# Mary River Water Quality Catchment Crawl

# 2018

*8 – 9 October 2018*

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# 2018 Mary River Catchment Water Quality Catchment Crawl

## Executive Summary

The 2018 Catchment Crawl was held on the 8th and 9th of October. Overall, 34 sites were sampled over the two days, including sites along the Mary River and seven of its tributaries, including the Susan River. Testing included basic physical chemistry, *E. coli*, total suspended solids and a suite of nutrients. The overall result for each parameter tested is described below. Overall, most sites were in compliance with the guidelines indicating that water quality throughout the catchment is in a reasonable condition. Sites which did not meet the guidelines are in some cases due to the low flow conditions in the lead up to the Crawl and in other cases it is likely due to an external influence related to diffuse or point sources of nutrients, sediments and/or pathogens. Catchment Crawl data is most useful when comparing results across a number of years. Individual data points need to be interpreted with considerable caution. Sixteen catchment crawls have occurred since 2002.

**Temperature**

Compared to 2017, which was one of the hottest years recorded for the Catchment Crawl, most sites recorded lower water temperatures in 2018. All but two sites fell within the temperature guidelines for their water type – Webb Park, Widgee Creek (WID399); and the Mary River headwaters at McCrae's Lane, Conondale (MAR009), which was the coolest site tested. The temperature at McCrae's Lane was 16.8°C. The hottest site was located 2KM upstream of Kenilworth (MAR148), with a temperature of 27.65°C. Based on the measurements during this 2018 Catchment Crawl Mary River cod populations would be unlikely to breed in the main trunk of the river and may struggle to survive in the Kenilworth reach. Only Six Mile Creek and the Mary River headwaters (MAR009) returned temperatures suitable for cod spawning. The sites in Obi Obi Creek at Houston Bridge in Coolabine (OBI940) and Widgee Creek at Webb Park (WID399) were also near this range. 2018 had a cold winter with many frosts and this may have been the reason for cooler water temperatures than 2017.

**pH**

The majority of sites show an increase in pH in 2018 when compared to 2017. Given the tendency for pH to become more alkaline when water temperature and therefore algal photosynthesis increases, it was surprising to find higher pH results in 2018 compared to 2017. Two sites – Six Mile Creek at Worba Lane near Cooroy (SIX080) and the Susan River near Hervey Bay (SUS500), were below the lower guideline for their water types.

**Electrical conductivity (EC)**

The overall trend reflects the results obtained in previous years' catchment crawl results where EC recordings increase from the upper to the lower catchment, most noticeable in the main trunk of the Mary River. Compared to 2017, four sites immediately downstream of Gympie continue to exceed the upper guideline for Electrical Conductivity of 580 µS/cm, although by a smaller margin.

This is due to the virtually cease-to-flow river flow conditions experienced along the entire length of the Mary River in September 2018. Tributaries generally showed values similar to 2017, with the exception of the Susan River (SUS500) and Munna Creek (MUN990) sites. Site MUN990 recorded a significant increase.

**Turbidity and Total Suspended Solids**

Turbidity complied with guideline values for all sites except the Mary River (MAR999) at River Heads and the Susan River site (SUS500). This was also the case in 2017. Low turbidity is to be expected at this time of year given it is a low rainfall period and therefore limited runoff occurs to cause turbidity. Rainfall rates prior to the Catchment Crawl were insufficient to elevate levels above those of previous years.

The guideline for total suspended solids for lowland and upland streams in the South-east Queensland region is 6 mg/L (Department of Environment and Resource Management, 2009). In 2018 all Mary River sites, except those at Olsen's Bridge in Tuchekoi (MAR372) and Widgee Xing (MAR 510), complied with this limit. One site exceeded this guideline in 2017, two in 2016 and 3 in 2015. Six Mile Creek upstream of Lake MacDonald (SIX080) and the two estuarine sites at Susan River (SUS500) and River Heads (MAR999) exceeded the guideline in 2018.

**Dissolved oxygen**

Dissolved oxygen measurements fell below the guideline range at almost a third of all sites in 2018. Generally, the Mary River itself was compliant with exceptions being the Mary River headwaters site (MAR009), at 88.8% saturation; Widgee Xing (MAR510) at 70.8% saturation; Miva (MAR605) at 81.85% saturation; and Emerys Xing (MAR660) at 81.40% saturation. However, these figures are just below guideline levels. In many tributaries, dissolved oxygen increased positively in 2018 when compared to 2017.

**Nitrogen & Phosphorus**

Most Mary River sites in the Catchment Crawl comply with nitrogen and phosphorus guidelines. However, Widgee Xing (MAR510) exceeded guidelines for both of these nutrients. The site on the Mary River at Emerys Xing (MAR660) significantly exceeded the phosphorus guideline while the sites at Tuchekoi (MAR372) and Kenilworth (MAR170) also exceeded the guideline but to a lesser degree.

All tributary sites exceed or come very close to the total nitrogen guideline and the Six Mile Creek site upstream of Lake MacDonald (SIX080) also exceeded the phosphorus guideline. Some sites had high levels of organically derived nitrogen and phosphorus. The tannin stained waters of Tinana Creek at Teddington weir (TIN800) and the Six Mile Creek site upstream Lake MacDonald (SIX080) were notable for this.

The highest result for nitrogen was at the Susan River site (SUS500) and the highest result for phosphorus was at River Heads (MAR999).

***E.coli***

Seven sites across the entire Catchment Crawl exceeded the *E.coli* guideline for primary contact of 150MPN/100ml, increasing from three sites in 2017. These were the Susan River site (SUS500) at

250MPN/100ml, the Mary River in Kenilworth (MAR170) at 190MPN/100ml, Moy Pocket (MAR300) at 390MPN/100ml, Olsens Bridge in Tuchekoi (MAR372) at 210MPN/100ml, the Gympie Weir site (MAR499) at 330MPN/100ml, Widgee Xing (MAR510) at 920MPN/100ml and Obi Obi Creek at Houston Bridge in Coolabine (OBI940) at 440MPN/100ml. Six Mile Creek at Victor Giles Bridge (SIX505) in Cooran reached 150MPN/100ml. *E.coli* was generally under guideline maximum levels at most sites, with spikes at sites along tributaries and the Mary River itself.

# 1 Introduction and background

The Mary River water quality Catchment Crawl, organised by the Mary River Catchment Coordinating Committee (MRCCC), takes place annually in the month of October. The 2018 Catchment Crawl was held on the 8th and 9th of October, and included testing of sites along the Mary River and seven of its tributaries (Obi Obi Creek, Six Mile Creek, Yabba Creek, Widgee Creek, Wide Bay Creek, Munna Creek and Tinana Creek), plus one site on the Susan River. Overall, 34 sites were sampled over the two days. Testing included basic physical chemistry, *E. coli*, total suspended solids and a suite of nutrients (N and P). This is the sixteenth catchment crawl held.

The aim of MRCCC's annual Catchment Crawl is to provide a snapshot of the state of the water quality in the Mary River catchment by sampling a large number of sites in a short period of time at the same time of the year. The impact of prevailing weather conditions (temperature, rainfall) is therefore often similar at all testing sites, making it easier to compare sites in one part of the catchment to another. Whilst several sites tested during the Catchment Crawl have accumulated several years' worth of data, there are testing sites which have been added to the schedule. For these newer sites, particular care needs to be taken when interpreting the results from one or two data points.

The Catchment Crawl data complements the data in the existing Waterwatch database. The Mary River Waterwatch program has been operating in the catchment since 2002. It is envisaged that by strategically selecting sites to repeatedly test during the annual Catchment Crawl, longer-term or seasonal trends may become apparent. For example, if a site consistently falls outside guidelines year after year the data may be indicating that there is an issue in that locality requiring further investigation. An important use for the Catchment Crawl data is to determine which sites have water temperature that is suitable for Mary River Cod breeding which occurs during September and October each year.

Catchment Crawls also provide an opportunity for members of the public to meet with MRCCC representatives and improve their understanding of water quality conditions of the whole catchment, whilst contributing their own localised expertise to build knowledge of the catchment. Often, Waterwatch volunteers and enthusiastic members of the community join MRCCC representatives for all or part of the Catchment Crawl. This willingness to participate is greatly appreciated. In addition to the regular water testing, each year wildlife sightings and riparian condition are recorded. These records are often enriched by visiting members of the public who have a keen interest and expertise in wildlife and plant identification. We have also had individuals undertake their own private Catchment Crawls that contribute to the database in their local area.

## 1.1 History of Mary River Catchment Crawls

The MRCCC has undertaken sixteen Catchment Crawls since 2002. In the first five years of Catchment Crawls it was common for two crawls to occur per year, one in Spring and one in Autumn. There was then a gap of six years between the 2009 crawl and the 2015 crawl. Crawls have occurred annually since 2015 and always in early October. This timing was selected because it coincides with the beginning of the Mary River Cod, Lungfish and Mary River turtle breeding season and it allows time for data to be collated and presented to the MRCCC AGM in the third week of October.

The standard Waterwatch physical and chemical parameters (pH, temperature, dissolved oxygen, electrical conductivity and turbidity) have been measured in all Catchment Crawls. In some years, additional parameters have been measured. The number of sites sampled has also varied. MRCCC is grateful to the Department of Environment and Science for their support of the nutrient and total suspended solids (TSS) analysis since 2015. Table 1 provides an overview of the Catchment Crawl history in the Mary River catchment.

In 2018 Seqwater has funded the Catchment Crawl which has enabled expansion of the program. Two teams of MRCCC staff sampled over the two days of the catchment crawl, enabling 34 individual sites to be sampled. The goal with the expanded sampling was to collect data at the up- and downstream extents of the three reaches of the catchment (Kenilworth, Goomong, Lake Macdonald) where Seqwater-MRCCC partnership projects are being undertaken. The selection of the additional sites was based on a detailed analysis of current Waterwatch sites, Catchment Crawl sites and other monitoring sites (e.g. Main Roads monitoring projects). This analysis aimed to identify any suitable sites that had historical data. Although it is difficult to infer a change in water quality from single data points collected in the Catchment Crawl our aim is to build a long term record that would enable change to be detected. However, these single data points do serve to flag particular points of interest. Information specific to the Seqwater partnership is reported in the 2018/2019 Performance Report.

**Table 1 Overview of all MRCCC-led Catchment Crawls**

| | Year | Dates | Number of sites | Report completed | Raw data | Interesting aspects |
|---|---|---|---|---|---|---|
| **1** | 2002 | 22-23 October | 14 on Mary River<br>13 on tributaries | Yes | Yes | |
| **2** | 2003 | 1-2 May | 16 on Mary River | Yes | Yes | Nitrate and FRP (orthophosphate) tested |
| **3** | 2003 | 20-21 October | 16 on Mary River | Yes | Yes | Nitrate and FRP (orthophosphate) tested |
| **4** | 2004 | 11-12 May | 17 on Mary River | Yes | Yes | Riparian condition assessments completed |
| **5** | 2004 | 16 and 22 October | 22 on Mary River<br>2 on tributaries | Yes | Yes | Riparian condition assessments completed |
| **6** | 2005 | 11-13 October | 22 on Mary<br>2 on tributaries | No | No | |
| **7** | 2006 | 14-15 March | 19 | Yes | Yes | Widgee and Wide Bay Creek sub catchments only |
| **8** | 2006 | 16-17 October | 17 on Mary River | Yes | Yes | |
| **9** | 2007 | 24-25 October | 14 on Mary River<br>7 on tributaries | Yes | No | Pesticide residue tested at six sites |
| **10** | 2008 | April | 14 | Yes | Yes | Reported with 10/08 data |
| **11** | 2008 | 22-23 October | 14 on Mary River<br>8 on tributaries | Yes | Yes | Nutrient tested at six sites |
| **12** | 2009 | 19 October | 3 on Mary River<br>2 on tributaries | No | No | Photos of Crawl available – Dickabram Bridge, Emery's Crossing and Coles and Skyring Creeks |
| **13** | 2015 | 8-9 October | 13 on Mary River<br>7 on tributaries | Yes | Yes (no e-DNA data) | Nutrients and TSS at all sites (through GBR loads monitoring)<br>Environmental DNA (through Harmony Patricio – Griffith University)<br>Riparian Condition Assessments |
| **14** | 2016 | 4-5 October | 14 on Mary River<br>7 on tributaries | Yes | Yes | Nutrients and TSS at all sites (through GBR loads monitoring)<br>*E.coli* at 14 main trunk sites, 2 tributary sites on Six Mile Creek |
| **15** | 2017 | 10-11 October | 19 on Mary River<br>13 on tributaries | | Yes | Nutrients and TSS at all sites (through GBR loads monitoring)<br>*E.coli* at 18 main trunk sites, 10 tributary sites |
| **16** | 2018 | 8-9 October | 20 on Mary River<br>14 on tributaries | | Yes | Nutrients and TSS at all sites (through GBR loads monitoring)<br>E.coli at 19 main trunk sites, 11 tributary sites |

## 1.2 Weather and river conditions relevant to 2018 crawl

The 2018 Catchment Crawl occurred on Monday 8th October and Tuesday 9th October.

The 2018 Winter/Spring season was cold with many frosts. The break in the winter dry period occurred in early October (like 2017) but following the Catchment Crawl, with consistent, well-distributed monthly rainfall through to December 2018.

Table 2 shows the river heights and flow rates at several gauging stations in the catchment. This data was sourced from the online 'Water Monitoring Information' Portal, which is provided by the Queensland Government's Department of Natural Resources and Mines. Data sourced represents the mean discharge. At all sites during the Catchment Crawl, river flow was increasing following cease to flow conditions in late September or early October (see Appendix C).

On the days of sampling, it is noted flow was slightly higher compared to 2017 data in the upper catchment and lower in the lower catchment. Of importance however, is whether the river is rising or falling at time of sampling. River levels at all the stations were rising in 2018, whereas in 2017 the three most upstream were falling, as was the case in 2016. In 2017 at the Miva station the river level was falling and Home Park at Tiaro was rising. The opposite was true for 2016. This can influence physical parameters which may become apparent in the physical chemistry test results.

**Table 2 Gauging station locations, river heights and flow rates**

| Gauging station location | Mean River height (m) on 09/10/2018 | Mean Discharge (ML/day)* 9/10/2018 (Oct 2017) | Notes, see appendix C for riverflow plots |
|---|---|---|---|
| **Mary River, above Kenilworth (Bellbird station)** | 0.523m (<20% flow) | 20.8 MEG (20.1) | Discharge peaked at ~40 ML/day on 1/10/18, after weeks of low riverflow (~5-20 MEG) |
| **Mary River, Moy Pocket station** | 0.781m (<20% flow) | 59 MEG (54.2) | Discharge peaked at ~80 ML/day on 3/10/18, after weeks of almost no riverflow in late September (~10 MEG) |
| **Mary River, below Gympie (Fishermans Pkt station)** | 1.6m (20-50% flow) | 155 MEG (104.7) | Discharge peaked at ~80 ML/day on 6/10/18, after a week of virtual cease to flow situation in late September |
| **Mary River, Miva station** | 1.718m (20-50% flow) | 136 MEG (196.7) | Discharge peaked at ~170 ML/day on 9/11/18, after the river virtually stopped flowing in late September for a week |
| **Mary River, above Tiaro (Home Park station)** | 1.201m (20-50% flow) | 116 MEG (182.1) | Discharge increasing from 6/10/18 from almost cease to flow river conditions for a week in late September |

*ML = 1 million Litres

# 2 Methods

## 2.1 Sites

In total 34 sites were sampled. 20 of these sites were on the Mary River itself and the other 14 were collected from the tributaries of Obi Obi, Yabba, Widgee, Wide Bay, Munna, Six Mile and Tinana Creek and the Susan River. All of the sites sampled are shown in Figure 1. Figure 2 and Figure 3 provide more detail of the sites sampled on Day 1 and Day 2 respectively. The Figures also show the Water Types discussed further in section 2.4. The full itinerary is provided in Appendix A.

All samples were analysed for the Waterwatch suite of parameters (pH, Electrical Conductivity, Dissolved Oxygen, Turbidity and temperature) and the Department of Environment and Science (DES) Great Barrier Reef Catchment Loads monitoring suite of parameters (see Table 5). *E.coli* samples were also collected at 19 Mary River sites and 11 tributary sites. Sampling for *E.coli* was limited to 30 sites because of logistical constraints of getting samples to the laboratory within 24 hours of collection.

Table 3 provides the details of all sites tested, their water type, their site code, a brief description of the site and the parameters tested. Duplicate samples were taken at seven sites across the two days for the nutrient and total suspended solids samples. Two duplicate *E.coli* sample were also taken at the sites. Duplicate samples provide a quality control measure to ensure our sampling methods are consistent and rigorous. The itinerary for all sites is provided in Appendix A.

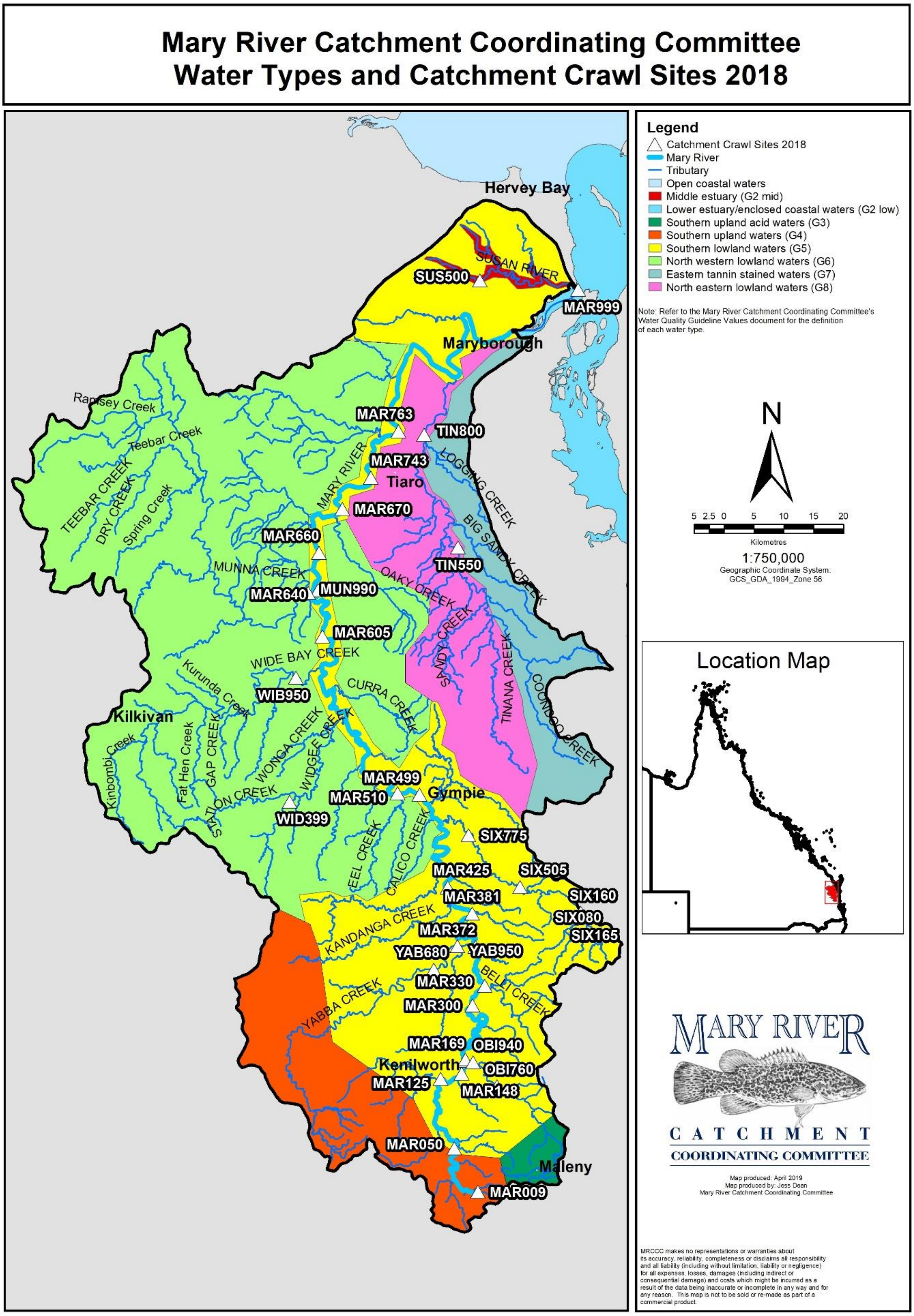


Figure 1 Overview of 2018 Catchment Crawl sites and the water types of the Mary River catchment

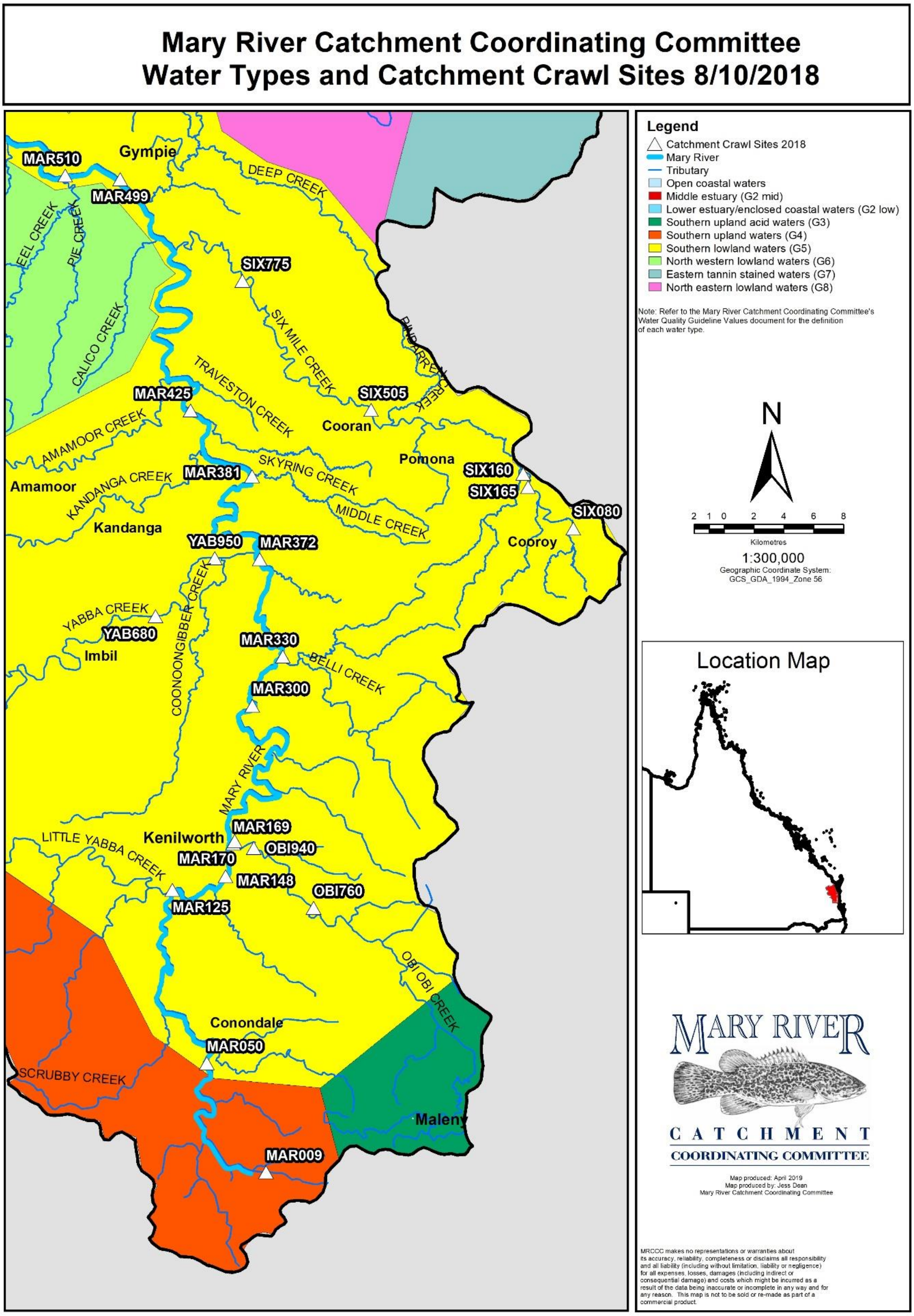


**Figure 2 Day 1 Catchment Crawl sites in further detail**

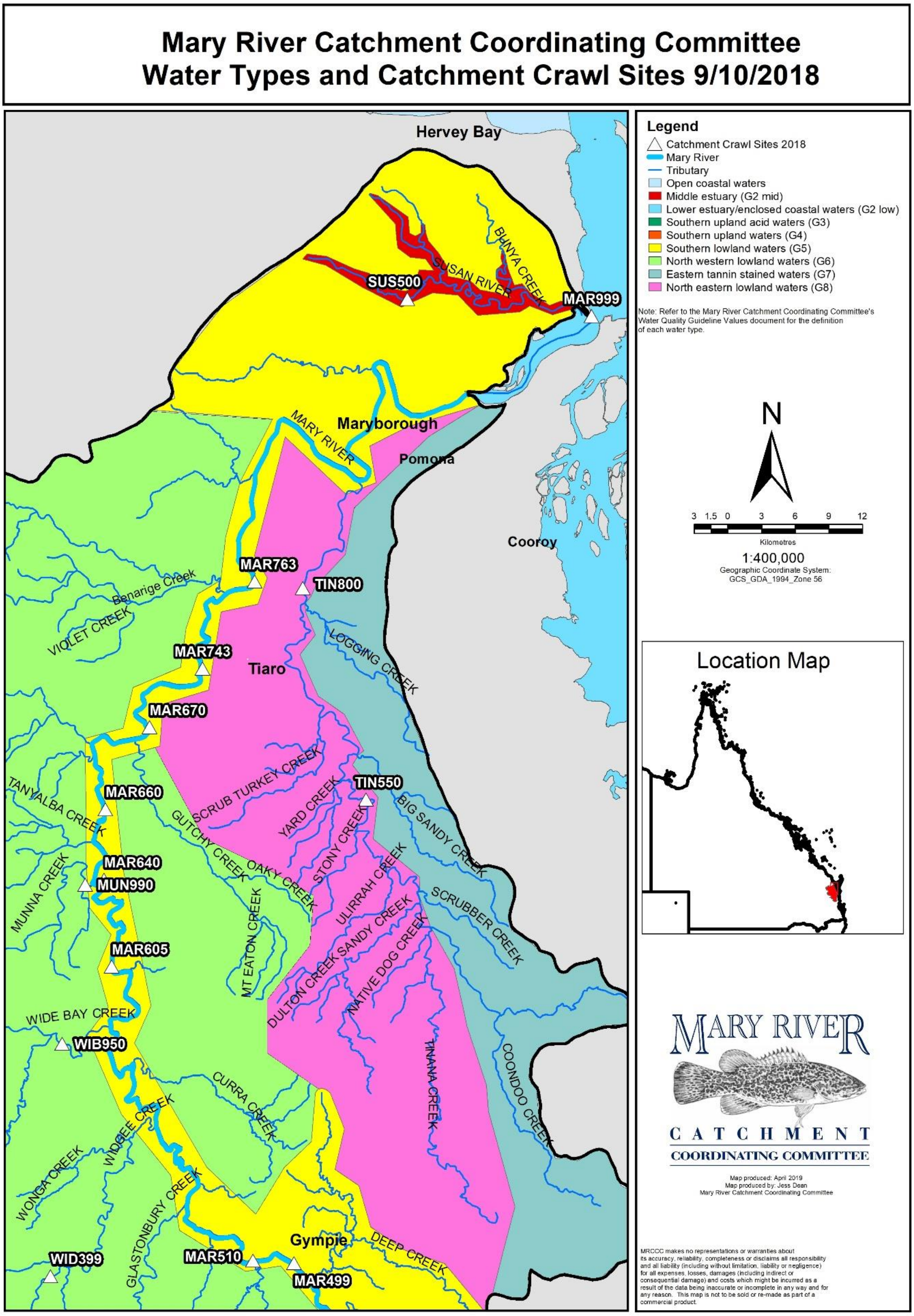


**Figure 3 Day 2 Catchment Crawl sites in further detail**

**Table 3 Details of all sites tested**

| Water Type | Site Code | Description of Site | Parameters tested* |
|---|---|---|---|
| **G4** | MAR009 | McCrea Lane, Conondale | WW, DES, *E.coli* |
| **G5** | MAR050 | Grigor Bridge, Conondale | WW, DES, *E.coli* |
| **G5** | MAR125 | Little Yabba Picnic Area, Cambroon | WW, DES (duplicate), *E.coli* |
| **G5** | MAR148 | Eales, Walli Mountain Rd | WW, DES, *E.coli* |
| **G5** | MAR169 | Charles St River park (u/s of Kenilworth) | WW, DES, *E.coli* |
| **G5** | MAR170 | Charles St River Park (d/s of Kenilworth) | WW, DES, *E.coli* |
| **G5** | MAR300 | Walker Rd bridge, Moy Pocket | WW, DES, *E.coli* |
| **G5** | MAR330 | Belli Creek confluence at Mary River | WW, DES (duplicate), *E.coli* |
| **G5** | MAR372 | Olsen's Bridge, Tuchekoi Rd, Tuchekoi | WW, DES, *E.coli* |
| **G5** | MAR381 | Skyring Ck confluence at Mary River | WW, DES (duplicate), *E.coli* (duplicate) |
| **G5** | MAR425 | Mary River Park, Traveston Xing | WW, DES, *E.coli* |
| **G5** | MAR499 | Gympie weir, Gympie | WW, DES, *E.coli* |
| **G5** | MAR510 | Eel Ck confluence, Widgee Xing | WW, DES, *E.coli* |
| **G5** | MAR605 | Dickabram Bridge, Miva | WW, DES (duplicate), *E.coli* (duplicate) |
| **G5** | MAR640 | Bauple Road Bridge | WW, DES, *E.coli* |
| **G5** | MAR660 | Emerys Xing , Gundiah | WW, DES, *E.coli* |
| **G5** | MAR670 | Home Park, Deborah Road, Netherby | WW, DES, *E.coli* |
| **G5** | MAR743 | Petrie Park, boat ramp, Tiaro | WW, DES, *E.coli* |
| **G5** | MAR763 | Riverside Park, Grevillea St, Owanyilla | WW, DES, *E.coli* |
| **G2** | MAR999 | River Heads, boat ramp | WW, DES (duplicate) |
| **G2** | SUS500 | Susan River on Hervey Bay Rd | WW, DES, *E.coli* |
| **G5** | OBI760 | Obi Crossing #2, Obi Obi | WW, DES, *E.coli* |
| **G5** | OBI940 | Houston Bridge, Coolabine Road | WW, DES, *E.coli* |
| **G5** | SIX080 | Six Mile Ck, Worba Lane, Worba Park . | WW, DES, *E.coli* |
| **G5** | SIX160 | Six Mile Creek, Collwood Drive off Lake Macdonald Drive (spillway pool) | WW, DES, *E.coli* |
| **G5** | SIX505 | Six Mile Creek, downstream of Victor Giles bridge, Cooran | WW, DES, *E.coli* |
| **G5** | SIX775 | Six Mile Creek, Woondum Rd bridge, Woondum | WW, DES, *E.coli* |
| **G5** | YAB680 | Yabba Creek, Imbil Town Bridge | WW, DES, *E.coli* |
| **G5** | YAB950 | Yabba Creek, Mary Valley Road | WW, DES, *E.coli* |
| **G6** | WID399 | Webb Park, Widgee | WW, DES |
| **G6** | WIB950 | Wilson Bridge, Carmyle Rd, Sexton | WW, DES (duplicate) |
| **G6** | MUN990 | Birt Rd bridge, Munna Creek | WW, DES |
| **G8** | TIN550 | Missings Crossing, Bauple | WW, DES (duplicate), *E.coli* |
| **G8** | TIN800 | Teddington Weir, Magnolia | WW, DES, *E.coli* |

***WW** = pH, Electrical conductivity, Dissolved Oxygen, Temperature, Turbidity; **DES** = Total suspended solids (TSS), Ammonium, Oxidised Nitrogen, Total Kjeldahl Nitrogen, Dissolved Kjeldahl Nitrogen, Phosphate, Total Kjeldahl Phosphorus, Dissolved Kjeldahl Phosphorus; **E.coli** = Escherichia coli

## 2.2 Equipment

The following equipment was used as part of the Catchment Crawl.

1. FLT 90 multi probe to measure pH, conductivity, salinity, temperature, dissolved oxygen and turbidity (and spare equipment).
2. WP80 and WP81 used to measure pH, conductivity, salinity, temperature, dissolved oxygen.
3. DES sample bottles and sampling equipment (sample pole, gloves, syringes, filters)
4. Esky and portable freezer
5. *E. coli* sample bottles
6. Digital camera
7. Garmin hand held GPS unit
8. Turbidity (clarity) tube
9. 10L bucket
10. Catchment map
11. Hat, sunscreen, first aid kit
12. Folder, data sheets, equipment instructions, itinerary and site hazard analysis assessment sheets

**Figure 4 Antoinette Augustinus using the FLT90 multiprobe**

## 2.3 Parameters

As Table 3 outlined, the same suite of tests is performed at each site during the Catchment Crawl (with some exceptions for *E.coli*). Table 4 shows the different types of tests performed, their units of measurement and the detection limit for laboratory analysis. At each site the team of MRCCC staff and volunteers performed the same tasks to ensure quality control. Where volunteers from the public were part of a team, they were assigned the task of doing the physical chemistry testing. The volunteers were Waterwatchers who had received training in the testing equipment and used it regularly as part of their Waterwatch commitments. A designated and suitably-trained staff member took the *E. coli*, nutrient and TSS samples at each site, as a particular procedure had to be followed to ensure sample integrity (Nutrient and TSS samples follow the Great Barrier Reef Catchments Loads Monitoring program sampling protocol).

To provide a rapid estimate of nutrient levels, a basic nitrate and phosphate test was performed using test kits on site. These were successful in providing preliminary results.

Aside from the water quality information collected at each Catchment Crawl site, a riparian zone condition assessment was performed using MRCCC's standardised method.

Table 4 Details of water tests performed at each Catchment Crawl site

| Test type | Unit | Detection Limit | Monitoring Suite |
|---|---|---|---|
| **Physical chemistry** | | | |
| Dissolved Oxygen | %sat | - | Waterwatch |
| Turbidity | NTU | - | Waterwatch |
| Electrical conductivity | µs/cm | - | Waterwatch |
| Temperature | °C | - | Waterwatch |
| pH | - | - | Waterwatch |
| Total suspended solids | mg/L | 1 | DES |
| **Microbiological** | | | |
| *Escherichia coli (E.coli)* | MPN/100mL | 1 | WaterOne |
| **Nutrients (directly measured)** | | | |
| Ammonium nitrogen as N | mg/L | 0.002 | DES |
| Oxidised nitrogen as N | mg/L | 0.001 | DES |
| Total Kjeldahl nitrogen as N | mg/L | 0.04 | DES |
| Dissolved Kjeldahl nitrogen as N | mg/L | 0.04 | DES |
| Phosphate phosphorus as P | mg/L | 0.001 | DES |
| Total Kjeldahl phosphorus as P | mg/L | 0.02 | DES |
| Dissolved Kjeldahl phosphorus as P | mg/L | 0.02 | DES |
| **Nutrients (calculated from direct measurements)** | | | |
| Total nitrogen as N | mg/L | 0.03 | DES |
| Organic nitrogen (dissolved) as N | mg/L | 0.03 | DES |
| Total nitrogen (dissolved) as N | mg/L | 0.03 | DES |
| Total nitrogen (suspended) as N | mg/L | 0.03 | DES |
| Total phosphorus (suspended) as P | mg/L | 0.02 | DES |
| Organic phosphorus (dissolved) as P | mg/L | 0.02 | DES |

## 2.4 Data interpretation

MRCCC's Water Types (Burgess, 2014) are used in this report to compare the results collected at the Catchment Crawl sites. The Water Types were developed in response to analysis of the long term Waterwatch data which revealed that the EPA's Water Quality objectives (WQOs) were not appropriate for all sites because of the underlying geology and other naturally occurring influences. Seven different water types were identified (see Figure 1). Water quality guidelines have been developed for each Water Type (Burgess, 2014) using Waterwatch data and procedures outlined in the regulations (Department of Environment and Resource Management, 2010). The guidelines values for each Water Type are showing in Table 5.

The main advantage of the Water Types approach is that Mary River main trunk sites and tributaries can be grouped where they fall in the same water type and tributaries within the same water type can also be compared. Not all water types are sampled as part of the Catchment Crawl. As Figure 1 shows most samples (eighteen on the Mary River, eight on tributaries) fall within the Water Type G5 (Southern Lowland waters), two sites fall within the water type G2, three within water type G6 (North Western Lowland Waters), two within water type G8 (North Eastern Lowland Waters) and one within G4 (Southern upland waters).

#### Table 5 Mary River Catchment Coordinating Committee water quality guideline values

| Quality Guideline Title & Description | Guideline Values | |
|---|---|---|
| **G1 – Artificial Water Bodies**<br>e.g. Settling ponds, farm dams, drains, bores and wells | N/A | |
| **G2low – Estuarine & Marine Waters**<br>**Area GSS1 lower estuary/enclosed coastal waters**<br>As mapped on the scheduled Mary Basin Water Quality Guidelines.<br>*Upper and lower guideline values need to be developed for electrical conductivity and temperature | Electrical Conductivity<br>pH<br>Dissolved Oxygen saturation<br>Turbidity<br>Temperature | N/A*<br>8.1 – 8.4<br>90 – 105 %<br>0 – 4 NTU<br>N/A* |
| **G2mid – Estuarine & Marine Waters**<br>**Middle Estuary - Susan River (SUS500)**<br>As mapped on the scheduled Mary Basin Water Quality Guidelines.<br>*Upper and lower guideline values need to be developed for electrical conductivity and temperature | Electrical Conductivity<br>pH<br>Dissolved Oxygen saturation<br>Turbidity<br>Temperature | N/A*<br>8.1 – 8.4<br>90 – 105 %<br>0 – 4 NTU<br>N/A* |
| **G3 – Southern Upland Acid Waters**<br>Upland (>150m) freshwaters draining acid red soils of the Maleny/Mapleton plateau | Electrical Conductivity<br>pH<br>Dissolved Oxygen saturation<br>Turbidity<br>Summer Temperature<br>Winter Temperature | 0 – 580 µS/cm<br>6.0 – 8.0<br>90 – 110 %<br>0 – 25 NTU<br>18 – 28 °C<br>13 – 21 °C |
| **G4 – Southern Upland Waters**<br>Upland (>150m) freshwaters in the main trunk of the Mary River and all tributaries which drain into the Mary River upstream of Deep Creek except for Southern Upland Acid Waters. | Electrical Conductivity<br>pH<br>Dissolved Oxygen saturation<br>Turbidity<br>Summer Temperature<br>Winter Temperature | 0 – 580 µS/cm<br>6.5 – 8.2<br>90 – 110 %<br>0 – 25 NTU<br>18 – 28 °C<br>13 – 21 °C |
| **G5 – Southern Lowland Waters**<br>Lowland (<150m) freshwaters in the main trunk of the Mary River and all tributaries which drain into the Mary River upstream of Deep Creek | Electrical Conductivity<br>pH<br>Dissolved Oxygen saturation<br>Turbidity<br>Summer Temperature<br>Winter Temperature | 0 – 580 µS/cm<br>6.5 – 8.0<br>85 – 110 %<br>0 – 50 NTU<br>18 – 28 °C<br>13 – 21 °C |
| **G6 – North Western Lowland Waters**<br>Lowland freshwaters (<150m) in all western tributaries which drain into the Mary River downstream of Six Mile Creek. As well as Gutchy and Curra Creeks and their tributaries. | Electrical Conductivity<br>pH<br>Dissolved Oxygen saturation<br>Turbidity<br>Summer Temperature<br>Winter Temperature | 0 – 1200 µS/cm<br>6.5 – 8.0<br>85 – 110 %<br>0 – 50 NTU<br>22 – 30 °C<br>16 – 24 °C |

| | |
|---|---|
| **G7 – Eastern Sandplain Tannin Stained Waters**<br>Tannin stained waters of the eastern tributaries of Tinana Creek<br><br>**from footnotes in Mary WQO document for water bodies in the natural state | Electrical Conductivity 0 – 580 µS/cm<br>pH 3.6 – 6.0**<br>Dissolved Oxygen saturation 85 – 110 %<br>Turbidity 0 – 50 NTU<br>Summer Temperature 22 – 30 °C<br>Winter Temperature 16 – 24 °C |
| **G8 – North Eastern Lowland Waters**<br>Lowland freshwater (<150m) eastern tributaries which drain into the Mary River downstream of Deep Creek, except for Eastern Sandplain Tannin Stained Waters. | Electrical Conductivity 0 – 580 µS/cm<br>pH 6.5 – 8.0<br>Dissolved Oxygen saturation 85 – 110 %<br>Turbidity 0 – 50 NTU<br>Summer Temperature 22 – 30 °C<br>Winter Temperature 16 – 24 °C |

Note: Not all water types are presented in this document. Refer to the Environmental Protection (Water) Policy 2009 Mary River environmental values and water quality objectives - Basin No. 138 including all tributaries of the Mary River, July 2010 (https://www.ehp.qld.gov.au/water/policy/pdf/documents/mary-river-ev-2010.pdf). Insufficient data for electrical conductivity and temperature to produce guideline values for estuarine and marine water values.

