FLOODS IN THE CATCHMENT – WATER QUALITY IMPACTS OF RAPID RESERVOIR INFLOW AND FILL

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ABSTRACT

During 2010, three rain events within the Queanbeyan River Catchment caused the Googong Reservoir to rapidly fill after a period of prolonged drought. The water quality during that time experienced spikes that had not previously been seen in the reservoir.

True colour peaked at ten times the average, and to date has still not returned to normal. Turbidity, on the other hand spiked almost as high, but returned to relatively normal within the next few months. Total and dissolved manganese followed similar trends to turbidity, whilst, total and dissolved iron is still significantly elevated. These never before seen spikes caused several breaches of action limits and critical limits set under the Hazard Analysis and Critical Control Point (HACCP) system. These limits were generally set on licence requirements, plant specification or historical water quality data.

The Googong Reservoir remains susceptible to poor water quality after rain events.

1.0 INTRODUCTION

The ACT relies on four storage reservoirs and the Murrumbidgee River for its drinking water supply. The Cotter River Catchment to the south west of Canberra has an area of 480 km^2. The Cotter River contains three storage reservoirs, Corin (70.9 GL), Bendora (11.5 GL) and Cotter (3.9 GL).The Murrumbidgee River catchment is located to the south of Canberra, with a catchment area of 6,826 km^2.

The Queanbeyan River catchment located to the south east of Canberra, has an area of 873 km^2, contains the Googong Reservoir (121.5 GL).

ACTEW operates two water treatment plants (WTP). The Mount Stromlo WTP to the west of the city treats water from the Cotter River catchments and the Murrumbidgee River. Googong WTP located to the east of the city treats water from the Googong Reservoir.

Both WTP's operate under a HACCP system with a Water Quality Management Plan (WQMP) reviewed annually. Critical and action limits are generally set on licence requirements (Australian Drinking Water Guidelines), plant specifications or historical data.

During three major rain events in September, October and December 2010, the Googong Reservoir went from 54% capacity to 100% capacity. These inflows had significant impact on the quality of the water being stored in the reservoir.

Some of these impacts are still apparent in the water quality in the reservoir today and continue to challenge the design limits of the source water for Googong WTP. The changes in raw water quality resulted in doubling coagulant dose rates, introduction of pre-lime dosing, de-rating clarifier and filter loadings, and presented a major challenge to the onsite sludge handling processes.

2.0 DISCUSSION

The ACT was officially drought declared in October 2006, however water restriction measures were in place since 2002. Capacity in the Googong Reservoir dropped to a low of 38% in June 2007. It had recovered slightly by January 2010 at 48% capacity. By December 2010 the reservoir was 100% full (see Figure 1).

The filling of the reservoir occurred within 3 major rain events. During September 2010 a rain event saw inflows into Googong reservoir go from approximately 40 ML/d to a peak of 3,647 ML/d. During this event the capacity in the reservoir went from 54% to 61% full.

The second rain event was during October 2010, which saw inflows into Googong reservoir go from approximately 40 ML/d to a peak of 4,454 ML/d. During this event the capacity of the dam went from 66% to 79% full.

The third rain event was during December 2010, which saw inflows into Googong reservoir go from approximately 70 ML/d to a peak of 23,361 ML/d. During this event the capacity of the dam went from 84% to 100% full and continued to spill for many months after.

