# Appendix 1. Channel reports (Component 1).

## 8.1. Wakool River

### 8.1.1. Location and setting description

The Wakool River is the major southern distributary of the Edward-Wakool alluvial system (Figure 8-1). The Wakool branches from the Edward ~8 km downstream of Deniliquin, and for the first ~10 km it follows the course of the palaeo-Edward River, within a broad, complex meander belt, the modern Edward having avulsed to the immediate north along this section. However, the Wakool then leaves this palaeo-channel, which continues to the north-west, the palaeo-channel being occupied 7 km further on by Colligen Creek. The Wakool then flows across a Shepparton surface, along the northern edge of the Cadell Tilt Block. Guided by the edge of the Block, the Wakool has a fairly straight planform until ~30 km downstream, where the Wakool falls into a broad Coonambidgal meander plain, and becomes highly sinuous. The river is narrow and of relatively insignificant dimensions until a further 10 km downstream, where the Wakool is joined by the morphologically larger anabranch Yallakool Creek (from the north). The Wakool, now having a substantial channel with large meander wavelengths, and situated within a broad meander belt, continues in a south-westerly direction towards the Murray River and Barham, until, at a point ~60 km downstream, the Wakool falls into the Thule Creek- Green Gully meander plain, being the palaeo-Murray River. The Wakool, along with a number of other modern anabranching and anastomosing channels and palaeo-channels, follows this palaeo-meander belt towards the north-west, being joined on the way by Barbers Creek, which flows from the Koondrook-Perricoota forest near Barham. The Wakool River continues for another ~70 km across a highly complex alluvial plan, until it reaches Coobool Island. The 'island' is surrounded on all sides during higher flows by the Wakool (southern and western sides), Mallan Mallan Creek (northern side), and the Niemur River (eastern side). Mallan Mallan Creek joins the Wakool ~12 km further on from the north, and, after another ~13 km, by Merran Creek from the south, with Yarrein Creek coming in ~5 km later from the north. At this point, all the major channels, with the exception of the Edward, have flowed back into the Wakool, which now assumes the proportions and morphology of the palaeo-Murray River, with channels widths, and meander wavelengths and widths generally in excess of that of the modern Murray. The Wakool is joined ~12 km later, by the Edward River from the north, just before Kyalite.

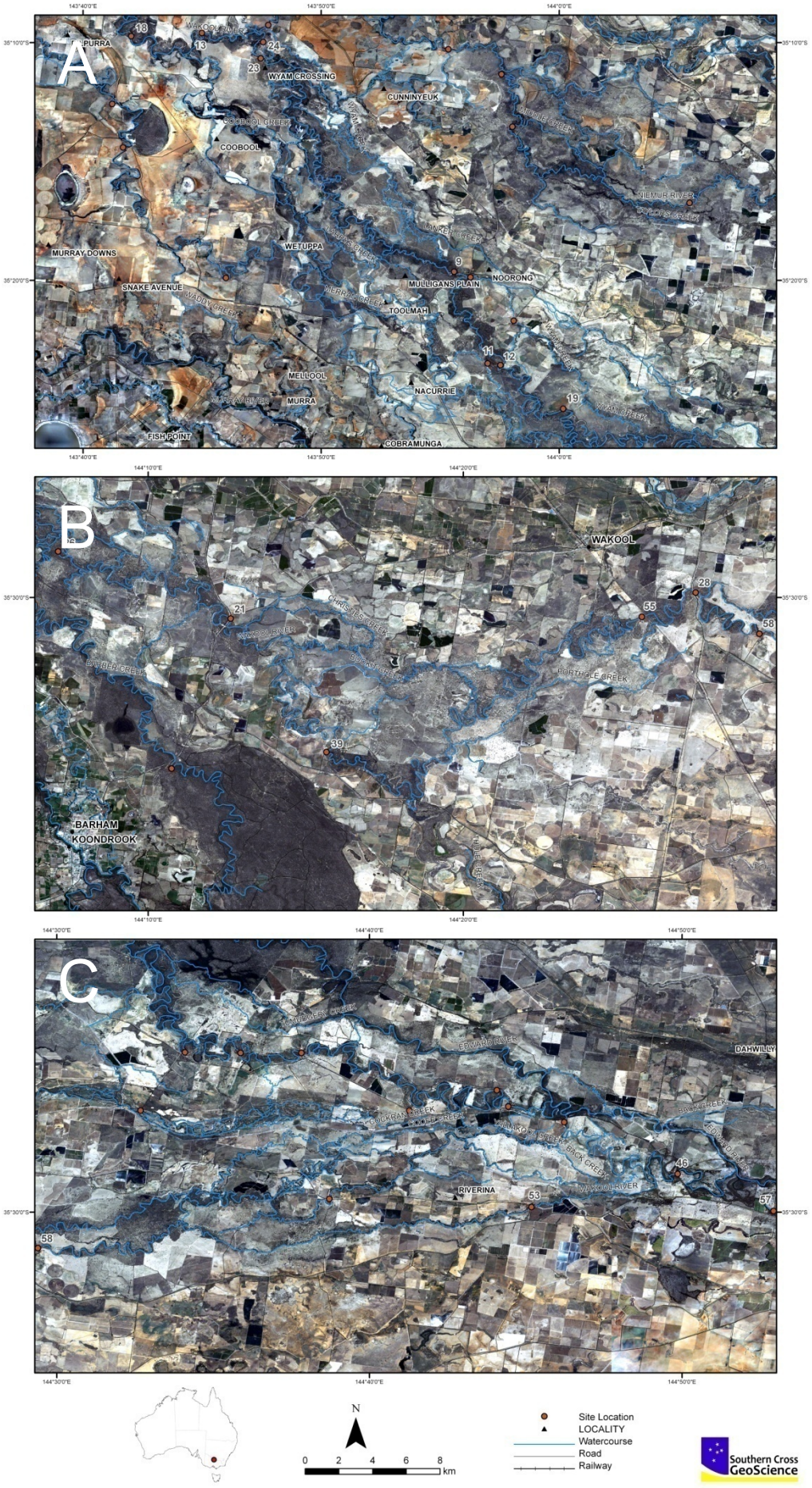


**Figure 8-1. Wakool River and sample site locations (A: west; B: centre; C: east).**

### 8.1.2. Soil profile description and distribution

Seventeen sites were described and sampled in the Wakool River. The soil subtype and general location description are presented in Table 8-1. Profile description data are presented in Table 8-4.

**Table 8-1. Soil identification, subtype and general location description for sites sampled in the Wakool River.**

| Site ID | Zone | Easting UTM | Northing UTM | Acid sulfate soil subtype class |
|---|---|---|---|---|
| WC_9 | 54H | 766016 | 6086735 | Subaqueous Soil |
| WC_11 | 54H | 767936 | 6079534 | Hypersulfidic Subaqueous Soil with Monosulfides |
| WC_12 | 54H | 768745 | 6079373 | Subaqueous Soil |
| WC_13 | 54H | 750470 | 6105761 | Hypersulfidic Subaqueous Soil with Monosulfides |
| WC_18 | 54H | 745958 | 6105637 | Hypersulfidic Subaqueous Soil |
| WC_19 | 55H | 227872 | 6175875 | Hyposulfidic Subaqueous Soil |
| WC_21 | 55H | 246996 | 6066694 | Subaqueous Soil |
| WC_23 | 54H | 754172 | 6103679 | Subaqueous Soil |
| WC_24 | 54H | 754362 | 6104949 | Hypersulfidic Subaqueous Soil with Monosulfides |
| WC_26 | 55H | 238603 | 6070395 | Subaqueous Soil |
| WC_28 | 55H | 269263 | 6068830 | Subaqueous Soil |
| WC_39 | 55H | 251807 | 6058998 | Subaqueous Soil |
| WC_46 | 55H | 303218 | 6071608 | Subaqueous Soil |
| WC_53 | 55H | 296191 | 6069488 | Hypersulfidic Subaqueous Soil |
| WC_55 | 55H | 266716 | 6067331 | Subaqueous Soil |
| WC_57 | 55H | 307907 | 6069511 | Subaqueous Soil |
| WC_58 | 55H | 272381 | 6066482 | Hypersulfidic Subaqueous Soil |


**Figure 8-2. Photographs of site WC_9 Wakool River, showing the site and the soil profile.**


**Figure 8-3. Photographs of site WC_11 Wakool River, showing the site and the soil profile.**


**Figure 8-4. Photographs of site WC_12 Wakool River, showing the site and the soil profile.**

**Figure 8-5. Photographs of site WC_13 Wakool River, showing the site and the soil profile.**

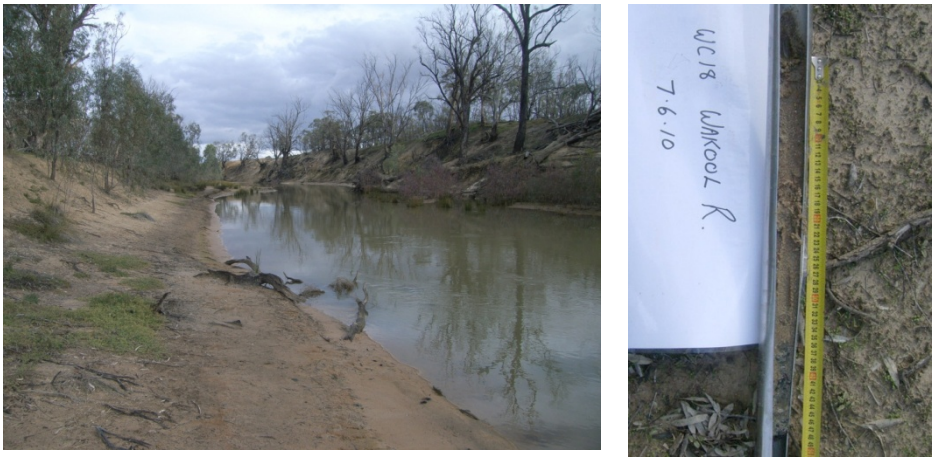


**Figure 8-6. Photographs of site WC_18 Wakool River, showing the site and the soil core.**


**Figure 8-7. Photographs of site WC_19 Wakool River, showing the site and the soil core.**

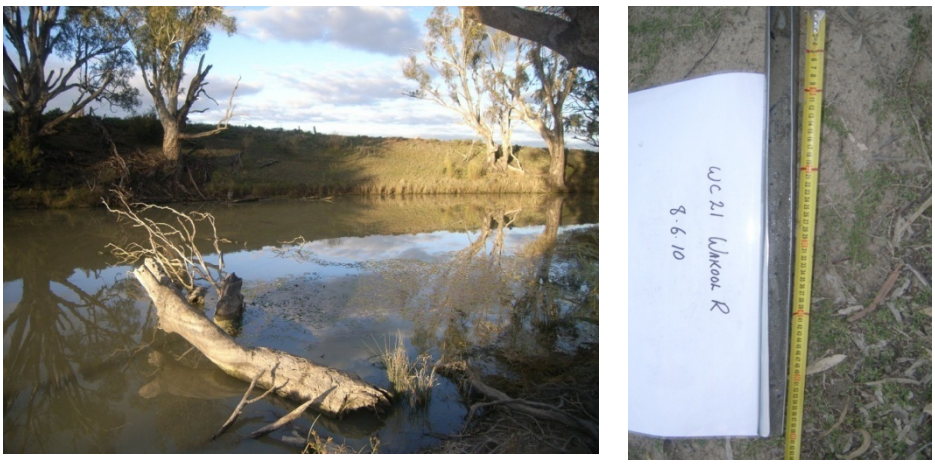


**Figure 8-8. Photographs of site WC_21 Wakool River, showing the site and the soil core.**


**Figure 8-9. Photographs of site WC_23 Wakool River, showing the site and the soil core.**

**Figure 8-10. Photographs of site WC_24 Wakool River, showing the site and the soil core.**


**Figure 8-11. Photographs of site WC_26 Wakool River, showing the site and the soil core.**


**Figure 8-12. Photographs of site WC_28 Wakool River, showing the site and the soil core.**


**Figure 8-13. Photographs of site WC_39 Wakool River, showing the site and the soil core.**

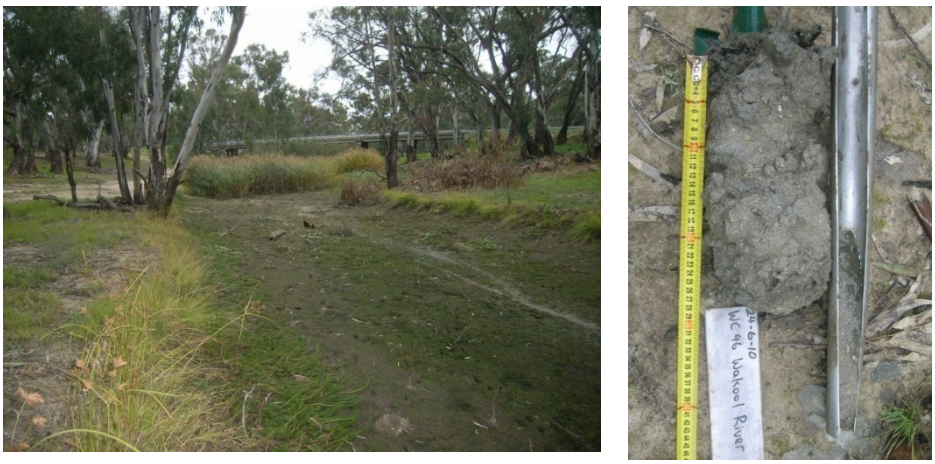


**Figure 8-14. Photographs of site WC_46 Wakool channel, showing the site and the soil core.**

**Figure 8-15. Photographs of site WC_53 Wakool River, showing the site and the soil profile.**

**Figure 8-16. Photographs of site WC_55 Wakool River, showing the site and the soil core.**

**Figure 8-17. Photographs of site WC_57 Wakool River, showing the site and the soil core.**

**Figure 8-18. Photographs of site WC_58 Wakool River, showing the site and the soil core.**

### 8.1.3. Laboratory data assessment

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

The pH data is provided in Table 8-2 and depth profiles of soil pH for all the sites sampled are presented in Figures 8-19 to 8-23. The $pH_W$ values ranged between 4.15 and 7.51. Sulfuric materials (i.e. $pH_W < 4$) were not present. The $pH_{FOX}$ values ranged between 1.66 and 6.77. The $pH_{FOX}$ results indicate that many of the surface soils may have the potential to acidify to pH < 4 as a result of sulfide oxidation. Fifteen 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 20 of the 78 layers examined contained detectable sulfide (i.e. $S_{CR} \geq 0.01\%$ S). The $pH_{KCl}$ values ranged between 3.57 and 8.72. Six 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 13 of the 17 sites examined, indicating acidity in the soil profile at levels where aluminium may mobilise. One of the other acidic soils acidified to pH < 4 after at least 8 weeks of incubation.

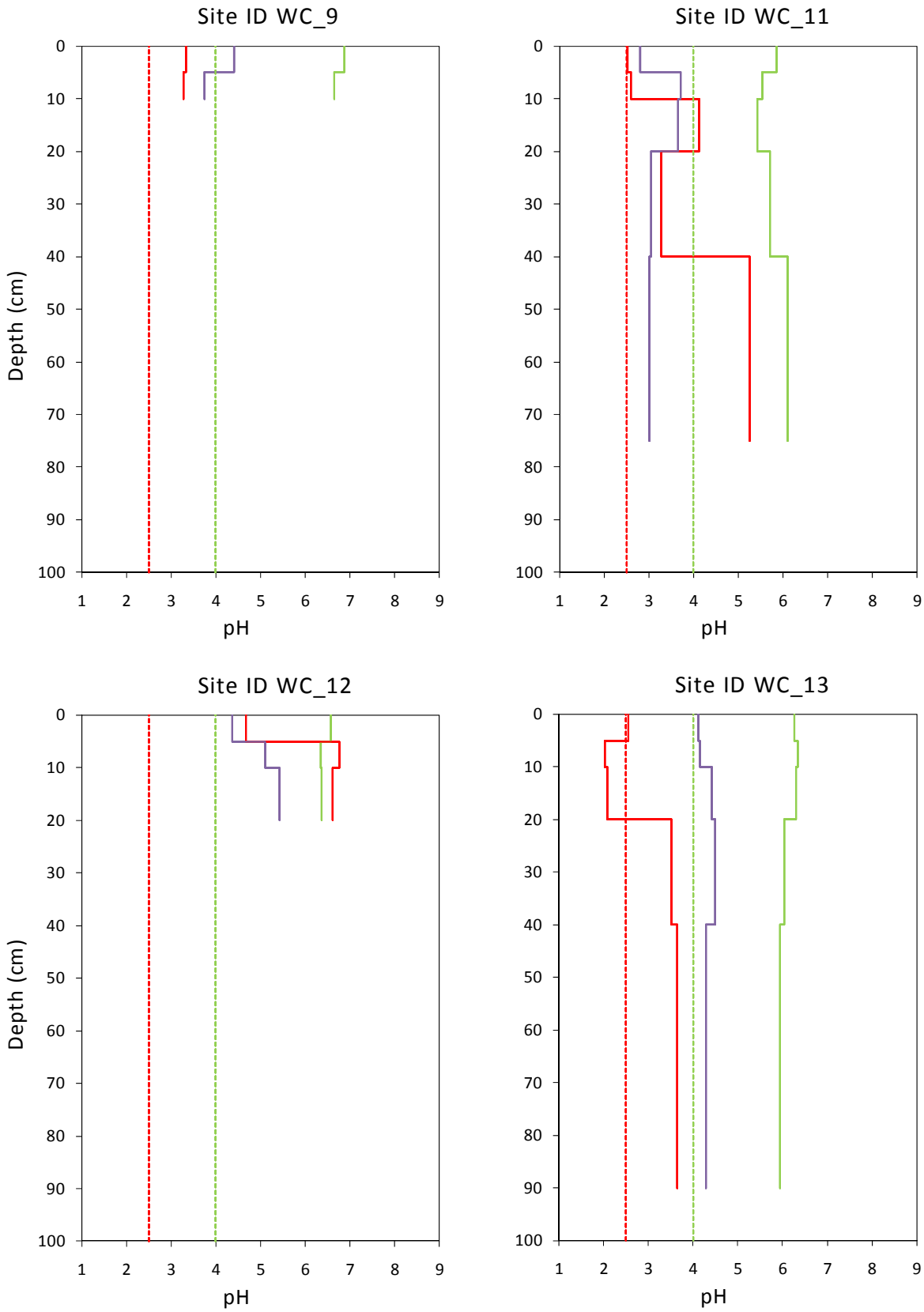


**Figure 8-19. Depth profiles of soil pH for sites in the Wakool River (sites 9, 11, 12 and 13), showing soil pH ($pH_W$ as green line), peroxide treated pH ($pH_{FOX}$ as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical $pH_W$ and $pH_{incubation}$ value of 4 (green dashed line) and critical $pH_{FOX}$ value of 2.5 (red dashed line).**