Compared to the G5 sites which reflect the majority of the catchment, G6 has a higher Electrical conductivity guideline (up to 1200 µS/cm rather than 580 µS/cm), G4 has a lower turbidity guideline (25 NTU rather than 50 NTU) and a more alkaline pH range (6.5-8.2 rather than 6.5-8.0) and G6 and G8 have a higher minimum and maximum temperature (22 -30$^{o}$C rather than 18-28$^{o}$C in summer). G2 guidelines are based on the High Environmental Value guidelines for the Great Sandy Strait. There are no scheduled guidelines for temperature, but the MRCCC has developed local guidelines in accordance with the procedures in the legislation to identify extreme summer and winter water temperatures (Dean et al, 2018).

# 3 Results and discussion

In this section the results are presented and discussed according to each parameter tested (temperature, pH, EC, turbidity, DO, TSS, nitrogen, phosphorus, *E.coli*) and then broken down into sub-sections for each water type. For the Southern Lowland Waters (G5), the Mary River and tributary sites are shown in separate graphs due to the large number of sites in this Water Type. The graphs show data from the last four years (2018, 2017, 2016, 2015) and data from 2008 when available. The High Environmental Value waters were sampled for the first time in 2017. If the sampling time of day is significantly different from previous years and may have contributed to a change in water quality that is noted. Otherwise it can be assumed that the time of day is not a factor in the comparison of the data points at a given sample site.

*Understanding the site codes on the graphs*

The results are plotted according to site code and for sites on the same stream they are ordered from the most upstream site to the most downstream site. The first three letters of the site code indicate which waterway (e.g. MAR - Mary River, OBI – Obi Obi Creek, WIB – Wide Bay Creek etc.) The numbers in the site code indicate how close to the mouth of the creek the site is. For example, a site at the confluence or mouth may be numbered 999 and a site at the upper headwater of the creek may be numbered 009. A brief description of the location is also provided with the site code. A more detailed description is given in the Itinerary in Appendix A.

## 3.1 Temperature

Temperature is an important factor to consider when assessing water quality. In addition to its own effects, temperature can influence several other parameters. It can also alter the physical and chemical properties of water. For example, high water temperatures can increase the solubility and thus toxicity of certain compounds and the solubility of oxygen and other gases will decrease as temperature increases. Water temperature can be affected by many ambient conditions such as sunlight, atmospheric temperature, turbidity, proximity to a stream confluence and releases from impoundments. Shallow water from low flow conditions is more easily influenced by these factors than deep water.

Ambient temperature has an influence on water temperature although it is certainly not the only factor (see Section 3.1.5). The conditions during the Catchment Crawl are shown in Table 6. On Day 1, sampling of the upper catchment began at 7:45 am with the last sample taken at Six Mile Creek at 4:45pm. Daytime temperatures in Gympie were 22.8°C at 9am and had risen to 27.3°C by 3pm, with 0.2mm of rainfall recorded. At Nambour's BOM weather gauging station, air temperature of 22.9°C was recorded at 9am and 19.6°C at 3pm, with 3mm of rainfall recorded.

On Day 2, Widgee Crossing near Gympie was sampled at 7.45am and Webb Park in Widgee at 4:05pm. Daytime temperatures at Gympie were 21.5°C at 9am 21.4°C at 3pm, with 3.4mm of rainfall recorded. At Maryborough's BOM weather station, air temperature was 23.3°C at 9am, 26.2°C at 3pm and zero rainfall was recorded.

**Table 6 Summary of rainfall prior to Crawl and ambient air temperature during the Crawl**

| Date | Location | Rainfall (mm) | Ambient Air Temperature (°C) | |
|---|---|---|---|---|
| | | | **9am** | **3pm** |
| **8/10/18** | Nambour | 3 | 22.9 | 19.6 |
| **8/10/18** | Gympie | 0.2 | 22.8 | 27.3 |
| **9/10/18** | Gympie | 3.4 | 21.5 | 21.4 |
| **9/10/18** | Maryborough | 0 | 23.3 | 26.2 |

It is noted, a cold, frosty winter was experienced across the catchment. This may have contributed to lower ambient water temperatures across the catchment during winter 2018, when compared to 2017 where higher than usual air and water temperatures were recorded.

The results for each Water Type are discussed in turn below.

### 3.1.1 Southern Lowland Waters (G5)

The Southern Lowland Waters is the main trunk of the Mary River and includes Obi Obi, Six Mile and Yabba creeks. The temperature guideline for this water type is between 18 and 28$^{o}$C for summer. The guideline range is indicated by horizontal purple lines in Figure 5 which provides the Mary River sites in the G5 (and single G4) water type and in Figure 6 which gives the tributary sites. Data points which fall above the upper or below the lower purple line are outside of the guideline range. The green line or bars show the result for 2018.

Among the Mary River sites, samples taken in 2018 show water temperatures appeared to be similar to 2008, 2015 or 2016, having dropped down from particularly high temperatures in 2017. All sites fell within the guideline. The Mary River headwaters site (MAR009) was 4.35°C cooler than in 2017 and was below the minimum temperature guideline.

In 2018 only one site, MAR009 at the headwaters of the Mary, is cool enough for successful Mary River cod spawning at 21$^{o}$C. Mary River cod can survive in water temperatures up to 28$^{o}$C. Based on the samples during this Catchment Crawl cod populations would be unlikely to breed in the main trunk of the river. However, there were no sites that exceeded or were very close to the 28$^{o}$C upper limit for cod. This is a significant improvement on 2017. This effectively means that at the time of the Catchment Crawl in 2018 there was more of the river with water temperature suitable for cod which means more options for seeking food, travelling to find mates and breeding.

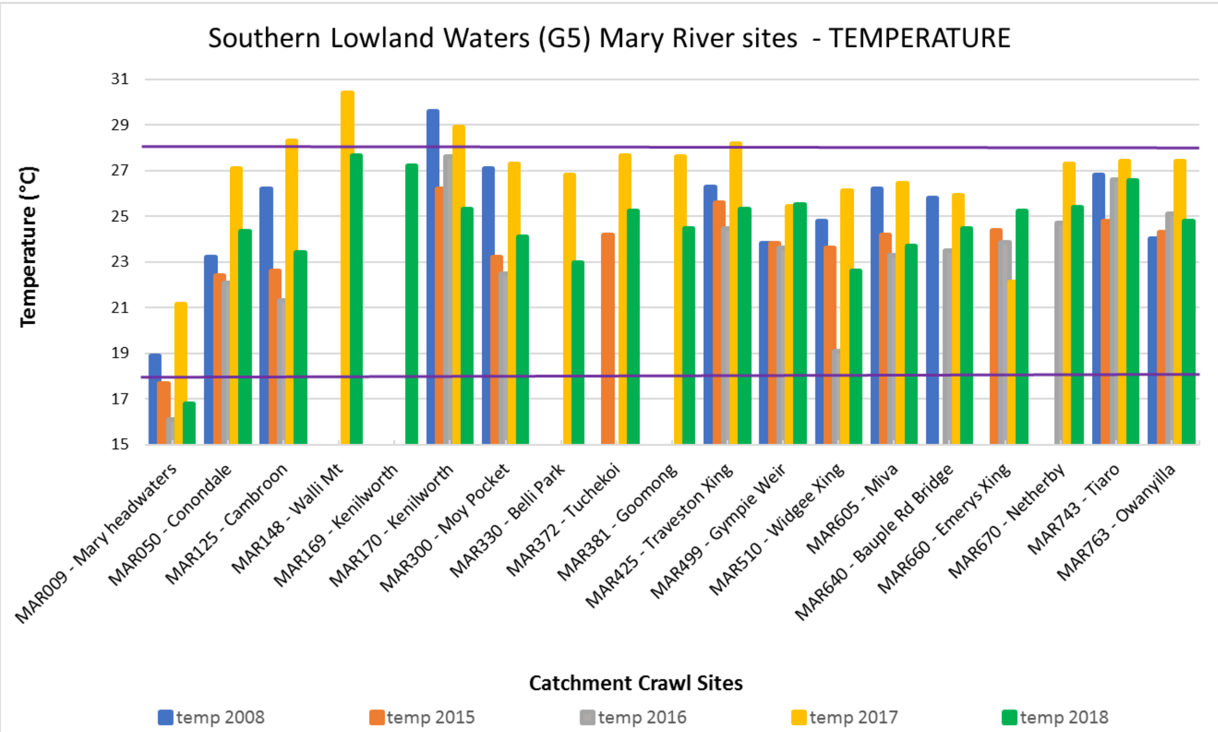


**Figure 5 Temperature of Mary River sites in Southern Lowland waters (G5)**

Figure 6 provides a comparison of results for 2002-2017 from five sites on the Mary River for which there is long term data and for which the sample was taken at a very similar time of day at every catchment crawl. There are nine data points for Conondale (MAR050) and Kenilworth (MAR170) that fit this criteria, and seven for Widgee Xing (MAR510), Miva (MAR605) and Emerys Xing (MAR660).

The box and whisker plots provide an indication of the spread of data for each site. The median (or middle value) is shown by the line in the middle of the box, the 25th and 75th percentiles by the lower and upper extent of the box and the highest and lowest values by the upper and lower extent of the whiskers.

The Widgee Xing site (MAR510) is measured in late afternoon (3:30-4:00pm) and the Conondale site (MAR050) during mid-morning (10:00-11:00am). The Kenilworth (MAR170), Miva (MAR605) and Emerys Xing (MAR660) sites have consistently been measured with an hour either side of midday. Despite being taken at the same time of day the Kenilworth site was hotter with a median value of 28.3$^{o}$C compared to a median of 26.3$^{o}$C at Miva and 24.3°C at Emerys Xing respectively, for the period 2002-2017.

The box and whiskers plot confirms that throughout the history of the Catchment Crawls, the Kenilworth site is consistently hotter than the other Mary River sites. While the site continues to be the hottest of the five in 2018, the temperature (25.30°C) is significantly lower than in previous years and has dropped to between the 25th and 75th percentiles of all other sites.

In 2018, the Widgee Xing (MAR510) and Miva (MAR605) sites are also below their medians, while both the Conondale (MAR050) and Emerys Xing (MAR660) sites are above their medians.

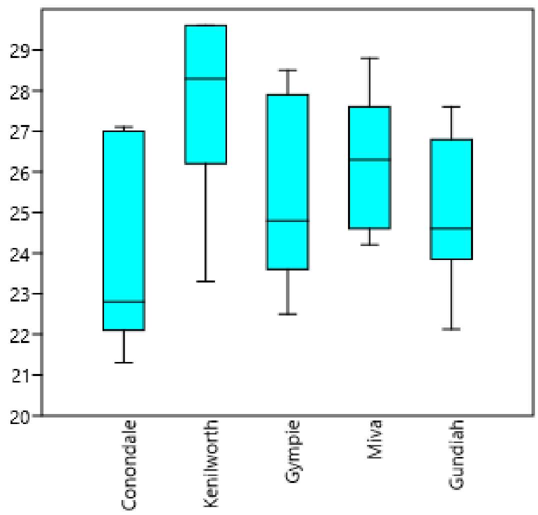


**Figure 6 Comparison of temperature at five Mary River sites (based on combined 2002-2017 data)**

Figure 7 shows the results from tributaries in the G5 water type. The G5 tributaries measured during the catchment crawl are Six Mile (SIX080, SIX160, SIX505 and SIX775), Obi Obi (OBI760 and OBI940) and Yabba Creek (YAB680 and YAB950). In 2018 the tributaries were generally cooler than the main trunk of the river in the G5 water type. Six Mile Creek (particularly the Cooran and Woondum sites which are measured mid-afternoon) is particularly cool, with temperature recordings within the range required to trigger Mary River Cod breeding. Temperatures in Obi Obi Creek have come back down after a significant increase in the temperature (over 6° rise) in 2017. Obi Obi Creek is also regarded as important cod breeding area and breeding would not occur at higher temperatures. Six Mile and Obi Obi Creeks have good riparian vegetation providing excellent shading of the waterway. Due to the limited amount of temperature data available for the G5 tributaries detailed comment is not possible.

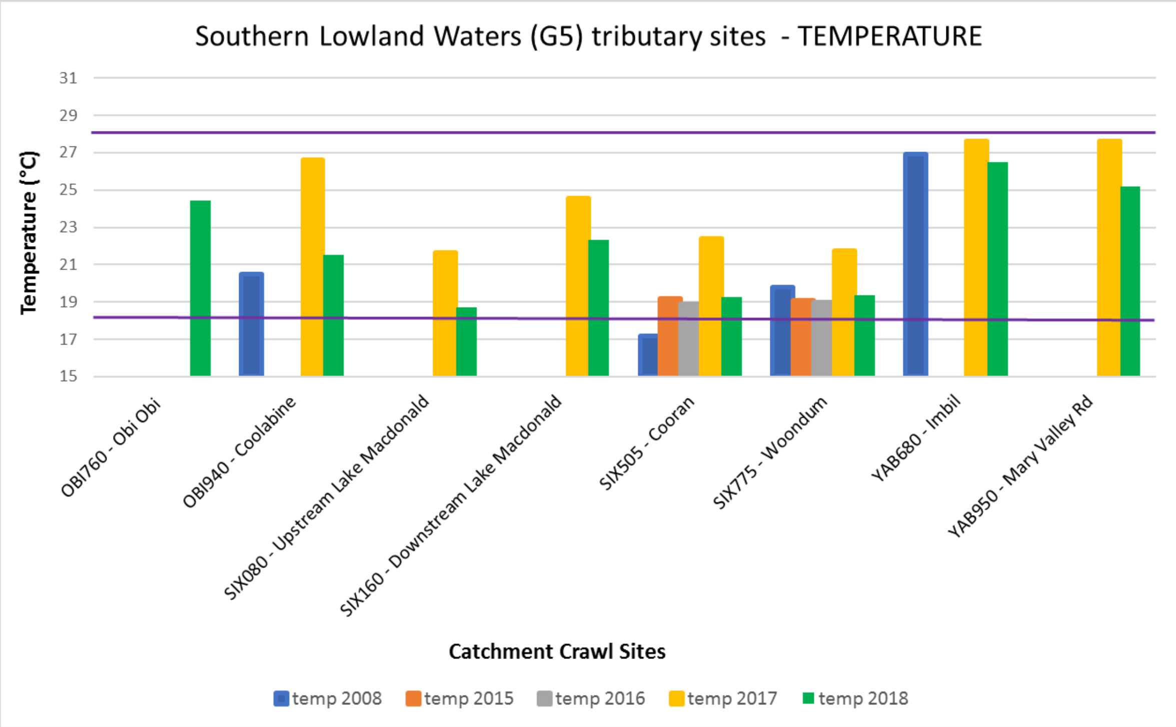


Figure 7 Temperature of Southern Lowland waters (G5) tributaries

### 3.1.2 North Western Lowland Waters (G6)

The North Western Lowland Waters tributaries measured during the catchment crawl are Munna (MUN990), Wide Bay (WIB950) and Widgee (WID399) Creeks. The temperature guideline for the North Western lowland waters is between 22 and 30$^{0}$C for summer. The horizontal purple lines in Figure 8 show the guideline temperatures. The green line shows the result for 2018. All measurements fell below the maximum guideline value. In 2018 all sites were cooler than in 2017, which had the highest temperature measurements for all three sites. Widgee Creek has good temperature compliance and could provide conditions suitable for Mary River Cod spawning. These temperature records were taken late in the afternoon when high water temperatures are expected, however Widgee Creek appears to have sufficient shading to moderate temperature fluctuations.

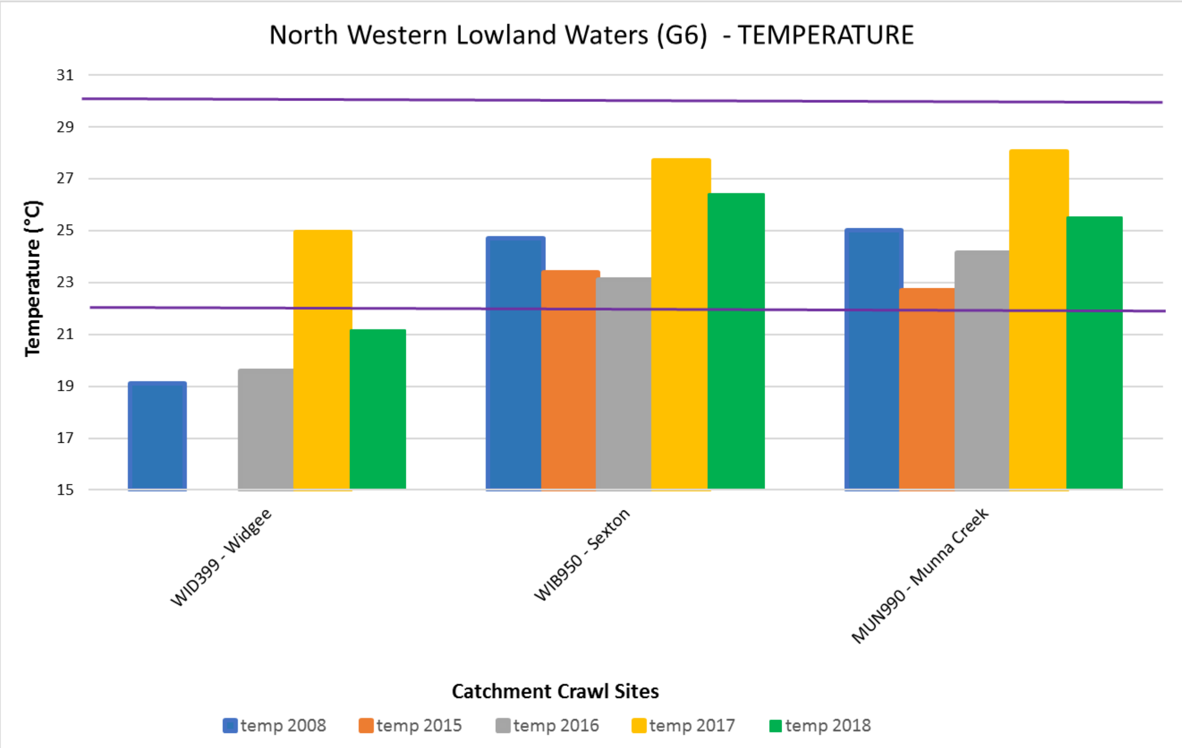


**Figure 8 Temperature of tributaries in North Western Lowland Waters (G6)**

### 3.1.3 North Eastern Lowland waters (G8)

Tinana Creek is the only tributary measured, at two sites. The temperature guideline for the North Eastern Lowland Water is between 22 and 30$^{o}$C for summer. The guideline range is indicated in Figure 9 by horizontal purple lines, with data points above the upper line or below the lower line outside of the guideline range.  The green line shows 2018 measurements. The 2018 temperatures were lower than the 2017 measurements, and TIN800 was 3.5°C warmer than 2015 and 2°C cooler than 2017.

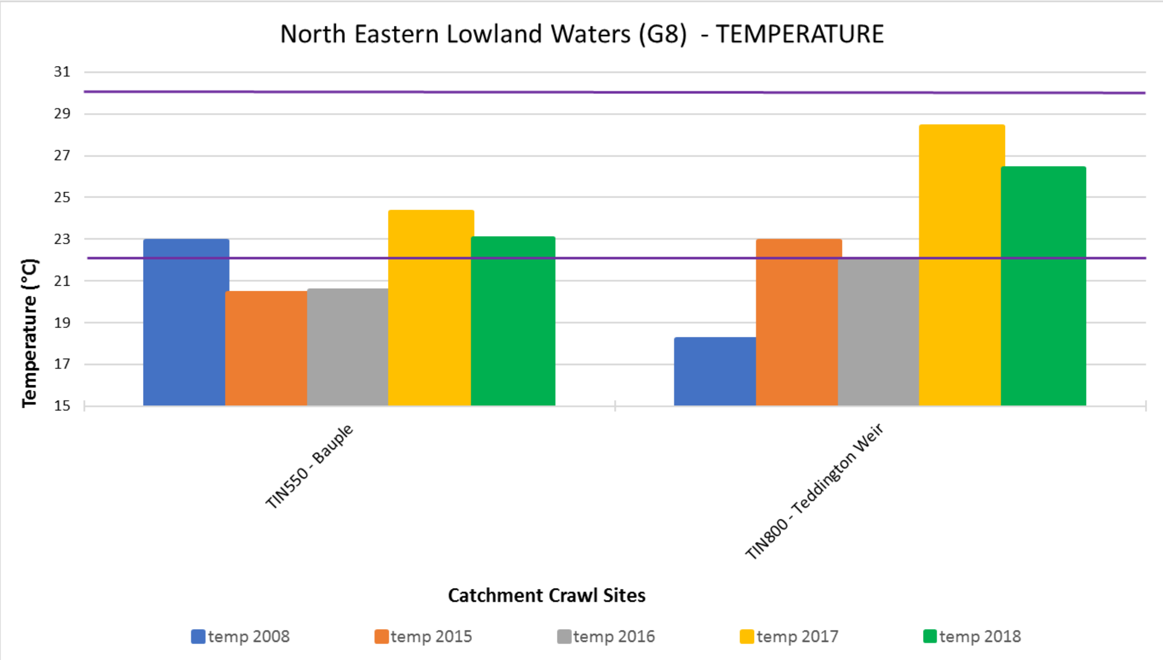


**Figure 9 Temperature of tributaries in North Eastern Lowland Waters (G8)**

### 3.1.4 Mary River Estuary – High Environmental Value Waters (G2)

Data collection of the estuary sites only commenced in a comprehensive manner in 2017. There are no guidelines for the High Environmental Value water for temperature, however there is meant to be no change from existing data. Figures 10 and 11 show that 2018 temperatures were lower than 2017 measurements.

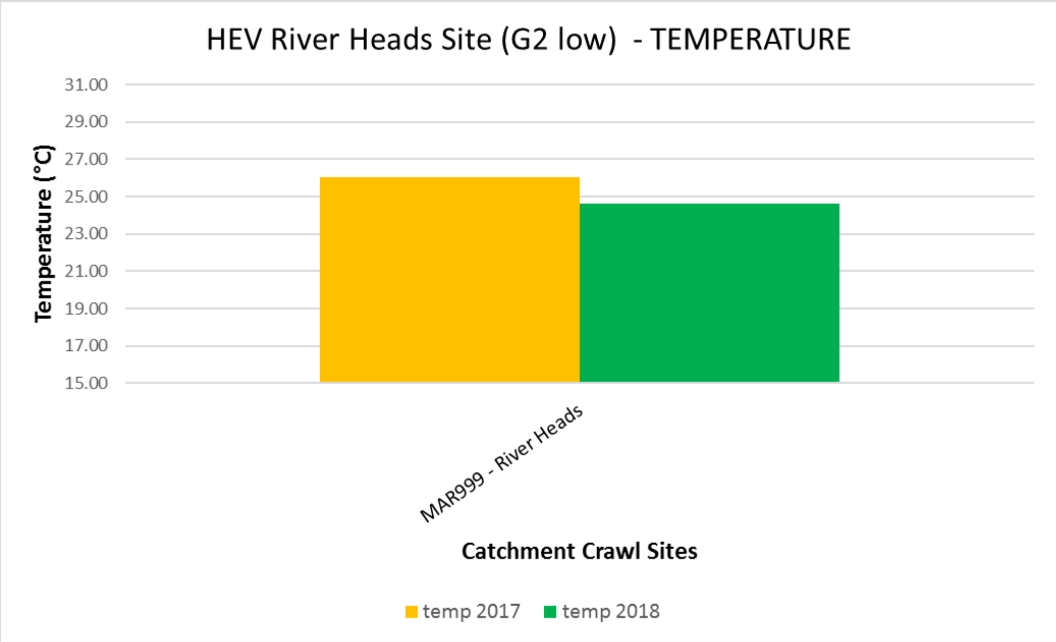


**Figure 10 Temperatures at the River Heads site (G2 low)**

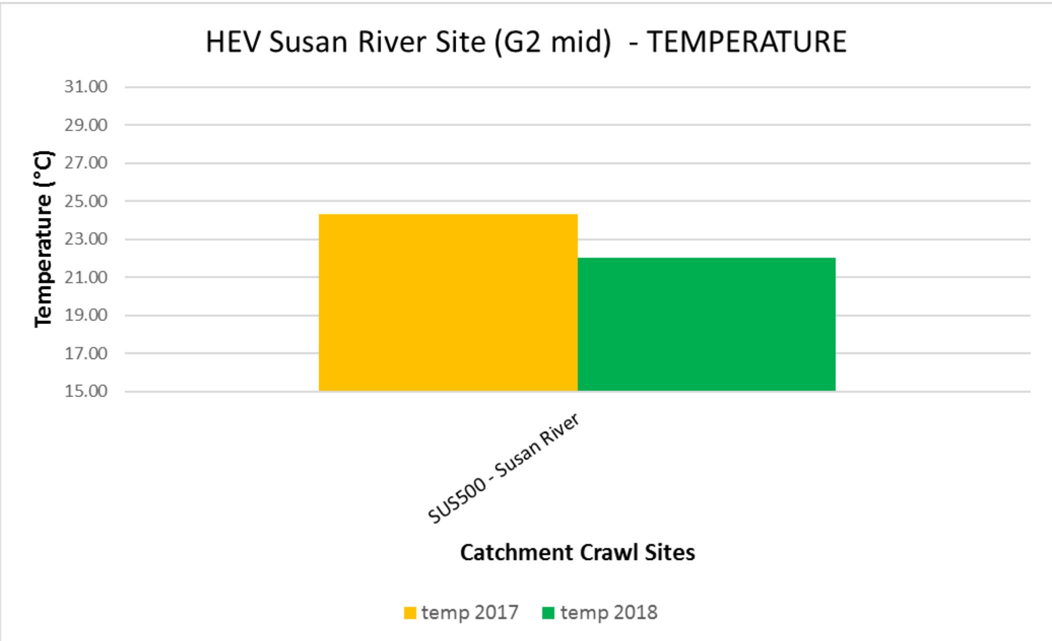


**Figure 11 Temperatures at the Susan River site (G2 mid)**

### 3.1.5 Comment on long term temperature trends

Results collected in 2017 raised questions regarding the long term temperature trends and whether or not the water in the catchment may be getting warmer. There are many factors that affect water temperature (e.g. ambient air temperature, river flow, rainfall, dam releases, shade, time of day) and the vulnerability of results to these factors make it difficult to draw conclusions from one off samples collected through the catchment crawl. This is one of the main reasons why sites are always sampled at the same time of day as much as possible.

An increase in temperature would be concerning for numerous reasons. As the guidelines provided in Table 5 show there is a particular range in which aquatic ecosystems are considered healthy. In addition, appropriate water temperature is extremely important for breeding and survival of endangered Mary River Cod, which are likely to be spawning naturally in the wild during Spring which coincides with the Catchment Crawl. The 2018 winter was much colder than the 2017 winter, with significant frosts, which appears to have the effect of dropping water temperatures throughout the catchment during the Catchment Crawl.

An analysis of temperature data collected during Catchment Crawls since 2002 sheds some light on long term temperature trends. Figure 12 below shows a box and whisker plot of all sites sampled in each catchment crawl where sufficient data is available. The line in the centre of each box provides the median (or middle result) result for that year. The lower end of the box is the 25$^{th}$ percentile result, the upper end the 75% percentile and the whiskers extend to include the highest and lowest results recorded. Inclusion of all sites (both Mary and tributaries) in this graph means the plot provides an indication of overall water temperature. Many sites are the same throughout the years, but some are also different.

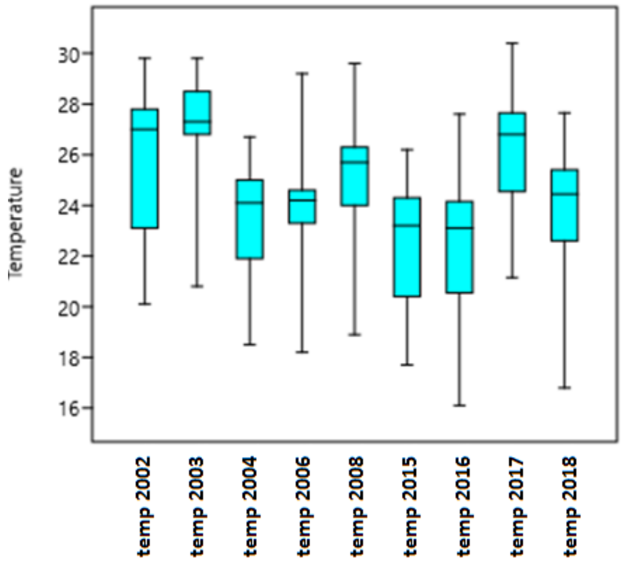


**Figure 12 Comparison of temperature data from all sites sampled during catchment crawls 2002-2018**

The box and whisker plot shows that 2003 had the hottest median temperature across all Catchment Crawl sites of 27.4°C. 2002 and then 2017 tie for second with a median of 27°C. 2017 had the highest result ever recorded in a Catchment Crawl which was 30.4°C, at Walli Mt (MAR148), approximately 2km upstream of Kenilworth township (this was a new site not previously sampled). 2015 and 2016 had the lowest and second lowest median temperatures of 23.3 and 23.1 respectively. 2016 also has the lowest minimum recorded which was 16.1°C at the Mary headwaters site (MAR009). It is worth noting that this same site was 5°C hotter in 2017. 2018 did not have a record high or low temperature, although it did have the second coldest temperature on record at MAR009, with a temperature of 16.9°C.

In conclusion it is not possible to make comment in depth on trends in water temperature from this data. However, it is apparent that the water during the 2017 was hot compared to most other years since the Catchment Crawl began in 2002 and the water in 2016 and 2015 was the coolest in this timeframe. 2018 temperatures dropped back to lower levels.

Ambient air temperature is one possible influence on water temperature. To assist with understanding the influence of air temperature, data from the Bureau of Meteorology for the Gympie weather station was downloaded and analysed. Daily maximum and minimums for October were calculated along with the average maximum and minimum for the seven days prior to the Catchment Crawl. The assumption is that the fluctuation in air temperature for several days prior to a sample has an influence on the water temperature. The results of this analysis are presented in Figure 13 which shows the average of the daily maximum and minimum air temperature for seven days prior to the Catchment Crawl together with the median water temperature (from Figure 12).

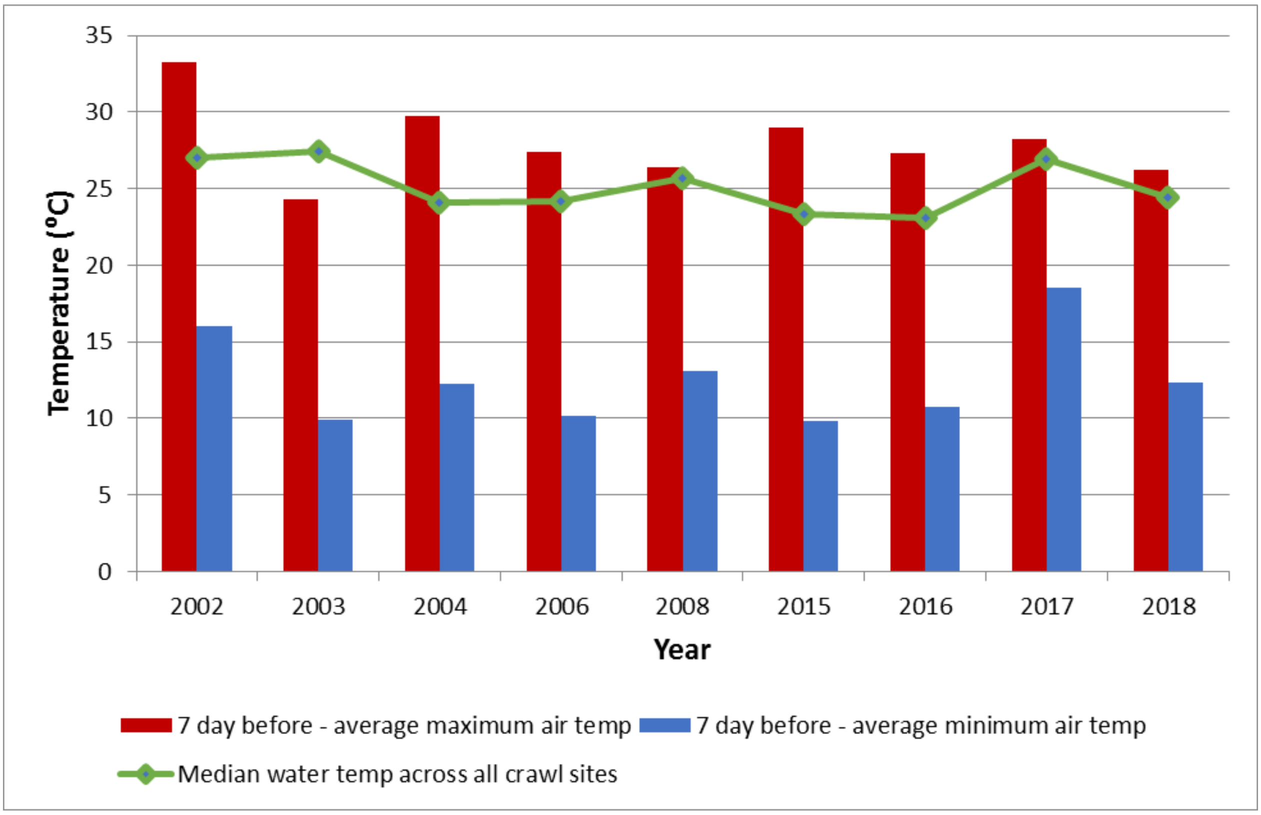


**Figure 13 Comparison of average maximum and minimum temperatures for 7 days prior to each catchment crawl**

This data would suggest that ambient air temperature is unlikely to fully explain the water temperature results. Even though 2002 and 2003 had very similar median water temperature, they had very different maximum and minimum average air temperature in the seven days prior to the Catchment Crawl. Interestingly the minimum air temperature in the lead up to the 2017 was higher than in any other year suggesting the minimum air temperature could be a driver of hot water temperatures. However, this hypothesis is brought into doubt by the 2003 data. 2003 has the lowest minimum air temperature in the lead up to the Catchment Crawl but was one of the hottest years for water temperature.

Streamflow also significantly influences water temperatures, combined with ambient air temperatures. Streamflow in 2003 was very low, while streamflow in 2017 in the weeks before the Catchment Crawl had ceased to flow across the catchment. Cease to flow conditions in 2018 just prior to the Catchment Crawl are likely to have influenced water temperatures. A full statistical analysis would enable more confident statements about this data.

**Figure 14 MAR148 – hottest site in 2018 (to the left), MAR009 – coolest site in 2018 (to right)**

## 3.2 pH

Water pH is influenced by catchment geology, overland flow and air pollution. However, there is also a close link between water temperature and pH. Temperature is directly associated with sunlight intensity. Increased sunlight increases temperature which stimulates photosynthetic activity of aquatic plants and algae in the water column. pH is influenced by the amount of photosynthesis in the water because photosynthesising plants take carbon dioxide from the water which increases alkalinity. Photosynthetic activity is increased with temperature and the associated high levels of incident sunlight (or lack of shade) that is often associated with higher temperatures. The photosynthetic activity can also be increased by nutrients in the water which increase the population of aquatic plants. This process promotes the higher pH readings, particularly in the afternoon when water temperatures are warmest. Plants only photosynthesise in the presence of sunlight. At night they respire, releasing carbon dioxide into the water which increases acidity (lowers the pH). Therefore, the pH at sites with high levels of aquatic plant growth would be expected to fluctuate from more acidic in the morning to more alkaline in the late afternoon. It is important to note that a pH above 7 is considered alkaline and a pH below 7 is considered acidic.

**Figure 15 Obtaining water samples for testing**

### 3.2.1 Southern Lowland Waters (G5)

The pH guideline for the Southern Lowland Water is 6.5-8. The horizontal purple lines in Figure 16 shows the guideline range. Data points above the upper line or under the lower line are outside of the guideline range. The green line shows the result for 2018.

A greater number of G5 sites on the Mary River were outside the guideline range in 2018 as compared to previous years. Sites at Conondale (MAR050), Walli Mt (MAR148), Kenilworth (MAR169), Miva (MAR605), Bauple Road Bridge (MAR640), Emerys Xing (MAR660), and Netherby (MAR670) were all above the 8.0 upper guideline. The pH value for Tiaro (MAR743) was on the upper guideline level (alkaline).

MAR169 in Kenilworth is furthest above guideline level (alkaline) in 2018. Temperature was also high at 27.2°C in 2018.

The comparison between temperature and pH reveals an association at the upper catchment sites from the headwaters to Kenilworth. However, from Kenilworth downstream there does not appear to be a clear association with temperature. It should also be noted that the sites on the Mary River sampled on day 2 are much wider naturally and are more prone to increased sunlight as the shading effect from riparian vegetation is not a strong influencing factor.

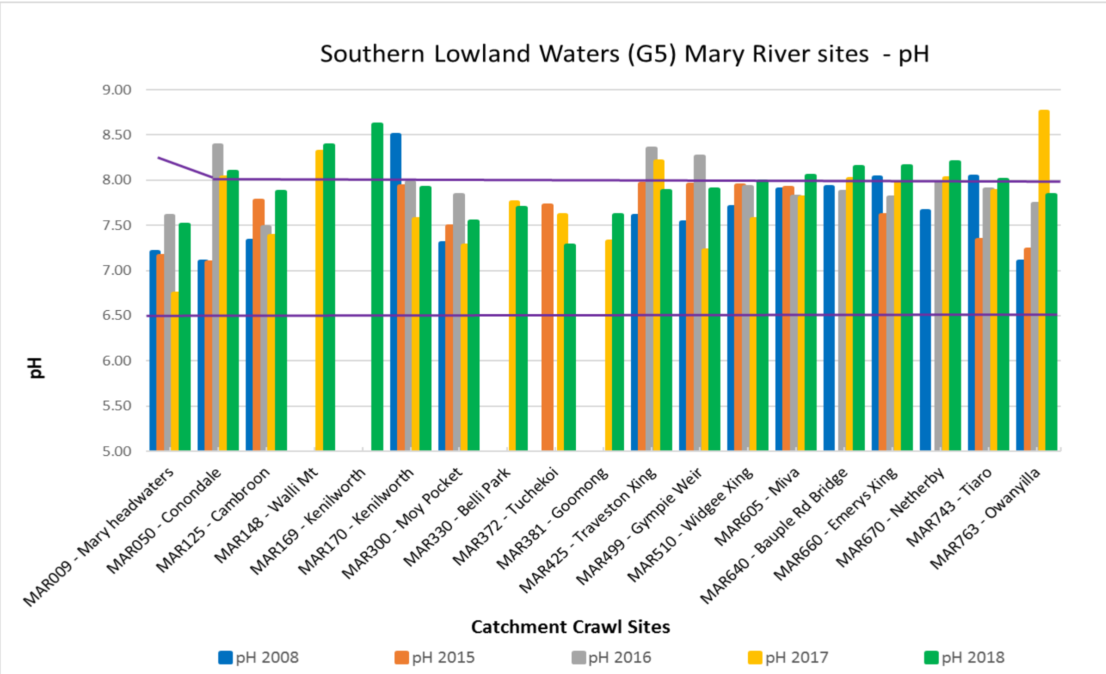


**Figure 16 pH of Mary River sites in Southern Lowland waters (G5)**

Further investigation is required to have a greater understanding of the reasons for the variation in pH levels between 2017 and 2018 at some sites both in the upper and lower catchment.