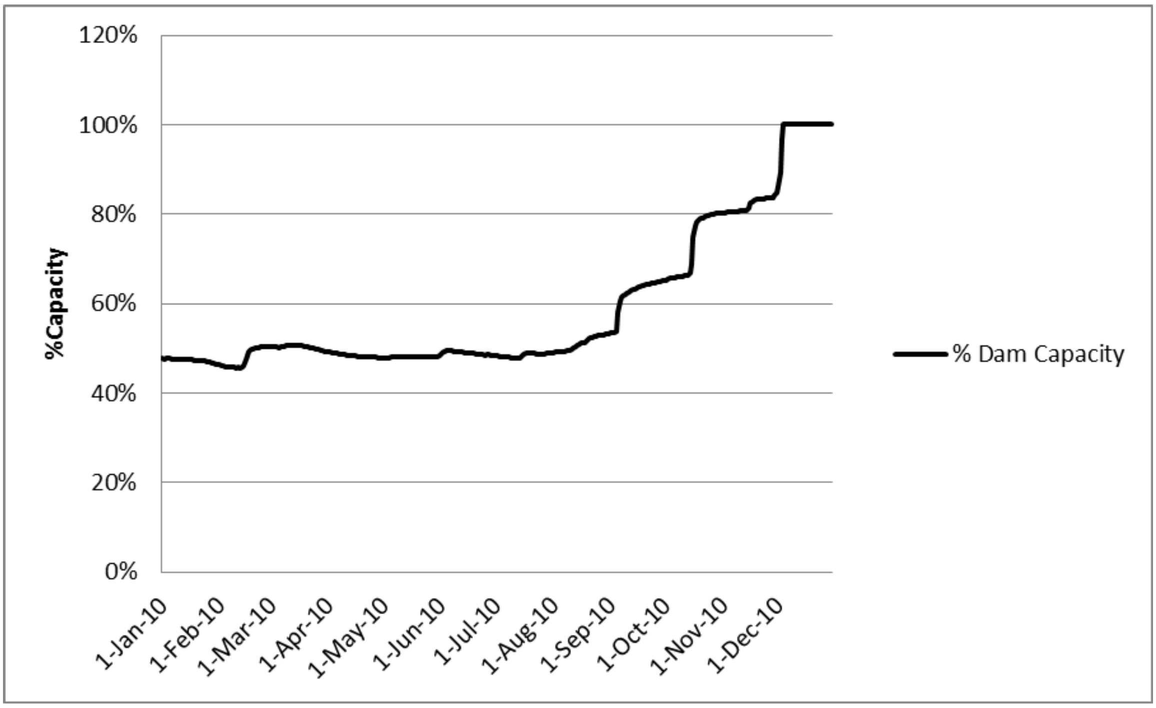


Figure 1: ***Rapid fill of Googong Reservoir during 2010***

Filling of the reservoir, which had been under 50% capacity had some significant impacts on water quality in the reservoir and in turn, impacts on the WTP which is reliant on the reservoir as its source of water.

During and after these events, the frequency of monitoring was increased in an attempt to capture the changes to water quality. Several other parameters were monitored including alkalinity, DOC, DO etc, however the parameters of note for water quality are: true colour, turbidity, total and dissolved iron and total and dissolved manganese.

2.1 True Colour

True colour is the measure of the colour of the water after the particulate matter has been filtered out. Colour levels derived from natural constituents can often be reduced or removed by coagulation and filtration. It is expected to see an increase in true colour after inflows into a reservoir. However, in the past, as the flow settles the colour drops at a similar rate to turbidity, iron and manganese. This expected drop in true colour has not happened in the Googong Reservoir since the 2010 inflows (see Figure 2).