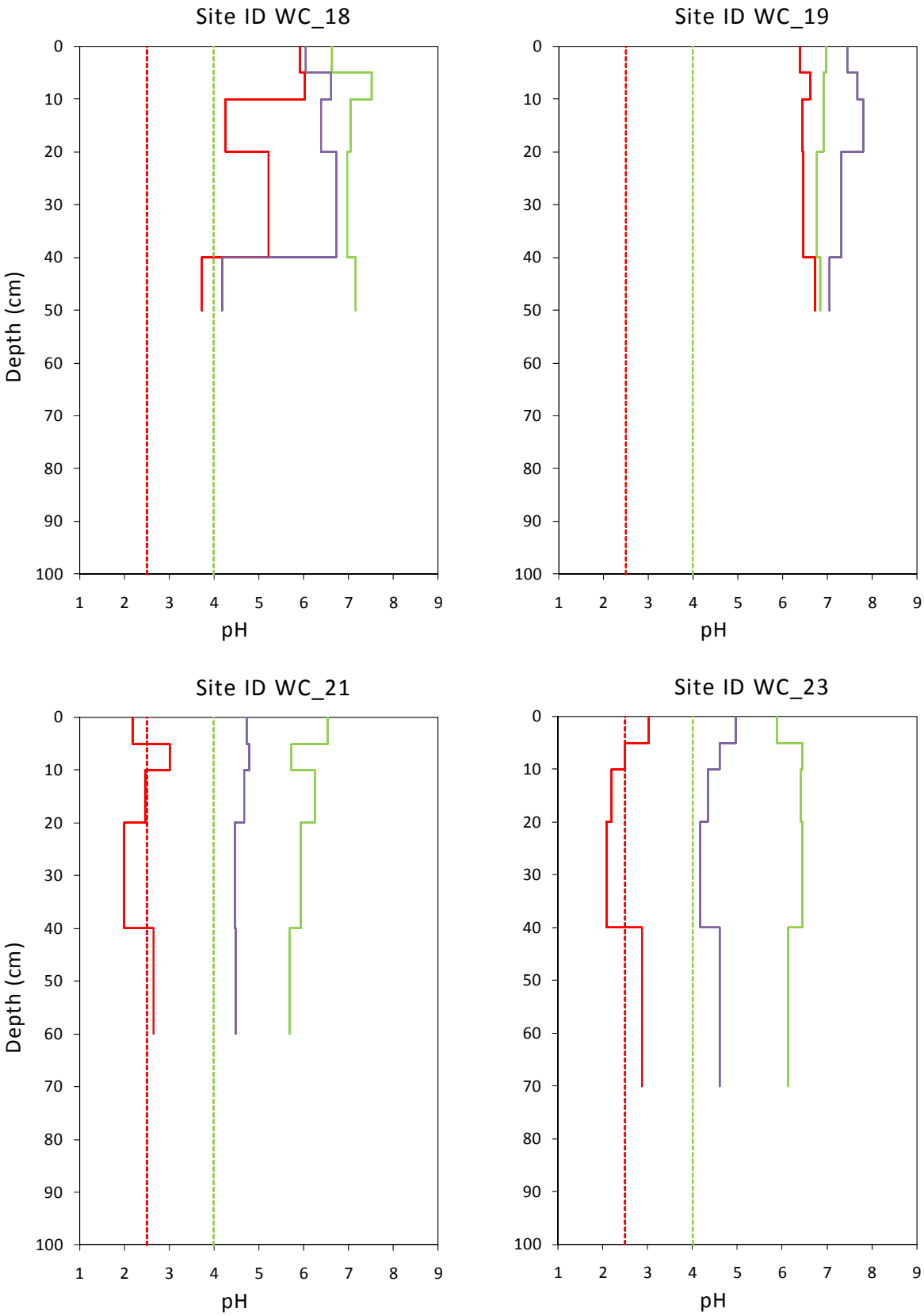


**Figure 8-20. Depth profiles of soil pH for sites in the Wakool River (sites 18, 19 21 and 23), showing soil pH ($pH_W$ as green line), peroxide treated pH ($pH_{FOX}$ as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical $pH_W$ and $pH_{incubation}$ value of 4 (green dashed line) and critical $pH_{FOX}$ value of 2.5 (red dashed line).**

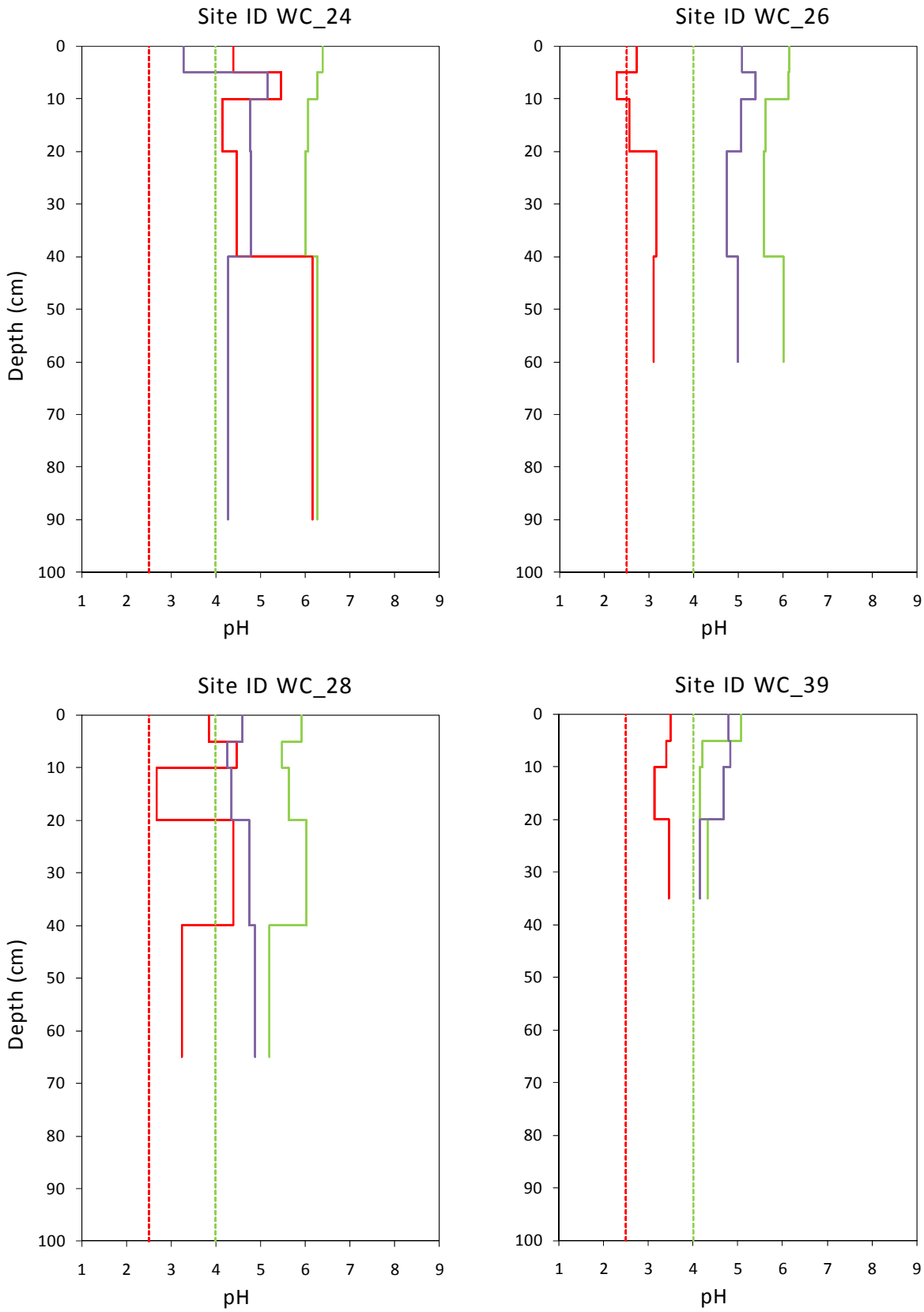


**Figure 8-21. Depth profiles of soil pH for sites in the Wakool River (sites 24, 26, 28 and 39), showing soil pH ($pH_W$ as green line), peroxide treated pH ($pH_{FOX}$ as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical $pH_W$ and $pH_{incubation}$ value of 4 (green dashed line) and critical $pH_{FOX}$ value of 2.5 (red dashed line).**

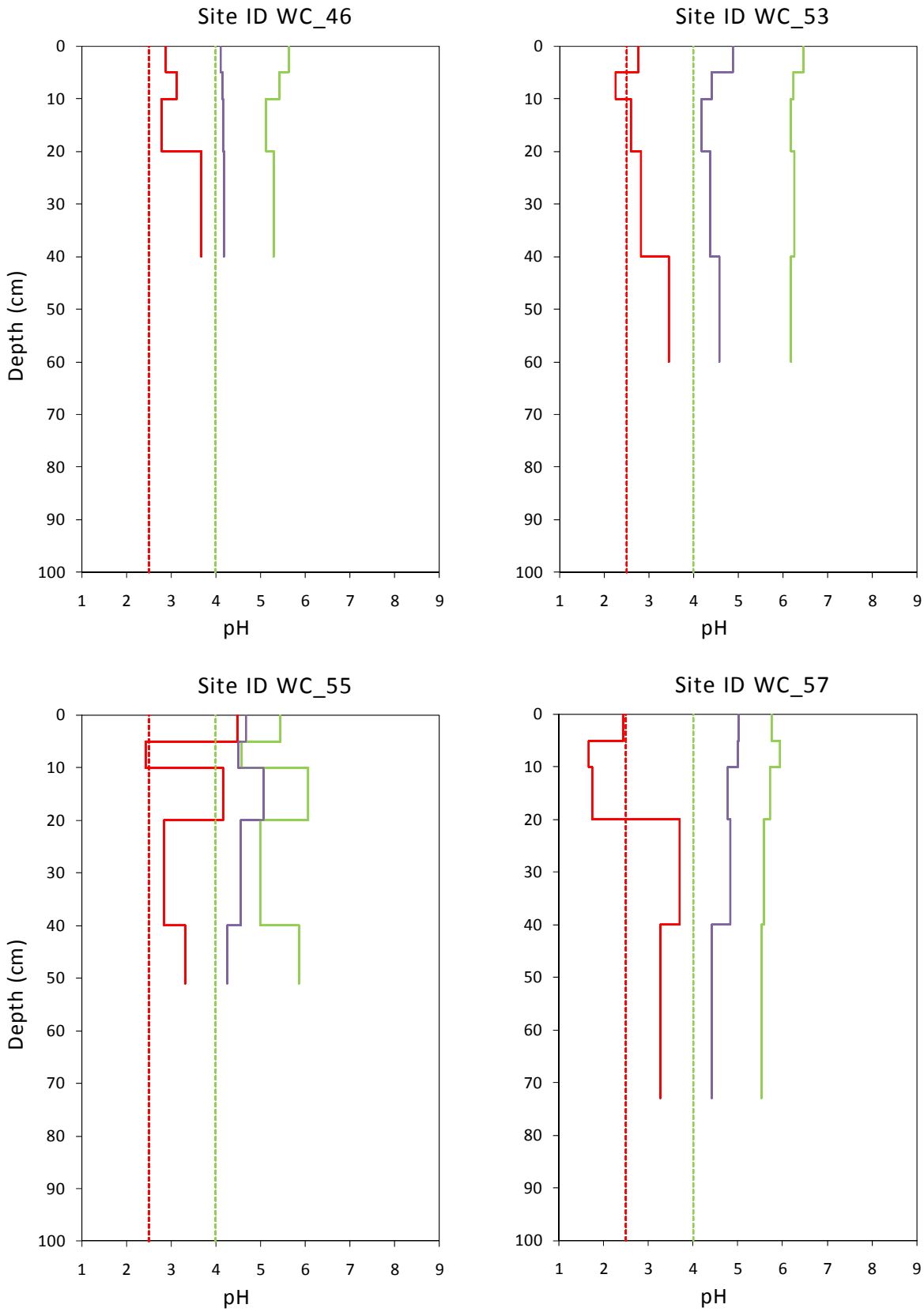


**Figure 8-22. Depth profiles of soil pH for sites in the Wakool River (sites 46, 53, 55 and 57), showing soil pH ($pH_W$ as green line), peroxide treated pH ($pH_{FOX}$ as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical $pH_W$ and $pH_{incubation}$ value of 4 (green dashed line) and critical $pH_{FOX}$ value of 2.5 (red dashed line).**

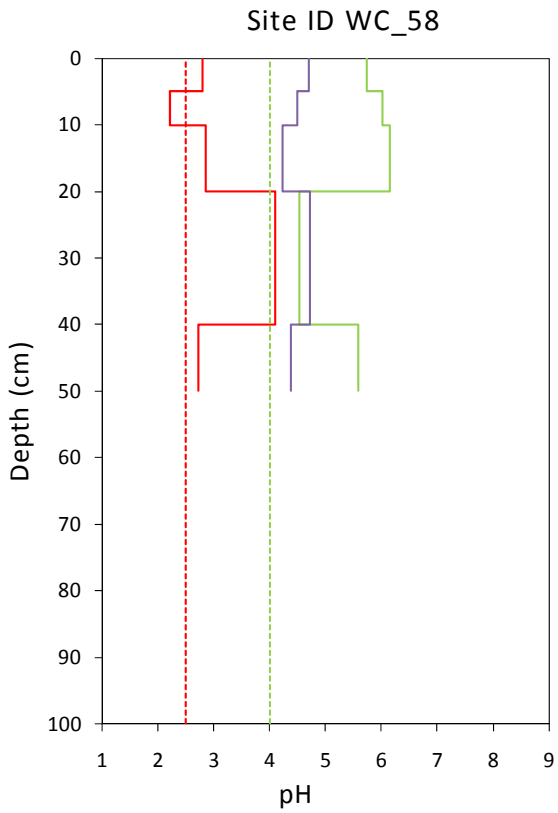


**Figure 8-23. Depth profiles of soil pH for sites in the Wakool River (sites 58), showing soil pH ($pH_W$ as green line), peroxide treated pH ($pH_{FOX}$ as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical $pH_W$ and $pH_{incubation}$ value of 4 (green dashed line) and critical $pH_{FOX}$ value of 2.5 (red dashed line).**

### Acid-base accounting

The acid-base accounting data is provided in Table 8-2 and summarised in Figures 8-24 to 8-28.

### Chromium reducible sulfur

Chromium reducible sulfur ($S_{CR}$) values ranged between < 0.01 and 0.34% $S_{CR}$. Sulfidic soil materials (i.e. $S_{CR}$ ≥ 0.01% S) were identified at seven of the 17 sampling sites (i.e. sites WC_11, WC_13, WC_18, WC_19, WC_24, WC_53 and WC_58), with 20 materials of the 78 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 0.25% $S_{AV}$. A total of nine monosulfidic soil materials (i.e. $S_{AV}$ ≥ 0.01% S) were found at three sites (i.e. sites WC_11, WC_13 and WC_24).

### Acid neutralising capacity

The acid neutralising capacity (ANC) ranged between zero and 4.19% $CaCO_3$ and was only present in two of the seventeen profiles.

### Titratable actual acidity

The titratable actual acidity (TAA) ranged between zero and 63 mole $H^+$/tonne. The trend of TAA with depth varied between sites.

### Retained acidity

Retained acidity was only detected in 20 layers and ranged between zero and 10 mole $H^+$/tonne.

### Net acidity

Net acidity ranged between -559 and 245 mole $H^+$/tonne. The 19 hypersulfidic soils had moderate to high net acidities ranging between 2 and 245 mole $H^+$/tonne.

### Water Soluble Sulfate

The water soluble sulfate in the surface soils (i.e. 0-20 cm) ranged between 17 and 1,860 mg $SO_4$/kg. The surface soil layers at six sites (i.e. WC_11, WC_13, WC_24, WC_39, WC_53 and WC_57) 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 8-3. The field pH of the surface waters collected ranged between 3.3 and 7.9, with seven sites being below the most relevant ANZECC/ARMCANZ (2000) trigger value for aquatic ecosystems of 6.5. The water data indicates that the surface water has been affected by acidification at some of the sites. Dissolved oxygen, SEC and turbidity values were sometimes found to be outside the most relevant ANZECC/ARMCANZ (2000) guideline value.

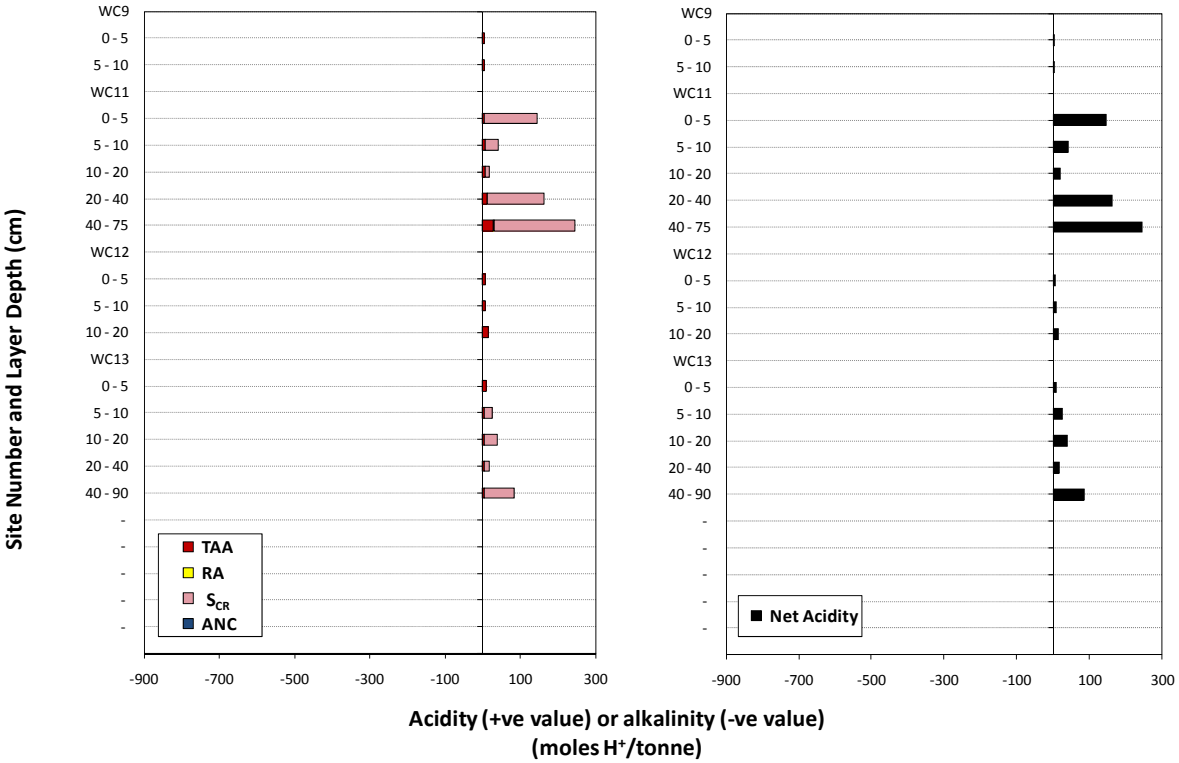


**Figure 8-24. Acid-base accounting depth profiles for sites in the Wakool River (sites 9, 11, 12 and 13). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as $S_{CR}$ -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.**

