Lower Lakes and Tributaries

Water Quality Report

Ambient and Event-based Monitoring

Report 24,February 2011

Government of South Australia
Department of Environment and Natural Resources

EPA South Australia

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Observations at a Glance

- ***Water quality continues to improve across the Lower Lakes following substantial inflows of floodwater from the Murray-Darling Basin***
- ***Salinity remains stable and at low levels across Lake Alexandrina due to dilution from river inflows and export of salt through the barrages***
- ***Salinity levels still remain elevated in Lake Albert and some embayments on the margins of the Lower Lakes compared to historical values***
- ***pH and alkalinity continue to remain satisfactory at all sites***

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 water quality 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 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. The pH in the Lower Lakes region is 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 $CaCO_3$.

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 the 2007–2009 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).

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. This ratio is usually about 0.06 (SO_4:Cl) ***in the Lower Lakes.***

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

***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 shallow Lower Lakes and influenced primarily by wind events. Prior to the 2007–2009 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 phosphorus and nitrogen can result in excessive growth of aquatic plants such as phytoplankton, cyanobacteria, macrophytes and filamentous algae. Prior to the 2007–2009 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).**

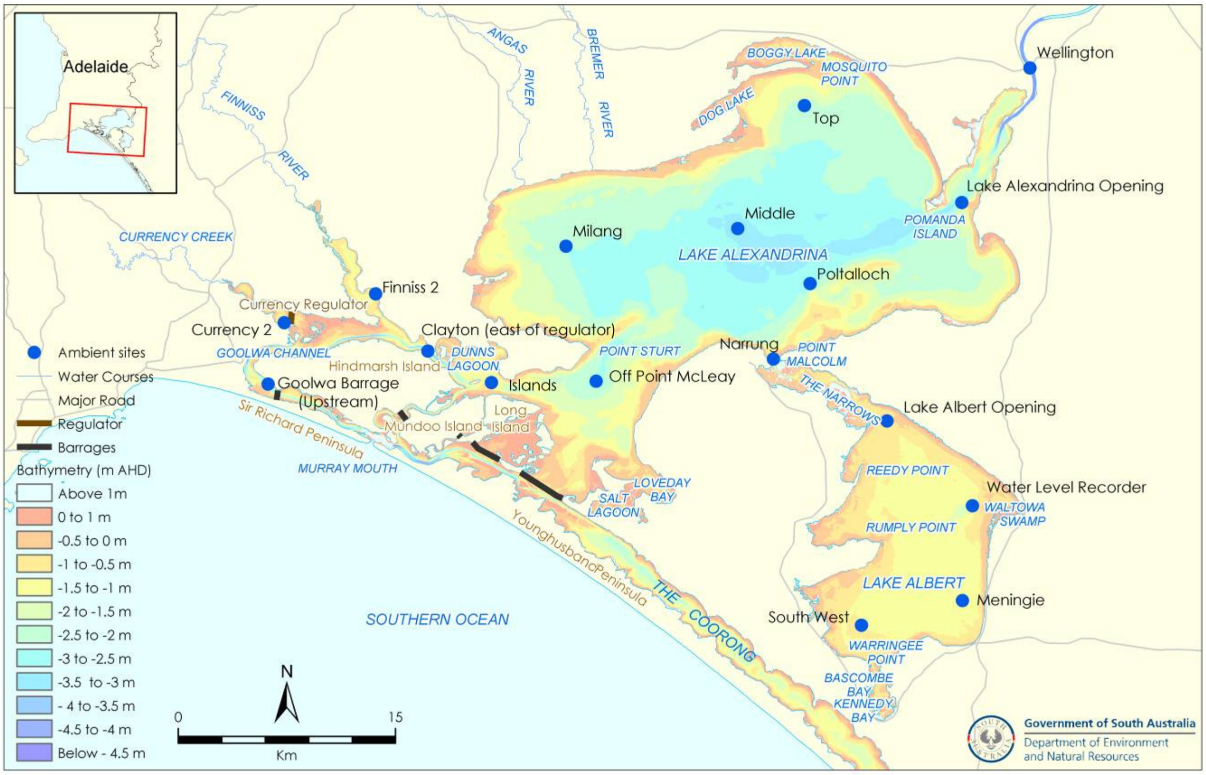
***Chlorophyll a* is the main photosynthetic pigment in green algae. The concentration of chlorophyll a gives an indication of the volume of aquatic plants present in the water column. Levels in excess of 15 μg/L are considered very high ("hyper-eutrophic") and nuisance algae and plant growth can occur. Prior to the 2007–2009 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 primarily to determine interactions between sediments and the lake water body. During water level declines (i.e. due to evaporation and low inflows during droughts) metal concentrations 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. If these exposed sediments are rewet, any subsequent increase in metal concentrations in the water body may indicate acid sulfate soil impacts.**

***Dissolved Oxygen* is a measure of the quantity of oxygen present in water. Oxygen is essential for almost all forms of life Aquatic animals, plants and most bacteria need it for respiration (getting energy for food) as well as for some chemical reactions. The concentration of dissolved oxygen is an important indicator of the health of the aquatic ecosystem. Persistently low dissolved oxygen will harm most aquatic life because there will not be enough for them to use.**

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).



DEH MapID: 2011-4844

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 five sites selected for reporting have been chosen as they are representative of the water body, incorporating water entering from the river (Wellington) and a transect across Lake Alexandrina from the northern corner (Top) through the centre (Middle) to the southern edge of the lake (Point McLeay) before it enters the Goolwa Channel. The site on the western margin (Poltalloch) provides an indication of the water quality near the entrance to Lake Albert.

pH

- pH levels in Lake Alexandrina (Figure 2) have continued to remain within ANZECC guideline levels (pH 6.5-9.0). The pH within the river channel at Wellington still remains lower than Lake Alexandrina due to floodwaters.

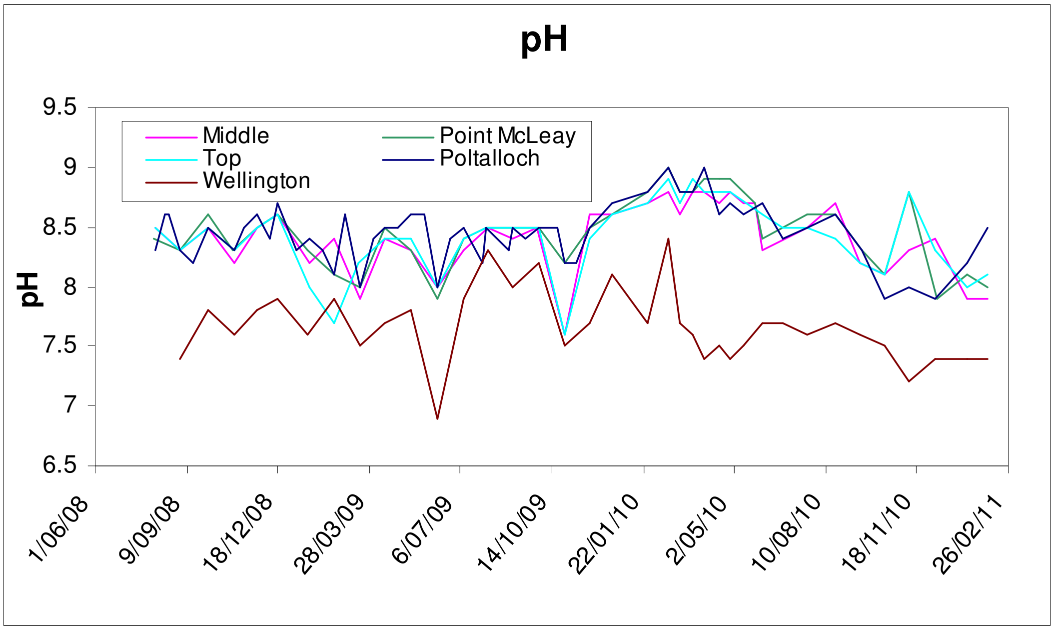


Figure 2 – pH at the Lake Alexandrina ambient monitoring sites

Alkalinity

- Alkalinity remains stable for all sites within Lake Alexandrina. All sites have trended towards an uniform alkalinity indicating the dominant influence of the River Murray flood inflows on the lake water quality (Figure 3).

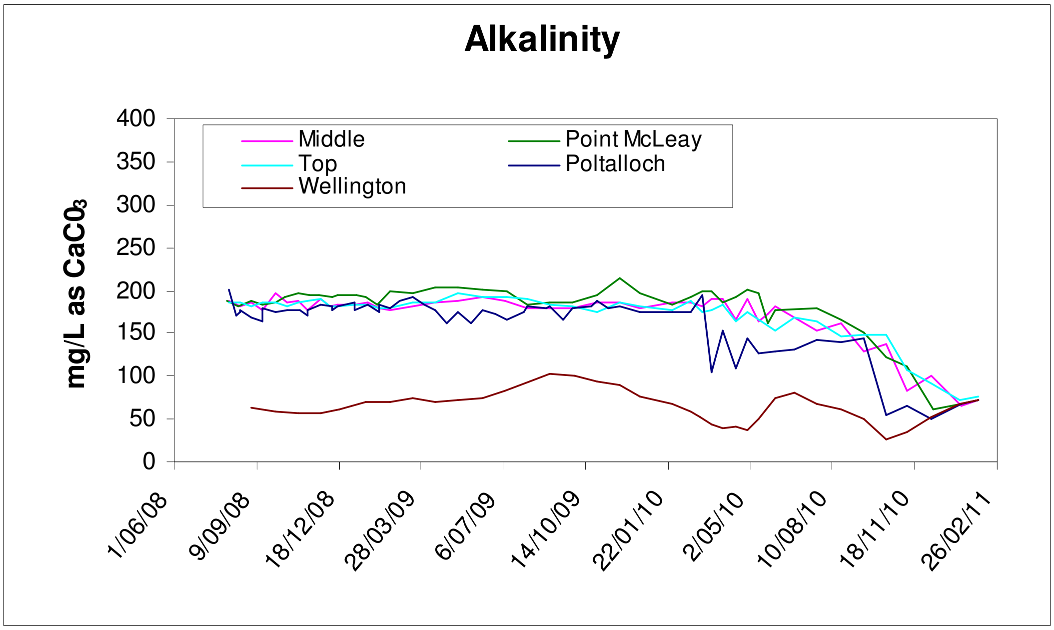


Figure 3 – Alkalinity at the Lake Alexandrina ambient monitoring sites

Sulfate:chloride ratio

- The sulfate:chloride ratio has been in decline in Lake Alexandrina since December 2011 and has continued to decline through February (Figure 4). Based on similar observations at Wellington, this is most likely a result of high inflow of flood waters dominating the lake major ion composition.

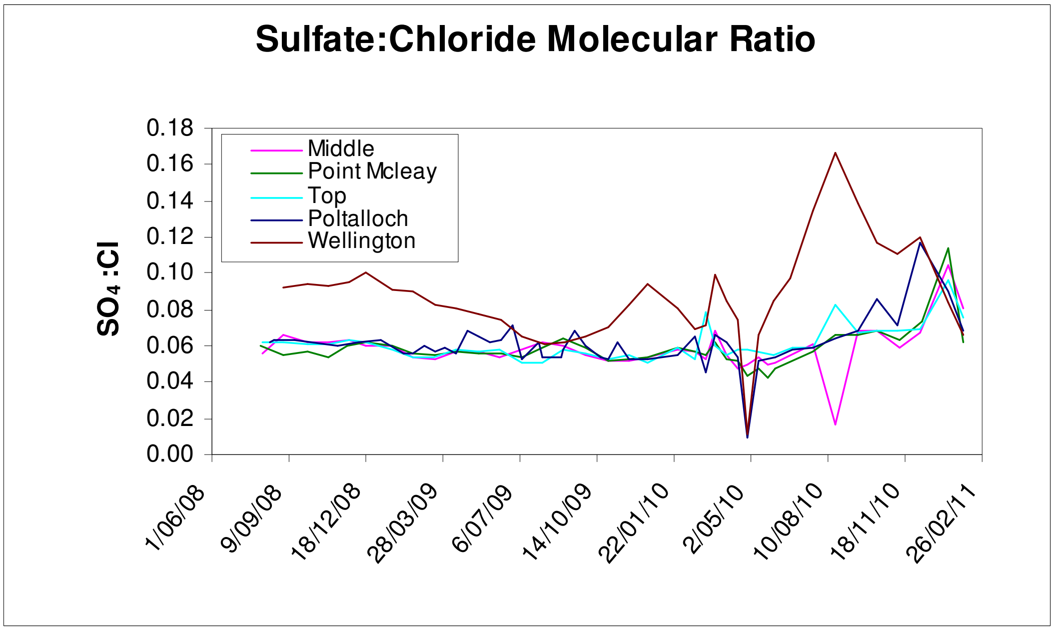


Figure 4 – Sulfate:chloride ratio at the Lake Alexandrina ambient monitoring sites

Salinity (EC)

- Salinity (as measured by electrical conductivity) levels remain below long term averages across Lake Alexandrina, however continues to decrease at all sites besides Wellington (Figure 5). The high Murray-Darling Basin inflows and export of accumulated salt through the barrages have contributed to the reduction and stabilisation of salinity within the lake.

