Lower Lakes and Tributaries

Water Quality Report

Ambient and Event-based Monitoring

Report 20, October 2010

Government of South Australia
Department of Environment and Natural Resources

EPA South Australia

This project is part of the South Australian Government's Murray Futures program funded by the Australian Government's Water for the Future program.

All maps reproduced are courtesy of the Department of Environment and Natural Resources unless otherwise stated.

Observations at a Glance

- ***Water quality continues to improve across the Lower Lakes following continued inflows of floodwater from the Murray-Darling Basin***
- ***Salinity levels have decreased due to dilution from lake refill but still remain high compared to historic levels***
- ***pH and alkalinity remain satisfactory at all sites in the main lake areas and tributaries***
- ***Localised acidity in and around sample areas has decreased and the water body has stabilised for the first time since pre drought conditions***

Background

The Environment Protection Authority (EPA), Department of Environment and Natural Resources (DENR), and the Department for Water (DFW) are co-ordinating a monitoring program to assess potential water quality impacts associated with changing water levels and acidity mobilisation in the Lower Lakes. Previous reports are contained on the EPA website[1].

Water Quality Parameters

A wide range of water quality parameters are monitored within the Lower Lakes with key parameters reported herein being pH, alkalinity, salinity, sulfate:chloride ratio, turbidity, nutrients (total nitrogen and total phosphorus), chlorophyll *a* and metals (aluminium and iron). A brief description of these parameters and typical historical (pre-drought) levels are provided below:

***pH* is an indicator of acidity or alkalinity. Neutral water has a pH of 7, acidic solutions have lower values and alkaline solutions have higher values. Prior to the current drought, the pH in the region was typically between 8.3 and 8.5.**

***Alkalinity* is a measure of the buffering capacity of water, or the capacity of the water to neutralise acids and resist pH change. Alkalinity within water bodies is consumed as acid is released from acid sulfate soils. Adding limestone contributes alkalinity to waters, helping to neutralise any acid released from the sediments. Historically, alkalinity levels within this region have been between 80 and 250 mg/L as $CaCO_3$.**

***Sulfate:chloride* is used to give an indication of any sulfate inputs to the water body from acid sulfate soils. Chloride concentration is largely determined by evaporation and dilution. An increase in the ratio of sulfate:chloride indicates possible external sulfate inputs from acid sulfate soils. Prior to the drought, this ratio was about 0.06 (SO_4:Cl).**

[1] See http://www.epa.sa.gov.au/environmental_info/water_quality/lower_lakes_water_quality_monitoring

***Salinity* is a measure of the amount of dissolved salts in the water. Saline water conducts electricity more readily than freshwater, so electrical conductivity (EC) is routinely used to measure salinity. As salinity increases, it may become toxic to native freshwater organisms. Prior to drought conditions, salinity was on average less than 700 µS/cm (EC) in Lake Alexandrina (at Milang) and less than 1600 EC in Lake Albert (at Meningie).**

***Turbidity* is a measure of the cloudiness or haziness in water caused by suspended solids (e.g. sediment, algae). Turbidity is expressed in Nephelometric Turbidity Units (NTU) and is measured using a relationship of light reflected from a given sample. Turbidity is very variable in the Lower Lakes and influenced primarily by wind events. Prior to drought conditions, turbidity was on average about 60 NTU in Lake Alexandrina (at Milang).**

***Nutrients - total nitrogen (TN) and total phosphorus (TP)* are the total amount of nitrogen and phosphorus present in the water body. Nitrogen can be present in different forms (e.g. organic nitrogen in plant material, ammonia, nitrate and nitrite). Phosphorus can also be present in different forms (e.g. organic phosphorus, phosphate). High concentrations of nitrogen and phosphorus can result in excessive growth of aquatic plants such as phytoplankton, cyanobacteria, macrophytes and filamentous algae. Prior to drought conditions, TN was on average about 1.2 mg/L in Lake Alexandrina (at Milang) and 1.6 mg/L in Lake Albert (at Meningie) with TP on average about 0.15 mg/L in Lake Alexandrina (at Milang) and in Lake Albert (at Meningie).**

***Chlorophyll a* is the main photosynthetic pigment in green algae. The concentration of chlorophyll a gives an indication of the volume of aquatic plants present in the water column. Levels in excess of 15 µg/L are considered very high ("hyper-eutrophic") and nuisance algae and plant growth can occur. Prior to drought conditions, chlorophyll a was on average about 24 µg/L in Lake Alexandrina (at Milang) and 35 µg/L in Lake Albert (at Meningie).**

***Metals* such as iron and aluminium are measured to determine interactions between sediments and the lake water body. During concentration events (i.e. evaporation and low inflows) volumes of metals are expected to increase. Similarly during large wind events total metal levels may also increase as they form part of the suspended solids composition. During floodwater inflows the concentration of metals may be diluted. Additional to this, if exposed acid sulfate sediments acidify and the pH is reduced, metals that were previously bound up within sediment are released. Any subsequent increase in metal concentrations in the water body can be used as an indicator of acid sulfate soil impacts.**

Ambient Water Quality Monitoring

Ambient water quality sampling is undertaken fortnightly at 16 sites in Lake Alexandrina (including Wellington, the Goolwa Channel, Currency Creek and Finniss River tributary regions), and Lake Albert (Figure 1).

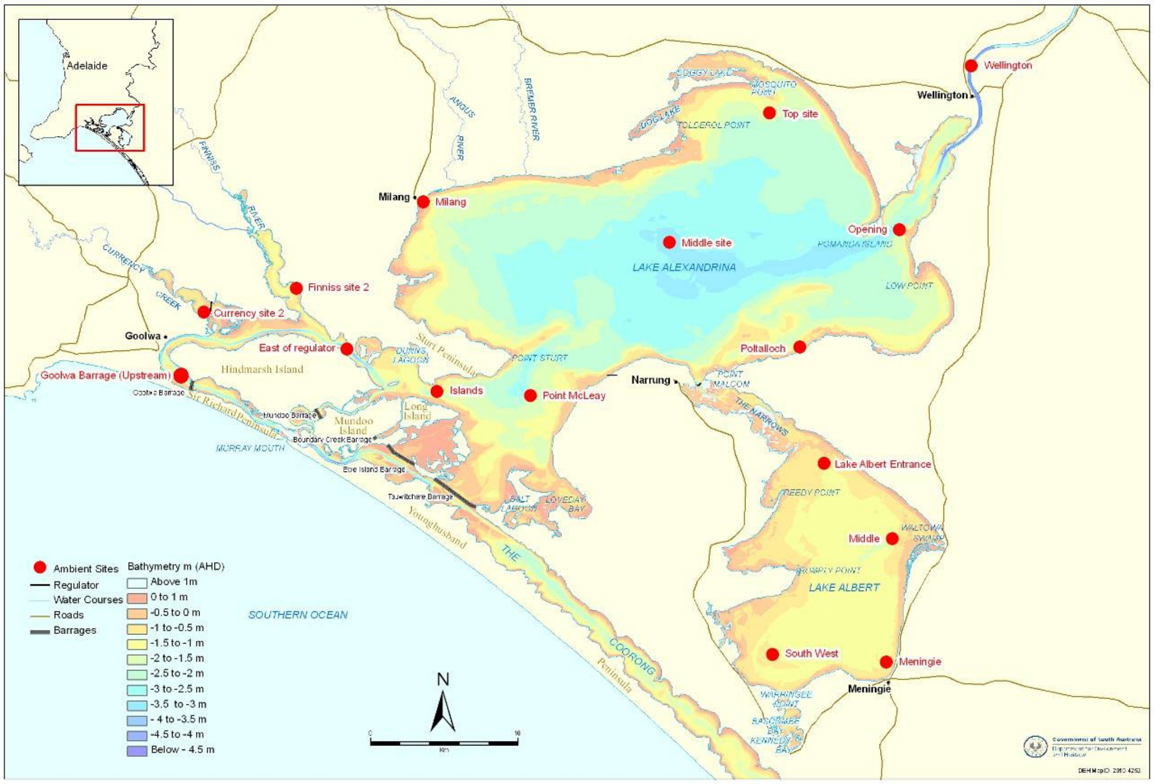

Figure 1 – Lower Lakes and tributaries ambient monitoring sites

Lake Alexandrina

Ambient water quality monitoring results are discussed below for selected sites and parameters in Lake Alexandrina. The four sites selected for reporting are representative of the water body, incorporating a transect across Lake Alexandrina from the northern corner (Top), through the centre (Middle), the southern edge of the lake (Point McLeay) before it enters the Goolwa Channel, and a site near the Narrung Narrows entrance to Lake Albert (Poltalloch).

pH

- pH levels have decreased over the last few months but remain within ANZECC guideline levels (pH 6.5-9.0) at all sites in Lake Alexandrina (Figure 2).

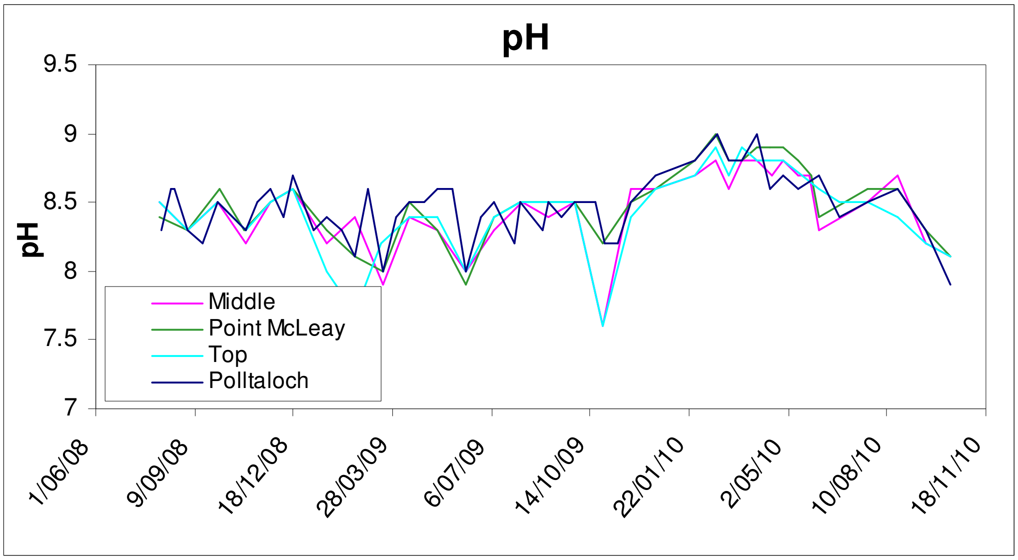

Figure 2 – pH at the Lake Alexandrina ambient monitoring sites

Alkalinity

- Alkalinity remains satisfactory for all sites in the main areas of Lake Alexandrina (Figure 3). Additional inflows to South Australia and subsequently Lake Alexandrina have led to an observable decline in alkalinity since May 2010 which is consistent with dilution of lake water with low alkalinity river water. Polltaloch has the lowest alkalinity water (down to 50 mg/L) but this is likely due to lake mixing patterns (river water mixing predominantly down this edge of the lake) rather than any acid sulfate soil inputs.

