MANAGING WATER QUALITY RISKS DURING EXTENDED TEMPORARY WORKS AT GRIFFITH WTP

David Bartley, *Head of Operations Support,* Atom Consulting
Jaco Opperman, *Senior Water & Wastewater Engineer*, Griffith City Council
Mick Walsh, *Treatment Plant Coordinator*, Griffith City Council

ABSTRACT

Extended plant refurbishment or upgrade works can introduce additional risks to drinking water quality, particularly when existing chemical dosing and treatment barriers require refurbishment or augmentation.

Griffith Water Treatment Plant (WTP) is owned and operated by Griffith City Council (GCC) and consists of a conventional filtration process; coagulation, rapid mixing, flocculation, dissolved air floatation (DAF), dual media rapid filtration and chlorination. GCC engaged Atom Consulting on two separate projects involving temporary works at Griffith WTP.

The first project involved a practical investigation of coagulant dosing and treatment configurations during remediation of the flocculation and DAF tanks. Although jar testing is typically used for optimisation, we utilised this method to simulate several alternative treatment configurations and scenarios, including changing the coagulant dosing location and temporarily converting the plant to a direct filtration process.

GCC are currently progressing the Griffith WTP masterplan, which involves reviewing options for high priority works as well as developing a long term plan for the Griffith WTP. We undertook a water quality risk assessment with NSW Health to assess the risks of extended temporary modifications to the plant's treatment process and capacity as part of the Griffith WTP masterplan upgrade.

This paper will summarise how practical, bench-scale methods can be used alongside qualitative consideration of risk in one instance, and how existing risks can be recontextualised to inform the planning of extended temporary works and mitigate potential water quality impacts.

1.0 INTRODUCTION

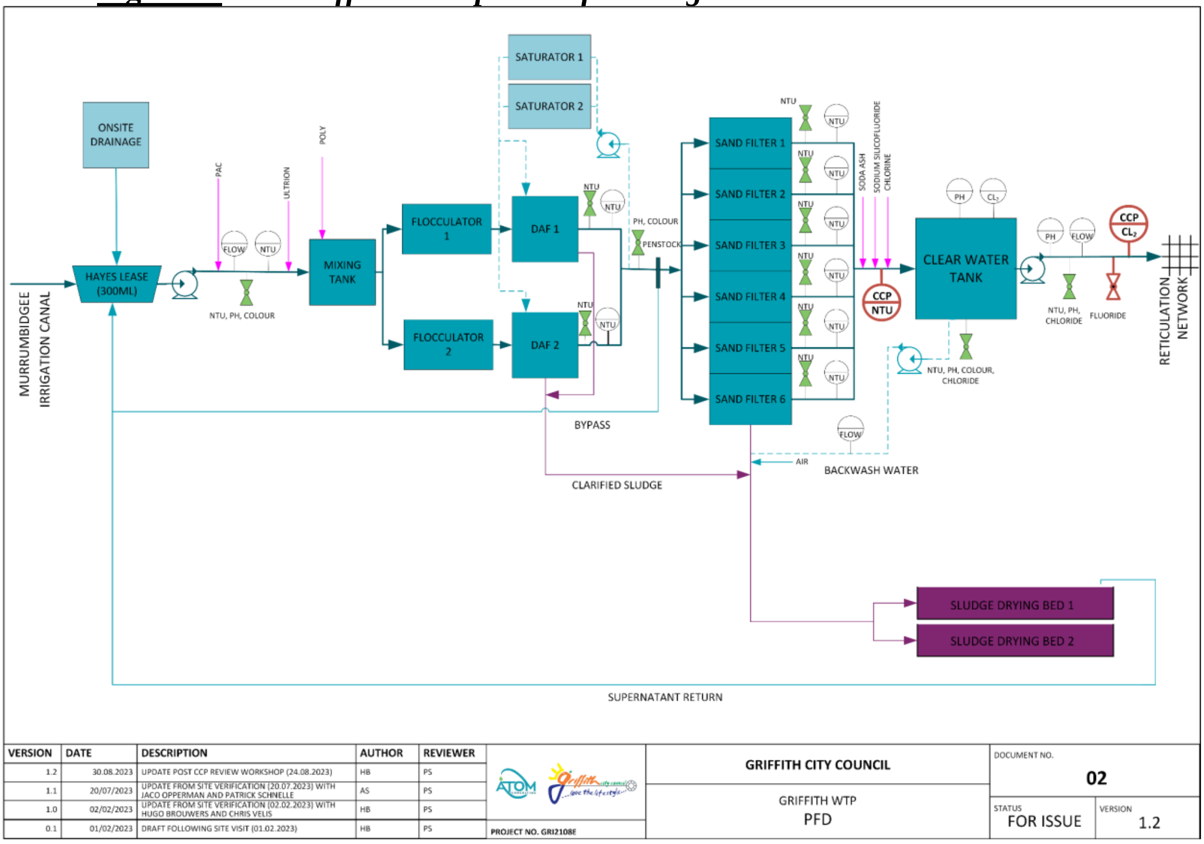
The Griffith WTP was commissioned in 1987 with a capacity of 60 ML/day, currently supplying water to more than 25,000 people. Over the years GCC has undertaken refurbishments and upgrades, but more work is now needed on certain concrete structures due to asset age, soft water attack, water erosion and low pH (due to aluminium sulphate dosing).