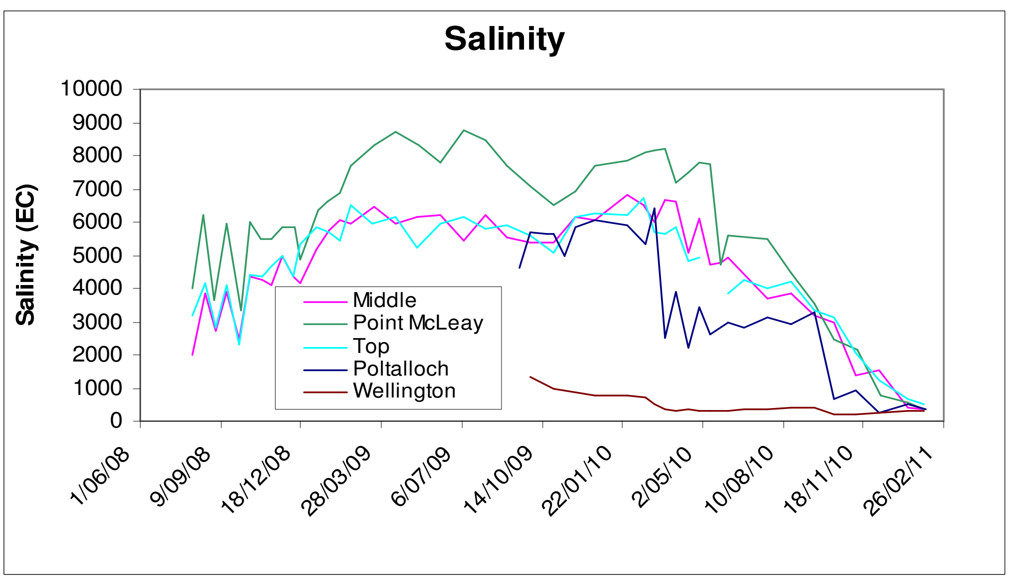


Figure 5 – Salinity at the Lake Alexandrina ambient monitoring sites

Turbidity

- Turbidity within Lake Alexandrina continues to be variable with slight decreases in levels across all sites in February (Figure 6). Inflowing flood waters containing high levels of suspended particles, and wind events causing resuspension and redistribution of sediment, are likely responsible for the high variability in turbidity.

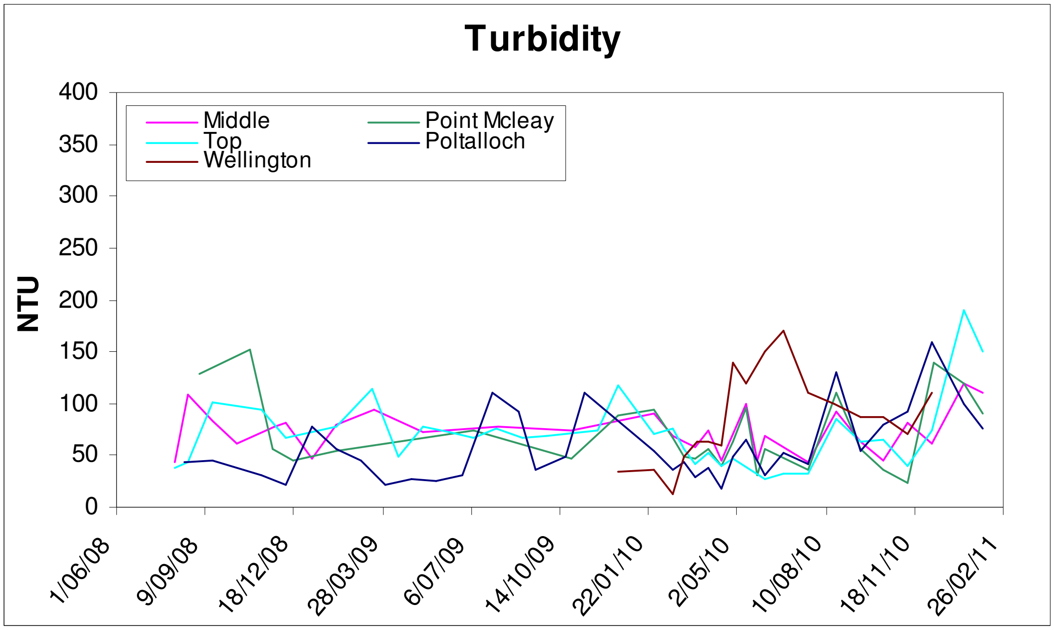


Figure 6 – Turbidity at the Lake Alexandrina ambient monitoring sites

Nutrients (total nitrogen and phosphorus)

- Total nitrogen and phosphorus levels within Lake Alexandrina show very little variation between January and February (Figures 7 and 8). As expected, nutrient levels and trends are similar to that of the River Murray (Wellington site) as high floodwater inflows continue to mix with the existing lake water. Total phosphorus levels increased in the river inflows near the end of 2010, likely due to runoff of soil and fertiliser off the wider Murray-Darling Basin catchment. These levels have stabilised between 0.2-0.3 mg/L but continue to remain above ANZECC guidelines, as does nitrogen, for freshwater ecosystems (<1mg/L TN, <0.025 mg/L TP).

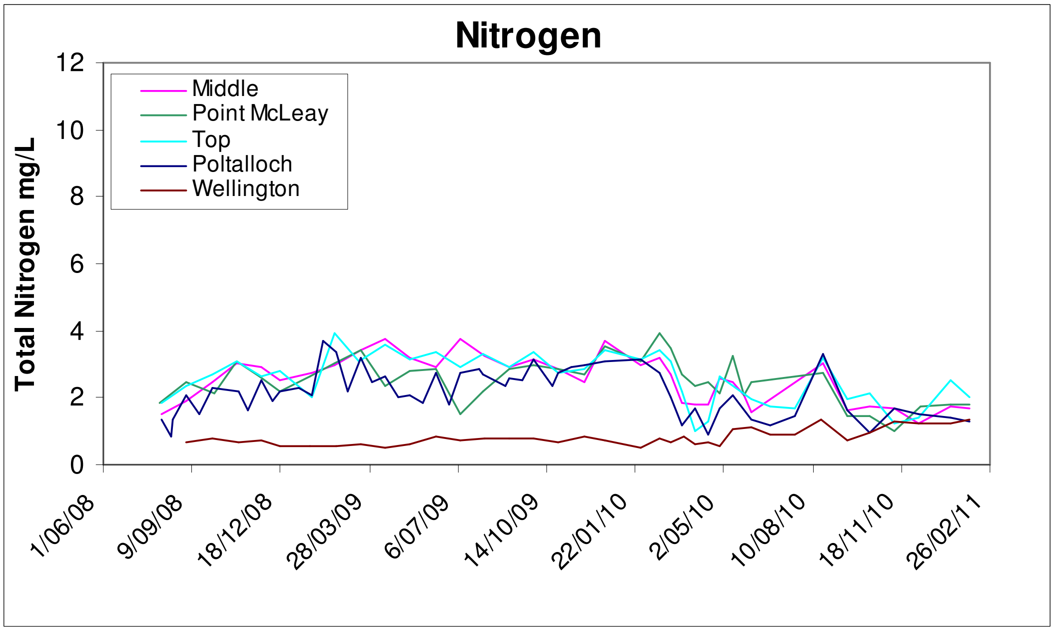


Figure 7 – Total nitrogen at the Lake Alexandrina ambient monitoring sites

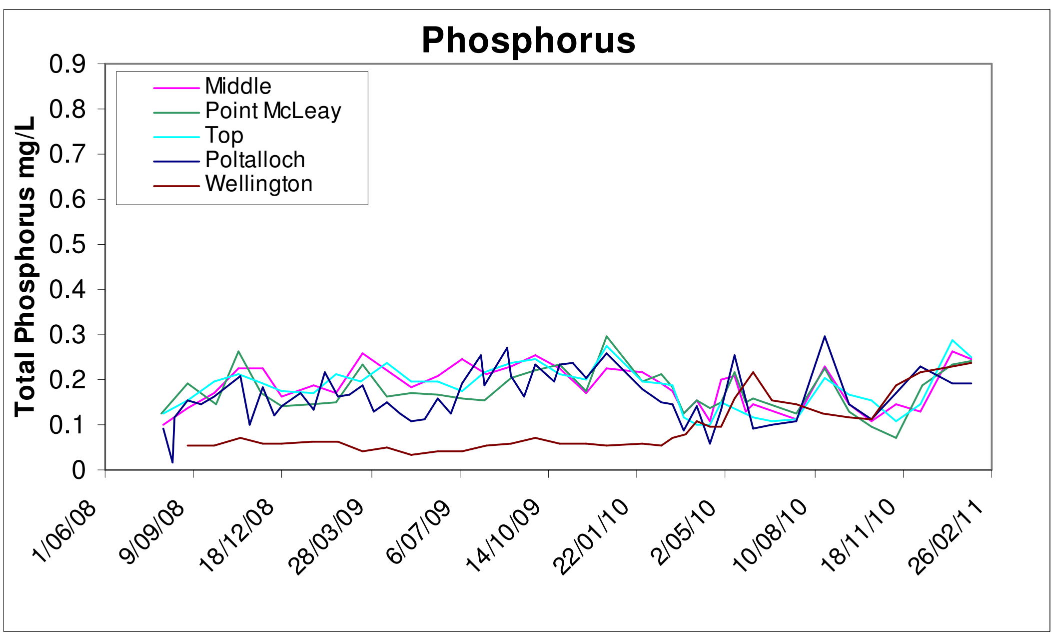


Figure 8 – Total phosphorus at the Lake Alexandrina ambient monitoring sites

Chlorophyll a (algae)

- Chlorophyll *a* has decreased across most Lake Alexandrina sites with 'Top' and 'Poltalloch' showing the greatest improvement which is mostly likely due to temperature decreases in February (Figure 9). However the system still remains highly nutrient enriched (hyper-eutrophic) and in excess of ANZECC guidelines (<15 µg/L). Although chlorophyll *a* levels in Lake Alexandrina remain high, no potentially toxic blue-green algal blooms are present.

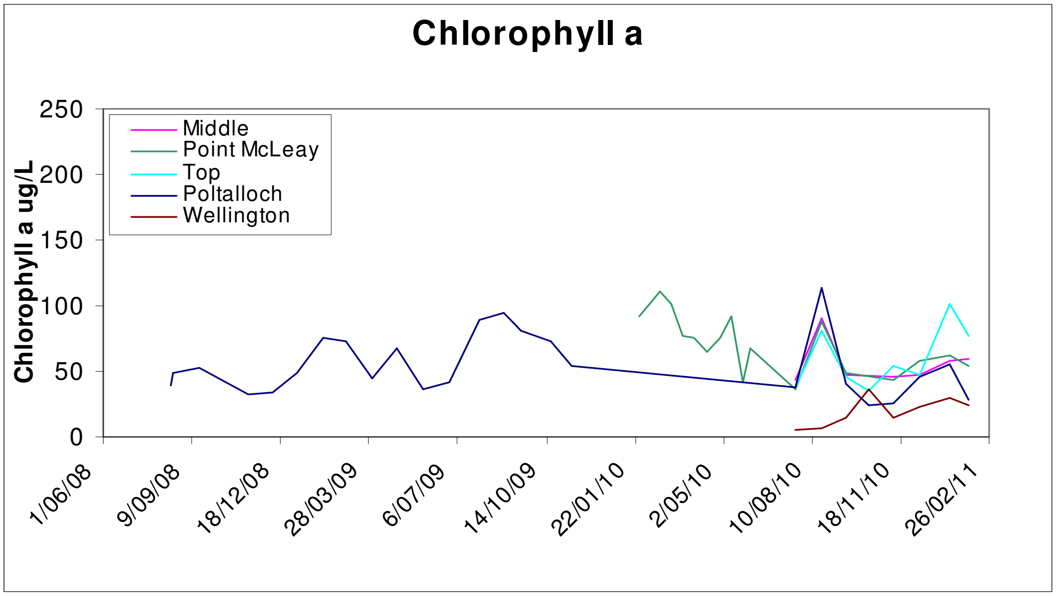


Figure 9 – Chlorophyll *a* at the Lake Alexandrina ambient monitoring sites

Metals

- Total aluminium and total iron within Lake Alexandrina have remained stable at three sites during February, with only the Poltalloch site showing a slight decrease in levels and the Top site showing a slight increase (Figure 10 and 11). At present, lake metal concentrations appear to be related to variable floodwater concentrations rather than lake system processes.