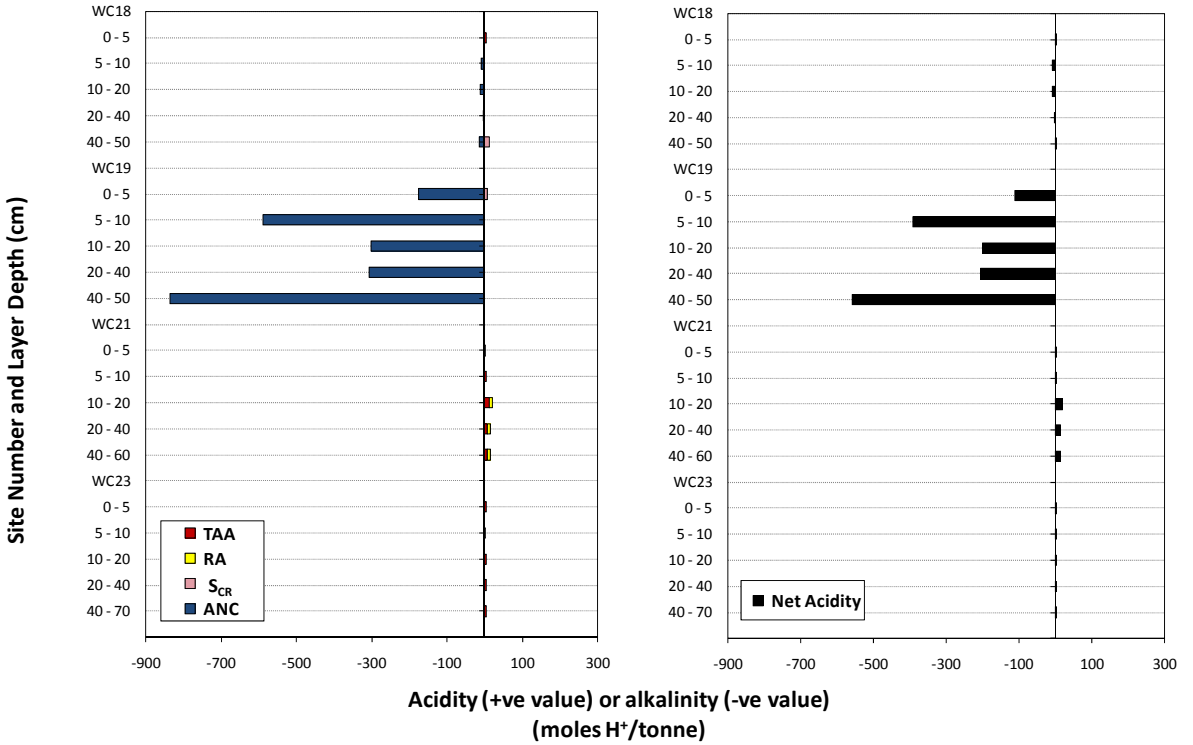


**Figure 8-25. Acid-base accounting depth profiles for sites in the Wakool River (sites 18, 19, 21 and 23). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as $S_{CR}$ -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.**

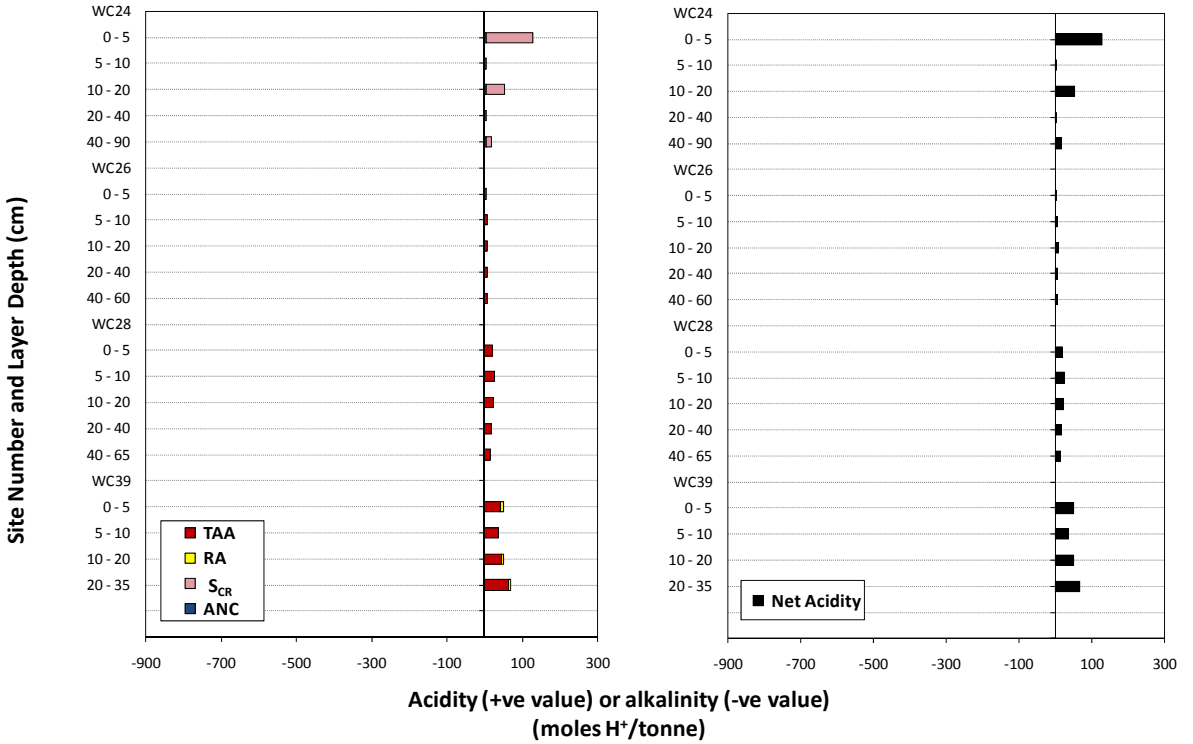


**Figure 8-26. Acid-base accounting depth profiles for sites in the Wakool River (sites 24, 26, 28 and 39). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as $S_{CR}$ -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.**

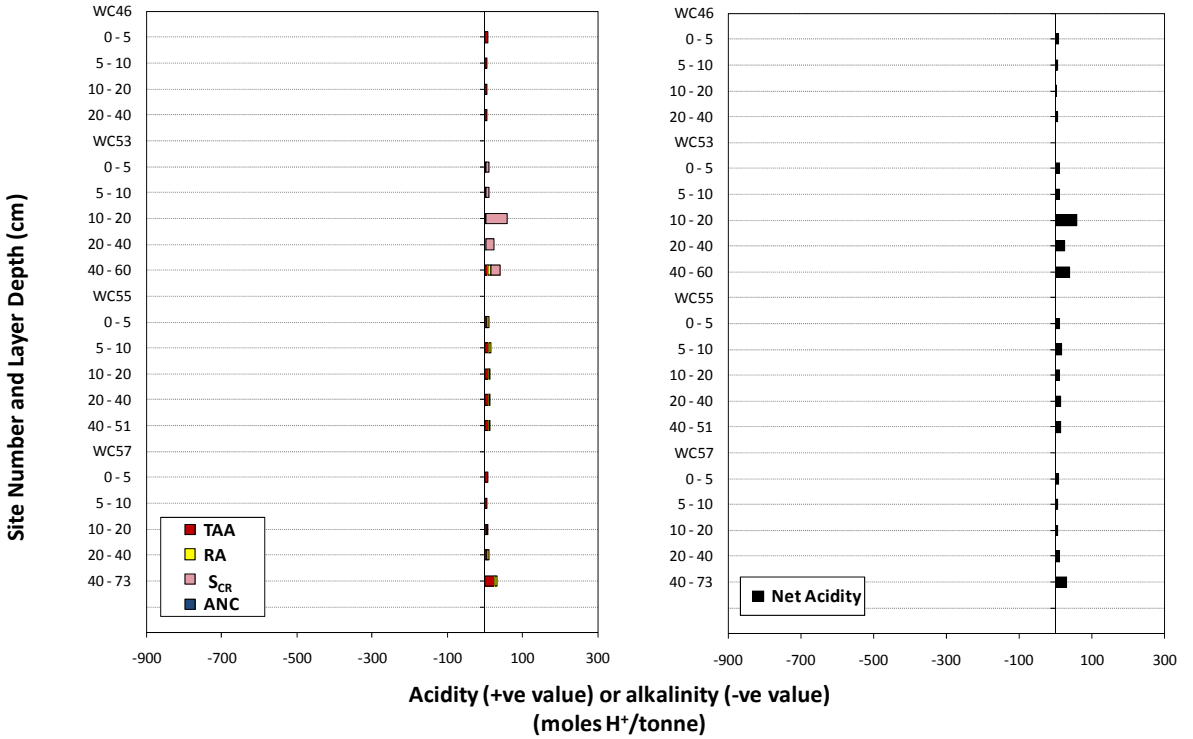


**Figure 8-27. Acid-base accounting depth profiles for sites in the Wakool River (sites 46, 53, 55 and 57). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as $S_{CR}$ -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.**

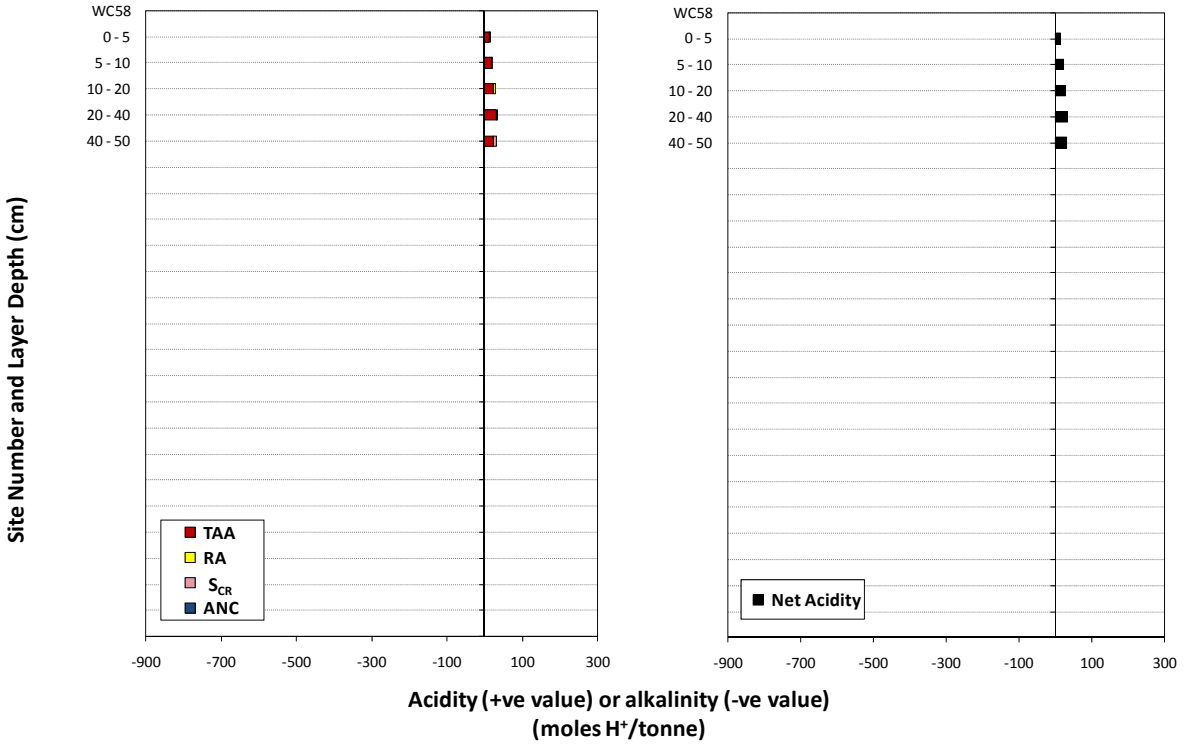


**Figure 8-28. Acid-base accounting depth profiles for sites in the Wakool River (site 58). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as $S_{CR}$ -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.**

### 8.1.4. Discussion

Acid sulfate soils occurred at seven of the 17 sites examined in the Wakool River (i.e. sites WC_11, WC_13, WC_18, WC_19, WC_24, WC_53 and WC_58). The presence of reduced inorganic sulfur was identified at seven sites, with a $S_{CR}$ of up to 0.34% S. Hypersulfidic soil materials with low to high net acidities (i.e. 2 - 245 mole $H^+$/tonne) were present in six soil profiles (i.e. sites WC_11, WC_13, WC_18, WC_24, WC_53 and WC_58). A hyposulfidic soil material ($S_{CR}$ < 0.10%) was present at site WC_19. Monosulfidic soil materials were also observed at three sulfidic sites, with $S_{AV}$ contents of up to 0.25% S. Monosulfidic soil materials ($S_{AV}$ ≤ 0.12% S) were observed in the upper 0-10 cm layers at three sites. These results indicate that acidity would be produced upon oxidation of the sulfidic materials. Six surficial soil materials 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 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 six high priority sites based on hypersulfidic material and three 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%. Six 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 in the Wakool River are:

- Acidification hazard: While low-moderate net acidities were dominant in this river, four hypersulfidic materials had high net acidities (i.e. 5% of layers), indicating that the overall degree of acidification hazard is high.

- Deoxygenation hazard: Monosulfidic soil materials ($S_{AV}$ ≤ 0.12% S) observed in the upper 0-10 cm layers at three sites represent a high deoxygenation hazard. In addition, the soluble sulfate content of surface soil materials at six 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 parts of this channel system 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 River:**

| | |
|---|---|
| ***Soil materials***: | Sulfuric materials were not observed. Sulfidic soil materials identified included: hypersulfidic (6 sites), monosulfidic (3 sites) and hyposulfidic < 0.10% (1 site). Low-moderate net acidities dominant within this river channel, although 4 hypersulfidic soil materials had high net acidities. |
| ***Acid sulfate soil identification***: | • Sulfidic materials occurred in both surface and sub-surface layers, and at some sites were prevalent across the entire depth profile. Similarly, monosulfides were recorded in materials from various depths. All sites were subaqueous. |
| ***Hazard assessment*** | • Acidification hazard - high level of concern<br>• Deoxygenation hazard - high level of concern<br>• Metal mobilisation hazard - high level of concern |

**Table 8-2. Laboratory analytical data for acid sulfate soil assessment of the Wakool River sites.**
(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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.1 | 0-5 | | 6.87 | 3.33 | 4.40 | 27.00 | 5.35 | 3.94 | 0.00 | 0.00 | 0.00 | 3.94 | 0.00 | Other Acid Soils |
| 9.2 | 5-10 | | 6.65 | 3.28 | 3.74 | 31.20 | 4.96 | 3.38 | 0.00 | 0.00 | 0.00 | 3.38 | 0.00 | Other Acid Soils |
| 11.1 | 0-5 | | 5.86 | 2.52 | 2.81* | 1860.00 | 5.70 | 4.20 | 0.23 | 0.00 | 0.00 | 145.03 | 0.12 | Hypermonosulfidic |
| 11.2 | 5-10 | | 5.54 | 2.61 | 3.72* | 702.00 | 5.28 | 7.15 | 0.05 | 0.00 | 0.00 | 41.19 | 0.02 | Hypermonosulfidic |
| 11.3 | 10-20 | | 5.43 | 4.12 | 3.66* | 1249.50 | 5.65 | 6.90 | 0.02 | 0.00 | 0.00 | 18.56 | 0.00 | Hypersulfidic |
| 11.4 | 20-40 | | 5.71 | 3.27 | 3.05* | 313.50 | 5.12 | 11.53 | 0.24 | 0.00 | 0.00 | 162.36 | 0.21 | Hypermonosulfidic |
| 11.5 | 40-75 | | 6.11 | 5.25 | 3.01* | 456.00 | 4.42 | 27.70 | 0.34 | 2.00 | 0.00 | 244.57 | 0.25 | Hypermonosulfidic |
| 12.1 | 0-5 | | 6.58 | 4.67 | 4.37* | 55.05 | 5.29 | 5.65 | 0.00 | 0.00 | 0.00 | 5.65 | 0.00 | Other Acid Soils |
| 12.2 | 5-10 | | 6.34 | 6.77 | 5.11 | 49.35 | 4.63 | 8.15 | 0.00 | 0.00 | 0.00 | 8.15 | 0.00 | Other Acid Soils |
| 12.3 | 10-20 | | 6.37 | 6.62 | 5.42 | 27.75 | 5.25 | 13.58 | 0.00 | 0.00 | 0.00 | 13.58 | 0.00 | Other Acid Soils |
| 13.1 | 0-5 | | 6.26 | 2.56 | 4.12* | 119.85 | 4.72 | 9.17 | 0.00 | 0.00 | 0.00 | 9.17 | 0.00 | Other Acid Soils |
| 13.2 | 5-10 | | 6.34 | 2.02 | 4.16 | 217.50 | 5.16 | 3.21 | 0.04 | 0.00 | 0.00 | 26.05 | 0.01 | Hypermonosulfidic# |
| 13.3 | 10-20 | | 6.30 | 2.09 | 4.42 | 232.50 | 5.09 | 4.09 | 0.05 | 0.00 | 0.00 | 37.82 | 0.03 | Hypermonosulfidic# |
| 13.4 | 20-40 | | 6.04 | 3.52 | 4.49 | 109.80 | 5.27 | 5.05 | 0.02 | 0.00 | 0.00 | 17.21 | 0.00 | Hypersulfidic# |
| 13.5 | 40-90 | | 5.95 | 3.65 | 4.29* | 205.50 | 5.49 | 5.24 | 0.13 | 0.00 | 0.00 | 84.29 | 0.04 | Hypermonosulfidic# |
| 18.1 | 0-5 | | 6.63 | 5.91 | 6.04 | 36.75 | 6.25 | 3.14 | 0.00 | 0.00 | 0.00 | 3.14 | 0.00 | Other Soil Materials |
| 18.2 | 5-10 | | 7.51 | 6.02 | 6.62* | 69.30 | 7.40 | 0.00 | 0.00 | 0.00 | 0.05 | -6.70 | 0.00 | Other Soil Materials |
| 18.3 | 10-20 | | 7.04 | 4.25 | 6.39* | 81.15 | 7.61 | 0.00 | 0.00 | 0.00 | 0.05 | -7.11 | 0.00 | Other Soil Materials |
| 18.4 | 20-40 | | 6.97 | 5.21 | 6.73* | 61.05 | 7.71 | 0.00 | 0.00 | 0.00 | 0.02 | -2.91 | 0.00 | Other Soil Materials |
| 18.5 | 40-50 | | 7.15 | 3.73 | 4.18* | 490.50 | 8.18 | 0.00 | 0.02 | 0.00 | 0.07 | 2.26 | 0.00 | Hypersulfidic# |
| 19.1 | 0-5 | | 6.97 | 6.38 | 7.45 | 38.70 | 8.27 | 0.00 | 0.01 | 0.00 | 0.88 | -109.70 | 0.00 | Hyposulfidic |
| 19.2 | 5-10 | | 6.92 | 6.62 | 7.67 | 52.50 | 8.72 | 0.00 | 0.00 | 0.00 | 2.95 | -392.95 | 0.00 | Other Soil Materials |
| 19.3 | 10-20 | | 6.91 | 6.44 | 7.79 | 55.20 | 8.63 | 0.00 | 0.00 | 0.00 | 1.51 | -200.86 | 0.00 | Other Soil Materials |
| 19.4 | 20-40 | | 6.76 | 6.46 | 7.31 | 77.10 | 8.01 | 0.00 | 0.00 | 0.00 | 1.54 | -204.93 | 0.00 | Other Soil Materials |
| 19.5 | 40-50 | | 6.83 | 6.72 | 7.04* | 58.50 | 8.35 | 0.00 | 0.00 | 0.00 | 4.19 | -558.71 | 0.00 | Other Soil Materials |
| 21.1 | 0-5 | | 6.53 | 2.19 | 4.72 | 45.45 | 4.80 | 2.70 | 0.00 | 0.00 | 0.00 | 2.70 | 0.00 | Other Acid Soils |
| 21.2 | 5-10 | | 5.72 | 3.01 | 4.79 | 51.60 | 4.73 | 3.58 | 0.00 | 0.00 | 0.00 | 3.58 | 0.00 | Other Acid Soils |
| 21.3 | 10-20 | | 6.25 | 2.46 | 4.68 | 85.65 | 4.32 | 11.27 | 0.00 | 10.00 | 0.00 | 21.27 | 0.00 | Other Acid Soils |
| 21.4 | 20-40 | | 5.93 | 2.00 | 4.47 | 34.20 | 4.37 | 6.90 | 0.00 | 8.00 | 0.00 | 14.90 | 0.00 | Other Acid Soils |
| 21.5 | 40-60 | | 5.68 | 2.66 | 4.48 | 22.80 | 4.43 | 6.66 | 0.00 | 8.00 | 0.00 | 14.66 | 0.00 | Other Acid Soils |

* Indicates that a stable pH has not yet been reached for this sample (after at least 15 weeks). # Classified as hypermonosulfidic/hypersulfidic based on positive net acidity.

