ADAPTIVE MANAGEMENT OF SYDNEY TASTE & ODOUR EVENT

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ABSTRACT

In June 2024, approximately 100 customer complaints were received relating to unfavourable taste and odour in Sydney Water's Orchard Hills distribution network. High geosmin concentrations (>25 ng/L) were detected at customer taps compared to operational guidelines of <10ng/L (Australian Government, 2011). Sydney Water's water quality, operations, process optimisation, laboratory, network operations and research and innovation (R&I) teams collectively addressed the issue within 10 days.

The Orchard Hills Water Filtration Plant (OHWFP) is a closed system where filter backwash wastewater is settled in three lagoons and supernatant is returned to the plant inlet. Extensive water quality monitoring revealed that geosmin concentration was <1 ng/L in the raw water but was elevated in Lagoon 1 and 2 (>200 ng/L) and Lagoon 3 (~30 ng/L). Lagoons 1 and 2 were immediately isolated and the supernatant flow from Lagoon 3 was restricted to prevent customer impact.

Ozonation and activated carbon absorption methods were trialled at bench-scale to treat elevated geosmin in supernatant. Up to 98% removal was achieved with ozone doses of 4 mg/L for the elevated concentration of geosmin >200 ng/L in the lagoons. Sydney Water's trailer-mounted ozone system was deployed for emergency treatment of supernatant. It successfully treated the elevated geosmin of the 10 ML of water from affected lagoons.

1.0 INTRODUCTION

Orchard Hills Water Filtration Plant (OHWFP) currently serves approximately 260,000 customers in Western Sydney with a current average day demand 65 ML/d and maximum day demand 120 ML/d. In June 2024, approximately 100 customer complaints were received relating to unfavourable taste and odour in the Orchard Hills Delivery System. High geosmin concentrations (>25 ng/L) were detected at customer taps which was determined to be the cause of the taste and odour. Sydney Water implemented a collaborative approach to ensure a rapid-response to minimise customer impacts.

2.0 DISCUSSION

The objectives of this incident response were to collaboratively: 1) effectively respond to customer complaints; 2) find the root cause of high geosmin; 3) employ effective operational controls and treatment to manage the source of geosmin. Sydney Water's water quality, plant operations, process optimisation, laboratory, network operation and Research & Innovation (R&I) teams were engaged in the taste and odour incident. Each team bringing unique skills and resources to achieve the response objectives and manage the incident.

2.1 Customer complaint response and geosmin source identification

OHWFP (Figure 1) utilises a direct filtration process involving coagulation and dual media filtration. The OHWFP is a closed system, whereby filter backwash waste is treated in lagoons and lagoon supernatant is returned to the plant inlet.

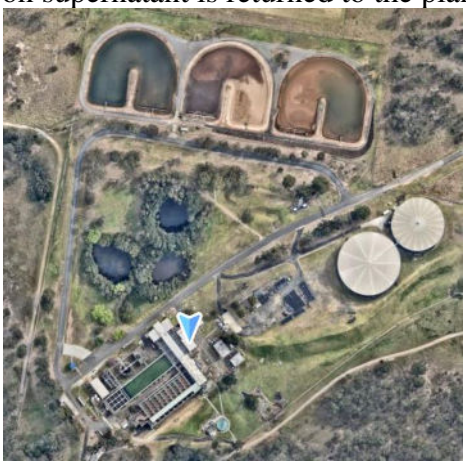

Figure 1: ***Orchard Hills Water Filtration Plant and residual drying lagoons***

Upon receiving the first customer complaint of poor water aesthetics in the Orchard Hills Delivery System, the Water Quality team attended the property within 2 hours, finding elevated taste and odour compounds such as those associated with geosmin/MIB. Consultation with WaterNSW confirmed in the weeks prior, there had been no detections of geosmin/MIB at the current offtake from Warragamba Dam.