The G5 tributaries (Obi Obi Creek, Six Mile Creek, Yabba Creek) show a different pattern to the main trunk sites with the pH being lower overall (Figure 17). The exception this is one of the Yabba Creek sites (YAB680) where the pH was just above the guideline at 8.02 in 2018. Yabba Creek has consistently recorded higher pH guideline levels at the Imbil township site (which is a weir pool with slow water flows). The sites upstream of Lake Macdonald (SIX080) and downstream of Lake Macdonald (SIX160) are the only two sites in the G5 water type to fall below the minimum pH of 6.5 in 2018. These low pH values of Six Mile creek reflect the natural characteristics of this tributary, and hence the WQO guidelines do not fit Six Mile Creek appropriately.

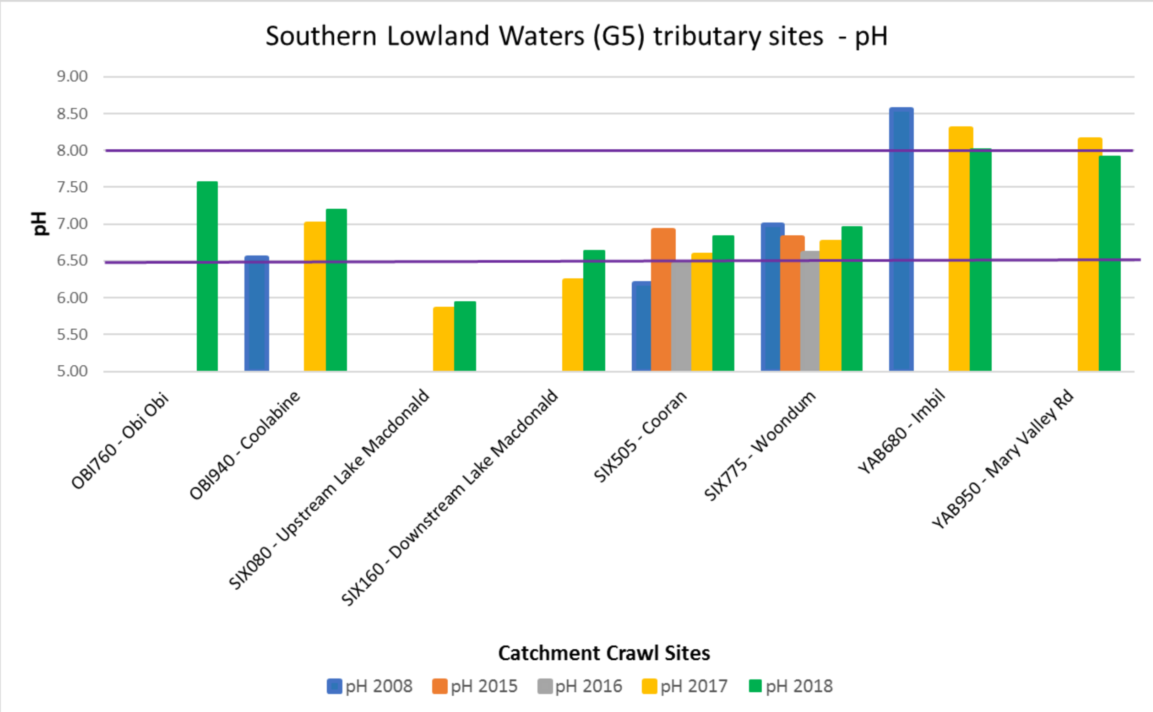


**Figure 17 pH of Tributary sites in Southern Lowland waters (G5)**

### 3.2.2 North Western Lowland Waters (G6)

The pH guideline for the North Western Lowland Water (Munna, Wide Bay, Widgee Creeks) is 6.5 to 8. The horizontal purple lines in Figure 18 show the guideline range. Data points above the upper line or below the lower line are outside of the guideline range.

In 2018 (and also 2016) none of the G6 tributaries complied with the guideline which is in contrast to 2017 when all sites complied. This shift is difficult to explain, because as Figure 8 showed all sites were much cooler in 2018 than in 2017 and the general expectation is that cooler water has a lower pH (due to reduced photosynthesis at lower temperature).

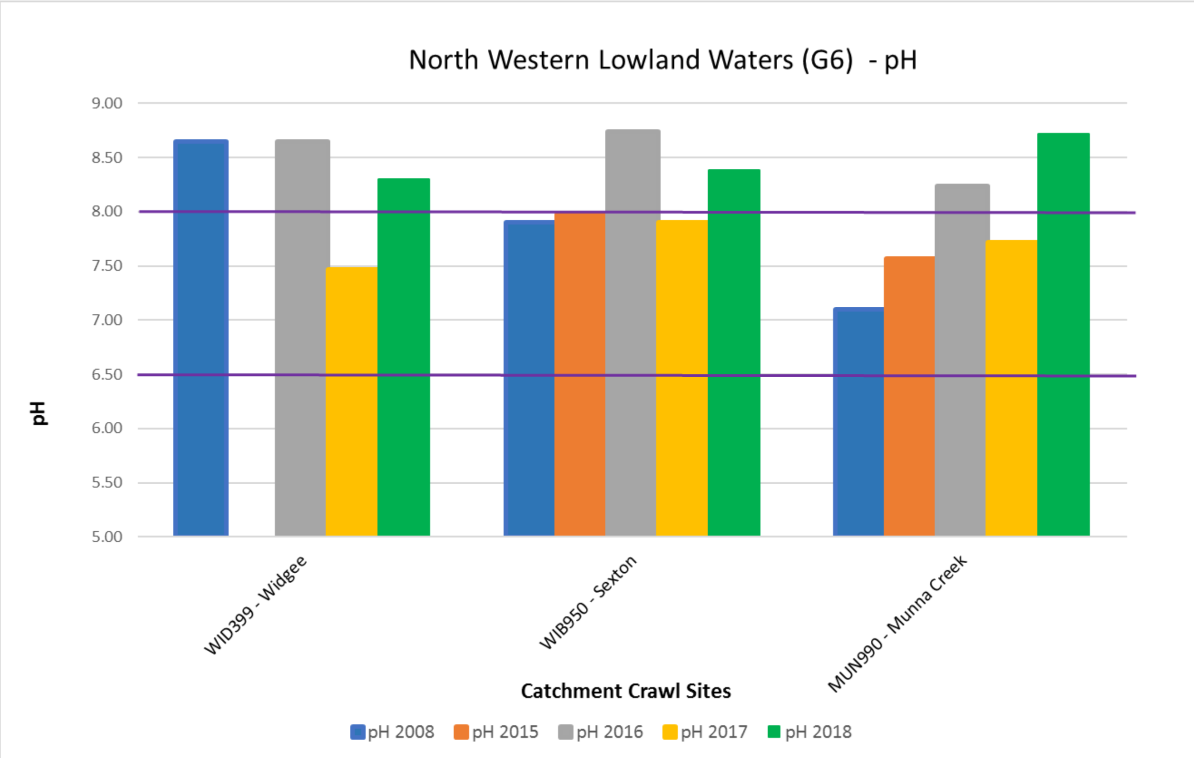


**Figure 18 pH of Tributary sites in North Western Lowland waters (G6)**

### 3.2.3 North Eastern Lowland waters (G8)

The pH guideline for the North Eastern Lowland Water (Tinana Creek only) is 6.5 to 8. The horizontal purple lines in Figure 19 show the guideline range. Data points above the upper line or below the lower line are outside of the guideline range. In 2018 sites sampled on Tinana Creek complied with the guideline.

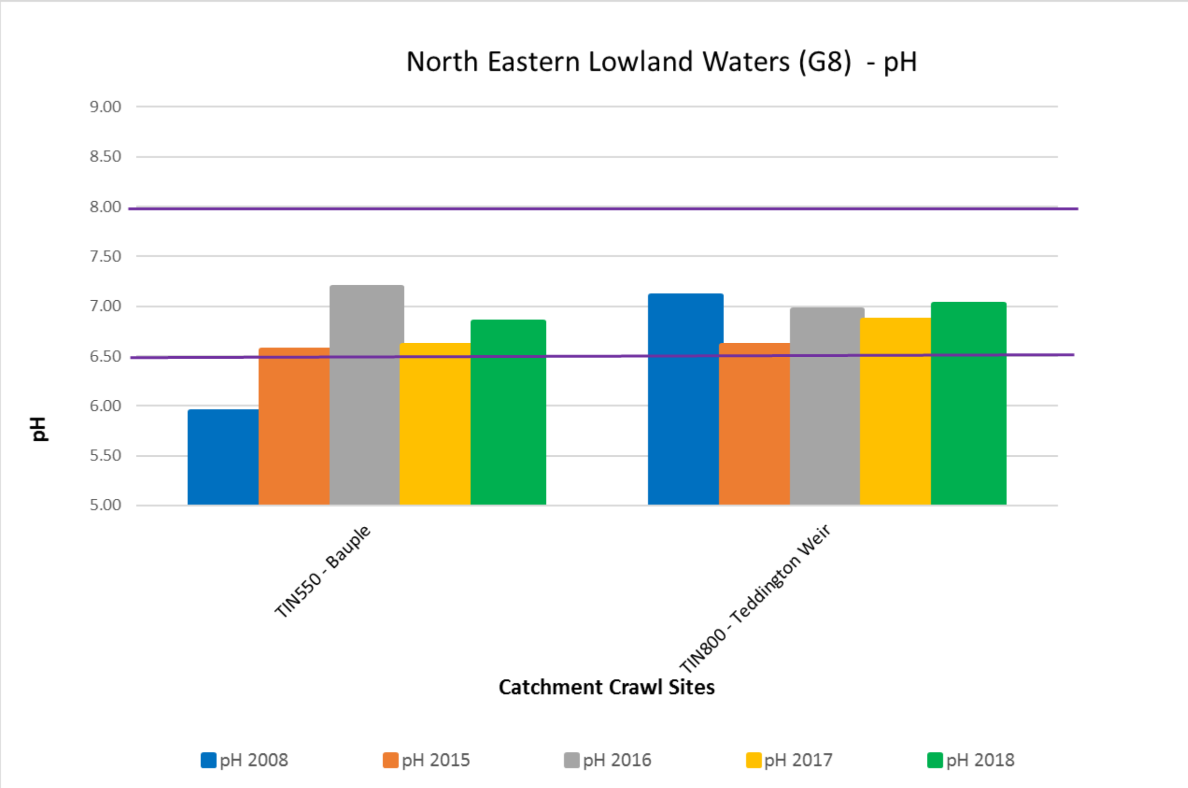


**Figure 19 pH of Tributary sites in North Eastern Lowland waters (G8)**

### 3.2.4 Mary River Estuary – High Environmental Value Waters (G2)

The guideline for pH for both High Environmental Value Water sites is 8.1 to 8.4 (see Table 5). The Mary River headwaters site (MAR999) was within the guideline in 2018, as shown in Figure 20. The Susan River site (SUS500) is considerably lower than the lower guideline of 8.1, as shown in Figure 21.

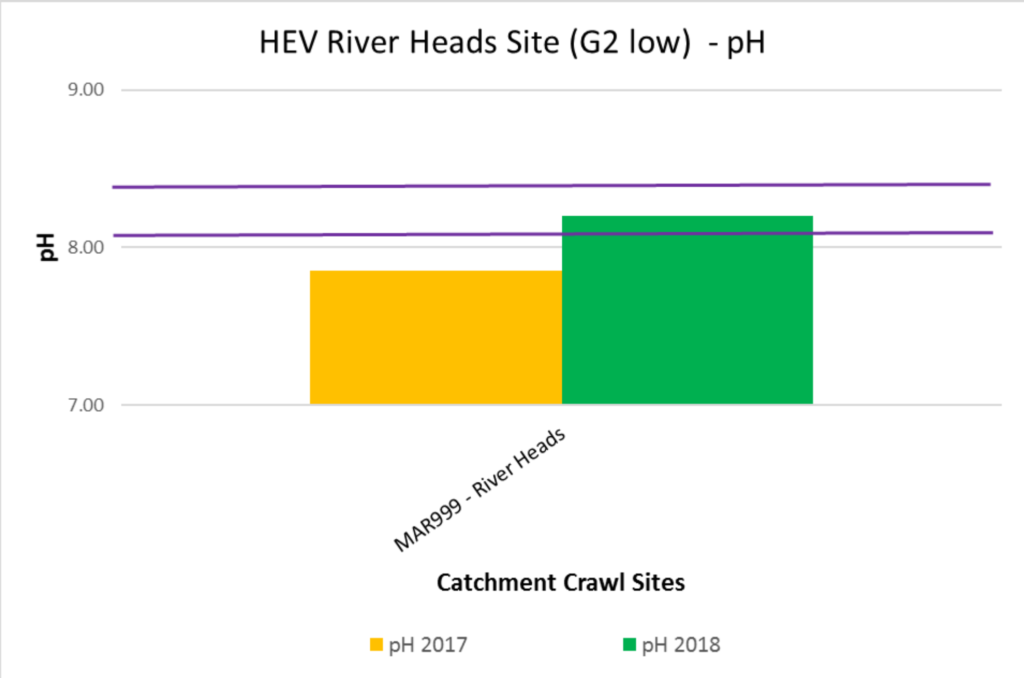


Figure 20 pH of the River Heads site (G2 low)

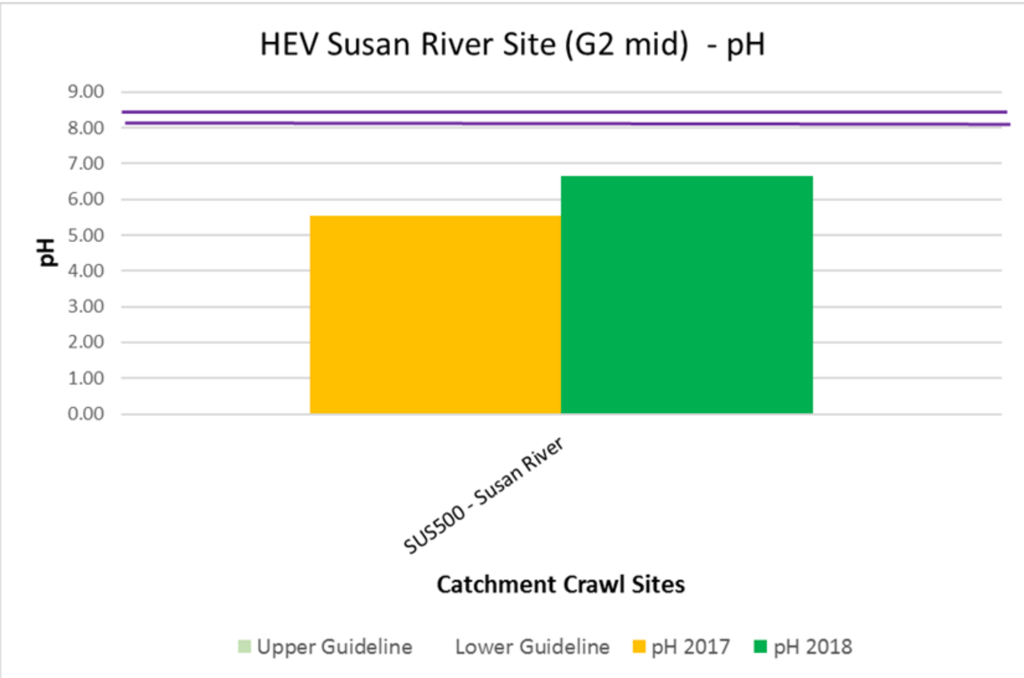


Figure 21 pH of the Susan River site (G2 mid)

## 3.3 Electrical Conductivity (EC)

Electrical Conductivity (EC) is a measure of water's ability to conduct electricity. The EC value is derived from the amount of dissolved salt content in the water. As dissolved salt increases so does the EC. Salt levels also tend to accumulate downstream in a catchment.

Influences include geology of parent rock material, river flow, inflow of groundwater into the stream and rising salt in the water table. The EC levels of the Mary River below Gympie are strongly affected by river flow. At times of higher flow, concentration of dissolved salts in the water would decrease therefore lowering salinity and thereby lowering EC.

EC recordings which lie above the upper guideline limit would place limitations on aquatic flora and fauna health and on water used for irrigation and domestic use.

**Figure 22 Denise Lindon from Sunshine Coast Council using water testing equipment**

### 3.3.1 Southern Lowland Waters (G5)

The Electrical Conductivity guideline for the Southern Lowland Waters is between 0 – 580 µS/cm. Results for the Mary River (G5) sites and the guideline range is shown in Figure 23. The horizontal purple line shows the upper guideline limit. Data points above the line are outside of the guideline range. The green line shows the results for 2018.

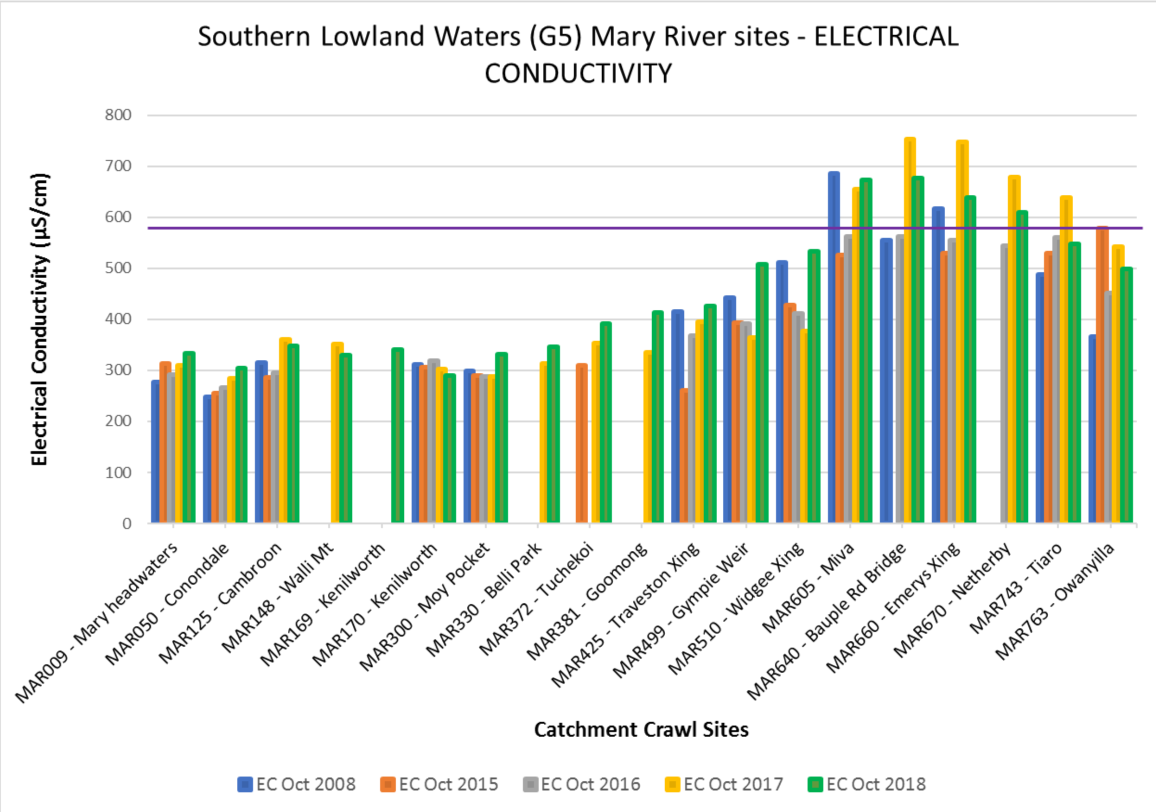


**Figure 23 Electrical conductivity of Mary River sites in Southern Lowland waters (G5)**

Four Mary River sites in this water type downstream of Gympie did not comply with the upper electrical conductivity guidelines – MAR605 at Miva, MAR640 at Bauple Road Bridge, MAR660 at Emerys Xing and MAR670 at Netherby. As in previous catchment crawls the Mary River electrical conductivity (salinity reading) was relatively stable from the headwaters to Gympie, satisfactorily meeting guideline levels. However downstream of Gympie on the Mary River the EC levels rise to guideline level (580us/cm) and occasionally exceed these levels. EC is linked very closely to stream flow. The 2018 EC results upstream of Gympie all complied. However, downstream of Gympie EC was much higher, although lower than 2017 levels, with non-compliance between Miva and Netherby in the lower section of the free-flowing river. Below Netherby the river flows into the ponded section of the Mary River barrage.

In the month before the Catchment Crawl most of the Mary River sites experienced very low or cease-to-flow conditions for approximately one week in late September. These conditions, particularly in the river below Gympie, would have contributed to the EC non-compliance.

The tributaries (Obi Obi, Six Mile & Yabba Creeks) in this water type are not affected in the same way with the 2018 and 2017 values being quite similar (see Figure 24) and well below the guidelines upper limit.

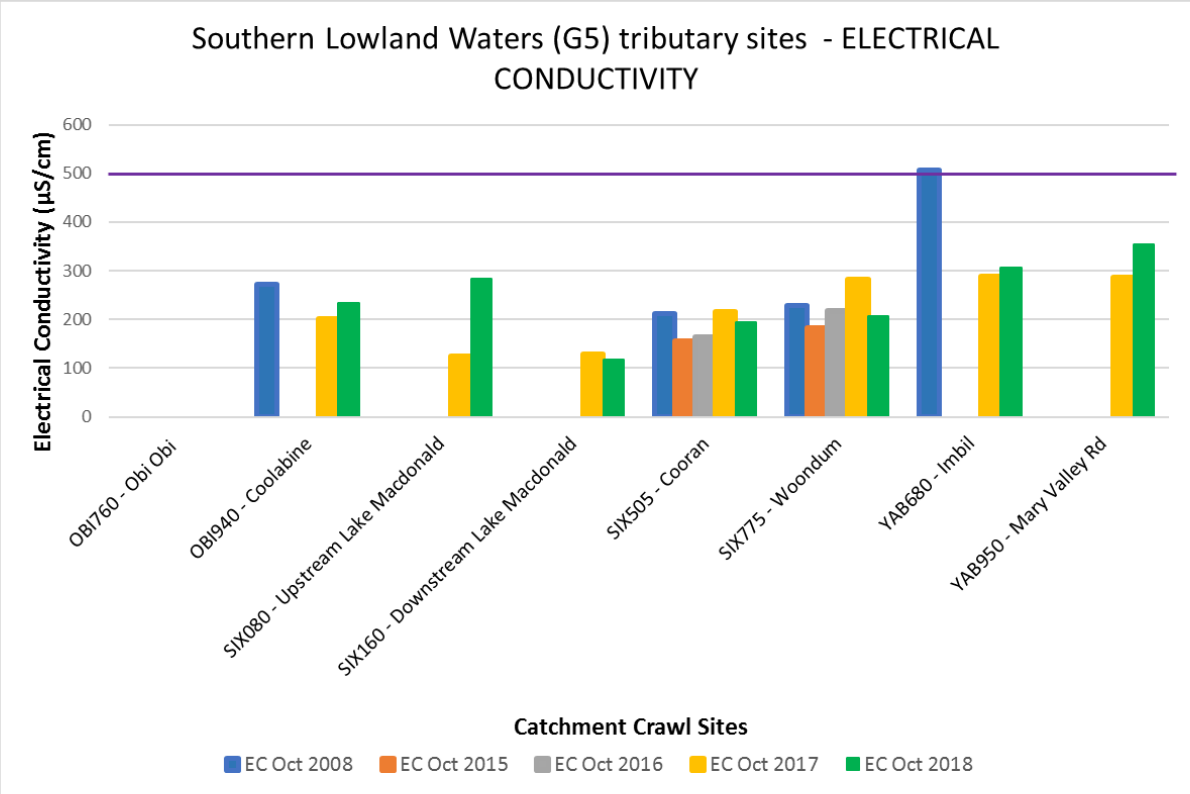


Figure 24 Electrical conductivity of tributary sites in Southern Lowland waters (G5)

### 3.3.2 North Western Lowland Waters (G6)

The Electrical Conductivity guideline for the Southern Lowland Water (Munna, Wide Bay, Widgee Creeks) is between 0 – 1200. The higher upper value reflects the naturally more saline geology in these waters. The Widgee (WID399) and Sexton (WIB950) sites complied with the guidelines and no notable difference is apparent between 2018 and previous years. The Munna Creek site (MUN990) shows a significant increase, however (see Figure 25). Waterwatch data for this site from 29/08/2018 recorded EC of 984 µS/cm. Historic Waterwatch data shows that while the site usually falls within the guideline for EC, periodic spikes occur. However, none of the records show EC as high as that recorded in the 2018 Catchment Crawl (3125 µS/cm).

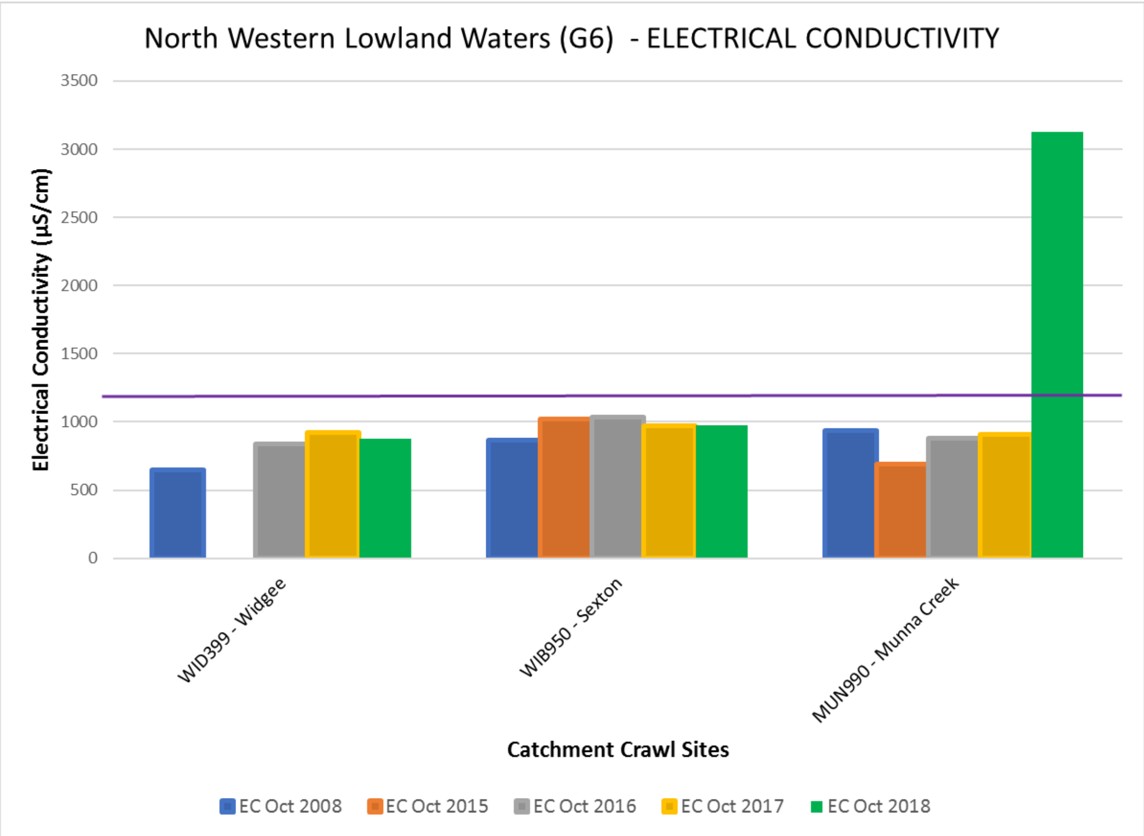


**Figure 25 Electrical conductivity of tributary sites in North Western Lowland waters (G6)**

### 3.3.3 North Eastern Lowland waters (G8)

The Electrical Conductivity guideline for the Southern Lowland Waters (Tinana Creek only) is between 0 – 580 µS/cm. The horizontal purple line in Figure 26 shows the maximum guideline value. Data points above the line are outside of the guideline range. The green line shows the result for 2018. All sites sampled comply with this guideline and there are no notable differences between years.

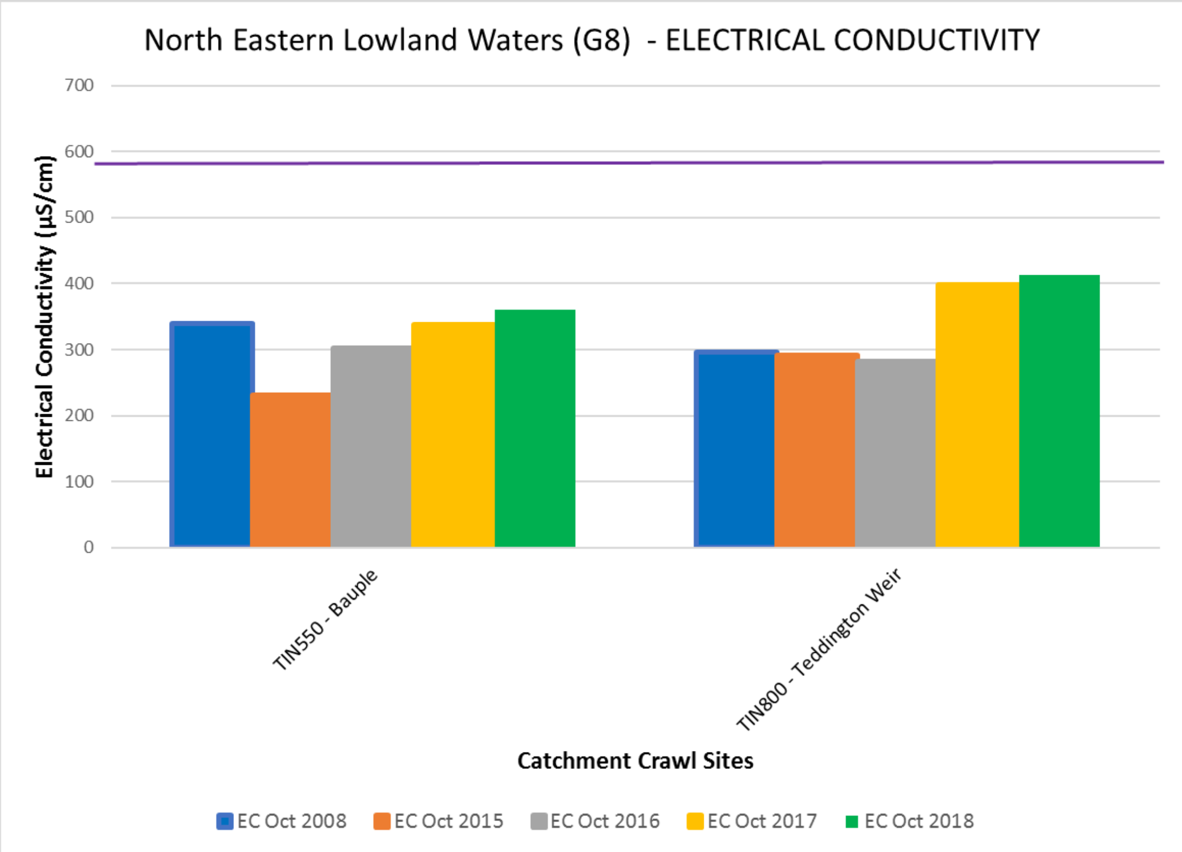


**Figure 26 Electrical conductivity of tributary sites in North Eastern Lowland waters (G8)**

### 3.3.4 Mary River Estuary – High Environmental Value Waters (G2)

Data collection of the estuary sites only commenced in a comprehensive manner in 2017. A guideline for EC for estuary waters does not currently exist.

2018 EC values for the Mary River riverheads site (MAR999) are very similar to those recorded in 2017, as shown in Figure 27. However, there is a significant rise in EC at site SUS500 IN 2018. As Figure 28 shows, the Susan River site is much more heavily influenced by freshwater than the River Heads site. The Susan River is at the upstream extent of the tidal influence. According to the Queensland Tide Tables for 2018 a low tide of 0.46m occurred at Urangan on 9th October at 2:53pm. The Susan River sample was taken at approximately 2pm so the tide will have had less influence on this sample. However, the highest tides for the month took place on the 7$^{th}$ and 8$^{th}$ of October, with high tides of 3.95 m and 3.94m respectively recorded. This may have caused saline/brackish water to flood into the pools sampled, which would have been left exposed as the tide retreated.

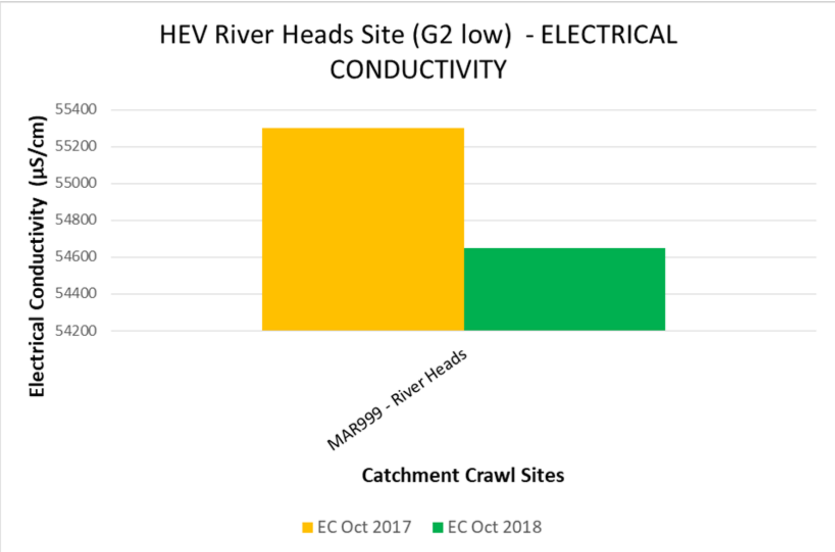


Figure 27 Electrical conductivity of the River Heads site (G2 low)

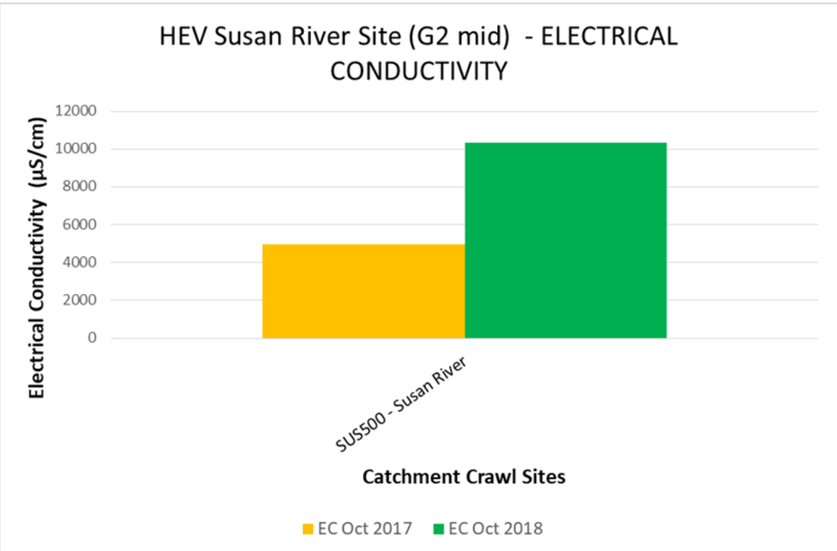


Figure 28 Electrical Conductivity of the Susan River site (G2 mid)

## 3.4 Turbidity and Total Suspended Solids (TSS)

Both turbidity and total suspended solids (TSS) data are discussed in this section.

Turbidity is the measure of suspended sediments within the water. It uses the penetration of light through a liquid to approximate the level of suspended sediments and can be rapidly measured in the field. Total Suspended Solids (TSS) is measured in a laboratory and it provides the concentration of solids in a liquid (in mg/L). Turbidity is effectively an approximation of TSS and is a valuable rapid assessment tool. Turbidity can be affected by colour of water and the nature of the sediments and algae in the water (e.g. colloidal sediments make water cloudy and it may therefore appear more turbid) whereas TSS is not affected by these as it is a physical measurement of the weight of solids in a known volume of water. TSS is the more accurate measurement but it requires samples to be analysed in a laboratory and therefore does not provide a rapid result like a turbidity measurement does.

Sediment in water can be from discrete sources for example river and stream bank erosion, runoff from dirt roads or diffuse sources such as sheet flow from land subject to heavy rainfall events.

### 3.4.1 Southern Lowland Waters (G5)

The guideline for Southern Lowland Waters (G5) turbidity is 50 NTU and for Southern Upland Waters (G4) is 25 NTU.

In 2018 all (both Mary River and tributary) sites in G5 and the one G4 site at the headwaters complied with their respective guideline. As Figure 29 shows, all results except MAR372 at Tuchekoi and the Six Mile Creek sites of SIX080 at Worba Park and SIX505 at Cooran were less than 10NTU. Many of these results are below the detection limit of the methods used (for example a turbidity tube cannot detect less than 7NTU) but the FLT90 can detect lower results. A result of 3.5 indicates that this site was measured with a turbidity tube and was below the detection limit.

Low turbidity is to be expected at this time of year given it follows the driest time year where there has been little potential runoff or rainfall to cause erosion. It is significant that the rainfall the week before this catchment crawl did not elevate levels compared to previous years.

The guideline for total suspended solids (TSS) for lowland and upland streams in the south-east Queensland region is 6 mg/L (Department of Environment and Resource Management, 2009). As Figure 30 shows, in 2018 two sites failed to comply with this limit, with significant increases in TSS as compared to 2017 values. In 2017 only one site failed to comply, while two sites exceeded the guideline in 2016 and three in 2015. When comparing turbidity levels (NTU) with TSS for each site there is a general correlation between each parameter (see Figure 31).

