Cohuna WTP – How to treat the untreatable?

Angus Bowles, *Manager Catchment & Water Treatment Operations,* Coliban Water
Cameron Kervin, *Senior Water Treatment Operator Northern,* Service Stream

ABSTRACT
Coliban Water experienced significant infrastructure impacts as a result of the 2022 floods in northern Victoria, but through an intense collaborative effort, maintained water services throughout. As the floods resided and the clean-up commenced a less visible risk emerged, a severe deterioration in and great variability of, raw water sources.

An exhausted treatment team turned their attention to the emerging threat and worked together to determine how to treat water that exceeded the treatment envelope of several water treatment plants, with raw water quality so poor, it was outside observed operational experience. This paper investigates the trials and tribulations of the team tackling a wave of challenges at the Cohuna Water Treatment Plant (WTP) to maintain a safe drinking water supply to the Cohuna community.

Highlights include:
- Implementation of enhanced coagulation to treat the high colour/low turbidity water
- An unsettled sludge blanket triggering poly trials and the return to service of decommissioned clarifiers
- 24/7 plant operation, resulting in break downs and rapid repairs
- Tri-daily cleaning program to manage weeds at the raw water inlet
- High concentrations of metals, requiring hypochlorite dosing to achieve pre-oxidation on the filters
- Taste and odour issues requiring a high powdered activated carbon (PAC) dose
- High concentrations of dissolved organics, requiring a maximum chlorine dose
- Demand exceeding supply, leading to the rural network isolation, a Boiled Water Advisory, and a major water carting operation

1.0 INTRODUCTION

Coliban Water provides water and wastewater services to 49 towns across 16,500 sqkm of North-Central Victoria. We service rural and urban areas from Cohuna and Echuca in the north, to Kyneton and Trentham in the south. We also manage, maintain, and operate 35 reservoirs and water storage basins. Service Stream are a key operational partner, providing operational services across many of Coliban Water's assets, including the Cohuna WTP.

Cohuna is in the Gannawarra Shire, one of Victoria's most diverse agricultural regions. Cohuna has a population of around 2,800 people. The urban drinking water network includes a population of 2,520, whilst the rural Supply-By-Agreement customers number approximately 357 people. Raw water is supplied from Gunbower Creek, which is fed from the Murray River. The Cohuna WTP is a conventional WTP and has a treatment capacity of 3.8 ML/d (operating 16 hrs/day).

The WTP consists of the following processes:
- Chemical Dosing
    - PAC to help with the removal of residual cyanobacterial toxins, and taste and odour compounds.
    - Caustic Soda for pH Correction (pre/post) to improve flocculation / coagulation and reduce corrosivity.
    - Aluminium Sulphate for effective coagulation

    - Polymer, to improve flocculation.
    - Sodium Hypochlorite for the pre-oxidation of metals onto the filters
    - Gaseous Chlorine for disinfection
    - Sodium Fluoride to improve oral health.
- Sludge blanket clarifier for sedimentation
- Dual media filters for rapid gravity filtration
- Approximately 3.5 megalitres of combined Clear Water Storage

There has been some form of water supply onsite at Cohuna WTP since 1901, but majority of the major civil infrastructure was built in 1967, with a lot of the process equipment added/replaced in the early 2000's. During this time, both raw water quality and drinking water regulation have changed considerably. The raw water quality now seen post a major flood events is well beyond the designed treatment envelope of the Cohuna WTP. As a result, until further process improvements are implemented, the treatment operations team must rely on experience, innovation, and fast thinking to respond to the unknowns that occur during such events, in order to maintain supply for the Cohuna township.

2.0 DISCUSSION

2.1 Raw Water Quality Impact at Cohuna WTP post 2022 Floods

Following a period of dry conditions, in late 2022 severe wet weather, including 1 in 100-year rainfall events, resulted in flooding across much of Northern Victoria. This led to significant surface water run-off into the Murray River catchment. The storms washed dried organic matter into the river system that had been accumulating for up to a decade. This sudden influx in organic matter resulted in a notable change to raw water quality. Table 1 below compares raw water quality results in a typical November to January period (2021/2022) against raw water quality results experienced during the post flood period (2022/2023). The data in Table 1 captures min-max values for the observed raw water quality, including both operational site data and NATA accredited laboratory data.

