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WHAT CAN YOU DO, TO GET TO 0.2?

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WHAT CAN YOU DO, TO GET TO 0.2?

Michael Carter, *Senior Process Engineer,* Hunter H2O

ABSTRACT

With reliance on surface waters from unprotected catchments, filtration is at the heart of many WTPs. A well operated and maintained filter serves to form a barrier to particles, including pathogens, that if not removed would result in poor disinfection, dirty water complaints and an increased disease burden on the community. Media filtration often follows the '80 / 20 rule', whereby a majority of the obvious benefit of filtration can be achieved easily. However, with increased focus on filter performance from regulators and consumers, it is critical that we aim to get the final 20% in order to achieve <0.2 NTU.

Filter inspections can be used as a preventative strategy and to lower filtered water turbidity, in the same way that cars are serviced to detect problems before they result in failure and to improve their performance. Filter inspections were undertaken at two regional NSW WTP's. At Plant A it was found that the media required replacement. Following media replacement, a ~40% reduction in filtered water turbidity occurred. At Plant B the filter inspection revealed it was the upstream conditions that required optimisation. Subsequently the filter feed conditions were optimised through jar testing, which resulted in a ~50% decrease in filtered water turbidity.

1.0 INTRODUCTION

1.1 Why Less Than 0.2 NTU?

As the water industries knowledge of water quality risks improves, water quality targets are becoming increasingly more and more stringent. The current version of the Australian Drinking Water Guidelines (ADWG), in regard to chlorine-resistant pathogen reduction, states: *"Where filtration alone is used as the water treatment process to address identified risks from Cryptosporidium and Giardia, it is essential that filtration is optimised and consequently the target for the turbidity of* water *leaving individual filters should be less than 0.2 NTU, and should not exceed 0.5 NTU at any time"*

In addition, health-based targets (HBTs) for microbial water quality have been in the foreground of water treatment planning for some time now, which also have stringent filtered water turbidity requirements. HBTs do not currently form part of the ADWGs, however, HBTs are already regulated in Victoria and the next revision of the ADWGs is likely to include some form of HBT framework. When HBTs are incorporated in the ADWGs, most water treatment plants in Australia will require an upgrade in some form to meet the requirements. In most conventional treatment and direct filtration plants, the improvement works required will most likely include online monitoring, plant optimisation and potentially addition of UV disinfection. The level of treatment necessary under HBTs depends upon the individual catchment category. In lieu of an HBT framework within the ADWG, most water authorities have resorted to using the WSAA manual for the application of microbial health-based targets which is broadly based on the USA EPA methodology. This manual sets filtered water quality targets ranging from <0.3 NTU through to <0.15 NTU, depending on the catchment category and the pathogen log reduction required. However, most run of river surface water sources will require filtered water quality to achieve either <0.15 NTU or <0.2 NTU.

1.2 Can Less Than 0.2 NTU Be Achieved?

Yes! Achieving less than 0.2 NTU with a granular media filtration process is absolutely possible. Whilst traveling throughout regional NSW, the ability of a granular media filtration process to achieve <0.2 NTU is often questioned. Hence, the author would like to share some of Hunter H2O's recent experiences undertaking filter inspections and the steps taken to reduce filtered water turbidity at two regional NSW Water Treatment Plants (WTP).

2.0 DISCUSSION

Media filtration often follows the '80 / 20 rule', whereby a majority of the obvious benefit of filtration can be achieved easily. However, with increased focus on filter performance from regulators and consumers, it is critical that we aim to get the final 20% in order to achieve <0.2 NTU. Although it is easy to blame poor filtered water quality on the performance of the filters, this is not always the case. It is therefore important to take a more holistic approach which includes consideration of the following, starting with:

- Verification of results
- Pre-treatment performance
- Filtration performance, operation and design

2.1 Verification of Results

Before launching into filter inspections or a jar testing investigation, if the results are only slightly above the filtered water turbidity target, it is best to confirm the filtered water turbidity through verification of the results. Measurement of filtered water turbidity has typically been an easy task, however with more stringent water quality targets, a manual grab sample and desktop measurement of <0.2 NTU can sometimes be more difficult to reliably achieve. Analyser suppliers have also previously indicated that online turbidity measurement is typically more accurate than the desktop measurement methods, due to measurement errors. Some common issues to initially check are:

- Calibration - Has the turbidity meter been calibrated recently?
- Dirt - Does the unit need a clean? Is there dust on the sensors or light source?
- Sample Vial Scratches - Are there any scratches on the sample vials?
- Interference - Are there any micro bubbles in the sample vial? Was the sample vial washed with distilled water prior to use?

2.2 Pre-Treatment Performance

Filtration performance can often be impacted by upstream pre-treatment system effectiveness. Effective coagulation and flocculation processes are vital when trying to achieve <0.2 NTU. It is therefore important to effectively control coagulation, flocculation and sedimentation processes to enable a consistent quality and feed to the filter which allows the filter to perform effectively. Key parameters that can affect coagulation performance are; coagulant dose rate, mixing, pH, turbidity, true colour and flow. If the raw water pH varies and dose rates are not adjusted accordingly the effectiveness of coagulation can be compromised. Similarly, raw water organics can also impact the required coagulant dose rate and therefore impact coagulation performance during fluctuations in raw water colour.

Jar testing therefore should be used regularly to optimise coagulant dose rates when the raw water quality changes in terms of turbidity, true colour or pH.

Another variable that should be monitored is the instantaneous raw water flow as this will impact the actual chemical dose (L/h) required to achieve a certain dose rate (mg/L). Therefore, ensuring a stable raw water flow, or having automatic chemical flow pacing is just as important as applying the correct chemical dose rates. Jar testing can be likened to a builder's hammer, it should be one of the first tools that operators use to optimise a conventional water treatment plant.

2.3 Filter Performance, Operation and Design

Filter performance, operation and design can be checked regularly through a filter inspection. The objective of undertaking a filter inspection is to set a benchmark for the condition and performance of the filters and in doing so identify areas that can be targeted to improve overall performance. Either through a step change or through a reduction in the likelihood of failure and thereby the associated risk. In addition, the benchmark can be utilised as a comparative tool for ongoing filter reviews. The objective is to utilise preventative strategies and not be reactive. In the same way that cars are serviced to detect problems before they result in failure and to improve their performance. Filter inspections should therefore be viewed as the equivalent of a car or truck service.

Hunter H2O has developed and uses a standardised '15-Point Check' for granular media filter inspections to identify issues before they manifest as failures and allow the tuning of operation. All of which reduces the likelihood and hence risk of filter failure, exceedance of filtered water quality targets and the ability to achieve < 0.2 NTU.

The 'Filter Service' or '15-Point Check' includes a process 'start to finish' review to ensure that all aspects which may impact upon filtration performance are considered during the onsite inspection. The '15-Point Check' includes checking the following parameters:

1. Pre-treatment chemical dose rates and conditions
2. Filtration rate
3. Filter outlet flow control
4. Air scour rates, duration and distribution
5. Filter backwash triggers
6. Backwash rates, duration and distribution
7. Filter headloss accumulation rate
8. Filter ripening period
9. Visual filter backwash observation
10. Wash water turbidity profiling
11. Filter media height and configuration, including wash water trough level
12. Filter media loss
13. Filter media condition – sludge analysis, visual inspection and sizing analysis –
    - Media sampling and sizing analysis compares the condition (size) of the filter media compared to the original design and determines if it is still adequate following years of attrition through backwashes.
14. WSAA Good Practice Guide checklist for Filtration
15. Review of filtration critical control point.

The first stage of the filter service involves collection of data and manipulation to gain an understanding of filter performance over two separate operational periods, usually high flow and average flow conditions. The following areas are examined:

- Filter duty, the percentage of time filters are in operation
- Unit Filter Run Volume
- Clean Bed Head loss

- Filter turbidity percentiles
- Filter ripening after backwash and on start-up (based on online data).
- Filter design criteria calculations and review.

The site inspection involves the collection of operational information and data, including:

- Coagulant and polymer dose rates, coagulation and flocculation conditions;
- Water temperature (current and range);
- Filter operation and backwash details:
  - Filter backwash triggers;
  - Filter dimensions;
  - Filter outlet valve control;
  - Drain down process;
  - Air scour flow and duration;
  - Water wash flow and duration;
  - Filter to Waste duration and triggers.
- Observation of filter/s backwashing:
  - Record 'rise rate' if possible, to confirm backwash flow rate;
  - Record backwash pressure;
  - Look at distribution of air, look for dead zones, upwelling and disturbances;
  - Take samples of the wash water for measuring turbidity of the wash water to create a turbidity profile.
- Filter media inspection:
  - Drain down and isolate filter;
  - Enter filter to inspect the surface for fines, mud-balls and build-up of detritus;
  - Take media samples for sludge volume testing (tested on site);
  - Check media height against media height plate (if available);
  - Take sample for acid washing and analysis for the level of manganese build up (if applicable)
  - Check clearwater tank for media;
  - Check backwash tank for media.

2.4 Case Studies

Hunter H2O was engaged by a proactive regional NSW council to investigate the performance of the open gravity filters at two WTP's with the objective of determining how to improve the filtered water quality. Hunter H2O performed the 15-point Filter Inspection service on the filters for both WTPs which revealed different causes of the elevated filtered water turbidity.

<u>Plant A</u>

At Plant A, the Filter Inspection identified that the filter media required replacement due to excessive manganese's build-up and shallow media depths due to loss of filter media during backwashes. The inspection was crucial in determining if the filtered water quality issues were related to the filter itself or due to ineffective pre-filter conditions (coagulation and flocculation). Once it was confirmed that the filter media was the cause of the poor filtered water turbidity, Hunter H2O was then engaged to plan, prepare and assist Council with the work required to replace the filter media. The work undertaken included the filter media and support gravel design, cost estimating, preparation of filter media specifications, media quotation review, procurement assistance, preparation of a risk management plan and installation procedures, followed by onsite assistance during the media replacement works.

Consideration of the filter media configuration is important as inappropriate selection of the filter media size and depths can lead to sub-optimal process performance.

Hunter H2O’s assistance and partnership with Council staff enabled the implementation of an effective filter refurbishment program, minimising Council’s risk to water supply during the works. The partnership approach enabled knowledge transfer to Council’s operating staff so that they would be able to undertake similar filter media replacement projects in the future.

The filter media replacement works were undertaken during the low demand period in late June 2018. As the local community only has a single reticulation storage reservoir, which is also used to provide filter backwash water, planning was crucial to the success of the project. The entire filter refurbishment was executed effectively, 1 full day ahead of schedule. Therefore, water restrictions for the community were minimised and there were no service interruptions.

Following the successful filter media replacement, the filtered water turbidity has improved by ~40% with results now lower than 0.3 NTU able to be achieved and some results <0.2 NTU. Further ongoing coagulation and flocculation optimisation work will ensure that the filtered water turbidity can continue to achieve very low results and eventually drop below 0.2 NTU continually.

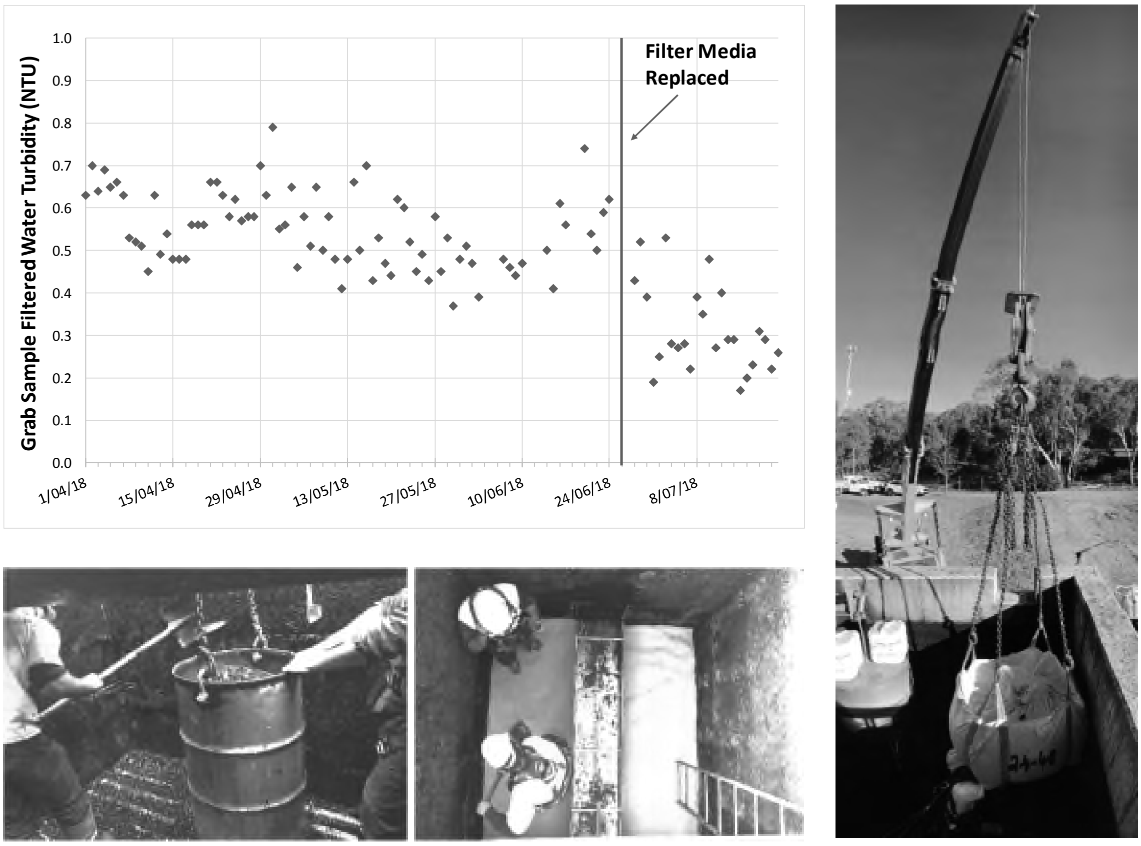

Figure 1: ***Filtered water turbidity and filter media replacement photos***

Plant B

At Plant B, the Filter Inspection identified that the filter media was in good condition and although there were a few minor issues with the control around the filter the key outcome was that the issue of high filtered water turbidity was more likely a function of poor pre-filter conditions rather than the filter itself.

Following the filter inspection site visit and based on the site discussions, Council made the following key changes to the WTP:

- Reduction of the drain down rate during a backwash:
- The PACl dose rate was increased from 14 to 40 mg/L following jar testing.

These key changes, with the most important one being the jar test which revealed the WTP was under-dosing coagulant, resulted in improved filtered water quality as seen in Figure 2.

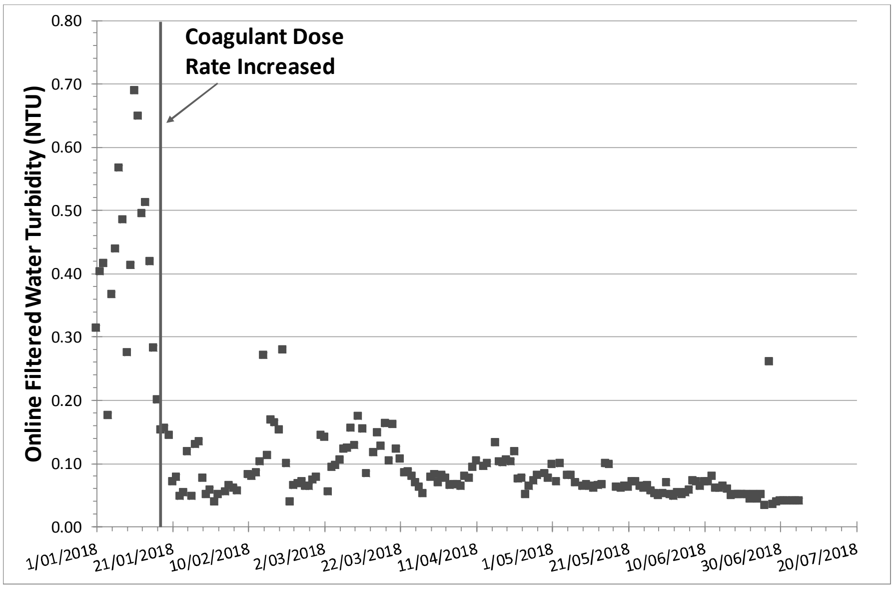

Figure 2: ***Improved filtered water quality from 18th January onwards***

Following the plant optimisation in early January 2018, filtered water turbidity remained low and did not appear to be affected by changes in raw water turbidity. A 95%ile filtered water turbidity of 0.16 NTU was now being achieved, which was a dramatic reduction from the previous 95%ile result of 0.41 NTU. Continued pre-treatment optimisation as raw water quality changes are expected to continue to enable the filtered water turbidity to achieve < 0.2 NTU.

3.0 CONCLUSION

Although it is easy to blame poor filtered water quality on the performance of the filters, this is not always the case. The two case studies discussed above show that the filtered water turbidity can be influenced by various factors and that a structured approach to the optimisation of granular media filters is required in order to achieve less than 0.2 NTU.

4.0 REFFERENCES

NHMRC. (2016, November). Australian Drinking Water Guidelines (2011), page 1009.

DISTRIBUTED TEMPERATURE SENSING TO IDENTIFY INFLOW/INFILTRATION IN AUSTRALIAN SEWER MAINS

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DISTRIBUTED TEMPERATURE SENSING TO IDENTIFY INFLOW/INFILTRATION IN AUSTRALIAN SEWER MAINS

Julie March, *Civil Engineer,* Hunter Water Corporation

ABSTRACT

In January 2018, Hunter Water and Royal HaskoningDHV implemented Distributed Temperature Sensing to assess inflow/infiltration sources in the Dungog Wastewater Network. Dungog has a small network which experiences significant wet weather inflow/infiltration (I/I) and will require significant capital upgrades shortly if I/I is not reduced. Traditional investigation methods such as CCTV are usually carried out during dry weather and are unable to locate many I/I sources which only become apparent during wet conditions, so alternative technologies were considered for this project.

Distributed Temperature Sensing (DTS) measures the temperature of effluent in sewer mains using fibre optic cables which are able to detect temperature variations at intervals along the line. A decrease in temperature during a wet weather event is likely to be a location where I/I have entered the system, as stormwater is usually cooler than wastewater. DTS has been used in the UK and Europe, but no other trial of DTS in wastewater systems within Australia was known. The project was conducted during unusually dry conditions, which limited the findings, however inflows were observed through 5 maintenance holes.

The lessons learnt during the project could lead to a more successful implementation of this technology in the future. Hunter Water is currently conducting investigations in the network based on the outcomes of the project.

1.0 INTRODUCTION

The Dungog wastewater network has a history of wet weather I/I, which has been documented for over a decade. Traditional condition assessments have been ineffective at identifying sources of I/I so more innovative options were considered, resulting in a project employing Distributed Temperature Sensing.

Dungog is a country town located an hour north of Newcastle, NSW. The wastewater network in Dungog was originally constructed in the 1930s using vitrified clay pipes and contains 4 wastewater pumping stations (WWPS). The network was managed by Dungog Shire Council until 2008 when the Council transferred their water and sewer services to Hunter Water. At the time, Dungog Shire Council had identified significant infiltration within the network, but such issues had not been addressed.