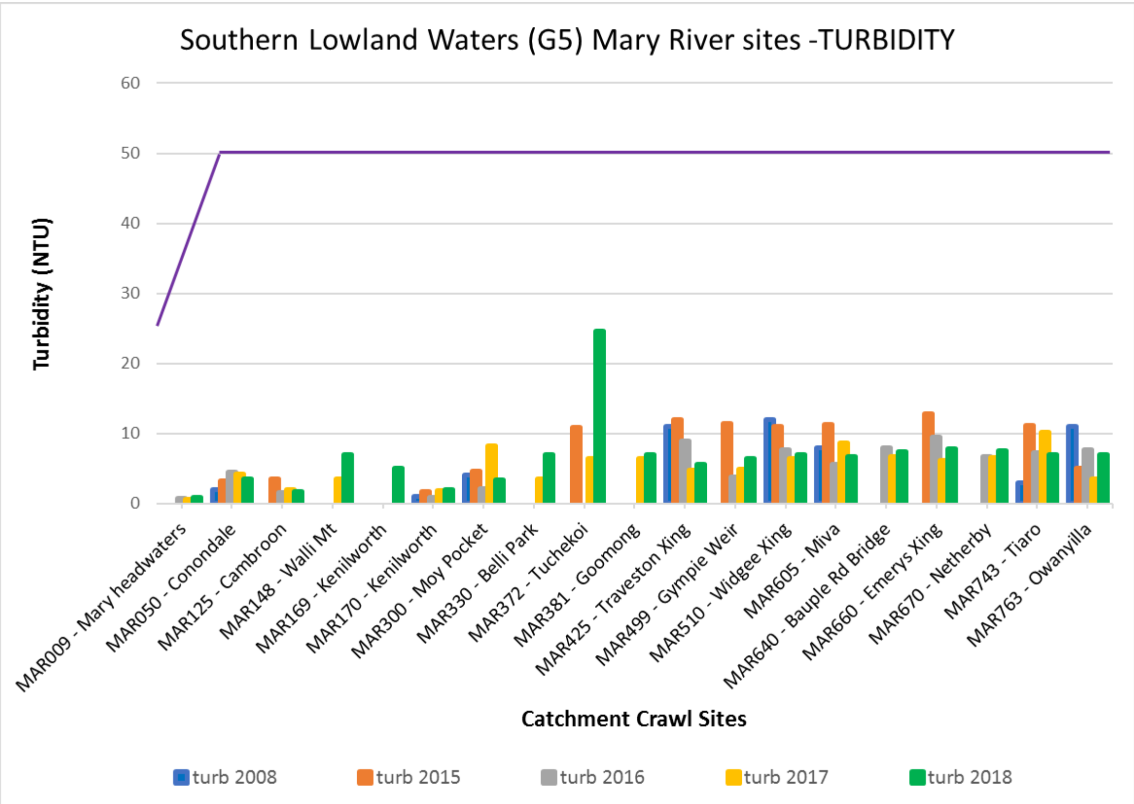


**Figure 29 Turbidity of Mary River sites in Southern Lowland waters (G5)**

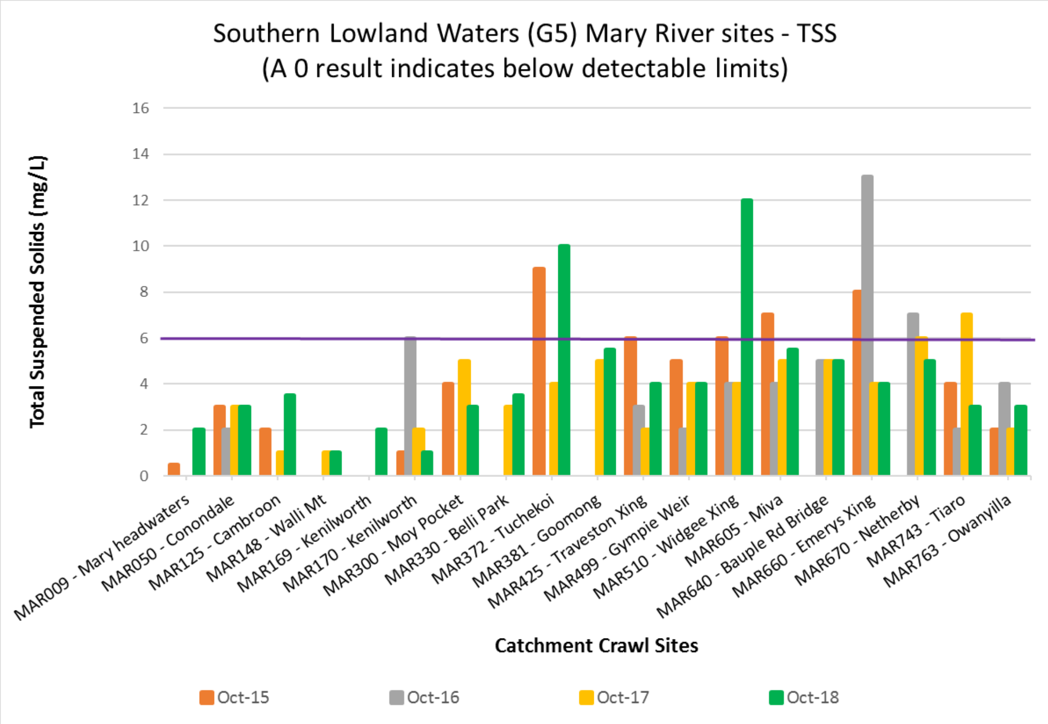


Figure 30 TSS of Mary River sites in Southern Lowland waters (G5)

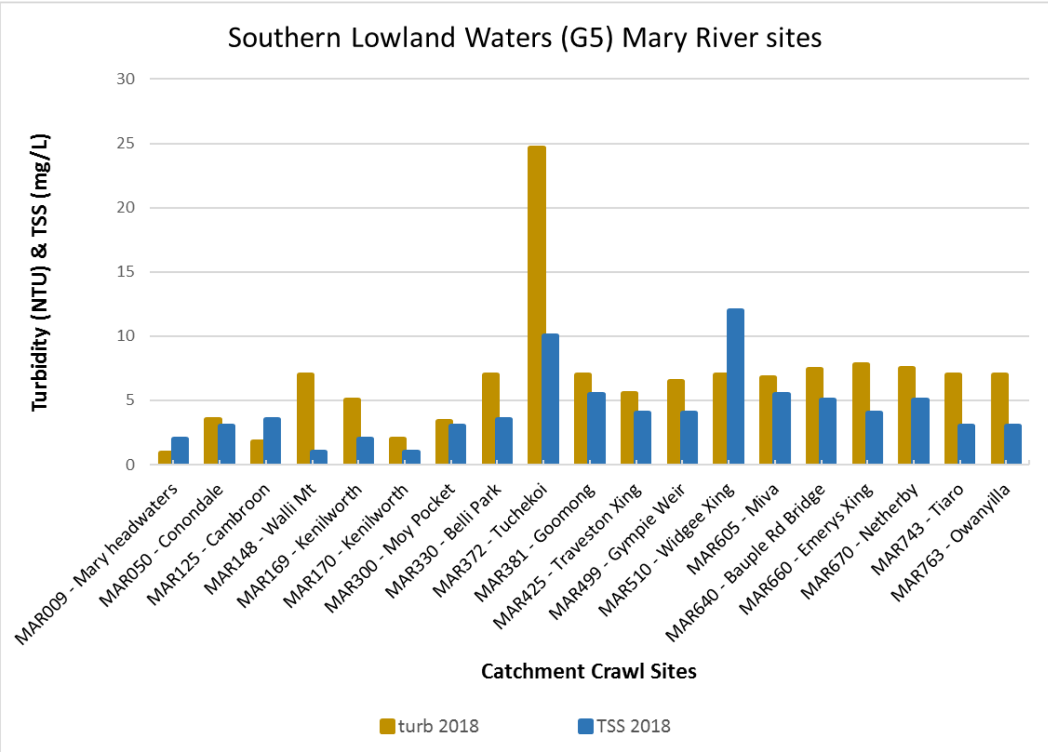


Figure 31 Comparison of TSS and turbidity values in 2018

Like they have in previous years, all tributary sites in the G5 water type (Obi Obi, Six Mile, Yabba Creeks) complied with the Turbidity guideline of 50NTU (see Figure 32). All sites except the Six Mile Creek site upstream of Lake MacDonald (SIX080) complied with the Total Suspended Solid (TSS) guideline (see Figure 33), although the value did halve between 2017 and 2018. This site returned a result of 10mg/L which was one of the highest results of all freshwater sites tested throughout the whole Catchment Crawl. This site had some recent bridge works – replacing the wooden bridge with a concrete one. This may have contributed to the 2018 result, but does not explain the high result in 2017.

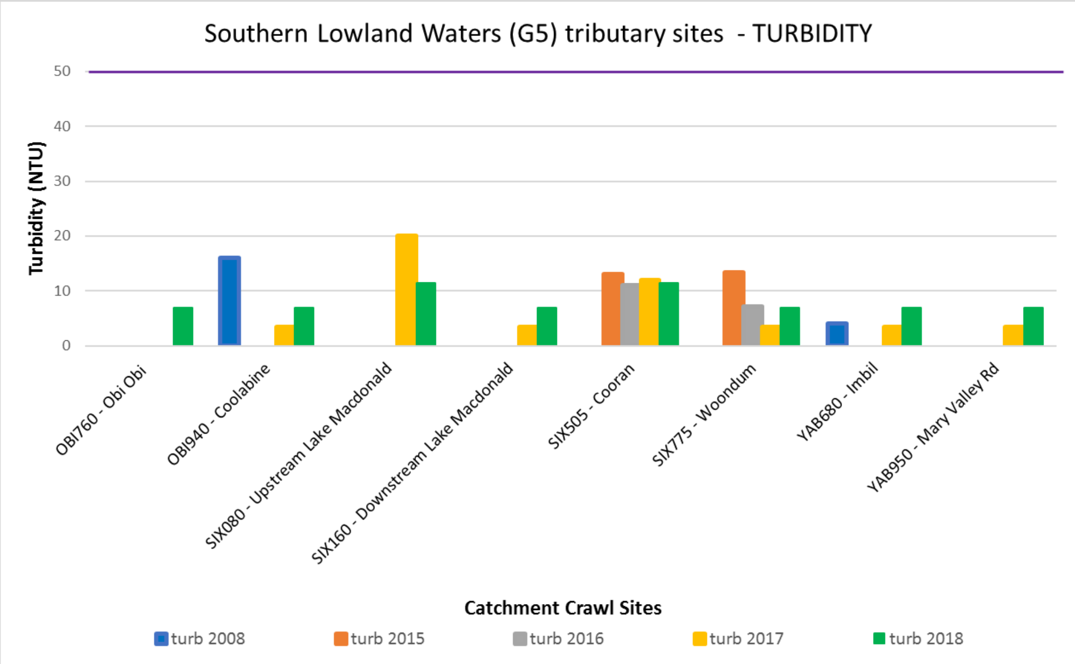


**Figure 32 Turbidity of tributary sites in Southern Lowland waters (G5)**

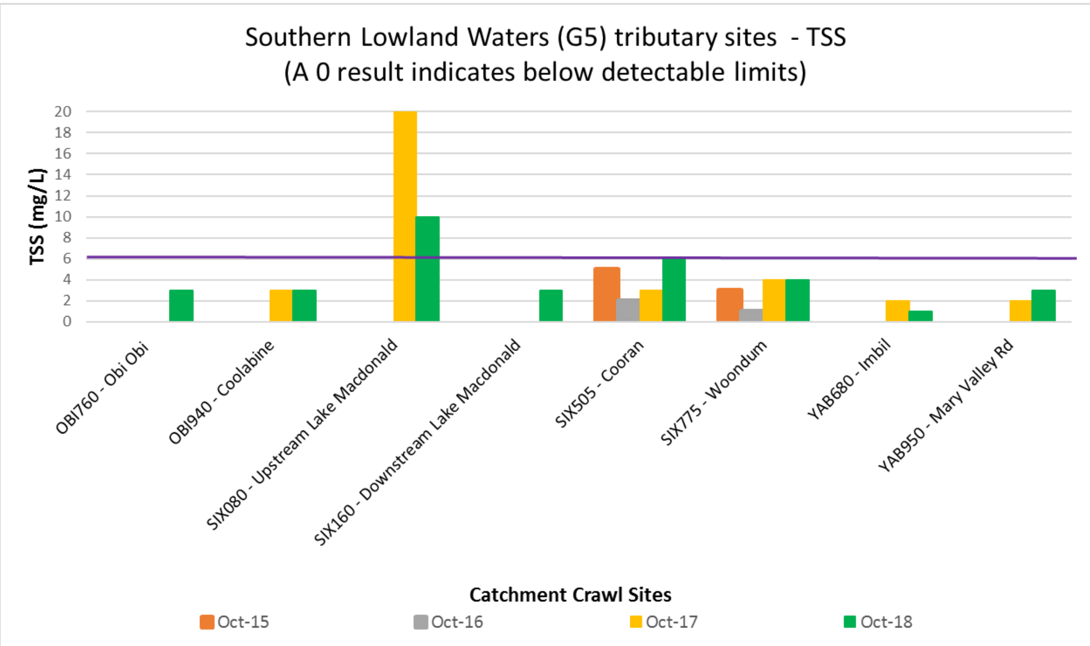


**Figure 33 TSS of tributary sites in Southern Lowland waters (G5)**

### 3.4.2 North Western Lowland Waters (G6)

All sites within the North Western lowland waters (Munna, Wide Bay, Widgee Creeks) were compliant with the turbidity guideline of 50NTU (see Figure 34) and the TSS guideline of 6mg/L (see Figure 35).

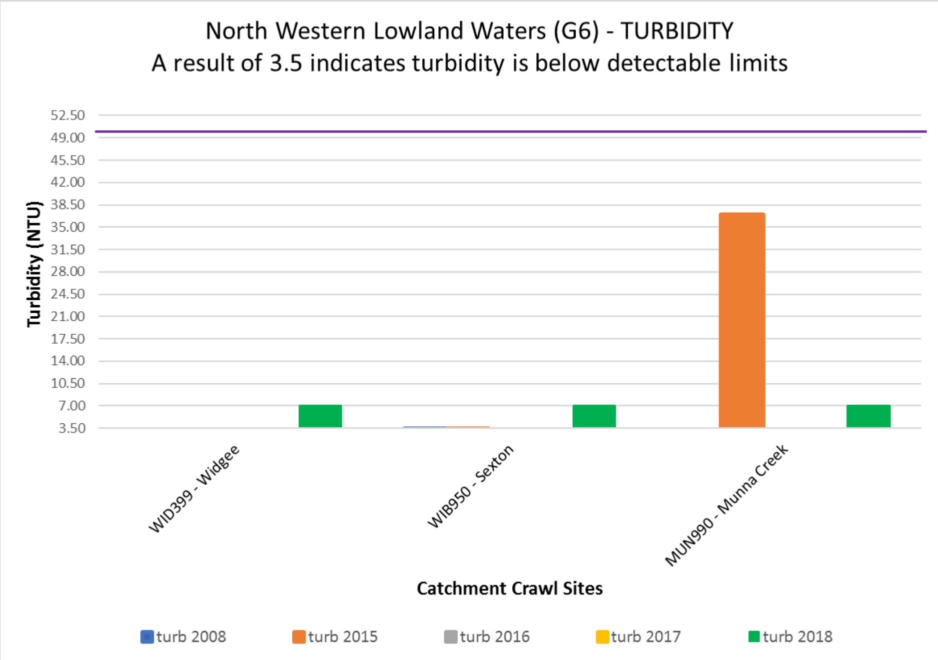


Figure 34 Turbidity of tributary sites in North Western Lowland waters (G6)

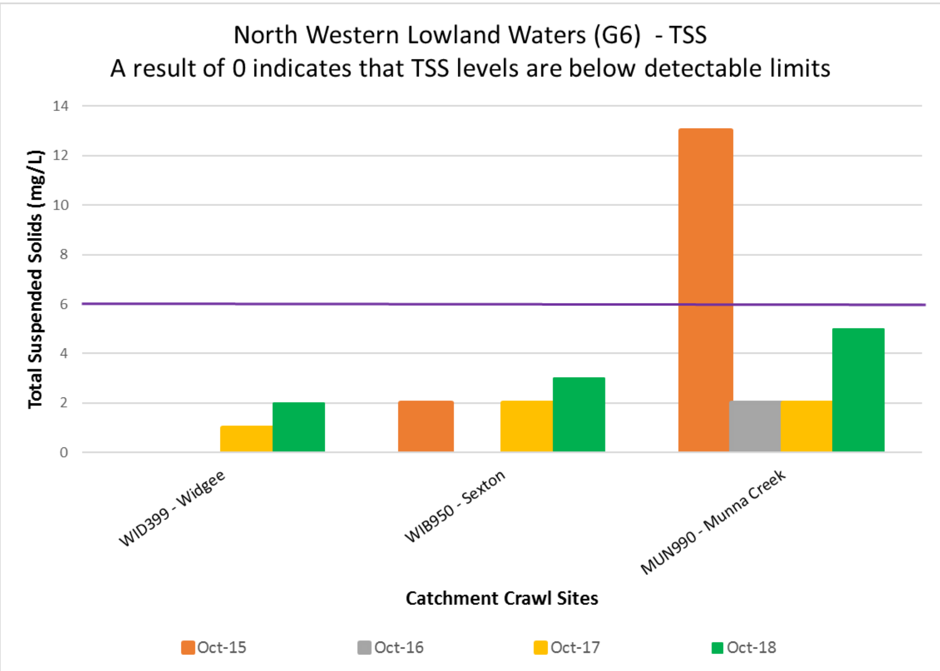


Figure 35 TSS of tributary sites in North Western Lowland waters (G6)

### 3.4.3 North Eastern Lowland waters (G8)

All sites within the North Eastern lowland waters (Tinana Creek only) were compliant with the turbidity guideline of 50 NTU (Figure 36) and the TSS (Figure 37) guideline of 6mg/L.

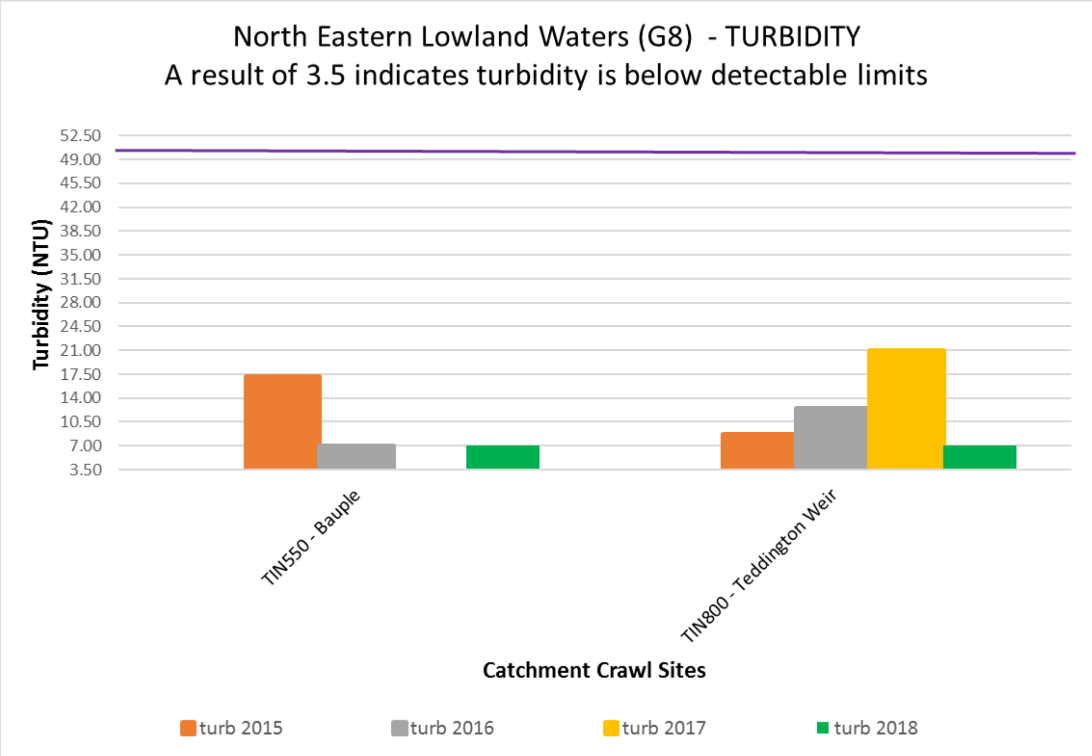


Figure 36 Turbidity of tributary sites in North Eastern Lowland waters (G8)

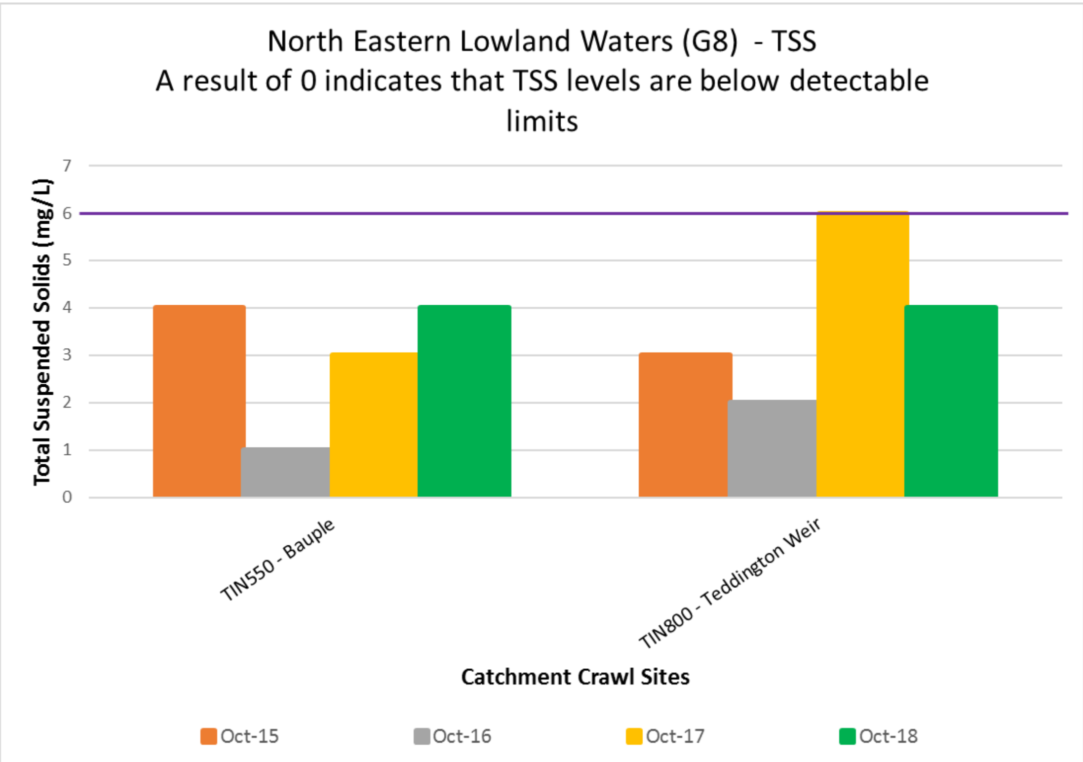


Figure 37 TSS of tributary sites in North Eastern Lowland waters (G8)

### 3.4.4 Mary River estuary – High Environmental Value Waters (G2)

Data collection of the estuary sites only commenced in a comprehensive manner in 2017.

The guideline for turbidity for High Environmental value waters is 4NTU (see Figure 35) and for suspended solids the 50th percentile value is 9 mg/L (Department of Environment and Resource Management, 2009). As Figures 38-41 show both sites exceed the guidelines for both turbidity and total suspended solids. The Susan River site (SUS500) also exceeded the turbidity guidelines in 2017, and experienced a significant increase in turbidity in 2018 when compared to the 2017 measurement.

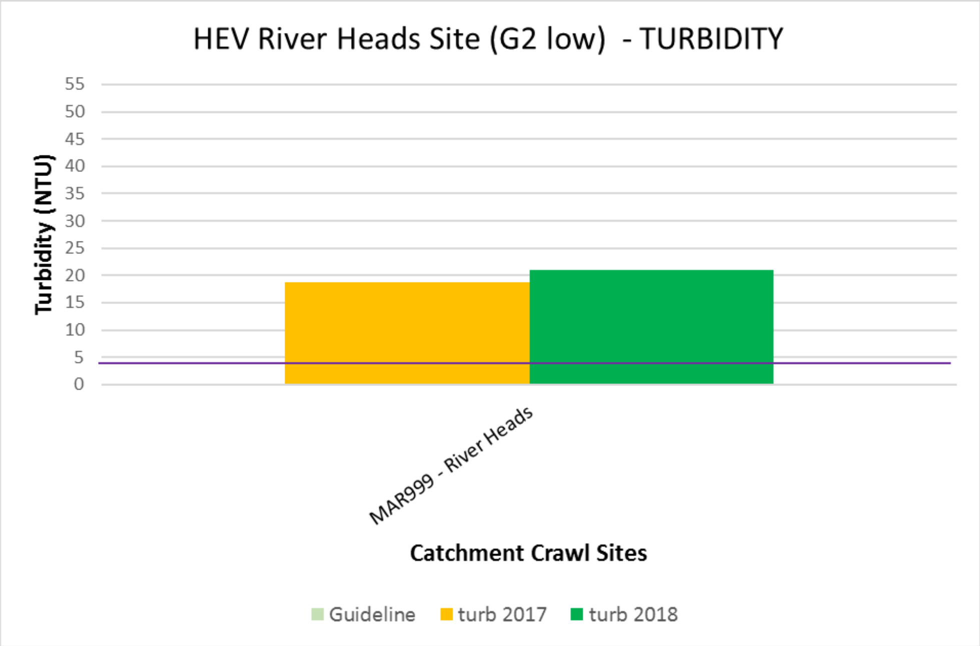


Figure 38 Turbidity of the River Heads site (G2 low)

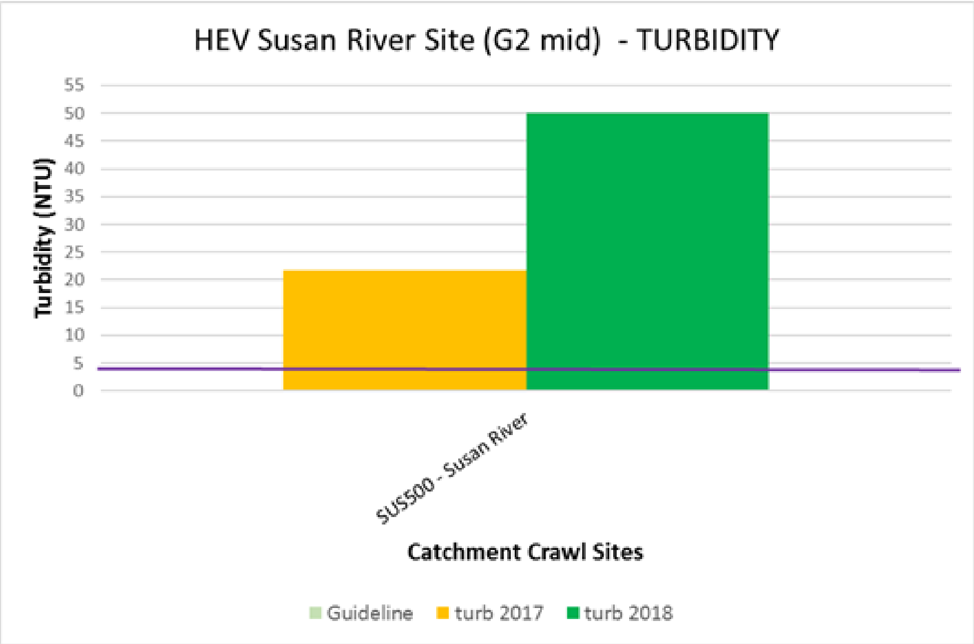


Figure 39 Turbidity of the Susan River site (G2 mid)

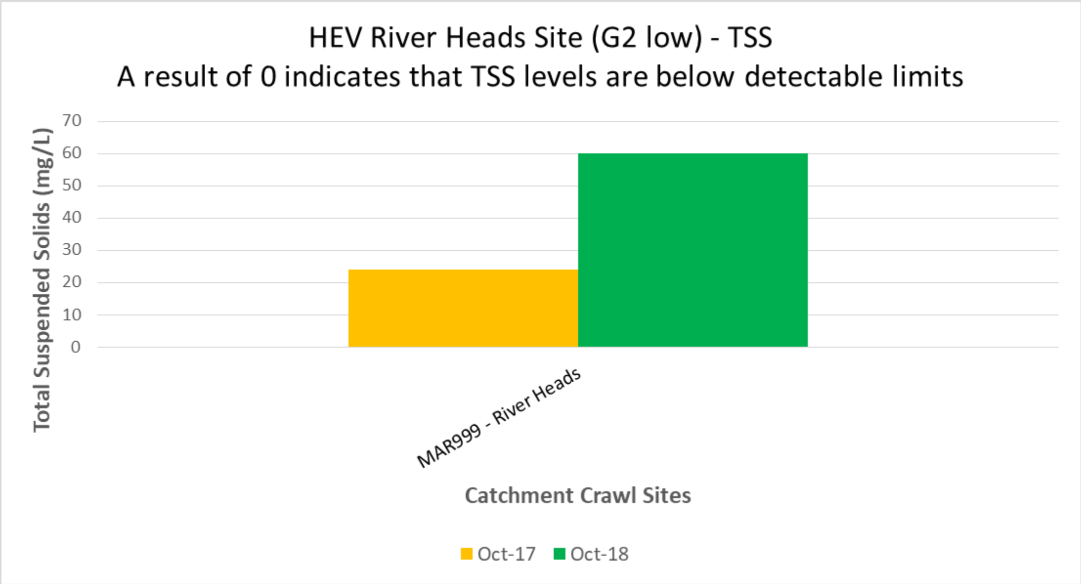


**Figure 40 TSS of the River Heads site (G2 low)**

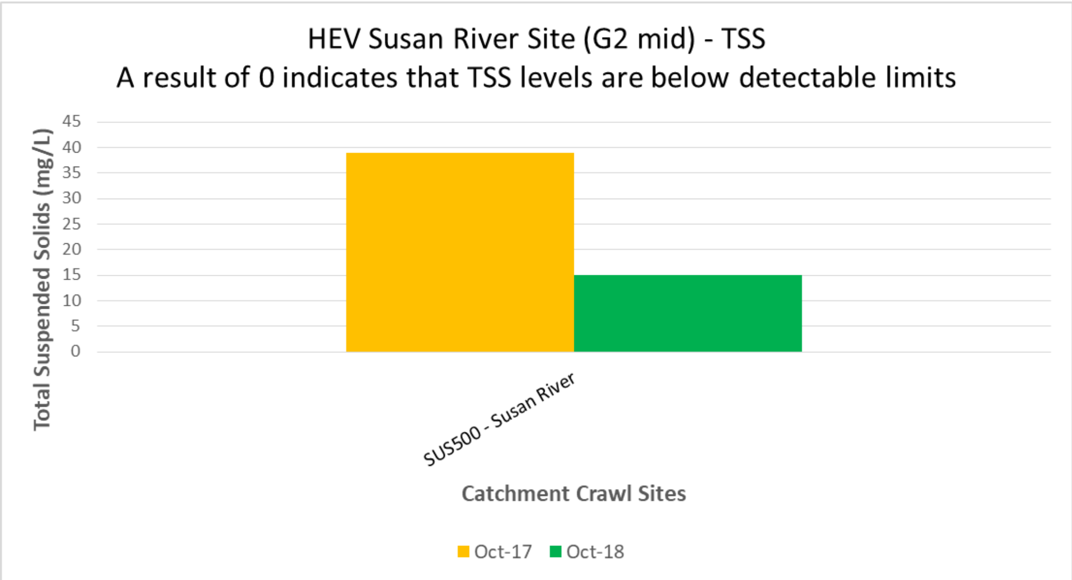


**Figure 41 TSS of the Susan River site (G2 mid)**

## 3.5 Dissolved Oxygen (DO)

Dissolved oxygen is a measure of the amount of oxygen dissolved in the water. The results are presented as a % with values above 100% indicating that the water is supersaturated with oxygen. Oxygen is essential for respiration of all living things in the water. It is also produced by photosynthesis of plants and fluctuates throughout the day as a result of the interaction of processes that use oxygen in the water and processes that produce oxygen and how these are affected by temperature and sunlight.

Fish in Australian freshwater ecosystems are adapted to fluctuating oxygen availability given the drought and flood events over the course of evolution. However, it is accepted that where DO% falls below 80%, fish survival is compromised. In waterways that are under stress, DO levels can fluctuate wildly, from very low levels (<10% saturation) early in the morning to super-saturation (>110%) in the late afternoon when air and water temperatures are highest. These wild fluctuations in dissolved oxygen levels are deleterious for fish life making potential habitat e.g. snags, timber debris structures, unusable. Waterways with good riparian vegetation and canopy cover (to moderate water temperatures during the day and overnight), coupled with good streamflows tend to have more stable dissolved oxygen levels, thus creating optimal conditions for fish and aquatic life.

The guideline for dissolved oxygen for the different water types were outlined in Table 5. For the Southern lowland (G5), North western (G6) and north eastern (G8) lowland water type the guideline range is 85 – 110 % saturation. For the Southern Upland waters (G4) the lower limit is slightly higher with a narrower range between 90-100% saturation. When available, data from 2008, 2015, 2016, 2017 and 2018 has been provided in this section.

Influences causing fluctuating DO% include water temperature (warmer water holds less DO), stream flow and agitation through riffles, timber debris structures, etc. (less agitation leads to lower DO), salinity (more saline water holds less DO) and turbidity (more turbid water holds less oxygen). Readings are taken as percentage saturation of water. For example, where a reading is 100%, would indicate no more oxygen could be dissolved in the water sample and the water is supersaturated with oxygen; a reading <100% would indicate the sample is not fully saturated and more oxygen could be dissolved; a reading > 100% indicates oxygen is being generated more quickly than can escape with water surface tension acting as a barrier resulting in more than 100% oxygen in the water body i.e. from aquatic plant or algae respiration.

### 3.5.1 Southern Lowland Waters (G5)

The dissolved oxygen results in the main trunk of the Mary were very different to the tributary sites (Obi Obi, Six Mile, Yabba Creeks) in the Southern lowland waters. As Figure 42 shows most of the main trunk Mary River sites complied with the guideline of 85-100% saturation (and 90-110% saturation for the upper Mary River) in 2017. The exceptions were MAR510 at Widgee Xing, MAR605 at Miva and MAR 660 at Emerys Xing which were below the guideline, and MAR148 at Walli Mt and MAR169 at Kenilworth were above the guideline (super-saturation). In contrast, only three of the tributary sites complied – OBI760 at Obi Obi, YAB680 at Imbil and YAB950 at Mary Valley Road (see Figure 43). The lowest value was at Worba Park (SIX080), at 9.50%. This low results may be partly explained by low flow and the measurements occurring between 8:30 and 9:00am.

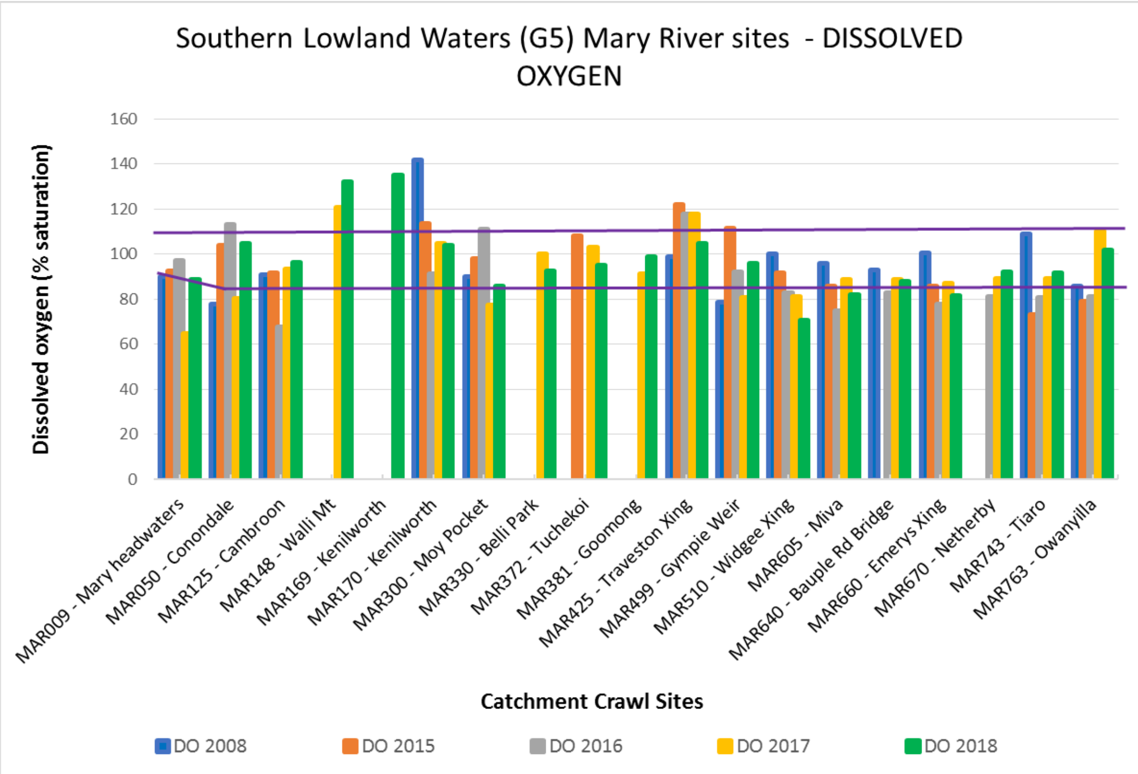


Figure 42 Dissolved Oxygen results for Mary River Southern Lowland Water (G5) sites

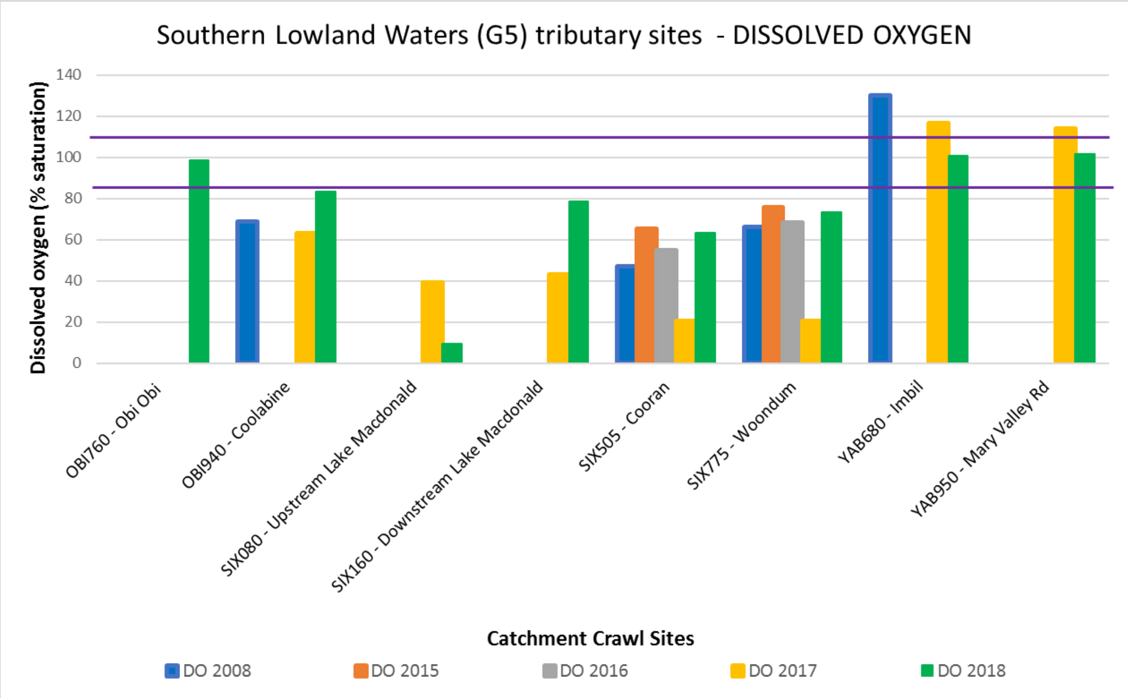


**Figure 43 Dissolved Oxygen results for tributary Southern Lowland Water (G5) sites**

The Six Mile Creek site at Worba Lane (SIX080) has low oxygen levels even though the sample was taken between 9-10am. The high nitrogen and phosphorus level may be contributing to the low oxygen levels at this site because of eutrophic conditions that occur in the presence of high nutrients (eutrophic refers to a situation where microorganisms in the water proliferate to use the nutrients and at the same time draw down the oxygen levels). All of the tributary sites sampled are located below a dam (apart from SIX080 Six Mile Creek upstream of Lake MacDonald). The releases from the dam will also affect dissolved oxygen levels.

### 3.5.2 North Western Lowland Waters (G6)

Figure 44 shows the dissolved oxygen results for North Western Lowland waters of Munna, Wide Bay and Widgee Creeks (G6). 2018 exhibited a similar pattern to 2017. Widgee Creek Township (WID399) fell below the guidelines, which is probably flow related because the creek has the smallest catchment of the three. The Wide Bay Creek site (WIB950) exceeding the guidelines. In contrast, the Munna Creek site (MUN990) complied with the guidelines in 2017 but slightly exceeded them in 2018.

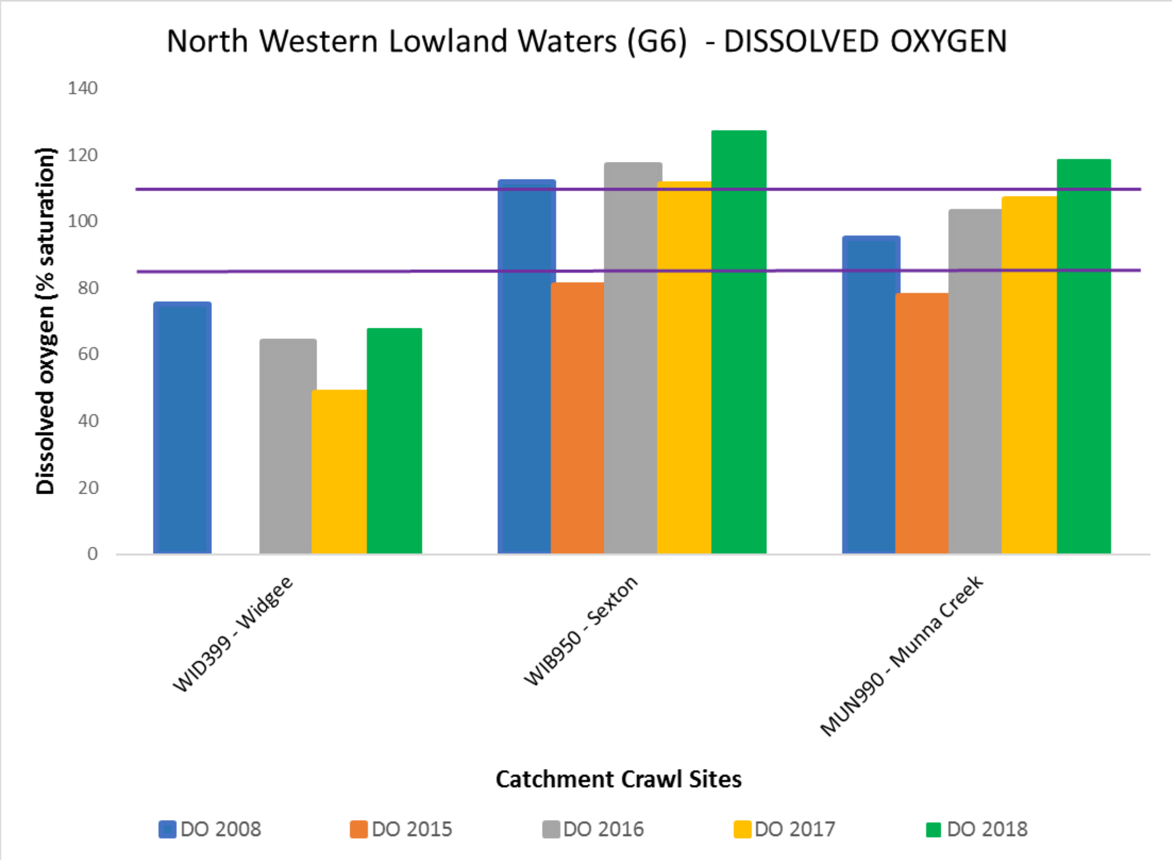


**Figure 44 Dissolved oxygen results for North Western Lowland waters (G6)**

### 3.5.3 North Eastern Lowland waters (G8)

As Figure 45 shows there is a history of the North Eastern lowland waters sites on Tinana Creek not complying with the guideline. In contrast to 2017, where both sites were below the lower guideline value of 85%, site TIN800 at Teddington Weir just met the lower guideline in 2018, while TIN550 at Bauple continued to be below with a measurement of 68.3%. The lower results are in part due to the tannin staining of the water. The flat longitudinal profile of Tinana Creek and limited geomorphic features (e.g. riffles) to introduce oxygen into the water, coupled with the Teddington and Tallegalla weir pools also contribute to the low results.