Table 1: ***Raw Water Quality Comparison Typical vs Post Flood***

Parameter (Unit)	Typical RWQ (11/21-1/22) range	Post Flood RWQ (11/22-1/23) range	Comparison
Alkalinity (mg/L as $CaCO_3$)	20 – 22	21 – 56	Increase
BGA Count (cells/mL)	194 – 4,234	1,148 – 38,309	Increase
Biovolume (mm^3/L)	0.002 – 0.02	0.007 - 0.292	Increase
Colour (Pt/Co)	14.4 – 40	52 – 152	Increase
DOC (mg/L)	-	5.4 – 11	-
EC (µS/cm)	74 - 82	130 -160	Increase
Hardness (mg/L)	21	38	Increase
Iron (mg/L)	0.26 – 1.7	0.13 - 2.1	Increase
Iron soluble (mg/L)	-	0.04 - 0.85	-
Manganese (mg/L)	0.01 – 0.31	0.039 - 0.97	Increase
Manganese soluble (mg/L)	-	0.0005 - 0.005	-
pH	6.66 - 7.91	6.61 - 7.6	-
TOC (mg/L)	4.2 – 5.6	5.4 - 12	Increase
Total Geosmin MIB (ng/L)	1 – 21.5	4 – 57	Increase
Turbidity	15.0 – 31.0	3.3 – 22	Decrease
THMs (Contact Point, not raw water) (mg/L)	0.04 – 0.08	0.07 - 0.21	Increase

As can be seen in Table 1, the floods resulted in a noticeable increase in almost all raw water quality parameters, including a dramatic increase in colour. The only decrease observed was in turbidity. These '1 in 100 year' conditions proved challenging for Cohuna WTP, with raw water quality outside the designed treatment capacity envelope. To ensure that the impact to treated water quality and production was minimised, a suite of changes had to be rolled out rapidly, and each of the sections below captures key issues and what was done to address them to keep the Cohuna township supplied with safe drinking water.

LEARNING 1 – RAW WATER QUALITY IS DETERIORATING; STORMS EXACERBATE THE ISSUE, BE READY.

2.2 Site Access / Operator Fatigue

During the 2022 floods rapid action was taken across the Coliban Water region to protect critical infrastructure. This included building an earthen levee / sandbag walls around at-risk assets. The majority of the treatment team were also heavily involved in flood protection efforts. As a result, when raw water quality issues began to emerge, we had a site with difficult access and an exhausted team. Works were undertaken to restore safe access through the excavation of access points and the removal of sandbags, which had become a trip hazard. To improve the situation, operator assistance was provided by Veolia Water, with temporary operators brought in to provide respite for the team.

LEARNING 2 – THIS IS A MARATHON NOT A SPRINT, MAINTAIN A SAFE ENVIRONMENT AND ENSURE ADEQUATE PERIODS OF REST.

2.3 Raw Water Weeds

Goulburn-Murray Water (GMW) typically undertake weed spraying of the Gunbower Creek to keep aquatic weeds controlled. However, due to the floods, GMW could not safely access the area to undertake this routine spraying. The result was far worse than any of us imagined. Weed growth was so thick in the Gunbower Creek that birds could literally walk on water, the weeds clogged the entire water column and were growing as far as the eye could see. This resulted in regular blockage of the raw water pump inlets. Manual cleaning of the inlets had to be increased to three times daily, 7 days a week. To minimise the impact to the treatment team, the networks team assisted in removing weeds from the inlet, and after reaching out to GMW to see if they had any suggestions, GMW organised for a 'weed muncher' to attend site and clear out the Creek.

LEARNING 3 – REACH OUT FOR ASSISTANCE, YOU NEVER KNOW WHAT OTHERS CAN OFFER.