At Hunter Water, the system controllers and operations staff have repeatedly observed Dungog 1 WWPS exhibiting a fast response to small wet weather events, which suggests significant inflow within the catchment during wet weather events. Over the last decade Hunter Water has carried out a number of I/I investigation and remediation projects in Dungog, including:

- Smoke testing in the Dungog 3 WWPS catchment in 2009
- Extensive CCTV and relining in 2010-11 encompassing around 25% of the Dungog 1 catchment
- Maintenance hole inspections and rehabilitation in 2016
- Additional CCTV relating to customer complaints and overflows

Despite the above works, 4 environmental incidents occurred within a 12-month period in 2015-16. All incidents were overflows into Myall Creek, a tributary of the Williams River which feeds Grahamstown Dam.

Due to the unsatisfactory outcomes from previous CCTV projects, it was deduced that the inflow may be coming from assets other than the sewer mains – such as customer lines and maintenance holes. A number of condition assessment options were considered and DTS was selected. The advantages of DTS included the ability to monitor within wastewater infrastructure during wet weather, when the inflow was occurring. DTS had not previously been used in Australian sewer mains but had promising results based on European case studies. Royal HaskoningDHV were engaged to conduct the project in collaboration with Hunter Water staff.

2.0 DISCUSSION

2.1 Distributed Temperature Sensing

DTS measures temperature along fibre optic cables that are laid in the sewer system and connected to a laser computer. The temperature gradients are measured at a high frequency and the laser computer calculates variances in the temperature along the cable from the reflections of the laser signal. DTS is able to detect any inflows of water (storm or ground water) as long as the difference in temperature is greater than 0.2 degrees centigrade. Projects in Europe have typically lasted for 2-4 weeks and were able to identify I/I locations to the nearest 1 metre.

For the Dungog project, the computer was housed in a portable office and required an external power source. The Dungog cable arrangement is shown in Figure 1.

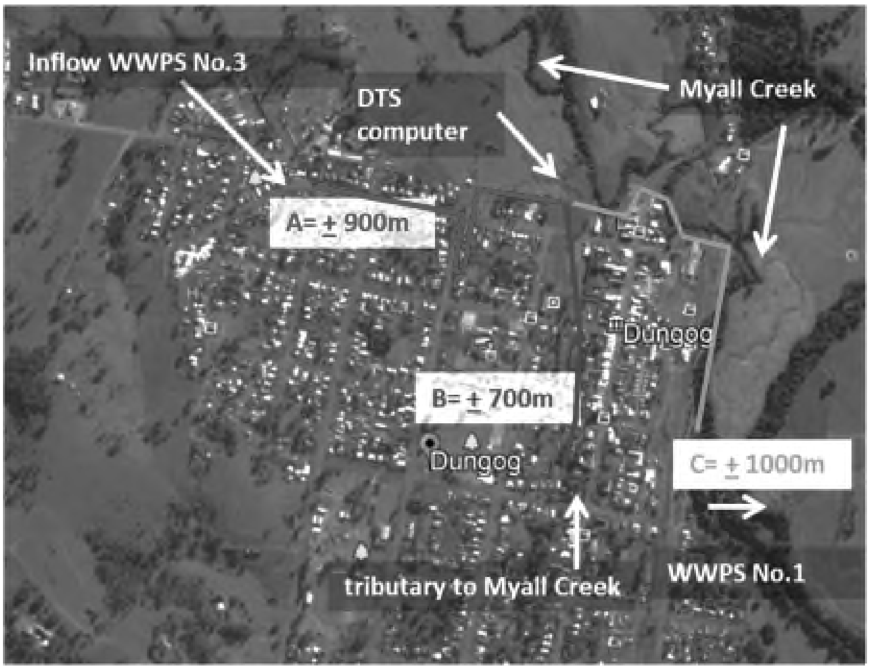

__Figure 1:__ ***Dungog DTS cable locations***

2.2 Results

The results along Cable A were obscured due to the influence of flows pumped into the sewer main from Dungog 3 WWPS via maintenance hole J4609.

There was a temperature difference of around 1 degree Celsius between the pumped and gravity flows, which lead to an alternating pattern in temperature as shown in Figure 2. There was also a loop in the cable – a section halfway along the cable was laid upstream along a branch and then downstream along the same main. As such, it was difficult to discern I/I along this cable.

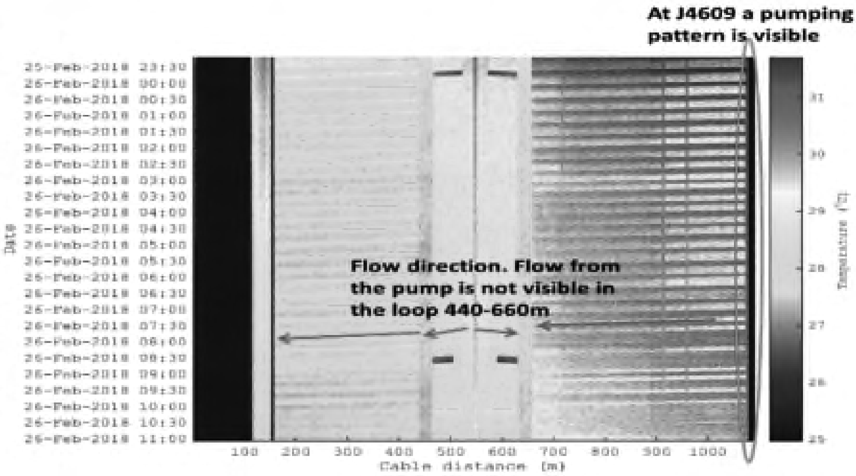

Figure 2: ***Example of Cable A DTS Output along entire length***

When inflow was detected in the cables, it can be seen as a temperature drop which affects the downstream flow but not the upstream flow. The temperature changes observed along Cable A during a rainfall event all correlated with a maintenance hole, as shown in Figure 3. There is a potential that illicit connections or damaged assets may occur at these locations and additional condition assessment is required to determine the nature of the I/I source.

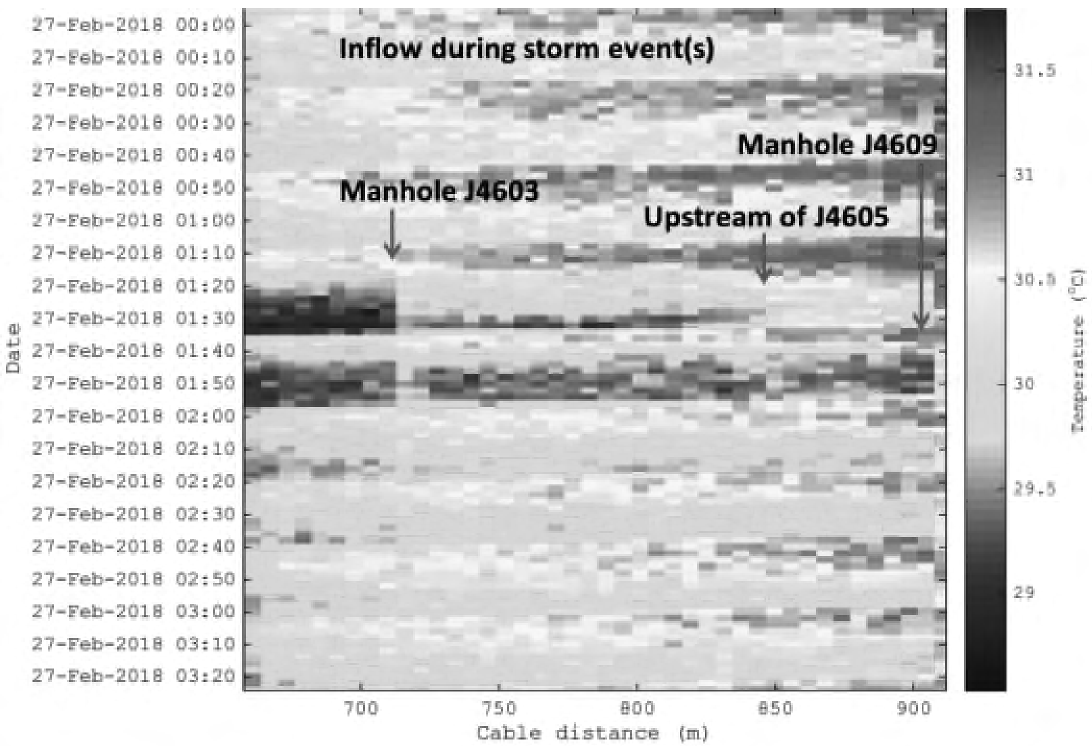

Figure 3: ***Cable A DTS output during wet weather***

Cable B also showed temperature changes at maintenance holes, but each of the locations highlighted in Figure 4 also had side branches.

As such, future investigations at both the maintenance hole and the side branch catchments are required to assess the location and nature of inflow.

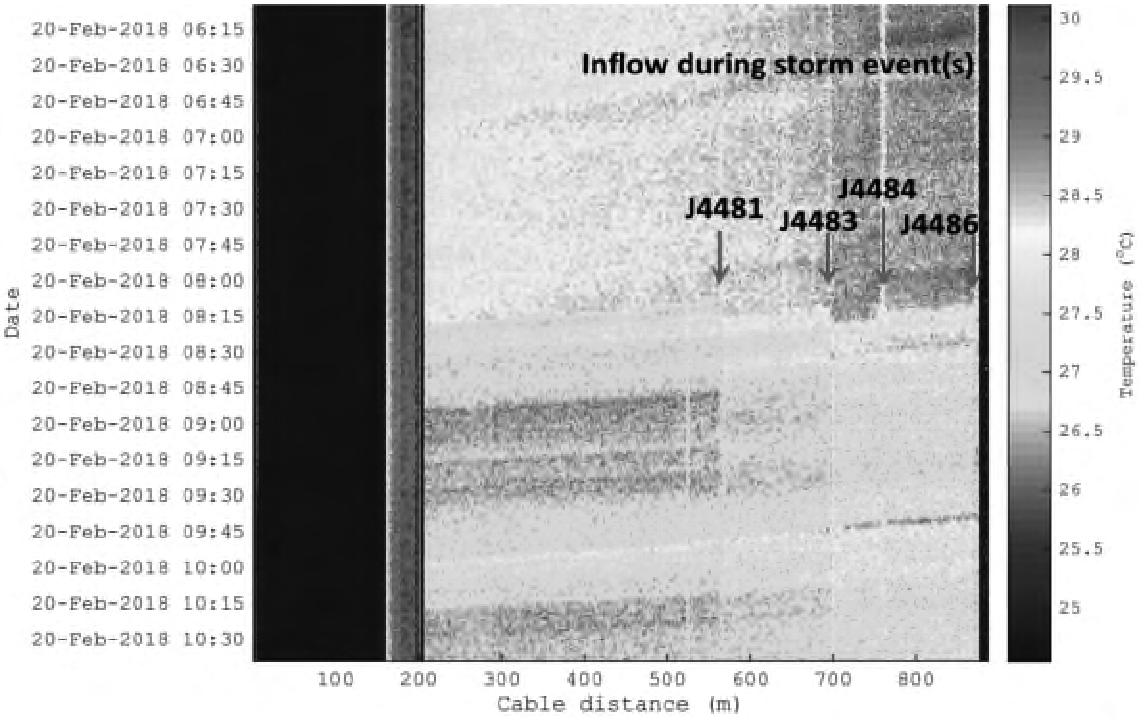

Figure 4: ***Cable B DTS output during wet weather***

Cable C output indicated possible dry weather I/I, shown in Figure 5, that is most likely related to the assets near Myall Creek. In April 2015, a large storm resulted in the destruction of 3 houses near this location and it is likely that assets deteriorated at this time, although I/I was not immediately observed.

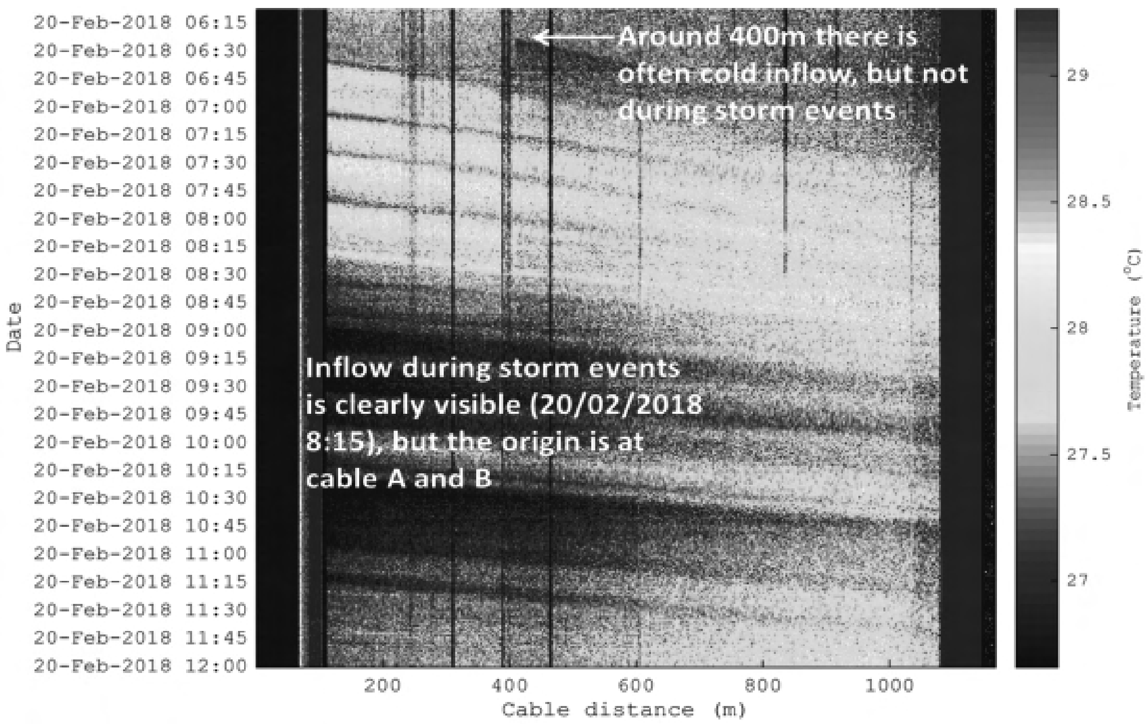

Figure 5: ***Cable C DTS output***

3.0 CONCLUSION

3.1 Lessons Learnt: *Timing*

Approval for this project was a lengthy process due to a number of unusual elements involved in the project. The cable was sourced from Taiwan and Hunter Water had to purchase the cable upfront without a guarantee it would be in working condition after shipping. There was a lack of experience using this technology within Australia and expertise from The Netherlands was required. Cable installation was carried out by Hunter Water field staff and because this activity was outside of their normal work duties, Workplace Health and Safety needed additional consideration. In addition, the portable office and external power had to be sourced. Arranging all these elements and gaining approval took over a year.

At the time the project was commenced, staff changes had occurred, and the project was undertaken during an unusually dry period. Wet weather I/I is not detectable during dry conditions. As such, the length of the project had to be extended in order to capture the network's response to a rainfall event. Eventually, 2 small storms occurred, and the cable was removed the day before a larger storm occurred. During dry conditions it is likely the I/I response would be decreased as soil had a higher than normal capacity to absorb runoff before it can reach the wastewater assets. Delaying the project to increase the likelihood of rainfall would be advisable for future projects, however this could carry additional expenses and rainfall predictions are not always accurate.

3.2 Lessons Learnt: *Cable Installation and Removal*

Cable installation proved more difficult than expected. Initially, a damaged cable connector required an electrician with specialised expertise to conduct repairs. The cable needed to be completely unrolled prior to installation to be able to utilise the connector at the other end to connect to the laser computer, which was possible in a country location such as Dungog. In a more built up area, the use of additional cable drums would be required.

A considerable amount of manpower was required to install the cables in the sewer. Ideally, the cable would be installed in a section of network with shallow mains with large pipe diameters, long straight sections and minimal drops at maintenance holes (internal or external). However, such conditions may not occur in target catchments and choosing pipes with larger diameters would impact how effectively DTS locates I/I sources. Conducting jetting immediately before installation would also be advised. For this project, the cable was installed manually but future projects may be able to utilise mechanical means to assist installation.

Cable removal was challenging due to significant build up of debris, particularly at junctions. The cable needed to be cut at multiple locations, which decreases the opportunities to reuse the cable at a later date. Extending the project duration to 8 weeks in order to capture a rainfall event may have contributed to additional build up and future projects should be limited to 2-4 weeks.

3.3 Lessons Learnt: *Cable locations*

The cable locations were selected based on pipe diameter and suspected I/I locations. The Dungog wastewater network primarily contains 150mm diameter sewer mains, but the routes for cable A, B and C are along the larger 225mm and 300mm mains.

Cable C contains a section that is 150mm which was included due to the proximity to customer complaints.

The sewer main where Cable B was installed includes several maintenance holes with a history of overflows during wet weather. Cable C was chosen due to the proximity to Myall Creek.

The original scope included an option to relocate a cable if early results indicated an unmonitored branch was introducing I/I. However, due to the lack of wet weather it was not practical to undertake cable relocation. If a similar project was repeated by Hunter Water with the aim to identify illicit connections, then smaller mains would be the preferable target so that the results are more precise.

3.4 Future works

Additional condition assessment is required to clarify the findings of the DTS project. As many of the inflow locations identified are maintenance holes, this is likely to include CCTV of the upstream catchments.

Due to delays in initiating the DTS project, other work was simultaneously approved for the Dungog catchment. This included extensive smoke testing of the entire network, which has not yielded significant results. There is also a Dungog I/I Strategy currently being prepared for Hunter Water by a consultant.

Although the project did not yield the results expected, the technology shows promise if a future project was better designed using the learnings from this case study and considering the nature of the target catchment. Use of mid- to long-range weather forecasts of varying timeframes (28 days and longer) may assist in optimising the deployment of equipment to capture target rainfall events.

4.0 ACKNOWLEDGEMENTS

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MANGANESE REMOVAL USING PRE-FILTER CHEMICAL OXIDATION

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MANGANESE REMOVAL USING PRE-FILTER CHEMICAL OXIDATION

Shawn Charlton, *Water & Sewerage Specialist,* Federation Council
Martin Woodhead, *Team Leader Water Treatment,* Federation Council

ABSTRACT

Prior to 2002, the Corowa water supply was unfiltered. Raw water was pumped from the Murray River and disinfected using chlorine gas then transferred to the town water supply reservoirs and from there into the distribution system. In 2002, the Corowa Water Treatment plant was constructed, but unexpectedly the council started to receive an increased amount of “dirty water” complaints. Customers were reporting black or dark brown water, with the majority of the complaints being generated in the spring and summer months. The council quickly discovered that a manganese biofilm was growing on the inside of the reticulation pipework and this biofilm was dislodged during times of high water use, causing the discoloured water. This problem is quite common in the water industry and an annual water mains air scouring project was introduced. The introduction of the air scouring was successful with dirty water complains falling to an acceptable level.

An investigation was undertaken to optimise or alter the treatment process at the Corowa Water Treatment Plant (WTP) with the aim of reducing the concentration of manganese in the treated water to a level which would not require air scouring of the towns water mains annually. The cost of the air scouring was approximately $40,000 per year. If spending $40,000 a year on air scouring could reduce dirty water complaints to a reasonable level, the aim of the trial was not only to remove the manganese but do it for less than $40,000 per year.

1.0 INTRODUCTION

Manganese occurs naturally in the environment and when present in surface water it is most commonly found in a soluble form. Surface water manganese concentrations in Australia are commonly in the range of 0.001 – 0.6 mg/L. The Corowa raw water supply sits within this range with concentrations ranging from 0.03 – 0.06 mg/L. Peaks of up to 0.3 mg/L do occur during times of high catchment run off. These peaks are expected 3 to 4 times a year and generally last for no longer than 1 week.