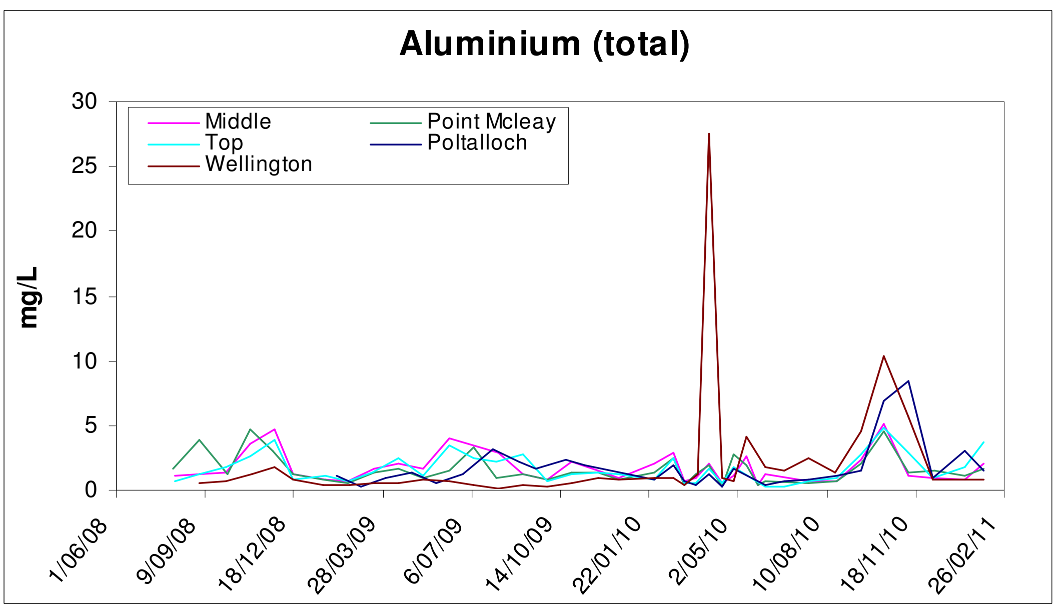


Figure 10 – Total aluminium at the Lake Alexandrina ambient monitoring sites

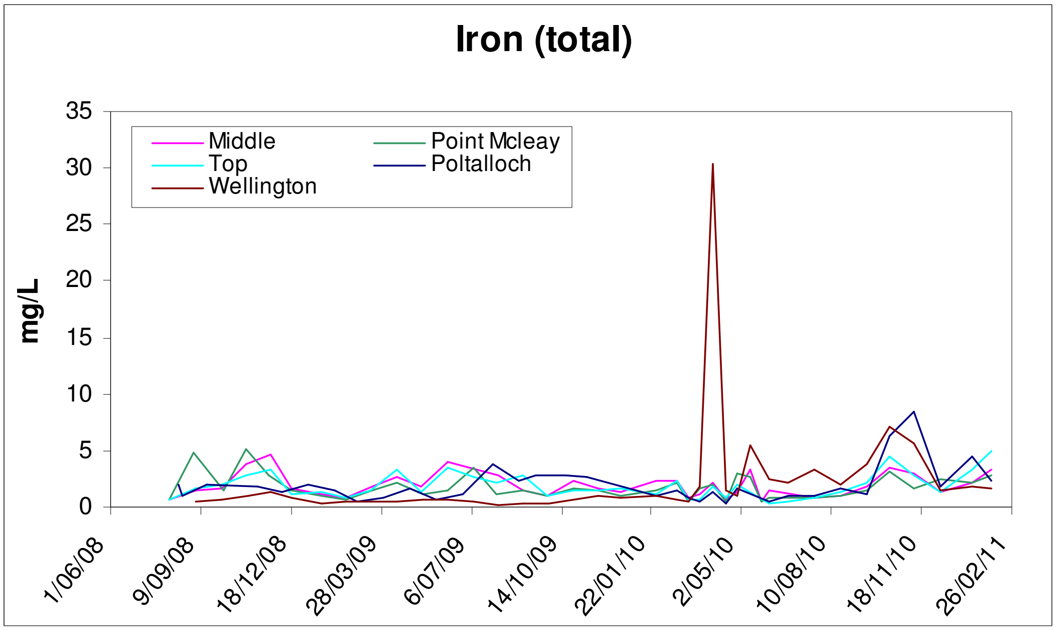


Figure 11 – Total iron at the Lake Alexandrina ambient monitoring sites

Lake Albert Water Quality

Ambient water quality monitoring results are discussed below for selected sites and parameters in Lake Albert. In mid September (starting 19/9/10), the Narrung bund was partially breached monitoring data after then will reflect changes due to inflows from Lake Alexandrina.

pH

- pH levels in Lake Albert remain stable with the exception of a decrease at 'Opening' (Figure 12). This decrease is most likely the result of mixing with the lower pH waters of Lake Alexandrina coming through the Narrung Narrows. All sites are within ANZECC guideline levels (pH 6.5-9.0)

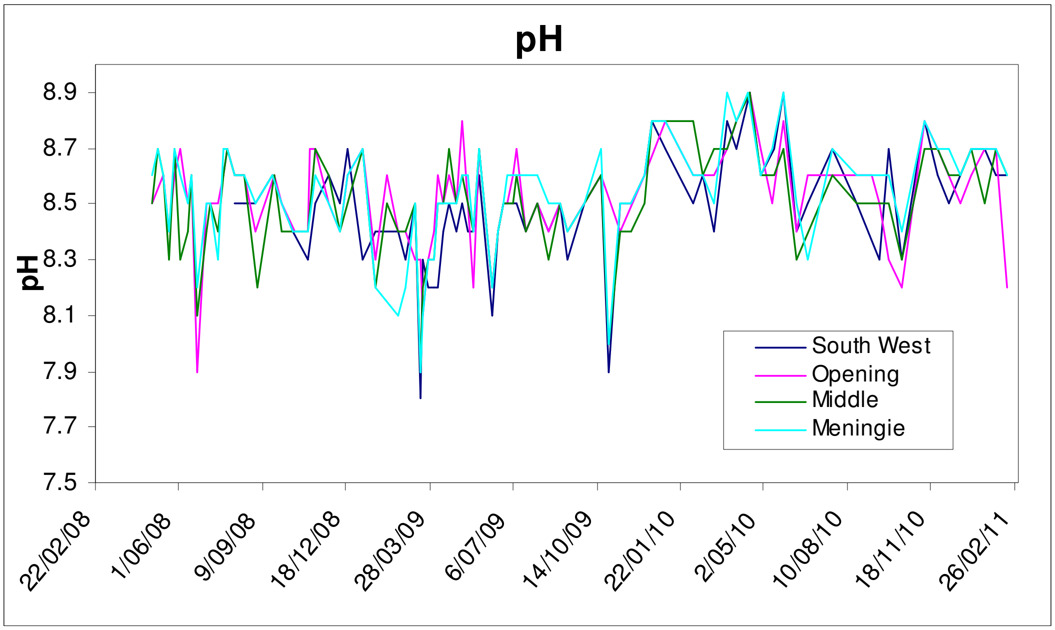


Figure 12 – pH at the Lake Albert ambient monitoring sites

Alkalinity

- Alkalinity within Lake Albert remains stable across most sites with the exception of Opening which has dropped significantly (Figure 13). The Opening site is the most influenced by inflow of lower alkalinity water from Lake Alexandrina and thus experiences more variability in concentrations. It is likely that the alkalinity will continue to decline across Lake Albert with further mixing with Lake Alexandrina water.

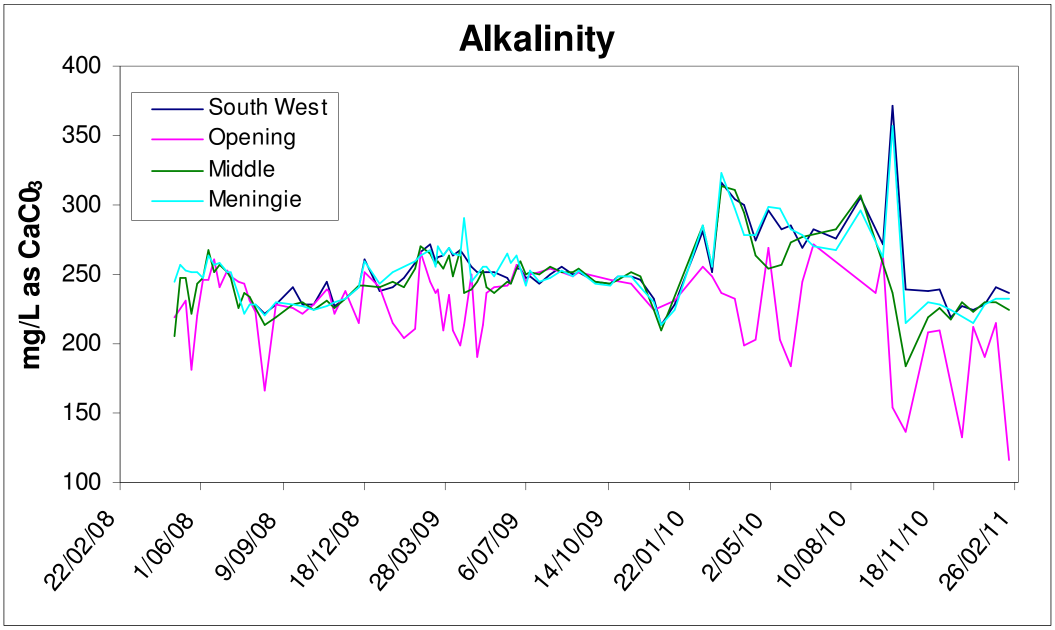


Figure 13 – Alkalinity at the Lake Albert ambient monitoring sites

Sulfate:chloride ratio

- The sulfate:chloride ratio is relatively stable across all Lake Albert sites (Figure 14) and similar to that found in Lake Alexandrina.

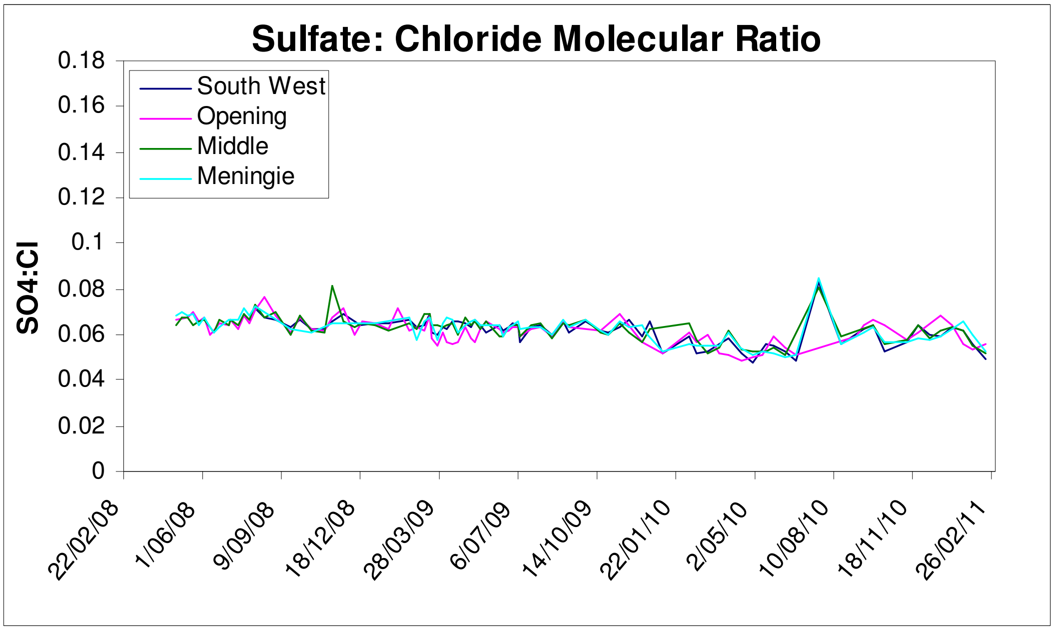


Figure 14 – Sulfate:chloride ratio at the Lake Albert ambient monitoring sites

Salinity (EC)

- Salinity levels are relatively stable across most sites but still remain high (between 2900 and 8000 µS/cm) compared to pre-drought levels (Figure 15). The Opening site continues to show variability in salinity levels as it is influenced the most by inflows from Lake Alexandrina and the wind direction at the time of monitoring. Lake Alexandrina water level manipulation is also influencing the exchange between the lakes. Further inflows and mixing of water from Lake Alexandrina are expected to reduce salinities across Lake Albert, however it is unlikely salinities will return to pre drought levels (<1600 µS/cm) for some time due to the limited water exchange between the two lakes.

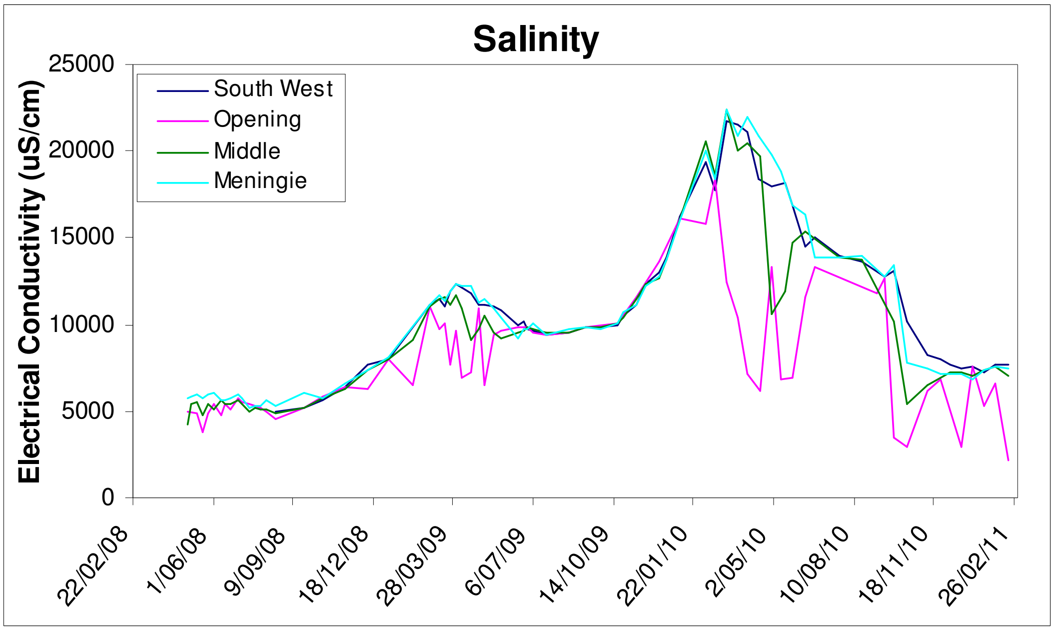


Figure 15 – Salinity at the Lake Albert ambient monitoring sites

Turbidity

- Turbidity in Lake Albert remains variable with slight increases being recorded for all sites (Figure 16). Similar to Lake Alexandrina, turbidity within Lake Albert is highly dependant on wind direction and strength.