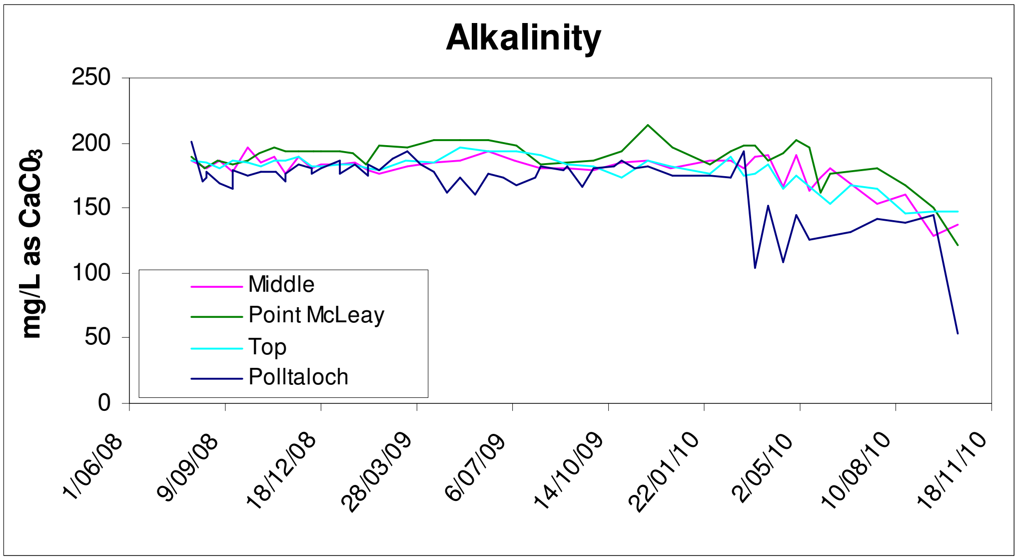

Figure 3 – Alkalinity at the Lake Alexandrina ambient monitoring sites

Sulfate:chloride ratio

- The sulfate:chloride ratio continues to show some variability, but does not show any large increases that would suggest widespread acid sulfate soil influences (Figure 4). Over October the sulfate:chloride ratio has become more uniform across these sites which likely indicates greater mixing in Lake Alexandrina with continued inflows. The exception to this is at Poltalloch where an increase was recorded. However this is consistent with a greater influence at this site from the slightly higher sulfate:chloride ratio in the river inflows.

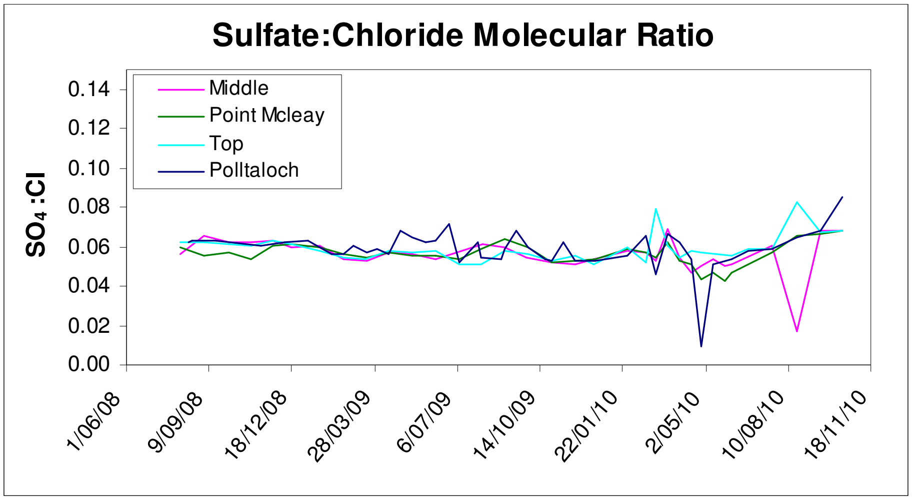

Figure 4 – Sulfate:chloride ratio at the Lake Alexandrina ambient monitoring sites

Salinity (EC)

- Salinity (as measured by electrical conductivity) has continued to decline across representative sites within Lake Alexandrina (Figure 5). Spring rainfall, increased Murray-Darling Basin inflows and cool weather (reducing evaporative losses) have contributed to this decline in salinity. Even so, salinity levels are still high at most sites (up to 2,000 EC) in comparison to historical levels (average of 700 EC prior to the drought). The lower salinity at Poltalloch is likely due to river inflow influences. The salinity should continue to decline as more flood water flows into South Australia and water releases from the barrages export accumulated salt.

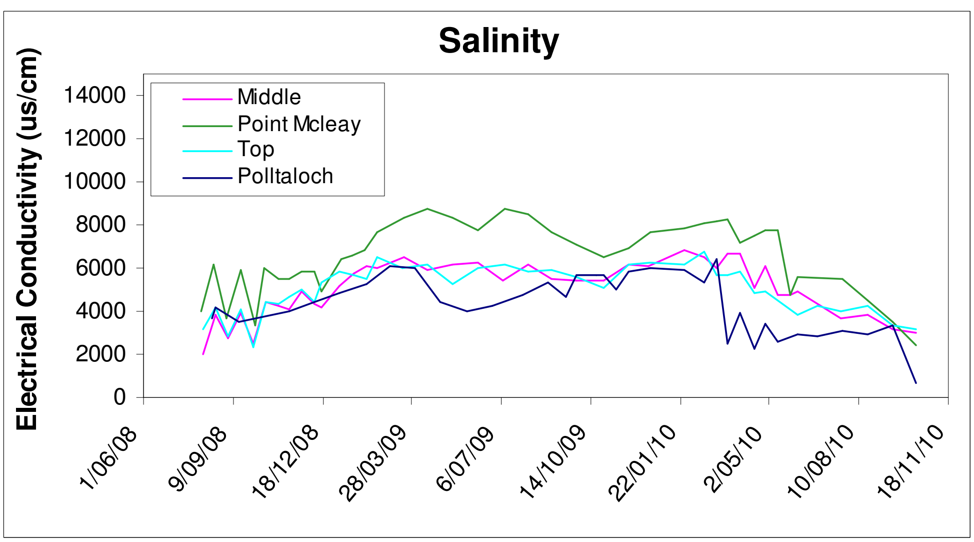

Figure 5 – Salinity at the Lake Alexandrina ambient monitoring sites

Turbidity

- Turbidity continues to be variable within Lake Alexandrina (Figure 6). Large shallow lakes with fine alluvial silt often display high turbidity as a result of wind events causing resuspension of fine material. This is consistent with historic data in the area showing variable turbidity results.

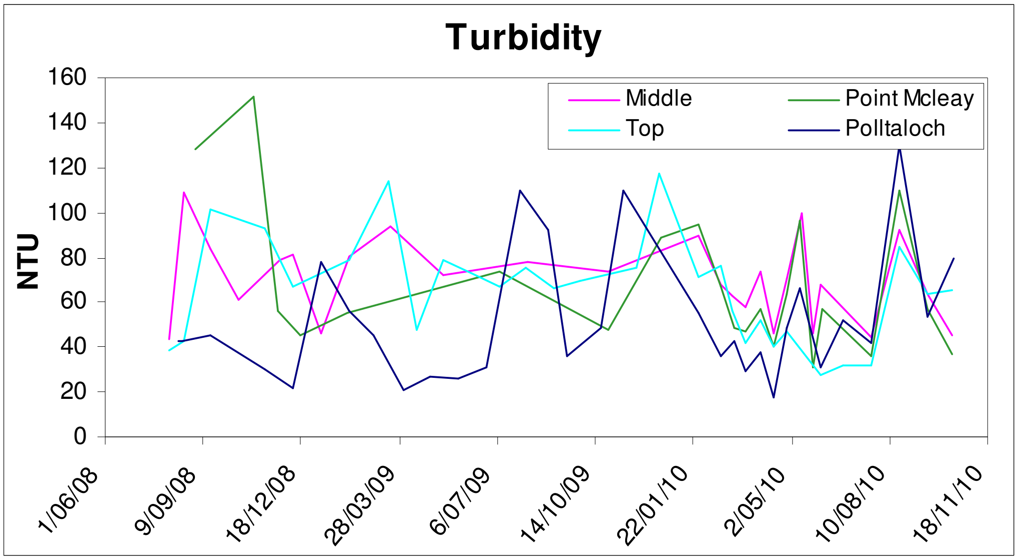

Figure 6 – Turbidity at the Lake Alexandrina ambient monitoring sites

Nutrients (total nitrogen and phosphorus)

- Total nitrogen and phosphorus levels have reduced slightly most likely due to dilution from the floodwater inflows (see Figures 7 and 8). However the nutrient levels remain high compared to historical levels in the Lower Lakes and are well in excess of the ANZECC guidelines for freshwater ecosystems (<1mg/L TN, <0.025 mg/L TP).

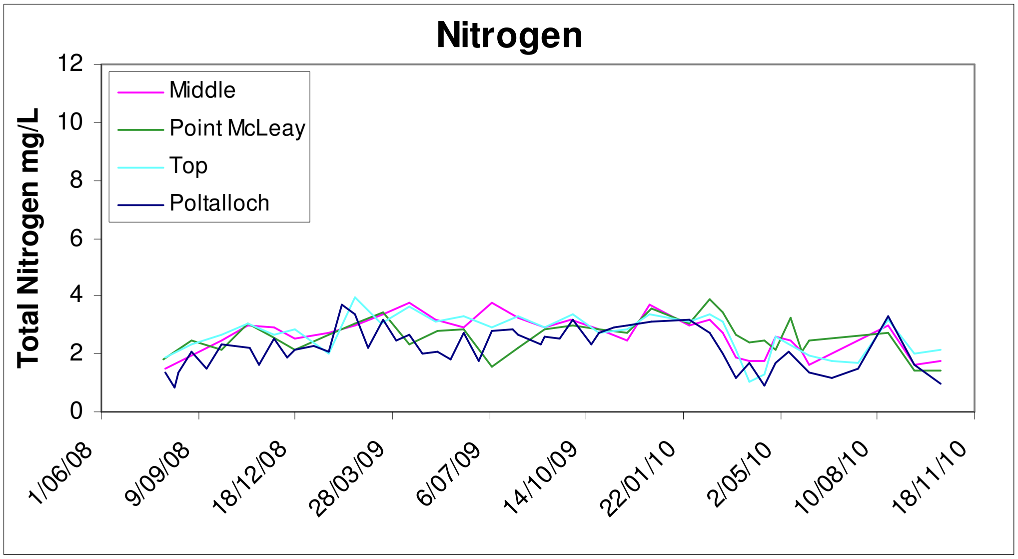

Figure 7 – Total nitrogen at the Lake Alexandrina ambient monitoring sites

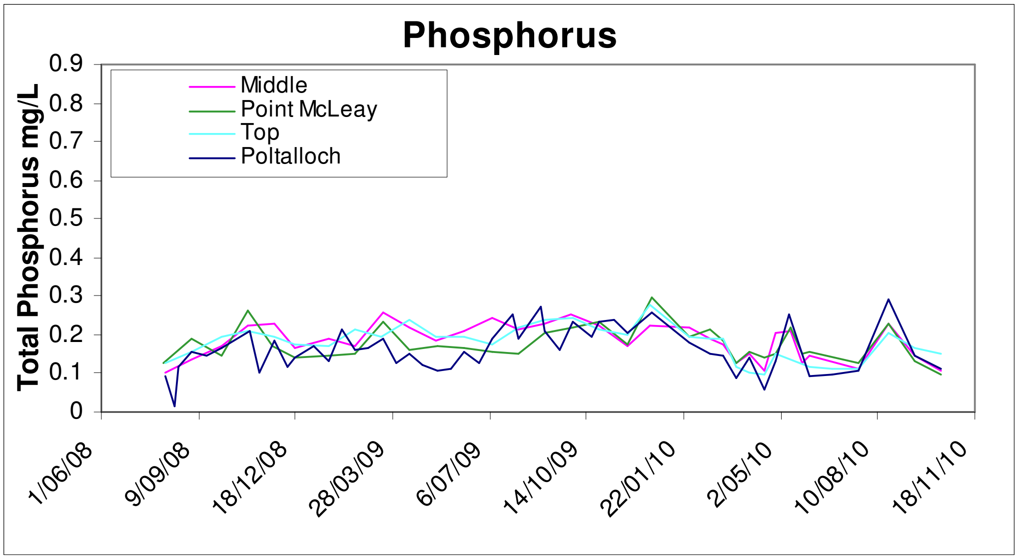

Figure 8 – Total phosphorus at the Lake Alexandrina ambient monitoring sites

Chlorophyll a (algae)

- Chlorophyll *a* decreased over October due to dilution from the increased River Murray inflows (Figure 9). These levels are still in excess of historical values and ANZECC guidelines (<15 µg/L) indicating a highly nutrient enriched (hyper-eutrophic) system. Although chlorophyll *a* levels in Lake Alexandrina are very high, no potentially toxic blue-green algal blooms are present.