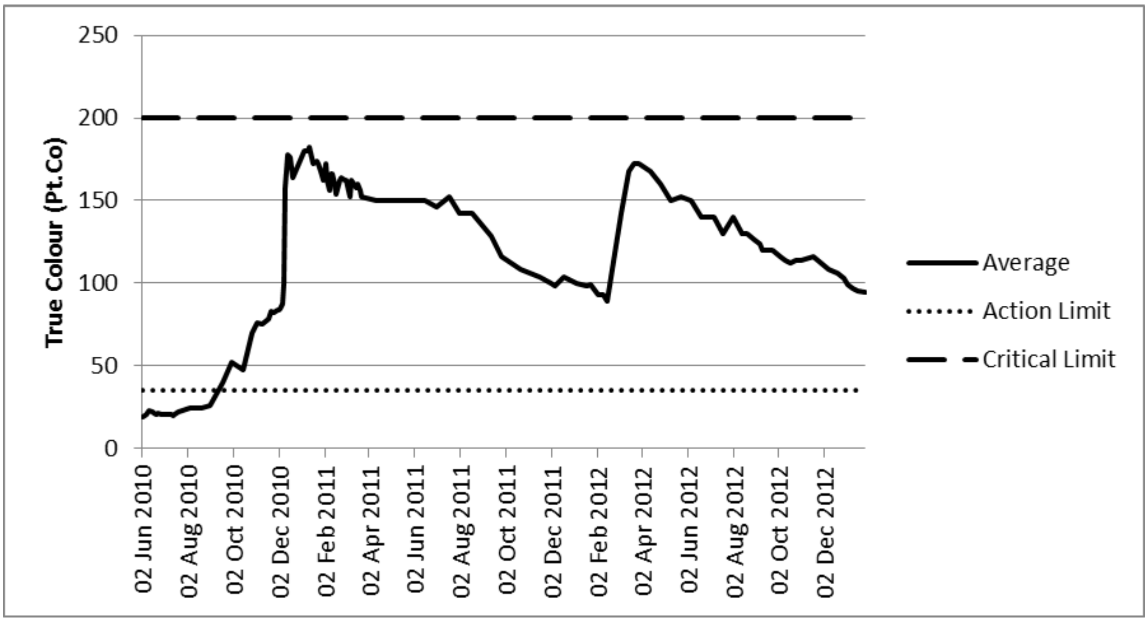


__Figure 2:__ ***Googong Reservoir true colour during the 2010 inflows to present***

The design range for Googong WTP is 15-30 Pt Co. The action limit for true colour for the WTP inlet channel was set at 35 Pt Co with the selective abstraction critical limit set at 200 Pt Co.

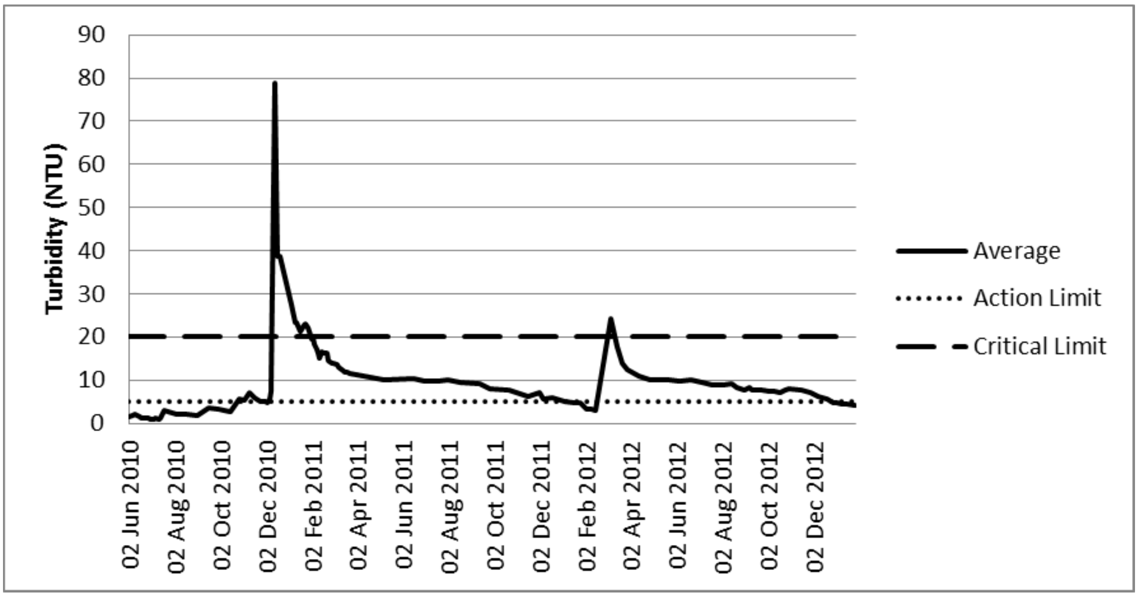
True colour levels in the reservoir prior to 2010 were averaging 20 Pt Co in the first 12 meters of water. After the December 2010 inflows, true colour peaked at 200 Pt Co (at 3 metres depth), averaging 162 Pt Co in the first 12 metres of water. This level of true colour remained for the next 6 months. By February 2012 the true colour level had dropped to approximately 90 Pt Co (which is still 70 Pt Co above the average for the same month in 2010), until another rain event in late February caused another spike in true colour averaging 157 Pt Co in the first 12 metres.