2.4 High organics and low turbidity

The raw water was found to be incredibly difficult to treat, particularly due to the combination of low turbidity and high dissolved organics. It was identified that standard coagulation was not working, and operator experience indicated that Enhanced Coagulation was a potential solution.

Enhanced Coagulation refers to the practise of dosing a coagulant, typically alum, at high concentrations and low pH, to increase the removal of Natural Organic Matter (NOM) during the coagulation process. NOM is a complex mixture of organic compounds originating primarily from decaying plant material. NOM contributes to colour, increases the required coagulant and disinfectant dose for treatment, and contributes to the formation of Disinfection by Products, but does not increase the turbidity of the water.

Jar testing was undertaken, and the results for enhanced coagulation were positive. A new caustic line was installed to allow enhanced coagulation to be undertaken. The trial was a success.

LEARNING 4 – ISSUES HAVE OFTEN BEEN OVERCOME BEFORE, LEARN FROM OPERATOR EXPERIENCE.

2.5 Light Floc

Due to the low turbidity of the raw water, the floc in the clarifier was found to be extremely light. As a result, the "sludge blanket" would continually lift, break up and carry over into the filters. This quickly resulted in exceeding the critical limit for the clarifier turbidity Critical Control Point, which, when exceeded, shuts down the WTP. When this occurs, it requires operator site attendance to restart the WTP. To manage the light floating sludge blanket uplift the following was undertaken:

- Jar testing to optimise chemical dosing.
- Poly trials and returning the poly dosing system to operation.
- Continual visual monitoring and stopping the plant to let the blanket settle.
- Installation of shade covers to reduce potential heat impacts.
- Increased PAC dosing to add extra weight to the formed floc to aid settling.
- WTP production reduced from 50 L/s to 25 L/s, as lower flows resulted in less uplift.

LEARNING 5 – MINOR ISSUES CAN RESULT IN MAJOR HEADACHES. GO HARD AND GO EARLY.

2.6 Low plant throughput

The WTP could not treat the water at a rate which allowed us to keep up with town demand. Therefore, to increase the clarification surface area we decided to reinstate three decommissioned clarifiers that had been out of service for more than 20 years!

This was no small feat, requiring.

- The removal of a roof (installed as part of the decommissioning project) to see what we were dealing with.
- Structural assessments were undertaken, which identified that only two of the three clarifiers could be safely filled with water without the risk of a structural collapse due to condition of the concrete supports. However, to safely fill the two structurally-sound clarifiers, additional steel supports were required. Footings were exposed and analysed, designs were drafted, and steel supports fabricated and installed.
- Redundant bypasses were removed, and new sludge pipework/valves installed.
- Inlets were designed and installed (had to be careful not to shear the floc)
- All debris / leaf litter was removed, and the clarifiers cleaned.

Following the completion of all the civil works, hydrostatic testing was undertaken, and it was identified that only one clarifier could be used due to leakage. This was still one more clarifier than we had before, so a positive outcome. The new clarifier was returned to service, requiring filling, the reestablishment of a sludge blanket and the management of flows to ensure even distribution across the two old and one renewed clarifier. This allowed the WTP flow rate to be increased to 35-40 L/s.

LEARNING 6 – IDENTIFY POTENTIAL CONTINGENCIES, YOU NEVER KNOW WHEN YOU MAY NEED THEM.

2.7 High Metals

High metals (specifically, iron and manganese) in the raw water required the dosing of sodium hypochlorite for pre-oxidation. However, due to the high organics in the raw water, there was high chlorine demand. Therefore, to effectively remove the metals chlorine had to be increased, however, high organics + high chlorine results in increased THMs (a disinfection by product). This became a balancing act, i.e., add only enough hypo to remove metals, whilst being mindful of potential THM production.

LEARNING 7 – WATER TREATMENT IS A BALANCING ACT; EVERY ACTION HAS A CONSEQUENCE.

2.8 24/7 Operation

WTPs are typically designed to operate around 16 hrs/day. However, during the poor raw water quality period, the Cohuna WTP was running 24/7. This resulted in both the plant and our team being pushed to the limit.