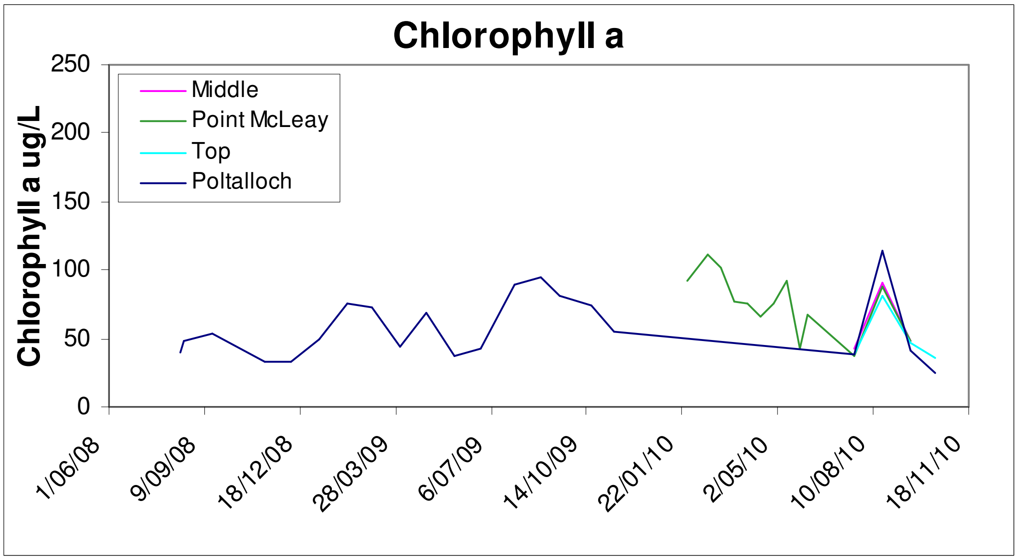

Figure 9 – Chlorophyll *a* at the Lake Alexandrina ambient monitoring sites

Metals

- Total aluminium and iron concentrations within Lake Alexandrina have continued to increase over October (Figures 10 and 11). This is associated with upstream inflows in recent months rather than significant external inputs from acidified sediments on the lake margins. Metal concentrations within the river are associated with re suspension of sediments that contain metals, as can be seen in figure 6 turbidity in Lake Alexandrina is high due to flood water inflows that are historically high in suspended sediment particles.

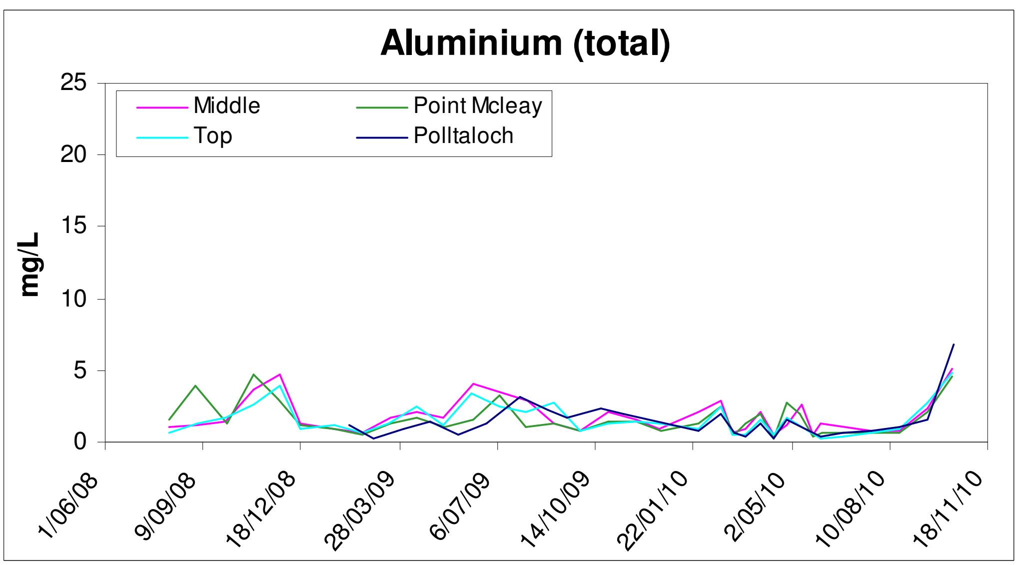

Figure 10 – Total aluminium at the Lake Alexandrina ambient monitoring sites

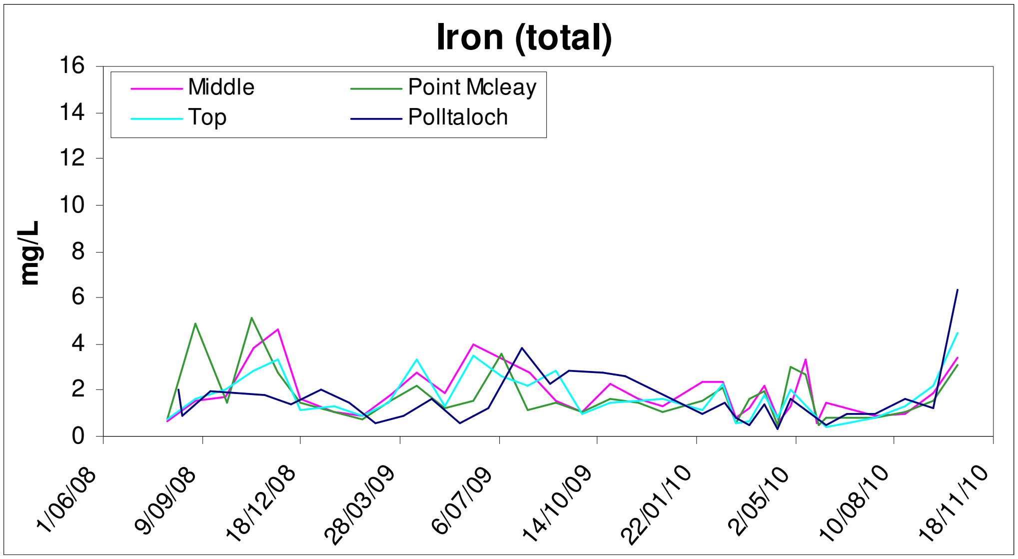

Figure 11 – Total iron at the Lake Alexandrina ambient monitoring sites

Lake Albert Water Quality

Ambient water quality monitoring results are discussed below for selected sites and parameters in Lake Albert. While the Lake Albert Opening site is not part of the ambient program (but rather part of monitoring for the pumping program) it is included at present to assist in interpretation of water quality data in the upper lake region. In mid September (starting 19/9/10), the Narrung bund was partially breached and so monitoring data after then will reflect changes due to inflows from Lake Alexandrina.

pH

- pH levels are stable and within ANZECC guideline levels (pH 6.5-9.0) at all sites in the main Lake Albert water body (Figure 12).

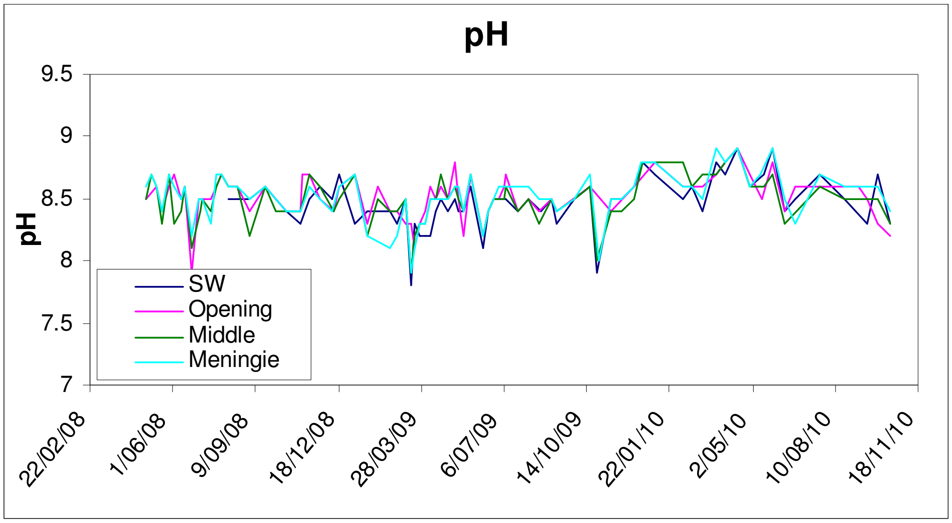

Figure 12 – pH at the Lake Albert ambient monitoring sites

Alkalinity

- There has been a marked decrease in Lake Albert alkalinity at all sites coinciding with the partial removal of the Narrung bund (previously separating Lake Albert and Lake Alexandrina) and subsequent dilution with lower alkalinity Lake Alexandrina water (Figure 13). The alkalinity fluctuations are similar to those for salinity (see Figure 15), suggesting the trends are influenced by water inputs and mixing patterns. It is likely that the alkalinity will continue to decline across Lake Albert with further inflows and mixing with Lake Alexandrina water.

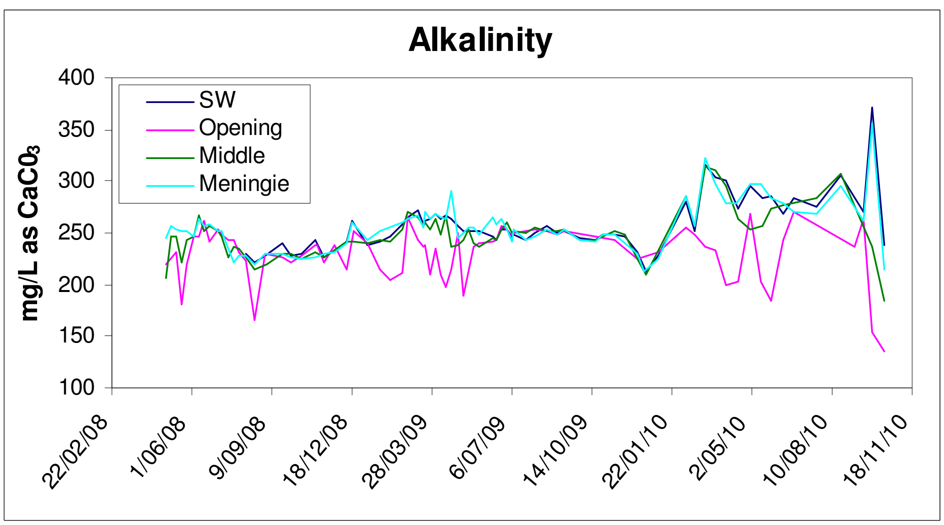

Figure 13 – Alkalinity at the Lake Albert ambient monitoring sites

Sulfate:chloride ratio

- The sulfate:chloride ratio continues to be variable at all sites (Figure 14). Water inflows following removal of the Narrung bund have caused the ratio to be similar to that for Lake Alexandrina (see Figure 4).