Once again true colour is following a similar downward trend to the 2010 rainfall events and is not expected to drop to pre-flood levels for many years. Currently true colour is averaging 95 Pt Co.

2.2 Turbidity

The Australian Drinking Water Guidelines describes turbidity as a measurement of the light scattering property of water, and the degree of scattering depends on the amount, size and composition of the matter. Turbidity is caused by fine suspended matter such as clay, silt, colloidal particles, plankton and other microscopic organisms. Turbidity is reduced or removed by coagulation and filtration within the WTP.
The design range for Googong WTP is 5-10 NTU. The action limit for turbidity for the

WTP inlet channel was set at 5 NTU with the selective abstraction critical limit set at 20 NTU. As can be seen from Figure 3, the turbidity critical limit was being breached for several weeks following the floods.



<u>Figure 3:</u> ***Googong Reservoir turbidity during the 2010 inflows to present***

As expected, turbidity follows a very similar trend in the reservoir as true colour, spiking after the December rain event. However, the turbidity levels are recovering and returning to pre-rain levels much faster than true colour. Prior to 2010, turbidity levels in the reservoir were averaging 1.3 NTU in the first 12 meters of water. After the December 2010 inflows, turbidity peaked at 95 NTU, averaging 79 NTU in the first 12 metres of water.

These levels of turbidity had halved 4 days later, averaging 39 NTU. Levels spiked again in late February after another rain event. Currently turbidity is averaging 4.3 NTU.

2.3 Total Iron

Iron is typically removed by coagulation and filtration processes. The design range for Googong WTP is 0.2-0.8 mg/L. The action limit for total iron for the WTP inlet channel was set at 1 mg/L. No critical limit was set. As can be seen from Figure 4, this action limit was breached very early in the flood events and to date has only just recovered.

Total iron levels followed a very similar pattern to true colour, with spikes after the December rain fall event and then remaining elevated. Total iron peaked at 3.4 mg/L (at 3 metres) after the December 2010 rain event. The levels stayed elevated averaging 1.5 mg/L for the following 6 months, dropping to approximately 1 mg/L prior to the rain event in late February 2012. Total iron levels are currently averaging 1.1 mg/L in the first 12 metres of water.

