FREE CHLORINE BURN OF PORTLAND'S RETICULATION NETWORK

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ABSTRACT

Portland, a town in the far South West of Victoria uses chlorine gas and the natural ammonia in the groundwater sourced from the Dilwyn Aquifer to achieve Chloramination (Total Chlorine) for its disinfection process. Portland has had low chlorine residuals in areas of the distribution system for many years. Monitoring of the distribution system had indicated that it was likely that biofilms had built up in a number of area's within the network. The biofilms have the effect of using up the available chlorine thus resulting in the low residuals experienced within the network. It was decided to remove resistant biofilms from the network by dosing high concentrations of free chlorine a 'burn' into the network. The burn would kill the biofilms and therefore improve residuals across the entire network. This was the first chlorine burn attempted at Portland. The chlorine burn was carrried out over the summer months when water use is at its highest to try and achieve the change as quickly as possible without the need of flushing.

The burn was a success and Wannon Water was able to achieve a constant free chlorine residual throughout the entire network before reverting back to chloramination of the system. Once chloramination was resumed total chlorine residuals improved signifcantly across the entire system, confirming the success of the chlorine burn. The success of the burn reduced the chances of water quality issues like taste and odours as well as provide better protection from pathogens entering the system.

1.0 INTRODUCTION

The potable water at Portland is supplied from three different bores, which are approximately 1000m deep, that draw water from the Dilwyn Aquifer. The water, which is between 800 and 28,000 years old, reaches the surface at approximatley 60°c and it is cooled by six cooling towers that lower the temperature to below 30°c. The water is dosed with chlorine by way of a gas injection system at 1800g/hr giving a residual of 3.2ppm. This dose compliments the natural ammonia that is in the water (1ppm) achieving a chlorine and ammonia ratio of 3:1 to provide a chloraminated (total chlorine) disinfection process.

The disinfected water then enters the 32ML plastic lined and covered clear water storage (CWS) at a residual of 2.2ppm. Portland utilises this total chlorine disinfection process to supply potable water to its 6000 customers.

Through routine reticulated water supply sampling, it was evident that there has been an ongoing issue with low chlorine residuals across the network for many years. The low chlorine residual issue leaves the areas involved suseptible to pathogens entering the network thus creating a public health risk. Chloramine resistant biofilms also grow inside the reticulation system increasing the chlorine demand while releasing ammonia from the chloramine, therefore providing a food source for nitrifying bacteria.

To overcome the issues caused by biofilm growth, it was decided by our treatment team to change the disinfection process from a total chlorine system to a free chlorine (break point chlorination) system for a short period, this chlorine 'burn' kills the biofilm in the network therefore allowing a better residual to reach the entire system.

The chlorine burn was scheduled for October 2014 to January 2015 when water usage was at its peak, using the two bores at the Bald Hill WTP (figure 1) to provide the free chlorinated water to the system, then return to a total chlorine system after three to four weeks.

Figure 1: ***Bald Hill WTP-Portland***

2.0 PROBLEMS IN PORTLANDS RETICULATION NETWORK

Portland's reticulation system is tested weekly for total chlorine residuals at three sites which include 276 Edgar St, 217 Wyatt St and 1 Theresa St and periodically at other sites through routine laboratory testing. The Theresa St sample point is at the extremity of the network and gives a good picture of the residuals achieved at the ends of the network. The other two sites represent the central areas of the network and shows that the chlorine residual does penetrate some areas of the network.

These field results along with weekly laboratory results at different sites are shown below in Table 1.