The Griffith WTP is the only water treatment plant in Griffith and cannot be taken off-line for more than 3 days during winter.

When planning for the extended shutdown of key treatment processes, water utilities can face the tension of maintaining their assets whilst causing minimal negative impact on levels of service for water quality and supply. Structural limitations, such as the age of the plant or lack of redundancy in the design can further complicate this task. External factors such as more conservative operational targets, tightening regulatory values, and raw water quality beyond the original design envelope can also complicate maintenance and upgrade planning processes. These are all issues that GCC have had to navigate in preparation for their projects.

Raw water for Griffith WTP is sourced from the Murrumbidgee Irrigation canal and stored in an offline storage. The current treatment process consists of coagulation, rapid mixing, flocculation, DAF, dual media rapid filtration and chlorination. Raw water dosed with coagulant flows into a common rapid mix chamber before being split between two identical flocculation and DAF trains. DAF subnatant flows into the filter inlet channel, which distributes the water between six dual media filters. Filtered water then flows into the clear water tank (CWT). Chlorine and fluoride are dosed at the inlet to the CWT as filtered water flows over a weir into the CWT. The plant is operated to produce a maximum flow of 60 ML over 22 hours of continuous operation (758 L/s).

Figure 1: ***Griffith WTP process flow diagram***



GCC are currently planning for two periods of extended temporary works at Griffith WTP. The first project involves the draining and remediation of the concrete rapid mixing, flocculators and DAF outlet channel. This work is expected to take approximately 4 weeks during winter 2025. Normally, water quality risks during temporary works to either the flocculation or DAF processes can be mitigated by shutting down and draining one train at a time. In this instance however, taking the common rapid mixing tank and the common DAF outlet channel offline would impact both trains simultaneously, and require the coagulant dosing point to be moved or the rapid mixing tank to be bypassed. GCC engaged Atom Consulting to conduct investigative jar testing to replicate potential dosing configurations and determine the water quality risks of potentially bypassing treatment barriers.

The second project involved planning for the remediation and upgrade of the existing CWT, as well as replacing the existing 1 Megawatt high voltage clearwater pumps. The upgrade work is needed due to the condition of the concrete in the CWT but also due to the age of the high voltage pumps. Atom Consulting facilitated an options and water quality risk assessment workshop for the Griffith WTP masterplan, which would involve temporary clear water storage and pumping while remediation works occur on the current tank.

In both instances, GCC has sought to find a cost-effective approach to safely take process units offline without compromising water quality.

2.0 DISCUSSION

2.1 Jar testing investigation

Although jar testing is typically used to optimise chemical dosing, Atom Consulting and GCC utilised this bench-scale method to simulate several potential coagulant dosing and treatment configurations.

GCC had originally proposed to bypass the rapid mixing, coagulation and DAF processes by supplying dosed raw water directly to the filter inlet channel. This was seen as a cost-effective solution; however, the potential water quality impacts were unknown. Several options for the bypass were identified for testing including:

- Keeping the existing dosing location
- Moving the dosing location to the raw water pump station to provide additional mixing
- Using alternative coagulants
- Installing a temporary flocculation process.

The coagulant used for jar testing was aluminium chlorohydrate (Ultrion 44560). Alternative coagulants were used for two tests to determine if an alternative coagulant would be more effective.