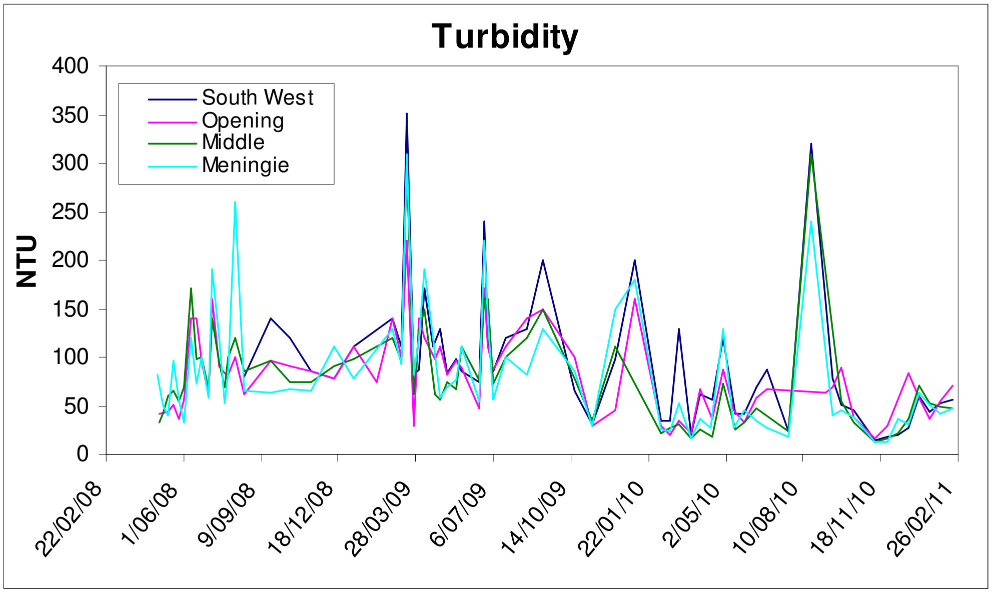


Figure 16 – Turbidity at the Lake Albert ambient monitoring sites

Nutrients (total nitrogen and phosphorus)

- Total nitrogen and phosphorus levels continued to increase across all Lake Albert sites in early February before stabilising towards the end of the month at December 2010 levels (Figure 17 and 18). Nutrient levels are comparable to historic data, however continue to be in excess of the ANZECC guidelines for freshwater ecosystems (<1mg/L TN, <0.025 mg/L TP).

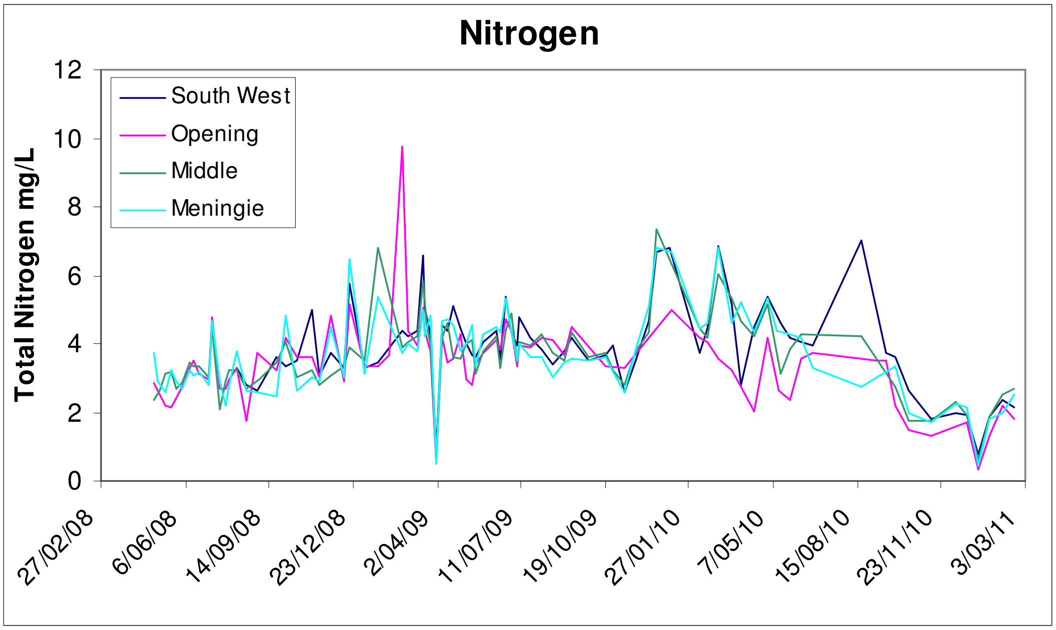


Figure 17 – Total Nitrogen at the Lake Albert ambient monitoring sites

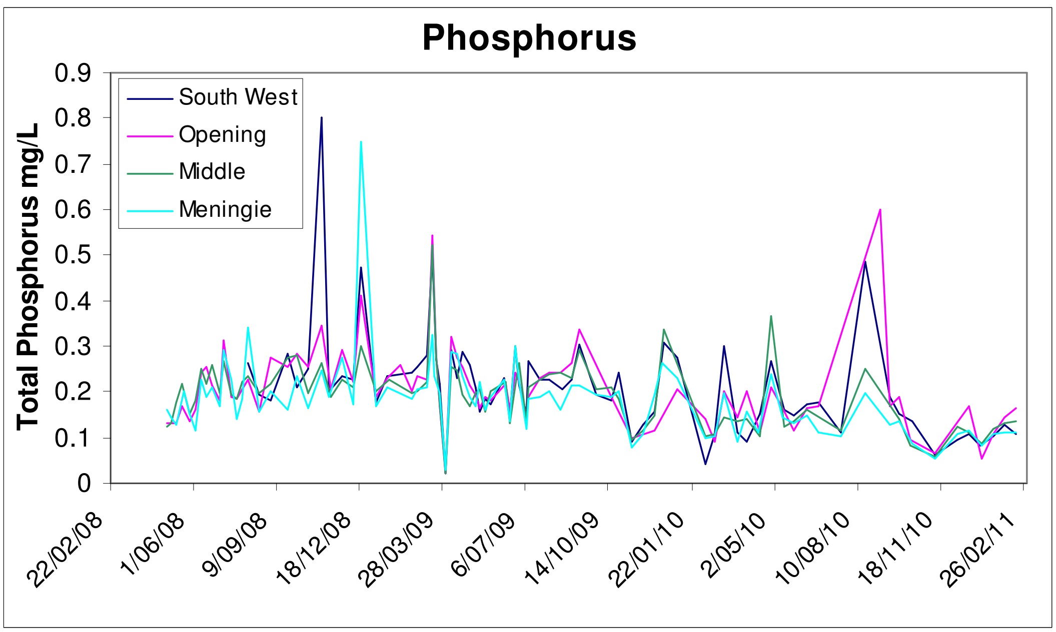


Figure 18 – Total phosphorus at the Lake Albert ambient monitoring sites

Chlorophyll a (algae)

- Chlorophyll *a* levels remained relatively stable in February with little change in any site (Figure 19). Levels are comparable to historic data for Lake Albert. These levels do however, continue to be in excess of ANZECC guidelines (>15 µg/L) and indicate a nutrient enriched system. Some blue-green algal species has been identified however these are only in small concentrations and not a significant risk at present.

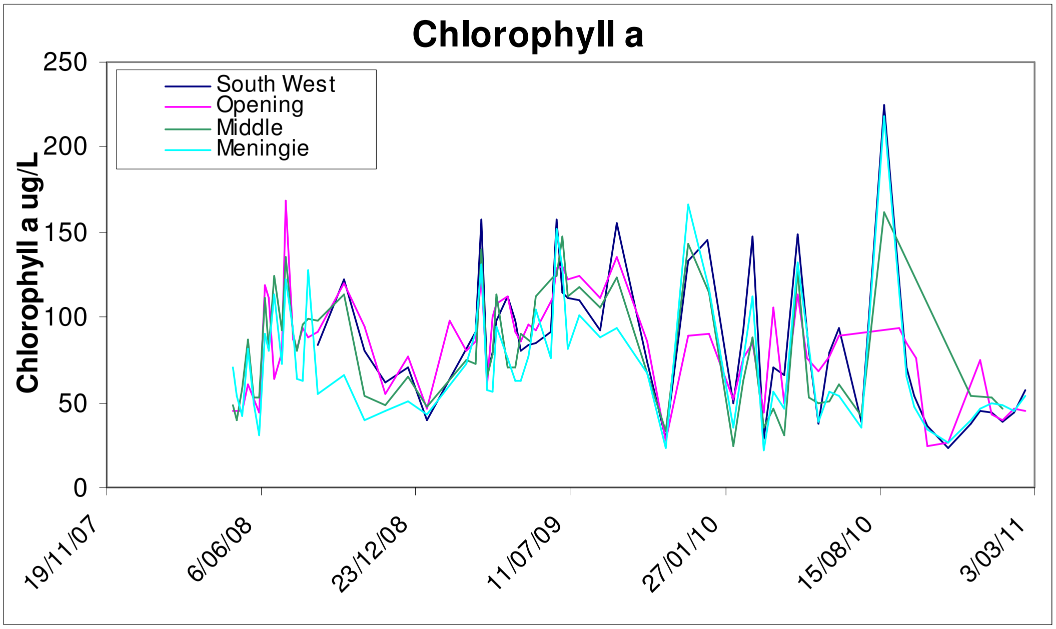


Figure 19 – Chlorophyll *a* at the Lake Albert ambient monitoring sites

Metals

Total aluminium and iron concentrations within Lake Albert (Figures 20 and 21) remain at low stable levels. This is to be expected whilst water levels remain high and re-suspension of sediment (containing metals) and lower flux from exposed acidic sediments is less common than during the 2008–2009 drought period.

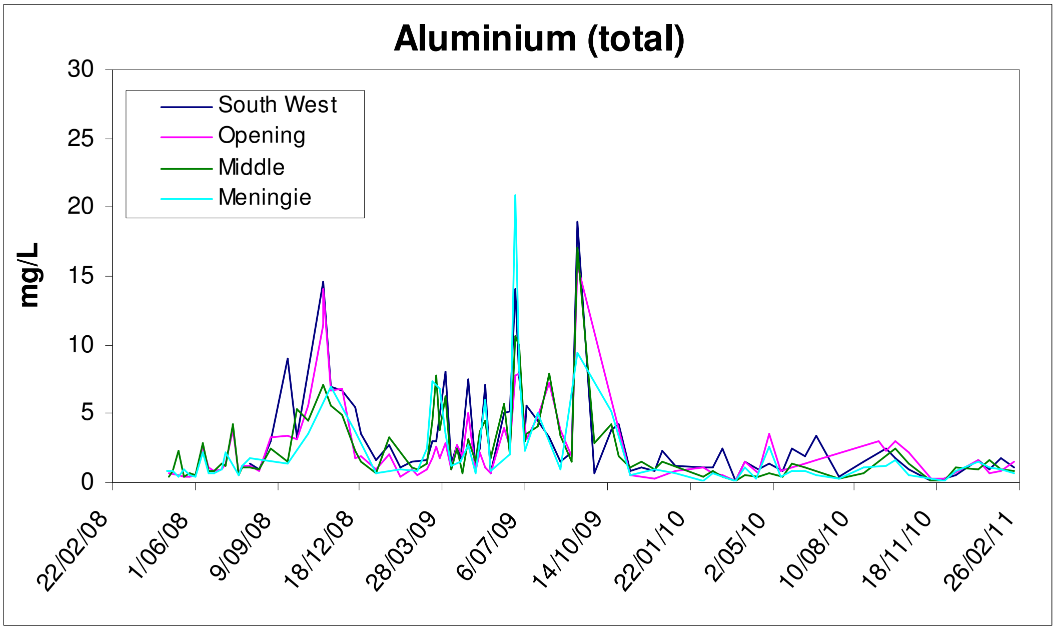


Figure 20 – Total aluminium at the Lake Albert ambient monitoring sites

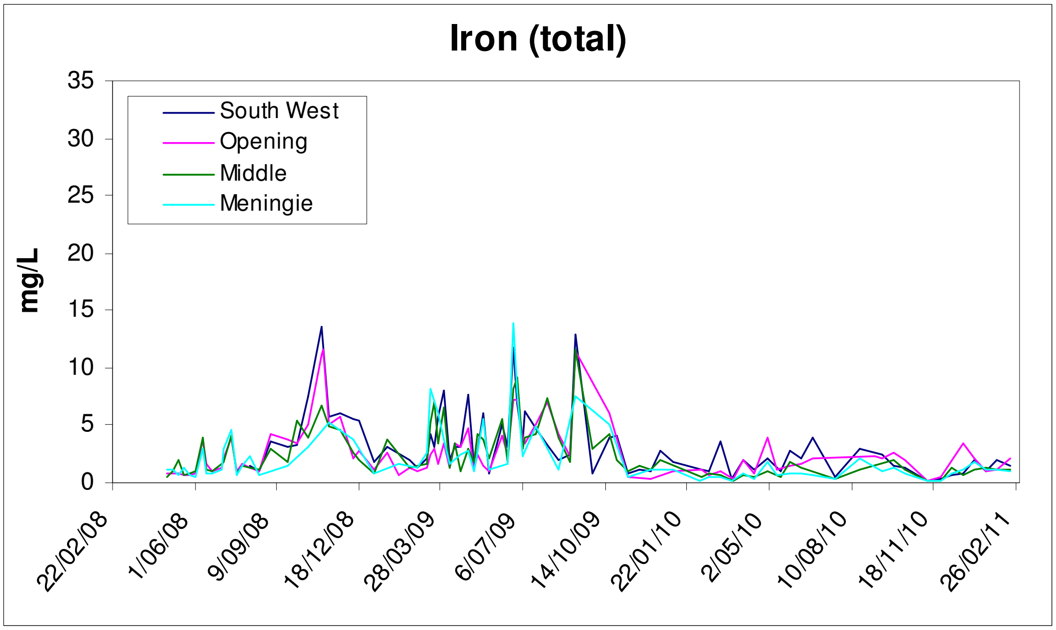


Figure 21 – Total iron at the Lake Albert ambient monitoring sites

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 the 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 so monitoring data after this will reflect changes due to inflows from Lake Alexandrina.