Table 1: ***Reticulation Samples Sites – Total Chlorine Results Vs Distance***

Sample site	Date	Total Cl_2(ppm)	KM from WTP
CWS Bald Hill	14-10-15	2.30	0
276 Edgar St	14-10-15	1.00	2.75
14 Balmoral	19-8-15	0.89	2.99
59 Gawler St	2-9-14	0.19	3.97
217 Wyatt St	14-10-15	0.35	5.08
15 Townsend St	2-9-14	0.04	5.30
3 Burns Rd	7-10-14	0.04	5.98
1 Theresea St	14-10-14	0.05	8.02
Lot 103 Darts Rd	12-8-14	0.04	8.34

Table 1 above, shows the chlorine residual dropping away the further the water travels from the WTP. 15 Townsend St, is approximately the mid point of the network and the low chlorine residual (0.04ppm) highlights the potential for a higher risk of pathogen growth.

2.1 Testing of Treatment Plant Equiptment

Once the extent of the low chlorine issue was highlighted Wannon Water decided to impliment a free chlorine burn. Prior to commencing the burn the chlorine dosing system needed to be tested to see if free chlorine was achievable. The ammonia in the system is naturally occuring at a concentration of 1mg/L and therefore to achieve break point chlorination, a dose rate in excess of 10ppm (a ratio >9:1) was required. The Portland WTP has never operated as a free chlorine system and therefore it was unknown if the plant had sufficent dosing capacity to meet the demand for break point chlorination.

A short 'break point chlorination' trial was undertaken in early October 2014 which confirmed there was sufficent capacity within the dosing system to produce a consistant free chlorine residual.

2.2 The Burn

With the confirmation that the WTP could be converted to produce a free chlorine system it was decided to go ahead with the burn of the reticulation network.

On 23rd October 2014 both the bores at the Bald Hill WTP were isolated to allow the Clear Water Storage (CWS) to drop to around 50% (16ML) of its nominal capacity. This enabled faster conversion of the water in the storage from total to free chlorine.

On the 27th October both bores were turned back on and chlorine was dosed at the new rate of 3700g/hr. The bores ran continuously to fill the CWS with free chlorinated water. It was quickly evident that with both bores running the chlorine dosing facility could not maintain a sufficient dose rate (due to the offtake rate being too high for the chlorine drums at the lower temperatures during the burn) to achieve a free chlorine residual therefore, one bore was isolated for the remainder of the project.This allowed reliable dosing of the water and maintained a more stable free residual going into the CWS.

Once the dosing issue was resolved and a constant stream of break point chlorinated water was entering the CWS it still took some time before the CWS showed any sign of the free residual. It was believed this was due to stratification caused by higher temperature of the incoming water compared with that of the water already in the storage. A free chlorine residual was first seen at the outlet of the CWS on the 3rd November. The free residual increased in the following days and stabilised at 1ppm.

In conjuction with the treatment response team it was decided to increase the chlorine dose to 4000g/hr from 3700g/hr. From then on the free residual in the CWS stayed constant for the remainder of the project at around 1.0ppm.

The free chlorine was first seen at the Edgar St sample point eight days after the free chlorine concentration had stabilised in the CWS,on the 11th November. By the 21st November the entire network had been converted to free chlorine. The free chlorine residuals remained stable within the network until completion of the project on the 8Th December 2014 with the majority of the results being within 0.5ppm of the CWS as can be seen in Table 2.

Table 2: ***Reticulation Samples Sites – Free Chlorine Residuals***

Sample Site	Date	Free Cl2 Residual(ppm)
CWS	3-12-14	1.04
276 Edgar St	3-12-14	0.86
59 Gawler St	3-12-14	0.76
217 Wyatt St	3-12-14	0.83
15 Townsend St	3-12-14	0.69
3 Burns Rd	3-12-14	0.81
1 Theresea St	3-12-14	0.56
Lot 103 Darts Rd	3-12-14	0.41

Table 2 above shows the success of the chlorine burn as there is significant residuals shown at the extremities when compared to Table 1.

2.3 Changing Back

Once the burn was completed the system was changed from free chlorine back to total chlorine. The naturally occuring ammonia requires high doses of chlorine to achieve break point therefore continueing operating on a free chlorine system was unsustainable.