According to the Australian Drinking Water Guidelines 2011 (ADWG) manganese concentrations of 0.02 mg/L will form a biofilm or black coating on the inside of pipes and this can dislodge as a black slime. At these concentrations, some nuisance microorganisms can concentrate the manganese, which can give rise to taste, odour and turbidity problems in distribution systems. This is why a discretionary target of 0.01 mg/L is a suggested treated water concentration limit. At a concentration of 0.01 mg/L manganese generally does not accumulate in distribution systems, while concentrations of 0.02 mg/L can lead to aesthetic water quality issues.

Historically, an average manganese concentration of 0.02 mg/L has been found in Corowa’s distribution system. This result would explain the high number of dirty water complaints from the residents of Corowa.

To reduce the concentration to below the discretionary target of 0.01 mg/L, soluble manganese in the source water must be transformed into insoluble manganese prior to the filtration process. If this can be achieved, then the insoluble manganese should be removed using existing treatment processes.

2.0 DISCUSSION

2.1 Trial

The aim of the trial was to determine if manganese concentrations less than 0.01mg/L could be achieved at the Corowa WTP, without large process changes, capital or operations costs. The trial sought to oxidise the soluble manganese prior to filtration, using sodium hypochlorite due to its use as a disinfectant at the treatment plant.

2.2 Method

The trial ran from January 2017 to May 2017. This period was selected to best maintain steady raw water quality conditions during the annual irrigation season.

Four treatment methods were selected:

1. Sodium hypochlorite was injected into the raw water rising main up stream of the Aluminium sulphate injection point. This would in theory oxidise any soluble manganese present in the raw water and this now insoluble manganese would behave in a similar way to other suspended solids in the raw water and be removed during the floatation process.
2. Sodium hypochlorite was injected into the raw water rising main up stream of the Aluminium sulphate injection point. In theory, this would oxidise any soluble manganese present in the raw water allowing it to be removed during the floatation process like the other solids. Powered Activated Carbon was added to adsorb organic molecules in the raw water, which would reduce the generation of disinfection by-products (DBP).

3. Sodium hypochlorite was injected into the raw water rising main up stream of the Aluminium chlorohydrate injection point. In theory, this would oxidise any soluble manganese present in the raw water allowing it to be removed during the floatation process. Powered Activated Carbon was added to adsorb organic molecules in the raw water, which would reduce the generation of DPB. The change in primary coagulant from Aluminium sulphate to Aluminium chlorohydrate will allow the coagulated water pH to be maintained at a pH >7.5 which will aid the oxidation process.

4. Sodium hypochlorite was injected into the entry of the DAFF filter below the float. This in theory, would oxidise any soluble manganese to insoluble manganese, which will then be removed during the filtration process. The injection of Sodium hypochlorite under the float should limit the generation of DBPs due to the majority of organic material already being removed during the floatation process. Removing the majority of the solids prior to the injection of sodium hypochlorite should also reduce the amount of chemical needed to achieve the same rate of manganese oxidation. The change in primary coagulant from Aluminium sulphate to Aluminium chlorohydrate will allow the coagulated water pH to be maintained at a pH >7.5 which will aid the oxidation process.

Each trial was run for 3 weeks, with the first week being considered as the optimisation phase with no water quality data analysed. During the second and third weeks, daily sampling and testing was conducted using the sampling program shown in Table 1.

Table 1: ***Trial sampling program***

Sample	Frequency
Filtered water manganese	Daily (Nata Accredited)
Filtered water free chlorine	Daily
Clear water chloroacetic acids	Once during week3 (Nata Accredited)
Clear water trihalomethanes	Once during week3 (Nata Accredited)
Clear water stability	Once during week3 (Nata Accredited)

Chemical dosing rates for all chemicals used at the treatment plant, excluding sodium fluoride were recorded and analysed to produce chemical usage costs.

2.3 Success Criteria

Five criteria were selected to assess each treatment method:
1. Filtered water manganese concentration
2. Chemical usage cost
3. Disinfection by-product (DBP) generation
4. Filtered water turbidity
5. Clear Water stability (CCPP)

Each of these variables were not evenly weighted with greatest consideration given to filtered water turbidity and DBP generation. The successful removal of manganese was not to come at a compromise to public health.

2.4 Results

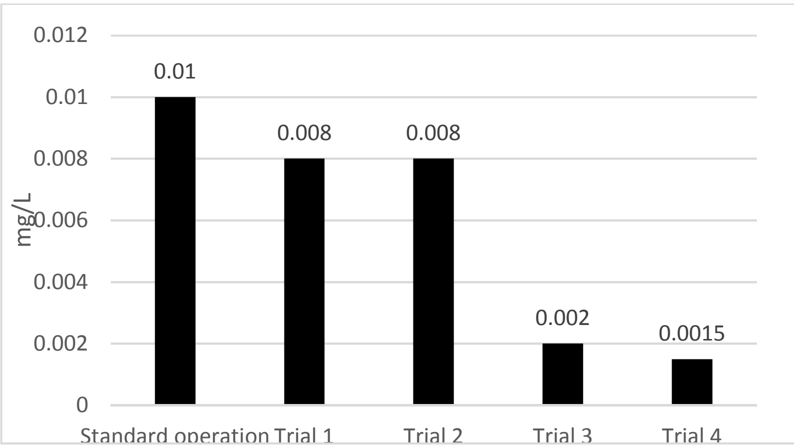

Figure 1: ***Filtered water manganese concentration***

The results show that all the methods used had some success in the further removal of manganese during the treatment process, with the greatest removal rates being achieved when Aluminium chlorohydrate was used as the primary coagulant (trial Nos.3 & 4).

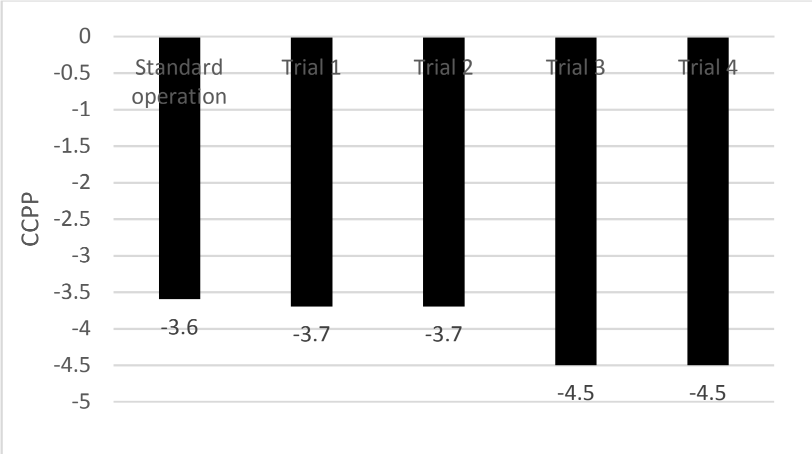

Figure 2: ***Clear water stability***

Water stability did not alter significantly during trial Nos. 1 & 2. There was a noticeable decrease in stability during trial Nos. 3 & 4.

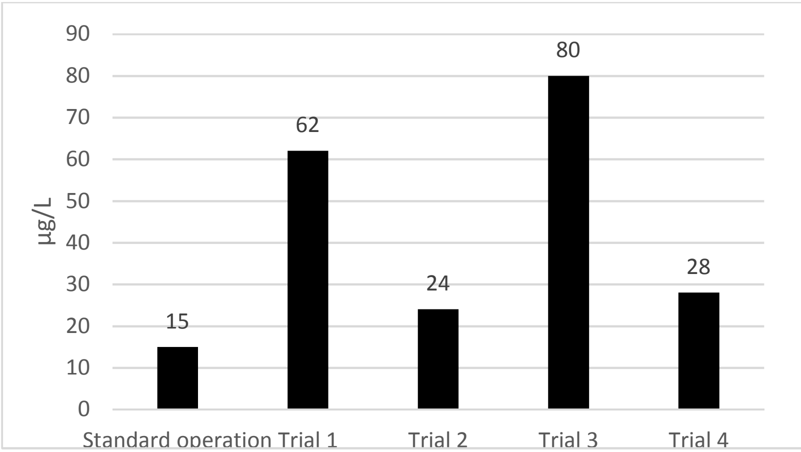

Figure 3: ***Clear water DBP***

The generation of DPB increased under all trial conditions. The largest increases were recorded during trial Nos.1 & 3. Only slight increases were detected during trial Nos. 2 & 4. Under all trial conditions the ADWG health based target of 250 µg/L was not exceeded.

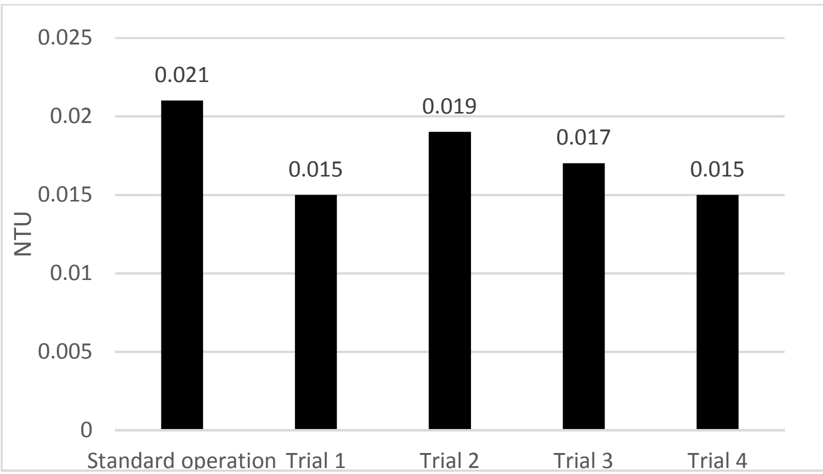

Figure 4: ***Filtered water turbidity***

Trial Nos. 1 & 4 showed the lowest recorded average filtered water turbidity 0.015 NTU. The remaining 2 trials remained constant when compared to the standard operation, with no significant increases or decreases observed.

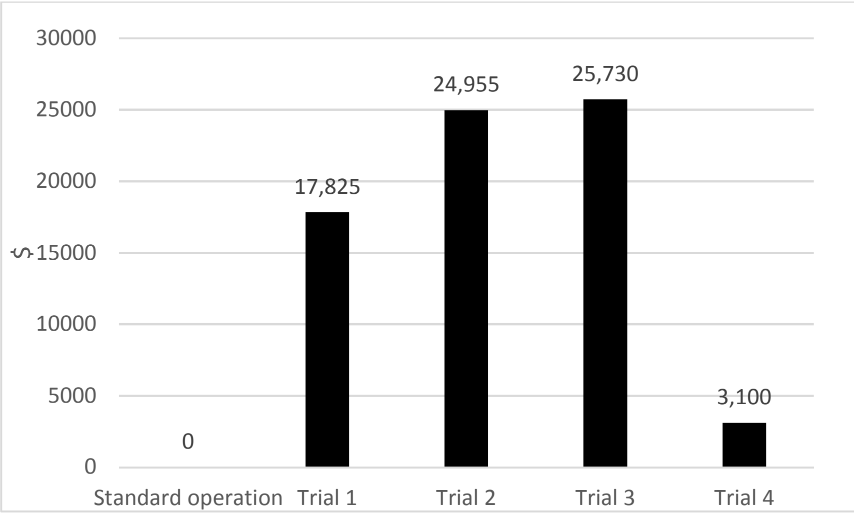

Figure 5: ***Yearly additional chemical costs above standard operation***

An increase in chemical costs was recorded for all trials, ranging from $3,100 to $25,730.

Table 2: ***Chemical cost comparison (¢/kL)***

	Alum	ACH	PAC	Pre Lime	Pre Hypo	Post Lime	Post Hypo	Total (¢/kL)	Yearly Cost	Yearly addition cost
Standard Operation	0.018					0.0025	0.013	3.30	$51,150.00	$0.00
Trial 1	0.018				0.015	0.0025	0.009	4.45	$68,975.00	$17,825.00
Trial 2	0.018		0.0046		0.015	0.0025	0.009	4.91	$76,105.00	$24,955.00
Trial 3		0.020	0.0046	0.001	0.015		0.009	6.16	$76,880.00	$25,730.00
Trial 4		0.020		0.001			0.009	4.70	$54,250.00	$3,100.00

The largest chemical cost increase can be attributed to pre-sodium hypochlorite dosing. The cost of pre-chlorine dosing was identical for all trials excluding No.4, which recorded a significantly lower usage and therefore cost. The change of primary coagulant from aluminium sulphate to Aluminium chlorohydrate also saw a slight increase in cost, although this cost increase was partially offset by a decrease in the cost of the existing lime dosing.

2.5 Summary

Table 3: ***Summary table of trial results***

	Standard operation	Trial 1	Trial 2	Trial 3	Trial 4
Filtered water manganese (mg/L)	0.010	0.008	0.008	0.002	0.0018
Clear water stability (CCPP)	-3.6	-3.7	-3.7	-4.5	-4.5
Clear water DBP (µg/L)	15	62	24	80	28
Yearly increase chemical cost ($)	0	+17,825	+24,955	+25,730	+3,100
Filtered water turbidity (NTU)	0.021	0.015	0.019	0.017	0.015

3.0 CONCLUSION

Due to the poor manganese removal rates of trial Nos. 1 & 2 these methods of removal were not considered viable. Trial Nos. 3 & 4 showed the greatest potential for the removal of manganese from the system with both trials producing average filtered water manganese concentrations of below <0.002 mg/L.
Taking into consideration the annual chemical cost and the generation of DBP of these two trials it was concluded that the most efficient method of removing manganese from the system was trial No.4. Trial no.4 did see a decrease in water stability due to a lowering of the required hydrated lime dosage caused by the change in primary coagulant. This result although concerning was not deemed significant enough to discount other positive results of the trial.

It is expected that the additional chemical cost of implementing trial no. 4 will be $3,100 annually, which is well below the current $40,000 annual cost of air scouring. It is expected that some kind of water mains cleaning program will still be required in Corowa, but with average Manganese concentrations below 0.01 mg/L from the treatment plant, it is plausible to expect the cleaning program could be extended out to be a 4 or 5 year event.

The capital cost of permanently installing trail No. 4 was $90,000. The majority of this was associated with the installation of a new 5000 L Aluminium chlorohydrate chemical storage tank and chemical dosing system. A new pre-Sodium hypochlorite dosing system and associated delivery pipework. Augmentation of the pre-hydrated lime dosing system and associated delivery pipework. Installation of inline filtered water pH and free chlorine monitoring. PLC and SCADA design and programming.

With final system installation costing $90,000 and a $3,100 additional annual chemical cost, it is expected that financial pay back for the system will be within 2 to 3 years.

4.0 ACKNOWLEDGEMENTS

I would like to acknowledge the hard work and assistance of the entire water treatment team and electrical department at the Federation Council. The biggest thank you must go to the then Manager of Water & Sewerage Geoff Lewis, who was the original driver of this project.

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Winner of the Best Operator Paper at the
43rd Annual WIOA Queensland Water Industry Operations Conference,
Logan,2018

BOTULISM AT MT ST JOHN SEWAGE TREATMENT PLANT

Paper Presented by:

Glenn Twite

Author:

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Townsville Regional Council

13th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Orange PCYC,
3 & 4 April, 2019

BOTULISM AT MT ST JOHN TREATMENT PLANT

Glenn Twite, *Team Leader Mt St John Sewage Treatment Plant*, Townsville City Council

1.0 INTRODUCTION

Townsville City Council's (TCC) Mt St John Sewage Treatment Plant (MSJSTP) is a five stage Bardenpho plant located in Townsville, North Queensland. MSJSTP treats 17 megalitres (ML) of wastewater daily, 15 ML of which is discharged to waters of Little Snaggy Creek and subsequently flows through a wet land and into the Bohle River. The remaining 2 ML is recycled effluent, used for irrigation purposes.

Ducks have historically occupied the MSJSTP clarifiers towards the end of the dry season when the Town Common wetlands are at their driest. During this time, in previous years, ducks have been found deceased on the MSJSTP site. This generally occurs in the summer for the duration of approximately a month prior to the onset of rain.

In November 2017, MSJSTP staff began recording duck deaths in and around the clarifiers, disposing of 25 duck carcasses per week. In December 2017, the quantity of removed ducks increased to 100 per week, and up to 100 Tilapia per day. In December other species of birds and eels were also removed (see Figure 1). In January 2018, the quantity of ducks and Tilapia removed had decreased immensely. No wildlife was found deceased after January 2018. All species of birds and fish were adults.

TCC began conducting investigations into the wildlife deaths and MSJSTP's plant conditions in December 2017. Effluent samples were collected and analysed for blue green algae and deceased wildlife samples collected and analysed for botulism. Dissolved Oxygen (DO) profiling was also conducted in the affected areas of the plant to determine whether the plant's biomass had been compromised.

Figure 1: ***Location of deceased wildlife; green - ducks, orange – Tilapia***

2.0 DISCUSSION

In November 2017, MSJSTP staff started noticing the ducks inhabiting the effluent clarifiers (3 x 3.5ML) becoming ill and losing mobility. It was common practice for ducks to occupy the MSJSTP clarifiers towards the end of the dry season in search of water for the duration of approximately a month prior to the onset of rain. This generally occurs mid-summer when the Town Common wetlands are at their driest. The last time ducks were found deceased onsite was October 2013.

Historically, Tilapia have occupied the clarifiers and dissolved air flotation (DAF) lagoon year round. Fish are not able to naturally access these parts of the plant and are presumed to have been introduced through birds. Tilapia, nor any other wildlife species were found deceased during the 2013 incident, yet Tilapia were found deceased in volumes in many areas of the plant in November 2017 – January 2018. Therefore, the two incidents are not related, and the cause of the deaths is not resultant of MSJSTP's operations.

The cause of death of the ducks is unknown. There are however, theories why they may have been dying in the MSJSTP plant. One theory extends to the drying out of the Town Common due to clearing of paragrass from the outfall channel and the birds moving from that site to the plant, in combination with the well-known reports of wetland bird deaths (ducks, geese and ibis etc) from botulism. This raised concerns among staff as to the cause of the deaths, raised questions as to whether the treatment plant was the cause of the problem, potential environmental harm, and risks to human health.

Wildlife Health Australia Fact Sheet on Botulism in Australian Wild Birds describes the incidents of duck deaths in wetland systems. The fact sheet describes Botulism as a paralytic disease that is caused by ingestion of a toxin produced by the bacterium *Clostridium botulinum*. Botulism can occur in any bird species, but is most frequently seen in ducks, geese, swans, ibis, egrets and pelicans. It occurs worldwide and has been reported in wild birds in Australia. The majority of birds that develop botulism, if they are not treated, will die. Toxin production by *Clostridium botulinum* can only happen under specific environmental conditions and most outbreaks of botulism occur in the summer and may occur in the same environment repeatedly. The number of birds dying in these outbreaks can be substantial and thus can contribute to local and regional population decline.

2.1 Historical Ducks Deaths at MSJSTP

In October 2013 (a previous duck death incident), Townsville Waste water commissioned James Cook University's (JCU) Veterinary and Biomedical Science laboratory to autopsy a deceased duck. The report concluded that the deaths were possibly caused by a trematode parasite that is typically found in snails which would likely have been consumed within the town common wetland. JCU also stated that the likely cause of death was botulism, despite the samples testing negative. The presence of snails has not been reported within the clarifiers and therefore, operation of the plant including the effluent within the structures, were determined not to be the cause of death of the ducks in 2013.