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

pH

- pH levels at all site have increased slightly but largely remain stable and within ANZECC guideline levels (pH 6.5-9.0) at most sites in the Goolwa Channel and Tributaries region (Figure 23).

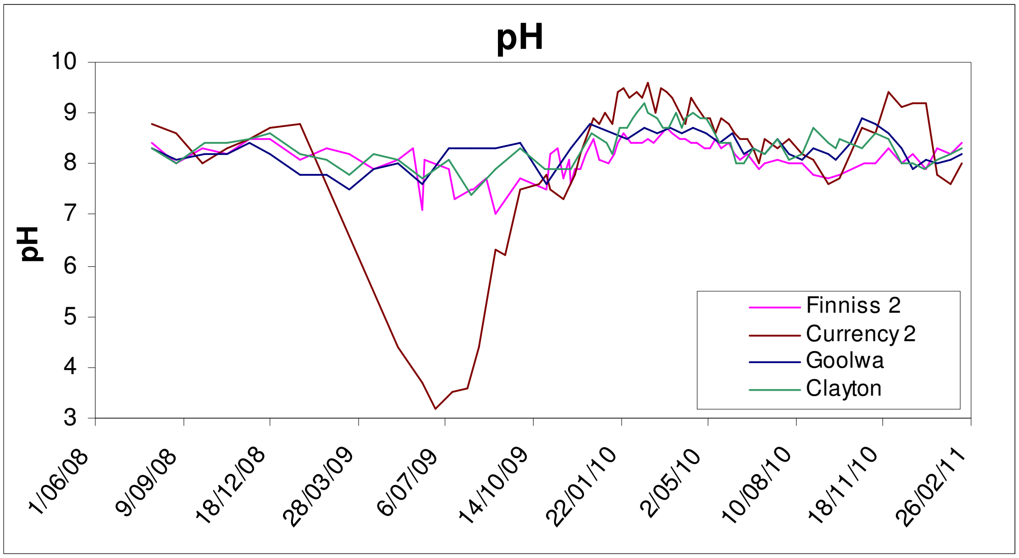


Figure 23 – pH at the Goolwa Channel and Tributaries monitoring sites

Alkalinity

- Alkalinity levels at all of the Goolwa Channel and Tributaries sites are stable with the exception of the Currency 2 site which had a slight increase all sites recorded values above 75 mg/L (Figure 24). This is due to higher alkalinity water pooling behind the regulator.

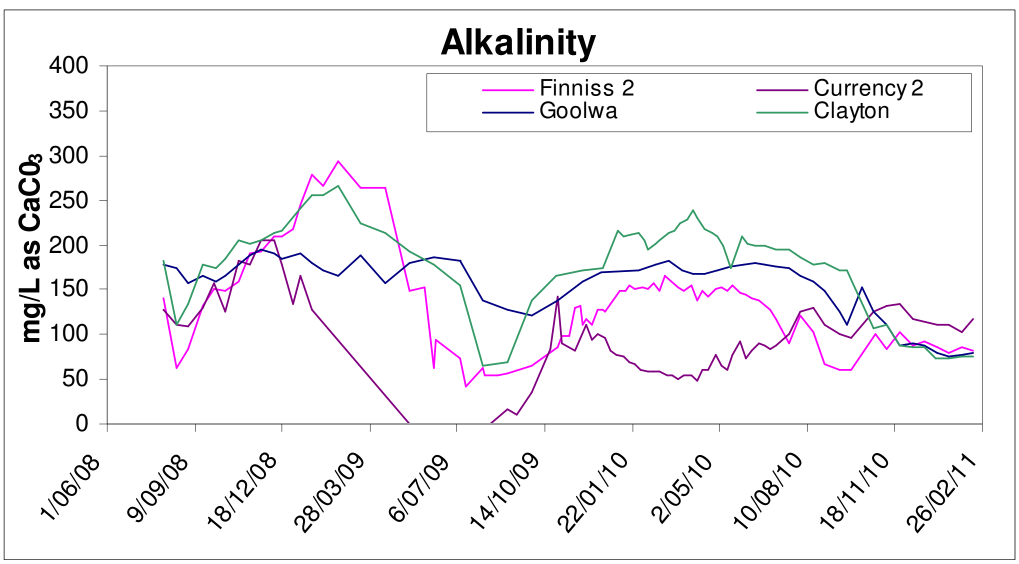


Figure 24 – Alkalinity at the Goolwa Channel and Tributaries monitoring sites

Sulfate:chloride ratio

- The sulfate: chloride ratio remains relatively uniform and stable at all sites in February (Figure 25). Trends do not indicate any widespread acid sulfate soil inputs.

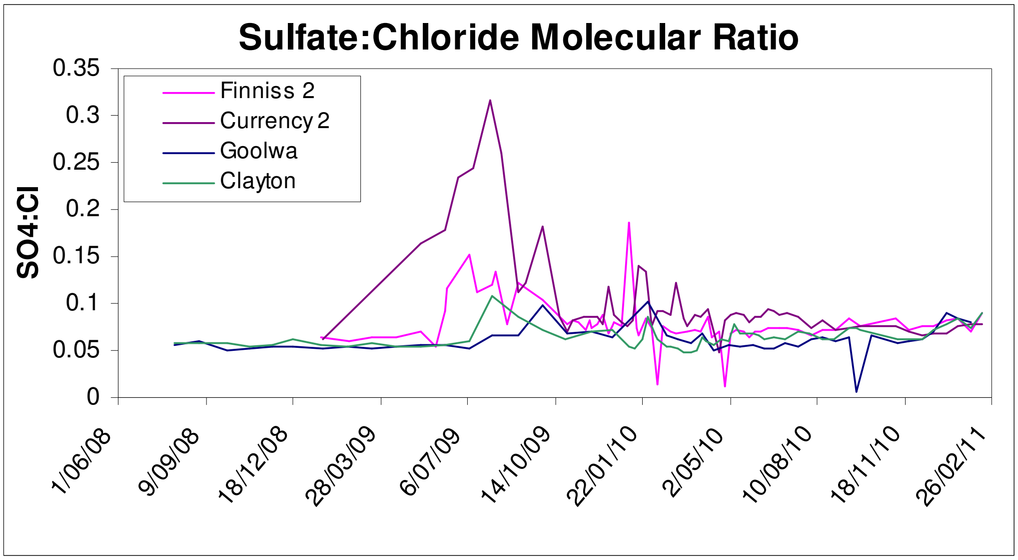


Figure 25 – Sulfate:chloride molecular ratio at the Goolwa Channel and Tributaries monitoring sites

Salinity (EC)

- Salinity levels remain low and stable for most sites in the tributaries and Goolwa Channel. Currency 2 salinity has fallen in February yet still remains higher then the other sites (Figure 26). This site is located on the north western side of the Currency Creek regulator which is likely restricting mixing with the lower salinity flood waters and thus slowing the rate of salinity decline for Currency 2.

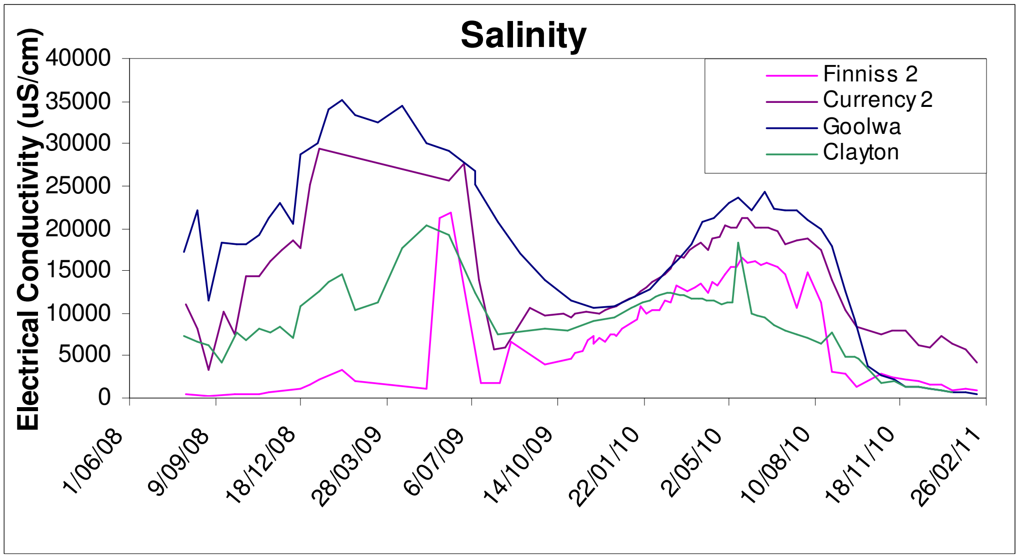


Figure 26 – Salinity at the Goolwa Channel and Tributaries monitoring sites

Turbidity

- Turbidity levels in the Goolwa Channel and Tributaries sites have stabilised and remain high in February 2011 (Figure 27) this is consistent with the inflows of highly turbid floodwaters through Lake Alexandrina. The lower turbidity at the Currency 2 site is likely due to the presence of the Currency regulator restricting mixing with the more turbid flood waters.

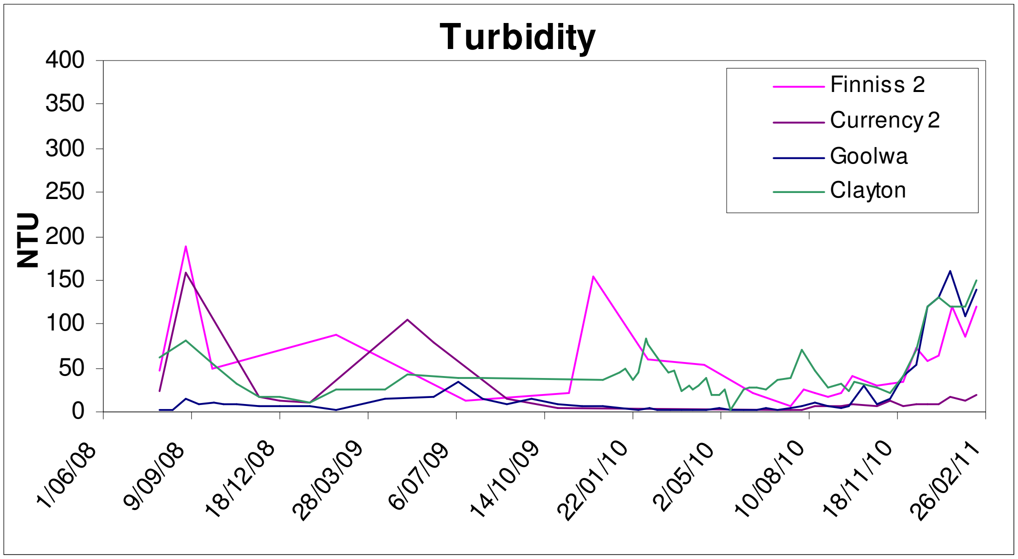


Figure 27 – Turbidity at the Goolwa Channel and Tributaries monitoring sites

Nutrients (total nitrogen and phosphorus)

- Nitrogen levels have remained relatively stable in the Goolwa Channel and Tributaries during February with only a slight increase across all sites (Figures 28 and 29). Phosphorous levels continue to increase at most sites with a slight decrease at Finniss 2. Currency 2 remains similar to January 2011 levels. Nutrient trends in this region appear currently driven by flood water inflow composition and mixing processes in Lake Alexandrina (cf. Figures 7 and 8). Nutrient levels continue to remain above ANZECC guidelines for freshwater ecosystems (<1mg/L TN, <0.025 mg/L TP).