Key flow and mixing parameters for the existing process were calculated for each option based on the rapid mixing and flocculation resident times and the mean velocity gradients of the mechanical mixers. For alternative dosing points and temporary flocculation tank the mixing velocity gradient was estimated from typical design values.

At the time of jar testing the dose rate of Ultrion 44560 was 9.1 mg/L and this was used in all jar tests as a reference value. The jar testing scenarios are shown in Table 1

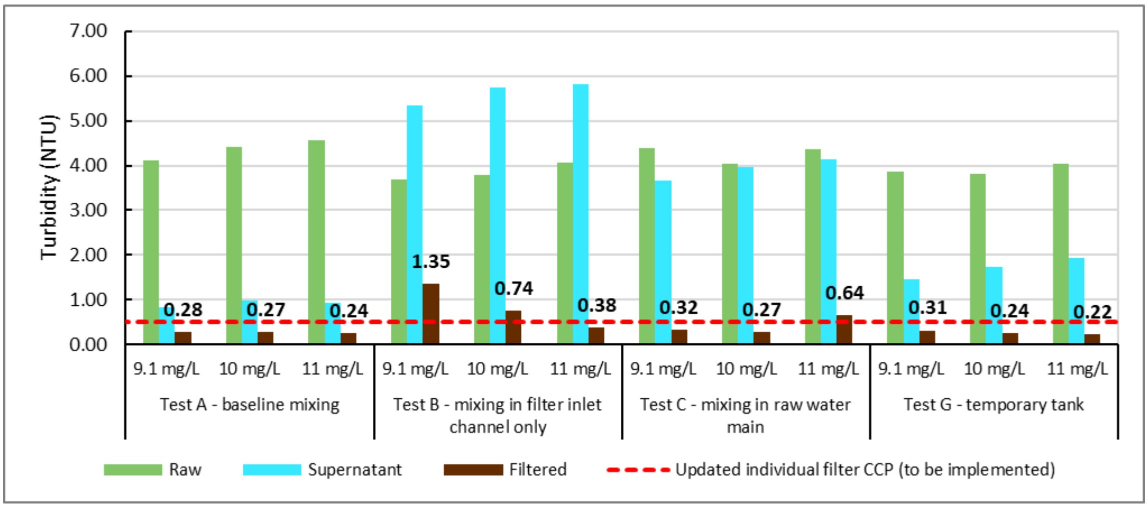
Table 1: ***Jar testing scenarios***

Test	Description	Coagulant	Dose (mg/L)			
			Test 1	Test 2	Test 3	Test 4
A	Baseline test of current process, i.e. rapid mix and flocculation (without DAF)	Ultrion 44560	8	9.1	10	11
B	Bypass to filter inlet channel after current dosing location	Ultrion 44560	8	9.1	10	11
C	Bypass to filter inlet channel with dosing at raw water pump station	Ultrion 44560	8	9.1	10	11
D		Ultrion 44560	9.1	11	13	15
E		Ultrion 44697	9.1	10	11	12

Test	**Description**	**Coagulant**	**Dose (mg/L)**			
			Test 1	**Test 2**	**Test 3**	**Test 4**
F		Alum	9.1	10	11	12
G	Temporary flocculation tank	Ultrion 44560	9.1	10	11	12
H	Bypass to filter inlet channel with dosing at raw water pump station (high turbidity raw water)	Ultrion 44560	9.1	11	13	15

The results of the jar testing are shown in Figures 2 and 3.