Odour analysis conducted by the Water Quality team and Plant Operations team, at OHWFP confirmed a strong earthy smell in the treated, combined filter and coagulated water but not the pre-dosed or raw water. This was confirmed by lab analysis, with raw water geosmin concentration being <1 ng/L but treated water at OHWFP was 23 ng/L, compared to operational guidelines of <10ng/L (ADWG, 2011). It was determined that the high geosmin concentrations in the treated water was sourced from within the OHWFP closed system. It was realised that this a first of its kind incident, as geosmin had only ever previously entered the distribution system via the raw water. On Day 3 of the incident, samples from Lagoons 1, 2 and 3 were taken to be analysed. The following day, the laboratory results determined elevated geosmin in Lagoon 1 and 2 (>200 ng/L) and Lagoon 3 (~30 ng/L) therefore, confirming the lagoons to be the source of the geosmin. Prior to the incident occurring, the Plant Operations team had switched the supernatant return source from Lagoon 3 to Lagoon 2, as part of a normal operational procedure to rotate online lagoons. Supernatant was being returned at a rate of 6% of the plant raw water feed to the flash mixing chamber, therefore causing elevated geosmin concentrations in the treated water.

2.2 Operational response to reduce customer impacts

Through effective collaboration by Water Quality, Water Supply and WaterNSW on the first few days of the incident, immediate operational changes such as the movement of balance points and reconfiguration of source water network were made. The Water Quality team spatially tracked customer complaints to monitor the extent of the incident and inform operational changes. When it was suspected that the geosmin was coming from the OHWFP closed system, the lagoons and supernatant return were immediately taken offline. Once sample analysis confirmed Lagoons 1 and 2 as the source, the plant operations and process optimisation teams worked together to employ operational

controls at the plant to reduce geosmin in the treated water. Lagoons 1 and 2 were kept offline. As Lagoon 3 showed relatively reduced geosmin concentrations, it was kept online with a restricted supernatant flow (<6%) to allow OHWFP to maintain operation. This operational control maintained low levels (<5 ng/L) of geosmin in the OHWFP treated water by method of dilution to avoid aesthetic impacts to customers. With support of Sydney Water's West Ryde laboratories and Water Quality team, a monitoring program was developed to collect and analyse daily samples of the lagoons.

Table 1: ***Incident response timeline and stakeholder involvement***

Day of incident	Actions	Stakeholder groups involved (accumulative)	Geosmin in treated water
Day 1 (13/06)	Initial customer complaints.	OHWFP team, Water Treatment, Water Quality, Water Supply, WaterNSW, West Ryde Laboratories	
Day 2 (14/06)	Customer complaints. Confirmed no geosmin in current raw water supply.	Process Optimisation	22 ng/L
Day 3 (15/06)	Supernatant return taken offline.		21 ng/L
Day 4 (16/06)	Sample results confirmed high geosmin in lagoons.		9 ng/L
Day 5 (17/06)	Supernatant return remained offline.	Research & Innovation	3 ng/L
Day 6 (18/06)	Put supernatant return online from Lagoon 3 to allow plant to operate.		3 ng/L
Day 7 (19/06)	Commenced technology trials.	Prospect pilot plant	5 ng/L
Day 8 (20/06)	Continued technology trials		3 ng/L
Day 9 (21/06)	Zero customer complaints.	Network Operations	<1 ng/L

2.3 Benchtop technology studies for geosmin removal

The Plant Operations and Process Optimisation teams collaborated to determine a suitable treatment method to remove geosmin from Lagoons 1 and 2. On day 7 and 8 of the incident, benchtop studies were conducted in collaboration with Sydney Water's West Ryde Laboratories and Prospect Pilot Plant team to identify if treatment technologies could effectively reduce geosmin concentration in supernatant water. Benchtop ozonation was performed to observe removal of geosmin at different ozone dosages using an oxygen-fed 4g/h corona discharge Oxyzone ozone generator (Figure 2). The high concentration ozone gas was dissolved in a glass reactor that was prefilled with 0.5 L of geosmin containing supernatant for various lengths of time to achieve 1.5, 2, 2.5, 3, 4 and 5 mg/L ozone dosing respectively. The aliquots were immediately transferred to duplicate amber colour bottles, where in one of the bottles the reaction was quenched after 0.5 seconds to find the removal rate. The tests determined that >3 mg/L of ozone could reduce 98% of geosmin in the lagoon 2 water with geosmin concentration >200ng/L (Figure 3).

Benchtop studies were also conducted on the lagoon supernatant with activated carbon absorption methods. The tests were successful with high dose rates; however, the

application was determined to be operationally non-practical as an emergency solution.