The number of deceased ducks found and the duration of the deaths during the 2017/18 incident was higher and prolonged in comparison to the 2013 incident.

2.2 Clearing of the Outfall

In 2014, TCC was requested by the Department of Environment and Science and National Parks, Sport and Racing (NPSR) to act to improve the hydraulic flow of the outfall channel. MSJSTP discharges effluent to the outfall channel that is within the Town Common. Over a number of extreme wet seasons, paragrass had choked the channel to the point that fresh water was spreading across the Town Common, changing the natural environment and impacting flood drainage.

Following consultation with NPSR and the Department of Agriculture and Water Resources, TCC was granted permission to clear the paragrass choking the channel. Throughout the month of August 2017, the amphibious excavator unblocked the 2.5 km of channel which allowed the Town Common to drain down. The drying out of the Town Common in the summer months of 2017 coincides with the duck death event at MSJSTP.

2.3 In-House Investigation.

A MSJSTP staff member conducted DO profiling onsite in the DAF lagoon, clarifier 1 and the reuse pump station in December 2017. DO profiling examines whether the plant's biomass has been compromised and adequate treatment is occurring. These results are synonymous with the areas of the plant that were tested, no discrepancies were identified.

Also, in December 2017, a senior veterinary officer from Biosecurity Queensland attended MSJSTP to discuss the duck deaths with staff and suggested the deaths were caused by botulism or blue green algae. Most importantly, Biosecurity Queensland confidently advised MSJSTP that the cause of the deaths in no way could be transmitted to humans.

2.4 Testing

During the November 2017 to January 2018 incident, ducks were autopsied by both JCU and Biosecurity Queensland. Duck carcasses were taken to JCU for analysis. JCU offered a carcass to Biosecurity Queensland to also conduct analysis. JCU examined the ducks' gross pathology and histopathology with a diagnosis of presumptive botulism based on the history as clinical signs lacked conclusions. Biosecurity Queensland performed analyses on Lead (biochemistry), Botulinum toxin type C-D (microbiology), Influenza A virus (molecular diagnostics), and Newcastle disease virus (molecular diagnostics). All results came back negative. Again, botulism was suspected as the cause of death but was unable to be confirmed.

We also contacted JCU University to carry out several autopsies on the dead ducks. The results came back negative to botulism, but this is still the presumptive cause of death.

Samples were collected from the clarifier and reuse pump station and taken to Townsville Laboratory Services (TLS) for analysis of blue green algae, the results returned a negative result.

NATA accredited effluent sampling as per the EA undertaken prior to and during the peak of the duck deaths (October-December) remained within licence parameters. Likewise, the receiving environment monitoring program (REMP) did not returned any results of concern. There were no signs of stressed wildlife in the outfall channel and associated waters during the monthly REMP sampling events.

Figure 2: ***Ducks inhabiting the MSJSTP outfall drain 30 January 2018***

2.5 Handling of the Dead Animals

In addition to the onsite testing, MSJSTP staff had the task of removing the deceased wildlife from site, from water bodies and hard surfaces. This task was new to the MSJSTP team given the higher number of carcasses, and staff changeover since the 2013 event. The operators double bagged all carcasses and placed them in the regulated waste bins onsite. The removal equipment was sterilised, and procedures have been updated to include this. A procedure has since been developed, *WPP001 Collecting and Disposing Dead Animals from a Wastewater Treatment Plant*, following this event to assist operators in the safe removal of ducks should this recur next dry season.

3.0 CONCLUSION

TCC undertook autopsies and process investigations to determine the cause of the wildlife mortalities. Duck carcasses were sent to JCU and Biosecurity Queensland for autopsy examination. The results were inconclusive but a presumptive diagnose of botulism was made by JCU based on past history. Process investigations did not indicate the MSJSTP was in poor health and therefore is not expected to be a contributing factor to the deaths of the animals.

As a result of this event, TCC is investigating long term strategies to prevent ducks from settling on the clarifiers in the dry season when the Town Common is dry and for managing existing fish populations in the clarifiers, DAF lagoon and upstream of the UV. Netting is not considered cost effective and cannot be cyclone rated. TWW is exploring the feasibility of lasers and other bird deferring devices.

Options to humanely remove the existing population of fish from the clarifiers, DAF lagoon and UV structure are being investigated and TCC is in discussions with Tropical River Consulting regarding this. Options include draining of structures and electrofishing.

Figure 3: *Example of Electro Fishing*

Despite methods being employed to exclude fish and birds from these structures, it is probable that incidents such as these will recur given the location of the MSJSTP to the wetland and the large, calm water surfaces of the clarifiers and DAF lagoon. There is no absolute solution to eliminating Tilapia at MSJSTP and a population management program may be a more appropriate use of resources.

4.0 ACKNOWLEDGEMENTS

- Biosecurity Queensland, Department of Agriculture and Fisheries
- James Cook University's Veterinary and Biomedical Science
- Mt St John Sewage Treatment Plant Staff
- Townsville Laboratory Services
- Townsville Wastewater Environmental and Process Team.

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MURRURUNDI LITREE PLANT INSTALL

Paper Presented by:

James Davis

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Upper Hunter Shire Council

13th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Orange PCYC,
3 & 4 April, 2019

MURRURUNDI LITREE PLANT INSTALL

James Davis, *Town Water Supervisor,* Upper Hunter Shire Council

1.0 INTRODUCTION

The small town of Murrurundi in Upper Hunter Shire Council has for many years had issues with water supply to the community due to challenges of both quantity and quality. Murrurundi originally ran solely off a gravity fed pipe from the river, dosed with chlorine and then straight into the town reservoirs. This was until the late 70's early 80's when the river started to dry up.

The then Murrurundi Shire Council decided to build an off-creek storage dam to manage the increasingly sporadic flows. In 1983 the Murrurundi Dam was constructed with a capacity of 150 ML. Initially this was a great idea however the dam wasn't even full for the first time and there were already issues with algae. This ebbed and flowed for many years – algae then no algae.

In 2008 a de-stratification impeller was installed to stir the water and stop the algae blooms. This helped for a few years. In 2014, blue green algae returned to the dam big time (30mg/L). This meant trucking water to Murrurundi.

This event was a major driver in the decision to commit to the construction of a 40km water supply pipeline from Scone to Murrurundi, to fix both water reliability and quality issues permanently. In the meantime, Council continued to investigate ways to improve things before the pipeline arrived.

2.0 DISCUSSION

Council had the challenge of attempting to address a complicated water treatment issue, with what would likely only be a temporary measure. The pipeline was a committed permanent solution; however, the project approvals process was taking a long time. Water quality continued to deteriorate.

Council was then approached by Litree China who supply more than 50% of the UF Membranes in the world (over 216 commissioned plants). After some negotiations, Council purchased a package plant for installation at a nominal fee, which would become the first Litree plant installed in Australia.

2.1 Plans and Installation

A local firm was engaged to draw up the plans and supervise the installation of the plant along with construction of the pad site for the membrane plant. Two sludge lagoons were constructed to enable them to be used for backwash water treatment before sending it back into the supply dam, meaning there is minimal water wastage at the site.

Another company was contracted to install the tanks and Pipework consisting of

- 2 x 22.5 kL poly balance tanks for clear water storage;
- 1 x 10kL tank for backwash water; and
- 1 x 3m shipping container for auxiliary equipment, switch board, alum dosing pump and air compressor.

Electrical contractors were engaged to both install power to the plant and upgrade the Litree wiring to comply with Australian Standards.

Litree China flew two engineers and one translator to site to supervise the install and check operations of the plant – this was done within a 3-week window of time.

2.2 Operations of the Plant

The plant can be run on automatic or manual. The maximum plant production is 1.2 ML/day or 50 kL per hour to fill clear water tanks and shutdown, pump to reservoirs.

Day to day operations of the plant include filter water for 30 minutes then conduct a backwash. Every 20 backwashes, a chemical enhanced backwash with a 30 minute soak is required. Depending on pressures a CIP clean is conducted every four to six months. All these parameters are operator adjustable and easily changed via touch screen in the plant.

In the first three weeks Council ran the plant during working hours only to gain confidence in the plant, constantly monitoring and testing water to make sure the algae was being removed by the membranes.

Once confidence was gained, the plant went into full operation and now runs full time automatically. After full operation for a couple of weeks, Council received great feedback from the community about the improvement in the quality of the water and the test results showed likewise.

TREATMENT PROCESS OVERVIEW

Murrurundi WTP treatment process consists of the following process units:

- Raw water inlet pipework with by-pass valve
- Membrane plant raw water feed pumps
- Membrane filtration
- Membrane backwash system including CIP backwashing
- Backwash water collection tank and duty transfer pump
- Duty/standby sludge lagoons
- Chemical dosing systems including:
    - Alum Coagulant (sludge settling)
    - Chlorine (existing disinfection process)

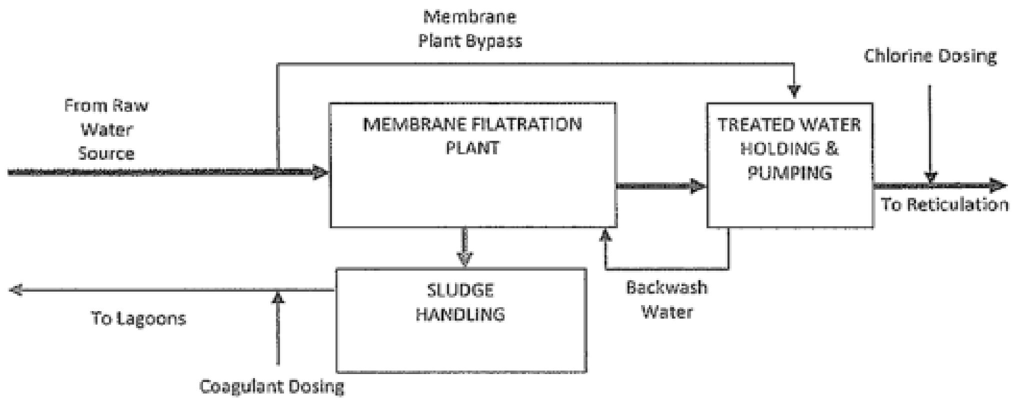


Figure 1: ***Treatment Process Overview***

Figure 2: *Membrane Module*

2.3 Financials

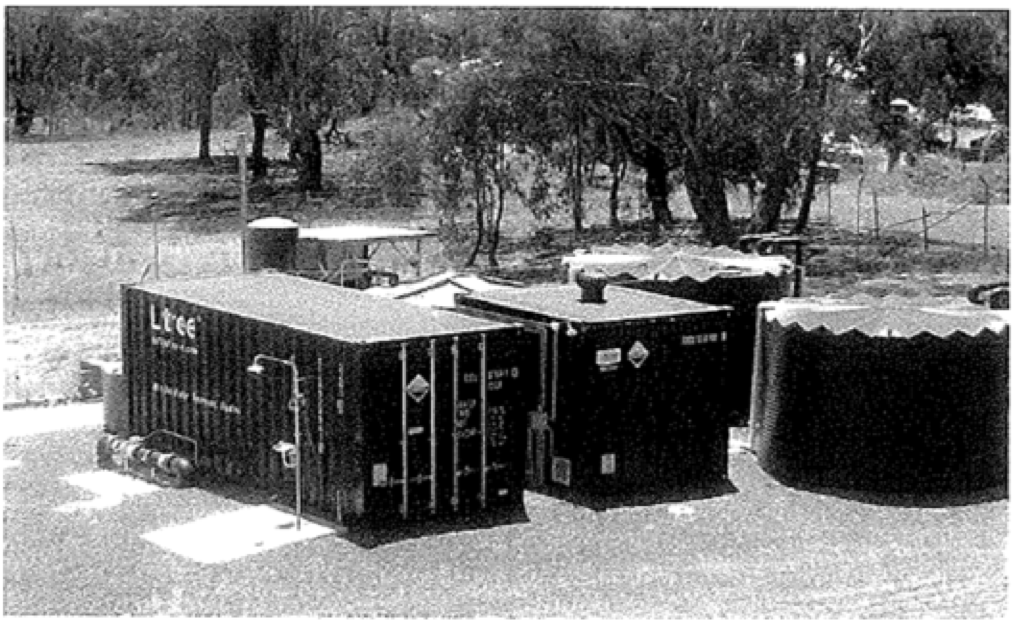
The Litree company was keen to implement an operating pilot plant running in the South Pacific Region. Litree was prepared to provide the plant for a nominal $1 cost to Council, even though the plant was valued at $250,000. This led staff to jokingly refer to the plant as the '$1 treatment plant'. In reality, there was a lot of work required to establish the unit on the site.

Table 1: ***Summary of Litree Pilot Plant Establishment Costs***

Item	Cost
Litree Plant	$250,000.00
Associated pipe work	$178,880.00
Sludge lagoons & site work	$81,500.00
Power upgrade works & install	$105,000.00
Design Work	$25,000.00
Project Management	$8,250.00
Total Cost	**$648,630.00**
Less gifted value of Litree plant	$249,999.00
Total Cost to Council	**$398,631.00**

2.4 Issues During Installation

- Had to the adapt pipework to fit into container. The Chinese were using 132 mm pipe & Roll Groove pipe fittings.
- Installation was close to Christmas, so suppliers were shut down or close to shutting shutdown.
- Installation into existing the pipe work whilst still supplying water to the town.
- Various contractors working on the same site (vehicles and machinery in the way of other contractors).



<u>Figure 3:</u> ***Overview of Litree plant***

3.0 CONCLUSION

Installation of the plant has been a success. We were very sceptical at first to see how the plant would perform.

We still have not run the plant to its full potential due to drought and water restrictions, but the improvement in Chlorine disinfection and turbidity results are quite outstanding for a town that constantly struggled to comply with Department of Health standards, particularly for turbidity. Now at the end of reticulation having turbidity drop from 5 NTU to 0.5 NTU speaks for itself.

This was envisioned as a temporary solution to Murrurundi's water woes. About to start soon is the 40 km pipeline from Glenbawn Dam which will provide relief from restrictions during the summer months. However, Council now intends to keep the Murrurundi Dam and Litree treatment plant as a permanent alternative source to the pipeline.

4.0 ACKNOWLEDGMENTS

Litree China / Australia
MJM Environmental Pty Ltd
No Bull Building
National Civil Projects
Control IT
Alan Fletcher UHSC
Andrew Brown & Phil Hood UHSC – who I know received quite a few stressful phone calls from me on this project.

THE LEAP TO DIGITAL: A SCADA UPGRADE 10+ YEARS IN THE MAKING

Paper Presented by:

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Shoalhaven Water

13th Annual WIOA
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THE LEAP TO DIGITAL: A SCADA UPGRADE 10+ YEARS IN THE MAKING

Adam Drenoyanis, *Project Engineer – Control Systems,* Shoalhaven Water
Allan Gilkes, *Unit Manager – Electrical, Communications and Fitters,* Shoalhaven Water

ABSTRACT

Shoalhaven Water (SW) is currently embarking on a multi-generational leap in their remote telemetry systems. SW has identified the need to improve a number of areas within their current organisation-wide Supervisory Control and Data Acquisition (SCADA) system including the data analytics capability to provide better intelligence for their business. The gaps in the capabilities and features of the current SCADA system stem from the following main issues; by the very nature of the older technologies, there are limitations in the features of the existing analogue radio system and Radtel telemetry units to support more sophisticated data diagnostics, time and date information required to facilitate data analysis. The current system contains primarily a combination of 3000/5000/8000 series remote telemetry units (RTUs). These RTUs are now unsupported and well past their end-of-life. With minimal ongoing annual capital works funding on SCADA enhancements, the current system has fallen significantly behind state of the art. Hence, the objectives of this project are to address the gaps in the capabilities and features of the current SCADA system through upgrade works including; enhancements to the current ClearSCADA applications software configuration, upgrade of the data communications network from analogue to digital, and implementation of new digital RTUs at all remote sites. This paper details the steps taken to achieve cutover of such a significant portion of remote sites in the first year of a major capital works project, the experiences learned along the way, as well as presenting some state-of-the-art SCADA displays, reporting and systems integration.

1.0 INTRODUCTION

Shoalhaven Water (SW) is a large regional utility on the New South Wales south coast. Tied to Shoalhaven City Council, the approximate 5000 km^2 coverage area consists of many satellite wastewater schemes, as well as delivery of potable water from two large water treatment plants (WTPs) in both the north and south. The water system consists of five dams, four WTPs, and numerous water reservoirs, water pumping stations (WPS), valves and other dosing systems; treating and distributing approximately 45 ML of potable water each day.

The wastewater system consists of 13 wastewater treatment plants (WWTPs), 220 sewer pumping stations (SPSs), numerous valves and other dosing systems to collect and treat approximately 18 ML of wastewater per day. All of these assets are monitored through SW's Supervisory Control and Data Acquisition (SCADA) system and have been for some time. With the recent wave of Internet of Things (IoT), the 1100 low pressure pumping units (LPPUs) within the wastewater network are progressively being retrofitted with low cost sensors for inclusion onto the existing SCADA system for exception reporting and alarming.

Historically, SW has operated on a Radtel-based SCADA system with a mix of 3000/5000/8000-series RTUs communicating over an analogue radio network. With these RTUs now unsupported and well past their end-of-life, a major push for a digital telemetry and SCADA upgrade was initiated in 2015. Through extensive expressions of interest (EOI) and request for tender (RFT) processes, three tender packages were awarded late in 2017, with the major rollout commencing in January 2018.

One year on, 210 SPS, 4 WWTPs, 228 LPPUs and a number of water assets have been cutover to the new digital telemetry system. This is supplemented by state of the art ClearSCADA software and reporting enhancements; significantly improving day to day operations for field staff, emergency response, as well as management decision making and forecasting system-wide.

This exceptional rollout pace has been thanks to a committed project team; consisting of both internal SW staff, and partnerships with key external contractors for both hardware supply and installations, as well as SCADA system integration.

2.0 DISCUSSION

A 20+ year old telemetry system has its drawbacks, although for SW and many other water utilities, in its day, the RadtelSCADA telemetry systems very well served their purpose. However, over the years and turnover of staff in both management and the field; SCADA services and water/wastewater operations as a whole, what started as standards slowly, over time, became not-so. For SW specifically, the siloed schemes allowed staff to request their own means of displays, reporting methods and alarming protocols, to the point where maintenance between the 13 databases ceased. Subsequently, when staff from opposing schemes were scheduled for on-call duties, responses to problem situations would vary from site to site and scheme to scheme. To gain a better understanding of where SW had started before this upgrade, and what has been achieved so far, one must know some background of the systems which were historically in place, the underlying issues with this, as well as the intermediary steps taken to improve before the major drivers for telemetry upgrade.

2.1 The Underlying Issues

As with most analogue radio networks, SW was in a situation where, with all scheme's SCADA servers situated at their respective treatment plants, all remote sites managed by that scheme must find a communication path to that specific server. In the Shoalhaven region there are some large areas within schemes with problematic geographic terrain. Due to this there were many store-and-forward type arrangements between sites for data communications. The data received by the SCADA servers from the older RTUs was quite unreliable, being timestamped when received by the master station as opposed to the actual time of occurrence. The 3000- and 5000-series RTUs particularly would cause a large influx of data with the same timestamp if communications with the outstation were lost for long periods of time.