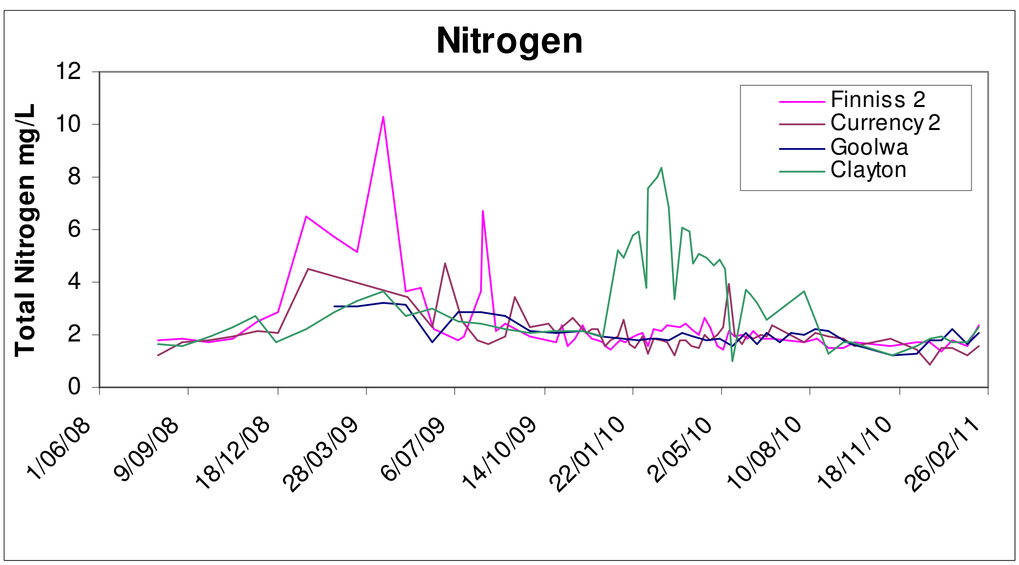


Figure 28 – Total Nitrogen at the Goolwa Channel and Tributaries monitoring sites

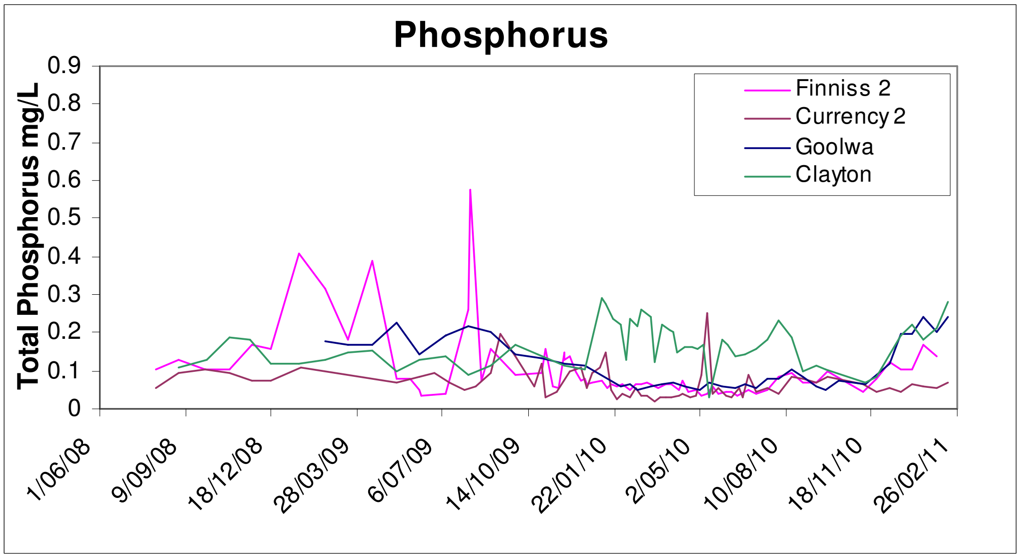


Figure 29 – Total phosphorus at the Goolwa Channel and Tributaries monitoring sites

Chlorophyll (algae)

- Chlorophyll *a* remains variable within the Goolwa Channel and the Tributaries (Figure 30). Increases in Chlorophyll *a* have occurred at the Clayton and Goolwa sites, the reason for this is unclear and will be closely monitored over the coming months.

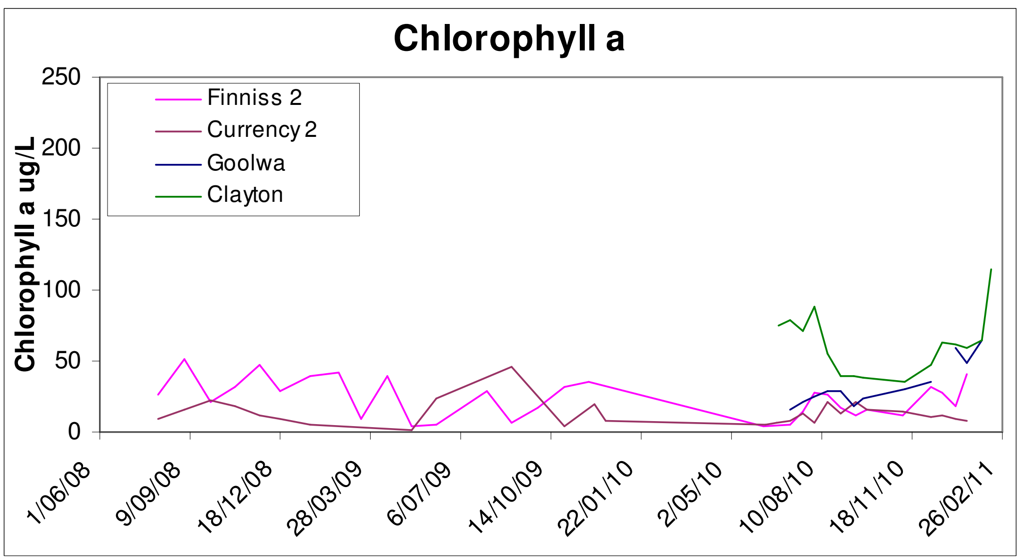


Figure 30 – Chlorophyll *a* at the Goolwa Channel and Tributaries monitoring sites

Metals

- Total aluminium and iron concentrations within the Goolwa Channel and Tributaries have dropped at all sites since the increases recorded in January and remain relatively low compared to the 2008–2009 drought period (Figures 31 and 32). Currency 2 still has lower metals concentrations in comparison with the other sites tested, which could be due to the presence of the Currency Creek regulator reducing mixing.

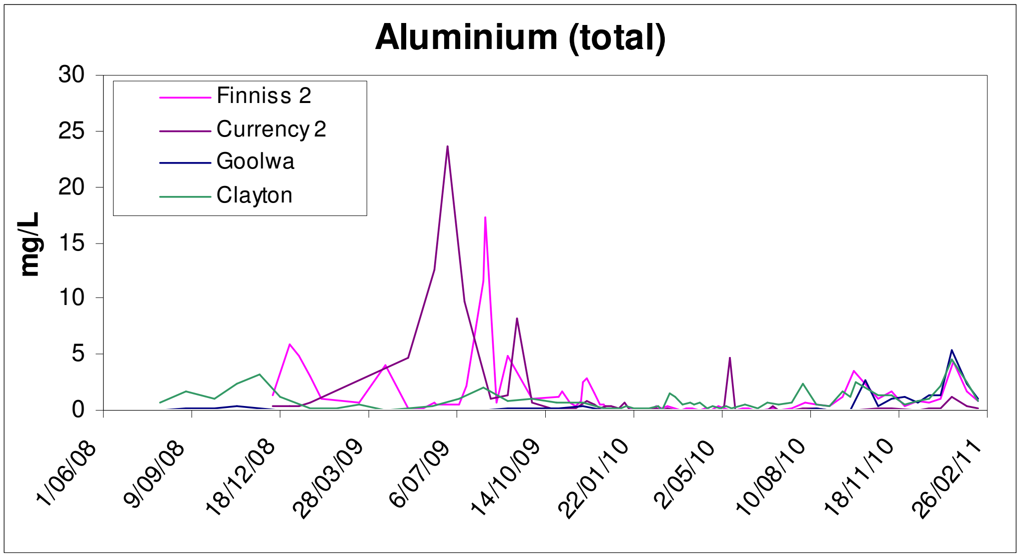


Figure 31 – Total aluminium at the Goolwa Channel and Tributaries monitoring sites

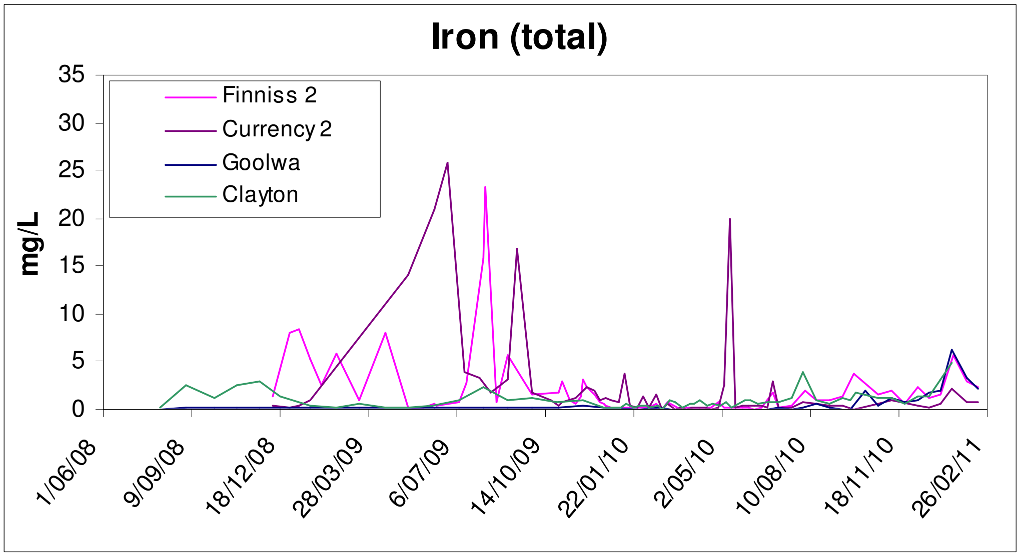


Figure 32 – Total iron at the Goolwa Channel and Tributaries monitoring sites

Event-based monitoring

Event-based water quality sampling is undertaken in regions that have experienced acidification or were at risk of acidification (Figure 33). The selection of sites was based upon previous acid sulfate soil risk assessments, 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. Previously this information has been used to determine the need for management actions, such as limestone dosing which occurred in Currency Creek, Finniss River and Boggy Lake, Lake Alexandrina in 2009 and 2010. Limestone dosing reduces the acidity hazard and mitigates further metal release.

Event-based sampling is also presently undertaken in the Narrung Narrows to better understand the water exchange between the two lakes (see Figure 34 for sites). Sampling is also undertaken near the Tauwitchere and other barrages (see Figure 40) to better understand salt and other constituent export from the lakes during high flows.

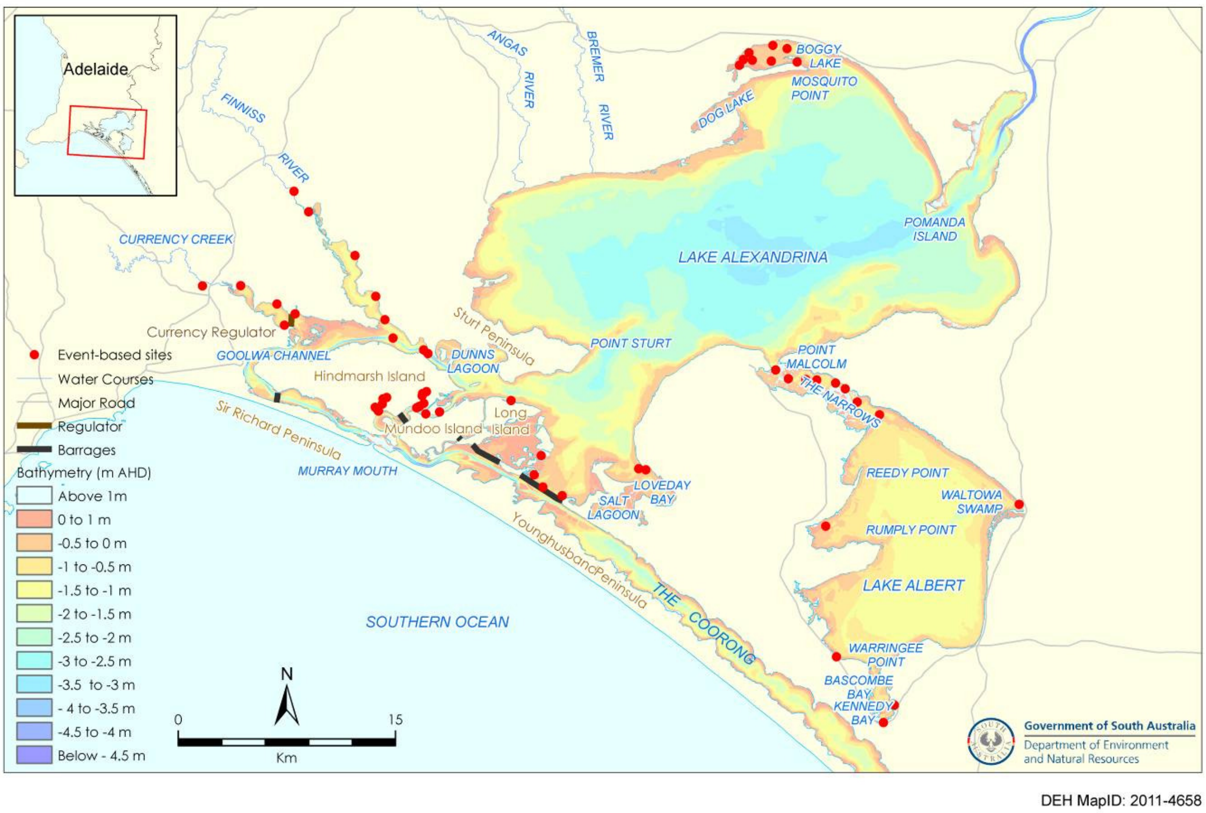


Figure 33 – Event-based water quality monitoring sites

Narrung Narrows

Figure 34 shows the various sample sites for the Narrung Narrows separating Lake Alexandrina from Lake Albert. Sites within the Narrung Narrows have been monitored since the Narrung bund was breached in August 2010. pH levels (Figure 35) show a drop towards the end of February after earlier increases for most sites. Similar early increases and decreases towards the end of February were recorded for Alkalinity and Salinity (Figure 35). The variability of the Narrows water quality results is likely a result of the varying wind directions and interactions with flood waters pushing water with lower salinity and pH from Lake Alexandrina into the narrows. Water level manipulations in Lake Alexandrina may also be influencing these trends. Narrows 19 and 18 are typically higher in Salinity and pH due to their proximity to Lake Albert and reduced mixing with Lake Alexandrina.

