LANDERS SHUTE ADVANCED WATER TREATMENT PLANT ON THE SUNSHINE COAST

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ABSTRACT

Landers Shute Advanced Water Treatment Plant (WTP) is situated in the Sunshine Coast hinterland between the townships of Palmwoods and Montville. Landers Shute WTP Stage 1 primarily consisted of conventional WTP technology and commenced operations in 1989 with a design capacity of 87ML/d. Stage 1 utilised some modern, innovative technology with hydro electricity generation on the incoming raw water main, which produced enough power to run the WTP and also export substantial energy benefits to the power grid.

In 2002, the Landers Shute WTP Stage 2 upgraded the plant from its original, conventional technology to some of the most advanced WTP process technologies available, which are still considered to be of the highest standard today. Stage 2 basically duplicated the Stage 1 WTP and increased the plant's design capacity to 140ML/d, with the addition of another sedimentation basin. We upgraded the six existing Stage 1 rapid sand primary filters to dual media filters and constructed five more dual media primary filters. Stage 2 also delivered biologically activated carbon filters, and both pre and intermediate ozonation, which assisted in mitigating the raw water quality risks associated with the high risk catchment of Baroon Pocket Dam. We maintain both solar and hydro Electricity generation at Landers Shute. Chemical dosing consists of aluminium sulphate, carbon dioxide, pre and post lime, gaseous chlorine, and finally the addition of fluoride. Landers Shute is unique in many ways and is the most cost-effective WTP in Seqwater's portfolio. It has the ability to supply exceptionally high quality water to more than half a million people located between Noosa on the northern end of the Sunshine Coast and the greater Brisbane area, all without pumping.

In summary, my paper will provide an understanding of some of the recent trials conducted using pre ozone to effectively treat raw water soluble manganese levels of up to 0.313mg/L, which in previous years would immediately initiate potassium permanganate dosing. Typically with potassium permanganate dosing, we were forced to initiate a 24 hour shift due to fluctuating manganese levels in the raw water. This resulted in increased costs to our organisation, increased WH&S risks associated with working alone after hours, fatigue issues, and also water quality risks associated with potassium permanganate dosing with fluctuating raw water manganese. This process was labour intensive, with frequent testing and dose rate changes, and was generally considered to be problematic.

Our recent findings show pre-ozone can effectively treat soluble manganese concentrations in the raw water of up to 0.313mg/L. This has eliminated the need for potassium permanganate dosing and has provided certainty when the WTP is unmanned overnight. We are understandably excited at the possibility of never, or very rarely, having to initiate potassium permanganate dosing in the future.

1.0 INTRODUCTION

Seqwater is a Queensland Government statutory authority that is responsible for ensuring a safe, secure and reliable potable water supply for almost three million people across South East Queensland. We also supply irrigation services to around 1,000 rural customers in five water supply schemes.

We are one of Australia's largest water businesses with the most geographically spread and diverse asset base of any capital city water authority in the country. Our operations extend from the NSW border to the base of the Toowoomba ranges and North to Gympie. Seqwater manages more than $10 billion of water supply assets and natural catchments of the region's major water supply sources, which includes dams, weirs, conventional water treatment plants, a desalination plant, and the Western Corridor Recycled Water Scheme. Seqwater also operates more than 600 kilometres of pipeline that is connected to 12 of our larger water treatment plants.

I have been working in the water industry for more than two decades, primarily as a water treatment plant operator at Landers Shute Water Treatment Plant. In this time I have encountered all manner of challenging situations. Some of these have been severe storms, lightning strikes, floods, droughts and yearly dam turnovers. As required of Water Treatment Operators, we have managed these challenges with dedication and team work.

There are a few key phrases that provoke heightened alert from water treatment operators: high rainfall predicted; cyclone. Another would be the mention of manganese in the raw water, or the prospect of the dam turning over or mixing. The mention of these phrases indicates the prospect of major change in your daily routine, workload, and work / life balance.

At Landers Shute in years gone by, dam turnover and soluble manganese in the raw water have generally lead to increased plant coverage, with 24 hour shifts after initiating potassium permanganate dosing. During this time, the operational duties become focused on control of soluble manganese in the incoming raw water, which requires frequent testing and many potassium permanganate dose rate changes. Our manganese season – as varied as it can be depending on cold weather and strong westerly winds – created an extremely problematic and labour intensive period that could last days, weeks or even months.

2.0 DISCUSSION

Landers Shute pre-ozonation runs continuously to assist us with some of the raw water quality issues faced within our catchment. Pre-ozone assists in the removal of toxins, taste and odour causing compounds, colour, organics etc. However, the primary benefit that drove the initial concept of pre ozonation was to assist with the removal of filter clogging algae (FCA) which had caused significant operational issues at Landers Shute in the past. Manganese removal was not considered at this time as a benefit, and the initial advice to operations was to turn pre ozone off in times of elevated raw water manganese and initiate potassium permanganate dosing.