The 8000-series RTUs solved this issue, so most critical sites were upgraded to this model as budgets allowed. This older protocol was inherently polling-based rather than change of state, so each outstation must wait their turn in the polling queue, regardless of the severity. Another inadequacy of the polling-based protocol is that each point would store another historic record each poll, regardless of whether it was in the same state or not. This created significant amounts of unnecessary stored 'junk' data. The telemetry overviews were also very dated, with upgrades in software only keeping the original telemetry screens as shown in Figure 1.

The last telemetry upgrade project in 2012 conducted extensive consultation with mainly field staff, where the majority wanted "the same look and feel" of the existing system. As such, this upgrade was purely a conversion from RadtelSCADA to ClearSCADA, reproducing the same screens without any rejuvenating of SCADA mimics or reporting functionality. Significant money was spent for no real improvements.

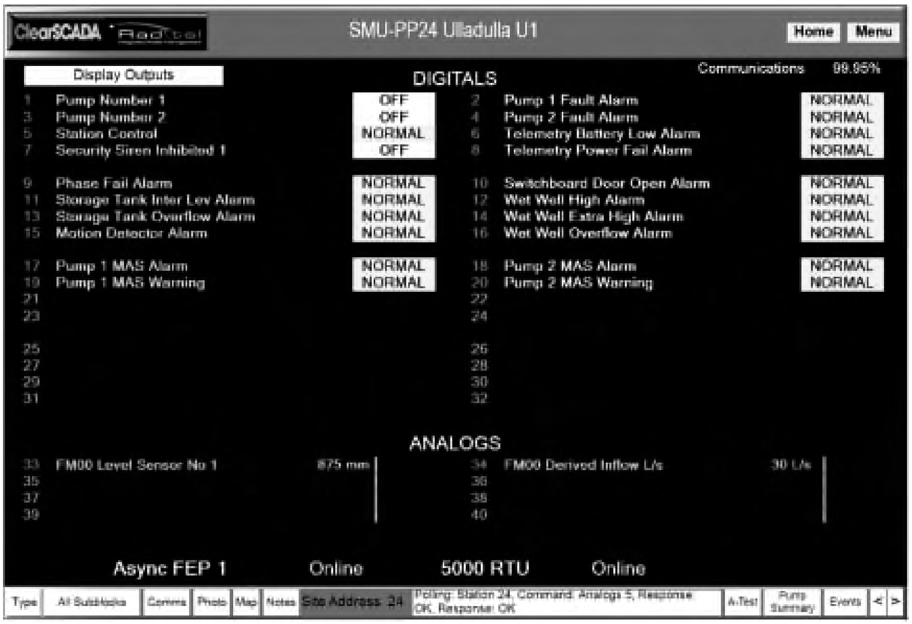


Figure 1: *A typical RadtelSCADA RTU station page*

2.2 The Major Driver for this Upgrade

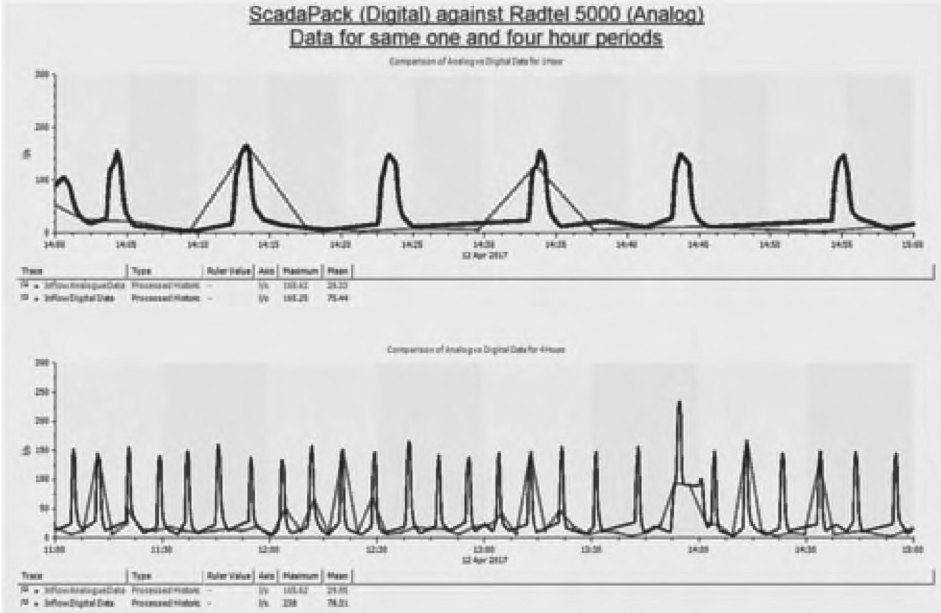
This current upgrade has been driven from management, after external consultants provided a 30-year asset assessment and upgrade forward plan based on the data extracted from the SCADA system above. Due to the inaccuracy of these records, most sites had over 1 million data points, when even filtered down to a usable 100,000 points have proven to be a significant overshoot. This has led to inaccuracies is asset life and system capacity predictions, where some major capital works projects could have been delayed for extended periods and thus decreasing costs.

2.3 Where to from here?

An EOI process was advertised in 2015, whereby the SW SCADA team went out to the industry to ask the questions and test the market. The EOI asked for submissions based on current best-practices and design methodologies. It also enabled submissions of various hardware options to allow a comparison of many RTU and radio combinations for implementing a state-of-the-art digital telemetry system. This became quite a long internal review process, though enabled SW to trial a number of digital telemetry solutions throughout, including Xylem Multismarts, Schneider Trio E/Q series radios, as well as SCADApack 334/337/535E RTUs. A comparison between a polled RTU analogue point and the same analogue as a buffered SCADApack 334E point in figure 2 below shows a distinct difference in data integrity.

Learning a lot along the way, SW were able to clearly define where they wanted to go for the future. Then, in 2017, some two years after the EOI was advertised, SW was ready to advertise RFTs. Clear decisions were made on the arrangement of these tenders, splitting the project into three separate tender packages:
Package 1: SCADA software enhancements/System integration (SAFEgroup Automation)
Package 2: Supply of Hardware (SAFEgroup Automation)
Package 3: Installation of Hardware (Downer EDI)

This arrangement allowed SW to be risk averse, and award successful tenderers best-fit to each of the package's defined scope.



<u>Figure 2:</u> ***An analogue point comparison between polling-based and buffered events-based RTUs***

2.4 Project Planning and Rollout

Working closely with SAFEgroup system integrators (SIs), a clear plan was defined for a quick delivery of remote sites in both telemetry hardware and SCADA software enhancements. Beginning with the wastewater section first, the integral part of this was to develop a new standard SPS code and mimic; covering as many remote sites with a single template as possible. Developed based on Nowra SPS 17, this included the most common input/output (IO) arrangements of all two-pump SPS. While extensive field work was required to audit all SPS sites within SW's network prior to this, regardless of where the common IO was connected in the existing RTUs, all IO of the new RTU hardware would become standardised. For example, Pump 1 Running will be DI-0, Pump 1 Fault will be DI-1 etc, eliminating the confusion where some RTUs had these same inputs in card 3/page 3 on SCADA. This allowed development of standard termination schedules to be issued to Downer contractors for hardware installation as shown in figure 3 below.

Nowra SPS22 - Radtel 5000 RTU

Card 1: Col. 1

Radtel DI	Wire Number	Point Name	New RTU
Led		Led 7	
Led		Led 6	
Led		Led 5	
Led		Led 4	
Led		Led 3	
Led		Led 2	
Led		Led 1	SCADAPACK
Led		Led 0	To RTU Terminal
Black	Black	GND	Remove/Terminate
Red	Red	PWR	Remove/Terminate
8	Yellow	Telem Pwr Fail	Remove/Terminate
0V Terminal			
7	Yellow	BA Siren Status	Remove/Terminate
0V Terminal			
6	Orange	Tel Batt Low	Remove/Terminate
0V Terminal			
5	Orange/Blue	Stat Control	Remove/Terminate
0V Terminal	Pink	Stat Control	Remove/Terminate
4	Red/Black	P2 Fault	D3L26 (24V Com)
0V Terminal	White	P2 Fault	DI-03
3	White/Red	P2 Running	D3L26 (24V Com)
0V Terminal	Yellow	P2 Running	DI-02
2	Yellow/Red	P1 Fault	D3L26 (24V Com)
0V Terminal	Green	P1 Fault	DI-01
1	Green/Red	P1 Running	D3L26 (24V Com)
0V Terminal	Blue	P1 Running	DI-00
REMOVE FROM			WIRE TO

Col. 2

DI-BIT (DO)	Wire Number	Point	
8	Blue	Remove	N/O
BA Off			N/C
	Orange	Remove	COMMON
7			N/O
			N/C
			COMMON
6	White/Blue	DO-00	N/O
Stn Inhibit			N/C
	Purple	D5L32 (Gnd Com)	COMMON
5	Blue/Black	Remove	N/O
Stn Normal			N/C
	Orange	Remove	COMMON
4			N/O
			N/C
			COMMON
3			N/O
			N/C
			COMMON
2			N/O
			N/C
			COMMON
1			N/O
			N/C
			COMMON

Card 2: Col. 1

Radtel DI	Wire Number	Point Name	New RTU
Led		Led 7	
Led		Led 6	
Led		Led 5	
Led		Led 4	
Led		Led 3	
Led		Led 2	
Led		Led 1	SCADAPACK
Led		Led 0	To RTU Terminal
Black	Black	GND	Remove/Terminate
Red	Red	PWR	Remove/Terminate
16	O/FLOW Grey	WW Overflow	D3L26 (24V Com)
0V Terminal	O/FLOW Grey/Blue	WW Overflow	DI-06
15	White	Intruder Alarm	Remove/Terminate
0V Terminal		Intruder Alarm	
14	XHIGH Green/Blue	WW Extra High	D3L26 (24V Com)
0V Terminal	XHIGH Blue	WW Extra High	DI-05
13			
0V Terminal			
12	Red/Blue	WW High	D3L26 (24V Com)
0V Terminal	Red	WW High	DI-04
11			
0V Terminal			
10			
0V Terminal			
9	Red/Brown	Phase Fail	D3L26 (24V Com)
0V Terminal	Black	Phase Fail	DI-11,DI-12 (bridge)
REMOVE FROM			WIRE TO

Others:

Pos +	Switchboard	(PULLED FROM	D3L26 (24V Com)
Neg -	Door	ATE PCB)	DI-07
Pos +	BA	(NEW SIREN)	DO-01
Neg -	Siren		D5L32(Gnd Com)

<u>Figure 3:</u> ***Standard termination schedules issued for hardware installations***

With the above, and some other valuable tools developed by SAFEgroup Automation, configuring new telemetry hardware in preparation for installations was significantly streamlined. And, with a steady stream of fully-built RTU panels being ordered, delivered and installed, SW has successfully cutover 210 SPS, 4 WWTPs, 228 LPPUs and a number of water assets in the first year of the three-year project, well over 50% of telemetry sites.

2.5 SCADA overviews and reporting

The new telemetry station pages offer significantly more information on a single display, eliminating the previous requirement to jump from page to page just to trace back history, reports and events. Compared to that shown in figure 1 above, the move to a more abnormal situation management (ASM) standard displays, as shown in figure 4 below, has improved staff response to critical events and allows clear alerts to any states out of the ordinary.

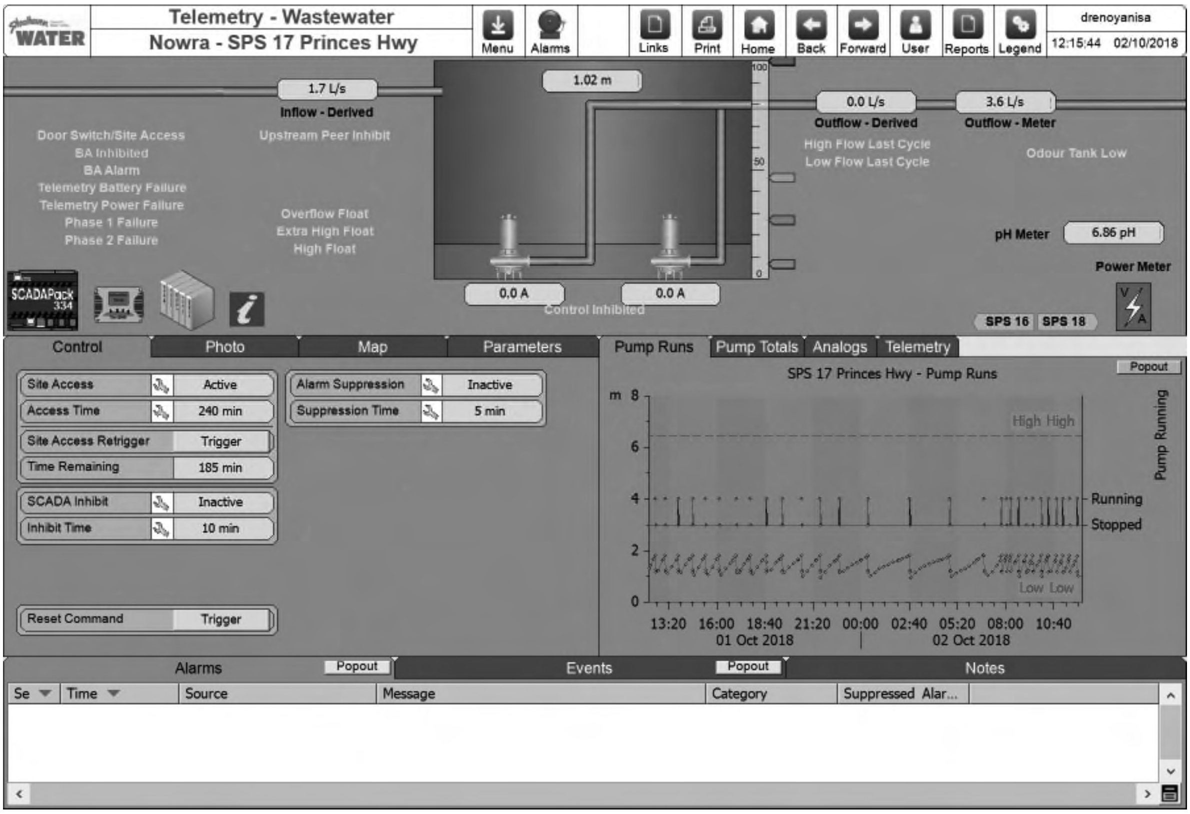


Figure 4: *SCADA upgrade – new standard SPS telemetry station pages*

More focused on the scheme-based overviews, the recent upgrade to ClearSCADA 2017 software has enable the inclusion of map-based geographic displays. This, in turn, provides the ability to overlay web-based map service layers such as internal GIS layers and Bureau of Meteorology data-feeds. This functionality has allowed vastly improved management of emergency response. These are shown in figures 5 and 6 below respectively.

Furthermore, utilising fixed radar level sensors in SPS, and continued improvements in SCADA data collection and prediction has allowed for the plotting of standard, expected diurnal inflows at critical wastewater sites. This gives the ability to alarm in real-time lower than (or greater than) expected flows at specific time-slices of a day, allowing early identification of potential problems upstream from the corresponding SPS site.

Figure 5: ***Geographic overviews – ArcGIS layer***

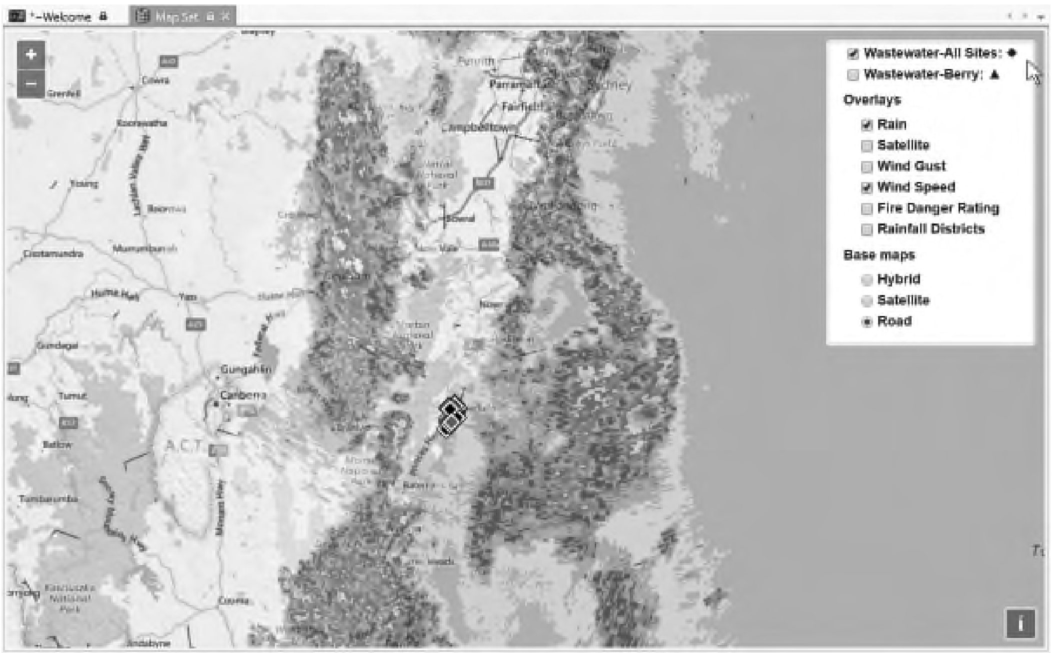


Figure 6: ***Geographic overviews – BOM weather overlay***

3.0 CONCLUSION

This paper has detailed the current SCADA upgrade currently being undertaken by Shoalhaven Water. From the historic system outlined above, to the improved system in the process of being delivered, the benefits are clear. These are not only from visual software enhancements, but also in the way data is collected from sites. The move from RDCMP-based protocols to DNP3 has enabled a vastly greater trust in the data produced by SW's SCADA system. This has allowed better-quality asset life forecasting as well as predictive alarming based on operationally historic trends.

4.0 ACKNOWLEDGEMENTS

The authors would like to thank all who are currently involved in this upgrade project. Both internal operations staff and key stakeholders who have provided support and guidance to allow this project to endure, as well as the external contractors from SAFEgroup Automation and Downer EDI who have kept up with a rapid rollout pace, allowing SW to remain ahead of schedule and under budget.

OPTIMISING AN OLD WATER TREATMENT PLANT DURING DROUGHT

Paper Presented by:

Natasha Chapman

Author:

Natasha Chapman, *Specialist Operator,*

Tamworth Regional Council

13th Annual WIOA
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3 & 4 April, 2019

OPTIMISING AN OLD WATER TREATMENT PLANT DURING DROUGHT

Natasha Chapman, *Specialist Operator,* Tamworth Regional Council

ABSTRACT

Manilla Water Treatment Plant sources raw water predominantly from the Namoi River with a supplementary supply also available from the Manilla River. The existing treatment plant was constructed and commissioned in 1933 and due to the age of the plant there are challenges in optimisation of the plant when there are changes in raw water quality. During recent drought conditions, low flows in the Namoi River led to high raw water pH and alkalinity. Despite jar tests showing the ability for the alum to provide acceptable treatment, the plant struggled to maintain effective coagulation and flocculation which led to short filter run times.

Town consumption demands are low enough to not require the plant to operate continuously. This allowed the operators to isolate the plant, perform jar tests and identify options to address the issue before poor water quality was sent to the distribution system.

Proactive thinking by the operators identified an option to use an alternative coagulant in a temporary dosing arrangement. Further Jar tests were undertaken using an Aluminium Chlorohydrate coagulant and successful results were achieved. After installing the temporary dosing system and bringing the treatment plant back online, improved plant performance was noticed immediately. Settled and filtered water turbidity was reduced, and longer filter run times were able to be achieved.