Figure 2: ***Oxyzone ozone generator***

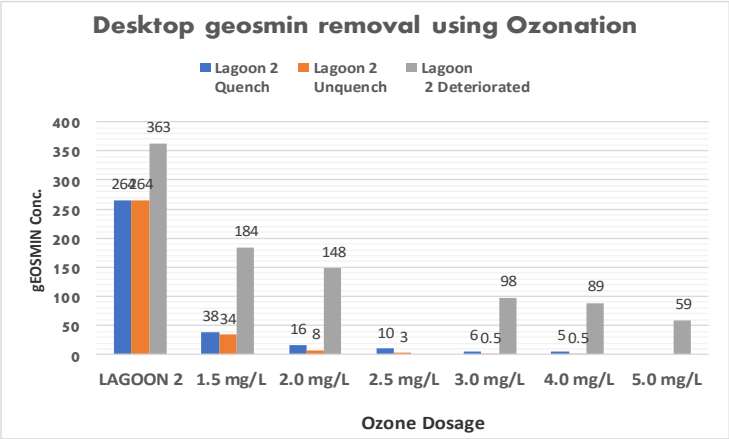

Figure 3: ***Benchtop ozonation results***

2.4 Geosmin removal using Sydney Water's mobile ozone trailers

Following successful benchtop ozonation trials, Sydney Water's Network Operations team were engaged to deploy Sydney Water's mobile trailer-mounted ozone system for emergency treatment of supernatant. The trailers are usually implemented by the Network Operations teams for disinfection of water mains and have not been utilised for this purpose previously. A three-phase high pressure pump was setup at Lagoon 2 to feed ozone trailer with lagoon supernatant via the supernatant return wet well (Figure 4). During the initial trial, the outlet trailer stream was returned into lagoon 2.

Operating at 100% capacity the ozone trailer would produces ~120 g/hr of ozone and the flow rate of water through the ozone trailer could be controlled between 300 L/min to 580 L/min. The concentration of ozone dissolved into the water by the trailer was estimated to be 3.5 – 6.7 mg/L. The actual concentration of ozone in solution was likely to be substantially less than the estimate above due to operating conditions such as water pressure, ozone injection and its dissolution efficiency. Ozone reacts almost instantaneously and significant proportion of the ozone is expected to react with the water between the dissolution point in the ozone trailer and the sample point at the end of the long lay flat hose attached to the trailer outlet. The ozone concentration was measured at the outlet of trailer and lay flat represented the ozone residual present in supernatant at the sample point. Samples for ozone residual were taken at both outlet of ozone trailer and lay flat. A geosmin concentration of 30-35ng/L from the outlet of the ozone trailer was targeted to ensure the plant finished water could confidently be maintained below typical detectable limits for sensitive customers (<3 ng/L).

Once samples were tested by Sydney Water West Ryde Laboratories and confirmed to have reduced geosmin below the target range of 30-35ng/L, the ozone trailer outlet was fed to the operational lagoon (Lagoon 3) before being returned to the plant inlet (flash mixing chamber) at a supernatant return rate of <6%. An ozonated sample was also analysed to confirm that ozonation would not form harmful disinfection by-products.

Figure 4: *Ozone trailer*

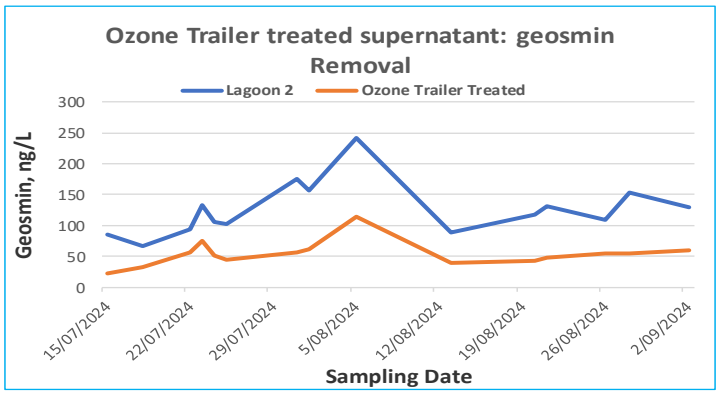

Figure 5: *Lagoon geosmin removal with ozonation*

2.5 Root cause research and investigations

When it was determined that this was a unique incident where geosmin was entering treated water via the OHWFP supernatant return, a root cause investigation commenced. Visual inspection of the lagoons revealed signs of cyanobacterial/algal presence. Cyanobacterial/algal concentrations and taste & odour compounds have been widely reported (Hosada et al. 2024). Cyanobacterial growth has also reported to be partly dependent on nutrients as growth can intensify when TN/TP ratio is low (Smith, 1983). This prompted further investigation into the cyanobacterial/algal concentrations in the lagoons, the root cause of algal presence in the lagoons and subsequent impact on geosmin concentrations.

