.19	35.49	0.00	0.00	0.00	35.49	0.00	Other Acid Soils
P8_4	20-40		6.04	2.13	4.36*	82.20	4.58	16.40	0.00	0.00	0.00	16.40	0.00	Other Acid Soils
P8_5	40-42		5.44	2.20	4.28*	37.95	4.94	2.91	0.00	0.00	0.00	2.91	0.00	Other Acid Soils
P9_1	0-5		5.97	1.69	4.28*	128.10	4.65	11.56	0.01	0.00	0.00	18.70	0.00	Hypersulfidic#
P9_2	5-10		6.13	1.69	4.49*	96.60	4.86	9.43	0.00	0.00	0.00	9.43	0.00	Other Acid Soils
P9_3	10-20		6.29	2.70	4.94*	140.25	4.95	10.81	0.01	0.00	0.00	17.56	0.01	Hypermonosulfidic#
P9_4	20-40		6.13	3.44	5.32	77.85	4.88	11.07	0.00	0.00	0.00	11.07	0.00	Other Acid Soils
P9_5	40-90		6.30	2.84	4.84*	77.10	4.81	15.73	0.00	0.00	0.00	15.73	0.00	Other Acid Soils
P10_1	0-5		5.72	1.40	4.58	118.35	4.53	13.61	0.00	0.00	0.00	13.61	0.00	Other Acid Soils
P10_2	5-10		5.93	2.15	4.37*	100.50	4.59	17.37	0.00	0.00	0.00	17.37	0.00	Other Acid Soils
P10_3	10-20		6.04	2.31	4.41	88.35	4.63	19.18	0.00	0.00	0.00	19.18	0.00	Other Acid Soils
P10_4	20-40		6.54	3.97	7.03*	76.05	7.43	0.00	0.00	0.00	0.95	-127.00	0.00	Other Soil Materials
P10_5	40-45		6.28	3.12	5.07*	81.30	5.09	10.29	0.00	0.00	0.00	10.29	0.00	Other Acid Soils

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). # Classified as hypermonosulfidic/hypersulfidic based on positive net acidity.

Table 8-62 (continued). Laboratory analytical data for acid sulfate soil assessment of Kyalite Boat Ramp (Site 6).

(red printed values indicate data results of potential concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	pH water	pH peroxide	pH incubation	Sulfate (mg SO_4 / kg)	pH KCl	Titratable Actual Acidity (mole H^+/t)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H^+/t)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/t)	Acid Volatile Sulfide (%S_{AV})	Acid Sulfate Soil Material Classification
P11_1	0-5		5.87	1.73	4.24*	45.45	4.18	40.23	0.01	0.00	0.00	48.11	0.00	Hypersulfidic#
P11_2	5-10		5.97	2.26	4.31	32.85	4.13	44.89	0.02	0.00	0.00	54.59	0.00	Hypersulfidic#
P11_3	10-20		6.10	1.83	4.46*	132.00	4.41	25.90	0.01	4.00	0.00	36.93	0.00	Hypersulfidic#
P11_4	20-40		6.59	3.29	5.33*	171.00	4.77	13.74	0.02	0.00	0.00	23.93	0.00	Hypersulfidic#
P11_5	40-45		6.61	3.09	5.13*	93.75	5.38	5.57	0.01	0.00	0.00	12.82	0.00	Hypersulfidic#
P12_1	0-5		6.41	1.95	4.35*	118.05	4.55	26.96	0.01	0.00	0.00	34.68	0.00	Hypersulfidic#
P12_2	5-10		6.42	2.26	4.47*	94.95	4.59	22.39	0.00	0.00	0.00	22.39	0.00	Other Acid Soils
P12_3	10-20		6.65	2.10	4.43	247.50	5.33	9.56	0.03	0.00	0.00	27.06	0.00	Hypersulfidic#
P12_4	20-40		6.72	2.51	4.88*	220.50	5.76	5.89	0.17	0.00	0.00	112.54	0.01	Hypermonosulfidic#
P12_5	40-80		7.25	5.89	7.12	292.50	7.76	0.00	0.11	0.00	1.02	-67.34	0.04	Hypomonosulfidic
P12_6	80-90		7.37	4.95	6.95	274.50	8.57	0.00	0.09	0.00	3.20	-369.25	0.05	Hypomonosulfidic

* Indicates that a stable pH has not yet been reached for this sample (after 12 weeks). # Classified as hypermonosulfidic/hypersulfidic based on positive net acidity.

Table 8-63. Field hydrochemistry data for acid sulfate soil assessment of Kyalite Boat Ramp (Site 6).

Site ID.	Depth (m)	Specific Electrical Conductivity (µS/cm)	pH
*Lowland River**		*125-2,220*	*6.5-8.0*
KBR_1	0.1	205.0	7.78
KBR_1	1.5	200.6	7.61
KBR_1	2.5	198.1	7.59
KBR_9	0.1	202.3	7.91
KBR_9	0.9	200.6	7.62
KBR_9	1.5	199.0	7.62

* ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for relevant parameters (ANZECC/ARMCANZ, 2000).
Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text.

Table 8-64. Profile description data for acid sulfate soil assessment of Kyalite Boat Ramp (Site 6).