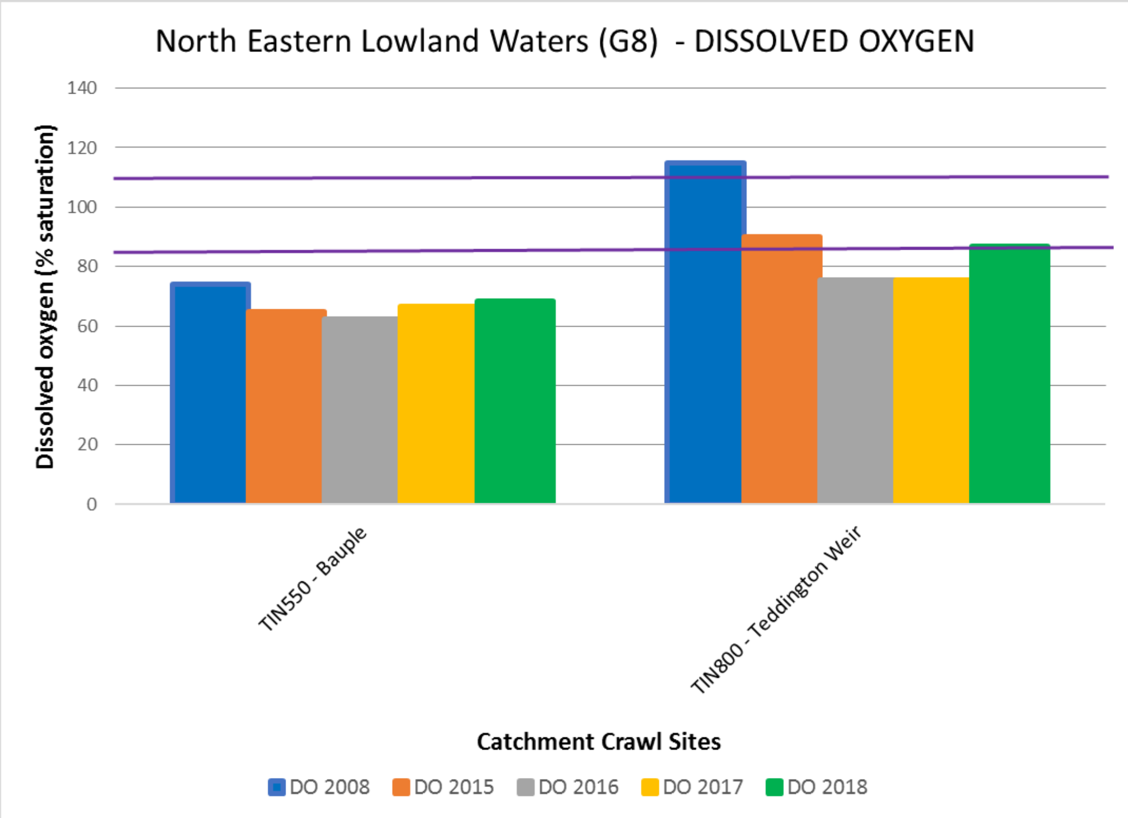


**Figure 45 Dissolved oxygen results for North Eastern Lowlands waters (G8)**

### 3.5.4 Middle Estuary – High Environmental Value Waters (G2)

Data collection of the estuary sites only commenced in a comprehensive manner in 2017.

The guideline for dissolved oxygen for High Environmental value waters is 90-105% saturation (see Table 5). Figures 46 and 47 show that in contrast to 2017, both sites were below the lower guideline in 2018.

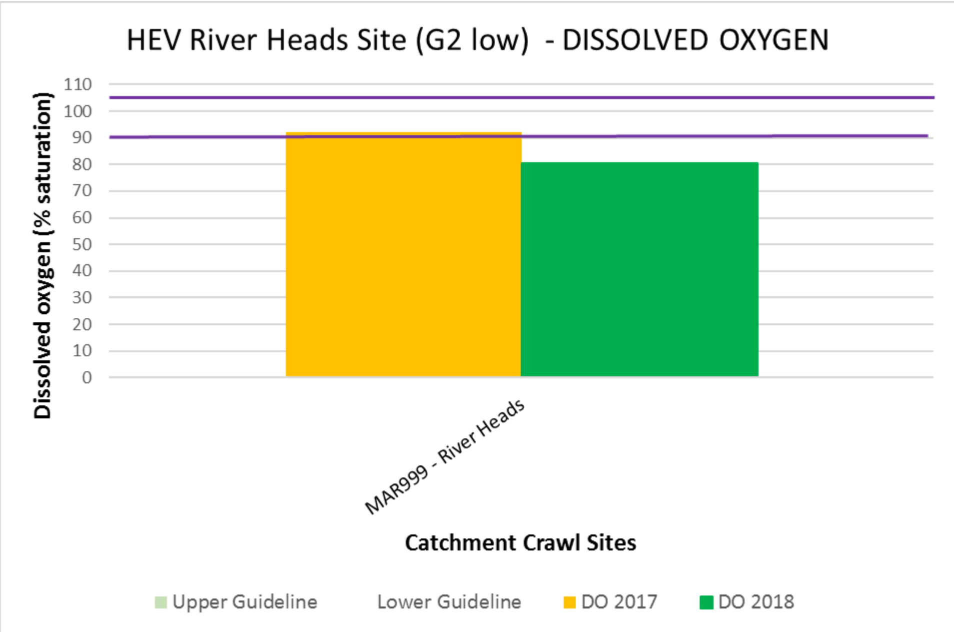


Figure 46 Dissolved oxygen results for the River Heads site (G2 low)

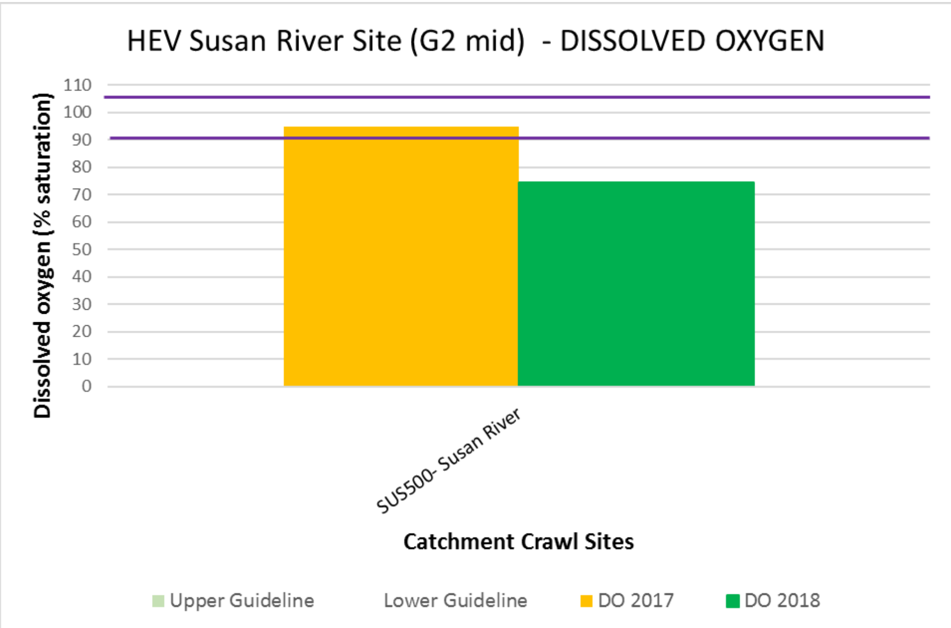


Figure 47 Dissolved oxygen results for the Susan River site (G2 mid)

## 3.6 Nitrogen

The importance of nitrogen in aquatic environments varies according to what forms the nitrogen takes, and the amount of each form. Total oxidised nitrogen is a measure of the type of nitrogen (nitrite and nitrate) that is available in the water. These are forms of nitrogen that can be readily taken up by plants, and therefore provides a useful indicator of whether a waterbody can produce an algal bloom.

Kjeldahl nitrogen is a measure of both ammonia and organic forms of nitrogen. Excess ammonia contributes to the eutrophication of water bodies, which results in algal blooms that negatively impact other aquatic life, decrease drinking water quality and affect recreational activities. At high concentrations, ammonia is toxic to aquatic life.

Organic nitrogen is not able to be used directly by aquatic life for biological activity, so it does not contribute to plant proliferation until it decomposes into usable forms. Nitrogen changes form in the environment according to the nitrogen cycle which is depicted in Figure 48.

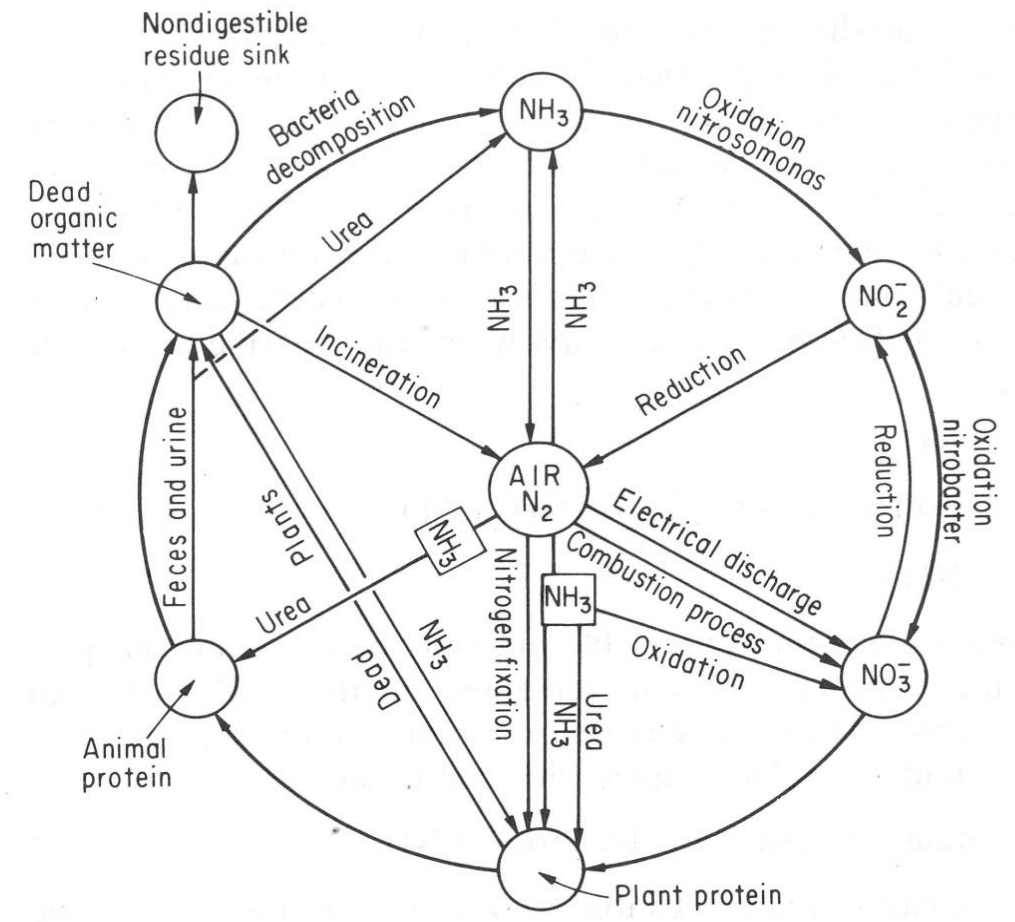


**Figure 48 The Nitrogen Cycle (Source: Sawyer et al 1994, p.553)**

For nitrogen the Queensland Water Quality guidelines (Department of Environment and Resource Management, 2009) for the South East Queensland region set the following limits for Aquatic Ecosystem health in the upland (>150m elevation), lowland (<150m elevation) and high environmental value (HEV) water of the Great Sandy Strait and lower Mary and Susan Rivers (see Table 7).

**Table 7 South East Queensland region water quality guideline values for nitrogen parameters**

| Parameter | Lowland streams | Upland streams | HEV water (50th percentile) |
|---|---|---|---|
| Ammonia N (mg/L) | 0.02 | 0.01 | 0.007 |
| Oxidised N (mg/L) | 0.06 | 0.04 | 0.002 |
| Organic N (mg/L) | 0.42 | 0.2 | 0.1 |
| Total N (mg/L) | 0.5 | 0.25 | 0.115 |

Results for ammonium, oxidised nitrogen and total nitrogen are presented in the graphs in this section. Nitrogen is found in water in organic and inorganic forms and in dissolved and suspended forms. Total nitrogen values are calculated from measured results to include all of these forms nitrogen in the result. Ammonium and oxidised nitrogen are the main forms of dissolved inorganic nitrogen that can be found in water. The organic nitrogen values are determined from a combination of direct measurement and calculations. The organic nitrogen value includes both suspended and dissolved forms of organic nitrogen. Comparing these can provide an indication of the sources of the nitrogen in the water. For example, manure contains organic nitrogen, urine is high in ammonium and synthetic nitrogen fertilisers are high in nitrate.

### 3.6.1 Southern Lowland Waters (G5)

Figure 49 – 51 provide the oxidised nitrogen, ammonium and total nitrogen results for the Mary River sites in the Southern Lowland water types. Figure 49 shows that MAR510 at Widgee Xing has exceeded the guideline value of 0.06mg/L for oxidised nitrogen for the last four years. In 2017 the result was particularly high at 3 times the guideline level of 0.06 mg/L.

The Ammonium results show a slightly different pattern with a general rise around Kenilworth to Tuchekoi (see Figure 50). The Widgee Xing site (MAR510) exceeds the guideline of 0.02mg/L slightly. All other sites returned Ammonium results well within the guideline value.

As Figure 51 shows, the Widgee Xing site (MAR510) exceeds the guideline value for total nitrogen of 0.05 mg/L in 2018. The Mary River Tuchekoi site (MAR372) returned a near guideline result for total nitrogen.

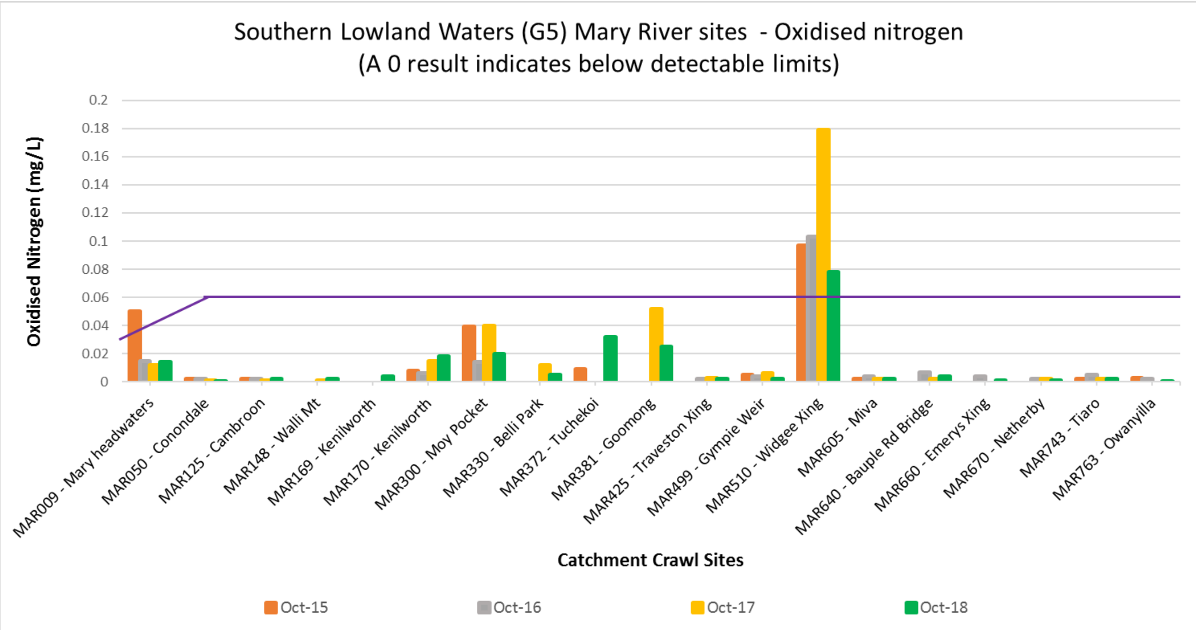


Figure 49 Oxidised nitrogen results for Mary River sites in Southern Lowland Waters (G5)

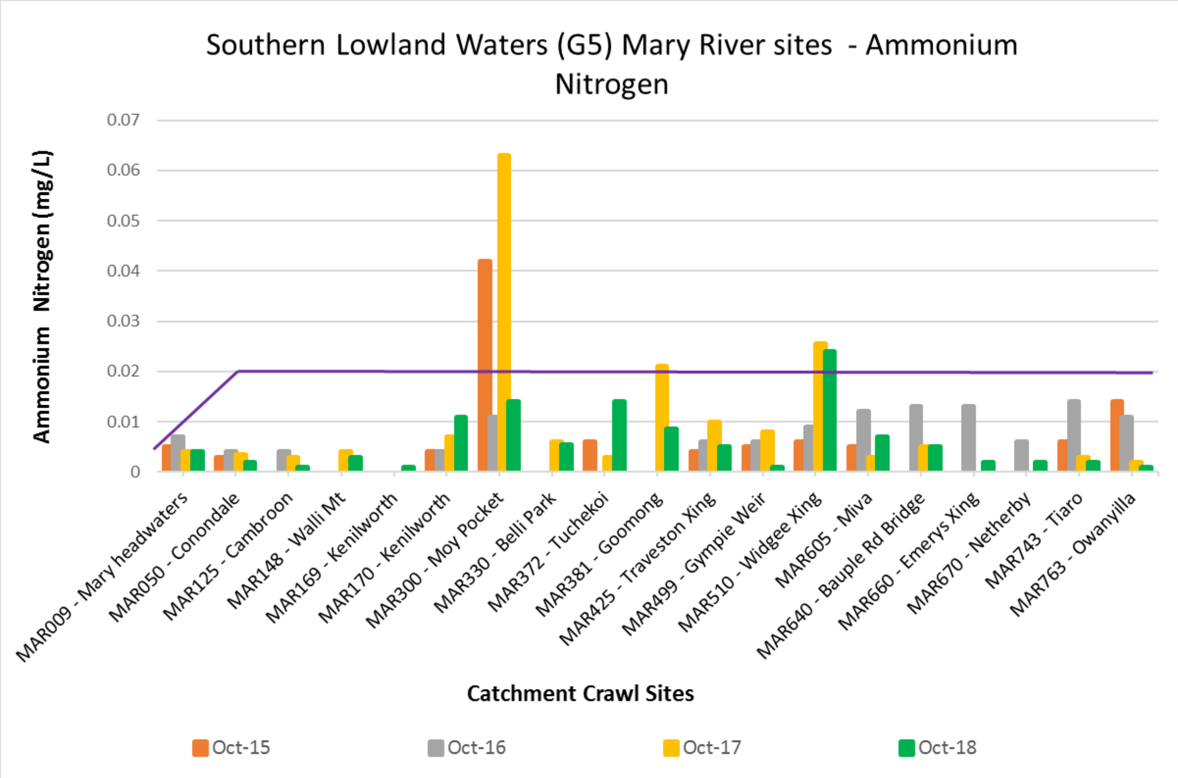


**Figure 50 Ammonium Nitrogen results for Mary River sites in Southern Lowland Waters (G5)**

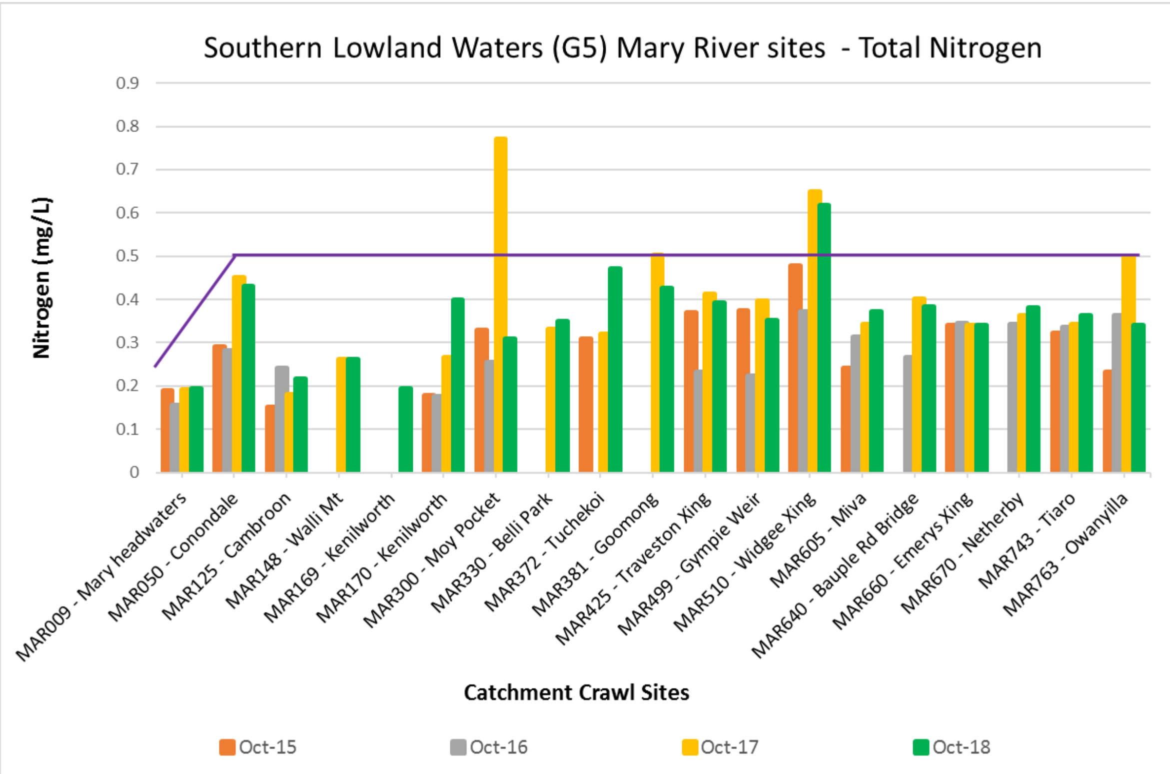


**Figure 51 Total nitrogen results for Mary River sites in Southern Lowland Waters (G5)**

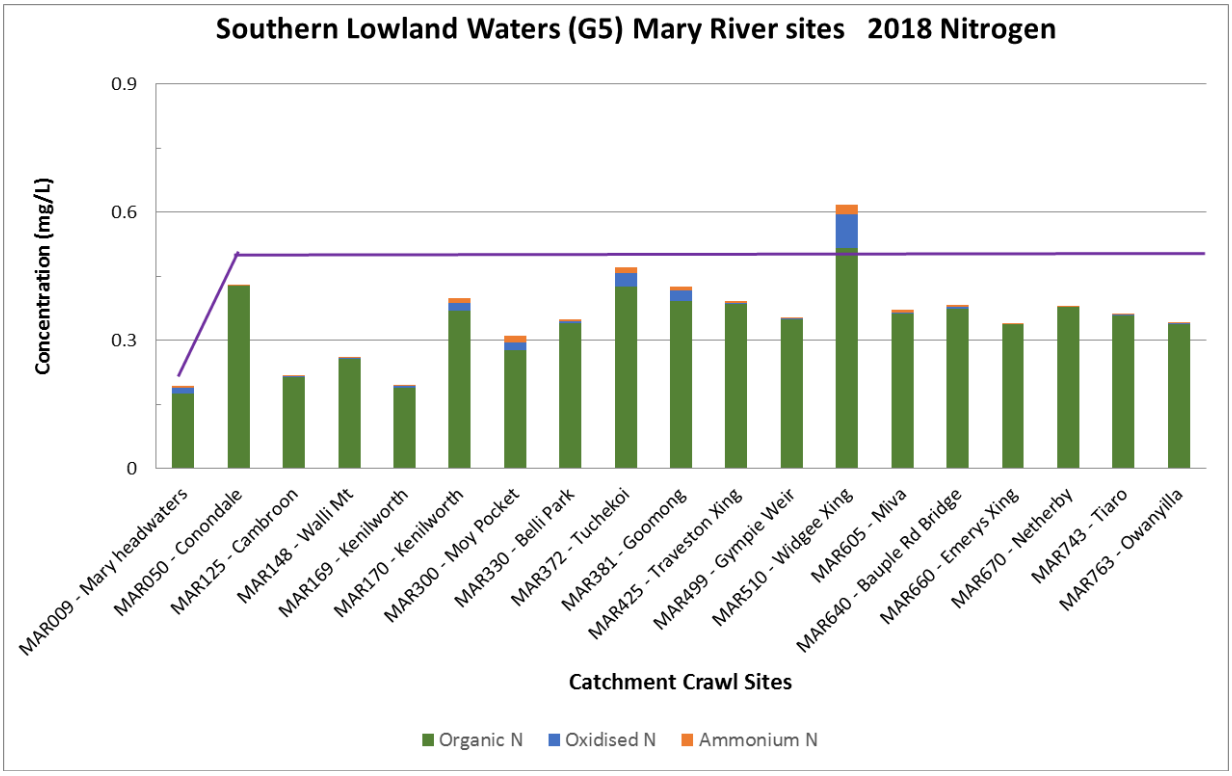


**Figure 52 Relative contribution of the different forms of Nitrogen in Mary River Southern Lowland waters (G5)**

Figure 52 provides a comparison of the different forms of nitrogen across all the sites. The total value of each column is the total nitrogen result which is made up of organic nitrogen, oxidised nitrogen and ammonium. Organic nitrogen (both dissolved and suspended) is the dominant form of nitrogen in all samples. However, the site that exceeds the total nitrogen guidelines has significant amounts of nitrate and ammonium. This suggests there is a source of inorganic nitrogen upstream of this site (e.g. effluent, sewage etc.).

The remainder of this section focusses on the tributaries that fall in the Southern Lowland water type (Obi Obi, Six Mile, Yabba Creek). As Figure 53 shows only Obi Obi Creek at Houston Bridge (OBI940) exceeds the guidelines for oxidised nitrogen this year. In 2018 only Six Mile Creek upstream of Lake MacDonald (SIX080) and downstream of Lake MacDonald (SIX160) exceed both the guidelines for Ammonium (see Figure 54) and Total Nitrogen (see Figure 55). Six Mile Creek at Woondum (SIX775) also marginally exceeds the guideline for total nitrogen. Most tributary sites sit below the Total Nitrogen guideline in 2018.

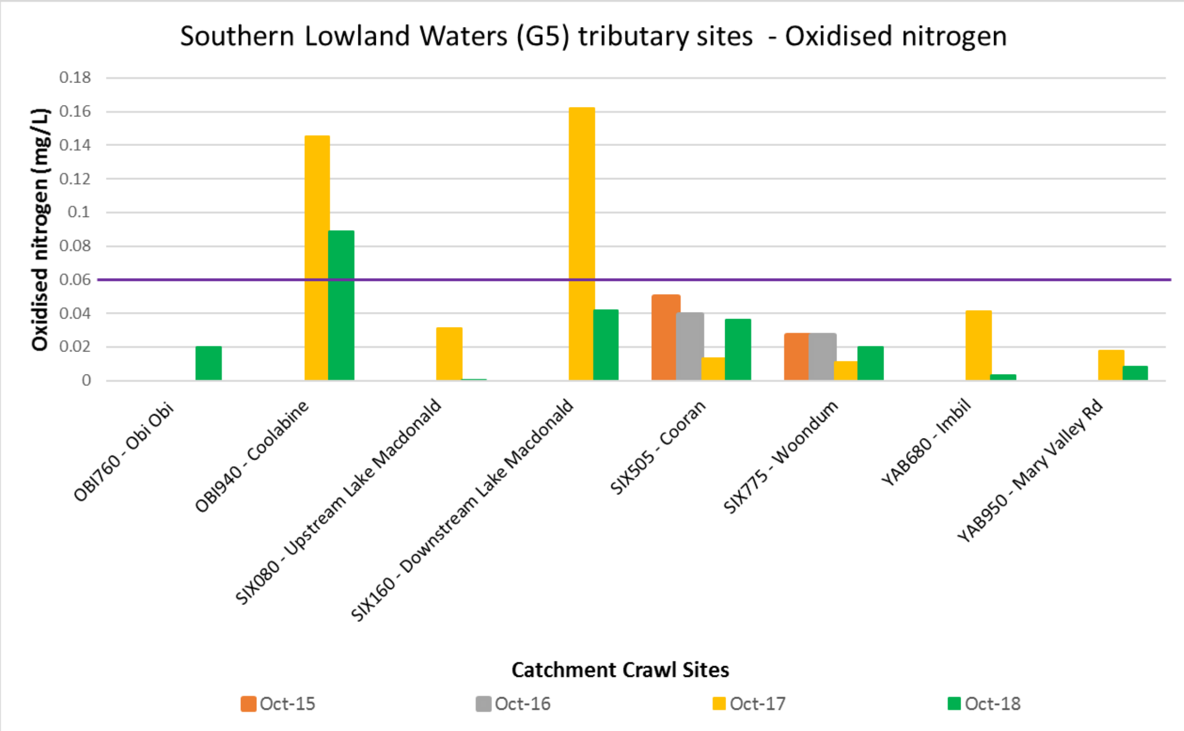


**Figure 53 Oxidised nitrogen results for tributary sites in Southern Lowland Waters (G5)**

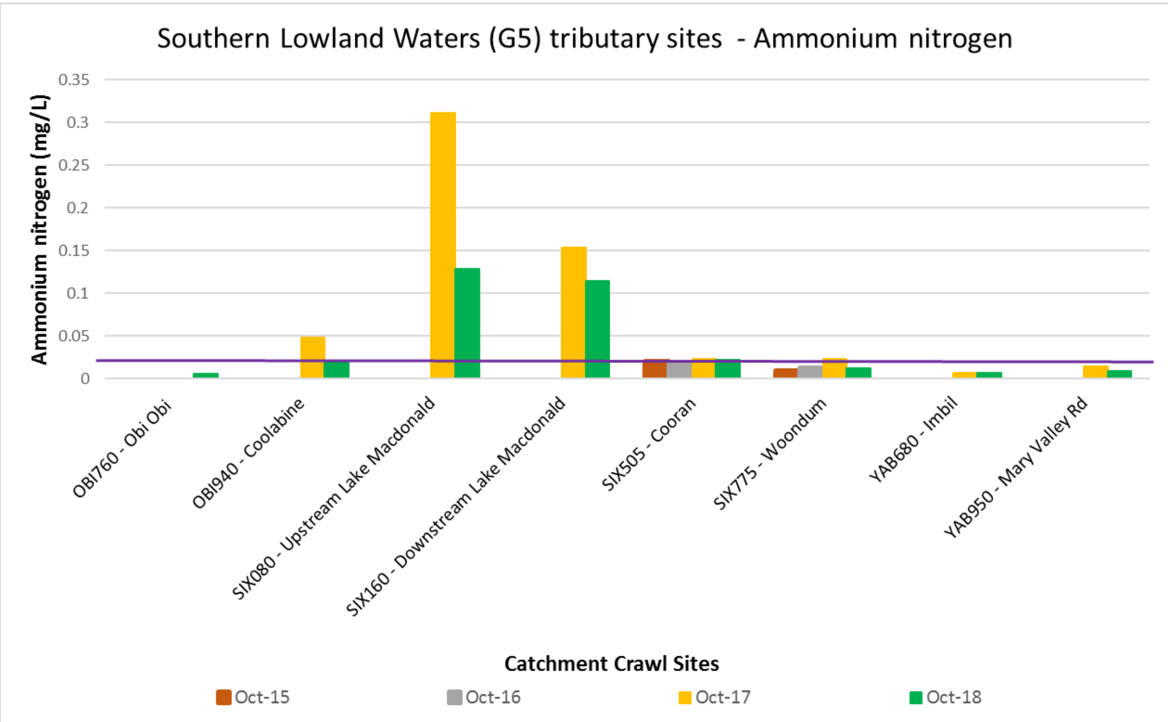


**Figure 54 Ammonium results for tributary sites in Southern Lowland Waters (G5)**

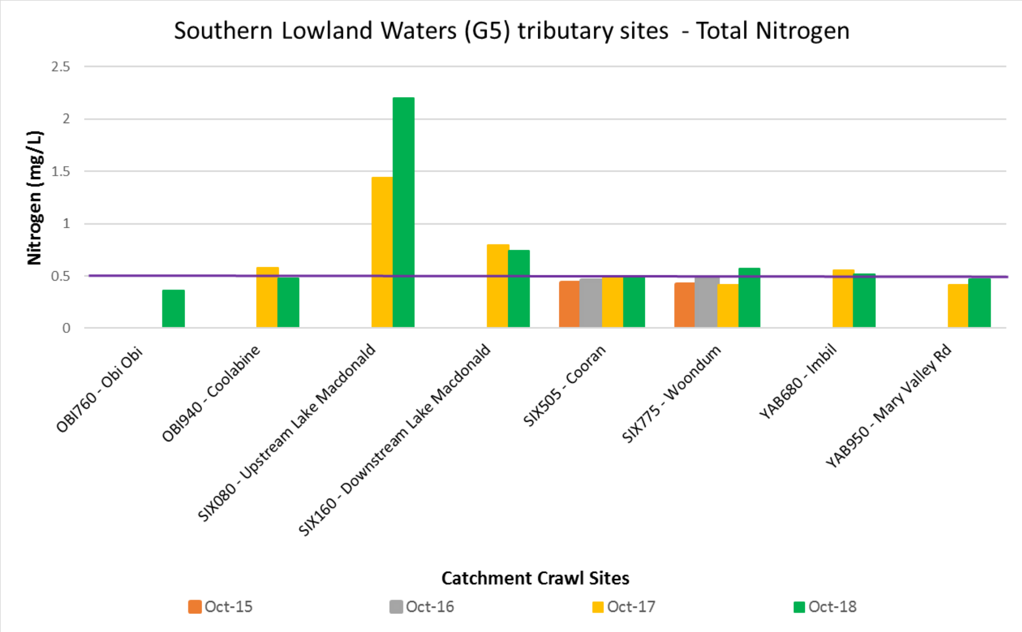


**Figure 55 Total Nitrogen results for tributary sites in Southern Lowland Waters (G5)**

Figure 56 shows the comparison of the organic nitrogen, ammonium and oxidised nitrogen for these tributary sites. It shows that Six Mile Creek downstream of Lake Macdonald (SIX080) has very high levels of organic nitrogen compared to the other sites, as well as high levels of ammonium. The high levels of organic nitrogen may be explained by decomposing organic matter found near this wetland-type site above Lake McDonald. The site would need to be checked for the prevalence of this material. The presence of the high levels of ammonium indicate there is a possible source of dissolved nitrogen such as effluent also entering Six Mile creek upstream of this site. Similar results were observed at the Six Mile Creek site downstream of Lake McDonald (SIX160), but not to the same degree as SIX080.

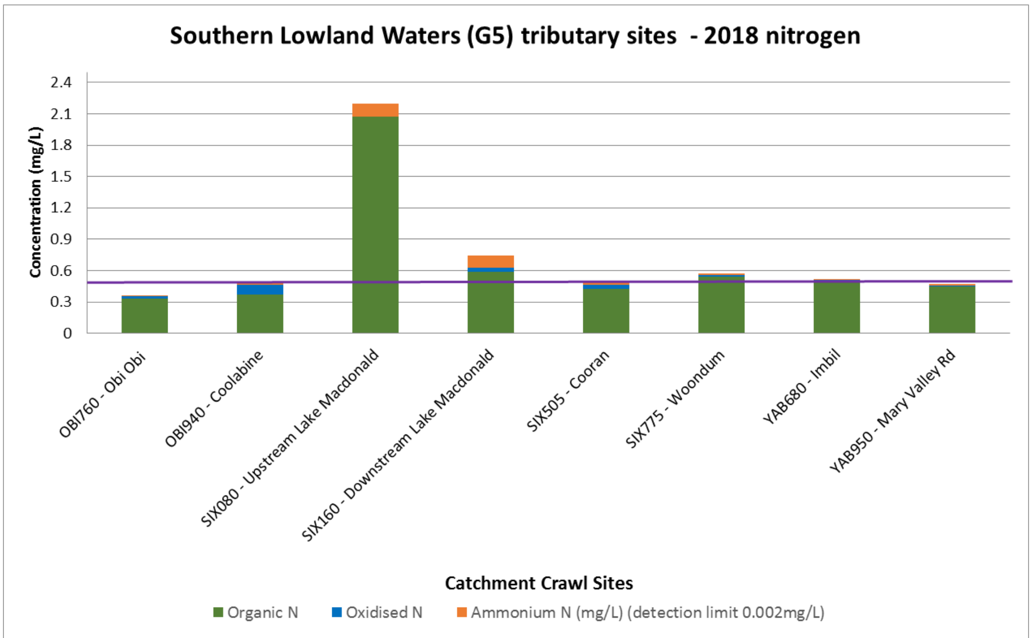


**Figure 56 Relative contribution of the different forms of Nitrogen in tributaries of Southern Lowland waters (G5)**

It is of significance to note that these values in Six Mile Creek are the highest of all samples collected in the freshwater during the Catchment Crawl. As will be discussed in section 3.6.4 the Susan River site gave the highest result of all sites.

### 3.6.2 North Western Lowland Waters (G6)

Figures 57-59 show that all three sites (Munna, Wide Bay, Widgee Creeks) in this water type complied with all of the guidelines for the different forms of nitrogen, except for Total Nitrogen which was marginally exceeded by the Wide Bay site (WIB950).

Over the four years compared, the nitrate levels have been well below the guideline of 0.06mg/L (all less than 0.01 mg/L) across all sites and all years (see Figure 57). The Ammonium values were more variable and came closer to the guideline value of 0.02mg/L in previous years. The result at the Wide Bay Creek site (WIB950) was below the detection limit for Ammonium. Total nitrogen for all three sites has been well within the limit. However, in 2018 it was exceeded marginally at the Wide Bay Creek site (WIB950) and Munna Creek (MUN990) was just below the guideline.

Figure 60 shows the relative contribution of the different forms of nitrogen to the total nitrogen. It shows that the Wide Bay Creek site (WIB950) is entirely dominated by organic N and that both WID399 and MUN990 have small amounts of ammonium and nitrate with the Ammonium portion being roughly equal the oxidised nitrogen portion.