**Table 8-2 (continued). Laboratory analytical data for acid sulfate soil assessment of the Wakool River sites.**
(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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.1 | 0-5 | | 5.88 | 3.03 | 4.96 | 50.40 | 5.26 | 4.03 | 0.00 | 0.00 | 0.00 | 4.03 | 0.00 | Other Acid Soils |
| 23.2 | 5-10 | | 6.46 | 2.49 | 4.61 | 69.75 | 5.12 | 2.25 | 0.00 | 0.00 | 0.00 | 2.25 | 0.00 | Other Acid Soils |
| 23.3 | 10-20 | | 6.42 | 2.20 | 4.35* | 71.55 | 4.94 | 3.47 | 0.00 | 0.00 | 0.00 | 3.47 | 0.00 | Other Acid Soils |
| 23.4 | 20-40 | | 6.45 | 2.09 | 4.17 | 77.70 | 4.90 | 3.41 | 0.00 | 0.00 | 0.00 | 3.41 | 0.00 | Other Acid Soils |
| 23.5 | 40-70 | | 6.13 | 2.87 | 4.61* | 51.00 | 5.20 | 3.88 | 0.00 | 0.00 | 0.00 | 3.88 | 0.00 | Other Acid Soils |
| 24.1 | 0-5 | | 6.38 | 4.39 | 3.28 | 1189.50 | 6.32 | 4.71 | 0.20 | 0.00 | 0.00 | 128.34 | 0.12 | Hypermonosulfidic |
| 24.2 | 5-10 | | 6.28 | 5.46 | 5.16 | 565.50 | 5.87 | 3.86 | 0.00 | 0.00 | 0.00 | 3.86 | 0.00 | Other Acid Soils |
| 24.3 | 10-20 | | 6.07 | 4.14 | 4.76* | 811.50 | 5.62 | 4.67 | 0.08 | 0.00 | 0.00 | 52.09 | 0.03 | Hypermonosulfidic# |
| 24.4 | 20-40 | | 6.01 | 4.46 | 4.78* | 873.00 | 6.03 | 4.36 | 0.00 | 0.00 | 0.00 | 4.36 | 0.00 | Other Acid Soils |
| 24.5 | 40-51 | | 6.27 | 6.16 | 4.28* | 1138.50 | 6.47 | 3.65 | 0.02 | 0.00 | 0.00 | 17.43 | 0.00 | Hypersulfidic# |
| 26.1 | 0-5 | | 6.15 | 2.74 | 5.09* | 24.60 | 4.67 | 4.21 | 0.00 | 0.00 | 0.00 | 4.21 | 0.00 | Other Acid Soils |
| 26.2 | 5-10 | | 6.12 | 2.29 | 5.38 | 25.80 | 4.42 | 6.65 | 0.00 | 0.00 | 0.00 | 6.65 | 0.00 | Other Acid Soils |
| 26.3 | 10-20 | | 5.61 | 2.56 | 5.07 | 17.25 | 4.40 | 7.68 | 0.00 | 0.00 | 0.00 | 7.68 | 0.00 | Other Acid Soils |
| 26.4 | 20-40 | | 5.57 | 3.16 | 4.75* | 34.65 | 4.70 | 6.94 | 0.00 | 0.00 | 0.00 | 6.94 | 0.00 | Other Acid Soils |
| 26.1 | 40-51 | | 6.01 | 3.10 | 4.99* | 21.75 | 4.95 | 6.12 | 0.00 | 0.00 | 0.00 | 6.12 | 0.00 | Other Acid Soils |
| 28.1 | 0-5 | | 5.91 | 3.84 | 4.59* | 98.55 | 4.06 | 20.59 | 0.00 | 0.00 | 0.00 | 20.59 | 0.00 | Other Acid Soils |
| 28.2 | 5-10 | | 5.48 | 4.46 | 4.26* | 99.00 | 3.94 | 25.88 | 0.00 | 0.00 | 0.00 | 25.88 | 0.00 | Other Acid Soils |
| 28.3 | 10-20 | | 5.63 | 2.68 | 4.36* | 83.70 | 4.03 | 23.41 | 0.00 | 0.00 | 0.00 | 23.41 | 0.00 | Other Acid Soils |
| 28.4 | 20-40 | | 6.02 | 4.38 | 4.75* | 65.40 | 4.31 | 16.96 | 0.00 | 0.00 | 0.00 | 16.96 | 0.00 | Other Acid Soils |
| 28.5 | 40-51 | | 5.19 | 3.24 | 4.88* | 33.15 | 4.34 | 13.80 | 0.00 | 0.00 | 0.00 | 13.80 | 0.00 | Other Acid Soils |
| 39.1 | 0-5 | | 5.07 | 3.50 | 4.79* | 160.50 | 3.76 | 42.64 | 0.00 | 7.00 | 0.00 | 49.64 | 0.00 | Other Acid Soils |
| 39.2 | 5-10 | | 4.21 | 3.40 | 4.84* | 40.50 | 3.85 | 36.26 | 0.00 | 0.00 | 0.00 | 36.26 | 0.00 | Other Acid Soils |
| 39.3 | 10-20 | | 4.15 | 3.14 | 4.68 | 31.80 | 3.67 | 45.14 | 0.00 | 6.00 | 0.00 | 51.14 | 0.00 | Other Acid Soils |
| 39.4 | 20-35 | | 4.33 | 3.46 | 4.15 | 36.30 | 3.57 | 63.00 | 0.00 | 5.00 | 0.00 | 68.00 | 0.00 | Other Acid Soils |
| 46.1 | 0-5 | | 5.64 | 2.89 | 4.11* | 71.85 | 4.51 | 7.37 | 0.00 | 0.00 | 0.00 | 7.37 | 0.00 | Other Acid Soils |
| 46.2 | 5-10 | | 5.42 | 3.13 | 4.15* | 25.35 | 4.56 | 4.93 | 0.00 | 0.00 | 0.00 | 4.93 | 0.00 | Other Acid Soils |
| 46.3 | 10-20 | | 5.13 | 2.78 | 4.17* | 28.05 | 4.55 | 4.37 | 0.00 | 0.00 | 0.00 | 4.37 | 0.00 | Other Acid Soils |
| 46.4 | 20-40 | | 5.29 | 3.68 | 4.18* | 47.55 | 4.57 | 5.43 | 0.00 | 0.00 | 0.00 | 5.43 | 0.00 | Other Acid Soils |

* Indicates that a stable pH has not yet been reached for this sample (after at least 15 weeks). # Classified as hypermonosulfidic/hypersulfidic based on positive net acidity.

**Table 8-2 (continued). Laboratory analytical data for acid sulfate soil assessment of the Wakool River sites.**
(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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 53.1 | 0-5 | | 6.47 | 2.77 | 4.88* | 98.70 | 5.13 | 2.87 | 0.01 | 0.00 | 0.00 | 11.99 | 0.00 | Hypersulfidic# |
| 53.2 | 5-10 | | 6.24 | 2.27 | 4.40* | 89.40 | 4.91 | 3.43 | 0.01 | 0.00 | 0.00 | 11.77 | 0.00 | Hypersulfidic# |
| 53.3 | 10-20 | | 6.18 | 2.61 | 4.18* | 180.00 | 4.85 | 2.96 | 0.09 | 0.00 | 0.00 | 59.53 | 0.00 | Hypersulfidic# |
| 53.4 | 20-40 | | 6.25 | 2.83 | 4.37 | 92.10 | 4.76 | 4.01 | 0.03 | 0.00 | 0.00 | 24.67 | 0.00 | Hypersulfidic# |
| 53.5 | 40-60 | | 6.18 | 3.44 | 4.57* | 97.80 | 4.31 | 8.86 | 0.04 | 7.00 | 0.00 | 40.03 | 0.00 | Hypersulfidic# |
| 55.1 | 0-5 | | 5.45 | 4.48 | 4.68 | 22.65 | 4.45 | 6.19 | 0.00 | 6.00 | 0.00 | 12.19 | 0.00 | Other Acid Soils |
| 55.2 | 5-10 | | 4.58 | 2.43 | 4.51* | 27.75 | 4.36 | 10.86 | 0.00 | 5.00 | 0.00 | 15.86 | 0.00 | Other Acid Soils |
| 55.3 | 10-20 | | 6.07 | 4.17 | 5.07* | 27.90 | 4.29 | 11.63 | 0.00 | 1.00 | 0.00 | 12.63 | 0.00 | Other Acid Soils |
| 55.4 | 20-40 | | 5.00 | 2.84 | 4.56* | 28.65 | 4.24 | 11.60 | 0.00 | 3.00 | 0.00 | 14.60 | 0.00 | Other Acid Soils |
| 55.5 | 40-51 | | 5.86 | 3.32 | 4.26* | 21.30 | 4.12 | 10.35 | 0.00 | 3.00 | 0.00 | 13.35 | 0.00 | Other Acid Soils |
| 57.1 | 0-5 | | 5.75 | 2.44 | 5.03 | 105.75 | 4.57 | 7.63 | 0.00 | 0.00 | 0.00 | 7.63 | 0.00 | Other Acid Soils |
| 57.2 | 5-10 | | 5.95 | 1.66 | 5.00* | 50.55 | 4.58 | 5.30 | 0.00 | 0.00 | 0.00 | 5.30 | 0.00 | Other Acid Soils |
| 57.3 | 10-20 | | 5.72 | 1.75 | 4.77* | 62.10 | 4.41 | 6.27 | 0.00 | 1.00 | 0.00 | 7.27 | 0.00 | Other Acid Soils |
| 57.4 | 20-40 | | 5.59 | 3.70 | 4.83* | 64.95 | 4.49 | 5.17 | 0.00 | 6.00 | 0.00 | 11.17 | 0.00 | Other Acid Soils |
| 57.5 | 40-73 | | 5.52 | 3.27 | 4.41* | 98.25 | 3.83 | 27.37 | 0.00 | 4.00 | 0.00 | 31.37 | 0.00 | Other Acid Soils |
| 58.1 | 0-5 | | 5.73 | 2.81 | 4.70* | 46.05 | 4.10 | 13.32 | 0.00 | 2.00 | 0.00 | 15.32 | 0.00 | Other Acid Soils |
| 58.2 | 5-10 | | 6.03 | 2.21 | 4.50* | 74.10 | 4.04 | 16.44 | 0.00 | 5.00 | 0.00 | 21.44 | 0.00 | Other Acid Soils |
| 58.3 | 10-20 | | 6.16 | 2.85 | 4.24* | 60.60 | 3.84 | 23.38 | 0.00 | 6.00 | 0.00 | 29.38 | 0.00 | Other Acid Soils |
| 58.4 | 20-40 | | 4.54 | 4.10 | 4.72* | 101.55 | 3.77 | 30.70 | 0.00 | 4.00 | 0.00 | 34.70 | 0.00 | Other Acid Soils |
| 58.5 | 40-50 | | 5.58 | 2.72 | 4.38* | 186.00 | 3.92 | 23.18 | 0.01 | 0.00 | 0.00 | 31.45 | 0.00 | Hypersulfidic# |

* Indicates that a stable pH has not yet been reached for this sample (after at least 15 weeks). # Classified as hypersulfidic based on positive net acidity.

**Table 8-3. Field hydrochemistry data for acid sulfate soil assessment of the Wakool River sites.**

| Site ID. | Temperature (Deg C) | Specific Electrical Conductivity (µS/cm) | Dissolved Oxygen (%) | Dissolved Oxygen (mg/L) | pH | ORP (mV) | Redox potential (mV) | Turbidity (NTU) | Comment |
|---|---|---|---|---|---|---|---|---|---|
| *Lowland River** | | *125-2,220* | *85-110* | | *6.5-8.0* | | | *6-50* | |
| WC_9 | 12.2 | 74.6 | 78.3 | 8.43 | 7.18 | 342 | | 38 | |
| WC_11 | 17.7 | 59,600 | 21.9 | 2.07 | 3.30 | 401 | | 95 | |
| WC_12 | 14.0 | 108 | 45.7 | 4.87 | 7.49 | 343 | | 20 | |
| WC_13 | 11.2 | 185 | 99.9 | 11.06 | 4.51 | 321 | | 43 | |
| WC_18 | 12.0 | 184 | 100.9 | 10.98 | 4.35 | 315 | | 34 | |
| WC_19 | 10.8 | 50.2 | 91.2 | 9.86 | 4.07 | 298 | | 35 | |
| WC_21 | 11.8 | 49.2 | 92.6 | 10.02 | 4.07 | 269 | | 55 | |
| WC_23 | 11.5 | 101 | 92.6 | 10.08 | n.a. | 303 | | 31 | |
| WC_24 | 13.9 | 7,810 | 20.5 | 2.09 | n.a. | 311 | | 31 | |
| WC_26 | 13.2 | 53.2 | 91.1 | 9.61 | 7.10 | 347 | | 31 | |
| WC_28 | 10.5 | 126 | 75.4 | 8.45 | 6.90 | 279 | | 150 | |
| WC_39 | 8.9 | 553 | 82.1 | 9.87 | 7.40 | 310 | | 63 | |
| WC_46 | 11.5 | 56.3 | 82.2 | 9.00 | 7.85 | 283 | | 29 | |
| WC_53 | 10.7 | 2,910 | 84.8 | 9.46 | 5.90 | 255 | | 17 | |
| WC_55 | 9.5 | 70.0 | 76.1 | 8.82 | 6.50 | 293 | | 102 | |
| WC_57 | 10.4 | 293 | 95.4 | 10.72 | 6.10 | 267 | | 89 | |
| WC_59 | | | | | | | | | Site dry at the time of sampling |

* 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.

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**Table 8-4. Profile description data for acid sulfate soil assessment of the Wakool River sites.**

| Site and Sample No. | Horizon Depth Range (cm) | Soil Colour – moist [1] | Texture Class [1] | Texture Modifiers [1] | Moisture State [1] | Redoximorphic Features Abundance (%) [2] | Redoximorphic Features – Kind [2] | Redoximorphic Features - Colour [2] | Redoximorphic Features - Location [2] | Structure - Type [1] | Structure - Grade [1] | Consistency (moist or dry) - Rupture Resistance [1] | pH (field measurement) | Comments (odour, fragments, minerals, plant material, inclusions, other) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.1 | 0-5 | 10YR 5/1 | S | | W | | | | | SG | 0 | | 6.89 | |
| 9.2 | 5-10 | 10YR 6/1 | S | | W | | | | | SG | 0 | | 7.08 | |
| 11.1 | 0-5 | 10YR 2/1 | Muck | | W | | | | | MA | 0 | | 5.74 | MBO; iron floc |
| 11.2 | 5-10 | 10YR 4/1 | ZC | | W | | | | | MA | 0 | | 5.46 | MBO throughout |
| 11.3 | 10-20 | 10YR 4/1 | ZC | | W | | | | | MA | 0 | | 5.98 | MBO throughout |
| 11.4 | 20-40 | 10YR 4/1 | ZC | | W | | | | | MA | 0 | | 6.27 | MBO throughout |
| 11.5 | 40-75 | 10YR 3/1 | ZC | | W | | | | | MA | 0 | | 6.29 | MBO throughout |
| 12.1 | 0-5 | 5GY 5/1 | C | | W | | | | | MA | 0 | | 6.65 | |
| 12.2 | 5-10 | 5GY 5/1 | C | | W | 20 | FM | | | MA | 0 | | 6.50 | |
| 12.3 | 10-20 | 5GY 6/1 | C | | W | 50 | FM | | | MA | 0 | | 6.66 | |
| 13.1 | 0-5 | 2.5Y 5/4 | CL | | W | 20 | FM | | | n.r. | | | 4.80 | Iron floc |
| 13.2 | 5-10 | 2.5Y 4/1 | CS | | W | 20 | FM | | | n.r. | | | 6.10 | |
| 13.3 | 10-20 | 2.5Y 4/2 | CL | | W | 20 | FM | | | n.r. | | | 5.20 | |
| 13.4 | 20-40 | 2.5Y 3/2 | CL | | W | 20 | FM | | | n.r. | | | 5.30 | |
| 13.5 | 40-90 | 2.5Y 3/2 | CL | | W | 20 | FM | | | n.r. | | | 5.00 | |
| 18.1 | 0-5 | 10YR 5/3 | S | | W | | | | | SG | 0 | | 4.44 | |
| 18.2 | 5-10 | 10YR 5/3 | S | | W | | | | | SG | 0 | | 4.26 | |
| 18.3 | 10-20 | 10YR 5/4 | S | | W | | | | | SG | 0 | | 3.96 | |
| 18.4 | 20-40 | 10YR 6/3 | S | | W | | | | | SG | 0 | | 4.04 | |
| 18.5 | 40-50 | 10YR 4/1 | S | | W | | | | | SG | 0 | | 3.97 | |

**Table 8-4 (continued). Profile description data for acid sulfate soil assessment of the Wakool River sites.**

| Site and Sample No. | Horizon Depth Range (cm) | Soil Colour – moist [1] | Texture Class [1] | Texture Modifiers [1] | Moisture State [1] | Redoximorphic Features Abundance (%) [2] | Redoximorphic Features – Kind [2] | Redoximorphic Features - Colour [2] | Redoximorphic Features - Location [2] | Structure - Type [1] | Structure - Grade [1] | Consistency (moist or dry) - Rupture Resistance [1] | pH (field measurement) | Comments (odour, fragments, minerals, plant material, inclusions, other) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.1 | 0-5 | 10YR 4/2 | LS | | W | | | | | MA | 0 | | 3.57 | carbonate nodules |
| 19.2 | 5-10 | 10YR 4/2 | LS | | W | | | | | MA | 0 | | 3.49 | carbonate nodules |
| 19.3 | 10-20 | 10YR 4/1 | C | S | W | | | | | MA | 0 | | 3.55 | carbonate nodules |
| 19.4 | 20-40 | 2.5Y 5/1 | C | S | W | | | | | MA | 0 | | 3.66 | carbonate nodules |
| 19.5 | 40-50 | 2.5Y 5/1 | C | S | W | | | | | MA | 0 | | 3.66 | carbonate nodules |
| 21.1 | 0-5 | 10YR 5/1 | LS | | W | | | | | MA | 0 | | 3.25 | |
| 21.2 | 5-10 | 10YR 5/2 | LS | | W | | | | | MA | 0 | | 2.52 | |
| 21.3 | 10-20 | 10YR 6/1 | LS | | W | | | | | MA | 0 | | 2.35 | |
| 21.4 | 20-40 | 10YR 4/1 | SCL | | W | | | | | MA | 0 | | 2.82 | |
| 21.5 | 40-60 | 10YR5/2 | SCL | | W | | | | | MA | 0 | | 2.81 | |
| 23.1 | 0-5 | 10YR 5/2 | S | | W | | | | | MA | 0 | | n.r. | |
| 23.2 | 5-10 | 10YR 4/1 | LS | | W | | | | | MA | 0 | | n.r. | |
| 23.3 | 10-20 | 10YR 4/1 | LS | | W | 10 | FM | | | MA | 0 | | n.r. | |
| 23.4 | 20-40 | 10YR 5/1 | LS | | W | | | | | MA | 0 | | n.r. | |
| 23.5 | 40-70 | 10YR 5/1 | LS | | W | | | | | MA | 0 | | n.r. | |
| 24.1 | 0-5 | 10YR 4/2 | C | | W | | | | | MA | 0 | | n.r. | |
| 24.2 | 5-10 | 10YR 4/2 | C | | W | 10 | FM | | | MA | 0 | | n.r. | |
| 24.3 | 10-20 | 2.5Y 5/1 | C | | W | 10 | FM | | | MA | 0 | | n.r. | |
| 24.4 | 20-40 | 10YR 5/2 | C | | W | 10 | FM | | | MA | 0 | | n.r. | |
| 24.5 | 40-90 | 10YR 2/1 | C | | W | 10 | FM | | | MA | 0 | | n.r. | |

[1] See National Committee on Soil and Terrain (2009) for abbreviation definitions and further details.