Figure 2: ***Jar testing turbidity results***



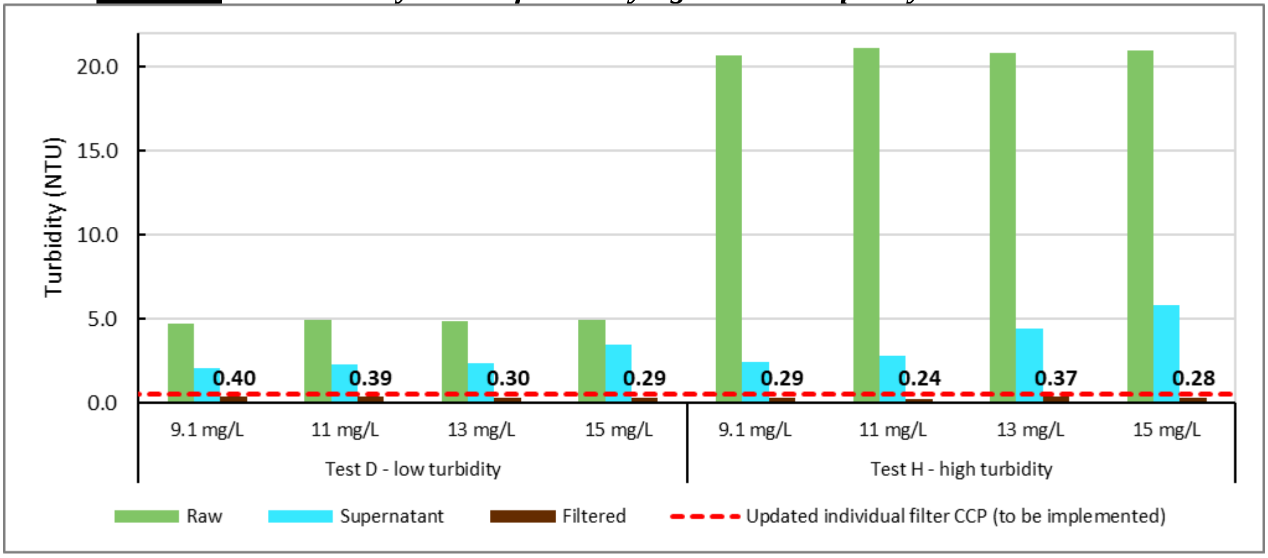
The baseline performance in Test A produced a medium floc between 0.5-1.0 mm, which is optimal for a DAF process.

Test B showed a higher sensitivity to coagulant dose, which is attributable to the short mixing time and low energy input from the hydraulic mixing in the filter inlet channel. Flocculation only in the filter inlet channel (Test B) provided very little opportunity for floc growth. Mixing produced suspended particulates with no settling evident.

Ultrion 44560, Ultrion 44697 and alum were used in Tests C, E and F respectively. Turbidity results showed that the Ultrion 44697 tended to provide greater settling which increased with dose. Alum tended to be less effective at true colour removal and lowered the pH with increasing dosage.

At the time of jar testing, the turbidity in the offline storage at Griffith WTP was low. To assess the performance of the different options with higher turbidity and colour, samples were collected from Yenda WTP which collects raw water directly from the Murrumbidgee Irrigation canal. The results of this jar testing are shown in Figure 3.