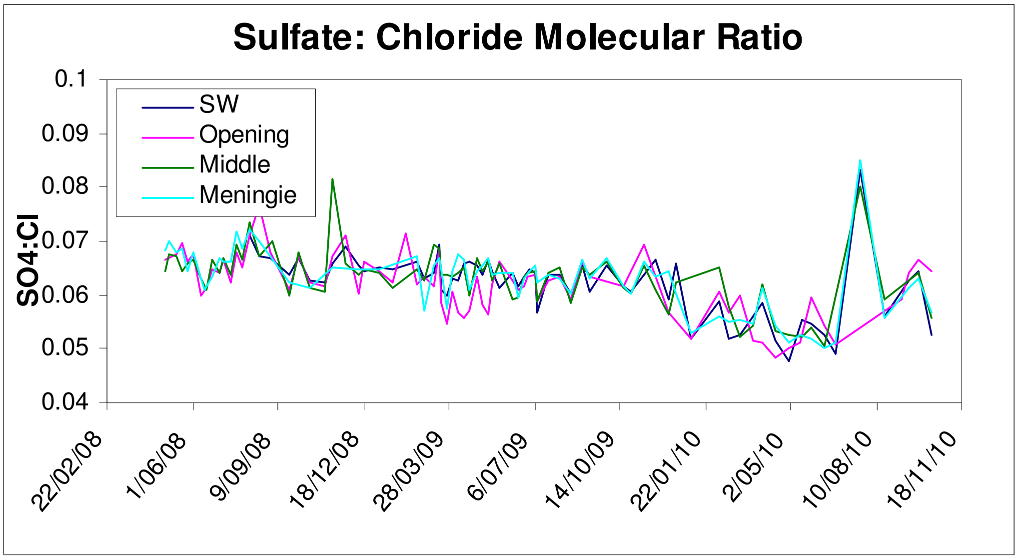

Figure 14 – Sulfate:chloride ratio at the Lake Albert ambient monitoring sites

Salinity (EC)

- Salinity has been decreasing at all sites but still remains high compared to historical levels (Figure 15). The Opening site has experienced the biggest decline in salinity since the partial removal of the Narrung bund took place. Further inflow and mixing of water from Lake Alexandrina are expected to reduce salinities further across Lake Albert. However it is unlikely salinities will return to pre drought levels (<1600 µS/cm) until sufficient dilution or flushing of salt can occur.

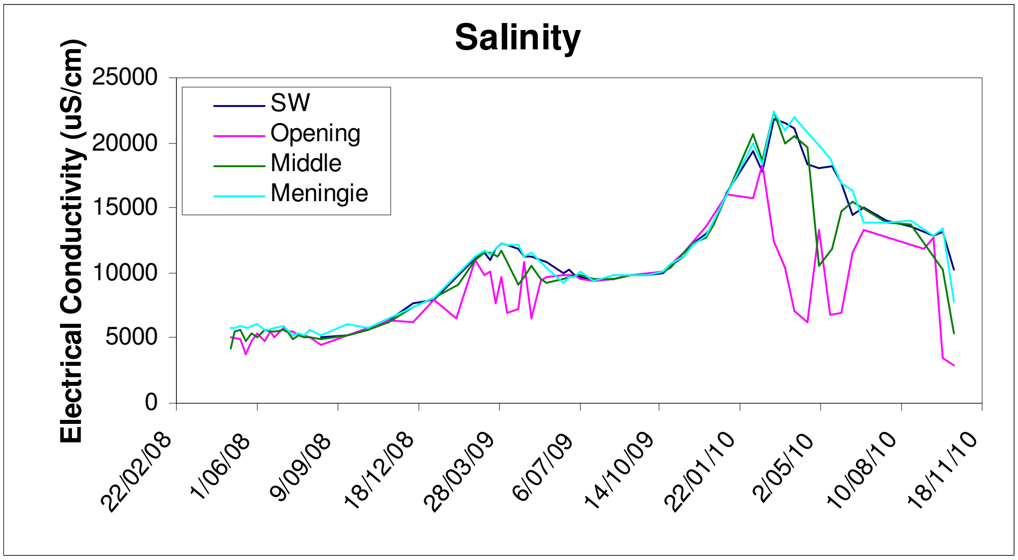

Figure 15 – Salinity at the Lake Albert ambient monitoring sites

Turbidity

- Turbidity has stabilised over October which is likely due to the increased water levels within Lake Albert (Figure 16). Higher water levels mean that less resuspension of sediments occurs during wind events. However ,it should be noted that turbidity continues to remain very high compared to historical levels.

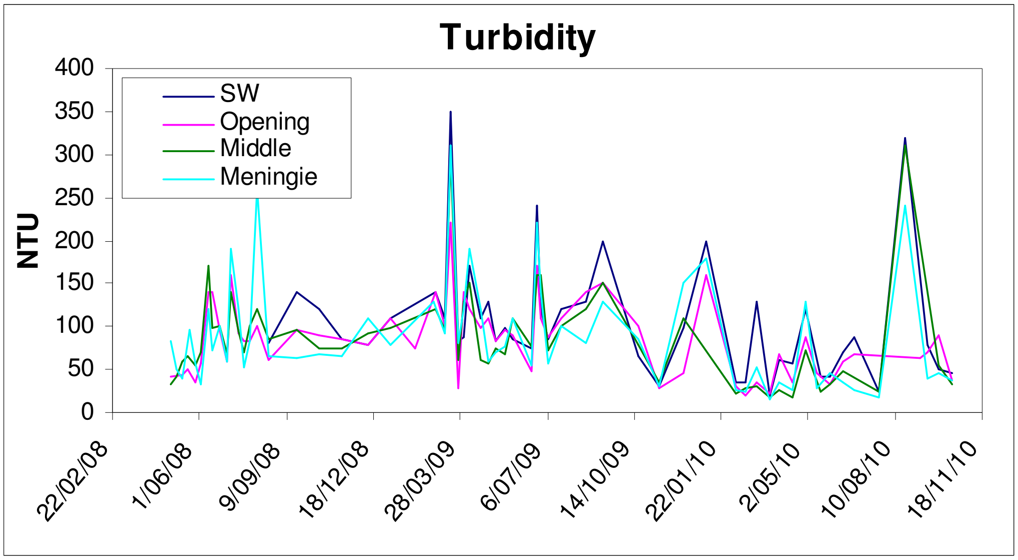

Figure 16 – Turbidity at the Lake Albert ambient monitoring sites

Nutrients (total nitrogen and phosphorus)

- Total nitrogen and total phosphorus levels have reduced over October which is likely due to some dilution as the lake has refilled (Figures 17 and 18). However the nutrient levels are still very high compared to historical levels and well in excess of the ANZECC guidelines for freshwater ecosystems (<1mg/L TN, <0.025 mg/L TP).

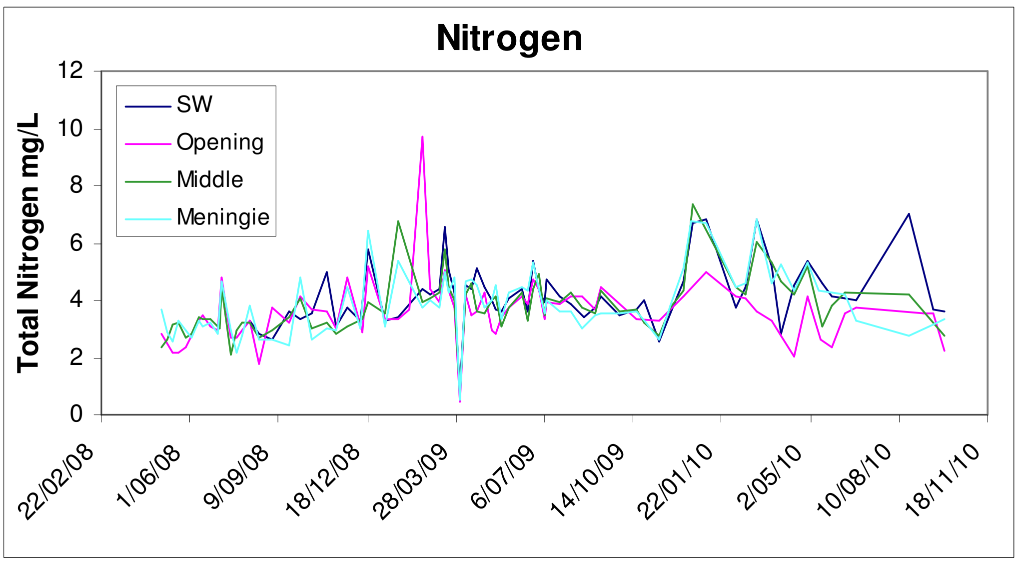

Figure 17 – Total Nitrogen at the Lake Albert ambient monitoring sites

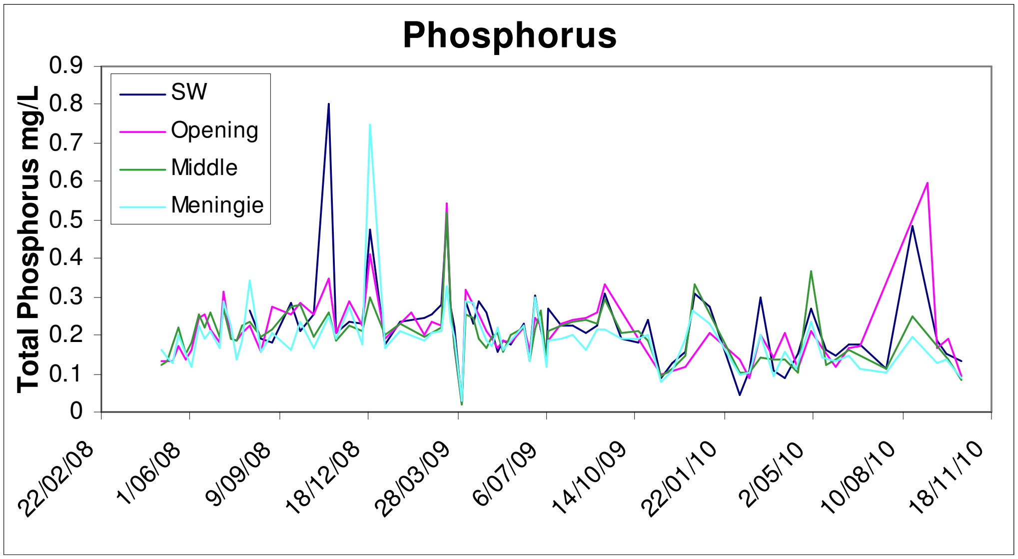

Figure 18 – Total phosphorus at the Lake Albert ambient monitoring sites

Chlorophyll a (algae)

- Chlorophyll *a* is variable but remains at very high levels in Lake Albert (Figure 19). These levels are well in excess of the ANZECC guidelines (>15 µg/L) and indicate a nutrient enriched system (hyper-eutrophic). No toxic blue-green algal species have been identified at present.