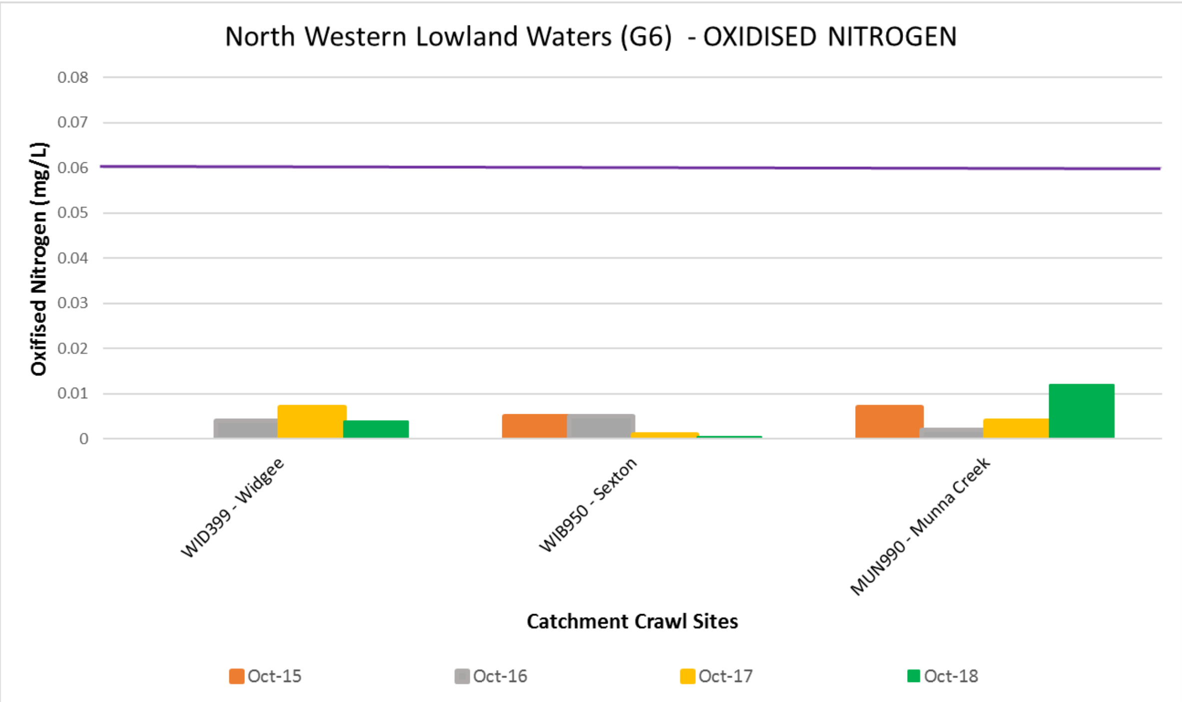


Figure 57 North Western Lowland waters (G6) oxidised nitrogen

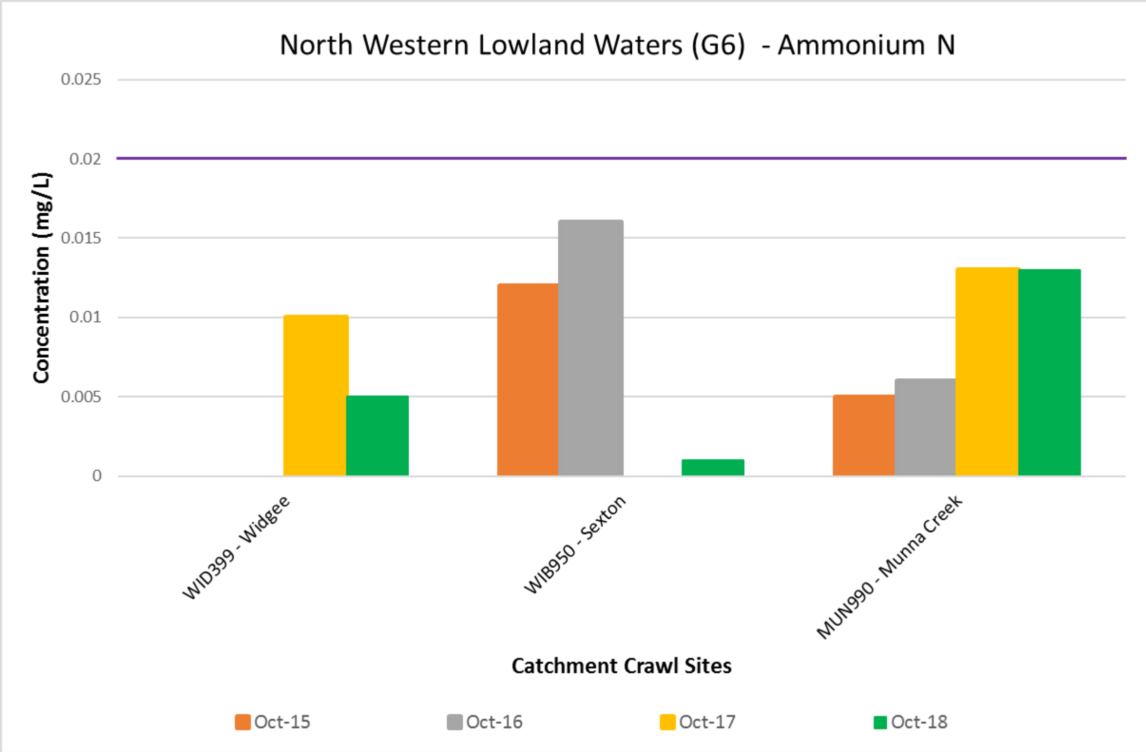


Figure 58 North Western Lowland waters (G6) Ammonium

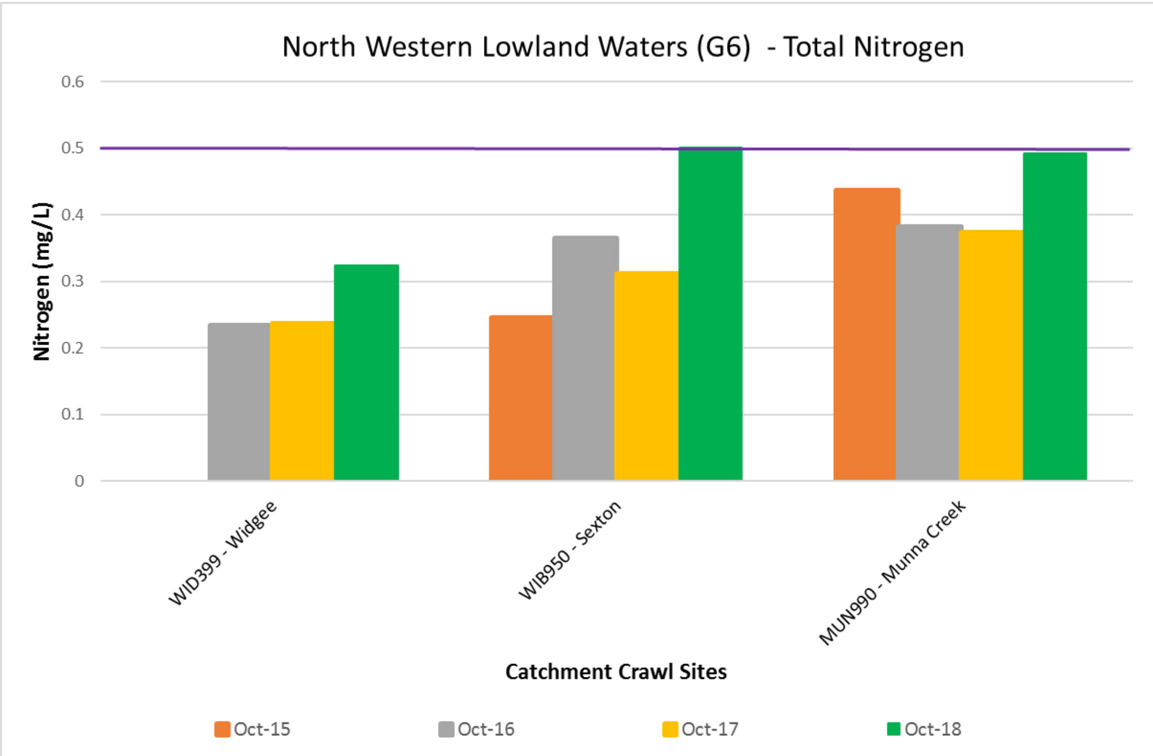


Figure 59 Total Nitrogen results for North Western Lowland waters (G6)

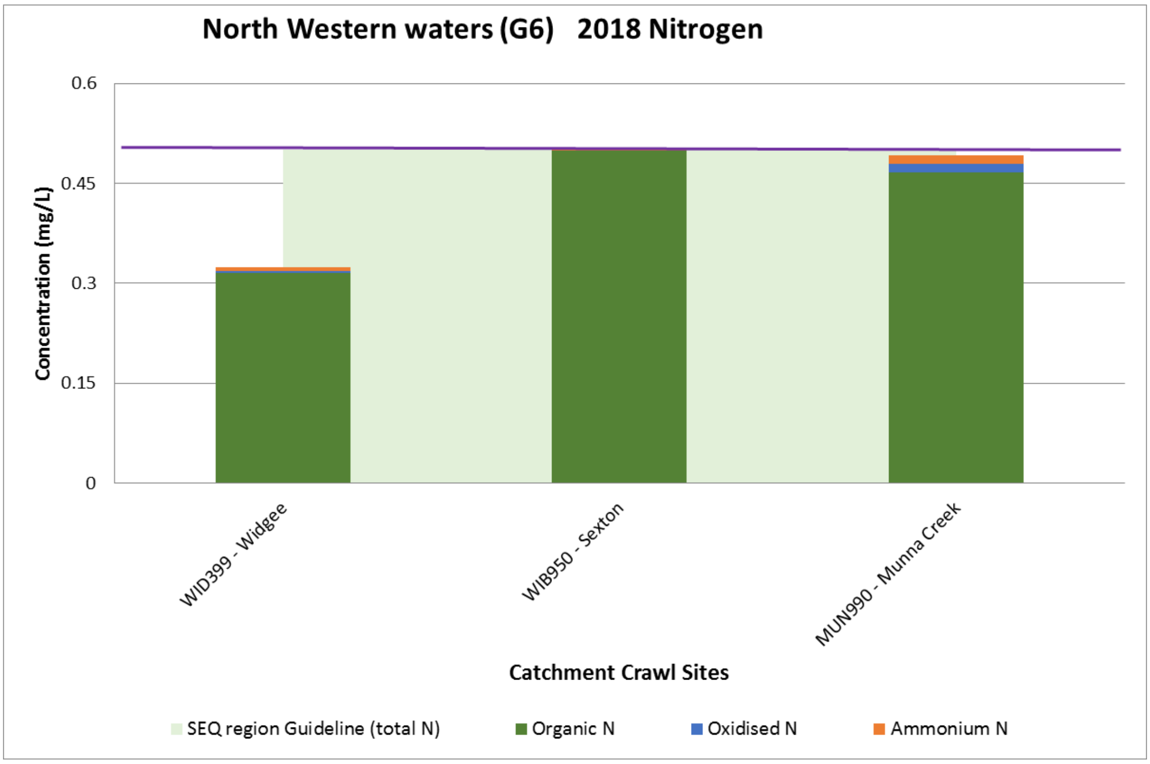


**Figure 60 Relative contribution of the different forms of nitrogen to the North Western waters (G6).**

### 3.6.3 North Eastern Lowland waters (G8)

The North Eastern Lowland waters (Tinana Creek only) comply with oxidised nitrogen (Figure 61) and ammonium (Figure 62) guidelines at both sites in this water type. However, as Figure 63 shows, the total nitrogen guideline of 0.5mg/L was exceeded at both sites in 2018. Figure 64 shows that in 2018 the organic nitrogen component of the Teddington Weir site (TIN800) alone exceeded the total nitrogen guideline, as it did in 2017. These results suggest that there is a source of organic material which contains a significant nitrogen component. Lower Tinana Creek is dominated by weir pools formed largely by Teddington Weir, and further upstream, Tallegalla Weir, which results in low flowing or even stagnant water bodies, coupled with high leaf litter inputs from excellent riparian vegetation. Teddington Weir (TIN800) can have high levels of floating aquatic weeds (Hyacinth, Salvinia) which decompose and provide organic nitrogen sources to the waterway. This may explain the high levels of organic nitrogen.

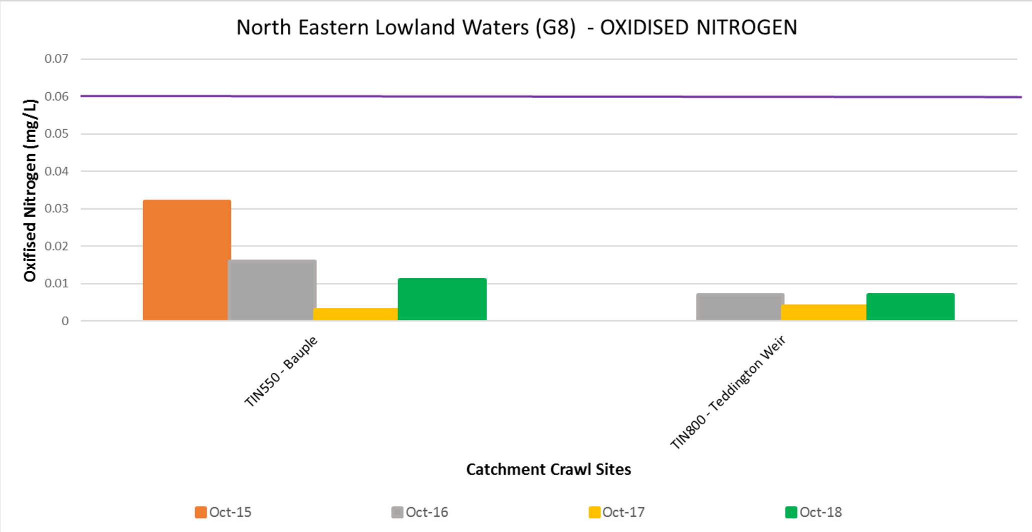


Figure 61 Oxidised nitrogen results for the North Eastern lowland waters (G8)

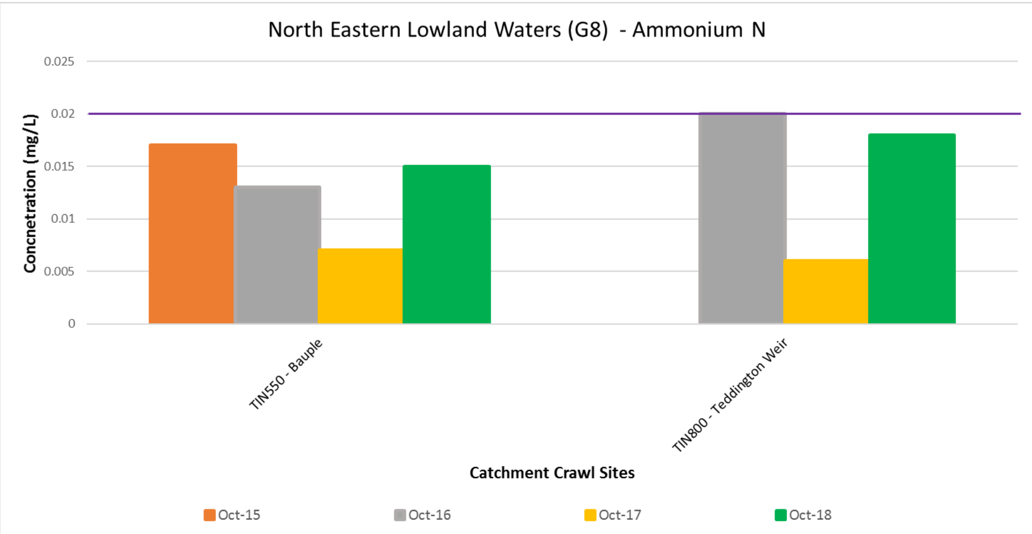


Figure 62 Ammonium results for the North Easter Lowland Waters (G8)

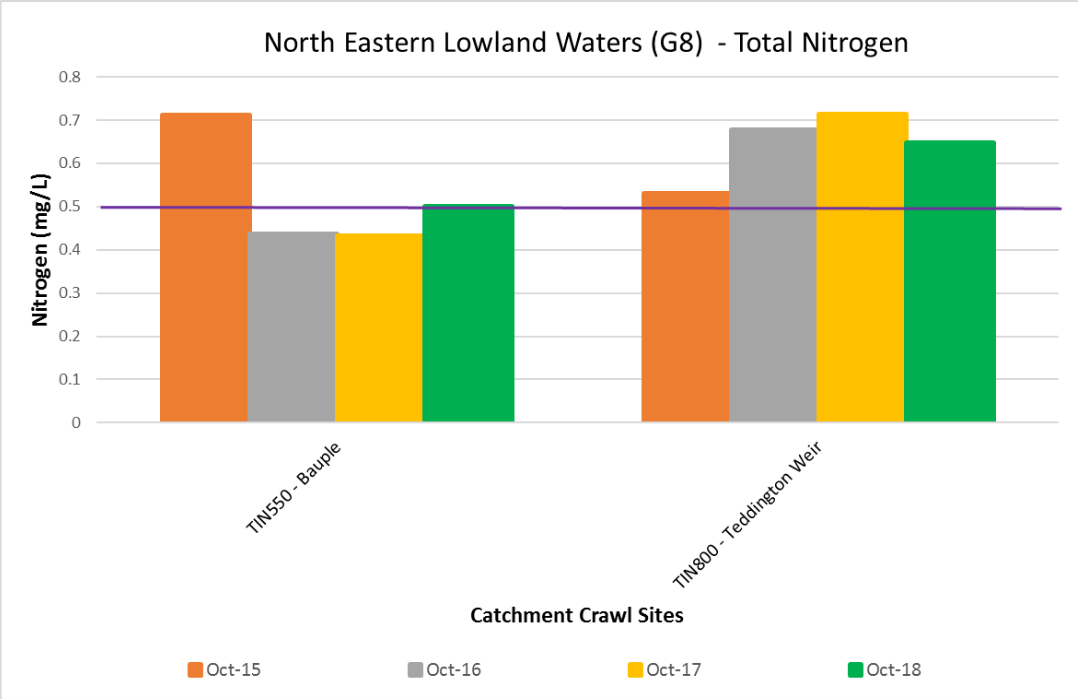


**Figure 63 Total Nitrogen Results for the North Eastern Waters (G8)**

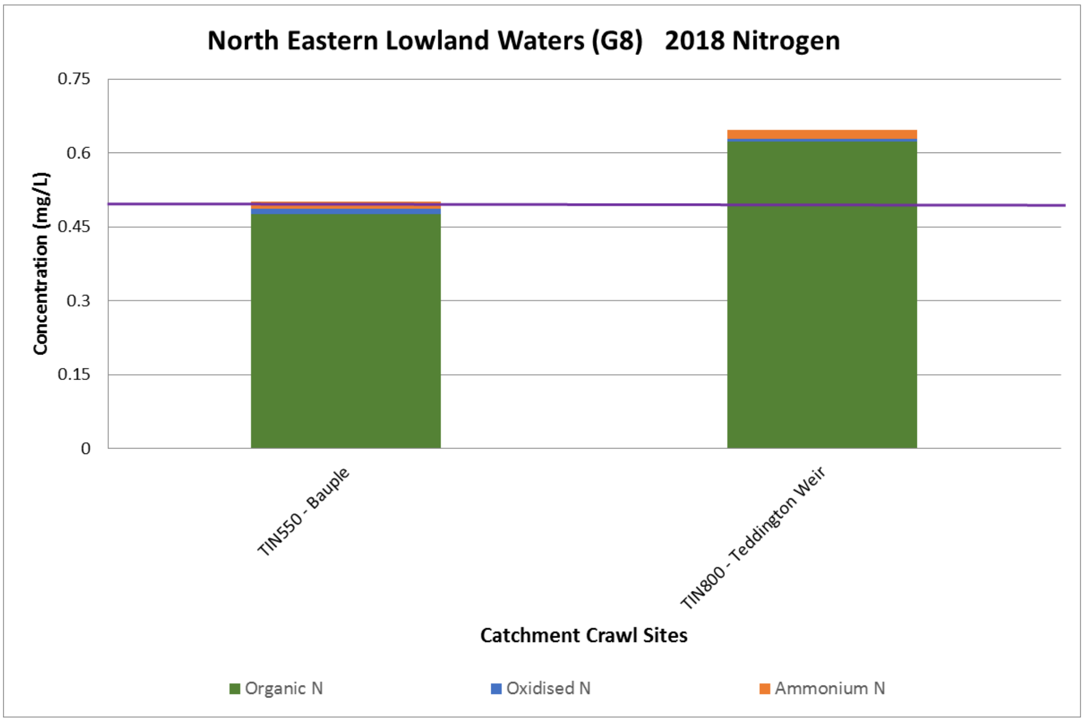


**Figure 64 Relative contribution of the different forms of nitrogen to the North Eastern Lowland waters (G8)**

### 3.6.4 Mary River Estuary – High Environmental Value Waters (G2)

Figures 65 and 67 provide the results for different forms of nitrogen at each site. They show that the River Heads site exceeds the guideline for ammonium and oxidised N and complies with the upper limit with the total nitrogen guideline. The Susan River (SUS500) site had an elevated nitrogen level. This result is the highest for all sites tested in the Catchment Crawl. Figures 66 and 68 show the relative contribution of different forms of nitrogen at each site.


**Figure 65 Results for River Heads site (G2 low): Oxidised nitrogen (upper left), ammonium nitrogen (upper right), organic nitrogen (lower left) and total nitrogen (lower right)**

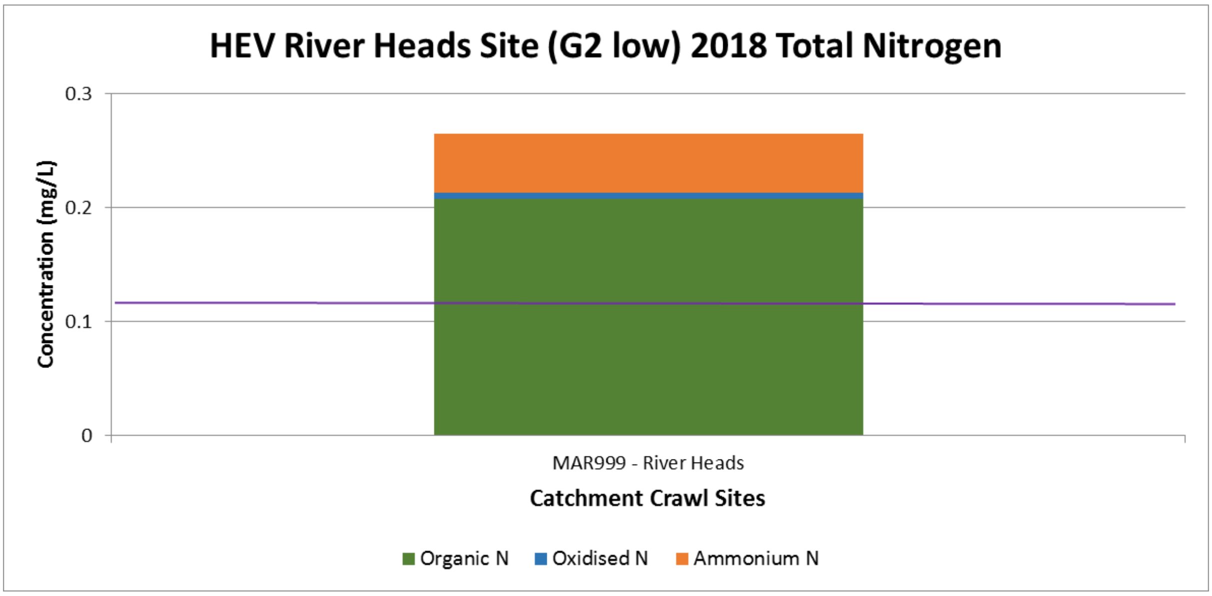


**Figure 66 Relative contribution of different forms of nitrogen to the River Heads site (G2 low)**

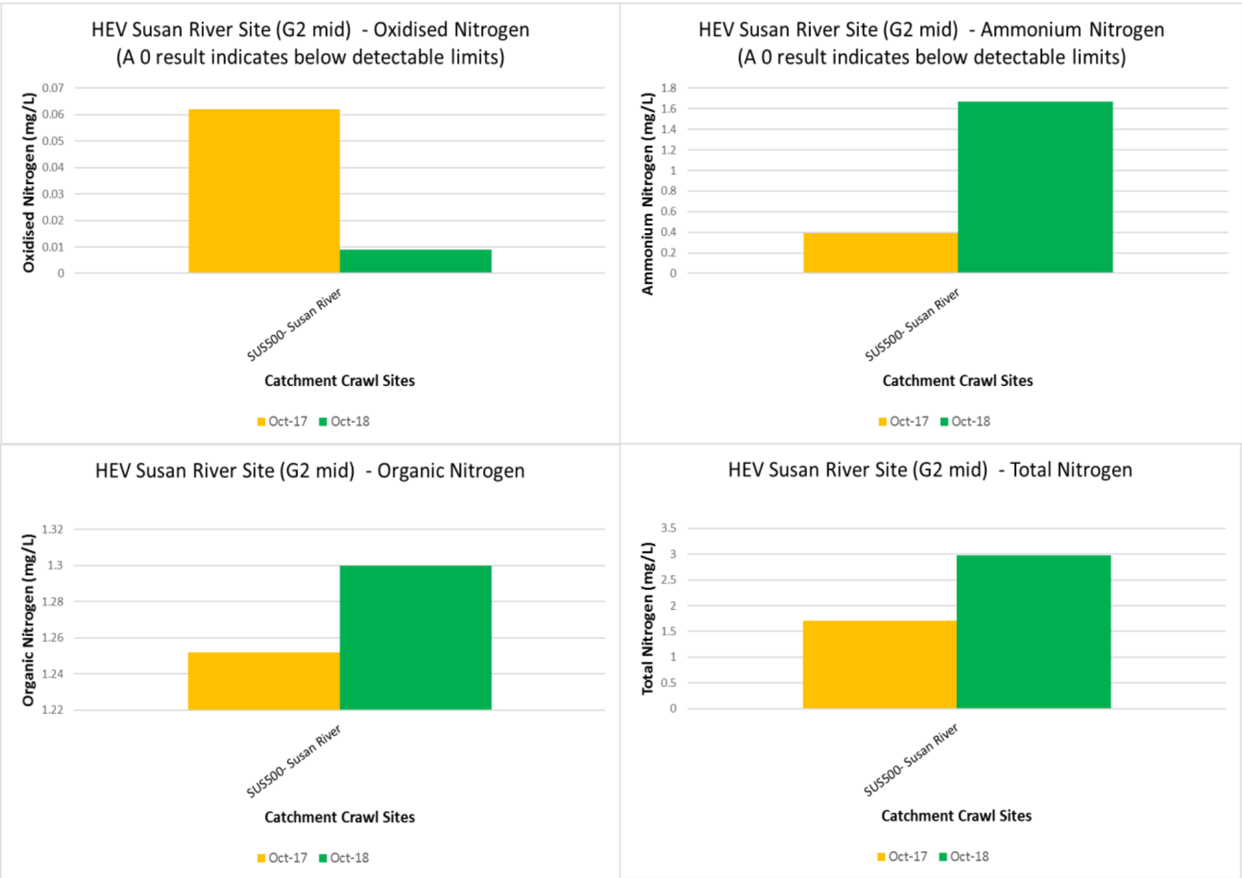


**Figure 67 Results for the Susan River site (G2 mid): Oxidised nitrogen (upper left), ammonium nitrogen (upper right), organic nitrogen (lower left) and total nitrogen (lower right)**

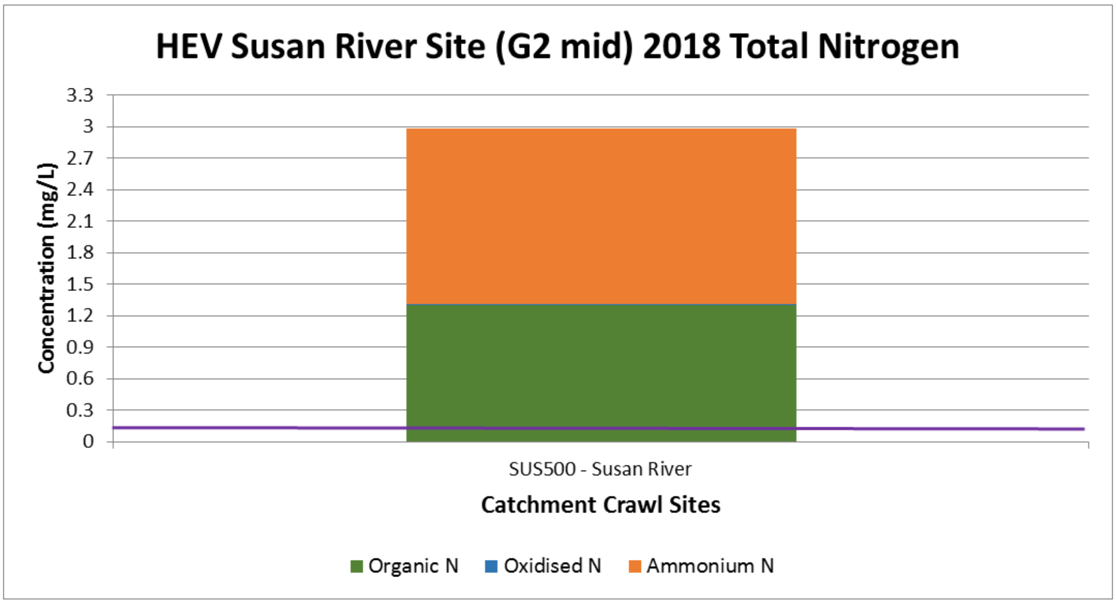


**Figure 68 Relative contribution of different forms of nitrogen to the Susan River site (G2 mid)**

## 3.7 Phosphorus

Total phosphorus is a measure of both the organic and inorganic forms of phosphorus. Phosphorus can be present in water as dissolved or particulate matter. It is an essential plant nutrient which is often the most limiting nutrient to plant growth in fresh water. It is uncommon to find it in significant concentrations in surface waters. Therefore, if significant concentrations of phosphorus do enter a freshwater system, extreme algal blooms can occur. Phosphorus inputs are the main contributing factor in the eutrophication of freshwater systems.

For phosphorus the Queensland Water Quality guidelines (Department of Environment and Resource Management, 2009) for the South East Queensland region set the limits listed in Table 8 for Aquatic Ecosystem health in the upland (>150m elevation), lowland (<150m elevation) and high environmental value (HEV) water of the Great Sandy Strait and lower Mary and Susan Rivers.

**Table 8 South East Queensland region water quality guideline values for phosphorus parameters**

| Parameter | Lowland streams | Upland streams | Upper estuarine | HEV water ($50^{th}$ percentile) |
|---|---|---|---|---|
| Filterable reactive P (mg/L)* | 0.02 | 0.015 | 0.01 | 0.002 |
| Total P (mg/L) | 0.05 | 0.03 | 0.03 | 0.01 |

*primarily phosphate ($PO_4^-$)

### 3.7.1 Southern Lowland Waters (G5)

The guideline value for Southern Lowland waters (G5) is 0.02 mg/L for Filterable reactive phosphorus and 0.05 mg/L for total phosphorus.

As Figure 69 shows, all sites except Tuchekoi (MAR372) and Widgee Xing (MAR510) complied with the phosphate guideline. The MAR510 site has exceeded the guideline for the last four years. The upland waters have a stricter guideline which the only upland site at the Mary River headwaters (MAR009) exceeded in 2016 and just met in 2017. However, in 2018 this site was well within the guideline.

The total phosphorus results exhibit more exceedances of the guideline (see Figure 70). Four sites exceed or exactly meet the guideline value of 0.05 mg/L for the lowland waters. The four lowland sites include the Mary River in Kenilworth (MAR170), Tuchekoi (MAR372), Widgee Xing (MAR510) and Emerys Xing (MAR660) which was eight times above guideline. Previously MAR660 has not been a problem.

Figure 71 shows the contribution of both phosphate and organic phosphate to the results in 2017. It shows that the Kenilworth (MAR170) and Emerys Xing (MAR660) sites exceed the total phosphorus guideline based on the organic component alone.

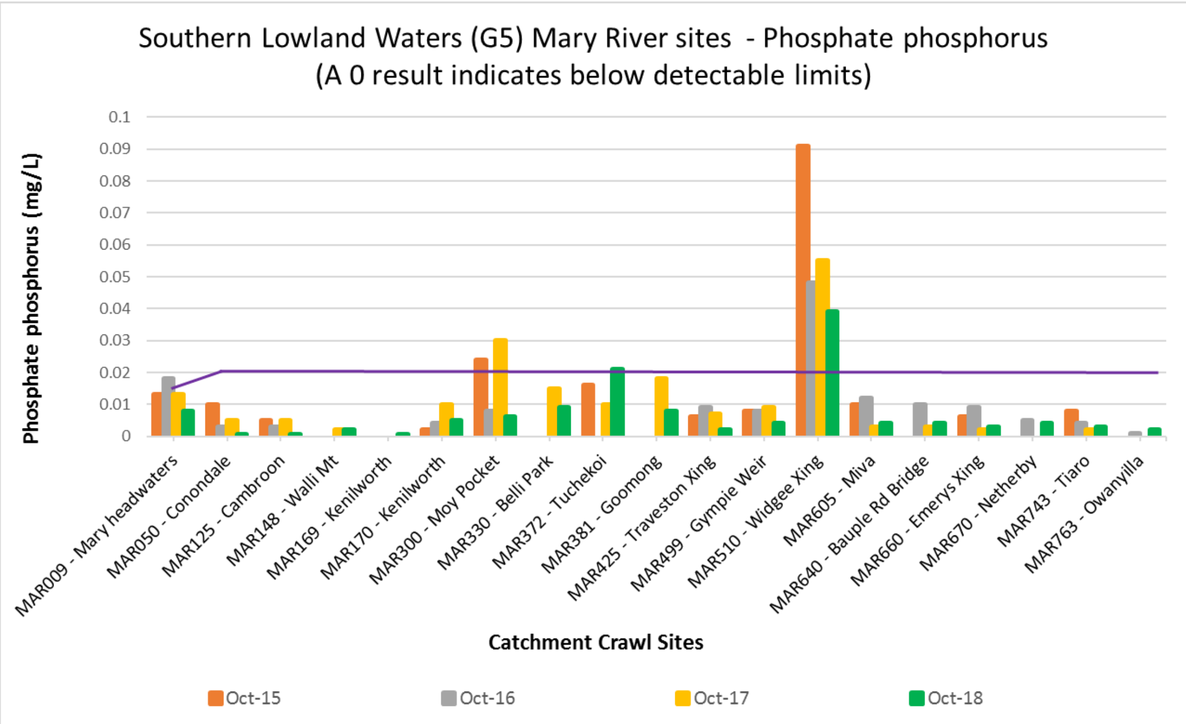


Figure 69 Phosphate results for the Mary River Southern Lowland waters (G5)

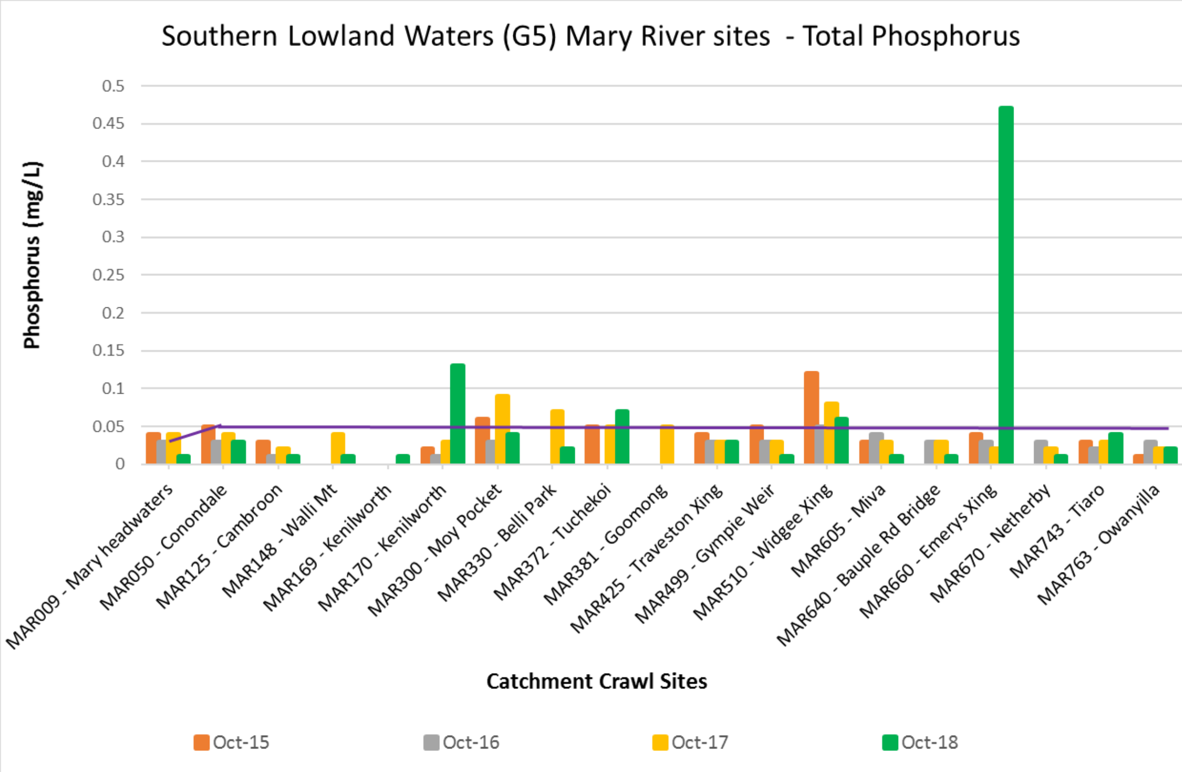


**Figure 70 Total Phosphorus results for the Mary River Southern Lowland waters (G5)**

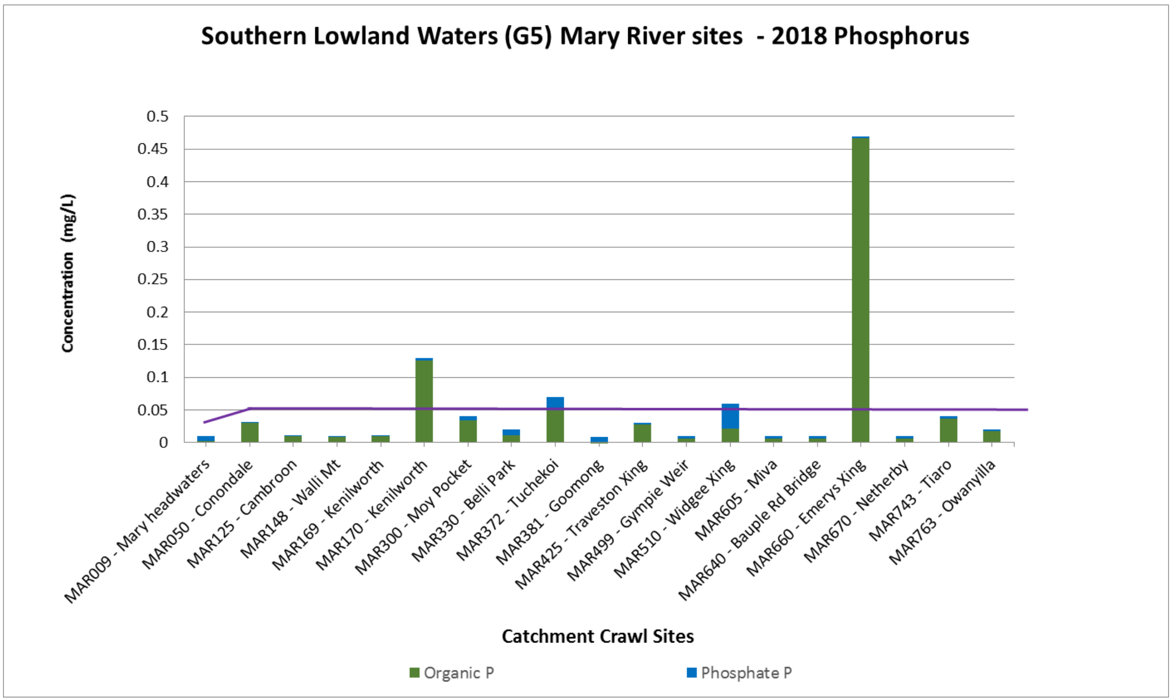


**Figure 71 Relative contribution of the different forms of Phosphorus in Mary River Southern Lowland waters (G5)**

Of the seven tributaries tested in this water type only one returned a value that equalled the phosphate guideline of 0.02 mg/L (see Figure 72) but two sites equal or exceed the 0.05mg/L guideline for total phosphorus (see Figure 73). The Obi Obi site at Houston Bridge (OBI940), which significantly exceeded the guideline in 2017, equalled both these guidelines in 2018 and Six Mile Creek at Worba Lane (SIX080) exceeded the total phosphorus guideline. Figure 74 shows the relative contribution of organic and phosphate phosphorus to this total phosphorus result. It shows that the Obi Obi site is almost half phosphate and half organic forms of phosphorus whereas the Six Mile Creek site is almost entirely organic phosphorus.