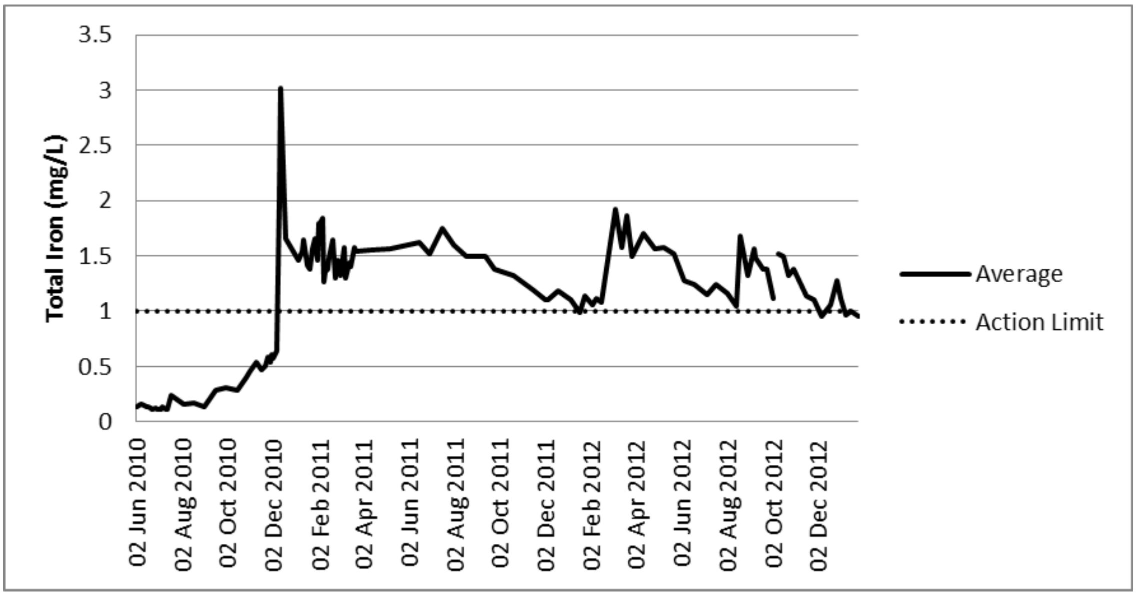


Figure 4: ***Googong Reservoir total iron during the 2010 inflows to present***

Dissolved iron levels have remained significantly elevated since the December 2010 rain event. Dissolved iron levels hit a maximum of 1.5 mg/L in August 2010 and are still currently elevated at an average of 0.84 mg/L in the first 12 metres of water.

There were no action or critical limits set for dissolved iron.

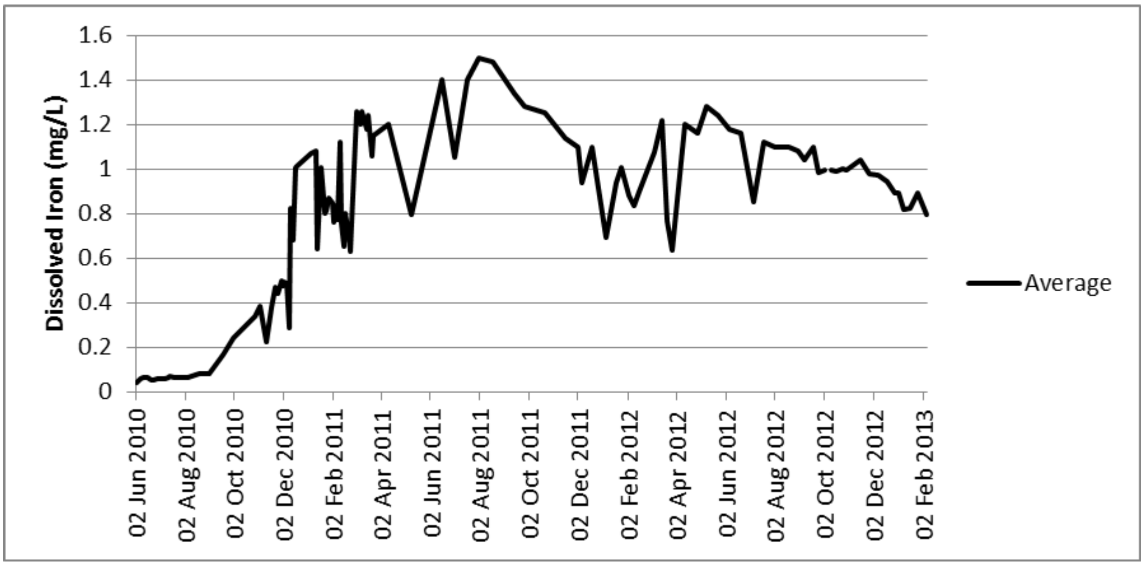


Figure 5: ***Googong Reservoir dissolved iron during the 2010 inflows to present***

2.4 Total Manganese

Total manganese levels follow a similar pattern to turbidity. Initially after the December rain event, manganese levels spiked at 0.15 mg/L. Levels then dropped relatively quickly. It is worth noting that the total manganese levels actually spiked even higher in May 2012 reaching a maximum of 0.17 mg/L. Again levels have dropped relatively quickly.