Site and Sample No.	Horizon Depth Range (cm)	Sediment	Organics	Colour	Eh (mV)	pH
P1_1	0-5	Clayey Medium Sand	None	10YR5/1	20	6.09
P1_2	5-10	Clayey Medium Sand	None	10YR5/1	-34	6.19
P1_3	10-20	Clayey Medium Sand	None	10YR5/1	40	6.22
P1_4	20-40	Clayey Medium Sand	None	10YR5/1	-25	5.98
P2_1	0-5	Clayey Medium Sand	Some	10YR5/1	29	6.06
P2_2	5-10	Clayey Medium Sand	Some	10YR5/1	-31	6.28
P2_3	10-20	Clayey Medium Sand	Some	10YR5/1	-9	6.28
P3_1	0-5	Clayey Medium Sand	Some	10YR5/1	-50	6.47
P3_2	5-10	Clayey Medium Sand	Much	10YR5/1	-69	6.33
P3_3	10-20	Clayey Medium Sand	Some	10YR5/1	-5	6.10
P3_4	20-40	Clayey Medium Sand	Some	10YR5/1	-47	6.28
P3_5	40-80	Clayey Medium Sand	Some	10YR5/1	50	6.14
P4_1	0-5	Clayey Medium Sand	Minor	10YR5/4	159	6.21
P4_2	5-10	Clayey Medium Sand	Minor	10YR5/1	43	6.33
P4_3	10-20	Clayey Medium Sand	Minor	10YR5/1	-2	6.10
P4_4	20-40	Clayey Medium Sand	Minor	10YR5/1	-8	6.28
P4_5	40-80	Clayey Medium Sand	Minor	10YR5/1	-12	6.14
P5_1	0-5	Clayey Medium Sand	Minor	10YR5/4	8	6.41
P5_2	5-10	Clayey Medium Sand	Minor	10YR5/1	30	6.34
P5_3	10-20	Clayey Medium Sand	Minor	10YR5/1	-46	6.36
P5_4	20-40	Clayey Medium Sand	None	10YR5/1	24	6.25
P5_5	40-60	Clayey Medium Sand	None	10YR5/1	4	6.45
P5_6	60-90	Clayey Medium Sand	None	10YR5/1	6	6.50
P6_1	0-5	Silty Sand	Minor	10YR5/1	25	6.24
P6_2	5-10	Silty Sand	None	10YR5/1	33	6.34
P6_3	10-20	Silty Sand	None	10YR5/1	18	6.24
P6_4	20-40	Silty Sand	None	10YR5/1	-6	6.52
P6_5	40-50	Silty Sand	None	10YR5/1	-48	6.78
P7_1	0-5	Silty Sand	Minor	10YR5/1	43	6.33
P7_2	5-10	Silty Sand	Minor	10YR5/1	33	6.30

Table 8-64 (continued). Profile description data for acid sulfate soil assessment of Kyalite Boat Ramp (Site 6).

Site and Sample No.	Horizon Depth Range (cm)	Sediment	Organics	Colour	Eh (mV)	pH
P7_3	10-20	Silty Sand	None	10YR5/1	18	6.28
P7_4	20-40	Silty Sand	None	10YR5/1	16	6.21
P7_5	40-85	Silty Sand	None	10YR5/1	17	6.15
P8_1	0-5	Clayey Medium Sand	Minor	10YR5/4	64	6.29
P8_2	5-10	Clayey Medium Sand	Minor	10YR5/1	32	6.08
P8_3	10-20	Clayey Medium Sand	Minor	10YR5/1	55	5.97
P8_4	20-40	Clayey Medium Sand	Minor	10YR5/1	14	6.32
P8_5	40-42	Clayey Medium Sand	Minor	10YR5/1	24	6.12
P9_1	0-5	Silty Sand	Much	10YR5/1	17	6.39
P9_2	5-10	Silty Sand	Much	10YR5/1	18	6.23
P9_3	10-20	Silty Sand	Much, Debris	10YR5/1	-6	6.40
P9_4	20-40	Silty Sand	Much, Debris	10YR5/1	-22	6.39
P9_5	40-90	Silty Sand	Much, Debris	10YR5/1	123	6.27
P10_1	0-5	Medium Sand	Minor	Sand	-51	6.84
P10_2	5-10	Clayey Medium Sand	None	10YR5/1	-56	6.40
P10_3	10-20	Clayey Medium Sand	None	10YR5/1	-44	6.48
P10_4	20-40	Clayey Medium Sand	None	10YR5/1	-48	6.40
P10_5	40-45	Clayey Medium Sand	None	10YR5/1	0	6.28
P11_1	0-5	Clayey Medium Sand	None	10YR5/1	108	6.19
P11_2	5-10	Clayey Medium Sand	None	10YR5/1	92	6.16
P11_3	10-20	Clayey Medium Sand	None	10YR5/1	-28	6.06
P11_4	20-40	Clayey Medium Sand	None	10YR5/1	-43	6.41
P11_5	40-45	Clayey Medium Sand	None	10YR5/1	74	6.46
P12_1	0-5	Medium Sand	Some	Sand	93	6.42
P12_2	5-10	Silty Sand	Some	10YR5/1	174	6.29
P12_3	10-20	Silty Sand	Much, Debris	10YR5/1	69	6.54
P12_4	20-40	Silty Sand	Much, Debris	10YR5/1	28	6.62
P12_5	40-80	Silty Sand	Minor	10YR5/1	5	6.99
P12_6	80-90	Silty Sand	Minor	10YR5/1	-87	7.20