Tamworth Regional Council is currently in the process of finalising the designs for a new treatment plant to be constructed. Events such as this one highlights the importance of the need for the upgrade. In the meantime, this was an example of how an existing plant can be optimised to maintain acceptable water quality.

1.0 BACKGROUND

Tamworth Regional Council (TRC) was established in 2004 after the amalgamation of Tamworth City Council and several other smaller City and Shire Council's. Since the amalgamation, TRC has invested significant capital in the augmentation of many of the water treatment plants across the region to address operational and water quality and supply risks. Construction of a new Water Treatment Plant will soon commence at Manilla.

Located approximately half an hour north-west of Tamworth, Manilla is a town with a population of approximately 2500 The Manilla Water Treatment Plant commenced operation in 1933 and 85 years later, with minimal upgrades, the same conventional water treatment plant struggles to treat water during periods of poor raw water quality
The Manilla water treatment plant normally doses Alum for coagulation which is effective under typical raw water quality conditions. However, in 2018 the treatment plant performance began to deteriorate which was observed through:

- An increase in the frequency of filter backwashing (reduced filter run time)
- An increase in filter turbidity breakthrough

At times, the treated water tank needed to be scoured to prevent poor treated water quality being pumped to the distribution system.

In response to deteriorating plant performance, some initial strategies that were implemented included:

- Continuing to optimise chemical (Alum) dose rates
- ‘Topping-up’ the filter media
- Reducing the plant flow rate

These actions provided short-term improvement to plant performance. However, with prolonged periods of minimal rainfall there was a noticeable decline in the raw water quality, leading to higher pH, hardness and alkalinity, which made treatment more difficult.

The demand on the plant was beginning to show through the following operational observations:

- A further increase in the required filter backwash frequency
- An increased in the clarifier sludge scouring required
- An increase in the Aluminium residual in the filtered water
- A further increase in filter turbidity breakthrough.

2.0 A CHANGE MUST BE MADE

The main concern for the plant operators centred on the increasing filtered water turbidity and with no indication that the raw water quality would improve in the near future. It became more and more apparent that optimising the alum dose rate was no longer effective with plant performance no longer sustainable and that there was an unacceptable risk to water quality and supply.

The operators considered the available options and it was decided that using Aluminium Chlorohydrate (PAC-AC) would be a possible solution as it was being used successfully in a neighbouring plant whose raw water source was of a similar pH and alkalinity to Manilla’s present source. Jar tests were performed using the new coagulant and the results indicated that a dose rate of 20 mg/L of PAC-AC was optimal to produce an effective floc within the clarifier and be more likely to hold together through the filters.

The WTP operators and technical support staff set up a ‘temporary’ dosing system consisting of four IBC’s that were retrofitted into the dosing pump previously used for Alum. As a result, dosing of PAC-AC at 20 mg/L commenced on the 16th of August 2018 with operators closely monitoring.

Figure 1: ***PAC-AC filled IBC's atop bunds retrofitted to the Alum dosing system***

Figure 2: ***Retrofitting PAC-AC to chemical dosing pump previously used for Alum***

3.0 RESULTS

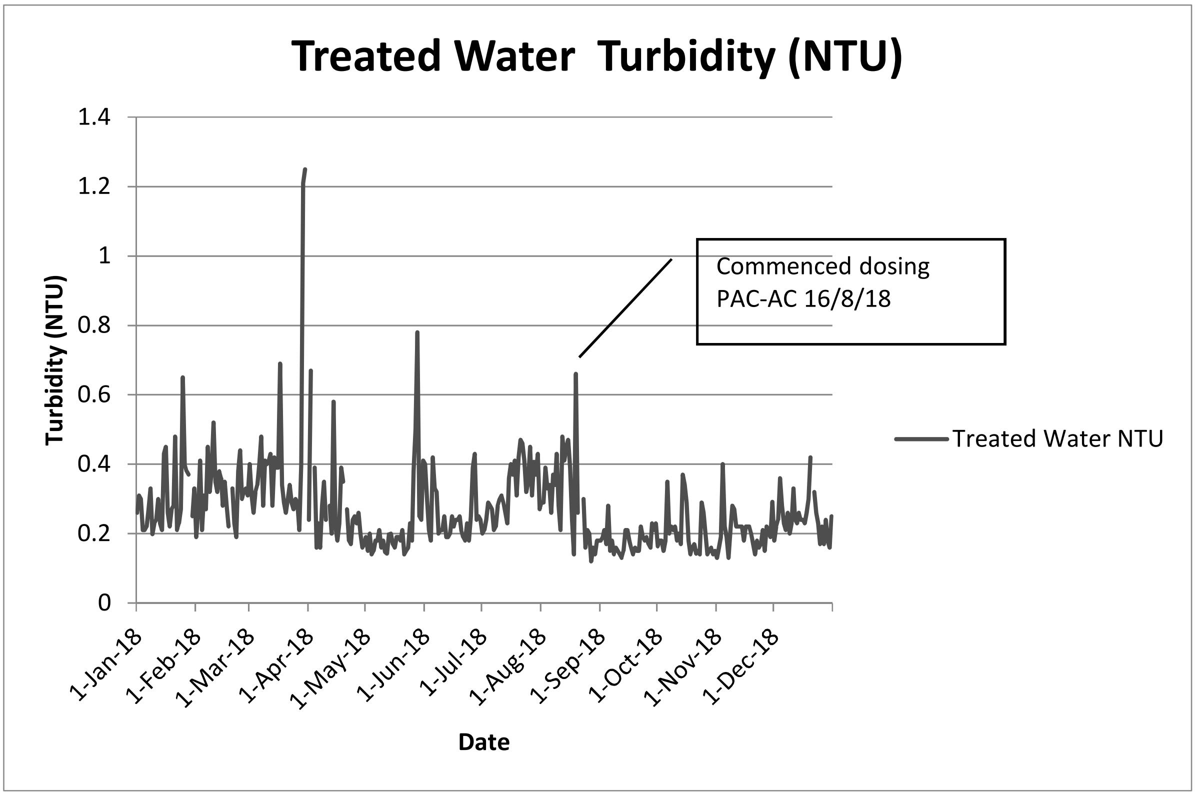

Figure 3: ***Treated water turbidity over the course of 2018***

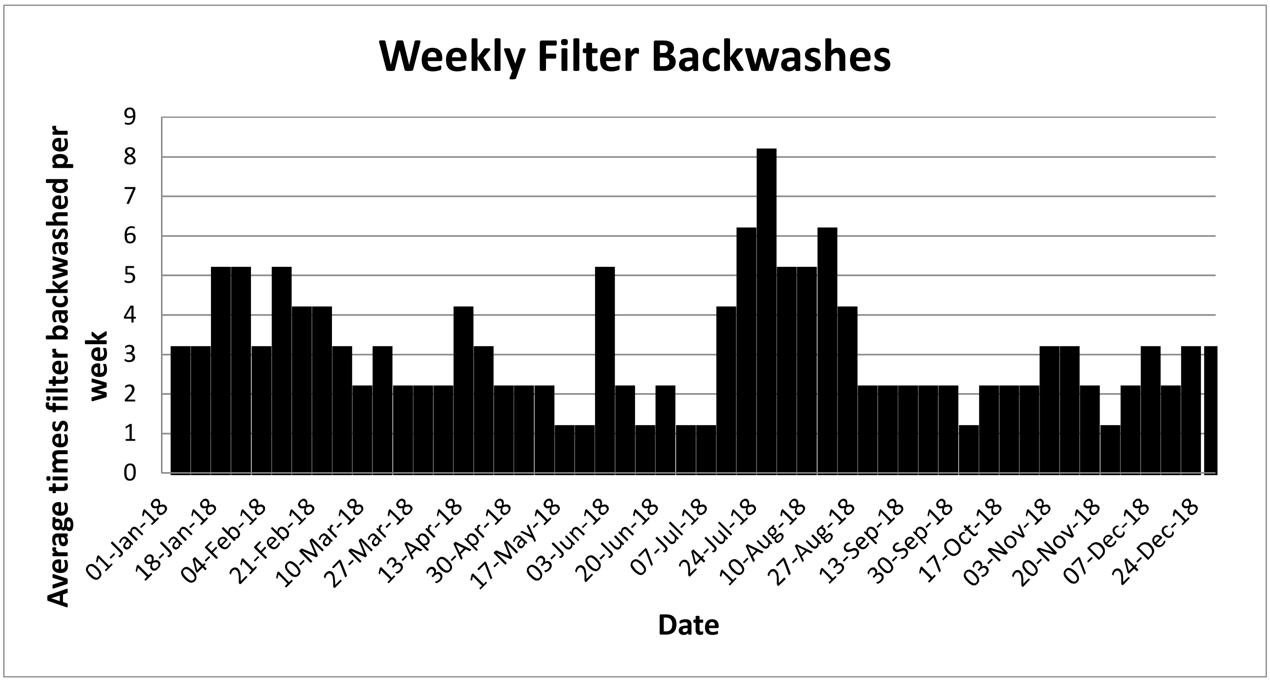

Figure 4: *Filter backwashing of the Manilla Water Treatment Plant 2018*

4.0 DISCUSSION

The final treated water turbidity test results taken every day for a period of 12 months is shown on Figure 3. From this graph it can be seen that there was a gradual increase in the treated water turbidity from the month of May until PAC-AC was introduced on the 16th of August. From the 16th of August onwards, there is a noticeable decrease in the turbidity values, with most values after the introduction of PAC-AC less than 0.5 NTU and consistently less than 0.25 NTU.

When the plant is running to its optimal capacity, filter backwashes are performed approximately every 3 days with clarifier sludge scouring being performed every second day. However, as Figure 4 shows, filter backwashing can be observed increasing in frequency from July 2018, with filter backwashing occurring almost every day from mid July to mid August 2018, with clarifier sludge scouring occurring every day. During the worst plant performance period the clarifier was being emptied every week to help improve plant performance.

The addition of dosing PAC-AC to the raw water has seen the following immediate improvements in plant performance:

- Filtered and treated water turbidity has decreased significantly. On the day of dosing PAC-AC (16th August 2018) the turbidity returned a result of 0.39 NTU and within a week was down to 0.16, a significant improvement!
- A decrease in filter backwashing frequency (longer filter run time). Filter backwashes are now being performed every two to three days as required for continued plant performance. For the old Manilla water treatment plant, changing from Alum to PAC-AC has significantly increased its longevity as an efficiently working treatment plant.

In addition to these issues, the levels of organic compounds in the raw water also became a concern as visually there were signs of algal growth on the surface of the Namoi River.

The existing treatment does not have a PAC dosing system for algae treatment. In response, the operators setup a temporary PAC dosing system to be ready in the event there was a toxic algae bloom.

5.0 CONCLUSION

The issue currently being experienced is an example of the challenges of operating aging infrastructure whilst also complying with more stringent water quality controls and an ever changing climate have made treating our local water supply an increasingly harder task.

This experience also highlights the importance of the following:

- Raw water quality monitoring. Whilst poor raw water quality is often associated with high turbidity following high rainfall events, this is an example of how other environmental factors and raw water quality parameters also impact on the treatment process
- Innovative thinking, communication and option assessment. The process of identifying the problem, identifying and assessing options and implementing a solution required high levels of communication between operators and technical support staff. A successful outcome was achieved without compromise to the town's water quality or supply. This can be a challenge in regional areas with aging infrastructure and limited resources.

Although Manilla will have a new Water Treatment Plant constructed in the near future, the existing plant will continue to operate until then. The design and capabilities of the new treatment plant will much more easily cope with conditions like this by:

- Having dedicated raw water source selection (rather than only being able to pump out of the Namoi River)
- Improved coagulation, clarification and filtration processes
- Improved plant automation and instrumentation
- Improved, operational and process systems to control changes in raw water quality (e.g.: acid dosing to improve coagulation pH)

However, the ever increasing possibility of an event like this reoccurring means that operators must monitor and respond quickly in order to optimise an elderly conventional plant. The innovative thinking and proactive response by the Manilla operators ensured that the water quality produced complied with NSW Health and the Australian Drinking Water Guidelines. With the drought continuing in NSW there will be many treatment plants that may run into similar situations that Manilla's operators faced and it is our hope that our struggle and eventual solution may give other operators ideas in similar events.

6.0 ACKNOWLEDGMENTS

I would like to acknowledge Russell Lyne (Headworks Engineer), Gina Watt (Process Engineer), Benjie Burge (Team Leader) and Emily Falvey (Specialist Operator) for their help and knowledge that was invaluable for the completion of this report.

KNOWLEDGE AND SKILLS PLUG THE LEAKS

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KNOWLEDGE AND SKILLS PLUG THE LEAKS

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Claire McInnes, *Senior Research Manager*, Water Research Australia

ABSTRACT

The 'Value of Operator Competency' project is a Water Research Australia (WaterRA) member-funded initiative. The objective of the project is to demonstrate the value provided to water industry organisations by having frontline operators that are equipped with the right level of competency to fulfil their roles. Using the analogy of a "leaking / burst pipe" this presentation aims to illustrate the crucial role the level of frontline operator competency plays in the prevention of active human errors (analogy of a burst pipe) and the introduction of latent errors (analogy of cracks or integrity breaches just waiting for the conditions to align for the inevitable burst to occur). Three actual water quality safety incidents will be used to highlight the link between frontline operator competency and active and latent human errors.

1.0 INTRODUCTION

The 'Value of Operator Competency' project is a Water Research Australia (WaterRA) member-funded initiative. The objective of the project is to demonstrate the value provided to water industry organisations by having frontline operators that are equipped with the right level of knowledge, skills and experience applicable to the role and responsibilities undertaken. This forms the basis of the competency required to exercise good judgement for a sound and informed decision-making process.

Frontline operators on a daily basis are responsible for making decisions that directly influence drinking water safety and the treatment of wastewater and recycled water to specification. Many of these decisions are made specifically to ensure public health and safety or environmental protection. Fulfilling this responsibility demands a workforce that is competent to deliver these services without vulnerability to failure from human error.

The link between frontline operator competency deficiencies and human error, due to poor judgement and decision making, has long been established following water quality safety incidents worldwide (Hrudey and Hrudey, 2003; Hrudey and Hrudey, 2014). Wu, et al. (2009) reviewed 62 water quality safety incidents and reported that 78% of the errors identified were human related. In hindsight the frontline operator competency deficiency was often obvious.

Using the analogy of a "leaking / burst pipe" this presentation aims to illustrate the crucial role the level frontline operator competency plays in the prevention of human errors. Human error was defined by Wu, et al. (2009) as either:

1. active errors - where the consequence is apparent within a very short period of time, such as, an omission or using the wrong rule or procedure;
2. latent errors – where the consequence may only become apparent after a period of time, or when combined with other errors, or particular operational conditions.

Active errors in this presentation are likened to that of a burst pipe drama, the impact is immediate and is obvious. While, latent errors are likened more to integrity breaches of a pipe – small cracks that may be appear over time and weaken the structure. It is when the system is stressed or challenged by other factors the ultimate burst occurs.

2.0 DISCUSSION

2.1 Five Operational Principles

The Value of Operator Competency project identified five operational principles to demonstrate the diversity of competency frontline operators require to exercise good judgement and for sound and informed decision making.

A brief description of each operational is provided below:

- **Operational culture** – is defined as the non-technical aspects. For example, the values, attitudes, beliefs and behaviour that exists within an operational team. It fosters an employee's commitment to the "personal sense of responsibility and dedication to providing consumers with safe water" as described by the Australian Drinking Water Guidelines (ADWG) guiding principle (NHMRC, 2011).
- **Regulation and compliance understanding** – is defined as "to know why you do what you do". It is critical for frontline operators to know the water quality regulatory rules that apply to an operational setting, for example, parameter targets and limits. More importantly, to clearly understand the implication to public health or the environment from failing to comply with a regulatory requirement and what to do to comply. That is the translation of the regulatory rule into functional operational practices to achieve a compliant outcome.
- **Asset capability and operational performance** – is defined as the knowledge, skills and experience required to ensure effective functionality of the barriers in place to control and manage water quality risks. The multibarrier approach as described by the Australian Drinking Water Guidelines (ADWG) "the drinking water system must have, and continuously maintain, robust multiple barriers appropriate to the level of potential contamination facing the raw water supply" (NHMRC, 2011).
- **Know-your-system risk-based thinking** – is defined as the knowledge, skills and experience required to analyse the water supply system and to critically assess the available information to identify, for example, changing conditions or suboptimal process performance, and to foresee the potential water quality safety risks and the implications of these risks. It is vital for frontline operators to thoroughly know and understand the water supply system they work within, as described by the ADWG and the Australian Guidelines for Water Recycling (AGWR) framework element 2. Also, to be competent in the application of risk-based thinking to predict potential water quality safety risks and to proactively implement appropriate corrective action.
- **Operational response and emergency management** – is defined as the actions initiated in response to a deviation from "normal operational conditions" and the management of an escalating situation with the potential to cause public health and safety or environmental harm. It is critical for frontline operators to competently respond with the appropriate corrective actions in a timely manner – to know what to do and when to do it. This is described by the ADWG principle "system operators must be able to respond quickly and effectively to adverse monitoring signals" (NHMRC, 2011). Equally as important is to ensure frontline operators are well practiced in an organisation's emergency management processes and procedures as described by the ADWG element 6.

2.2 Actual Water Quality Safety Incidents

Three actual water quality safety incidents are presented below to demonstrate the link between the level of frontline operator competency and human error.

The competencies are discussed in terms of the five operational principles. It must be noted that there were other contributing factors involved in each of these water quality safety incidents. To read the full account of each incident refer to the publication by Hrudey and Hrudey *Ensuring Safe Drinking Water – Learning from Frontline Experience with Contamination* (2013).

Milwaukee, Wisconsin, USA (1993)

In Milwaukee (1993) a disease outbreak occurred due to the drinking water supply contaminated with C*ryptosporidium*. The incident was preceded by – the introduction of a new regulatory rule that required a coagulant chemical change from alum to Polyaluminium Chloride (PACl) and immediately prior to the incident the source water was influenced by heavy rainfall and spring snow melt. What human errors contributed to an estimated 403,000 cases of cryptosporidiosis?

The new regulatory rule introduced frontline operator inexperience. The frontline operators were very experienced using alum to optimise the water treatment plant during challenging conditions. However, with slightly over six months experience using the PACl coagulant the operators were left without the right level of knowledge, skills or experience to optimise the water treatment plant when challenged by a source water quality change. As a result, active human errors occurred, and the frontline operators failed to optimise the coagulation process. This led to poor filter performance and an elevated turbidity in the treated water.

Due to the heavy rainfall and snow melt the source water at the time was contaminated with *Cryptosporidium* from catchment sources. The poor water treatment plant performance allowed the passage of *Cryptosporidium* through to the drinking water supply.

What competency deficiencies existed?

1) The new regulatory rule introduced a latent error in to the system. The inexperience using PACl coagulant did not result in immediate consequences. However, when it was aligned with the source water quality change this inexperience lead to active human errors - failure to apply the correct PACl dose for optimal *Cryptosporidium* removal across the filters. Process optimisation and troubleshooting competencies in this case were deficient – *asset capacity and operational performance*.
2) The source water quality change did not alert frontline operators to an elevated pathogen risk. Competency deficiency to identify a water quality hazard risk profile change existed – *know-your-system risk-based thinking*. This may have been influenced by the view expressed by the City's Health Commissioner at the time "Hey the water's always been fine". This is evidence of complacency toward water quality safety and therefore was not critically questioned – *operational culture present*.