Until recently, we controlled manganese in the raw water by potassium permanganate dosing, with the aim of reducing incoming raw manganese to an acceptable level. The optimum target level for manganese at the flash mix had always been <0.030mg/L soluble, and for many years we managed to achieve these results through constant monitoring and effective process control. The pre-lime dose rate was also increased as soon as soluble manganese was discovered, thus assisting oxidation with high pH prior to carbon dioxide (CO^2) dosing, which lowered and stabilised pH prior to coagulant chemical dosing, flocculation and sedimentation.

After the Stage 2 upgrade, we stopped pre-ozone dosing when significant soluble manganese was present in the raw water. This was primarily due to insufficient evidence of how pre-ozone worked on soluble manganese in the raw water, as well as the uncertainty of the effects of inter ozone, which occurs downstream in the process chain prior to the biologically activated carbon filters. We investigated and sought extensive advice on this subject over many years; however, due to Ozone technology not being used for pre-dosing in many installations at this time, we continued down the path of potassium permanganate being used as our primary control for manganese in the raw water – until recently.

Over the 2013-14 summer, we experienced significantly elevated soluble manganese in the raw water of 0.313mg/L, with total manganese of 0.356mg/L. In the past, this triggered staff resource planning and initiated potassium permanganate dosing; however, the constant pre-ozone dose of 1.75mg/L effectively oxidised the elevated raw water manganese, and allowed normal operations to continue. The Duty Operator who collected and analysed the initial samples was pleasantly surprised by the raw results, and was very happy that pre-ozonation seemed to be effectively treating such a high concentration of soluble manganese in the raw water. The dramatic reduction in soluble manganese throughout the process was a direct result of pre-ozone oxidation.

Note: Analysis results are an average of process results during this short lived manganese event.

Raw Sol	F/Mix Sol	Settled Sol	Filtered Sol	Treated Sol
0.313mg/1	0.030mg/1	0.045mg/1	0.018mg/1	0.000mg/1
Raw Total	**F/Mix Total**	**Settled Total**	**Filtered Total**	**Treated Total**
0.356mg/1	0.271mg/1	0.045mg/1	0.020mg/1	0.000mg/1

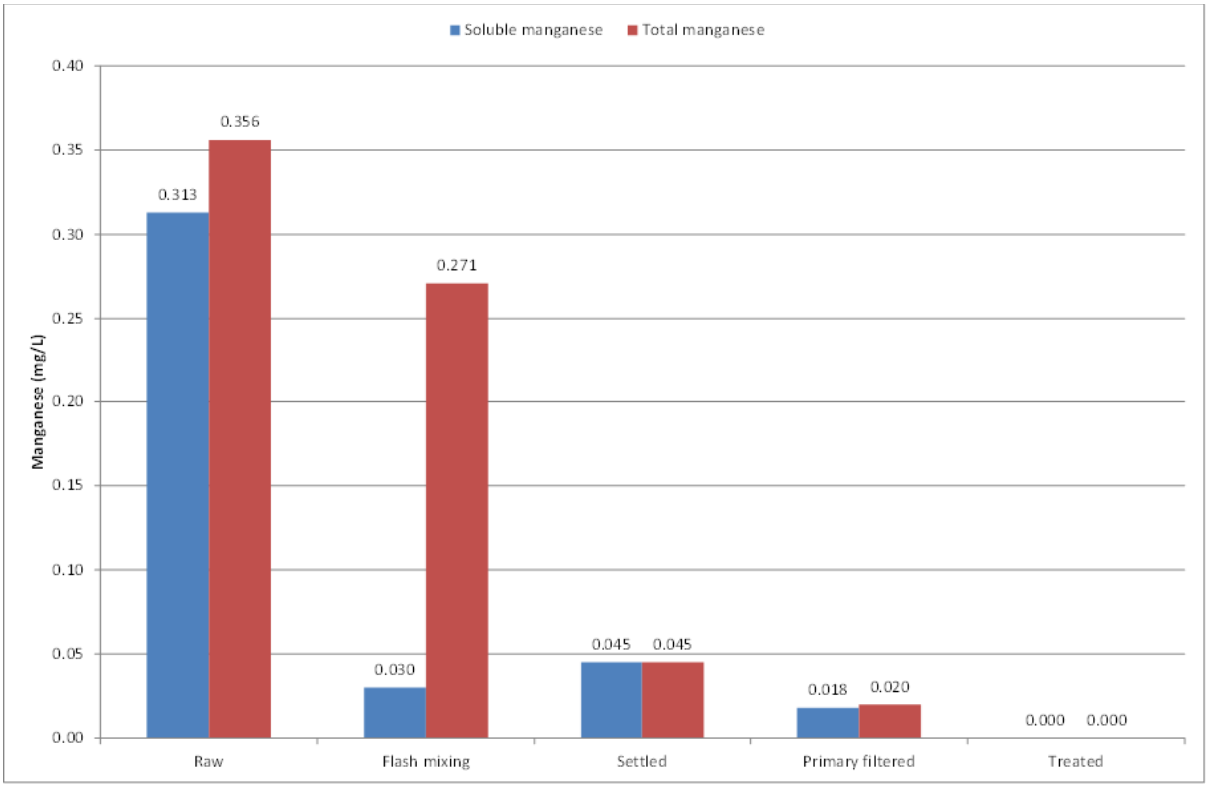

Figure 1: ***Manganese profile during an elevated manganese event Averaged raw water analysis for event commencing 27 January 2014.***