2.6 Ongoing monitoring plan

Through collaboration between the Water Quality team, West Ryde laboratories, Process Optimisation and R&I team, a monitoring plan was developed to monitor the lagoons throughout the initial response and ozonation treatment. Raw water, supernatant, and finished water samples were collected from OHWFP system for pH, TOC, DOC, geosmin, MIB, cyanobacteria, algae etc. and were measured in the Sydney Water laboratory using NATA accredited methods over a period of two months. Thrice in a week lagoons samples were collected for geosmin, MIB, and chosen samples were analysed for nutrients, TOC, DOC etc. A few sediment samples were also collected for benthic activity analysis.

2.6 Completion of the lagoon ozonation

During lagoon ozonation initiative, the impact of geosmin removal in lagoon 1 and 2 supernatant was closely monitored on lagoon 3 and filtered water quality. It was observed that because of depletion in lagoons volume, the TOC/DOC and geosmin concentrations in supernatant had steadily increased (Figure 6). The increase in TOC/DOC concentration exerted high ozone demand reflecting in very low ozone residuals at the outlet ozone trailer. Water quality parameters such as dissolved organic carbon (DOC) strongly influence required ozone dosage levels. Ozone being a universal oxidant, the reaction kinetics will not be favourable for oxidation of geosmin when organic material is present in the supernatant. This was reflected in the rising geosmin in lagoon 3 (Figure 7), therefore the ozone trailer was taken offline and lagoons 1 and 2 were taken out of service and left to dry out while an operational decision could be made on how to proceed.

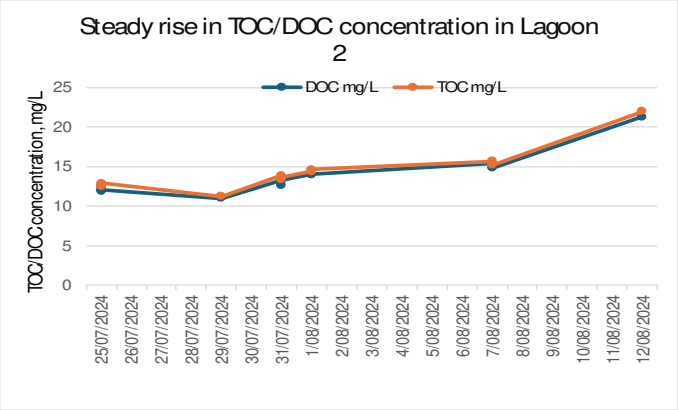

Figure 6: ***Lagoon TOC/DOC increase***

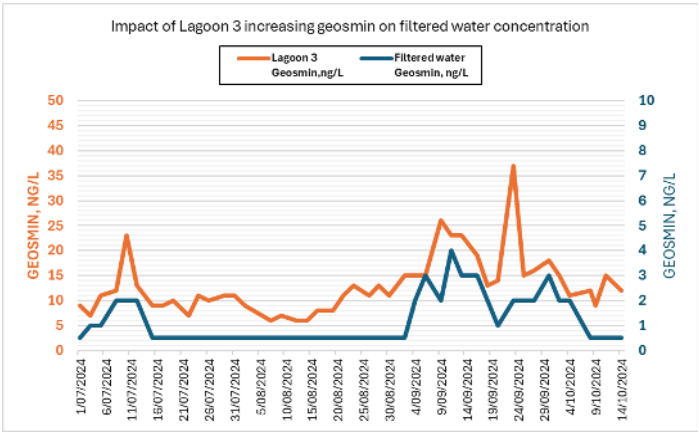

Figure 7: ***Impact on ozonation performance***

3.0 CONCLUSION

Following a unique taste and odour incident, Sydney Water's Water Quality, Water Treatment, Process Optimisation, and laboratory teams collectively addressed the issue. Within 10 days, the collaborative effort between the various stakeholders involved meant that Sydney Water were able to identify the cause of the high geosmin and effectively employ operational controls to reduce geosmin in the treated water to <1ng/L and drop customer complaints to zero. Following the initial incident response, adaptive management and stakeholder collaboration effectively enabled a treatment technology solution to address the elevated geosmin in lagoons using ozonation.

4.0 ACKNOWLEDGEMENTS

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