[2] See Schoeneberger *et al.* (2002) for abbreviation definitions and further details.

**Table 8-4 (continued). Profile description data for acid sulfate soil assessment of the Wakool River sites.**

| Site and Sample No. | Horizon Depth Range (cm) | Soil Colour – moist [1] | Texture Class [1] | Texture Modifiers [1] | Moisture State [1] | Redoximorphic Features Abundance (%) [2] | Redoximorphic Features – Kind [2] | Redoximorphic Features - Colour [2] | Redoximorphic Features - Location [2] | Structure - Type [1] | Structure - Grade [1] | Consistency (moist or dry) - Rupture Resistance [1] | pH (field measurement) | Comments (odour, fragments, minerals, plant material, inclusions, other) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26.1 | 0-5 | 2.5Y 5/2 | LS | | W | | | | | MA | 0 | | 6.90 | fine quartz gravels common |
| 26.2 | 5-10 | 2.5Y 5/1 | LS | | W | | | | | MA | 0 | | 7.20 | fine quartz gravels common |
| 26.3 | 10-20 | 2.5Y 5/2 | LS | | W | | | | | MA | 0 | | 7.00 | fine quartz gravels common |
| 26.4 | 20-40 | 2.5Y 5/1 | LS | | W | | | | | MA | 0 | | 7.10 | fine quartz gravels common |
| 26.1 | 40-60 | 2.5Y 4/1 | CS | | W | | | | | MA | 0 | | 6.90 | fine quartz gravels common |
| 28.1 | 0-5 | 2.5Y 5/2 | ZL | | W | | | | | MA | 0 | | 7.90 | |
| 28.2 | 5-10 | 2.5Y 5/2 | ZL | | W | | | | | MA | 0 | | 7.40 | |
| 28.3 | 10-20 | 10YR 5/2 | ZL | | W | | | | | MA | 0 | | 7.10 | |
| 28.4 | 20-40 | 2.5Y 4/1 | ZC | | W | | | | | MA | 0 | | 6.90 | |
| 28.5 | 40-51 | 10YR 5/1 | ZC | | W | | | | | MA | 0 | | 6.90 | |
| 39.1 | 0-5 | 2.5Y 5/2 | Muck | | W | | | | | | | | 7.70 | |
| 39.2 | 5-10 | 5G 5/1 | C | | W | | | | | n.r. | 1 | | 7.50 | |
| 39.3 | 10-20 | 5GY 6/1 | C | | W | | | | | n.r. | 1 | | 7.50 | |
| 39.4 | 20-35 | 5G 6/1 | C | | W | | | | | n.r. | 1 | | 7.50 | |
| 46.1 | 0-5 | 5YR 4/1 | CS | | W | | | | | SG | 0 | | 7.30 | Fine quartz gravels common |
| 46.2 | 5-10 | 2.5Y 5/2 | CS | | W | | | | | SG | 0 | | 7.20 | Fine quartz gravels common |
| 46.3 | 10-20 | 5Y 4/2 | CS | | W | | | | | SG | 0 | | 6.70 | Fine quartz gravels common |
| 46.4 | 20-40 | 5Y 4/3 | CS | | W | | | | | SG | 0 | | 6.80 | Fine quartz gravels common |
| 53.1 | 0-5 | 2.5Y 5/3 | S | | W | | | | | SG | 0 | | 6.70 | Detritus |
| 53.2 | 5-10 | 2.5Y 5/2 | S | | W | | | | | SG | 0 | | 6.70 | Detritus |
| 53.3 | 10-20 | 2.5Y 5/1 | S | | W | | | | | SG | 0 | | 7.00 | Detritus |
| 53.4 | 20-40 | 2.5Y 4/1 | CS | | W | | | | | MA | 0 | | 7.20 | |
| 53.5 | 40-60 | 2.5Y 5/1 | C | S | W | | | | | MA | 0 | | 7.50 | Detritus |

**Table 8-4 (continued). Profile description data for acid sulfate soil assessment of the Wakool River sites.**

| Site and Sample No. | Horizon Depth Range (cm) | Soil Colour – moist [1] | Texture Class [1] | Texture Modifiers [1] | Moisture State [1] | Redoximorphic Features Abundance (%) [2] | Redoximorphic Features – Kind [2] | Redoximorphic Features - Colour [2] | Redoximorphic Features - Location [2] | Structure - Type [1] | Structure - Grade [1] | Consistency (moist or dry) - Rupture Resistance [1] | pH (field measurement) | Comments (odour, fragments, minerals, plant material, inclusions, other) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 55.1 | 0-5 | 5Y 5/2 | S | | W | | | | | SG | 0 | | 7.00 | |
| 55.2 | 5-10 | 5Y 4/1 | CS | | W | | | | | MA | 0 | | 7.30 | |
| 55.3 | 10-20 | 5Y 3/1 | C | S | W | | | | | MA | 0 | | 7.20 | |
| 55.4 | 20-40 | 5Y 4/1 | C | S | W | | | | | MA | 0 | | 7.10 | |
| 55.5 | 40-51 | 5Y 4/1 | C | S | W | | | | | MA | 0 | | 7.50 | |
| 57.1 | 0-5 | 5Y 4/1 | CS | | W | | | | | SG | 0 | | 6.40 | Strong odour; detritus |
| 57.2 | 5-10 | 5Y 5/2 | CS | | W | | | | | SG | 0 | | 6.40 | Detritus |
| 57.3 | 10-20 | 5Y 5/1 | CS | | W | | | | | SG | 0 | | 6.40 | Detritus |
| 57.4 | 20-40 | 2.5Y 4./2 | CS | | W | | | | | SG | 0 | | 6.30 | Detritus |
| 57.5 | 40-73 | 5Y 4/1 | ZC | | W | | | | | MA | 0 | | 6.30 | |
| 58.1 | 0-5 | 2.5Y 4/2 | CS | | W | | | | | SG | 0 | | 7.10 | |
| 58.2 | 5-10 | 2.5Y 4/2 | CS | | W | | | | | SG | 0 | | 7.20 | |
| 58.3 | 10-20 | 5Y 4/1 | C | S | W | | | | | MA | 0 | | 7.30 | |
| 58.4 | 20-40 | 5Y 4/1 | C | S | W | | | | | MA | 0 | | 7.10 | |
| 58.5 | 40-50 | 2.5Y 3/2 | CS | | W | | | | | MA | 0 | | 7.30 | Peaty |

[1] See National Committee on Soil and Terrain (2009) for abbreviation definitions and further details.

[2] See Schoeneberger *et al.* (2002) for abbreviation definitions and further details.

## 8.2. Niemur River – Collagen Creek

### 8.2.1. Location and setting description

The Niemur River begins as several distinct overflow channels off Colligen Creek, immediately above the confluence of that creek and the Edward River in the Werai forest. The upper Niemur channels gradually form into one main channel as it leaves the Werai forest, and is joined by several more from the north as it heads in a generally westerly direction. Approximately 29 km downstream it is joined by another branch of the Niemur, which meanders within a broad, low sinuosity ancestral channel coming from the south-east (Figure 8-29). The Niemur crosses this ancestral valley at right angles as the two branches converge, and ~5 km further on, is joined by Jimaringle Creek from the south. A larger channel at this stage, the Niemur meanders through a low elevation forested area, before turning generally towards the north and north-west and becoming more confined within a large area of former lake basin, lunette remnants and dunefields, and passing through these north of Lake Nangtree before emerging at Coobool Island. The Niemur avulsed in the geomorphically recent past through Shepparton materials in a southerly direction into the Wakool, leaving its partially abandoned former lowest reach as Mallan Mallan Creek. This avulsion may have been caused by the development of a lunette formed from a deflation basin in the eastern part of Coobool Island.

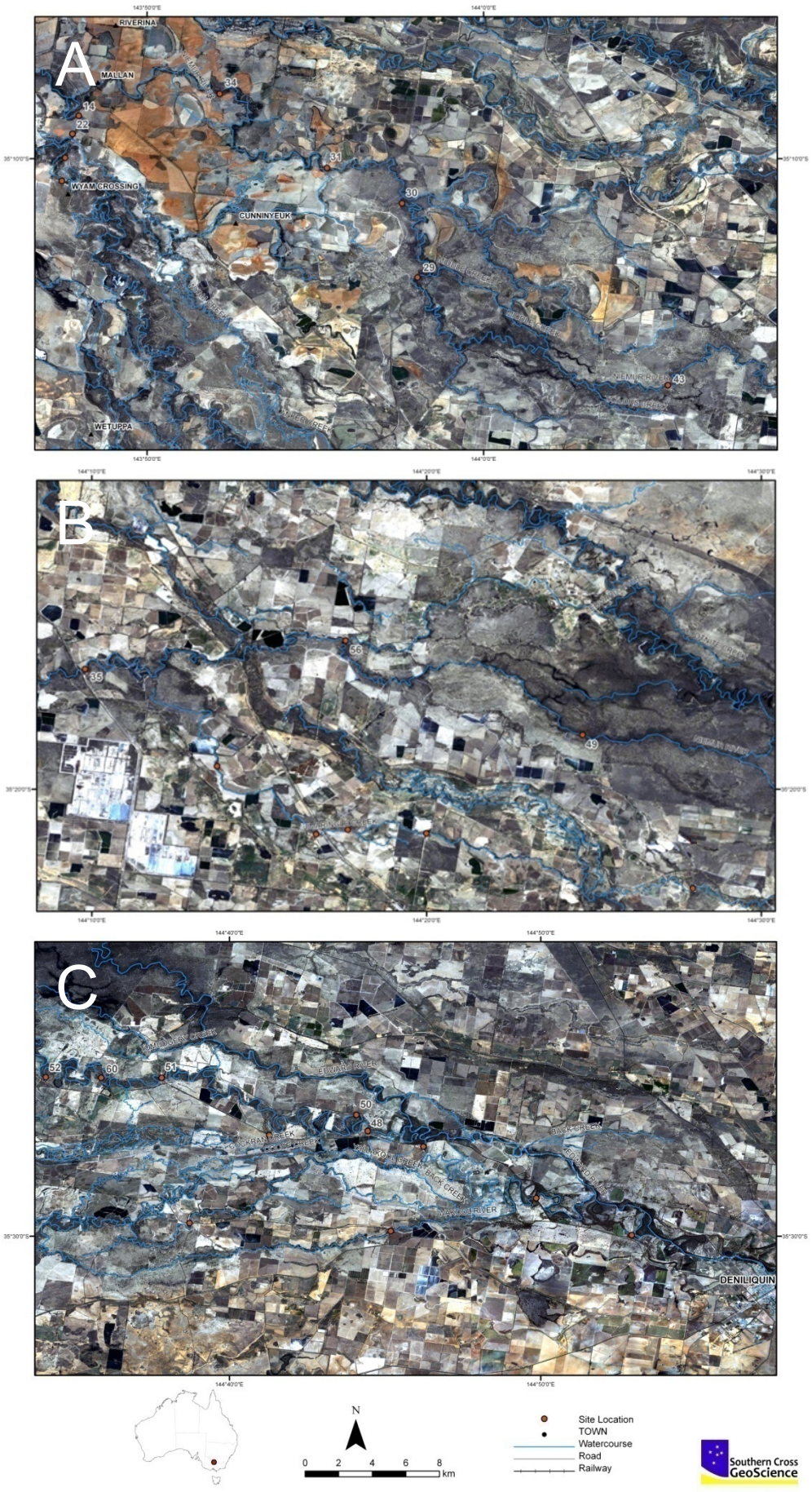


**Figure 8-29. Niemur River – Collagen Creek and sample site locations (A: west; B: centre; C: east).**

### 8.2.2. Soil profile description and distribution

Fifteen sites were described and sampled in Niemur River – Collagen Creek. The soil subtype and general location description are presented in Table 8-5. Profile description data are presented in Table 8-8.

**Table 8-5. Soil identification, subtype and general location description for sites sampled in Niemur River – Collagen Creek.**

| Site ID | Zone | Easting UTM | Northing UTM | Acid sulfate soil subtype class |
|---|---|---|---|---|
| WC_14 | 54H | 755037 | 6107247 | Hypersulfidic Subaqueous Soil with Monosulfides |
| WC_22 | 54H | 754724 | 6106256 | Hypersulfidic Subaqueous Soil with Monosulfides |
| WC_29 | 54H | 770065 | 6097897 | Subaqueous Soil |
| WC_30 | 54H | 769488 | 6102002 | Subaqueous Soil |
| WC_31 | 54H | 766160 | 6104046 | Subaqueous Soil |
| WC_34 | 54H | 761437 | 6108273 | Subaqueous Soil |
| WC_35 | 55H | 241974 | 6092946 | Subaqueous Soil |
| WC_43 | 55H | 235442 | 6092128 | Hypersulfidic Subaqueous Soil |
| WC_48 | 55H | 294935 | 6075412 | Hypersulfidic Subaqueous Soil |
| WC_49 | 55H | 264604 | 6089918 | Subaqueous Soil |
| WC_50 | 55H | 294362 | 6076359 | Hypersulfidic Subaqueous Soil |
| WC_51 | 55H | 284846 | 6078340 | Subaqueous Soil |
| WC_52 | 55H | 279207 | 6078240 | Subaqueous Soil |
| WC_56 | 55H | 253733 | 6094854 | Subaqueous Soil |
| WC_60 | 55H | 281903 | 6078271 | Subaqueous Soil |


**Figure 8-30. Photographs of site WC_14 Niemur River, showing the site and the soil profile.**


**Figure 8-31. Photographs of site WC_22 Niemur River, showing the site and the soil profile.**


**Figure 8-32. Photographs of site WC_29 Niemur River, showing the site and the soil core.**


**Figure 8-33. Photographs of site WC_30 Niemur River, showing the site and the soil core.**


**Figure 8-34. Photographs of site WC_31 Niemur River, showing the site and the soil core.**

**Figure 8-35. Photographs of site WC_34 Niemur River, showing the site and the soil profile.**


**Figure 8-36. Photographs of site WC_35 Niemur River, showing the site and the soil core.**


**Figure 8-37. Photographs of site WC_43 Niemur River, showing the site and the soil profile.**

**Figure 8-38. Photographs of site WC_48 Collagen Creek, showing the site and the soil core.**

**Figure 8-39. Photographs of site WC_49 Niemur River, showing the site and the soil profile.**

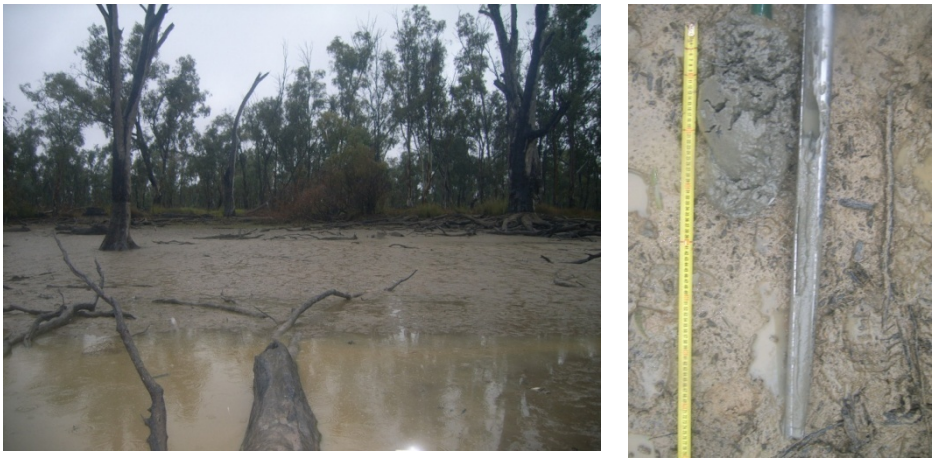

**Figure 8-40. Photographs of site WC_50 Collagen Creek, showing the site and the soil core.**

**Figure 8-41. Photographs of site WC_51 Collagen Creek, showing the site and the soil core.**

**Figure 8-42. Photographs of site WC_52 Collagen Creek, showing the site and the soil core.**

**Figure 8-43. Photographs of site WC_56 Niemur River, showing the site and the soil core.**

**Figure 8-44. Photographs of site WC_60 Collagen Creek, showing the site and the soil core.**

### 8.2.3. Laboratory data assessment

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

The pH data is provided in Table 8-6 and depth profiles of soil pH for all the sites sampled are presented in Figures 8-45 to 8-48. The $pH_W$ values ranged between 4.28 and 7.29. Sulfuric materials (i.e. $pH_W < 4$) were not present. The $pH_{FOX}$ values ranged between 1.48 and 6.99. The $pH_{FOX}$ results indicate that many of the surface soils may have the potential to acidify to pH < 4 as a result of sulfide oxidation. Nineteen 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 11 of the 65 layers examined contained detectable sulfide (i.e. $S_{CR} \geq 0.01\%$ S). The $pH_{KCl}$ values ranged between 3.94 and 7.35. 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 (i.e. WC_48 (10-20 cm)). Other acidic soil materials were identified at 13 of the 15 sites 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.