Ultimately, the frontline operators involved in the Milwaukee incident made the decision to revert back to alum dosing to bring the process back under control. They went back to what they knew how to do best – where competency was assured.

Nokia, Finland (2007)

In Nokia, Finland (2007) a disease outbreak occurred due to the drinking water supply contaminated with numerous microbial pathogens. This incident was preceded by – the inability to start the water treatment plant automatically and led to the decision to draw water from an alternative supply system; plus, a deviation from a routine maintenance procedure at the local wastewater treatment plant.

What human errors contributed to the two recorded fatalities and the 6,500 reported cases of gastrointestinal illnesses?

When the drinking water quality customer complaints began, after the alternative water supply system was put into service, the operations team at the water treatment plant immediately assumed that this change was the cause. The operations team immediately began flushing the drinking water supply system. They continued with this action despite no improvement to the water quality and that the customer complaints coming from the other end of the distribution system. Other sources of contamination were not considered until 48 hours after the first complaint was received. It was at this point emergency management action commenced with the issuing of a boiled water alert.

On the same day as the alternative water system was put into service by the water treatment operation team, a maintenance procedural deviation occurred at the local wastewater treatment plant. It was a routine maintenance practice at the wastewater treatment plant to use the treated effluent (non-disinfected effluent) as a source of washdown water. On this particular day the non-disinfected treated effluent was not available. The person completing the task made the decision to open the valve to access the drinking water supply system to finish the task. This action created a cross connection between the non-disinfected treated effluent at the wastewater treatment plant and the drinking water supply system. The person then forgot to close the valve, and this allowed non-disinfected treated effluent to back flow into the drinking water supply system. The valve remained open for approximately 48 hours.

What competency deficiencies existed?

1) The water treatment plant operators erroneously attributed the customer complaints to the alternative water source change and continued to do so despite the complaints from the other end of the distribution (active human errors). The lack of knowledge and ability to broadly analyse the water supply system for other possible customer complaint sources and also understanding the system hydraulics were competency deficiencies – *know-your-system risk-based thinking*.
2) Continuing to flush the system despite no improvement (active human error) is an indication of a competency deficiency to critically review the effectiveness (or ineffectiveness) of the operational response implemented– *operational response and emergency management*.
3) The decision at the wastewater treatment plant to deviate from the routine maintenance practice caused an active human error that led to the contamination event. This may have been due to a lack of understanding regarding the importance of following maintenance procedures or an omission to obtain authorisation for a deviation. It may also have been due to a failure to understand the water supply system and the water quality safety risk introduced when a change is made to an asset. These competency deficiencies fall in the operational principles categories of – *asset capability and operational performance*; *know-your-system risk-based thinking*.

North Hampton, UK, (2008)

In North Hampton, UK (2008) a disease outbreak occurred due to the drinking water supply contaminated with *Cryptosporidium*. This incident was preceded by – the early adoption of a regulatory rule for *Cryptosporidium* monitoring, at the time, this was beyond the utility's compliance obligations. What frontline operator competencies aided in the management of this water quality safety incident?

The early adoption of the regulatory rule was instrumental in the detection of this contamination event. However, equally important was the translation of the regulatory rule into functional operational practices with clear frontline operator competencies. This was evident by the immediate and rapid action taken in response to the detection of *Cryptosporidium* in the treated water sample. This response was taken despite the operational team having no definitive evidence of the contamination source. Historically, the raw water supply monitoring results at this site had recorded zero detections. Therefore, a treated water monitoring result positive for *Cryptosporidium* had the real potential to be dismissed as an anomaly. Fortunately, in this case the result was not dismissed, and action implemented to protect customers and the community.

Frontline operators displayed competency by:

- understanding the positive *Cryptosporidium* result obtained in the treated water sample presented a serious public health risk (even though it was an unexpected result).
- immediate action was taken to confirm the initial detection results.
- the monitoring results were immediately communicated and escalated for further action to senior management in an appropriate and timely manner.

While, this incident still resulted in significant customer and community disruption and a major financial burden, there were no reported fatalities. The competency displayed by the frontline operators ensured an appropriate operational response was taken to the *Cryptosporidium* detection and the required emergency management actions were not delayed. Boil water alerts were issued, and the community was notified. The utility actively sourced and installed a UV unit to restore treatment capability while the incident was investigated.

The *operational culture present* was proactive and responsive to public health risk; appropriate *regulatory and compliance understanding* was embedded within the operational team; *understanding the asset capability and operational performance* required to control *Cryptosporidium* was also evident and the importance of restoring treatment capability through UV disinfection; *know-your-system risk-based thinking* competency was broad and considered other sources of contamination in this case a rabbit was found dead inside a process unit; *operational response and emergency management* was appropriate and rapid.

2.3 Importance of Demonstrable Competency

Demonstratable competency is the ability to show or prove the right level of knowledge, skill and experience required to exercise good judgement for sound and informed decision making. The examples given demonstrate competency is too often tested during periods of uncertainty. It highlights the importance for organisations to meet their training and competency requirements / obligations e.g. ADWG, AGWR, State or Territory legislation via evidence of demonstrable frontline operator competency. In doing so competency deficiencies can be identified before faced with uncertainty and provides assurance good judgement can be applied to decision making. A key risk mitigation strategy to reduce the likelihood of human error contributing to the vulnerability of a water supply system to failure.

Evidence of demonstrable competency

National certification framework

The National Water Industry Certification Framework (National Certification Framework (NCF)) is the industry driven professional credential system available to Australian water industry operators.

A certified operator is recognised as having the knowledge, skills and experience to work within a water supply system. Maintaining certification status provides an operator with a framework to ensure knowledge, skills and experience are retained and advanced through continual professional development (CPD). The NCF provides an organisation with the evidence of basic demonstrable competency that is aligned to the workplace water quality risks managed.

Alternative approach

It is currently a voluntary initiative for an organisation to provide frontline operator training and competency via the NCF. As a consequence, the vast majority of organisations choose to implement their own internal policies and procedures related to frontline operator training and competency. The research conducted by the Value of Operator Competency project highlighted the importance of competency consistency across the industry. While organisations appear to be undertaking an array of frontline operator training and competency initiatives, it is clear there is difficulty translating this into or assuring this is evidence of basic demonstrable competency. Therefore, lacking the same level of competency assurance provided by the NCF. To assist organisations to achieve demonstrable competency the Water Industry Operators Association (WIOA) initiated the Technical Competency Project. This project aims to develop guidance material on technical competency for the water industry. A Technical Competency Handbook along with a series of documented industry case studies will be released during the first half of 2019.

3.0 CONCLUSION

Frontline operators require a diversity of competencies to fulfil the responsibilities of providing safe drinking water and treatment of wastewater and recycled water. Competency deficiencies that lead to human error may not always be obvious. Therefore, organisation should be encouraged to adopt an approach to frontline operator training and competency that assures evidence of basic demonstratable competency. This is a key risk mitigation strategy to manage both active and latent human error risks.

4.0 ACKNOWLEDGEMENTS

Thank you to WaterRA for the opportunity to undertake the Value of Operator competency project and to the member stakeholders – Coliban Water, SAWater, Seqwater, Veolia, the Victorian Department of Health and Human Services and WIOA – for project input and financial support.

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VALLA BEACH PUMP STATION ODOUR CONTROL

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13th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Orange PCYC,
3 & 4 April, 2019

VALLA BEACH PUMP STATION ODOUR CONTROL

Richard Spain, *Manager Water and Sewerage,* Nambucca Shire Council

ABSTRACT

Council has experienced ongoing odour complaints from a pump station at Valla Beach for a number of years. Different options have been tried such as carbon filters and bio- oxygen to eliminate the odour with varied levels of success.

This report discusses the use of a product supplied by Calix called ACTI-Mag (high surface area Magnesium Hydroxide slurry), which has been dosed into the sewerage system to control the odour issue.

The odour problem is accentuated due to the pump station's close proximity to established houses. Once the odour has been detected, it always seems to be on the residents' minds, and it becomes a continual source of complaint which is difficult to address.

Three pump stations discharge to the catchment of the problem pump station and the detention times must contribute to the odour problem.

1.0 INTRODUCTION

Council has had an ongoing issue involving odour complaints from a pump station in Valla Beach over a number of years. The problem came to a head prior to Christmas 2017, when residents near a rising main vent pipe downstream of the pump station also started complaining of the odour.

The pump station, Valla Beach Pump Station 1 (VB PS1) is very close to residential development, including a bed and breakfast establishment that is particularly sensitive to any odour.

Council has logged hydrogen sulphide gas levels at the pump station site, which shows that the concentration of that gas can reach 20 parts per million.

The odour problems are considered to be generated by long detention times for the sewage in upstream pump stations. It is likely that the problem has been exacerbated by the connection of a pressure sewerage system that discharges to an upstream pump station, Valla Beach Pump station 9 (VB PS9).

The pressure sewerage system services a rural residential subdivision that is located a few kilometres north of Valla Beach. Detention time in the sewerage rising main is significant and the sewage is virtually septic when it discharges to the pump station at Valla Beach.

Council has previously tried various methods to control the odour, including carbon filters and a bio-oxygen system. These options have had mixed success and did not provide a consistent result. Operational issues also led Council to look for alternative options.

Calix initially approached Council regarding its manhole and pump station coating product, which increases the alkalinity of the concrete surface, creating an environment that prevents the formation of the hydrogen sulphide gas, which is the cause of concrete deterioration.

Council was more concerned about the odour issue it was encountering and Calix advised that it had a product that would eliminate the odour. ACTI- Mag is a concentrated magnesium hydroxide slurry that raises the alkalinity of the environment into which it is dosed. When the pH is raised above eight, it prevents the formation of the hydrogen sulphide gas that is the cause of the odour.

Council liked the idea of a solution that prevented the formation of the odour-causing gases rather than trying to remove and treat the gas that has already formed. As a result, Council arranged a trial for the ACTI-Mag dosing.

Figure 1: ***Valla Beach Sewerage Layout showing PS 9 where ACTI- Mag was dosed and PS 1 where the odour problem was occurring***

2.0 DISCUSSION

It was determined that the most effective place for dosing the ACTI-Mag into the sewerage system would be at VB PS9 where the pressure sewerage system discharges. This would give the ACTI-Mag time to react with the initial septic sewage prior to being discharged to the pump station where the odour complaints emanate from.

Calix delivered and set up a portable tool-box dosing unit to VB PS9 for the dosing trial. The unit consisted of a 400-litre capacity bladder to contain the ACTI-Mag, a dosing pump and a pump cabinet all housed within a galvanised sheet metal box.

A photo of the dosing unit is shown below.

Figure 2: ***Toolbox dosing unit being installed at PS 9***

2.1 Dosing Rate and Timing

The dosing rate was set up to cater for the total volume of sewage that passes through VB PS1.

The recommended dosing rate was 100 kg of ACTI-Mag per ML of sewage. ACTI-Mag has a specific gravity of 1.5 which equates to a dosing rate of 67 litres per ML.

2.2 Results

The dosing of ACTI-Mag resulted in a significant reduction in both the concentration and frequency of hydrogen sulphide gas generation in VB PS1.

A gas detection logger was placed in the wet well of VB PS1 for two weeks to cover a one-week period before and after the dosing. Unfortunately, the logger was not properly set up and it failed to record.

However, Council had previous records of typical gas concentrations from previous logging and the logger was placed back into the wet well while dosing continued from the first week of the trial.

Logger charts of the typical gas concentrations without dosing and during a period of dosing are shown in Figure 3 and Figure 4 respectively below.

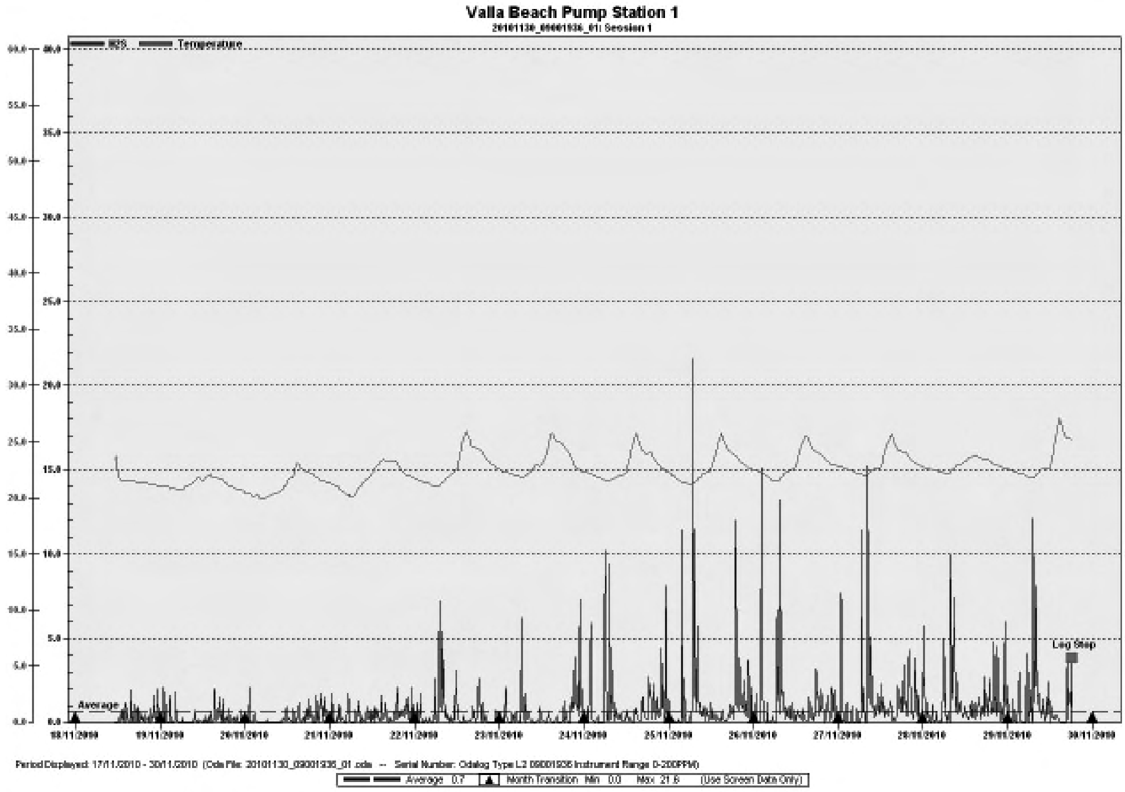

Figure 3: *Typical odour logging data prior to ACT-Mag dosing (Scale: 0 to 40 ppm)*

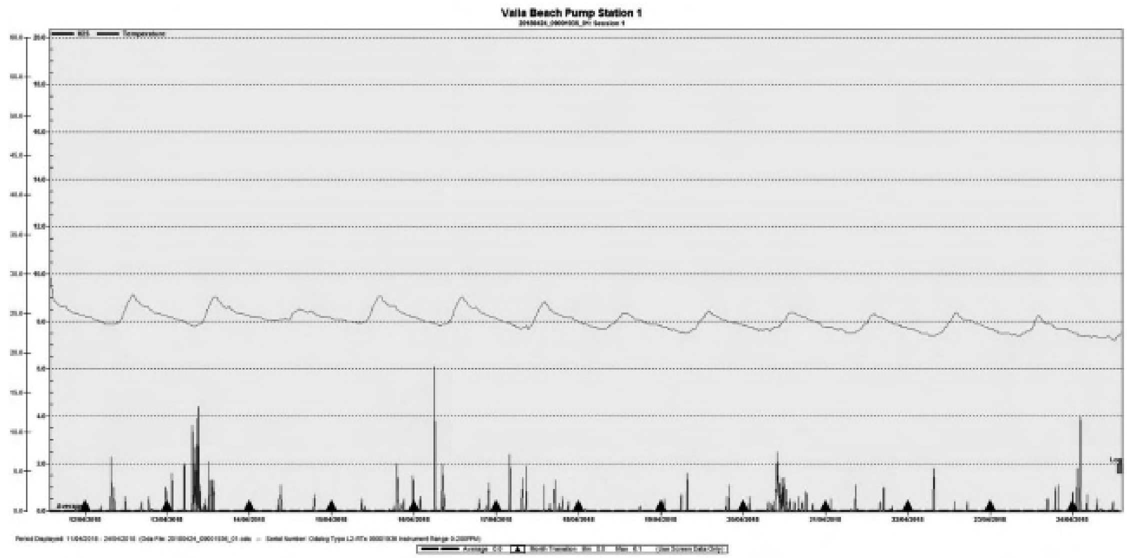

Figure 4: *Odour logging data during a week of ACT-Mag dosing (scale: 0 to 20 ppm)*

The charts indicate that the ACTI-Mag dosing significantly reduced the concentration of hydrogen sulphide gas and the frequency of gas detection.

Maximum concentrations without dosing reached 21.6 ppm and consistently reached concentrations in excess of 10 ppm daily. Gas was consistently detected even when it was at concentrations less than two ppm.

The maximum concentration with dosing was 6.1 ppm with only two readings exceeding four ppm. Most readings were less than two ppm and there were extensive periods of time when no hydrogen sulphide gas was detected at all.

These results provide compelling evidence that ACTI-Mag dosing is an effective means of significantly reducing the odour that can occur at a problem pump station.

2.3 Added Benefits

Dosing with ACTI-Mag presents no occupational health and safety or environmental issues. The product is non-toxic, not harmful to humans or animals, and can be handled and worked with using only standard personal protective equipment (PPE). These are major factors that Council considers when considering the use of dosing chemicals.

ACT-Mag raises the pH of the incoming sewage, preventing an alkaline environment and thus preventing the formation of hydrogen sulphide gas. This methodology prevents the gas problem from occurring rather than trying to deal with the gas itself. The higher alkalinity of the sewage is also beneficial for sewerage treatment and does not cause corrosion in the pipes and pump stations through which it is conveyed.

Council operators also observed that the downstream pump station, VB PS1, was noticeably cleaner once dosing had commenced, and was free of fat and scum build-up, making it much easier to maintain.

3.0 CONCLUSION

Council was satisfied that the trial dosing of ACTI-Mag was successful, resulting in a significant reduction in both the concentration and frequency of detection of hydrogen sulphide gas in VB PS1.

As a result, Council has purchased the tool-box dosing kit and continued dosing after the trial period. Council is now taking steps to construct a more permanent dosing arrangement on site.

The odour complaints have ceased, and the only complaint received was during a period when dosing was not occurring. This was because Council ran out of the chemical due to a delay in placing an order for additional product.

Council believes that ACTI-Mag is well worth considering as a solution to deal with odour problems in any sewer network.

4.0 ACKNOWLEDGEMENTS

I would like to than the members of Council's pump station crew for their diligence in setting up and operating the dosing system during the trial and since that time.

ALGAE CONTROL IN POTABLE WATER DAMS AND OTHER AQUATIC SYSTEMS

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13th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Orange PCYC,
3 & 4 April, 2019

ALGAE CONTROL IN POTABLE WATER DAMS AND OTHER AQUATIC SYSTEMS

Murray Jones, *Business Develop Manager*, Aquapac

ABSTRACT

Earth Science Laboratories (ESL) is an innovative technology development company in the USA that has developed products for the drinking water, agricultural and swimming pool industries. Aquapac is a water treatment specialist company based in Australia and has become the sole distributor for the ESL product range in Australia.