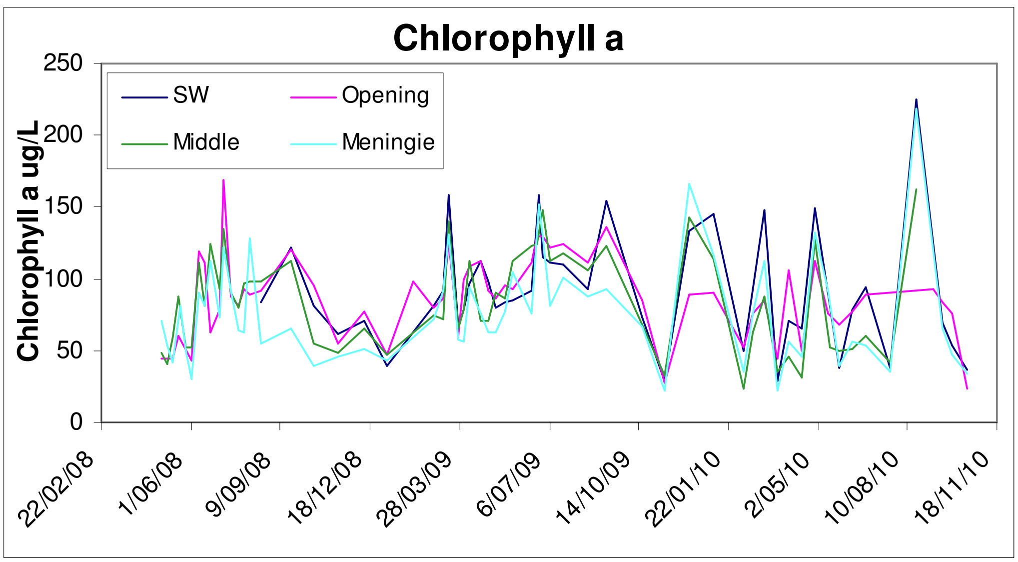

Figure 19 – Chlorophyll *a* at the Lake Albert monitoring sites

Metals

- Total aluminium and iron concentrations within Lake Albert are stable and lower than for Lake Alexandrina, and relatively low compared to 2008–2009 levels (Figures 20 and 21). Wind resuspension and/or shallow groundwater inputs from acid sulfate soils on the lake margins may have been responsible for the elevated metal levels seen during the previous water lower water level periods in much of 2009.

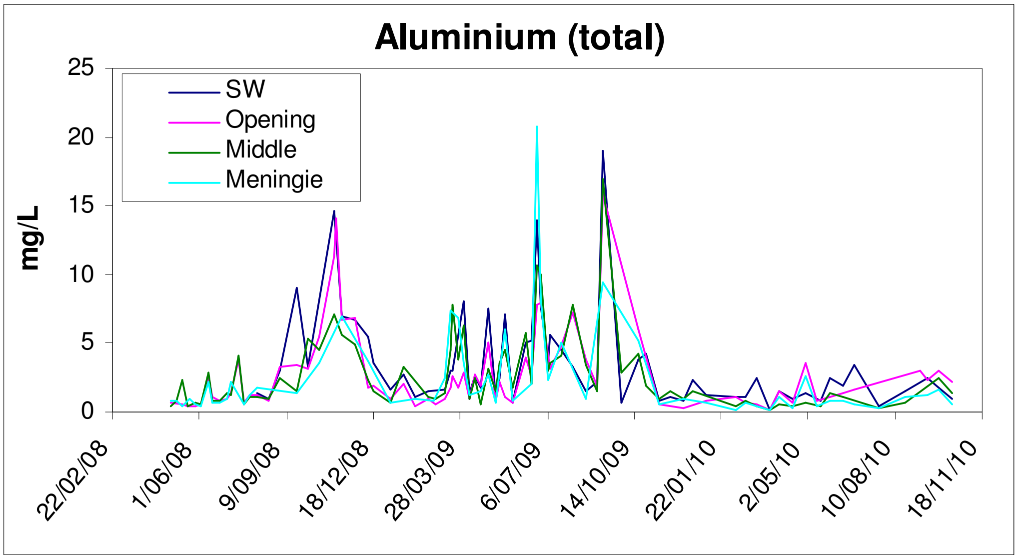

Figure 20 – Total aluminium at the Lake Albert ambient monitoring sites

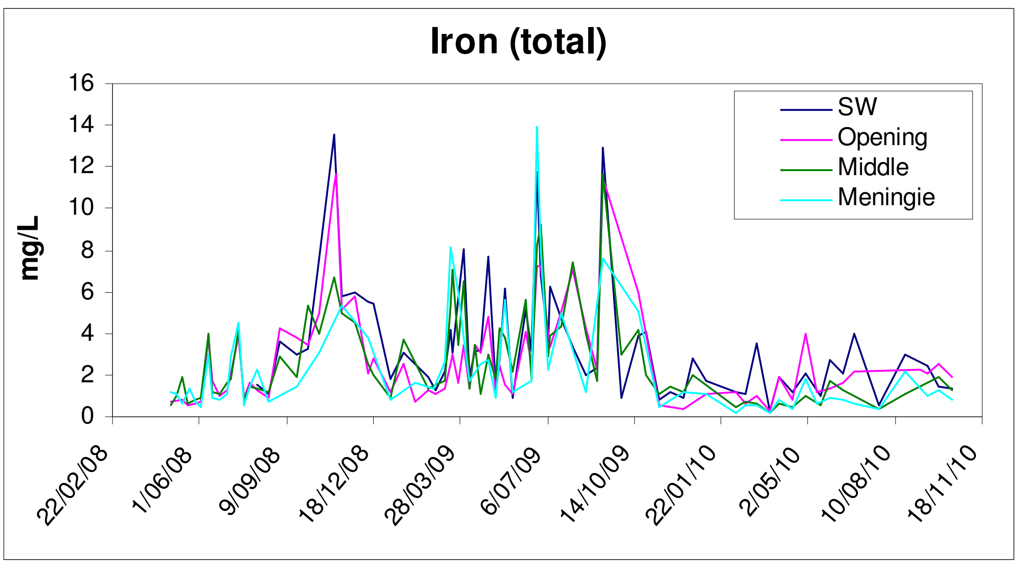

Figure 21 – Total iron at the Lake Albert ambient monitoring sites

Goolwa Channel and Tributaries Water Quality

Ambient and event-based water quality monitoring results are discussed for selected sites and parameters in the Goolwa Channel and tributaries region (see Figures 1 and 22 for site locations). Due to the nature of the monitoring program both ambient and event-based sites have been included in this section to compare data collected over the month. In late September (starting 26/9/10), the Goolwa regulator near Clayton was partially breached and so monitoring data after then will reflect changes due to inflows from Lake Alexandrina.

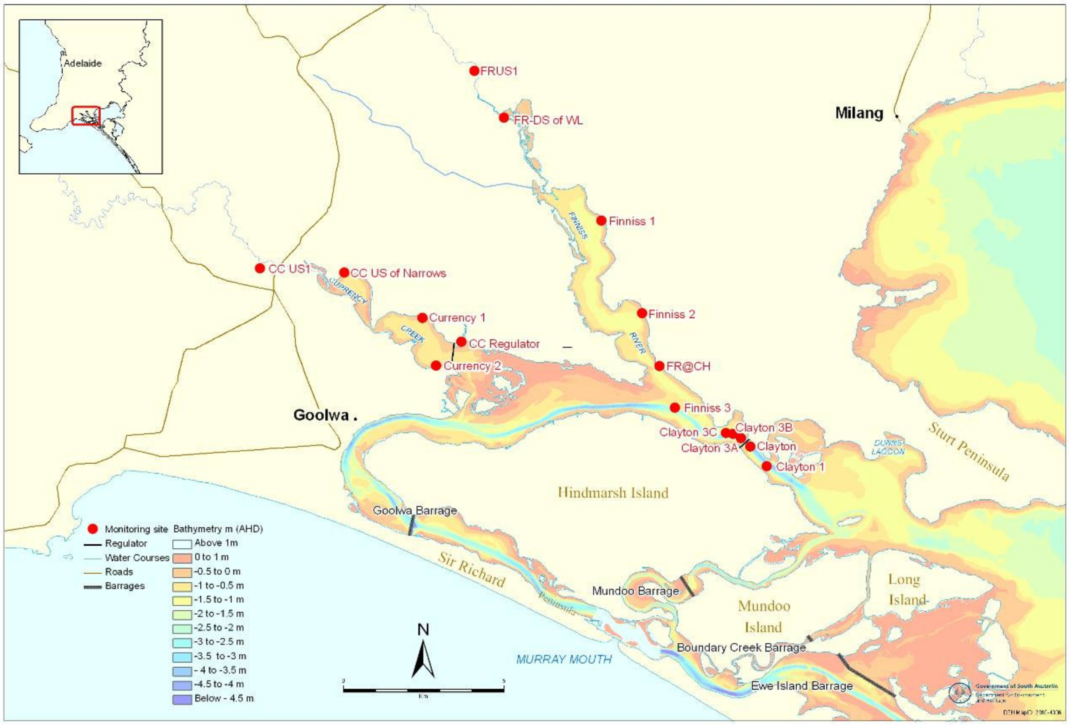

Figure 22 – Goolwa Channel and tributaries ambient and event-based monitoring sites

pH

- pH levels remain stable and within ANZECC guideline levels (pH 6.5-9.0) at all sites in the Goolwa Channel and tributaries region (Figure 23).

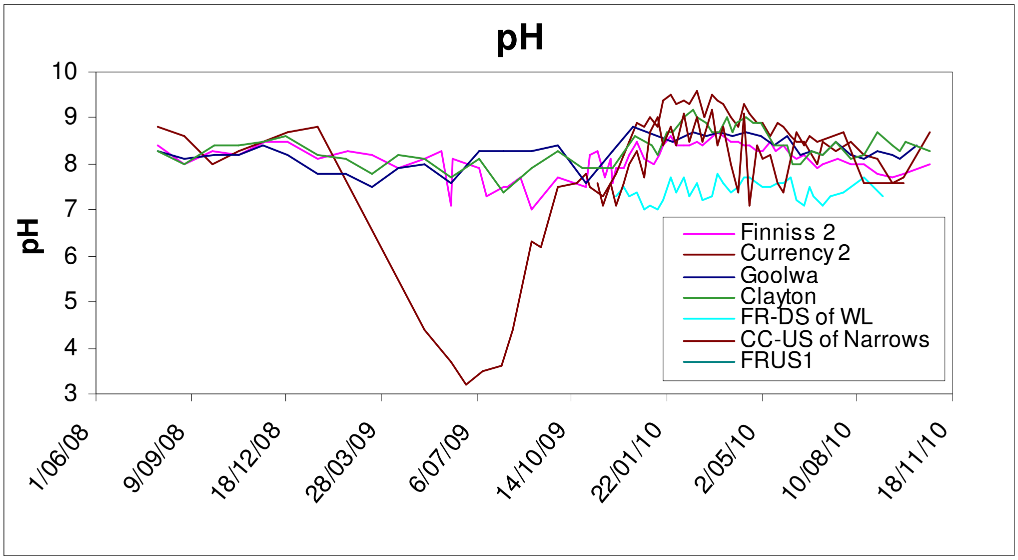

Figure 23 – pH at the Tributary monitoring sites

Alkalinity

- Alkalinity at all of the Goolwa Channel and tributaries sites is satisfactory (Figure 24). All sites with the exception of CC-US Narrows recorded declines in alkalinity over October. This is primarily due the floodwater flows from over the border making their way through the system and diluting alkalinity within the Goolwa Channel pool. The increasing trend in alkalinity at the CC-US of Narrows site could be due to sulfate reduction following acidic sediment re-inundation, and the natural constriction in the middle of Currency Creek that can limit mixing with the downstream sites.