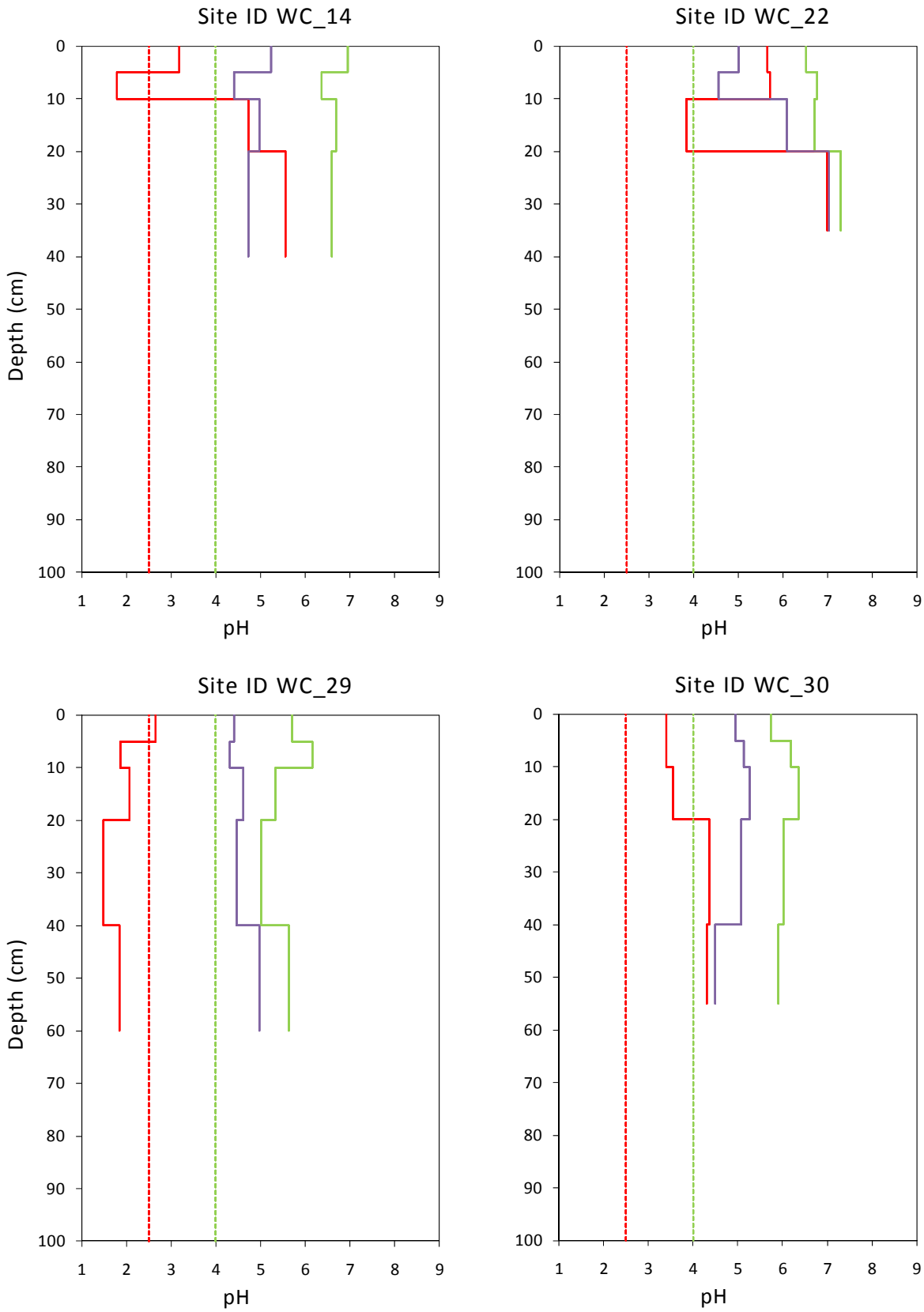


**Figure 8-45. Depth profiles of soil pH for sites in the Niemur River – Collagen Creek (sites 14, 22, 29 and 30), showing soil pH ($pH_W$ as green line), peroxide treated pH ($pH_{FOX}$ as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical $pH_W$ and $pH_{incubation}$ value of 4 (green dashed line) and critical $pH_{FOX}$ value of 2.5 (red dashed line).**

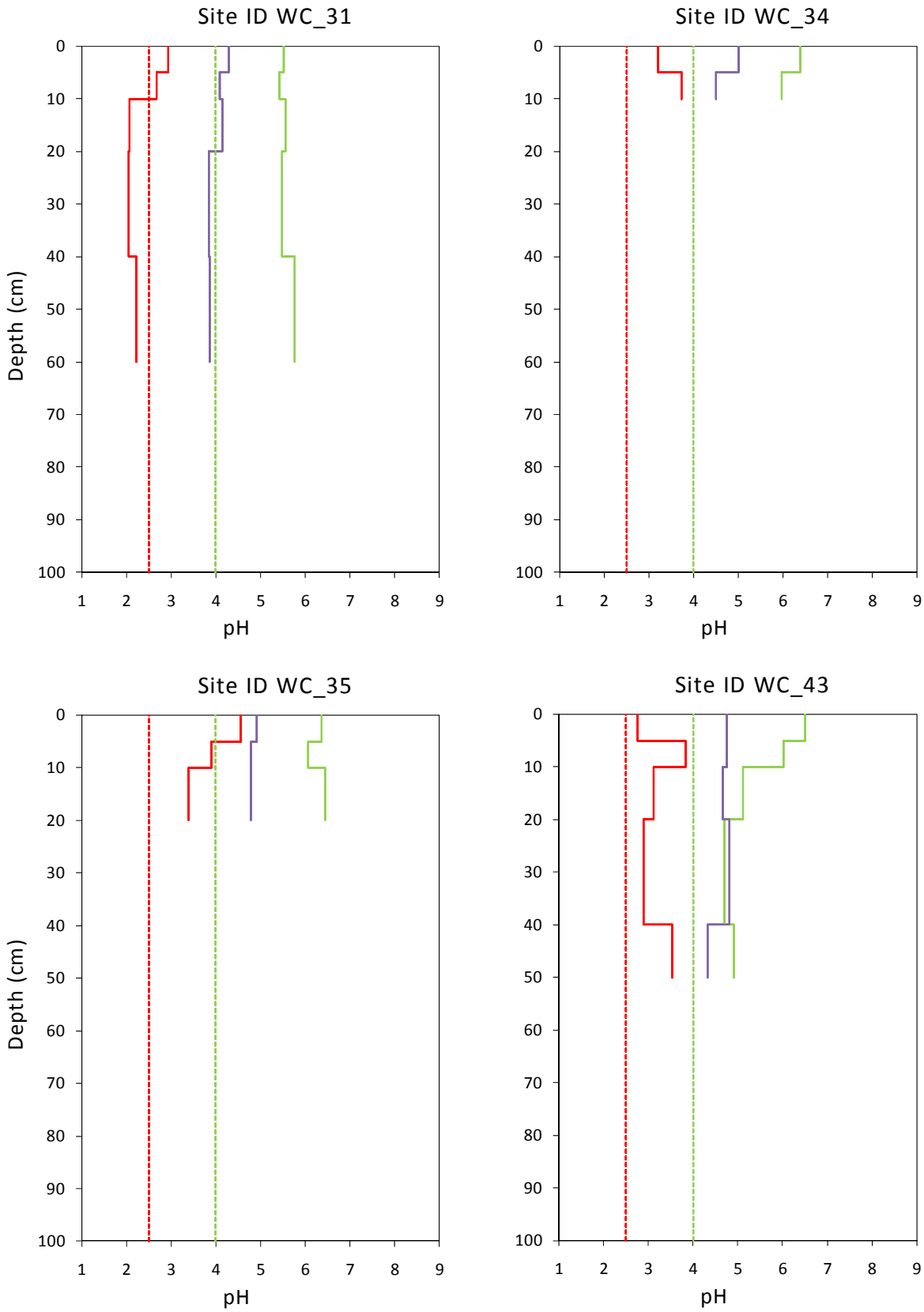


**Figure 8-46. Depth profiles of soil pH for sites in the Niemur River – Collagen Creek (sites 31, 34, 35 and 43), showing soil pH ($pH_W$ as green line), peroxide treated pH ($pH_{FOX}$ as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical $pH_W$ and $pH_{incubation}$ value of 4 (green dashed line) and critical $pH_{FOX}$ value of 2.5 (red dashed line).**

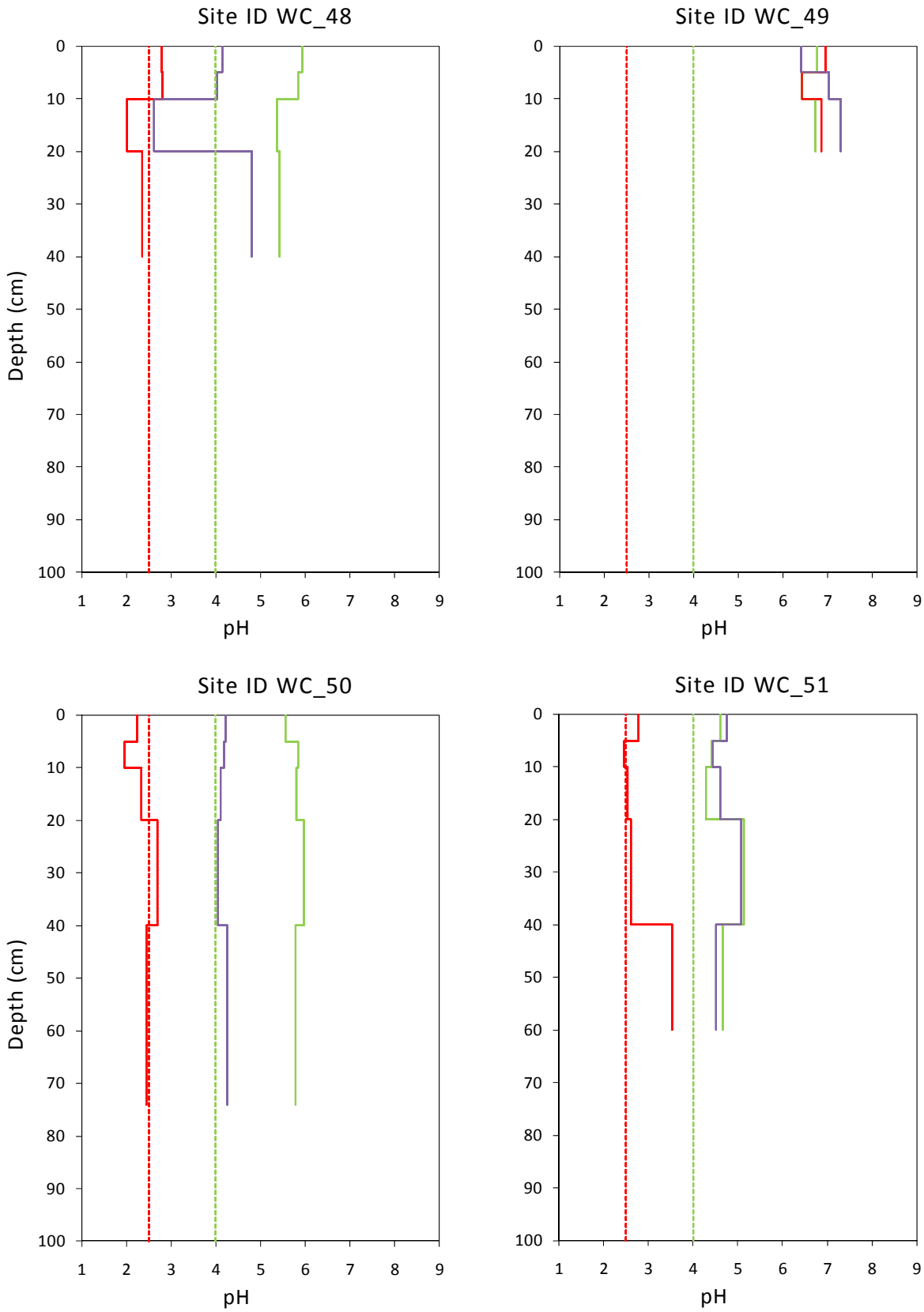


**Figure 8-47. Depth profiles of soil pH for sites in the Niemur River – Collagen Creek (sites 48, 49, 50 and 51), showing soil pH ($pH_W$ as green line), peroxide treated pH ($pH_{FOX}$ as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical $pH_W$ and $pH_{incubation}$ value of 4 (green dashed line) and critical $pH_{FOX}$ value of 2.5 (red dashed line).**

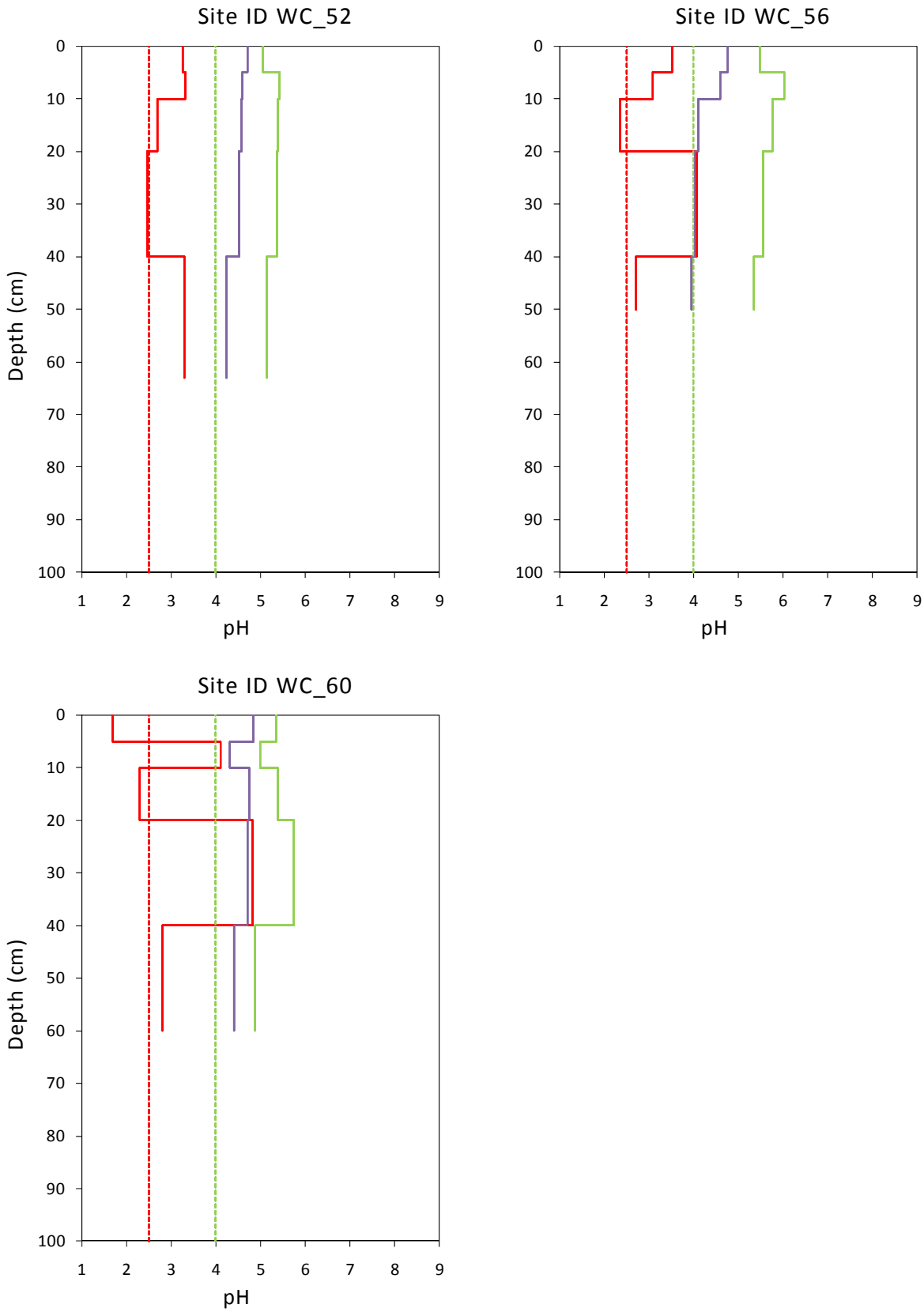


**Figure 8-48. Depth profiles of soil pH for sites in the Niemur River – Collagen Creek (sites 52, 56 and 60), showing soil pH ($pH_W$ as green line), peroxide treated pH ($pH_{FOX}$ as red line) and ageing pH ($pH_{incubation}$ after at least 8 weeks as purple line). Critical $pH_W$ and $pH_{incubation}$ 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 8-6 and summarised in Figures 8-49 to 8-52.

### Chromium reducible sulfur

Chromium reducible sulfur ($S_{CR}$) values ranged between < 0.01 and 0.11% $S_{CR}$. Sulfidic soil materials (i.e. $S_{CR}$ ≥ 0.01% S) were identified at five of the 15 sampling sites (i.e. sites WC_14, WC_22, WC_43, WC_48 and WC_50), with only 11 materials of the 65 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 0.09% $S_{AV}$. A total of four monosulfidic soil materials (i.e. $S_{AV}$ ≥ 0.01% S) were found at two sites (i.e. sites WC_14 and WC_22).

### Acid neutralising capacity

All soil materials had no acid neutralising capacity (ANC) except for two layers at site WC_22 with 0.16% and 0.23% $CaCO_3$.

### Titratable actual acidity

The titratable actual acidity (TAA) ranged between zero and 34 mole $H^+$/tonne. The trend of TAA with depth varied between sites.

### Retained acidity

Retained acidity was only detected in ten layers and ranged between zero and 8 mole $H^+$/tonne.

### Net acidity

Net acidity ranged between -16 and 75 mole $H^+$/tonne. The ten hypersulfidic soils had low to moderate net acidities ranging between 4 and 75 mole $H^+$/tonne.

### Water Soluble Sulfate

The water soluble sulfate in the surface soils (i.e. 0-20 cm) ranged between 9 and 713 mg $SO_4$/kg. The surface soil layers at three sites (i.e. WC_14, WC_22 and WC_50) 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 8-7. The field pH of the surface waters collected ranged between 5.9 and 8.5, with five sites being outside the most relevant ANZECC/ARMCANZ (2000) trigger values for aquatic ecosystems of 6.5 and 8.0. The water data indicates that the surface water has been affected by acidification at some locations. Dissolved oxygen, turbidity and SEC values were sometimes found to be outside the most relevant ANZECC/ARMCANZ (2000) guideline value.