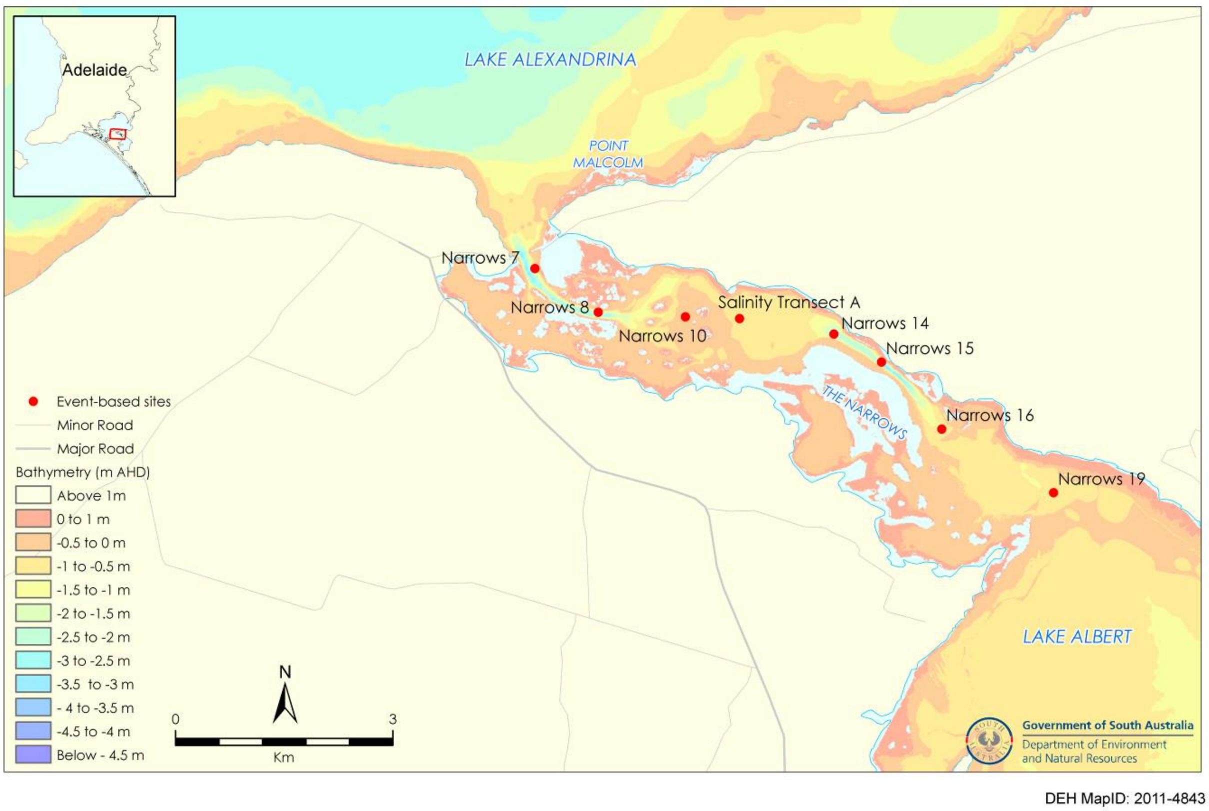


Figure 34 –Narrung Narrows monitoring sites

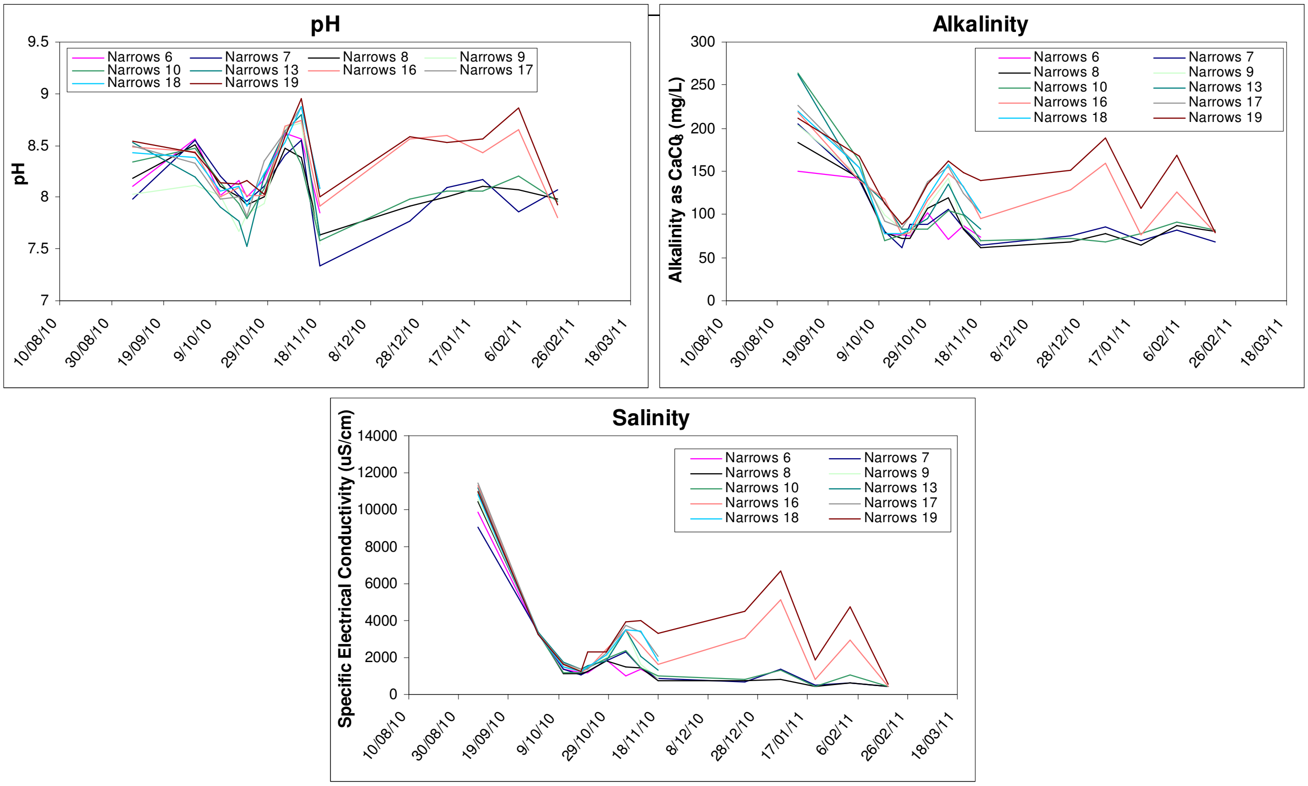
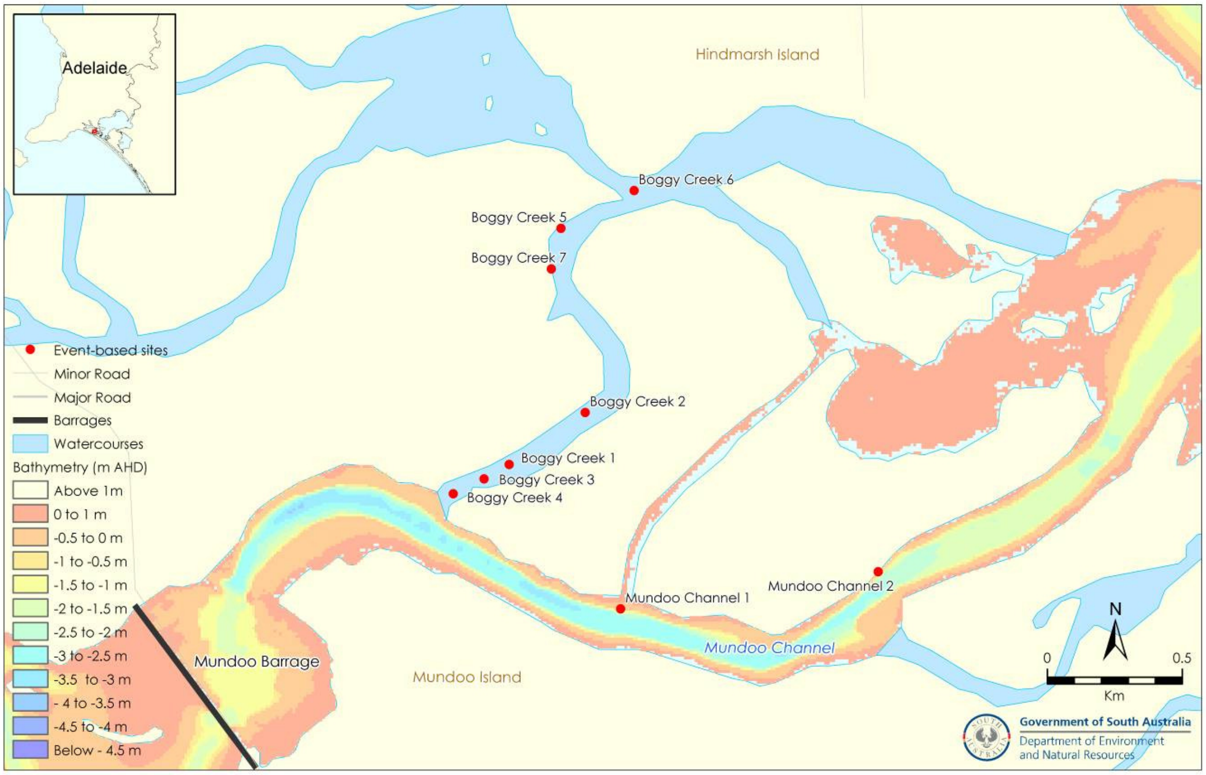


Figure 35 –Narrung Narrows water quality results

Boggy Creek and Hunters Creek

Figure 36–37 and 38–39 show the Boggy Creek and Hunters Creek sampling sites and water quality results respectively. pH levels within Boggy Creek began stabilising in early December 2010 (Figure 37), and have remained relatively stable throughout February after some initial increases. This trend is consistent with the declining salinity, as a result of increased inflow from the Mundoo Channel into Boggy Creek, due to increased floodwaters within Lake Alexandrina. Alkalinity dropped slightly in February but remains with in ANZECC guidelines. The pH levels within Hunters Creek have remained relatively stable since October 2010 (Figure 39) with only slight decreases recorded in February. Salinity has remained consistently stable at low levels over the same period. Alkalinity within Hunters Creek has decreased at all sites during February but remains within ANZECC guidelines. There have been some observations of low levels of acidity at both Boggy and Hunter’s Creek. This is likely due to diffusion of soluble Fe and Mn from the underlying acid sulfate soils (metal data not shown).