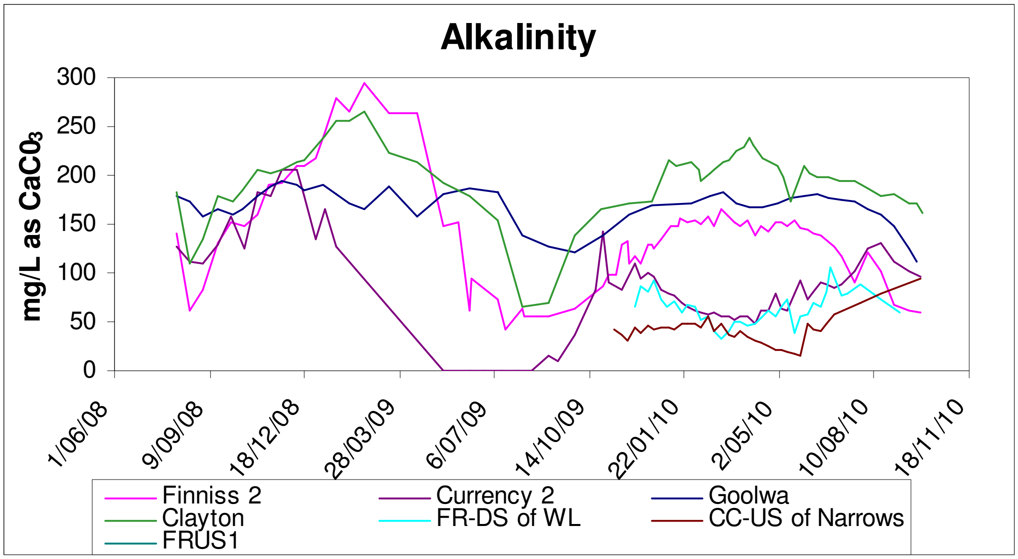

Figure 24 – Alkalinity at the Goolwa Channel and Tributaries monitoring sites

Sulfate:chloride ratio

- The sulfate:chloride ratio is similar at most sites and does not show any clear trends that would suggest widespread acid sulfate soil inputs (Figure 25). The ratio at CC-US of Narrows and Goolwa both recorded significant declines over October which could be due to localised sulfate reduction and salinity influences (see Figure 26).

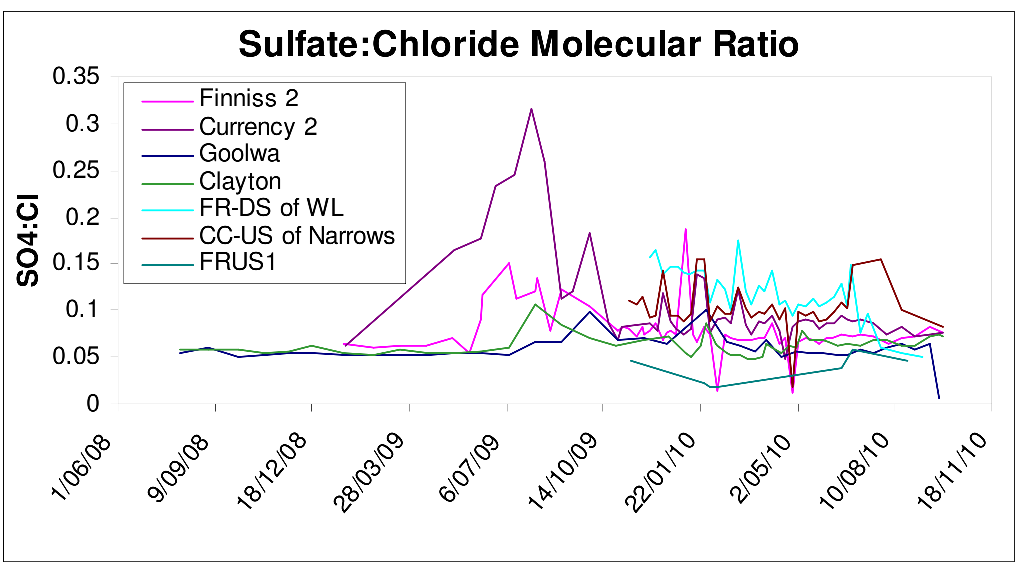

Figure 25 – Sulfate:chloride molecular ratio at the Goolwa Channel and Tributaries monitoring sites

Salinity (EC)

- Salinity is decreasing at all sites but still remains high compared to pre-drought levels (Figure 26). The decline in salinity is mostly a result of dilution from tributary inflows, although some mixing will have also occurred with Lake Alexandrina water via the partly breached regulator. Salinity is expected to continue to decrease over coming months as water continues to be released through the Goolwa Barrage.

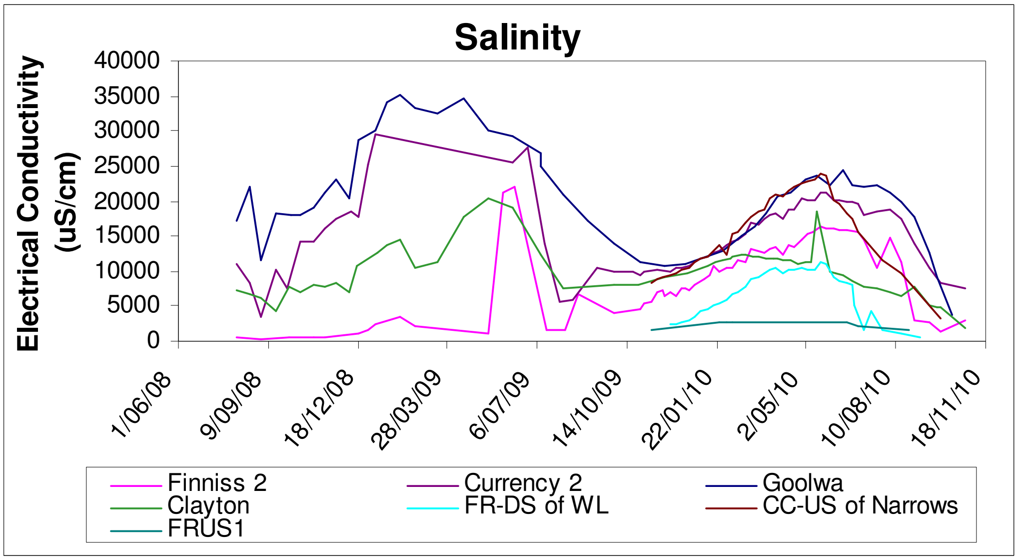

Figure 26 – Salinity at the Goolwa Channel and Tributaries monitoring sites

Turbidity

- Turbidity is variable in the Goolwa Channel and Tributaries sites (Figure 27). Since the partial breach in the regulator, turbidity has increased to match that seen in Lake Alexandrina (see Figure 6). Turbidity within the Goolwa Channel is expected to increase as floodwaters flow through the regulator bringing greater turbidity.

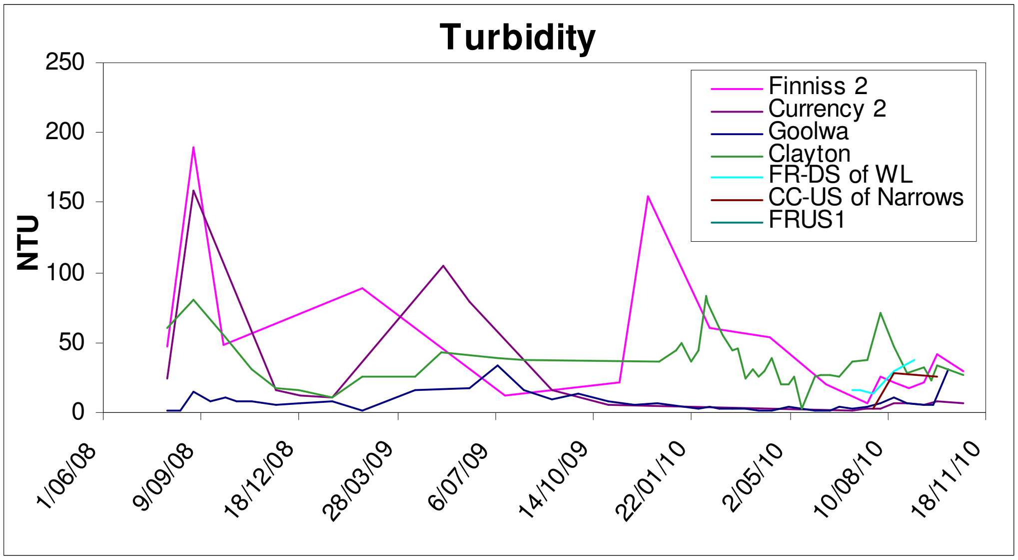

Figure 27 – Turbidity at the Goolwa Channel and Tributaries monitoring sites

Nutrients (total nitrogen and phosphorus)

- Total nitrogen is at relatively high levels but stable in the Goolwa Channel and tributaries. In comparison, total phosphorous has increased, particularly in the upstream Finniss River sites (Figures 28 and 29). The reason for this recent increase in phosphorus is unclear but could be related to runoff of phosphorus from the Southern Mount Lofty Ranges catchment area during rain events.

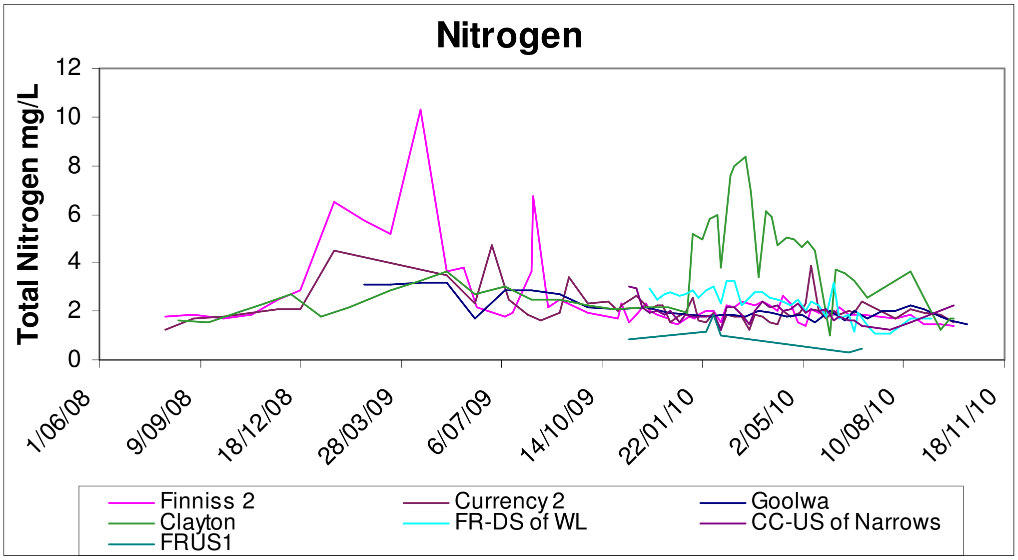

Figure 28 – Total Nitrogen at the Goolwa Channel and Tributaries monitoring sites

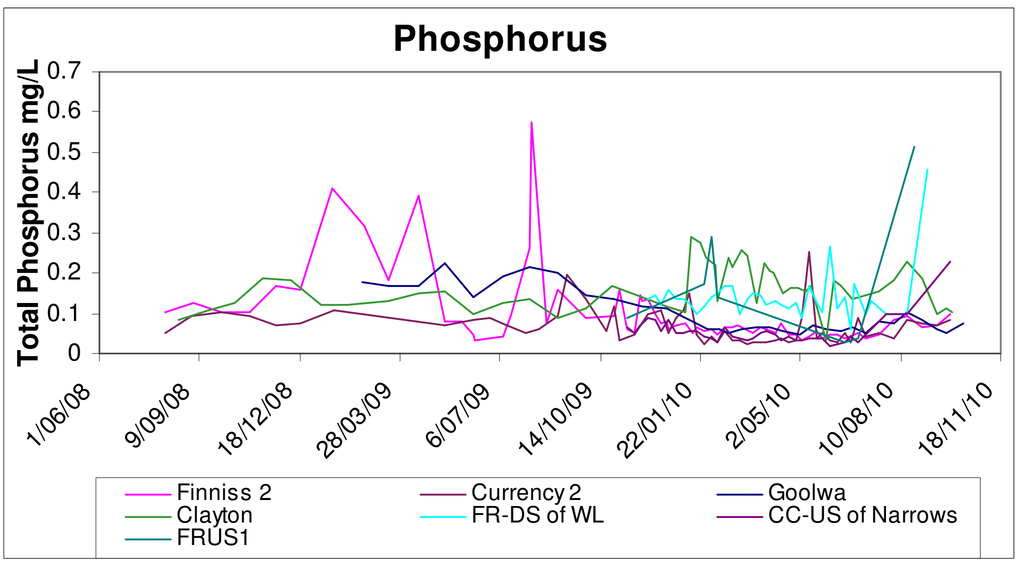

Figure 29 – Total phosphorus at the Goolwa Channel and Tributaries monitoring sites

Chlorophyll (algae)

- Chlorophyll *a* is variable at the Goolwa Channel and tributaries sites (Figure 30). A significant increase is observed at the Currency 2 site which may be driven by phosphorus inputs and more limited water movement in that area.