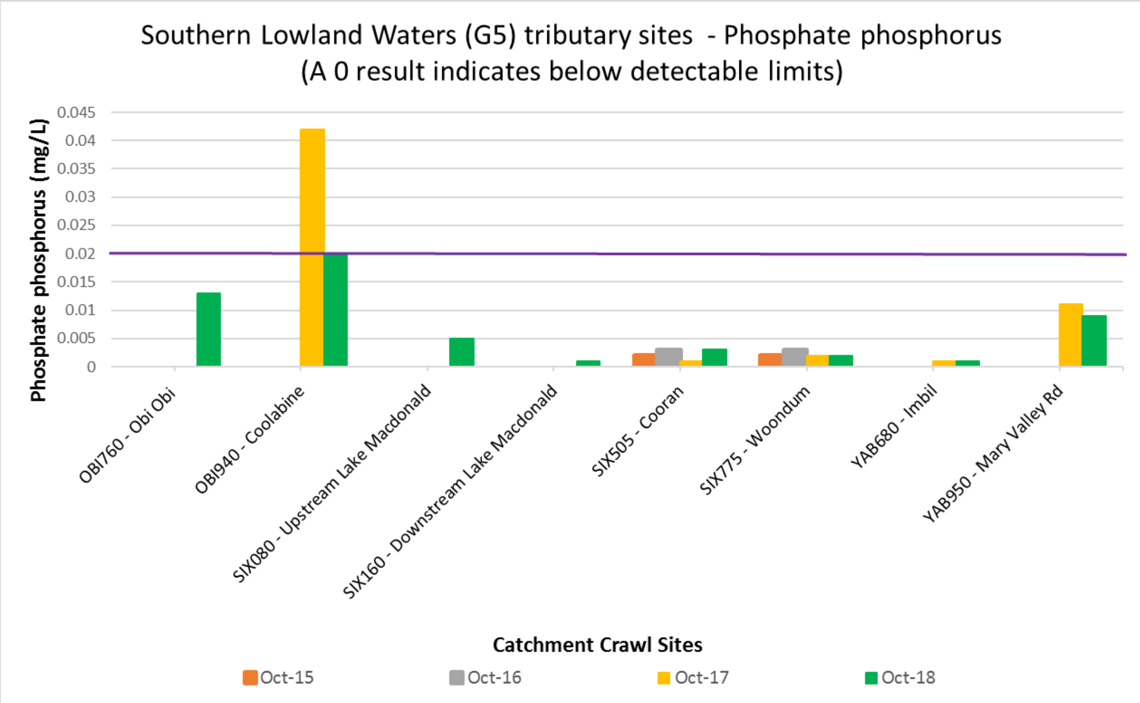


Figure 72 Phosphate results for the Southern Lowland water (G5) tributaries

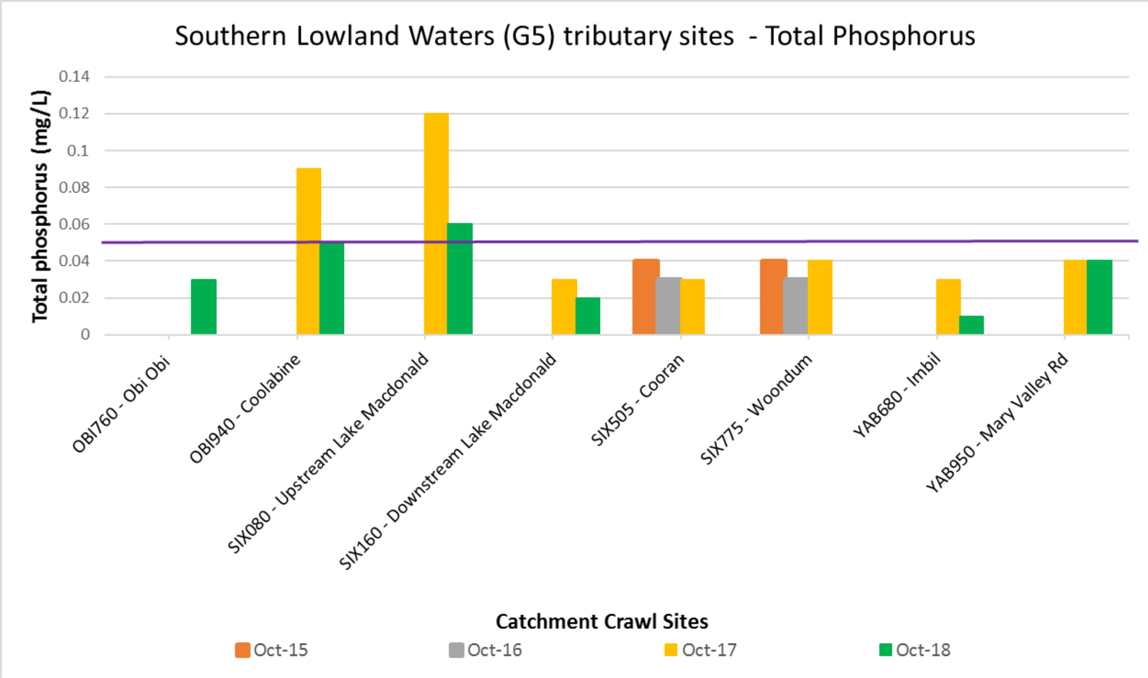


**Figure 73 Total Phosphorus results for the Southern Lowland water (G5) tributaries**

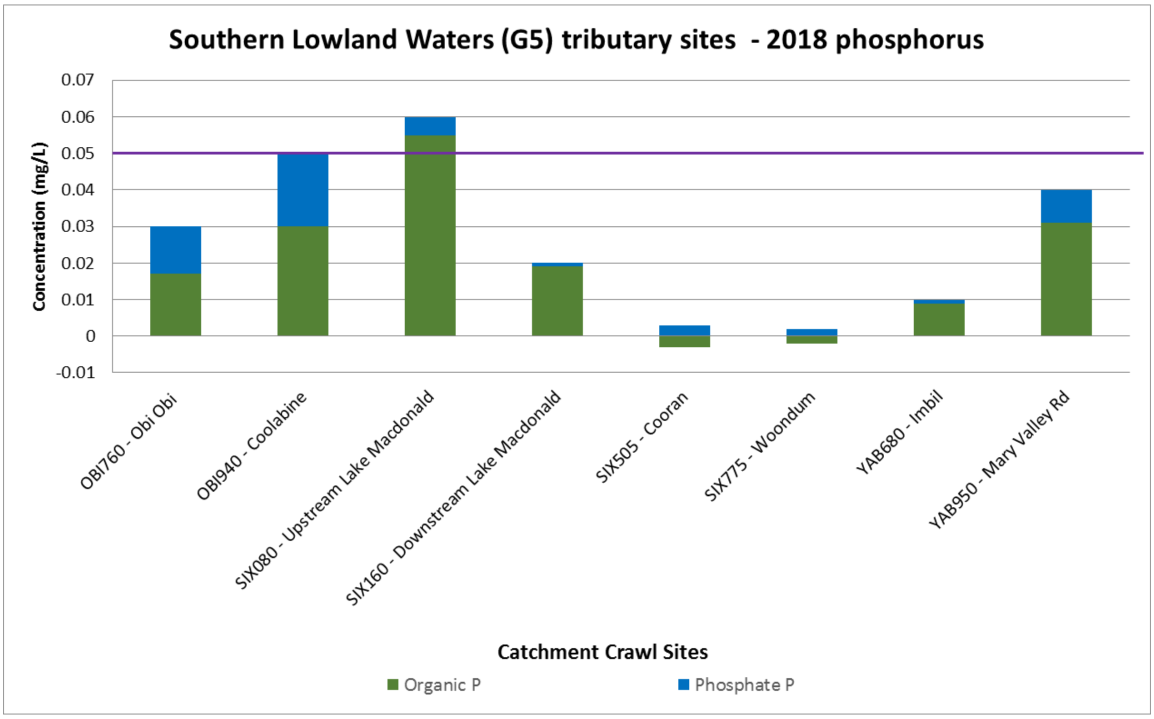


**Figure 74 Relative contribution of the different forms of Phosphorus in tributary Southern Lowland waters (G5)**

### 3.7.2 North Western Lowland Waters (G6)

The north western lowland waters (Munna, Wide Bay, Widgee Creeks) comply with phosphate at all sites in this water type (see Figures 75 and 76). The 2018 phosphate results were the lowest recorded in four years. The Total Phosphorous levels in 2018 were also the lowest recorded in four years.

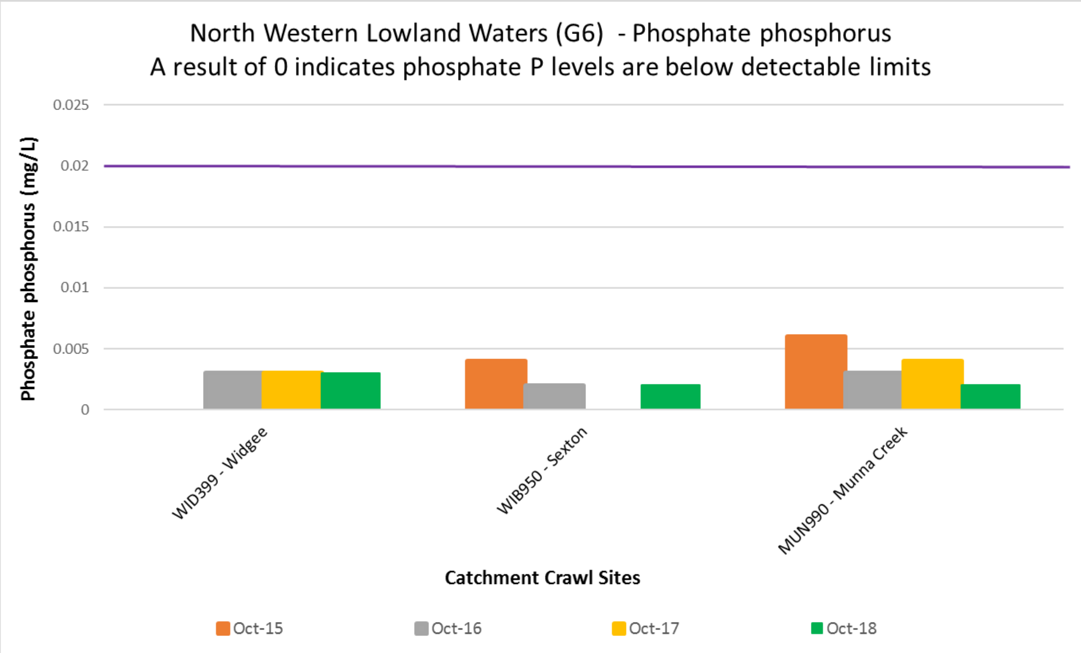


Figure 75 Phosphate results for North Western Lowland waters (G6)

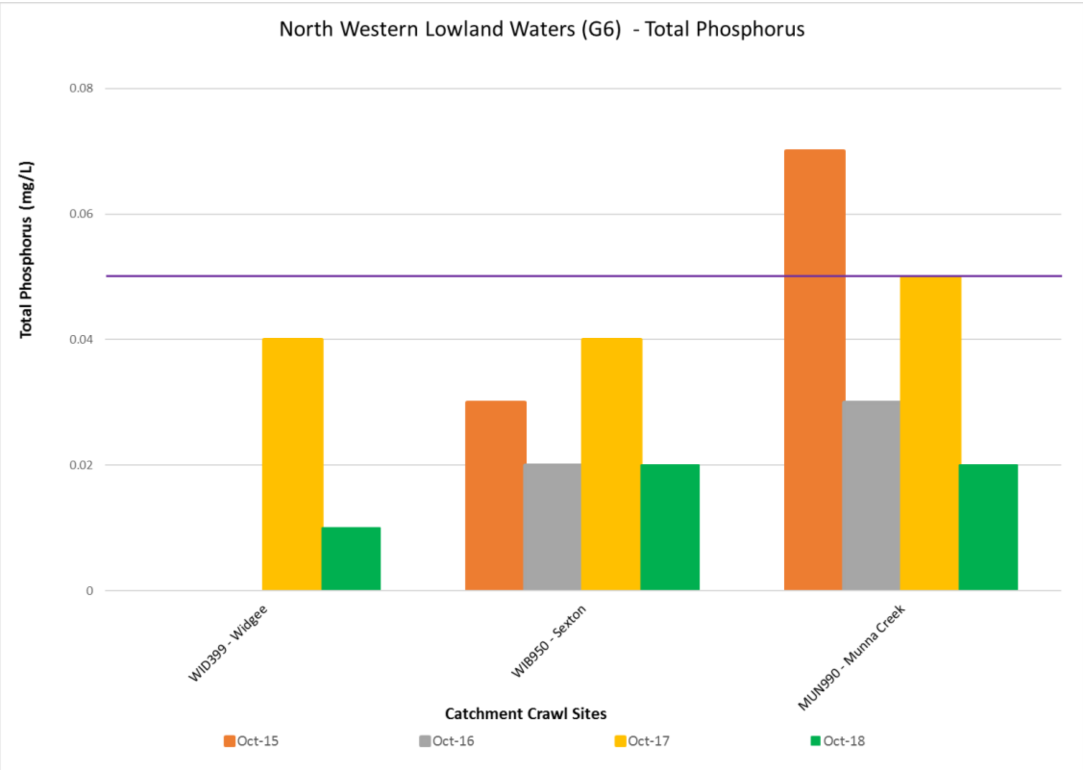


Figure 76 Total Phosphorus results for North Western Lowland waters (G6)

### 3.7.3 North Eastern Lowland waters (G8)

The north eastern lowland waters (Tinana Creek only) comply with phosphate (Figure 77) and total phosphate (Figure 78) at both sites in this water type. Figure 79 shows that in 2018 the organic phosphorus component dominates the results. These results suggest that there is a source of organic material which contains a significant phosphorus component.

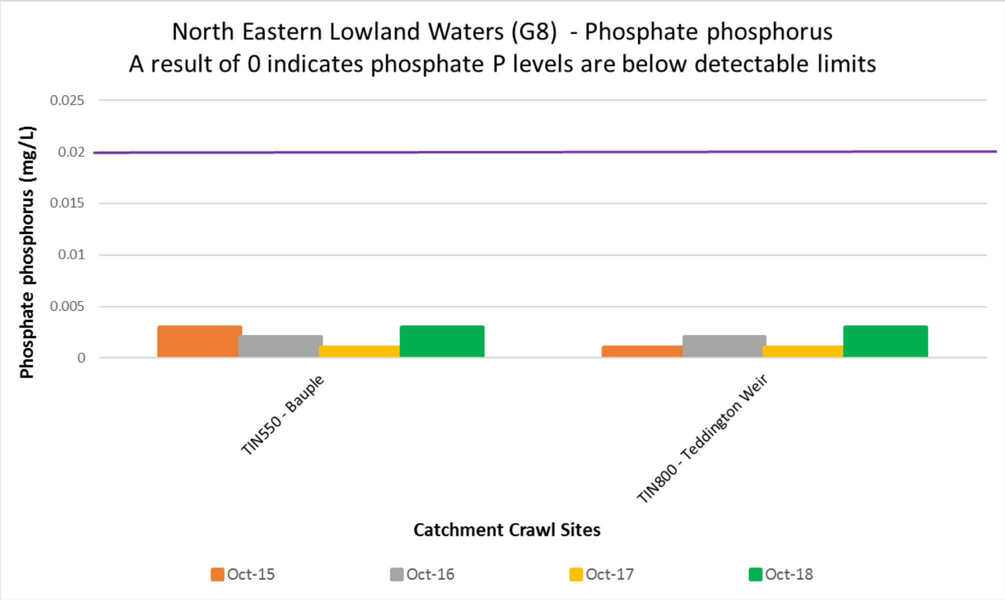


Figure 77 Phosphate results for North Eastern Lowland waters (G8)

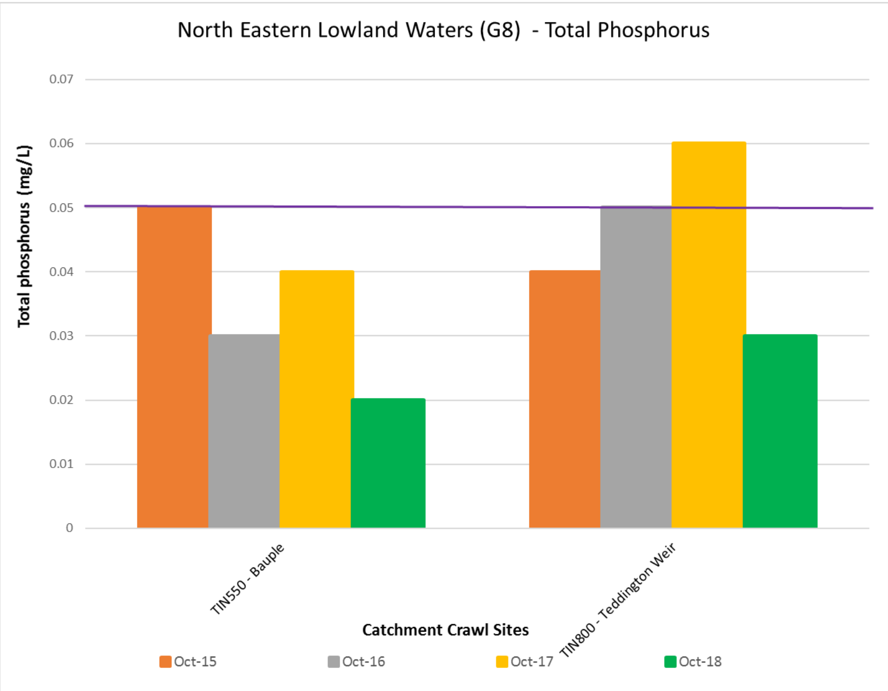


Figure 78 Total Phosphorus results for North Eastern Lowland waters (G8)

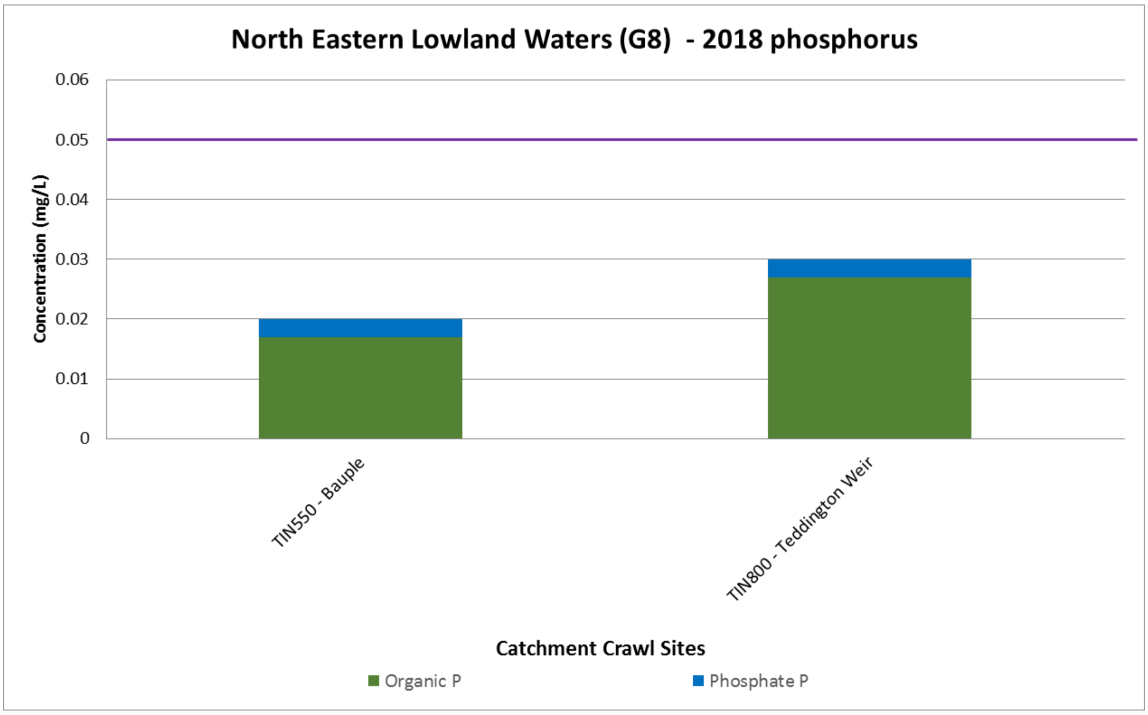


**Figure 79 Relative contribution of the different forms of phosphorus to the North Eastern Lowland waters (G8)**

### 3.7.4 Mary River Estuary – High Environmental Value Waters (G2)

Data collection of the estuary sites only commenced in a comprehensive manner in 2017.

Figures 80 and 82 show a comparison of total phosphorus for 2017 and 2018 for each site. This shows that total phosphorus increased in 2018 at the River Heads site (MAR999) and decreased for the Susan River site (SUS500). Figures 81 and 83 provide the guidelines for the HEV waters for total phosphorus and results for each site including phosphate P and Organic P. It shows that both sites exceed the total phosphorus guideline suggesting that a source of suspended or dissolved organic phosphorus is elevating levels within the water course. The River Heads site (MAR999) exceeds the Phosphate guideline.

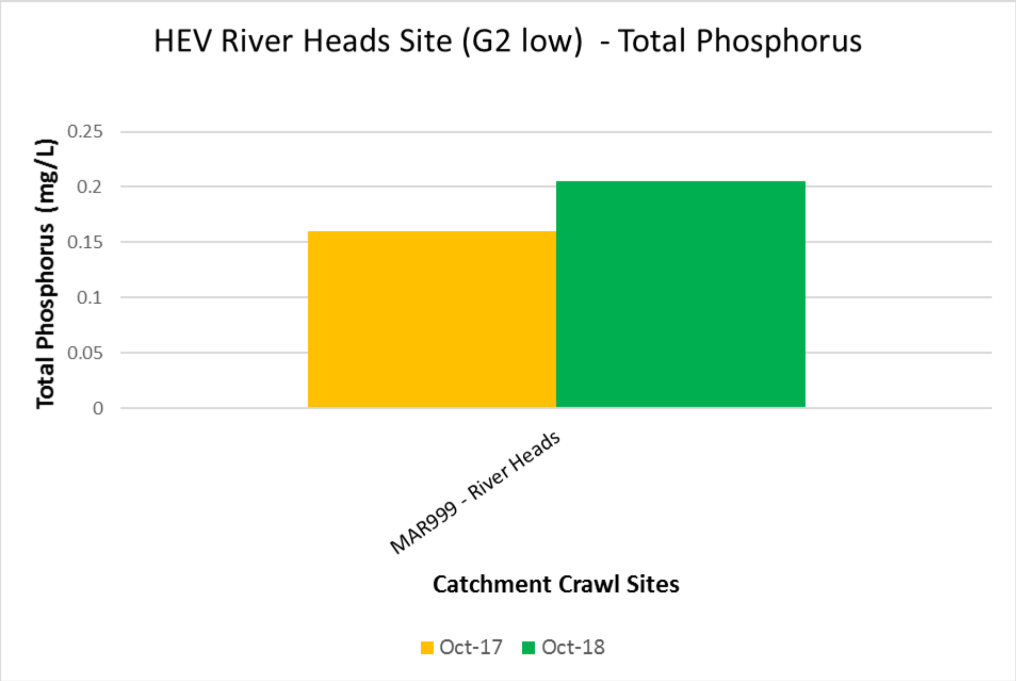


Figure 80 Total phosphorus results for the River Heads site (G2 low)

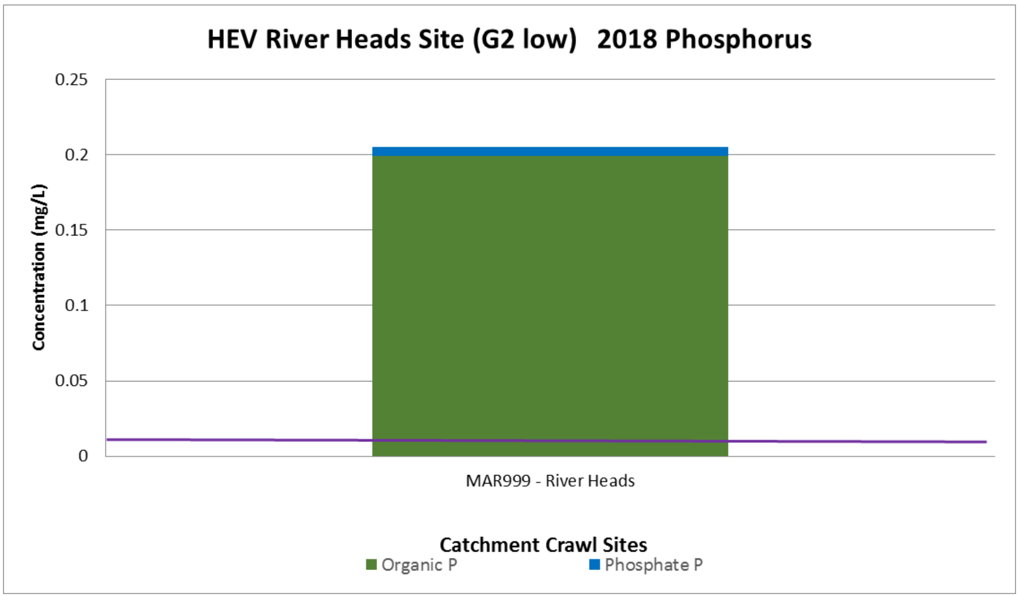


Figure 81 Relative contributions of different forms of phosphorus to the River Heads site (G2 low)

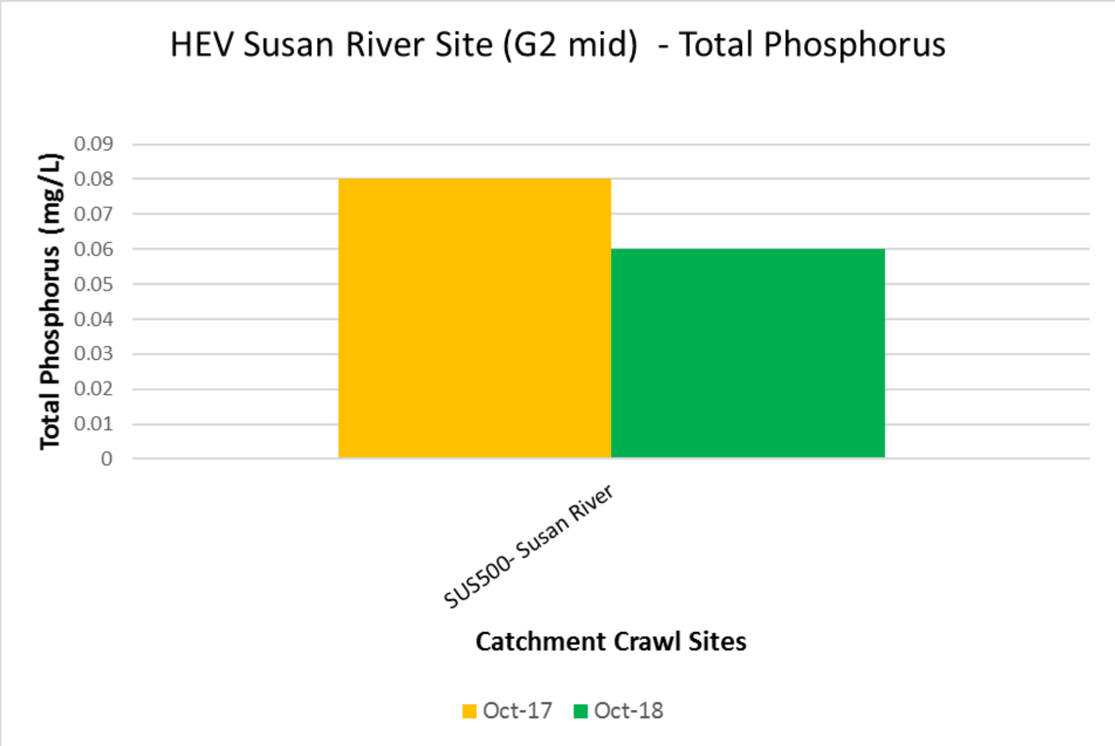


**Figure 82 Total phosphorus results for the Susan River site (G2 mid)**

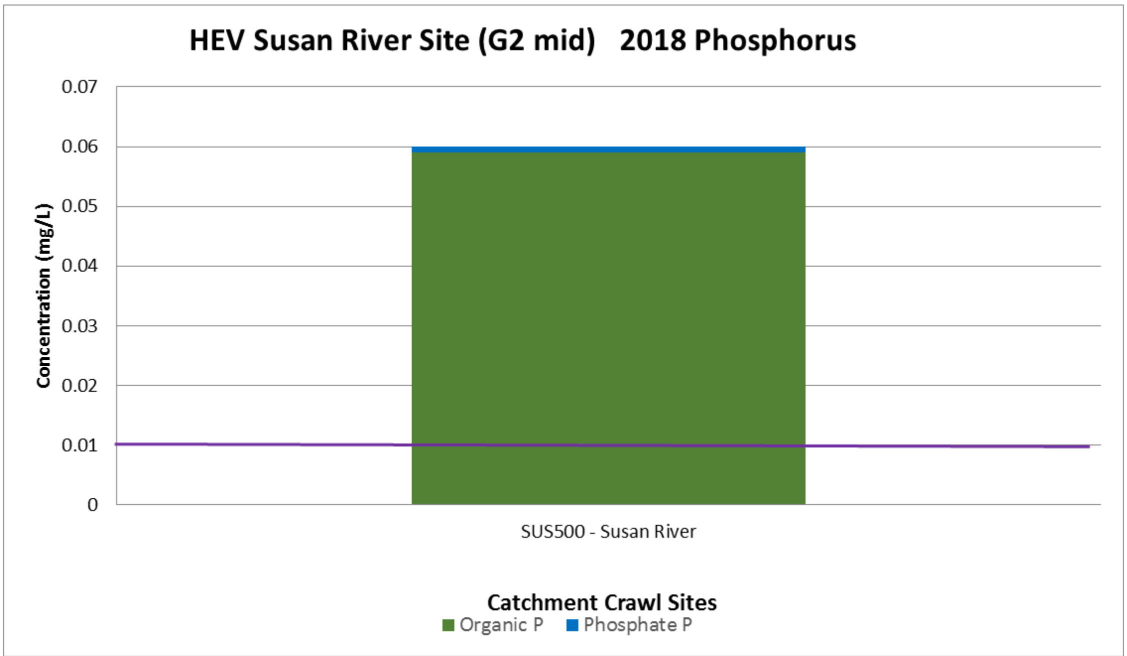


**Figure 83 Relative contibutions of the different forms of phosphorus to the Susan River site (G2 mid)**

## 3.8 E. coli

*Escherichia coli* (*E. coli*) is a bacterium that is commonly found in the gut of humans and warm-blooded animals. *E. coli* levels are used as indicators of the presence of faecal material in drinking and recreational waters. Both indicate the possible presence of disease-causing bacteria, viruses, and protozoans. Sources of bacteria include improperly functioning wastewater treatment plants, leaking septic systems, storm water runoff, animal carcasses, and runoff from animal manure and manure storage areas.

*E.coli* was not sampled at all sites due to constraints with delivery of samples to the laboratory within 24 hours of sample collection. Samples were collected for the Southern Lowland waters, North Eastern Lowland waters and one site in the High Environmental Value waters. These results are discussed below.

The guideline for *E.coli* level used is the Primary Contact guideline (ANZECC and ARMCANZ, 2000) and the value is 150 MPN/100ml. The most probable number (MPN) is the number of organisms that are most likely to have produced laboratory results in a particular test.

**Observations**

The *E.coli* reading at Moy Pocket (MAR300) is high, following a very high reading in 2017.The Widgee Xing (MAR510) result was extraordinarily high in 2018, after just exceeding the guideline in 2017. The high reading at Gympie Weir (MAR499) indicates that some *E.coli* could be attributed to stormwater inputs above the weir from Gympie.

Overall, more *E.coli* data is required over several years to identify trends.

### 3.7.5 Southern Lowland Waters (G5)

In 2018 the sample at  Kenilworth downstream of the Obi Obi confluence (MAR170), the Tuchekoi site (MAR372), the Gympie Weir site (MAR499), Widgee Xing site (MAR510) and Walkers Road Bridge site (MAR300) exceed the primary contact guideline (see Figure 84). Site MAR300 also exceeded the guideline in 2017, although by a greater amount. However, Widgee Xing (MAR510) exceeds the guideline in 2018 after just exceeding values in 2017. Among the tributary sites, the Obi Obi at Houston Bridge (OBI940) exceeded the guideline significantly (See Figure 85). These results need to be interpreted with care being one-off samples and should be supplemented with more detailed data collected during events.

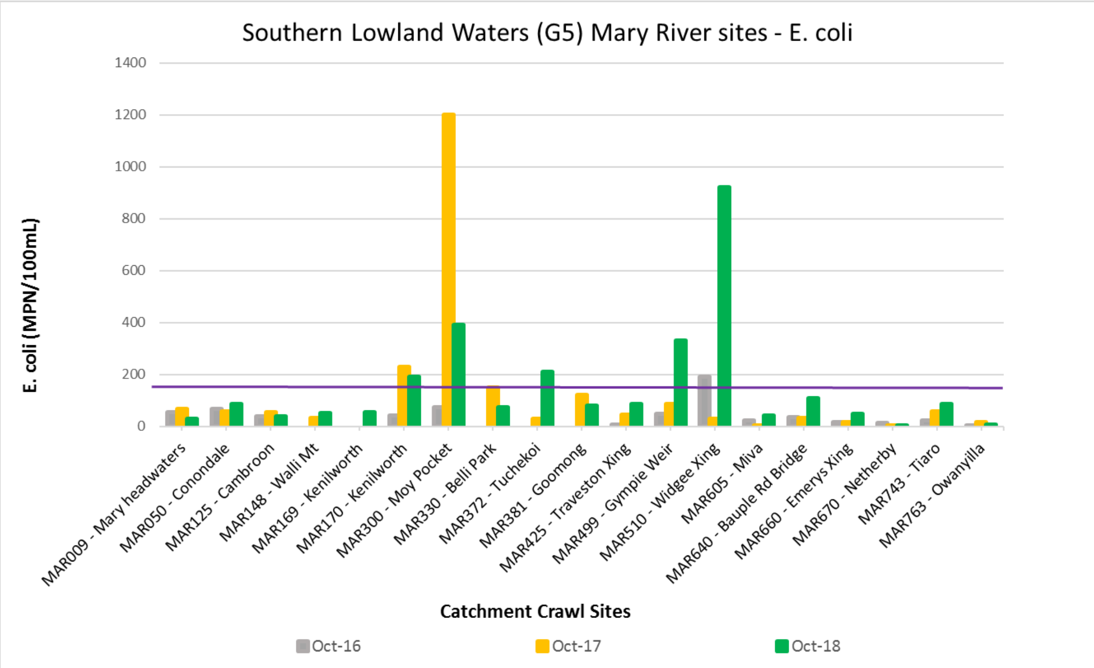


Figure 84 E.coli results for Mary River Southern Lowland waters (G5)

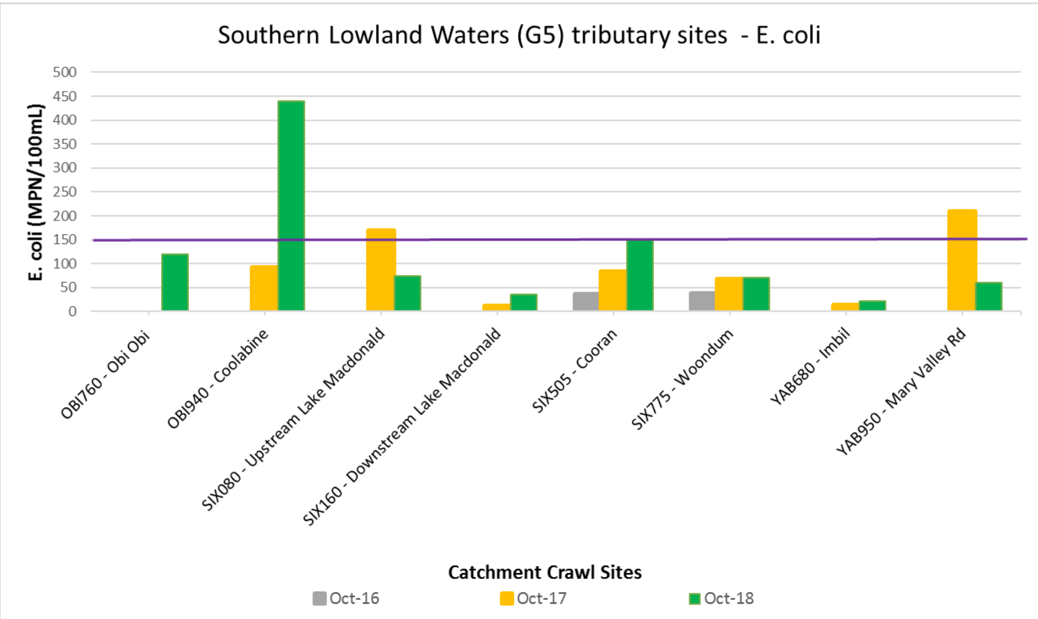


Figure 85 E.coli results for tributaries in the Southern Lowland waters (G5)

### 3.7.6 North Eastern Lowland waters (G8)

Figure 86 shows that the sites tested in the north eastern lowland waters (G8) of Tinana Creek both complied for *E.coli* guidelines in 2018 (and 2017). These sites were not tested in 2016.

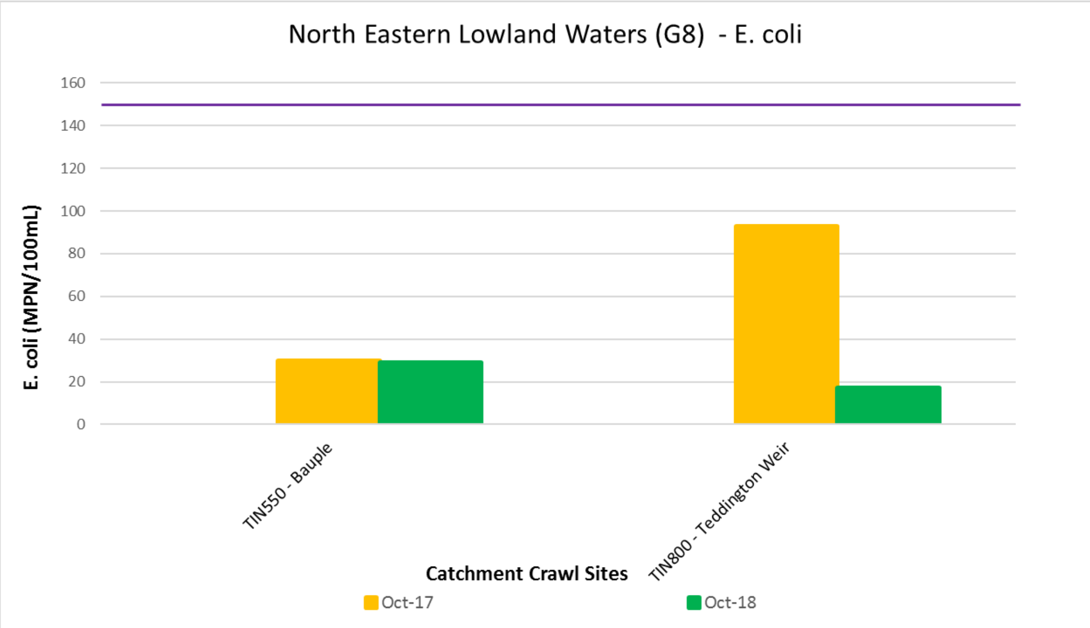


**Figure 86 E.coli results for North Eastern Lowland waters (G8)**

### 3.7.7 Mary River Estuary – High Environmental Value Waters (G2)

Only the Susan River site (SUS500) was sampled for *E.coli* in the G2 water type (see Figure 87). The result returned was 250 MPN/100ml, which is above the guideline for primary contact of 150 MPN/100ml.