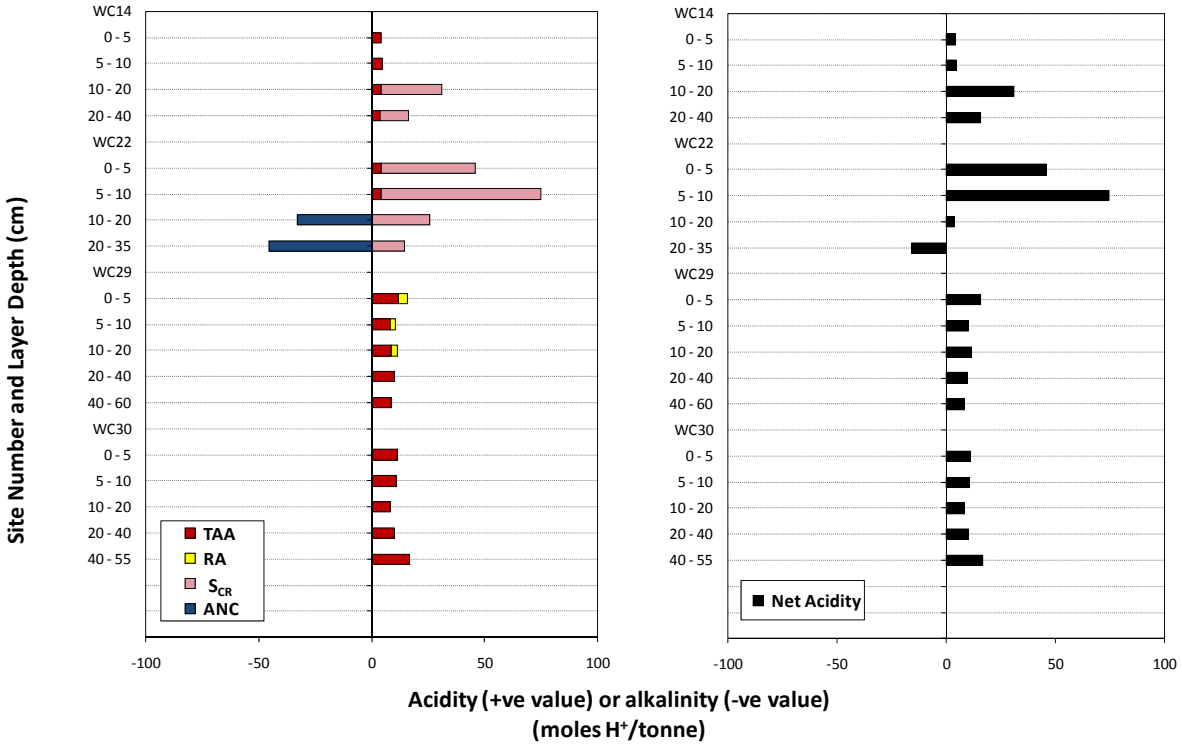


**Figure 8-49. Acid-base accounting depth profiles for sites in Niemur River – Collagen Creek (sites 14, 22, 29 and 30). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as $S_{CR}$ -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.**

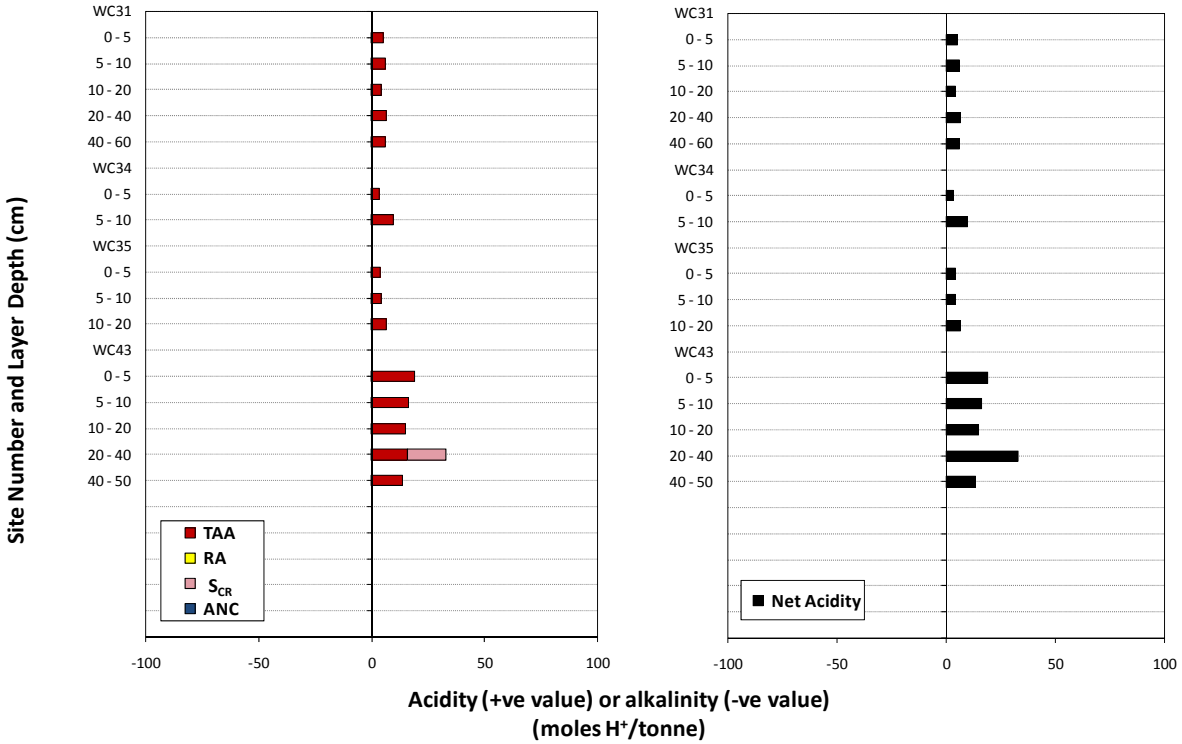


**Figure 8-50. Acid-base accounting depth profiles for sites in Niemur River – Collagen Creek (sites 31, 34, 35 and 43). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as $S_{CR}$ -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.**

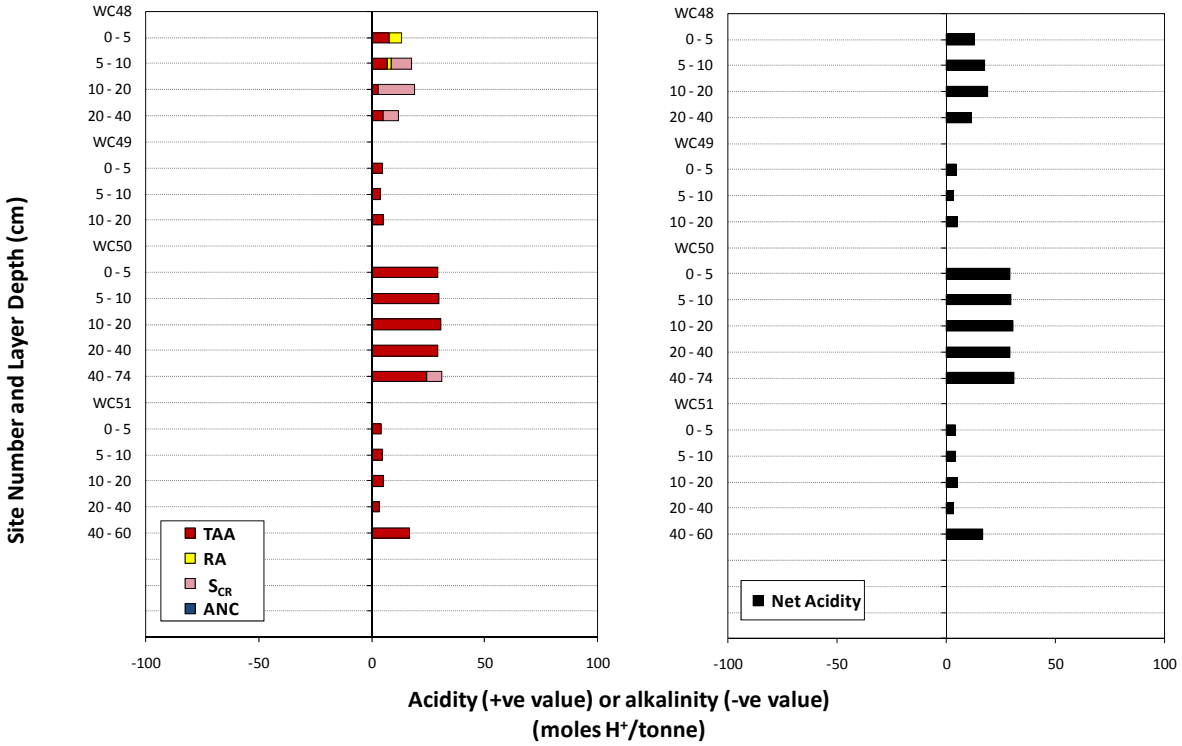


**Figure 8-51. Acid-base accounting depth profiles for sites in Niemur River – Collagen Creek (sites 48, 49, 50 and 51). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as $S_{CR}$ -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.**

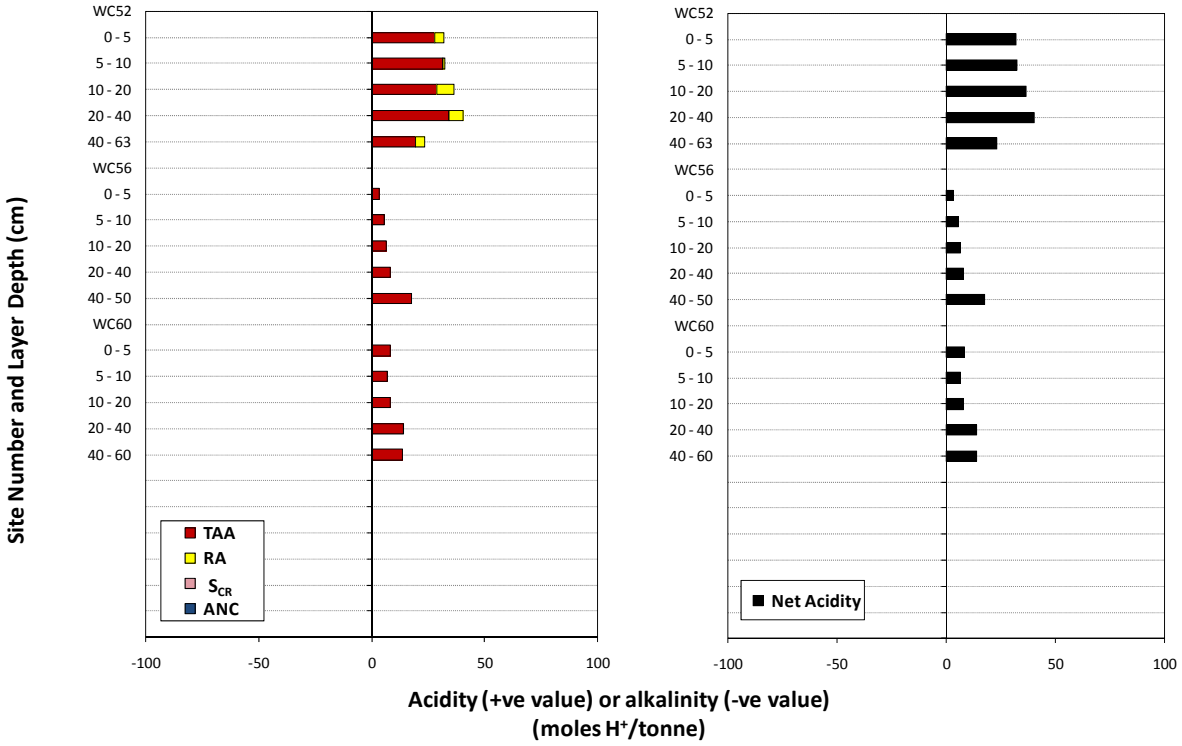


**Figure 8-52. Acid-base accounting depth profiles for sites in Niemur River – Collagen Creek (sites 52, 56 and 60). Left side shows the components: titratable actual acidity (TAA - red bar), acid generating potential (AGP as $S_{CR}$ -pink bar), acid neutralising capacity (ANC - blue bar), retained acidity (RA - yellow bar), and right side shows net acidity.**

### 8.2.4. Discussion

Acid sulfate soils occurred at five of the sites examined in the Niemur River – Collagen Creek (i.e. sites WC_14, WC_22, WC_43, WC_48 and WC_50). The presence of reduced inorganic sulfur was identified at five sites, with a $S_{CR}$ of up to 0.11% S. Hypersulfidic soil materials with low to moderate net acidities (i.e. 4 - 75 mole $H^+$/tonne) were present in the five soil profiles (one profile also contained a hyposulfidic material). Monosulfidic soil materials were also observed at two of the sulfidic sites, with $S_{AV}$ contents of up to 0.09% S. Monosulfidic soil materials ($S_{AV}$ ≤ 0.09% S) were observed in the upper 0-10 cm layers at site WC_22. These results indicate that acidity would be produced upon oxidation of the sulfidic materials. The surficial soil materials at three 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 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 five high priority sites based on hypersulfidic material and two 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%. Three of 15 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 in Niemur River – Collagen Creek are:

- Acidification hazard: While low net acidities were dominant in this channel system, five hypersulfidic materials had moderate net acidities (i.e. 9% of layers), indicating that the overall degree of acidification hazard is moderate.

- Deoxygenation hazard: Monosulfidic soil materials ($S_{AV}$ ≤ 0.09% S) observed in the upper 0-10 cm layers at one site represent a high deoxygenation hazard. In addition, the soluble sulfate content of surface soil materials at two other 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 system 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 Niemur River – Collagen Creek:**

| | |
|---|---|
| ***Soil materials***: | Sulfuric materials were not observed. Sulfidic soil materials identified included: hypersulfidic (5 sites), monosulfidic (2 sites) hyposulfidic < 0.10% (1 site). Low net acidities dominate within the channel system, although 5 hypersulfidic soil materials had moderate net acidities. |
| ***Acid sulfate soil identification***: | • Sulfidic materials were recorded at various subsurface depths at four sites, and throughout the depth profile at one site. Monosulfides were found at two sites at depths of 0-20 cm and 10-20 cm. All sites were subaqueous. |
| ***Hazard assessment*** | • Acidification hazard - moderate level of concern<br>• Deoxygenation hazard - high level of concern<br>• Metal mobilisation hazard - high level of concern |

**Table 8-6. Laboratory analytical data for acid sulfate soil assessment of Niemur River – Collagen Creek sites.**
(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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14.1 | 0-5 | | 6.95 | 3.18 | 5.24 | 18.75 | 5.31 | 4.07 | 0.00 | 0.00 | 0.00 | 4.07 | 0.00 | Other Acid Soils |
| 14.2 | 5-10 | | 6.37 | 1.79 | 4.40 | 31.05 | 4.69 | 4.45 | 0.00 | 0.00 | 0.00 | 4.45 | 0.00 | Other Acid Soils |
| 14.3 | 10-20 | | 6.68 | 4.72 | 4.98* | 330.00 | 5.56 | 3.96 | 0.04 | 0.00 | 0.00 | 31.20 | 0.01 | Hypermonosulfidic# |
| 14.4 | 20-40 | | 6.59 | 5.56 | 4.73* | 237.00 | 5.80 | 3.71 | 0.02 | 0.00 | 0.00 | 16.01 | 0.00 | Hypersulfidic# |
| 22.1 | 0-5 | | 6.51 | 5.66 | 5.01* | 696.00 | 5.85 | 4.14 | 0.07 | 0.00 | 0.00 | 46.00 | 0.05 | Hypermonosulfidic# |
| 22.2 | 5-10 | | 6.77 | 5.71 | 4.56* | 712.50 | 6.35 | 4.24 | 0.11 | 0.00 | 0.00 | 74.77 | 0.09 | Hypermonosulfidic# |
| 22.3 | 10-20 | | 6.70 | 3.85 | 6.09 | 528.00 | 6.82 | 0.00 | 0.04 | 0.00 | 0.16 | 3.81 | 0.01 | Hypermonosulfidic# |
| 22.4 | 20-35 | | 7.29 | 6.99 | 7.02* | 522.00 | 7.35 | 0.00 | 0.02 | 0.00 | 0.23 | -15.90 | 0.00 | Hyposulfidic |
| 29.1 | 0-5 | | 5.70 | 2.65 | 4.40* | 71.85 | 4.25 | 11.80 | 0.00 | 4.00 | 0.00 | 15.80 | 0.00 | Other Acid Soils |
| 29.2 | 5-10 | | 6.16 | 1.87 | 4.31* | 36.15 | 4.23 | 8.30 | 0.00 | 2.00 | 0.00 | 10.30 | 0.00 | Other Acid Soils |
| 29.3 | 10-20 | | 5.33 | 2.08 | 4.62* | 34.95 | 4.16 | 8.52 | 0.00 | 3.00 | 0.00 | 11.52 | 0.00 | Other Acid Soils |
| 29.4 | 20-40 | | 5.01 | 1.48 | 4.47* | 37.80 | 4.18 | 9.85 | 0.00 | 0.00 | 0.00 | 9.85 | 0.00 | Other Acid Soils |
| 29.5 | 40-50 | | 5.64 | 1.84 | 4.97 | 40.35 | 4.31 | 8.57 | 0.00 | 0.00 | 0.00 | 8.57 | 0.00 | Other Acid Soils |
| 30.1 | 0-5 | | 5.73 | 3.40 | 4.95 | 28.50 | 4.45 | 11.37 | 0.00 | 0.00 | 0.00 | 11.37 | 0.00 | Other Acid Soils |
| 30.2 | 5-10 | | 6.19 | 3.41 | 5.14 | 37.35 | 4.39 | 10.64 | 0.00 | 0.00 | 0.00 | 10.64 | 0.00 | Other Acid Soils |
| 30.3 | 10-20 | | 6.36 | 3.55 | 5.27* | 37.20 | 4.48 | 8.25 | 0.00 | 0.00 | 0.00 | 8.25 | 0.00 | Other Acid Soils |
| 30.4 | 20-40 | | 6.01 | 4.37 | 5.07 | 30.75 | 4.32 | 10.16 | 0.00 | 0.00 | 0.00 | 10.16 | 0.00 | Other Acid Soils |
| 30.5 | 40-50 | | 5.91 | 4.30 | 4.50 | 50.10 | 3.98 | 16.84 | 0.00 | 0.00 | 0.00 | 16.84 | 0.00 | Other Acid Soils |
| 31.1 | 0-5 | | 5.51 | 2.93 | 4.30* | 65.10 | 4.75 | 5.10 | 0.00 | 0.00 | 0.00 | 5.10 | 0.00 | Other Acid Soils |
| 31.2 | 5-10 | | 5.42 | 2.67 | 4.09 | 50.70 | 4.72 | 5.89 | 0.00 | 0.00 | 0.00 | 5.89 | 0.00 | Other Acid Soils |
| 31.3 | 10-20 | | 5.56 | 2.08 | 4.14 | 68.55 | 4.78 | 4.15 | 0.00 | 0.00 | 0.00 | 4.15 | 0.00 | Other Acid Soils |
| 31.4 | 20-40 | | 5.49 | 2.05 | 3.85* | 336.00 | 4.77 | 6.65 | 0.00 | 0.00 | 0.00 | 6.65 | 0.00 | Other Acid Soils |
| 31.5 | 40-60 | | 5.76 | 2.23 | 3.87 | 520.50 | 5.02 | 5.92 | 0.00 | 0.00 | 0.00 | 5.92 | 0.00 | Other Acid Soils |
| 34.1 | 0-5 | | 6.39 | 3.20 | 5.01 | 30.60 | 4.76 | 3.46 | 0.00 | 0.00 | 0.00 | 3.46 | 0.00 | Other Acid Soils |
| 34.2 | 5-10 | | 5.97 | 3.74 | 4.51 | 64.35 | 4.30 | 9.57 | 0.00 | 0.00 | 0.00 | 9.57 | 0.00 | Other Acid Soils |
| 35.1 | 0-5 | | 6.37 | 4.55 | 4.91 | 37.80 | 4.63 | 3.95 | 0.00 | 0.00 | 0.00 | 3.95 | 0.00 | Other Acid Soils |
| 35.2 | 5-10 | | 6.07 | 3.89 | 4.79 | 36.15 | 4.67 | 4.09 | 0.00 | 0.00 | 0.00 | 4.09 | 0.00 | Other Acid Soils |
| 35.3 | 10-20 | | 6.44 | 3.39 | 4.78 | 33.45 | 4.62 | 6.54 | 0.00 | 0.00 | 0.00 | 6.54 | 0.00 | Other Acid Soils |

* Indicates that a stable pH has not yet been reached for this sample (after at least 15 weeks). # Classified as hypermonosulfidic/hypersulfidic based on positive net acidity.