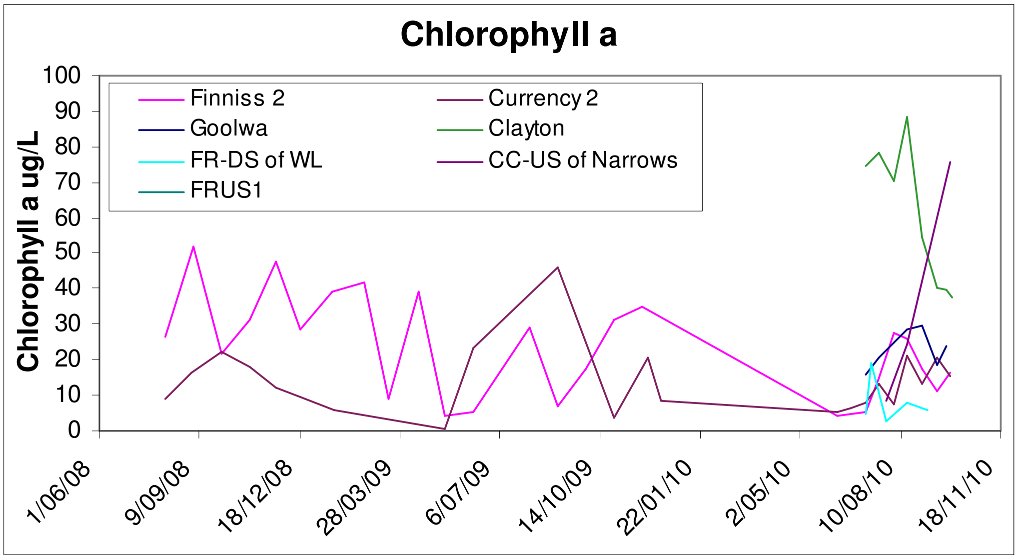

Figure 30 – Chlorophyll *a* at the Goolwa Channel and Tributaries monitoring sites

Metals

- Total aluminium and iron concentrations within the tributaries are relatively low and stable compared to when acidic conditions occurred in the winter of 2009 (Figures 31 and 32)

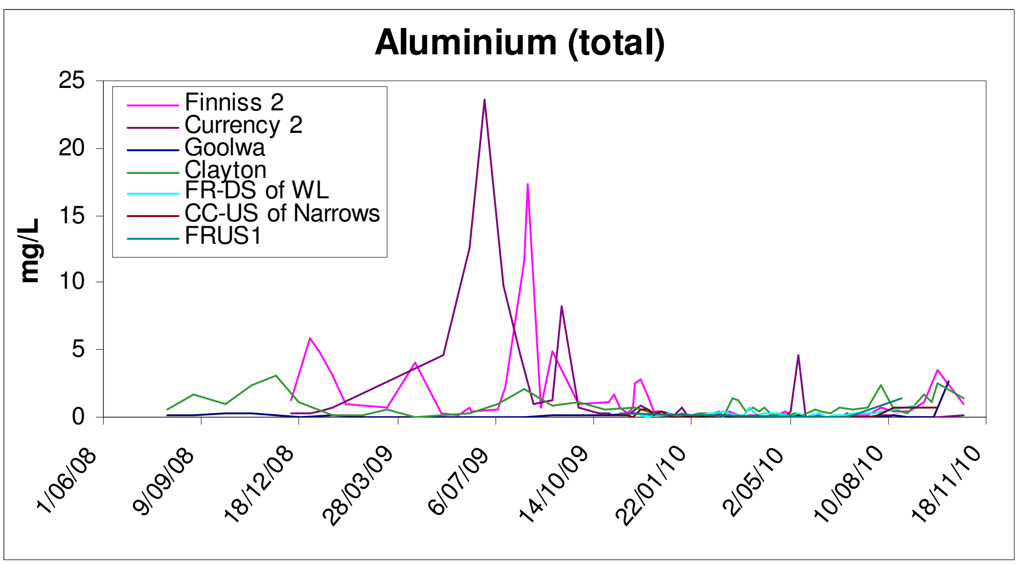

Figure 31 – Total aluminium at the Goolwa Channel and Tributaries monitoring sites

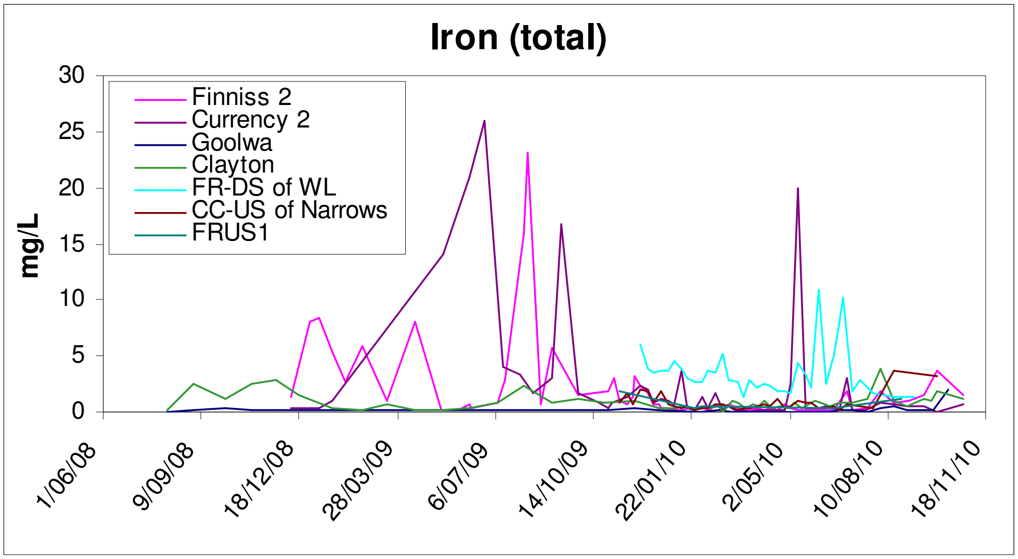

Figure 32 – Total iron at the Goolwa Channel and Tributaries monitoring sites

Additional Event-based monitoring

Additional event-based water quality sampling is undertaken in selected regions that have either experienced acidification or are at risk of acidification (Figure 33). The selection of sites is based upon acid sulfate soil risk assessment, in accordance with available data on the distribution of sulfidic and sulfuric materials and research and modelling into potential acidity fluxes. High risk locations were initially screened to identify the presence and extent of any acidity, and the frequency of further monitoring was determined from these results. The information is used to determine the need for management actions, such as limestone dosing, which has the capacity to reduce the acidity hazard and mitigate further metal release.

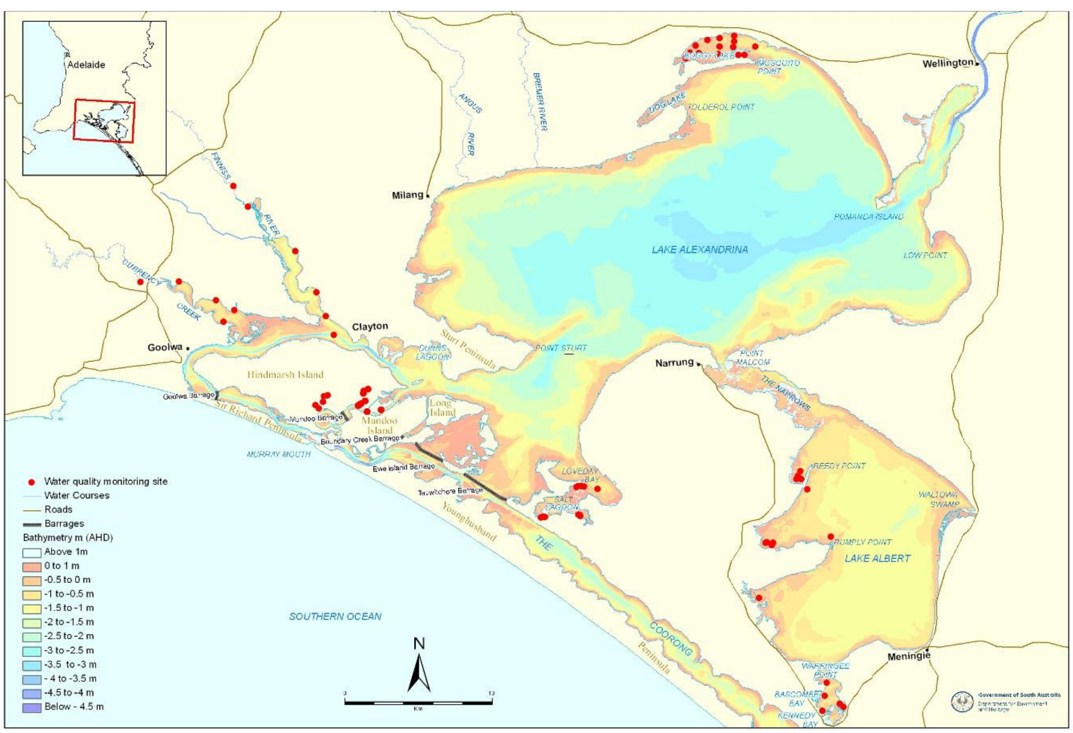

Figure 33 – Map of the event-based water quality monitoring sites

Boggy Lake

Figure 34 shows a map of sampling locations in Boggy Lake with water quality results from selected sites shown in Figure 35. During October, alkalinity was recorded at all of the sites within Boggy Lake and the pH at sites that previously recorded low pH has recovered. This indicates the success of the aerial limestone dosing program in the region together with mixing of freshening Lake Alexandrina water to provide additional alkalinity. This region will continue to be monitored to assess the potential for ongoing acid fluxes following re-inundation.