Raw Colour	Raw Turbidity	Raw pH	Raw Alk	F/mix pH	Raw Temp
8.0 (PtCo)	3.20 NTU	7.0	32mg/L	6.7	25.1

This manganese event only lasted approximately 24 hours, resulting in limited data being gathered. However, with a pre-ozone dose rate of 1.75mg/L and raw water quality comprising of the above parameters, we were able to quantify the following:

- Pre-ozonation very effectively oxidised soluble manganese to target levels in a more controlled and less labour-intensive manner than the potassium permanganate dosing method used in the past at Landers Shute WTP. It is also very important to note that as pre-ozone is dosed daily, regardless of water quality, a manganese event doesn't require us to markedly modify our process or start a standby chemical dosing system.
- The cost benefits associated with being able to confidently rely on pre-ozonation to oxidise soluble manganese will lead to significant savings in labour and chemical costs, helping Seqwater provide a cost-effective water supply for the region. Previously, potassium permanganate chemical costs alone equated to approximately $7,000 over a month period where we maintained a potassium permanganate dose for most of the month (varying depending on dose rate, flows and raw manganese concentration, etc).
- There are also significant WH&S benefits gained: staff are no longer working additional hours or working alone after hours, and the potential fatigue issues are also removed. By pre-ozone dosing for manganese removal we also remove chemical and manual handling risks associated with mixing potassium permanganate. In time, we aim to no longer require this chemical to be kept on site.

As this was a short trial, we understand that under certain conditions and depending on raw water quality, pre-ozonation may not be as effective and there may be some limitations with using pre-ozonation for the effective removal of manganese. For example, if there was an increased organic loading in the raw water with higher colour, turbidity, algal blooms and so on, it is likely the pre-ozone dose rate would be consumed relatively quickly, due to higher demand, even if the pre ozone dose was increased. Over the coming manganese season, we are aiming to investigate this and other potential variables, depending on water quality. We also aim to gain a clearer understanding of cost comparisons between increasing the pre-ozone dose rate if the manganese conversion was hampered by raw water quality, compared to potassium permanganate dosing.

We believe that if future trials are effective, pre-ozonation will be a far more cost efficient option for the reasons previously outlined and because the main cost involved in the production of ozone is power and Landers Shute has a hydro generator. The hydro generator at the headworks of the plant utilises the head pressure on the raw water pipeline from Baroon Pocket Dam. The hydro generator provides us with enough power to run Landers Shute water treatment plant depending on various factors, such as the pre-ozone dose rate. Combine these energy cost savings with a gravity distribution system covering most of the Sunshine Coast, as far north as Noosa, and south to Narangba and beyond, Landers Shute is a highly cost efficient water treatment plant that also produces excellent quality water.

3.0 CONCLUSION

Opinions are divided on the results of the trial, with merit on both sides of the argument. Some believe the results are inconclusive due to the short duration of the trial and the stability of the raw water quality during the period. Others suggest that pre-ozonation of soluble manganese is sure to work, as ozone is a very powerful oxidant. This latter view is the basis of this paper and the theory we aim to prove in the coming manganese season.

It is important to note that during this short event we effectively treated a raw water soluble Manganese of 0.313mg/L and reduced this to operational target parameters of 0.030mg/L soluble at the flash mix, which in the past has taken quite some time and much work. This time however, once initial results were analysed and verified, we were able to simply monitor closely without initiating a time consuming and very labour intensive potassium permanganate dose. Other benefits included:

- Not having to immediately organise staff to cover night time operations.
- Removal of WH&S issues associated with dosing of potassium permanganate.
- Having upmost confidence leaving the plant unattended overnight with soluble manganese present in the raw water for the first time.
- The pre-ozone dose rate remaining at 1.75mg/L throughout the event, only needing to be changed once from 1.75mg/L to 1.90mg/L as a further trial to see if we could reduce manganese even further (unfortunately soluble raw manganese reduced markedly to 0.010mg/L just after dose rate change).

This event reiterated to me that after 20 years in the water industry, there is hardly a day that goes by that I don't continue to learn. It is important, now more than ever, that we endeavour to work smarter and safer. In this and future trials we will continue to test different methods to find a better solution to a long term problem or problematic process.

It also reinforced that we are fortunate to have access to technology which assists us in maintaining a consistently high water quality at an extremely competitive cost, and I have always felt privileged to work at Landers Shute Water Treatment Plant for these reasons. With all we know and continue to learn about catchment and water quality management, and the impact of various environmental factors on these, we need to think carefully about new water treatment plants when they are needed. It seems that in future designs of water treatment plants, both within our country and around the world, utilising available technologies to achieve multi-barrier process control with the added benefit of sustainable energy production, where possible, is a way to ensure a safe, secure, cost efficient and reliable potable water supply for the future.