Fatigue Management

The greatest concern was fatigue management, and, in all honesty, this is somewhere that we could have improved. Regular team rotation was undertaken, and on ground assistance was provided by outsourced operators, as well as ex-operators, where possible.

LEARNING 8 – FATIGUE MANAGEMENT SHOULD ALWAYS BE FRONT OF MIND. HELP EACH OTHER OUT.

Asset Failure

Needing the WTP to operate 24/7 meant assets were running hot, and downtime was a luxury in short supply. This often led to asset failures, with minimal time for repair. Examples that occurred during the event included:

- The burn out of a unique duty only low lift pump. Thankfully, a local fabricator had a spare available from a previous job.
- Assets that were exposed to the sun overheating and/or gassing off, e.g., sodium hypo system. We had to erect temporary shade structures.

LEARNING 9 – CARRY CRITICAL SPARES, MAINTAIN ASSETS, AND INCORPORATE WEATHER PROTECTION.

2.9 Demand Exceeding Supply

Even with all the above works completed we still could not supply enough drinking water to keep up with demand. As a result, we undertook a staged demand management response:

a. Engaged with the community.

We worked with Gannawarra Shire to turn off watering systems and used communication channel, such as social media, to ask the community to limit water use.

b. Water Carting

We undertook a major water carting effort. This included.

- Installing fill points, including pumps, lay flat pipework and camlock connections.
- Bringing in additional gravel to improve truck access.
- Erecting boom lighting and the establishment of traffic management.
- Working with every available truck/driver in the region. There were approximately

eight trucks operating 24/7. Water was sourced from surrounding WTPs. Water carting is a logistical challenge, challenges such as queues at standpipes, a few blown tyres, and overheated engines occurred regularly.

c. Reduced pressure to town

We partially closed a valve entering the township to reduce pressure to reduce demand.

d. Last Resort - Reducing customers.

As a last resort, to ensure that the supply to Cohuna's urban system customers was maintained, Coliban Water had to restrict flow to 'Supply by Agreement' customers in the majority of Cohuna's rural supply system. Forward notice was provided to customers via door knocking. As such, these schemes were depressurised, and a Boiled Water Advisory put in place. A Section 22 notification to the Department of Health was also undertaken. Supply was returned once raw water quality improved.

LEARNING 10 – WORK WITH YOUR COMMUNITY, FACE TO FACE IS ALWAYS BEST.

3.0 CONCLUSION

Events like this challenge an organisation, and place staff under enormous pressure to deliver results in circumstances where there is no rule book to follow. Each event is unique, but we would like to provide this summary of what we learned out of this event, which may be useful for others who may face similar challenges.

Learning 1 – Raw water quality is deteriorating; storms exacerbate the issue, be ready.
Learning 3 – This is a marathon not a sprint, maintain a safe environment and ensure adequate periods of rest.
Learning 3 – Reach out for assistance, you never know what others can offer.
Learning 4 – Issues have often been overcome before, learn from operator experience.
Learning 5 – Minor issues can result in major headaches. Go hard and go early.
Learning 6 – Identify potential contingencies, you never know when you may need them.
Learning 7 – Water treatment is a balancing act; every action has a consequence.
Learning 8 – Fatigue management should always be front of mind. Help each other out.
Learning 9 – Carry critical spares, maintain assets, and incorporate weather protection.
Learning 10 – Work with your community, face to face is always best.

4.0 ACKNOWLEDGEMENTS

Coliban Water – an amazing effort from the entire team.
Service Stream – many operators went above and beyond for their community.
Veolia Water – for volunteering to assist in a time of need.

5.0 REFERENCES

Practical Guide to the Optimisation of Chemical Dosing, Coagulation, Flocculation and Clarification, Bruce Murray, and Peter Mosse, 2008

BLACKWATER 3.0 – THE RETURN OF THE ORGANICS
2017 Victorian Conference Papers (wioa.org.au)

YARRAMAN WTP THM CONTROL THROUGH ENHANCED COAGULATION & TECHNOLOGY
Microsoft Word - 2019-V2 Qld Conference book.docx (wioa.org.au)