On the 10th December the system was turned back to total chlorine by reducing the dose rate from 4000g/hr to 1800g/hr. This brought the system back to the dose rate used prior to the burn allowing us to compare the change in residuals as the distribution network reverted to total chlorine.

The CWS was maintained at its current level of around 30ML when changing back to total chlorine to try and prevent temperature based stratification. This provided positive results as the CWS changed over to total chlorine within three days of reducing the dose rate.

As the CWS changed over very quickly it also had a flow on affect throughout the distribution network. The rate of change from free chlorine to total chlorine was quite fast when compared to the initial change from total chlorine to free chlorine. This is probably due to the amount of excess ammonia made by biofilms, available within the network during the initial change to free chlorine. By the 15th December the entire network had reverted back to total chlorine.

The field testing on the 15th December showed that the system had large improvements in total chlorine residuals across the entire network. These can be seen in Table 3.

Table 3: ***Reticulation Samples Sites – Total Cl2 pre 'burn' vs Total Cl2 post 'burn***

Sample Site	Total Cl2 Pre burn'(ppm)	Total Cl2 Post 'burn'(ppm)	% Difference in residuals
CWS	2.30	2.20	
276 Edgar St	1.00	1.99	99
59 Gawler St	0.89	1.78	837
217 Wyatt St	0.19	2.02	477
15 Townsend St	0.35	1.48	3,600
3 Burns Rd	0.04	1.48	3,600
1 Theresea St	0.04	1.21	2,320
Lot 103 Darts Rd	0.05	1.11	2,675

Table 3 above, shows that the free chlorine 'burn' was an overwhelming success in providing a safe total chlorine residual to areas of the distribution network which previously had virtually none. This gives the network a greater barrier to potential pathogen contamination for all customers of Wannon Water.

2.4 After the Change

Once the distribution network was fully converted back to Total chlorine, the only issue we faced was that the higher chlorine residuals now found in the network had never been experienced by Wannon Water's Portland customers previously. This led to 21 customer complaints of chlorine tastes and odours.

Due to the high levels of cutomer complaints Wannon Water decided to reduce the chlorine dose rate, firstly to 1,300g/Hr and then to 600g/Hr in an effort to reduce the taste and odour complaints. At 1,300 g/Hr high residual were still achieved throught the network, however the taste and odour complaints still occurred. Once the dose rate was reduced to 600g/Hr (providing a residual of 1.15 ppm in the CWS) customer complaints dropped off significantly. However by reducing the dose below the ideal minimum (3:1 ratio) excess ammonia built up within the network allowing the biofilms to recolonise. The residuals in the network reduced significantly to pre burn levels.

After two weeks the dose rate was increased from 600g/Hr to the traditional rate of 1,800g/Hr. There were no more customer complaints however the chlorine residuals returned back to pre burn concentrations.

3.0 CONCLUSION

The free chlorine burn to rectify the low chlorine residual issue in Portland's distribution network was a resounding success. The burn removed biofilms and allowed total chlorine residuals to penetrate the network further than expected. Greater residuals than anticipated were achieved across the entire network. The success of the free chlorine burn was such that it will be incorporated into normal ditribution network operations.

Although the duration of the burn was compromised by the adverse public complaints the process itself was proven.

Before the next free chlorine burn more testing will be done by the Wannon Water treatment team to find the lowest dose rate possible to keep customers satisfied without negating the effects of the burn.

The project was ran professionally by the staff involved and was only slightly more labour intensive than normal operations. The addional labour requirements were due to the additional chlorine drum changeovers and testing of chlorine residuals within the network during the project.

Wannon Water plan on running this process again during July-August 2015. It is anticipated that the slower flow rates and lower usage during winter will enable the running of slightly lower chlorine residuals after the break point process is complete. It is hoped that this reduces the taste and odour complaints by customers as it will give them more time to adjust to the 'new' chlorine residual.

4.0 ACKNOWLEDGEMENTS

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