The action limit for total manganese for the WTP inlet channel was set at 0.25 mg/L. No critical limit was set. This limit was not breached.

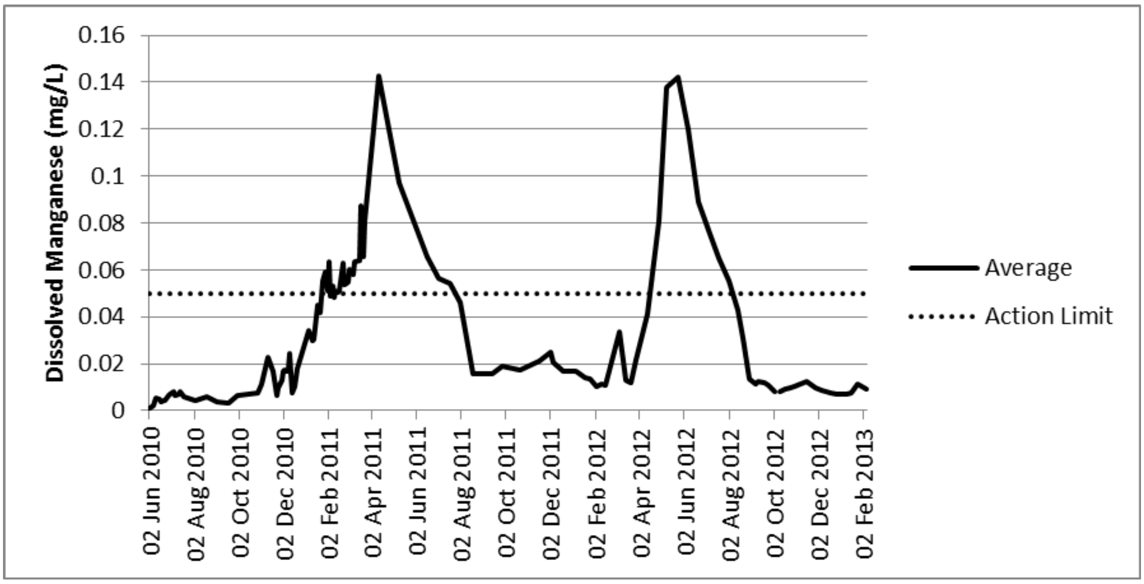


Figure 6: ***Googong Reservoir dissolved manganese during the 2010 inflows to present***

Dissolved manganese levels have followed similar trends to total manganese. Dissolved manganese levels spiked at 0.15 mg/L and peaked again at the same level in May 2012. The action limit for dissolved manganese is set at 0.05 mg/L. As can be seen from Figure 6 this limit was breached during the 2010 floods and again in 2012.

3.0 CONCLUSION

Turbidity and total and dissolved manganese all followed similar trends after a large rainfall event. That is a large spike after the initial event and slowly returning to pre event levels within the following months.

True colour and total and dissolved iron on the other hand, peaked after the initial event and have not (to date) returned to pre-event levels.

Situation proves value of long term monitoring and event sampling to capture the full picture of what is happening in the reservoir.

The impacts on the HACCP system included breaches to action and critical limits. As the WTP proved successful in operating whilst breaching these limits some of them have been reviewed and made less stringent. Several procedures were also drafted detailing the steps to be taken if it is expected that action or critical limits are going to be breached.

4.0 ACKNOWLEDGEMENTS

Thanks to all the Operations team at ACTEW Water!

5.0 REFERENCES

Australian Government, National Health and Medical Research Council. *Australian Drinking Water Guidelines 2011*
http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/eh52_aust_drinking_water_guidelines_update_120710_0.pdf