**Table 8-6 (continued). Laboratory analytical data for acid sulfate soil assessment of Niemur River – Collagen Creek sites.**
(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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 43.1 | 0-5 | | 6.51 | 2.77 | 4.75 | 20.40 | 3.97 | 18.91 | 0.00 | 0.00 | 0.00 | 18.91 | 0.00 | Other Acid Soils |
| 43.2 | 5-10 | | 6.01 | 3.84 | 4.76 | 23.40 | 4.02 | 16.27 | 0.00 | 0.00 | 0.00 | 16.27 | 0.00 | Other Acid Soils |
| 43.3 | 10-20 | | 5.11 | 3.11 | 4.66 | 21.15 | 4.04 | 14.87 | 0.00 | 0.00 | 0.00 | 14.87 | 0.00 | Other Acid Soils |
| 43.4 | 20-40 | | 4.70 | 2.90 | 4.81 | 24.30 | 4.17 | 16.08 | 0.03 | 0.00 | 0.00 | 32.80 | 0.00 | Hypersulfidic# |
| 43.5 | 40-50 | | 4.91 | 3.54 | 4.32* | 30.60 | 4.08 | 13.62 | 0.00 | 0.00 | 0.00 | 13.62 | 0.00 | Other Acid Soils |
| 48.1 | 0-5 | | 5.93 | 2.78 | 4.14* | 37.35 | 4.22 | 7.88 | 0.00 | 5.00 | 0.00 | 12.88 | 0.00 | Other Acid Soils |
| 48.2 | 5-10 | | 5.83 | 2.80 | 4.04* | 42.15 | 4.37 | 6.67 | 0.01 | 2.00 | 0.00 | 17.73 | 0.00 | Hypersulfidic# |
| 48.3 | 10-20 | | 5.37 | 2.01 | 2.61* | 53.55 | 4.59 | 2.96 | 0.03 | 0.00 | 0.00 | 18.97 | 0.00 | Hypersulfidic |
| 48.4 | 20-40 | | 5.43 | 2.35 | 4.80 | 53.40 | 4.67 | 5.04 | 0.01 | 0.00 | 0.00 | 11.68 | 0.00 | Hypersulfidic# |
| 49.1 | 0-5 | | 6.76 | 6.96 | 6.40 | 20.10 | 6.19 | 4.61 | 0.00 | 0.00 | 0.00 | 4.61 | 0.00 | Other Soil Materials |
| 49.2 | 5-10 | | 6.42 | 6.43 | 7.02 | 19.95 | 6.21 | 3.49 | 0.00 | 0.00 | 0.00 | 3.49 | 0.00 | Other Soil Materials |
| 49.3 | 10-20 | | 6.72 | 6.85 | 7.29 | 16.80 | 6.30 | 4.94 | 0.00 | 0.00 | 0.00 | 4.94 | 0.00 | Other Soil Materials |
| 50.1 | 0-5 | | 5.55 | 2.24 | 4.21* | 133.50 | 3.95 | 29.10 | 0.00 | 0.00 | 0.00 | 29.10 | 0.00 | Other Acid Soils |
| 50.2 | 5-10 | | 5.83 | 1.95 | 4.18* | 145.65 | 3.95 | 29.83 | 0.00 | 0.00 | 0.00 | 29.83 | 0.00 | Other Acid Soils |
| 50.3 | 10-20 | | 5.80 | 2.34 | 4.10* | 143.55 | 4.00 | 30.78 | 0.00 | 0.00 | 0.00 | 30.78 | 0.00 | Other Acid Soils |
| 50.4 | 20-40 | | 5.97 | 2.69 | 4.05* | 145.05 | 4.00 | 29.33 | 0.00 | 0.00 | 0.00 | 29.33 | 0.00 | Other Acid Soils |
| 50.5 | 40-74 | | 5.79 | 2.45 | 4.26* | 110.55 | 4.05 | 24.36 | 0.01 | 0.00 | 0.00 | 30.98 | 0.00 | Hypersulfidic# |
| 51.1 | 0-5 | | 4.61 | 2.78 | 4.75* | 11.70 | 4.65 | 4.34 | 0.00 | 0.00 | 0.00 | 4.34 | 0.00 | Other Acid Soils |
| 51.2 | 5-10 | | 4.41 | 2.45 | 4.43* | 8.73 | 4.47 | 4.42 | 0.00 | 0.00 | 0.00 | 4.42 | 0.00 | Other Acid Soils |
| 51.3 | 10-20 | | 4.28 | 2.53 | 4.60* | 9.50 | 4.49 | 5.13 | 0.00 | 0.00 | 0.00 | 5.13 | 0.00 | Other Acid Soils |
| 51.4 | 20-40 | | 5.13 | 2.61 | 5.08* | 11.01 | 4.77 | 3.43 | 0.00 | 0.00 | 0.00 | 3.43 | 0.00 | Other Acid Soils |
| 51.5 | 40-60 | | 4.66 | 3.54 | 4.52* | 33.45 | 4.11 | 16.82 | 0.00 | 0.00 | 0.00 | 16.82 | 0.00 | Other Acid Soils |
| 52.1 | 0-5 | | 5.05 | 3.25 | 4.70* | 79.05 | 4.12 | 27.80 | 0.00 | 4.00 | 0.00 | 31.80 | 0.00 | Other Acid Soils |
| 52.2 | 5-10 | | 5.43 | 3.31 | 4.60* | 71.70 | 3.95 | 31.57 | 0.00 | 1.00 | 0.00 | 32.57 | 0.00 | Other Acid Soils |
| 52.3 | 10-20 | | 5.38 | 2.70 | 4.58* | 90.15 | 3.99 | 28.61 | 0.00 | 8.00 | 0.00 | 36.61 | 0.00 | Other Acid Soils |
| 52.4 | 20-40 | | 5.37 | 2.46 | 4.52* | 72.00 | 3.98 | 34.37 | 0.00 | 6.00 | 0.00 | 40.37 | 0.00 | Other Acid Soils |
| 52.5 | 40-63 | | 5.15 | 3.30 | 4.24* | 30.90 | 4.42 | 19.32 | 0.00 | 4.00 | 0.00 | 23.32 | 0.00 | Other Acid Soils |

* Indicates that a stable pH has not yet been reached for this sample (after at least 15 weeks). # Classified as hypersulfidic based on positive net acidity.

**Table 8-6 (continued). Laboratory analytical data for acid sulfate soil assessment of Niemur River – Collagen Creek sites.**
(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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 56.1 | 0-5 | | 5.49 | 3.52 | 4.76* | 19.05 | 4.74 | 3.45 | 0.00 | 0.00 | 0.00 | 3.45 | 0.00 | Other Acid Soils |
| 56.2 | 5-10 | | 6.03 | 3.09 | 4.59* | 25.80 | 4.53 | 5.39 | 0.00 | 0.00 | 0.00 | 5.39 | 0.00 | Other Acid Soils |
| 56.3 | 10-20 | | 5.76 | 2.35 | 4.10* | 24.30 | 4.40 | 6.40 | 0.00 | 0.00 | 0.00 | 6.40 | 0.00 | Other Acid Soils |
| 56.4 | 20-40 | | 5.56 | 4.07 | 4.04* | 20.10 | 4.24 | 8.00 | 0.00 | 0.00 | 0.00 | 8.00 | 0.00 | Other Acid Soils |
| 56.5 | 40-60 | | 5.35 | 2.72 | 3.96* | 15.00 | 3.94 | 17.72 | 0.00 | 0.00 | 0.00 | 17.72 | 0.00 | Other Acid Soils |
| 60.1 | 0-5 | | 5.35 | 1.70 | 4.84* | 25.20 | 4.41 | 8.28 | 0.00 | 0.00 | 0.00 | 8.28 | 0.00 | Other Acid Soils |
| 60.2 | 5-10 | | 5.00 | 4.10 | 4.32* | 20.25 | 4.29 | 6.62 | 0.00 | 0.00 | 0.00 | 6.62 | 0.00 | Other Acid Soils |
| 60.3 | 10-20 | | 5.39 | 2.29 | 4.75* | 20.85 | 4.47 | 8.12 | 0.00 | 0.00 | 0.00 | 8.12 | 0.00 | Other Acid Soils |
| 60.4 | 20-40 | | 5.75 | 4.82 | 4.70* | 24.75 | 4.31 | 13.99 | 0.00 | 0.00 | 0.00 | 13.99 | 0.00 | Other Acid Soils |
| 60.5 | 40-60 | | 4.87 | 2.80 | 4.41* | 21.60 | 4.13 | 13.74 | 0.00 | 0.00 | 0.00 | 13.74 | 0.00 | Other Acid Soils |

* Indicates that a stable pH has not yet been reached for this sample (after at least 15 weeks).

**Table 8-7. Field hydrochemistry data for acid sulfate soil assessment of Niemur River – Collagen Creek sites.**

| Site ID. | Temperature (Deg C) | Specific Electrical Conductivity (µS/cm) | Dissolved Oxygen (%) | Dissolved Oxygen (mg/L) | pH | ORP (mV) | Redox potential (mV) | Turbidity (NTU) | Comment |
|---|---|---|---|---|---|---|---|---|---|
| *Lowland River** | | *125-2,220* | *85-110* | | *6.5-8.0* | | | *6-50* | |
| WC_14 | 12.2 | 63.9 | 91.8 | 9.81 | 5.99 | 341 | | 56 | |
| WC_22 | 10.5 | 74.2 | 98.5 | 10.97 | n.a. | 310 | | 78 | |
| WC_29 | 7.5 | 33.1 | 95.4 | 11.62 | 8.50 | 329 | | 35 | |
| WC_30 | 9.1 | 35.2 | 93.2 | 10.88 | 6.90 | 341 | | 52 | |
| WC_31 | 10.2 | 364 | 92.5 | 10.52 | 6.60 | 277 | | 63 | |
| WC_34 | 10.5 | 37.3 | 92.9 | 10.37 | 7.30 | 305 | | 40 | |
| WC_35 | 11.3 | 33.6 | 86.0 | 9.37 | 7.60 | 295 | | 40 | |
| WC_43 | 11.0 | 35,000 | 81.9 | 9.17 | 6.58 | 322 | | 67 | |
| WC_48 | 7.3 | 34.1 | 104.2 | 11.00 | 7.30 | 346 | | 120 | |
| WC_49 | 10.6 | 33.9 | 73.5 | 8.20 | 7.50 | 322 | | 48 | |
| WC_50 | 12.5 | 13.9 | 1.1 | 0.11 | 5.90 | -104 | | above limits | |
| WC_51 | 8.1 | 34.4 | 83.4 | 9.02 | 6.20 | 335 | | 115 | |
| WC_52 | 10.4 | 35.4 | 75.5 | 8.45 | 6.60 | 2014 | | 53 | |
| WC_56 | 10.7 | 33.3 | 83.2 | 9.31 | 6.50 | 280 | | 72 | |
| WC_60 | 9.6 | 83.2 | 87.4 | 9.97 | 6.10 | 345 | | 52 | |

* 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.

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**Table 8-8. Profile description data for acid sulfate soil assessment of Niemur River – Collagen Creek sites.**

| Site and Sample No. | Horizon Depth Range (cm) | Soil Colour – moist [1] | Texture Class [1] | Texture Modifiers [1] | Moisture State [1] | Redoximorphic Features Abundance (%) [2] | Redoximorphic Features – Kind [2] | Redoximorphic Features - Colour [2] | Redoximorphic Features - Location [2] | Structure - Type [1] | Structure - Grade [1] | Consistency (moist or dry) - Rupture Resistance [1] | pH (field measurement) | Comments (odour, fragments, minerals, plant material, inclusions, other) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14.1 | 0-5 | 7.5YR 6/6 | S | | W | | | | | SG | 0 | | 6.30 | |
| 14.2 | 5-10 | 7.5YR 6/6 | S | | W | | | | | SG | 0 | | 6.00 | |
| 14.3 | 10-20 | 10YR 5/1 | C | S | W | 10 | FM | | | n.r. | | | 6.20 | |
| 14.4 | 20-40 | 10YR 5/1 | CS | | W | 10 | FM | | | n.r. | | | 6.20 | |
| 22.1 | 0-5 | 10YR 4/1 | Muck | | W | | | | | MA | 0 | | n.r. | |
| 22.2 | 5-10 | N2.5 | Muck | | W | | | | | MA | 0 | | n.r. | |
| 22.3 | 10-20 | 10YR 4/1 | LS | | W | | | | | MA | 0 | | n.r. | |
| 22.4 | 20-35 | 5Y 5/1 | CS | | M | 20 | FM | | | MA | 0 | | n.r. | |
| 29.1 | 0-5 | 2.5Y 5/1 | CS | | W | | | | | n.r. | | | 8.40 | |
| 29.2 | 5-10 | 2.5Y 5/1 | LS | | W | | | | | n.r. | | | 7.60 | |
| 29.3 | 10-20 | 2.5Y 5/1 | LS | | W | | | | | n.r. | | | 7.20 | |
| 29.4 | 20-40 | 2.5Y 5/2 | LS | | W | | | | | n.r. | | | 7.10 | |
| 29.5 | 40-50 | 2.5Y 5/2 | LS | | W | | | | | n.r. | | | 6.70 | |
| 30.1 | 0-5 | 2.5Y 5/2 | LS | | W | | | | | n.r. | | | 6.80 | |
| 30.2 | 5-10 | 2.5Y 5/2 | LS | | W | | | | | n.r. | | | 6.60 | |
| 30.3 | 10-20 | 2.5Y 6/1 | CS | | W | | | | | n.r. | | | 6.90 | |
| 30.4 | 20-40 | 2.5Y 6/2 | SCL | | W | 50 | FM | | | n.r. | | | 6.70 | |
| 30.5 | 40-50 | 10YR 6/4 | CS | | W | 50 | FM | | | n.r. | | | 6.80 | |
| 31.1 | 0-5 | 10YR 5/2 | S | | W | | | | | SG | 0 | | 6.80 | Abundant charcoal |
| 31.2 | 5-10 | 10YR 5/2 | S | | W | | | | | SG | 0 | | 6.20 | Abundant charcoal |
| 31.3 | 10-20 | 10YR 5/2 | S | | W | | | | | SG | 0 | | 6.10 | Abundant charcoal |
| 31.4 | 20-40 | 2.5Y 5/1 | CS | | W | | | | | SG | 0 | | 6.00 | Abundant charcoal |
| 31.5 | 40-60 | 2.5Y 5/1 | CS | | W | | | | | SG | 0 | | 6.10 | Abundant charcoal |

**Table 8-8 (continued). Profile description data for acid sulfate soil assessment of Niemur River – Collagen Creek sites.**

| Site and Sample No. | Horizon Depth Range (cm) | Soil Colour – moist [1] | Texture Class [1] | Texture Modifiers [1] | Moisture State [1] | Redoximorphic Features Abundance (%) [2] | Redoximorphic Features – Kind [2] | Redoximorphic Features - Colour [2] | Redoximorphic Features - Location [2] | Structure - Type [1] | Structure - Grade [1] | Consistency (moist or dry) - Rupture Resistance [1] | pH (field measurement) | Comments (odour, fragments, minerals, plant material, inclusions, other) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34.1 | 0-5 | 10YR 6/2 | S | | | | | | | SG | 0 | | 7.60 | Mottled zone of hardpan |
| 34.2 | 5-10 | 2.5Y 5/3 | C | S | | 50 | FM | | | MA | 0 | | 7.40 | Ironstone nodules common |
| 35.1 | 0-5 | 10YR 6/1 | S | | W | | | | | SG | 0 | | 7.90 | |
| 35.2 | 5-10 | 10YR 6/1 | S | | W | | | | | SG | 0 | | 7.50 | |
| 35.3 | 10-20 | 10YR 6/1 | S | | W | | | | | SG | 0 | | 7.70 | |
| 43.1 | 0-5 | 2.5Y 5/1 | C | S | W | 2 | FM | | | MA | 0 | | 7.30 | Fine quartz gravels common |
| 43.2 | 5-10 | 2.5Y 5/2 | C | S | W | 2 | FM | | | MA | 0 | | 6.90 | |
| 43.3 | 10-20 | 2.5Y 5/1 | C | S | W | 2 | FM | | | MA | 0 | | 6.80 | |
| 43.4 | 20-40 | 2.5Y 5/2 | C | S | W | 10 | FM | | | MA | 0 | | 6.70 | |
| 43.5 | 40-50 | 2.5Y 5/1 | C | S | W | 20 | FM | | | MA | 0 | | 6.80 | Hardpan beyond 50cm |
| 48.1 | 0-5 | 5Y 4/1 | LS | | W | | | | | MA | 0 | | 7.10 | |
| 48.2 | 5-10 | 2.5Y 5/1 | CS | | W | | | | | SG | 0 | | 7.10 | |
| 48.3 | 10-20 | 5Y 4/1 | CS | | W | | | | | SG | 0 | | 7.20 | |
| 48.4 | 20-40 | 5Y 3/1 | CS | | W | | | | | SG | 0 | | 7.20 | |
| 49.1 | 0-5 | 2.5Y 6/2 | C | S | W | 50 | FM | | | MA | 0 | | 7.20 | |
| 49.2 | 5-10 | 2.5YR 7/1 | C | | W | 50 | FM | | | MA | 0 | | 7.40 | |
| 49.3 | 10-20 | 5Y 7/1 | C | | W | 50 | FM | | | MA | 0 | | 7.50 | |
| 50.1 | 0-5 | N 5 | ZC | | W | | | | | MA | 0 | | 6.80 | |
| 50.2 | 5-10 | 10Y 5/1 | ZC | | W | | | | | MA | 0 | | 6.80 | |
| 50.3 | 10-20 | 10Y 4/1 | ZC | | W | | | | | MA | 0 | | 6.90 | |
| 50.4 | 20-40 | 10Y 4/1 | ZC | | W | | | | | MA | 0 | | 6.90 | |
| 50.5 | 40-74 | 10Y 4/1 | ZC | | W | | | | | MA | 0 | | 6.70 | |

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**Table 8-8 (continued). Profile description data for acid sulfate soil assessment of Niemur River – Collagen Creek sites.**

| Site and Sample No. | Horizon Depth Range (cm) | Soil Colour – moist [1] | Texture Class [1] | Texture Modifiers [1] | Moisture State [1] | Redoximorphic Features Abundance (%) [2] | Redoximorphic Features – Kind [2] | Redoximorphic Features - Colour [2] | Redoximorphic Features - Location [2] | Structure - Type [1] | Structure - Grade [1] | Consistency (moist or dry) - Rupture Resistance [1] | pH (field measurement) | Comments (odour, fragments, minerals, plant material, inclusions, other) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51.1 | 0-5 | 10YR 5/4 | S | | | | | | | SG | 0 | | 7.10 | Very gravelly |
| 51.2 | 5-10 | 10YR 5/3 | S | | | | | | | SG | 0 | | 7.20 | Very gravelly |
| 51.3 | 10-20 | 10YR 5/4 | S | | | | | | | SG | 0 | | 6.90 | Very gravelly |
| 51.4 | 20-40 | 10YR 5/3 | S | | | | | | | SG | 0 | | 6.50 | Very gravelly |
| 51.5 | 40-60 | 2.5Y 5/1 | C | S | | | | | | MA | 0 | | 6.60 | Very gravelly |
| 52.1 | 0-5 | 10YR 4/2 | ZC | | W | | | | | MA | 0 | | 7.00 | |
| 52.2 | 5-10 | 10YR 5/2 | ZC | | W | | | | | MA | 0 | | 7.10 | |
| 52.3 | 10-20 | 10YR 3/1 | ZC | | W | | | | | MA | 0 | | 7.00 | |
| 52.4 | 20-40 | 10YR 3/1 | ZC | | W | | | | | MA | 0 | | 6.80 | |
| 52.5 | 40-63 | 2.5Y 3/1 | C | S | W | | | | | MA | 0 | | 6.80 | |
| 56.1 | 0-5 | 5Y 4/2 | S | | W | | | | | SG | 0 | | 7.00 | |
| 56.2 | 5-10 | 5Y 5/3 | CS | | W | | | | | SG | 0 | | 6.80 | |
| 56.3 | 10-20 | 5Y 5/2 | CS | | W | | | | | SG | 0 | | 6.90 | |
| 56.4 | 20-40 | N6 | C | S | W | | | | | MA | 0 | | 6.80 | |
| 56.5 | 40-60 | 10GY 5/1 | C | S | W | | | | | MA | 0 | | 6.80 | |
| 60.1 | 0-5 | 2.5Y 5/3 | CS | | W | | | | | SG | 0 | | 7.10 | |
| 60.2 | 5-10 | 2.5Y 5/3 | CS | | W | | | | | SG | 0 | | 7.10 | |
| 60.3 | 10-20 | 2.5Y 5/4 | CS | | W | | | | | SG | 0 | | 6.70 | |
| 60.4 | 20-40 | 2.5Y 3/1 | C | S | W | | | | | MA | 0 | | 6.50 | |
| 60.5 | 40-60 | 5Y 2/1 | C | S | W | | | | | MA | 0 | | 6.70 | |

[1] See National Committee on Soil and Terrain (2009) for abbreviation definitions and further details.

[2] See Schoeneberger *et al.* (2002) for abbreviation definitions and further details.