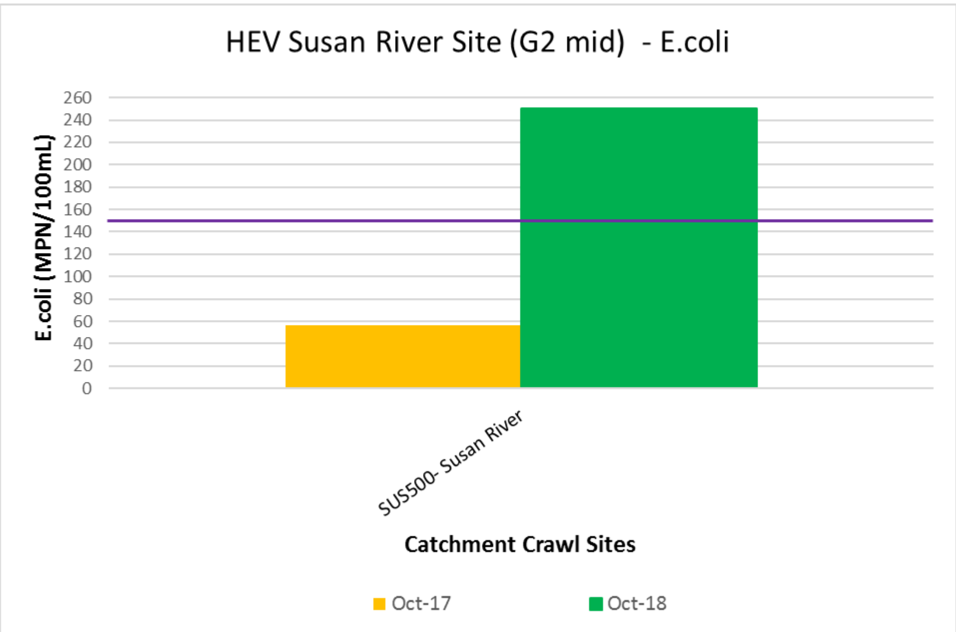


**Figure 87 E.coli results for the Susan River site (G2 mid)**

## 3.8 Aquatic weeds

**Table 9 Approximate coverage of water weeds observed during the 2018 catchment crawl**

| Site | Salvinia | Water Hyacinth | Dense Water Weed | Cambomba | Filamentous Algae | Other |
|---|---|---|---|---|---|---|
| **MAR009** | | | | | | None seen |
| **MAR050** | | | | | | Duckweed <20% |
| **MAR125** | | | | | | Azolla <20%, hydrilla <20%, vallisneria <20% |
| **MAR148** | | | | | <20% | |
| **MAR169** | | | | | <20% | |
| **MAR170** | | | | | <20% | |
| **MAR300** | | | | | | None seen |
| **MAR330** | | | | | | None seen |
| **MAR372** | | | | | | None seen |
| **MAR381** | | | | | | Ribbon weed <20% |
| **MAR425** | | | | | | Potamogeton <20%, water primrose <20%, milfoil <20% |
| **MAR499** | | | | | | Smartweed, water primrose |
| **MAR510** | | <20% | | | | |
| **MAR605** | | | | | | None seen |
| **MAR640** | | | | | | None seen |
| **MAR660** | | | | | | None seen |
| **MAR670** | | | | | | None seen |
| **MAR743** | | | | | | None seen |
| **MAR763** | | | | | | None seen |
| **MAR999** | | | | | | None seen |
| **MUN990** | | | | | <20% | |
| **OBI760** | | | <20% | | <20% | |
| **OBI940** | | | | | <20% | |
| **SIX080** | | | | | | None seen |
| **SIX160** | | | | <20% | | |
| **SIX505** | | | | | | None seen |
| **SIX755** | | | | | <20% | |
| **SUS500** | | | | | | None seen |
| **TIN550** | | | | | | None seen |
| **TIN800** | <20% | <20% | | | <20% | |
| **WIB950** | | | | | | None seen |
| **WID399** | | | | | | None seen |
| **YAB680** | | | | | | <20% Duckweed |
| **YAB950** | | | | | | None seen |

Aquatic weeds which were sighted on the catchment crawl and their approximate coverage are displayed in Table 9. Less than 20% coverage of filamentous algae was present at a number of sites. Teddington Weir (TIN800) had large amounts of Salvinia trapped by the road crossing with some Water Hyacinth present. Dense water weed was only observed at Obi Obi (OBI760).

## 3.9 Riparian Zone Condition Assessment

Riparian zone condition assessments were conducted for all sites in 2018. An analysis of the Mary River sites was conducted to assess whether changes to riparian condition occur along the length of the waterway. Sites were given a rating of between A+ and D-, with A+ representing sites in the best condition and D- representing those in the worst condition. Each site was assessed in four categories:

- Vegetation layers present

- Shading over the waterway

- Bank stability

- Aquatic and terrestrial weeds

Each category was given a score and then the site was given an overall score to represent overall riparian zone condition. As Figure 88 shows, Site MAR009 at the Mary River headwaters is in excellent condition but thereafter sites show a score in the C or lower B range until around 200km from the headwaters where most scores increase to the higher B range. At the Mary River Heads, the riparian zone was in the best condition of all sites assessed, largely because the site is intact and undisturbed apart from a number of boat ramps and jetties.

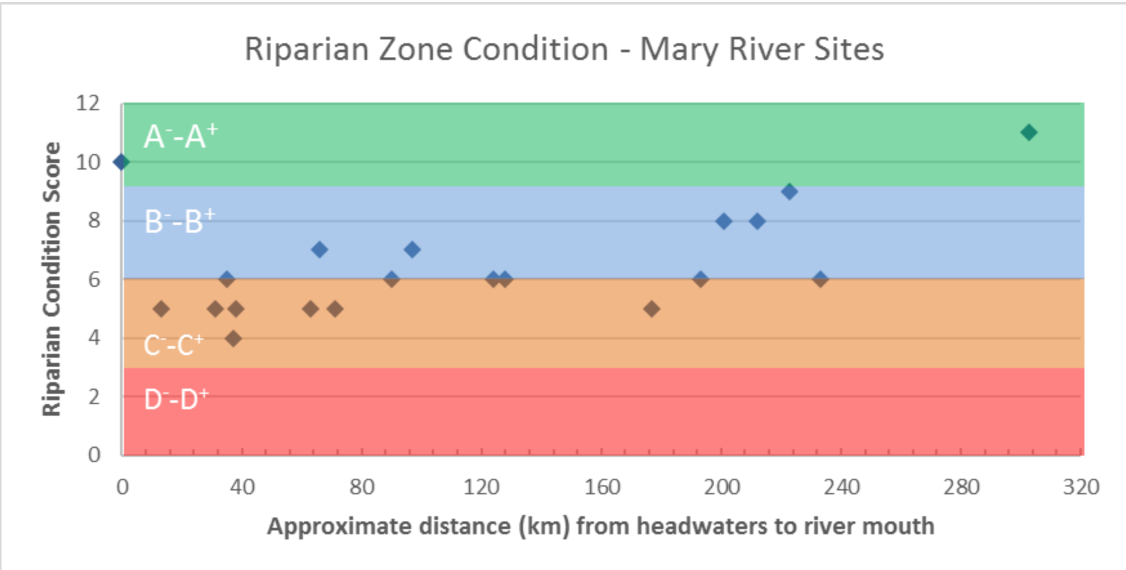


**Figure 88 Riparian Zone Condition scores for Mary River sites ranked A+ to D- showing change from the headwaters to the mouth along the course of the river**

# 4 Photographic evidence of historical change at Catchment Crawl sites

Figures 89 to 95 below show images from the 2018 Catchment Crawl compared with those taken during past Catchments Crawls. This provides photographic evidence of historical change within the stream and riparian zone. The sites chosen represent the Mary River along its course, starting at the Mary headwaters site (MAR009) and ending at the River Heads site (MAR999), and including the five sites represented in Figure 6 for which long term temperature records exist – Conondale (MAR050), Kenilworth (MAR170), Gympie (MAR510), Miva (MAR605) and Emerys Xing (MAR660).

**Mary headwaters (MAR009)**


Figure 89: McCrae Lane (MAR009) in 2003 (left) and 2018 (right)

**Conondale (MAR050)**

Figure 90: Conondale (MAR050) in 2017 (left) and 2018 (right)

**Kenilworth (MAR170)**


Figure 91: Kenilworth in 2003 (left) and 2018 (right)

**Widgee Xing (MAR510)**


Figure 92: Widgee Xing in 2003 (left) and 2018 (right)

**Miva (MAR605)**


Figure 93: Miva in 2003 (left) and 2018 (right)

**Emerys Xing (MAR660)**


Figure 94: Emerys Xing in 2009 (left) and 2018 (right)

**River Heads (MAR999)**

Figure 95: River Heads in 2004 (left) and 2018 (right)

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# Appendix A Catchment Crawl Itinerary

## Itinerary for Day 1

**Mary River Catchment Crawl 2018**

**Team Mary - Upper Mary River Monday 8th October 2018**

**Team:** Jess, Eva, Sarah **Car:** Dmax & Barina

**Depart MRCCC at 7:00am (1hr 18mins to MAR009)**

| Tributary | Site | Site code | Arrival Time | Departure Time | Transport time to next site | Who's coming/Notes |
|---|---|---|---|---|---|---|
| Mary | End of Policemans Spur Rd, Conondale | MAR009 | 8:20 AM | 10:00 AM | 15 mins | Release Tinana - Public to arrive at 8:45am |
| Mary | Grigor Bridge, Conondale U/S of bridge RHB | MAR050 | 10:15 AM | 10:45AM | 12 mins | MRCCC car - Antoinette 0448 258 270, Halena Scanlon 0478 706 380 |
| Mary | Little Yabba Picnic Area, Cambroon 150m U/S of Confluence | MAR125 | 11:00 AM | 11:30 AM | 9 mins | Denise Lindon 0438 167 633 (own car) meeting at conondale |
| Mary | Charles St River Park Kenilworth (downstream of Obi Obi mouth) (Lunch) | MAR170 | 11:45 AM | 12:45 PM | 19 mins | Tim Odgers may attended Charles st park |
| Mary | Charles St River Park Kenilworth (upstream of Obi Obi mouth) (Lunch) | MAR169 | 11:45 AM | 12:45 PM | | |
| Mary | Walker Rd bridge, Moy Pocket D/S | MAR300 | 1:15 PM | 1:45 PM | 15 mins via Lowe Rd | |
| Mary | Olsen's Bridge, Tuchekoi U/S | MAR372 | 2:00 PM | 2:30 PM | 20 mins via MV Rd | |
| Mary | Traveston Crossing, Traveston U/S of bridge | MAR425 | 2:45 PM | 3:15 PM | 15 mins via MV Rd | Glenda 0411 443 589 - meet us at Traveston. Call her to let her know how we're going for time |
| Mary | Gympie Weir U/S | MAR499 | 4:00 PM | 5:00PM | 10 mins fuel up on way home | |

**Arrive MRCCC at 5:15pm**

**Team tribs - Upper Mary catchment tributaries Monday 8th October 2018**

**Team**: Tanzi, Brad, Belinda **Car:** Triton

**Depart MRCCC at 7:00am**

| Tributary | Site | Site code | Arrival Time | Departure Time | Transport time to next site | Who's coming/Notes |
|---|---|---|---|---|---|---|
| Six Mile | u/s of Collwood Rd (spillway pool), off Lake Macdonald Drive | SIX160 | 7:45 AM | 8:15 AM | 9 mins | MRCCC car - Bob and Lorraine Hood |
| Six Mile | Worba Ln – Worba Pk (off Dath Henderson lane) D/S and under culvert | SIX080 | 8:30 AM | 9:00 AM | 34 mins via Ridgewood | |
| Mary | Mimburi – Newpaper Hill D/S of Belli mouth | MAR330 | 9:45 AM | 10:30 AM | 30 mins | Stan 0417 196 646 (NDSHS) - sign in at house first. |
| Obi Obi | Houston Bridge (D/S right bank) | OBI940 | 11:00 AM | 11:30 PM | 5 mins | |
| Obi Obi | Xing #2 (D/S of LWD, lhb) | OBI760 | 11:40 AM | 12:10 PM | 10 mins | |
| Mary | Charles St River Park Kenilworth (Lunch) | | 12:20 PM | 12:45PM | 11 mins | No sampling at Charles St |
| Mary | Eales/Jones boundary | MAR148/150 | 1:00 PM | 1:30 PM | 30 mins | |
| Yabba | Imbil Town U/S of Bridge | YAB680 | 2:00 PM | 2:30 PM | 5 mins | |
| Yabba | Mary Valley HWY (after barn) u/s of bridge rhb | YAB950 | 2:35 PM | 3:00 PM | 15 mins | |
| Mary | Kevindale (D/S of Skyring Ck confluence, u/s of offtake) | MAR381 | 3:15 PM | 3:45 PM | 15 mins | |
| Six Mile | Victor Giles Bridge, Cooran D/S of bridge lhb | SIX505 | 4:00 PM | 4:30 PM | 15 mins | 200m D/S of bridge accessed from rec club |
| Six Mile | Woondum Rd Bridge, Woondum u/s rhb | SIX775 | 4:45 PM | 5:15 PM | | |
| **Arrive MRCCC at 5:45pm** | | | | | 30 min fuel up on way home | |

## Itinerary for Day 2

**Mary River Catchment Crawl 2018**

**Team Mary - Lower Mary River Tuesday 9th October 2018 - Gympie North**

**Team:** Brad, Belinda, Becky **Car:** Triton

**Depart Gympie at 7:30am (12 mins to MAR510)**

| Tributary | Site | Site code | Arrival Time | Departure Time | Transport time to next site | |
|---|---|---|---|---|---|---|
| Mary | Widgee Crossing @ Eel Ck Junction | MAR510 | 7:45 AM | 8:30 AM | 36 mins (if bridge open) **53 mins (if bridge closed)** | **Bridge is CLOSED**. Call Darren as we leave the office. **Everyone must wear HiVis** |
| Mary | Dickabram Bridge, Miva Road, Miva (U/S under bridge, lhb) | MAR605 | 9:30 AM | 10:00AM | 14 mins | 2018 Site supervisor: Darren Manderson (ph 0417752047) |
| Mary | Bauple Woolooga Road Bridge (under bridge) | MAR640 | 10:15 AM | 10:45 AM | 13 mins | Contacted 5/10/18 - Garth Jacobsen (mrccc p/u at toyota - 7:30) |
| Mary | Emerys Bridge Road, Gundiah (between bridges, rhb) | MAR660 | 11:00 AM | 11:30 AM | 13 mins (to gate on Deborah Rd) | |
| Mary | Home Park, Deborah Road, Netherby (Garth's crossing, D/S) | MAR670 | 11:45 AM | 12:15 PM | 10 mins (from Home Park gate) | |
| Mary | Petrie Park, boat ramp, Tiaro (Lunch) | MAR743 | 12:30 PM | 1:30 PM | 45 mins | Kath to join this team and dropped in M'boro at cemetary |
| Susan | Susan River - bridge on Maryborough-Hervey Bay Road, rhb under bridge | SUS500 | 1:45 PM | 2:15 PM | 16 mins | Pick Maria Zann 0429 799 267 **up from Maryborough** (attending SUS500 and MAR999) |
| | Day 2 samples - Water One (31 Ellengowan St, Urangan) to deliver E.coli samples by 3.30pm. Ask for esky back | | 2:30 PM | 3:00 PM | 14 mins | |
| Mary | River Heads - most northern non-ferry boat Ramp | MAR999 | 3:15 PM | 3:45 PM | 1 hour 45 mins | |

**Arrive MRCCC at 5:30pm**

**Team Tribs - Lower Mary catchment tributaries Tuesday 9th October**

**Team:** Tanzi, Sarah, Eva **Car:** Dmax & Barina

**Depart Gympie at 7.30am**

| Tributary | Site | Site code | Arrival Time | Departure Time | Transport time to next site | |
|---|---|---|---|---|---|---|
| | Staff to courier Day 1 E.coli samples to 29-31 Ellangowan St Urangancontact Neisha at lab if doors locked at reception 0417124144 | | 9:00 AM | 9:15 AM | 16 mins | Tanzi and Sarah to drop off E.coli samples in Barina. Eva and Ian to meet at MRCCC 8:15am, meet Tanzi and Sarah at Grevillea St at 9:30AM. Pick up Kath at cemetary |
| Mary | Grevillea St, Riverside Park, Owanyilla (off wooden platform) | MAR763 | 9:30 AM | 10:00 AM | 11 mins | MRCCC car: Ian Mackay (msg left 5.10.18) |
| Tinana | Teddington Weir, Magnolia (D/S of crossing, lhb) | TIN800 | 10:15 AM | 10:45 AM | 35 mins (via Forestry Rd) | Kevin and Robyn Jackson 0428 865 172 and Beverly Biggs will meet you at Owanyilla |
| Tinana | Missings crossing, Bauple (D/S of bridge on lhb) | TIN550 | 11:20 AM | 11:45 AM | 25 mins (via Bauple) | |
| Mary | Petrie Park, boat ramp, Tiaro (Lunch) | MAR743 | 12:15 PM | 1:30 PM | 27 mins | |
| Munna | Birt Rd Bridge, Munna Creek (D/S) | MUN990 | 2:00 PM | 2:30 PM | 26 mins | |
| Wide Bay | Wilson Bridge, Carmyle Rd, Sexton (D/S, lhb) | WIB950 | 3:00 PM | 3:30 PM | 35 mins | |
| Widgee | Webb Park, Widgee (D/S of pedestrian x-ing) | WID399 | 4:05 PM | 4:30 PM | 24 mins | |

**Arrive MRCCC at 5.00pm**

# Appendix B Results

| Type | Site Code eg LAT001 | Site Description | temp 2018 | pH 2018 | EC 2018 | turb 2018 | DO 2018 | E.coli 2018 | Oxidised N 2018 | Ammonium N 2018 | Kjeldahl N 2018 | Total N 2018 | Organic N 2018 | Phosphate P 2018 | Kjeldahl P 2018 | Organic P 2018 | TSS 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G2 | MAR999 - River Heads | River Heads, boat ramp | 24.63 | 8.20 | 54650 | 21.00 | 80.35 | | 0.0055 | 0.052 | 0.26 | 0.2655 | 0.208 | 0.006 | 0.205 | 0.199 | 60 |
| G2 | SUS500 - Susan River | Susan River on Bruce Highway | 22.03 | 6.65 | 10320 | 50.00 | 74.45 | 250 | 0.009 | 1.67 | 2.97 | 2.979 | 1.3 | 0.001 | 0.06 | 0.059 | 15 |
| G4 | MAR009 - Mary headwaters | Causeway on McCrea Lane, Conondale | 16.80 | 7.51 | 333 | 0.90 | 88.80 | 30 | 0.014 | 0.004 | 0.18 | 0.194 | 0.176 | 0.008 | 0.01 | 0.002 | 2 |
| G5 | MAR050 - Conondale | Grigor Bridge, Conondale | 24.35 | 8.09 | 304 | 3.50 | 104.80 | 86 | 0.0005 | 0.002 | 0.43 | 0.4305 | 0.428 | 0.0005 | 0.03 | 0.0295 | 3 |
| G5 | MAR125 - Cambroon | Little Yabba Picnic Area, Cambroon | 23.40 | 7.87 | 348 | 1.75 | 96.25 | 39 | 0.002 | 0.001 | 0.215 | 0.217 | 0.214 | 0.0005 | 0.01 | 0.0095 | 3.5 |
| G5 | MAR148 - Walli Mt | Eales, Walli Mountain Rd | 27.65 | 8.39 | 330 | 7.00 | 132.30 | 51 | 0.002 | 0.003 | 0.26 | 0.262 | 0.257 | 0.002 | 0.01 | 0.008 | 1 |
| G5 | MAR169 - Kenilworth | Charles St Park Upstream of Obi Obi Mouth | 27.20 | 8.61 | 340 | 5.05 | 135.10 | 54 | 0.004 | 0.001 | 0.19 | 0.194 | 0.189 | 0.0005 | 0.01 | 0.0095 | 2 |
| G5 | MAR170 - Kenilworth | Charles St River Park, Downstream of Obi Obi Mouth, Kenilworth | 25.30 | 7.91 | 290 | 2.00 | 103.90 | 190 | 0.018 | 0.011 | 0.38 | 0.398 | 0.369 | 0.005 | 0.13 | 0.125 | 1 |
| G5 | MAR300 - Moy Pocket | Walker Rd bridge, Moy Pocket | 24.10 | 7.54 | 332 | 3.40 | 85.80 | 390 | 0.02 | 0.014 | 0.29 | 0.31 | 0.276 | 0.006 | 0.04 | 0.034 | 3 |
| G5 | MAR330 - Belli Park | Mimburi at Belli/Mary confluence | 22.95 | 7.69 | 347 | 7.00 | 92.60 | 73 | 0.005 | 0.0055 | 0.345 | 0.35 | 0.3395 | 0.009 | 0.02 | 0.011 | 3.5 |
| G5 | MAR372 - Tuchekoi | Olsen's Bridge, Tuchekoi Rd, Tuchekoi | 25.25 | 7.28 | 393 | 24.65 | 95.05 | 210 | 0.032 | 0.014 | 0.44 | 0.472 | 0.426 | 0.021 | 0.07 | 0.049 | 10 |
| G5 | MAR381 - Goomong | Skyring Ck confluence with Mary | 24.45 | 7.61 | 414 | 7.00 | 98.70 | 80 | 0.025 | 0.0085 | 0.4 | 0.425 | 0.3915 | 0.008 | | -0.008 | 5.5 |
| G5 | MAR425 - Traveston Xing | Mary River Park, Traveston Crossing | 25.30 | 7.88 | 427 | 5.55 | 104.60 | 86 | 0.002 | 0.005 | 0.39 | 0.392 | 0.385 | 0.002 | 0.03 | 0.028 | 4 |
| G5 | MAR499 - Gympie Weir | Gympie weir, Gympie | 25.50 | 7.90 | 509 | 6.45 | 96.05 | 330 | 0.002 | 0.001 | 0.35 | 0.352 | 0.349 | 0.004 | 0.01 | 0.006 | 4 |
| G5 | MAR510 - Widgee Xing | Widgee Crossing @ Eel Ck junction | 22.60 | 7.99 | 534 | 7.00 | 70.80 | 920 | 0.078 | 0.024 | 0.54 | 0.618 | 0.516 | 0.039 | 0.06 | 0.021 | 12 |
| G5 | MAR605 - Miva | Dickabram Bridge, Miva | 23.70 | 8.05 | 674 | 6.75 | 81.85 | 41 | 0.002 | 0.007 | 0.37 | 0.372 | 0.363 | 0.004 | 0.01 | 0.006 | 5.5 |
| G5 | MAR640 - Bauple Rd Bridge | Bauple Woolooga Road Bridge | 24.45 | 8.14 | 677 | 7.40 | 88.05 | 110 | 0.004 | 0.005 | 0.38 | 0.384 | 0.375 | 0.004 | 0.01 | 0.006 | 5 |

| Type | Site Code eg LAT001 | Site Description | temp 2018 | pH 2018 | EC 2018 | turb 2018 | DO 2018 | E.coli 2018 | Oxidised N 2018 | Ammonium N 2018 | Kjeldahl N 2018 | Total N 2018 | Organic N 2018 | Phosphate P 2018 | Kjeldahl P 2018 | Organic P 2018 | TSS 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G5 | MAR660 - Emerys Xing | Emerys Bridge Road, Gundiah (at John William's waterwatch site) | 25.25 | 8.15 | 639 | 7.80 | 81.40 | 49 | 0.001 | 0.002 | 0.34 | 0.341 | 0.338 | 0.003 | 0.47 | 0.467 | 4 |
| G5 | MAR670 - Netherby | Home Park, Deborah Road, Netherby | 25.40 | 8.20 | 610 | 7.50 | 92.15 | 5 | 0.001 | 0.002 | 0.38 | 0.381 | 0.378 | 0.004 | 0.01 | 0.006 | 5 |
| G5 | MAR743 - Tiaro | Petrie Park, boat ramp, Tiaro | 26.55 | 8.00 | 548 | 7.00 | 91.70 | 85 | 0.002 | 0.002 | 0.36 | 0.362 | 0.358 | 0.003 | 0.04 | 0.037 | 3 |
| G5 | MAR763 - Owanyilla | Grevillea St, Riverside Park, Owanyilla (off wooden platform) | 24.80 | 7.83 | 500 | 7.00 | 101.75 | 6 | 0.0005 | 0.001 | 0.34 | 0.3405 | 0.339 | 0.002 | 0.02 | 0.018 | 3 |
| G5 | OBI760 - Obi Obi | Obi obi crossing No #2 | 24.43 | 7.57 | | 7.00 | 98.40 | 120 | 0.02 | 0.005 | 0.34 | 0.36 | 0.335 | 0.013 | 0.03 | 0.017 | 3 |
| G5 | OBI940 - Coolabine | Houston Bridge, Coolabine Road | 21.50 | 7.20 | 233 | 7.00 | 83.30 | 440 | 0.089 | 0.018 | 0.39 | 0.479 | 0.372 | 0.02 | 0.05 | 0.03 | 3 |
| G5 | SIX080 - Upstream Lake Macdonald | Six Mile Ck, Worba Lane, Worba Park | 18.70 | 5.95 | 284 | 11.50 | 9.50 | 74 | 0.0005 | 0.128 | 2.2 | 2.2005 | 2.072 | 0.005 | 0.06 | 0.055 | 10 |
| G5 | SIX160 - Downstream Lake Macdonald | Six Mile Creek, Lake Macdonald Drive (d/s Lake) | 22.33 | 6.63 | 117 | 7.00 | 78.35 | 36 | 0.042 | 0.114 | 0.7 | 0.742 | 0.586 | 0.001 | 0.02 | 0.019 | 3 |
| G5 | SIX505 - Cooran | Six Mile Creek, Victor Giles bridge, Cooran | 19.25 | 6.84 | 194 | 11.50 | 63.45 | 150 | 0.036 | 0.022 | 0.45 | 0.486 | 0.428 | 0.003 | | -0.003 | 6 |
| G5 | SIX775 - Woondum | Six Mile Creek, Woondum Rd bridge, Woondum | 19.35 | 6.97 | 207 | 7.00 | 73.30 | 70 | 0.02 | 0.012 | 0.55 | 0.57 | 0.538 | 0.002 | | -0.002 | 4 |
| G5 | YAB680 - Imbil | Yabba Creek, Imbil Town Bridge | 26.48 | 8.02 | 307 | 7.00 | 100.60 | 22 | 0.003 | 0.006 | 0.51 | 0.513 | 0.504 | 0.001 | 0.01 | 0.009 | 1 |
| G5 | YAB950 - Mary Valley Rd | Yabba Creek, Mary Valley Road | 25.20 | 7.91 | 355 | 7.00 | 101.65 | 60 | 0.008 | 0.009 | 0.46 | 0.468 | 0.451 | 0.009 | 0.04 | 0.031 | 3 |
| G6 | WID399 - Widgee | Webb Park, Widgee | 21.18 | 8.30 | 873 | 7.00 | 67.50 | | 0.004 | 0.005 | 0.32 | 0.324 | 0.315 | 0.003 | 0.01 | 0.007 | 2 |
| G6 | WIB950 - Sexton | Wilson Bridge, Carmyle Rd, Sexton | 26.40 | 8.39 | 972 | 7.00 | 127.05 | | 0.0005 | 0.001 | 0.5 | 0.5005 | 0.499 | 0.002 | 0.02 | 0.018 | 3 |
| G6 | MUN990 - Munna Creek | Birt Rd bridge, Munna Creek | 25.50 | 8.72 | 3125 | 7.00 | 118.55 | | 0.012 | 0.013 | 0.48 | 0.492 | 0.467 | 0.002 | 0.02 | 0.018 | 5 |
| G8 | TIN550 - Bauple | Missings crossing, Bauple (D/S of bridge on lhb) | 23.05 | 6.84 | 361 | 7.00 | 68.30 | 29 | 0.011 | 0.015 | 0.49 | 0.501 | 0.475 | 0.003 | 0.02 | 0.017 | 4 |
| G8 | TIN800 - Teddington Weir | Teddington Weir, Magnolia (D/S of crossing, lhb) | 26.40 | 7.02 | 413 | 7.00 | 86.85 | 17 | 0.007 | 0.018 | 0.64 | 0.647 | 0.622 | 0.003 | 0.03 | 0.027 | 4 |

# Appendix C – River Flow Plots

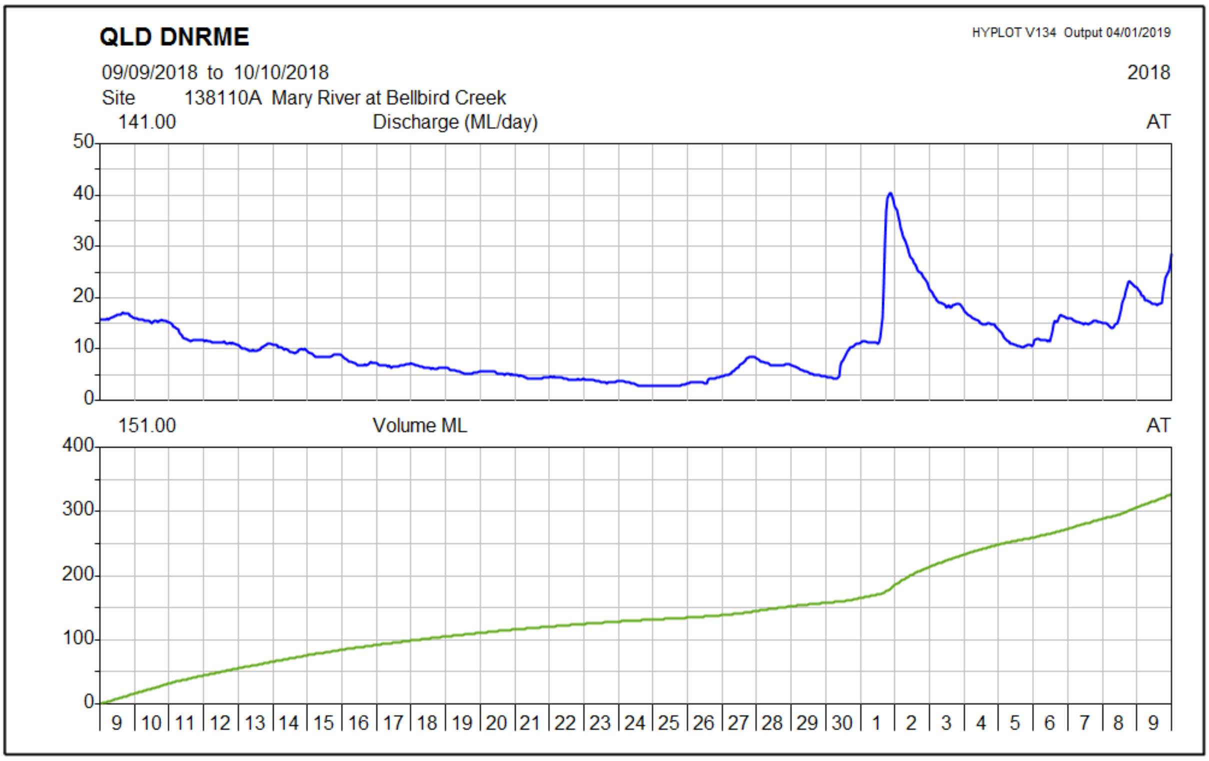


Figure 96 Discharge and volume plot for the Mary River at Bellbird Creek. Source: QLD DNRME (n.d.)

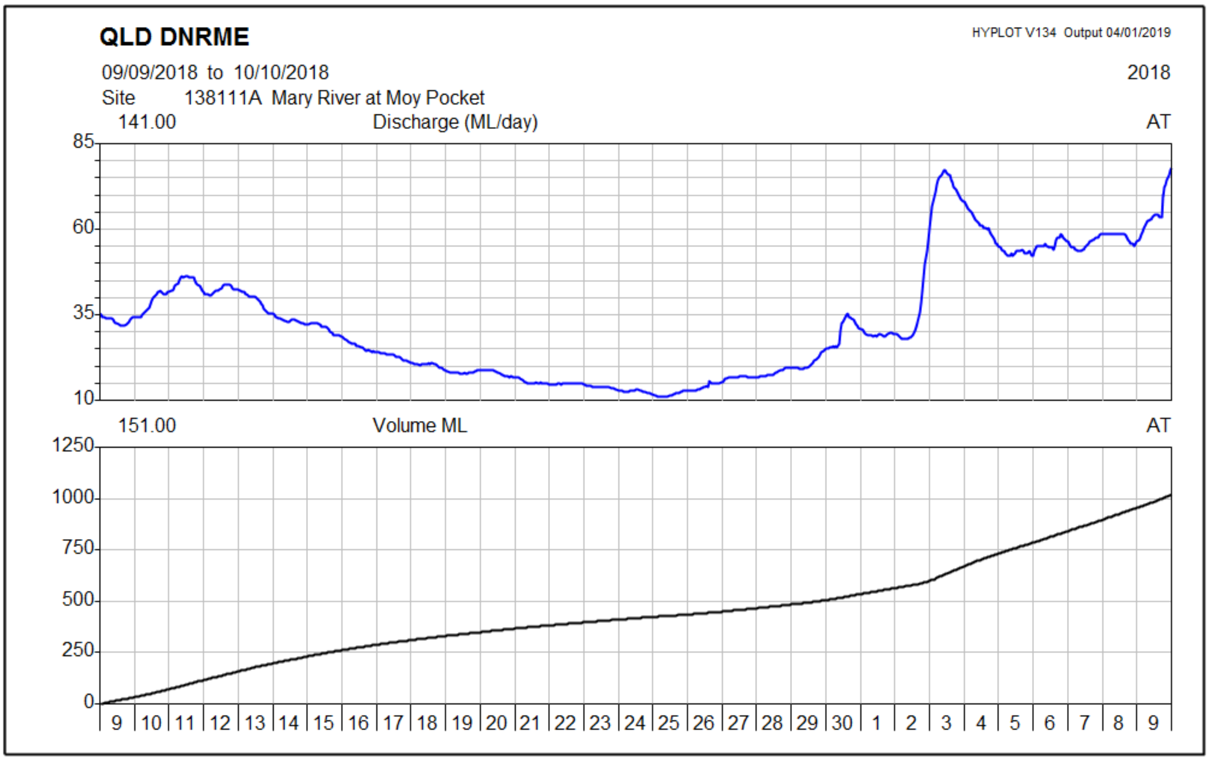


Figure 97 Discharge and volume plot for the Mary River at Moy Pocket. Source: QLD DNRME (n.d.)

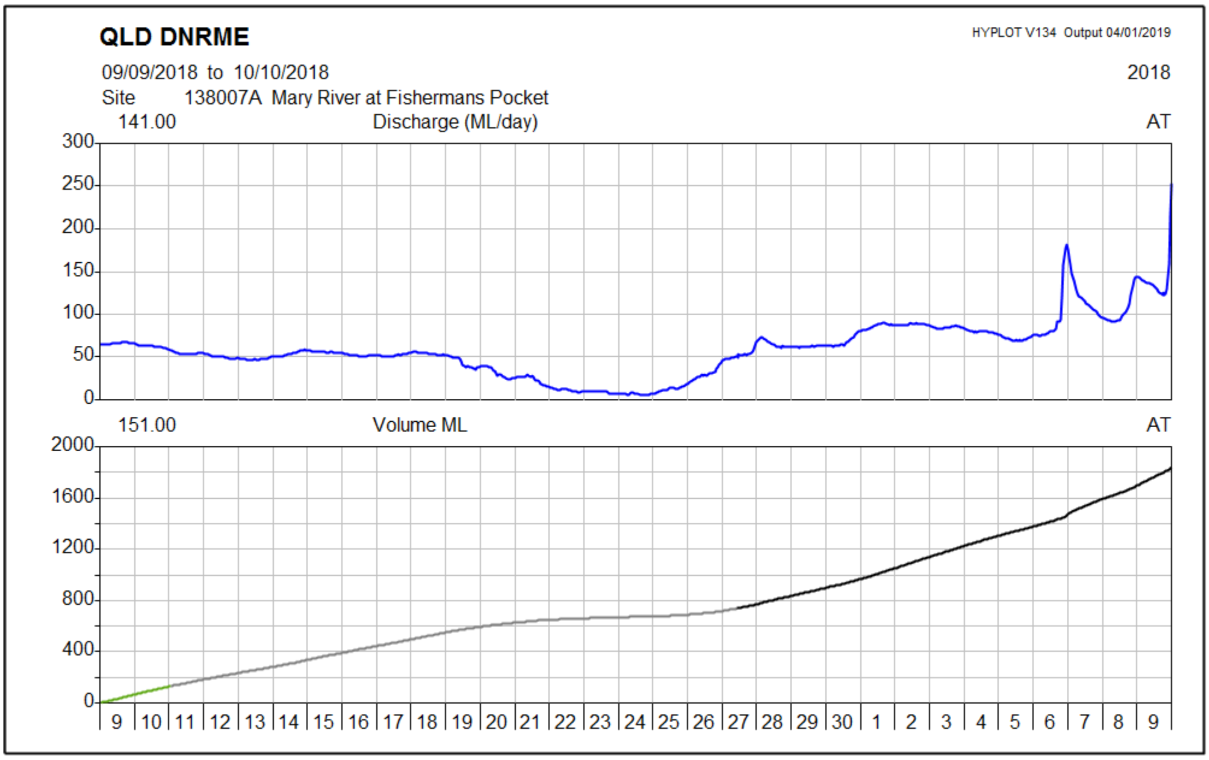


Figure 98 Discharge and volume plot for the Mary River at Fishermans Pocket. Source: QLD DNRME (n.d.)

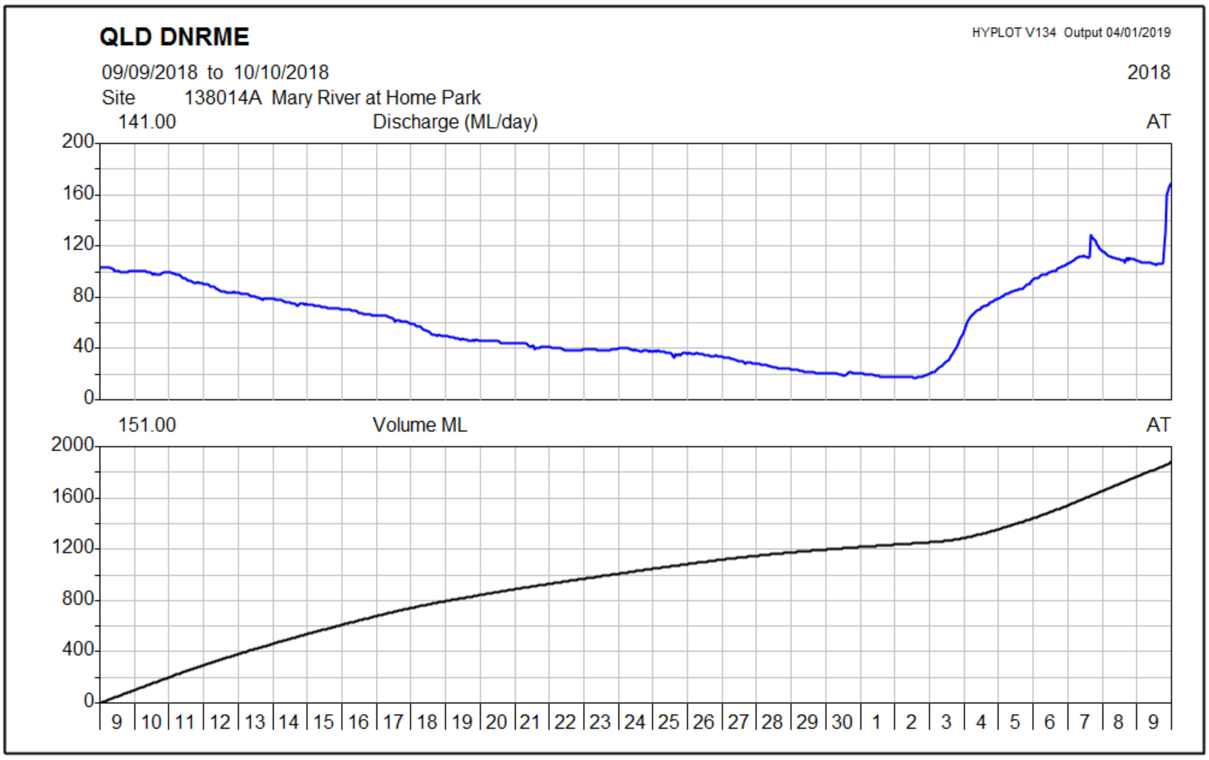


Figure 99 Discharge and volume plot for the Mary River at Home Park. Source: QLD DNRME (n.d.)