Figure 34 – Map of Boggy Lake monitoring sites

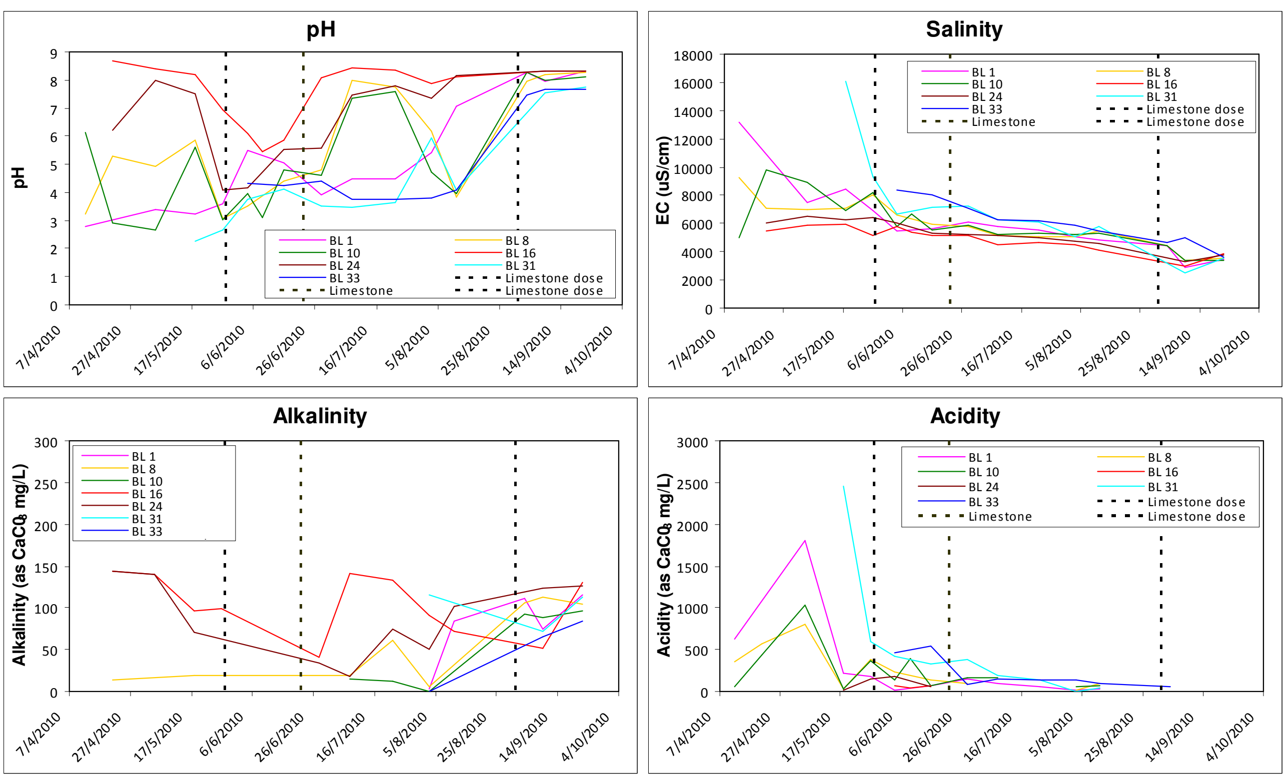

Figure 35 – Boggy Lake water quality results

Boggy Creek

The continued increase in Lake Alexandrina water levels has resulted in all sites within Boggy Creek (near Mundoo barrage, Figure 36) being re-inundated. As the sediments were previously identified by CSIRO to have a high net acidity; the screening of surface water quality was considered a high priority. Sampling in August showed that Boggy Creek 5, 6 and 7 sites were acidic (pH 3-4) with high salinity (Figure 37). Sampling over October indicated all of Boggy Creek now has a neutral pH with minimal spatial variation in water quality between the different sampling sites. This neutralisation is likely due to the input of alkalinity and dilution as Lake Alexandrina refilled and reflowed back into Boggy Creek.

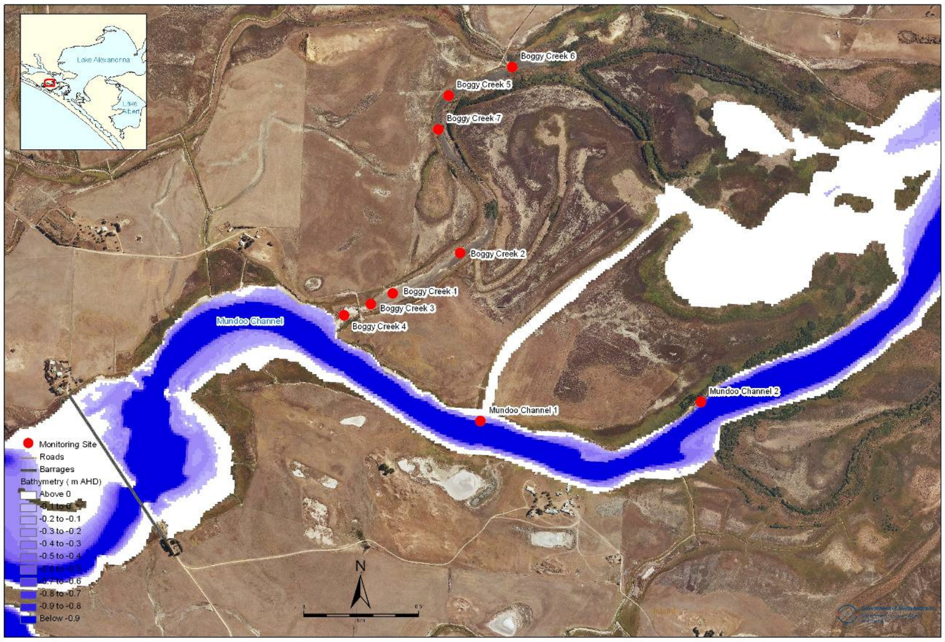

Figure 36 – Map of Boggy Creek sample sites

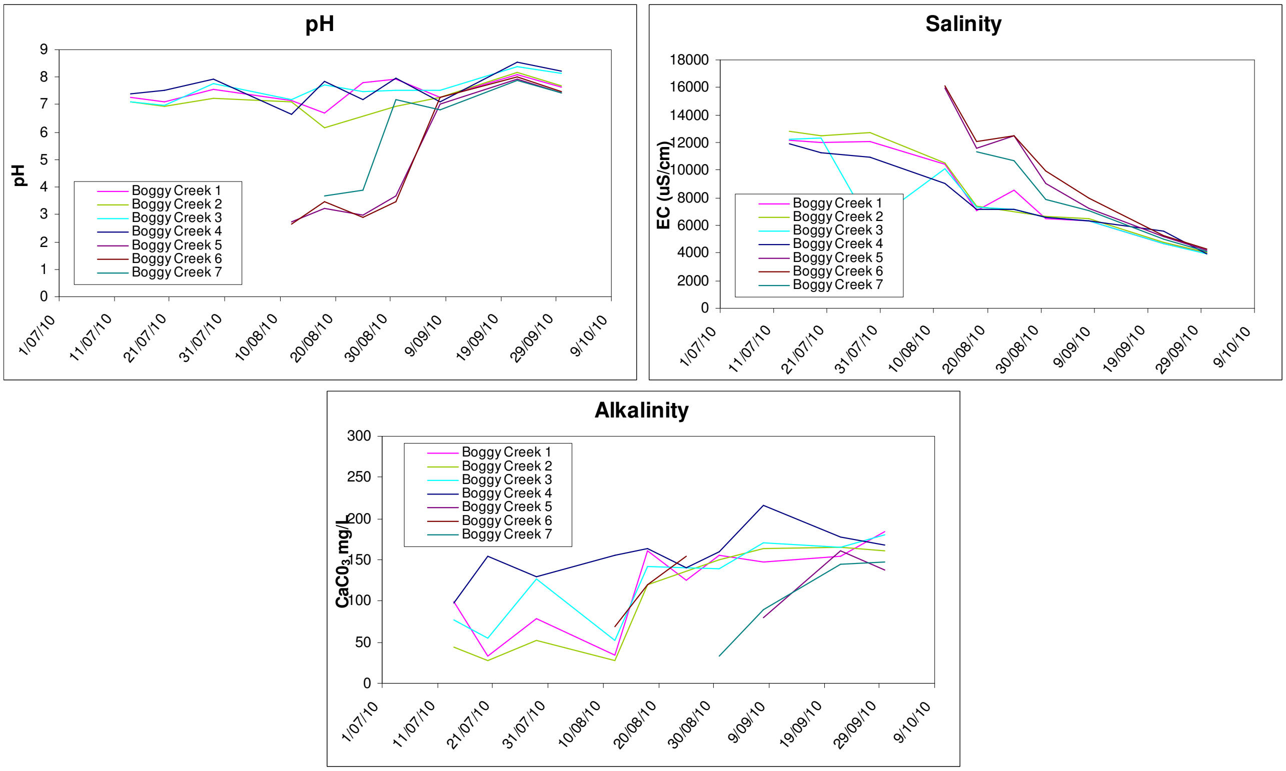

Figure 37 – Boggy Creek water quality results

Hunters Creek

Sampling over October has shown that previously acidic conditions in Hunters Creek (near Mundoo barrage, Figure 38) have now been neutralised and pH is at satisfactory levels low pH water (Figure 39). There have also been marked reductions in salinity (originally up to 50,000 EC to now approximately 5,000 EC). This is likely due to substantial inflow of fresh and alkaline lake water which has diluted and exported salinity, and neutralised the acidity in the water column and shallow sediments.

Figure 38– Map of Hunters Creek sample sites

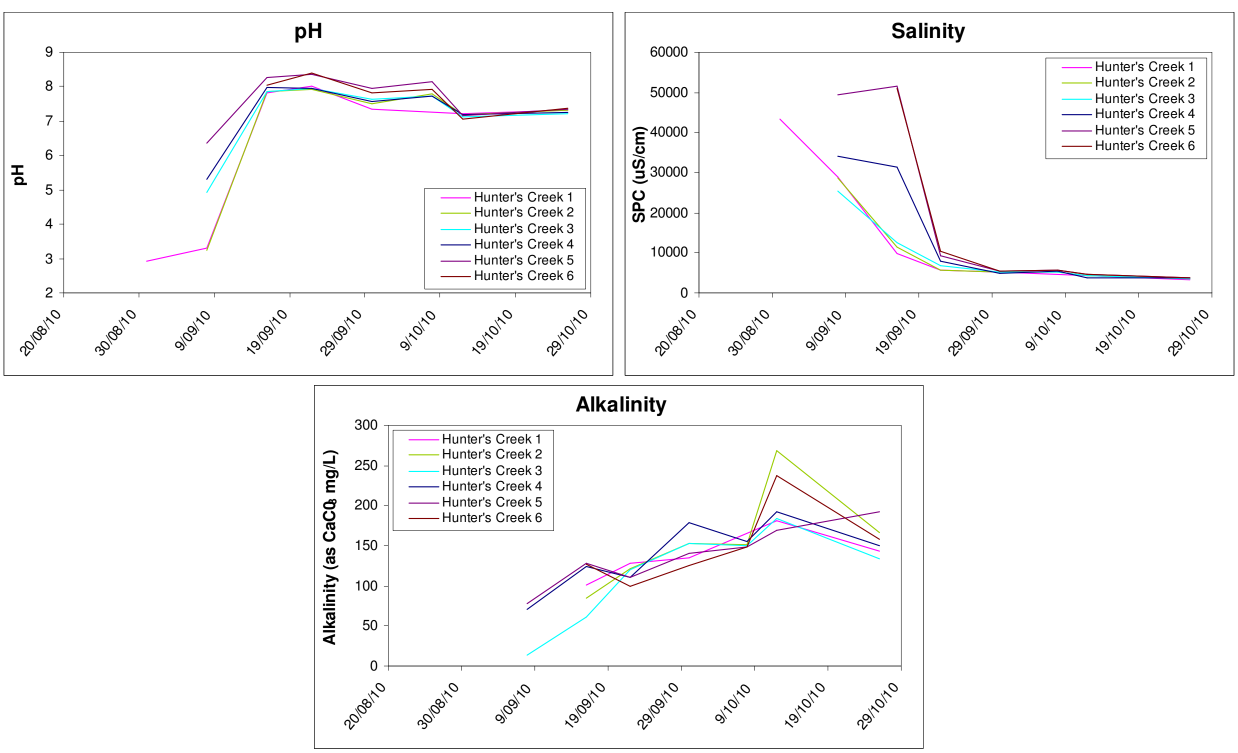

Figure 39 – Hunters Creek water quality results

Further Information

Further information on water quality and quantity, and acid sulfate soils, can be found on the following websites:

- Department of Environment and Natural Resources www.environment.sa.gov.au/cllmm/
- River Murray Data http://data.rivermurray.sa.gov.au/ (real-time data)
- Environment Protection Authority www.epa.sa.gov.au or for specific Lower Lakes data see www.epa.sa.gov.au/environmental_info/water_quality/monitoring_programs_and_assessments/lower_lakes
- Department for Water www.waterforgood.sa.gov.au/
- South Australian Murray–Darling Basin Natural Resource Management Board www.samdbnrm.sa.gov.au
- Murray–Darling Basin Authority www.mdba.gov.au
- Waterwatch www.waterwatch.org.au
- CSIRO acid sulfate soils www.clw.csiro.au/acidsulfatesoils/murray.html