DEH MapID: 2011-4846

Figure 36 –Boggy Creek sample sites

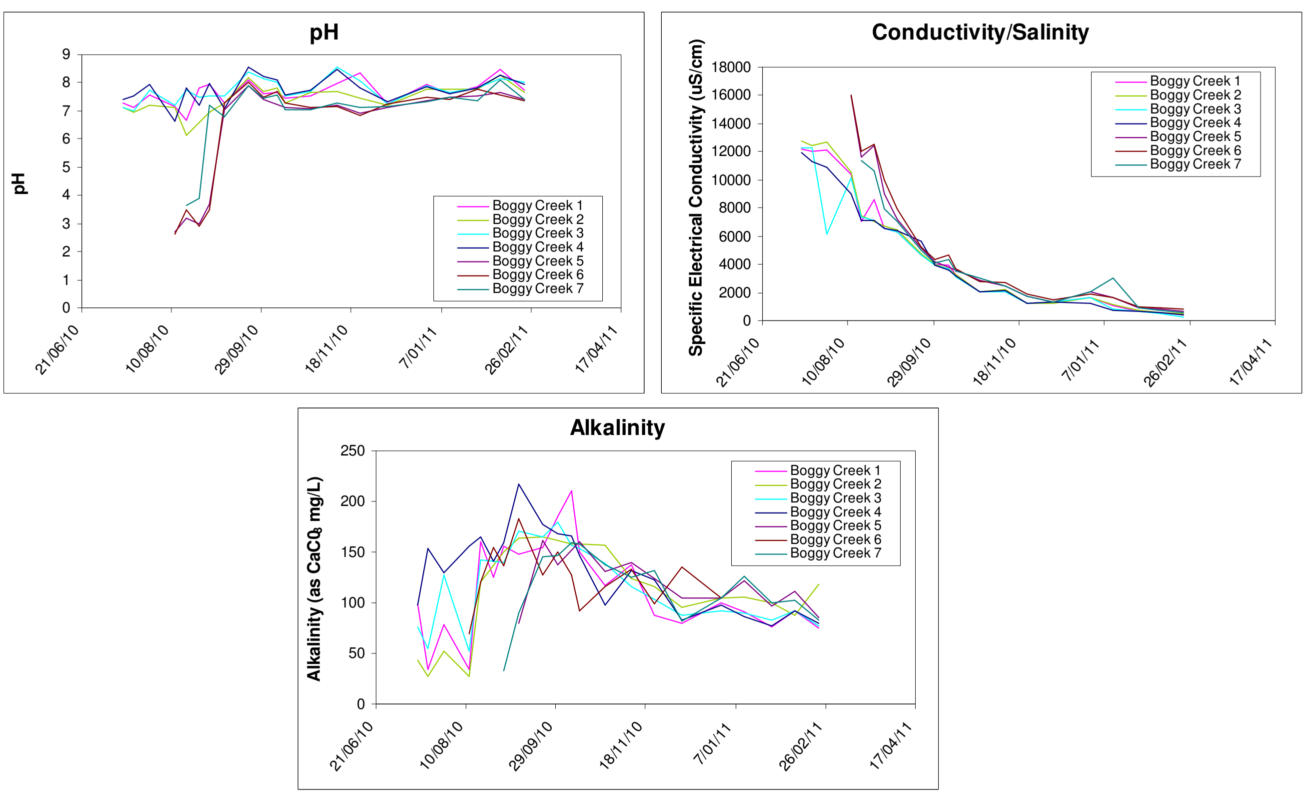


Figure 37 – Boggy Creek water quality results

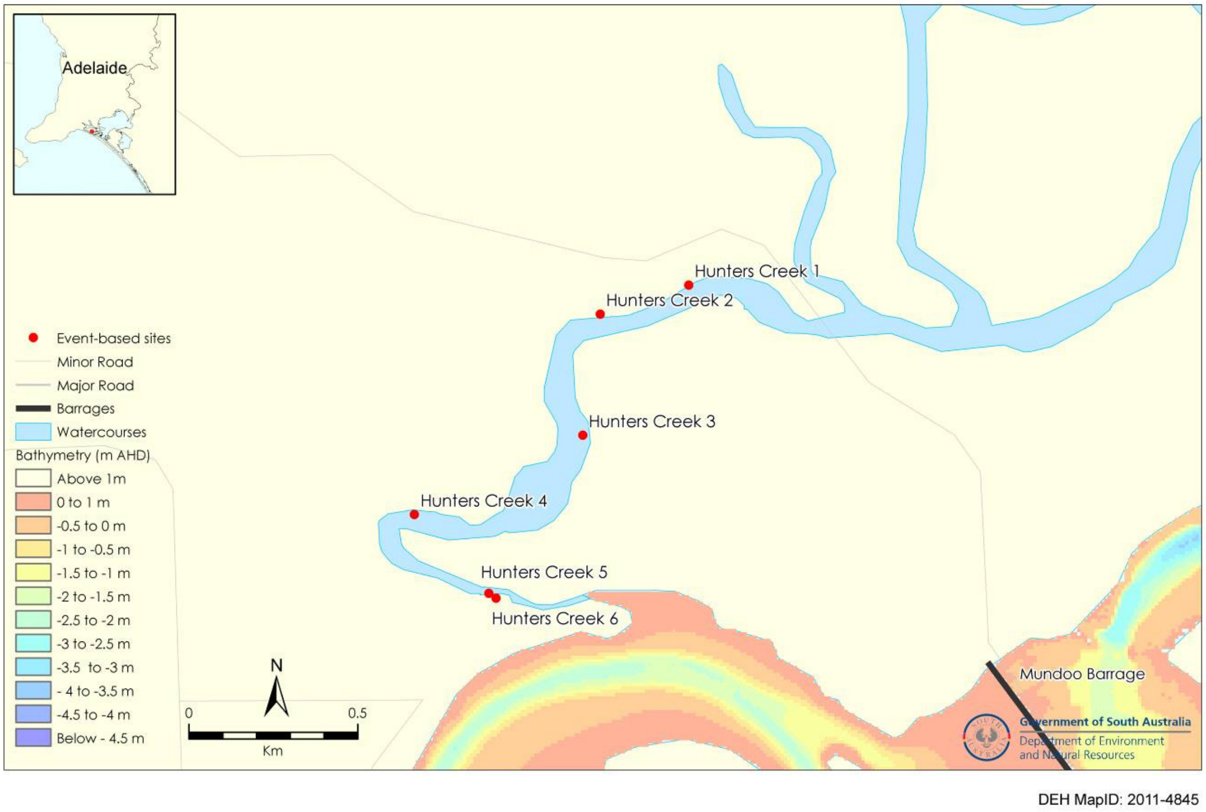
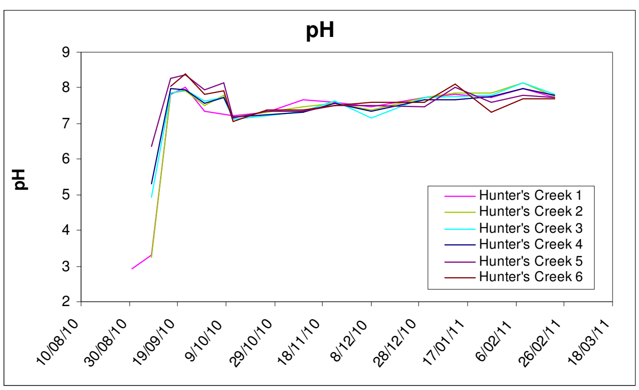
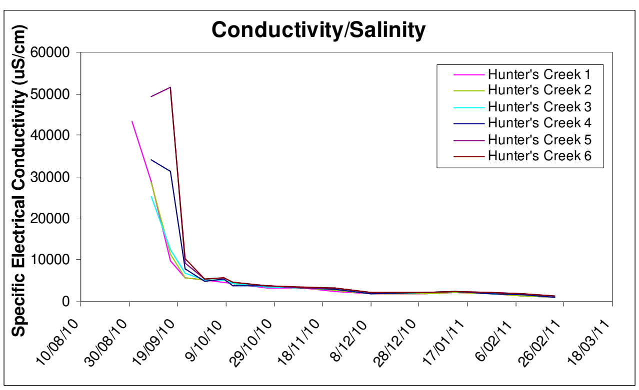


Figure 38 – Hunters Creek monitoring sites





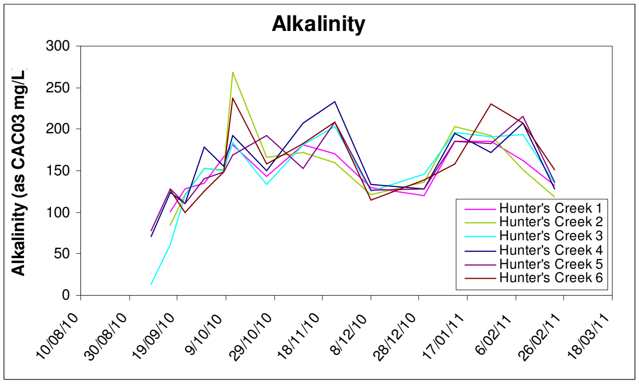
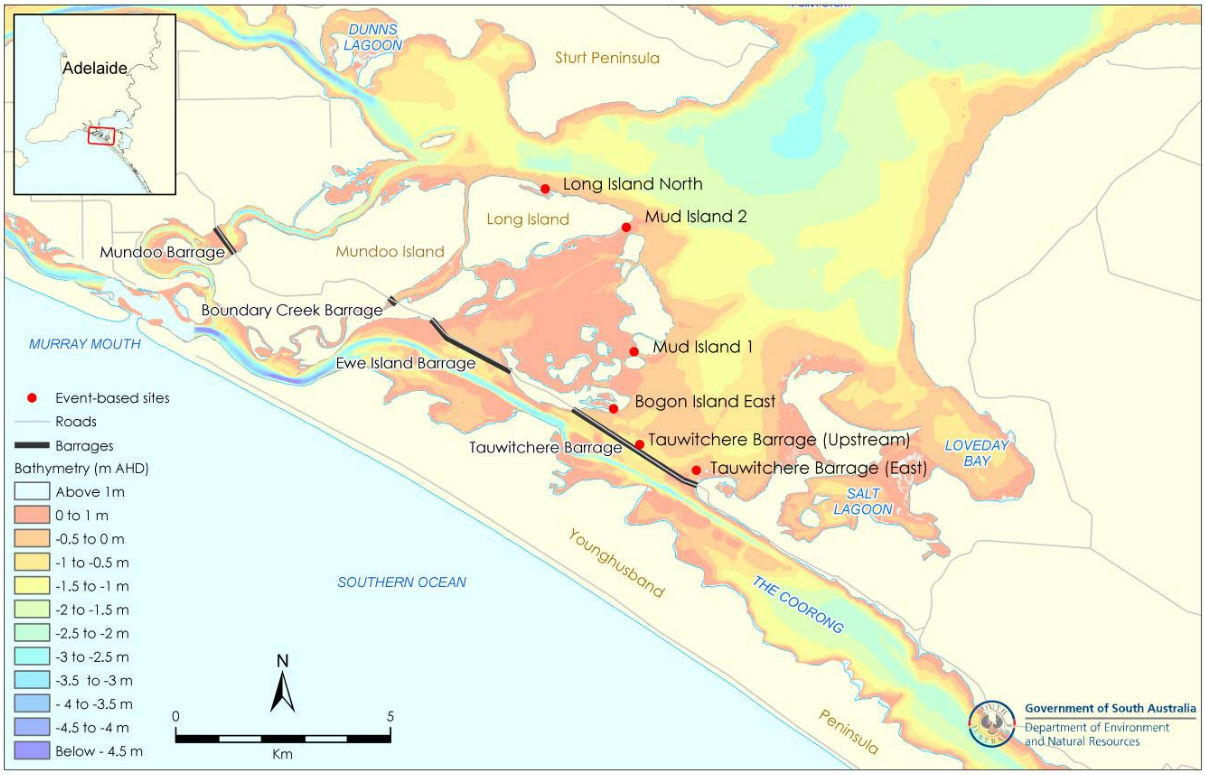


Figure 39 – Hunters Creek water quality results

Tauwitchere

Figure 40 shows a map of the Tauwitchere area and the selected sampling sites. pH levels within the area had remained reasonably stable since November 2010, however since January there has been a slight decrease (Figure 41). Salinity has remained relatively stable with some decreases recorded. The persistent low salinity is likely a result of the continued flushing of salt through the barrages. Alkalinity across all sites has increased slightly throughout February.



DEH MapID: 2011-4840

Figure 40 – Tauwitchere monitoring sites

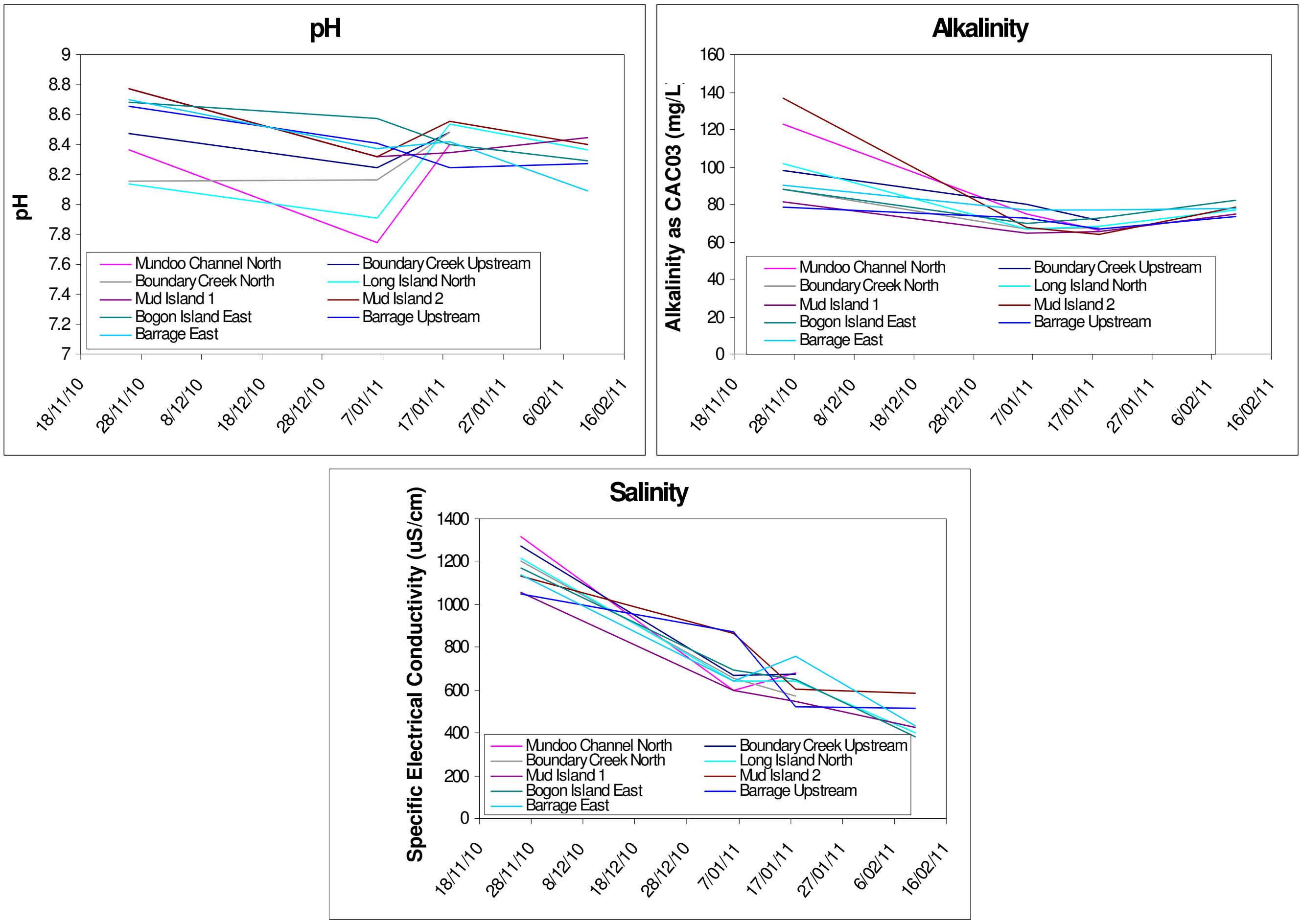


Figure 41 - Tauwitchere water quality results

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 http://www.epa.sa.gov.au/environmental_info/water_quality/lower_lakes_water_quality_monitoring
- Department for Water www.waterforgood.sa.gov.au/
- South Australian Murray–Darling Basin Natural Resources 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