Figure 3: ***Turbidity results from varying raw water quality***

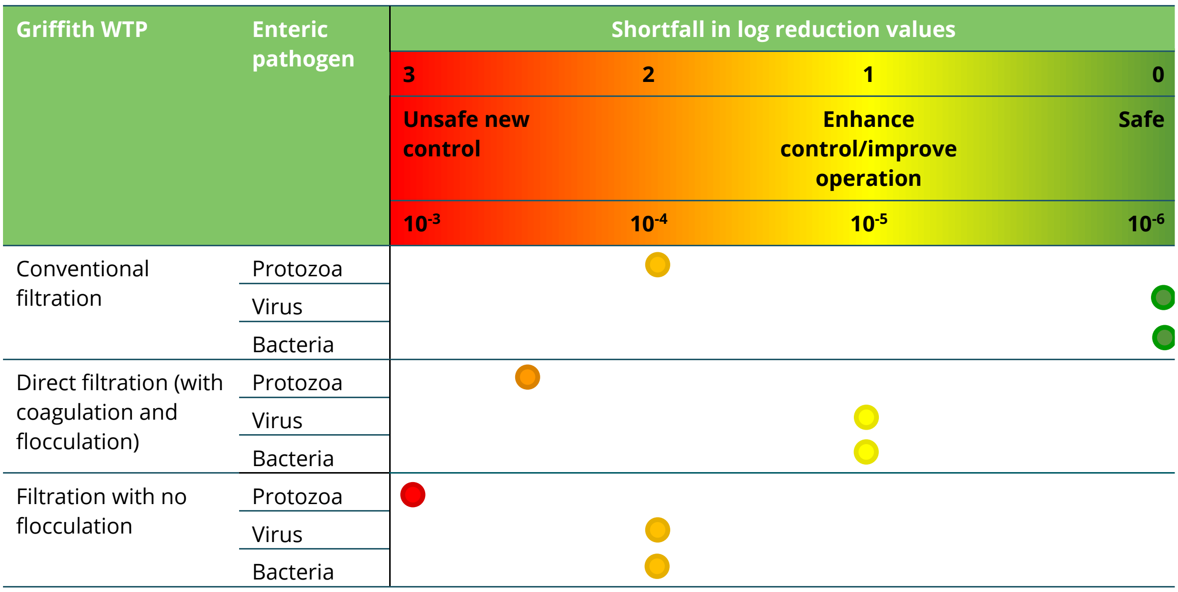


Tests C, D and H demonstrated the viability of dosing coagulant at the raw water pump station. After settling and filtering, Test H demonstrated that filtered turbidity below the CCP limit could be met. The raw water main would provide considerably more residence time, and a higher degree of hydraulic mixing compared to the filter inlet channel alone.

Floc sizes observed throughout the investigation were typically <0.3 mm during low raw water turbidity conditions (Tests C, D, E, F) and were around 1.0 mm for higher raw water turbidity conditions (Test H). The absence of large floc sizes (1.5 to 5 mm) for the pipe mixing option would indicate that the risk of large, dense floc settling on the filter media during this configuration is relatively low.

The shortfall in log reduction values (LRVs) of the options for temporary process modification are shown in Figure 4. Removing the flocculation and DAF processes introduces a 1 LRV shortfall for viruses and bacteria and 2.5 LRV shortfall for protozoa. This puts the shortfall into the unsafe area.

Figure 4: ***Water safety continuum – water supply system shortfalls in LRVs***



The jar testing showed that that the CCP limit could be achieved if the flocculation and DAF processes are bypassed and coagulant is dosed at the raw water pump station. However, removal of the sedimentation process, reduces the LRVs to an unsafe shortfall. This shortfall was a risk that GCC were not prepared to accept. An alternative method to refurbish one flocculation train at a time was identified. This would require the rapid mix chamber and DAF outlet channel to be bypassed which would require the temporary pipework and pumps. This cost to ‘buy out’ the water quality risk was preferred above the risk of supplying unsafe drinking water or the cost to the community of a boil water notice.

2.2 Temporary clear water storage and pumping

Recent condition assessments revealed that concrete refurbishment is needed in the CWT at Griffith WTP. It was proposed that temporary storage and pumping arrangements are needed to take the CWT offline while the concrete remediation work is conducted. As the CWT is used for chlorine contact time any temporary works would need to ensure the C.t of 15 mg.min/L could be met before supply to the first customer.

The high voltage existing clear water pumps are nearing the end of their life, and it is difficult to procure spares. As the high voltage pumps are fixed speed and operate intermittently, they are inefficient during startup and shutdown. It was therefore proposed to replace these pumps with low volage pumps with variable speed drives at the same time that the CWT was offline for repair.

It was planned that the works would be undertaken during winter when the demand for dinking water is lower. This would allow the capacity of any temporary storage and pumping to be minimised.

These works were assessed as part of the masterplanning project for the Griffith WTP. This was to ensure that any immediate work was consistent with the long-term plan for the upgrade of the plant to meet future capacity and water quality standards.

During the planning phase, additional options were identified including construction of a new CWT, new clear water pump station and different locations for new switchgear. These options are currently being assessed and have different costs and some are more suited to the addition of UV disinfection in the future to meet health-based targets.

A water quality risk assessment workshop was also held to ensure that the relative risk to drinking water quality of each option and actions identified to mitigate the risks can be incorporated into the options development and assessment.

3.0 CONCLUSION

Major asset maintenance that requires reconfiguration of bypassing of the water treatment processes must be planned in advance including an understanding of the risks to drinking water quality during the maintenance. This assessment may include bench or full scale trials before the maintenance is undertaken. Representatives of all operation and maintenance staff should be involved in this process.

The relative costs and risks of all options should be assessed so that water utilities can make an informed decision on how much additional cost is acceptable to “buy out” the risks.

Asset maintenance work should also consider how the refurbished assets will fit into the long term planning for the plant.

4.0 ACKNOWLEDGEMENTS

The authors of this paper would like to thank Griffith City Council for their support and permission to publish the information and lessons learned from the projects presented in this paper.

5.0 REFERENCES

Atom Consulting, *Technical Note – Griffith WTP jar testing investigation*, (2024)

Atom Consulting, *Griffith WTP masterplan – Basis of planning report* (2024)

Atom Consulting, *Griffith WTP masterplan – Water quality risk assessment output report* (2024)