1.0 INTRODUCTION

EarthTec® is a copper-based algaecide/bactericide that has a record of 20+ years of safe and effective use throughout the U.S. for treatment of potable water reservoirs, lakes, pipelines, canals, aqueducts, and even within water treatment plants, where it prevents algae and improves the drinking water treatment process. Some water utilities use EarthTec to eliminate geosmin and other compounds that cause taste and odour problems in drinking water.

EarthTec is NSF-approved for drinking water and is most often applied in lakes, reservoirs and at the intake of water treatment plants.

EarthTec employs a unique formulation of copper to keep it entirely in the cupric ion form, Cu^{++} – the most biologically active form of copper – and therefore works at a significantly lower copper dose than conventional copper sulfate or chelated copper products. There is virtually no waste or loss to precipitation or settling, and for that reason EarthTec is arguably the most environmentally safe and responsible way to apply copper for pest control.

Given that EarthTec is certified for use in drinking water, for many locations and utilities it is the only practical and economical choice available.

Advantages of EarthTec:

- It is a liquid formulation and is self-dispersing, thus greatly improving efficacy and reducing time and labour for application.
- The copper is formulated in the biologically-active form (as cupric ion, Cu2+), and stays in solution until it encounters a cell wall to bind to and penetrate, so virtually 100% of the copper applied is effective, with no waste or copper precipitating into bottom sediments.
- EarthTec is NSF-approved for drinking water, reservoirs, lakes, irrigation canals, and even for swimming pools & spas (under another name and label). It's also approved for raw water intakes or sedimentation basins within water treatment plants.
- Reduces odour, taste and precursors of disinfection by-products including THMs and HAAs.
- Long history of effective use with no negative impacts on fish and other non-targets.
- EarthTec provides effective control of algae and biofilm.

Because EarthTec is formulated as Cu^{2+} ions, after applying to an aquatic system it rapidly disperses throughout the water column and begins inhibiting the target pests. These cupric ions remain in solution even after being applied to the treated water rather than precipitating to the sediment, and that enables the product to be effective at unprecedentedly low doses, in the range of 30-240 ug/L as copper (equivalent to 0.5 to 4 ppm as product). Consequently, EarthTec is the most environmentally sound way to use copper for pest control.

In the USA Waters treated with EarthTec have no restrictions regarding immediate use for recreation, agriculture, drinking water plants, and aquaculture farms.

2.0 DISCUSSION

EarthTec has been used by more than 200 water utilities to stop or prevent algal and/or cyanobacterial blooms. Although other algaecide products may contain copper sulfate pentahydrate as the active ingredient, EarthTec's novel formulation is NSF-certified to Standard 60 (approved as a drinking water additive) and readily mixes and rapidly disperses throughout the water body. Laboratory and field studies have demonstrated that EarthTec does not cause rapid lysis of algal cells and, as such, there is no immediate widespread release of algal/cyanobacterial toxins into the surrounding water.

EarthTec has been used to treat impoundments, reservoirs, pipelines, canals, aqueducts, raw water intakes and pumping stations for the control and prevention of algae/cyanobacteria. EarthTec forms no disinfection by-products (DBPs), making it an attractive alternative to chlorine for pre-treatment of drinking water. Treated water also yields reduced concentrations of total organic carbon (TOC). EarthTec has also been shown to reduce/eliminate taste and odour complaints by reducing concentrations of geosmin and related compounds. Other documented advantages include cost savings through reductions in the amount of activated carbon needed in water treatment plants, reduced ozone consumption, enhanced coagulation of inorganic and organic materials, and extended filter runs.

An important advantage of EarthTec is that significantly less copper is needed to control/eliminate problems resulting from algal and/or cyanobacterial blooms. For example, the City of Norwalk, Ohio has a reservoir that serves as source water for the city and was historically treated with copper sulfate to control algal/cyanobacterial bloom-related problems. After changing the treatment program to EarthTec, the total amount of copper applied annually was reduced by 80%.

Furthermore, the water plant operators found they could achieve appropriate control of problematic organisms with fewer treatments per year.

Herriman, Utah has a recreational lake called Blackridge Reservoir that had to be closed due to a toxic cyanobacterial bloom. The lake was treated with 4 ppm of EarthTec (240 ug/L as copper) and within 2 days it was reopened to the public. A maintenance program consisting of periodic follow-up doses of 2 ppm kept the reservoir open for recreation the rest of the season.

2.1 How do Bloom-causing Organisms Die and Not Cause a Significant Increase in Concentrations of Algal and Cyanobacterial Toxins?

Laboratory studies were conducted on cyanobacteria collected from a waterway in South Florida during a severe cyanobacterial bloom event in 2016. The primary goal was to determine if treating the water with EarthTec would result in lysis of cells as has been reported in the literature. Near the point of sample collection, the biomass at the surface was measured to be ~8” thick. Samples were collected in areas without a surface layer of biomass and microscopic observations of subsamples showed large numbers of cells of a *Micrococcus* sp. growing in floating colonies. These assays were typically carried out for up to 96 hr. The structural integrity of cells within the colonies was evaluated on the basis of “optical density” relative to the illuminating light beam.

Untreated controls showed some flattening and compression of the colonies, but the colonies maintained structural integrity (see fig. 1 and note differences in colony dimensions after 18 hr). Individual cells within the colonies remained intact and retained their original intracellular materials as indicated by shape and optical density of the cell biomass. In some studies, algae contained on a wet-mount slide remain viable and active for up to 7 days (data not included herein).

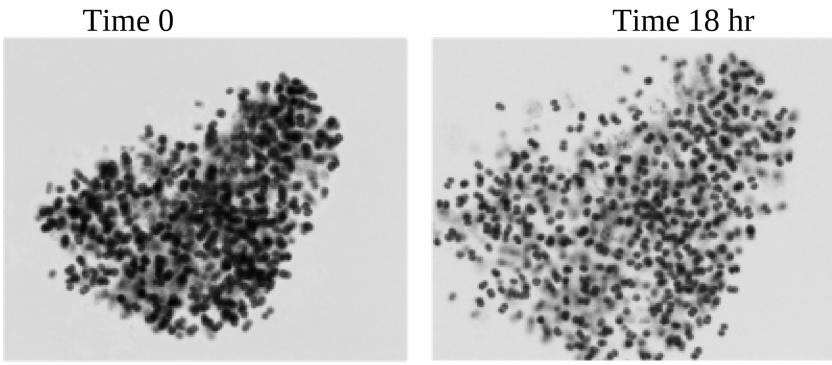

Figure 1: ***Untreated control Microcystis colony on a wet-mount slide (250X magnification)***

Cells treated with 120 ppb copper (applied as EarthTec) appear in Figure 2, where at T = 0 (left image), the 3-D shape of the *Microcystis* colony is apparent and all cells within the colony were optically dense, i.e., dark with chlorophyll. After 18 hr incubation at 24^{o} C, the colony had flattened and the cells were still within the colony matrix (right image), but it is noteworthy that while all cells within the colony were significantly less dense (loss of chlorophyll), they still retained their overall cell morphology, including integrity of the cell wall structure, etc.

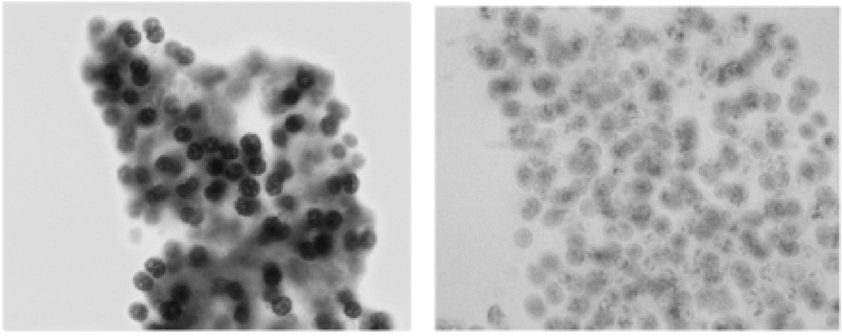

Figure 2: ***Comparison of colony and cell morphologies of Microcystis treated with 120 ppb Cu (supplied in EarthTec). Source water was treated for 1 hr before a subsample was transferred to a wet mount slide (400X magnification)***

Treated water samples were also assayed spectrophotometrically to compare absorbance spectra in the 200-350 nm range. The scans were performed to determine if leakage of organic materials could be detected in the water after centrifugation and removal of cells and particulate materials from the water. As illustrated in figure 3, there were dose-dependent increases in concentrations of general classes of organics that are known to have specific absorbance maxima, e.g., proteins, nucleic acids, etc.

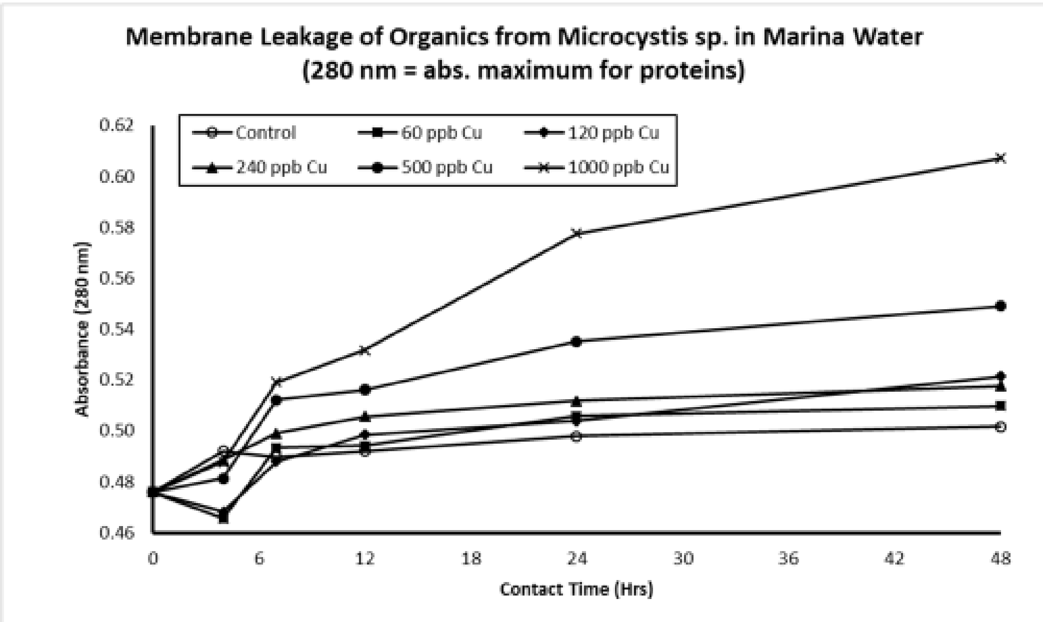

Figure 3: ***Dose-response of cells treated with selected concentrations of EarthTec***

2.2 Key Conclusions from this Observational Study:

- EarthTec does NOT cause immediate or extensive lysis of Microcystis cells when used at the recommended doses of 60 to 400 ug/L as copper.
- EarthTec treatment results in cells slowly leaking their cytoplasmic materials into the surrounding water, not a catastrophic rupture of the cell walls.
- Non-target microorganisms that consume leaked cytoplasmic materials are not inhibited -- this allows for a "mini-food web" to be established so that toxins, TOC, and DOC will be reduced via heterotrophic metabolic activity of the indigenous bacterial flora.

Treatment of Water for Taste and Odour Control

The main cause of earthy (musty) tasting water in a number of water treatment facilities in Australia Is production of geosmin by problematic species in the water and/or sediment. Activated carbon is traditionally used to remove geosmin and related compounds via absorption onto the carbon granules. ESL has had success in several locations with preventing formation of geosmin by applying EarthTec to the water source.

Municipal Water Treatment for Control of Algae

Citrus in California had a major issue with their drinking water storages. The treatment plant reservoir is connected to a "feeder" reservoir via a 16 km pipe (fig. 4). The systems were experiencing an algae bloom that was affecting taste and odour of the treated water.

__Figure 4:__ ***Photographs of the two pipeline-connected reservoirs used as the source of municipal water in Citrus, CA***

EarthTec was added to the lined water reservoir and, as illustrated below, numbers of problematic algae were reduced to an acceptable level within 48 hr. A qualitative index of the success of this treatment program was that the treatment plant was backwashing their filters at 2-hr intervals – after EarthTec was applied, the backwash interval increased to once every two weeks.

Little to No Adverse Effect of Fish or the Ecosystem

Results of field studies have demonstrated that, when used according to label directions, EarthTec provides safe, effective control of problematic species. Any impact on non-target species is quickly overcome as the treated system achieves homeostasis. After treatment, the concentration of Cu will usually decrease to background levels within a few days. One key factor in the overall mode-of-action of EarthTec is that harmful algae/cyanobacteria are inhibited without causing cell lysis. As a result, intracellular materials slowly leak out of treated cells and are subsequently metabolized by the indigenous heterotrophic bacterial community. This results in an increase in the size of the bacterial community with a concomitant decrease in total and dissolved carbon in the water column.

3.0 CONCLUSIONS

- Results of field and laboratory testing have demonstrated that, when used as per label directions, EarthTec provides cost effective control of problematic bloom-causing algae/cyanobacteria.
- Because of the unique method of production and formulation, the active ingredient in EarthTec products, Cu^{++} ions rapidly and evenly disperse in aquatic systems without the need for mixing or agitation.

- Control of problematic microorganisms and macroorganisms is achieved with low doses of Cu++ ions when applied as EarthTec products. In addition to durational control of harmful algal/cyanobacterial species, these products result in
- Reduced TOC (Total Organic Carbon)
- Reduced concentrations of undesirable taste and odour compounds, especially geosmin
- No production of DBPs, THMs or HAA5's (regulatory issues)
- Reduction many types of bacteria, especially enteric bacteria such as E. coli.

4.0 ACKNOWLEDGEMENTS

Dr Fred Singleton: Earth Tech Laboratories
Dr David Hammond

BONNY HILLS WASTEWATER TREATMENT PLANT OPTIMISATION - THE JOURNEY TO DATE

Paper Presented by:

Michael Ducat

Authors:

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13th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
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BONNY HILLS WASTEWATER TREATMENT PLANT OPTIMISATION - THE JOURNEY TO DATE

Mick Ducat, *Bonny Hills Wastewater Treatment Plant Operator in Charge*, Port Macquarie-Hastings Council
Alan Butler, *Water & Sewer Process Engineer*, Port Macquarie-Hastings Council

ABSTRACT

Bonny Hills STP as it was called then (now Bonny Hills Wastewater Treatment Plant) was constructed in the mid 1980's and was a 9000 Equivalent Persons (EP) activated sludge pasveer sewerage treatment plant with sludge lagoons and detention ponds. The discharge went to seepage trench along the sand dune at adjacent to the treatment plant and the ocean. The treatment plant was built to service the Bonny Hills and Lake Cathie catchments.

In the mid 2000's Council identified that meet the growing population and future projections the plant would need to be upgraded as it could exceed it capacity by 2011. In 2009 the plant had its phase one (1) upgrade to a 12000EP plant with the future options to increase to an 18000EP plant. These upgrades would ensure improved discharge quality and regulatory compliance and the option to utilise the treated water for a number of reuse proposals into the future.

1.0 INTRODUCTION

Over several years, the treatment plant at Bonny Hills has undergone many phased upgrades to augment the plant to meet the needs of the community and to ensure that the quality of the water meets the limits of Councils EPA licence and the ongoing requirements for reuse into the future.

The key phases the ware covered in this paper are as follows:

- 2009 – Phase 1 upgrade
- 2010 - Construction of Councils Hastings Effluent Management Strategy (HEMS) pipeline
- 2016 – Onsite re-use upgrade
- 2017 - Aeration upgrade trials
- 2018 – Bioreactor 2 aeration upgrade, chemical dosing upgrade (Hypo), pasveer condition assessment, instrument upgrade
- 2019 – Recycled water system (off site) commissioning, control system optimisation to optimise MF duty rotations, process flow control and chemical dosing.

<u>Figure 1:</u> ***Current Bonny Hills WWTP***

2.0 DISCUSSION

To outline the various upgrades over a number of years covering the design considerations, challenges and successes.

2.1 Phase 1 Upgrade

The phase 1 upgrade scope was to include the following:

- Inlet works, balance tank, screens, flow measurement, grit removal and screening
- Anoxic tank and mixers
- Modification to existing pasveer channels
- Solids contact pit and A-recycle and Waste Activated Sludge (WAS) pumps
- Secondary clarifiers
- Return Activated Sludge (RAS) pumping station
- Equalisation tank
- Recycled water pumping station
- Chemical storage and dosing systems
- Two new sludge lagoons
- Re-lining of effluent ponds 1 and 2
- Foul water pumping station
- Power, instrument and control upgrades
- Membrane Filtration

Table 1: ***Summary of the design flows for the Lake Cathie / Bonny Hills WWTP***

	Stage 1	**Stage 2**
Design Capacity	9000 EP	12000 EP
Adopted Flow Loading	240 L/EP/day	240 L/EP/day
ADWF	2.16 ML/day	2.88 ML/day
PDWF (hourly average)	2 x ADWF	2 x ADWF
Peak Treatment Flow (Secondary)	99 L/s	99 L/s
Peak Treatment Flow (Clarifiers)	231 L/s	231 L/s
Peak Pumped Flow to the Inlet Works Balance Tank	517 L/s	517 L/s

Table 2: **90th Percentile Effluent Quality Targets Adopted for the Design of the *Lake Cathie / Bonny Hills WWTP***

	Units	**Value**
Biological Oxygen Demand (BOD)	mg/l	10
Non-Filterable Residue (NFR)	mg/l	10
Total Nitrogen (TN)	mg/l	10
Ammonia (NH3)	mg/l	1
Total Phosphorus (TP)	mg/l	2*
Oil & Grease (O&G)	mg/l	< 5
Total Dissolved Solids (TDS)	mg/l	600
Coliforms	cfu	< 10/100 ml
Faecal Coliforms	cfu	< 1/100 ml
pH	pH	6.5 – 8.0

*The design had to ensure a phosphorus reduction in dry weather flow down to 0.3 mg/l

The phase 1 project upgrades went ahead with the exception of the UV plant. The upgrade was a great success and delivered as expected.

2.2 Onsite Reuse Upgrade

In 2016 an upgrade to the existing onsite reuse system was commissioned. An 110000L tank and duty standby variable speed booster pump was installed and connected to the treated effluent/recycled water manifold. This was connected to the site process water distribution main to allow this water to be used for screen cleaning, grit removal and general site water service for wash down. This system replaced an obsolete system that was in use and causing plant reliability issues.

2.3 Aeration Trial

In 2017 we undertook a review of aeration upgrade option with a view to start a roll out replacement of the outdated and obsolete surface aerators. A number of options were considered from replacing with new surface aerators, jet aerators, diffused aerators and mixers, and aspirating aerators.

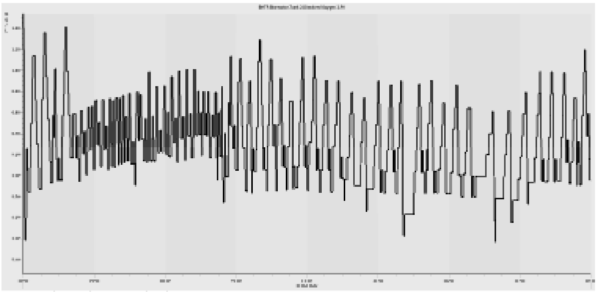
The key focus areas were efficiency, effectiveness whole life cost and suitability to be installed into an existing process. After an initial investigation a diffused aerator with mixer would be the most efficient and the return on investment over whole life costs would be favourable. However, the existing pasveers were too shallow to realise the benefits. The existing technology surface aerators had lower transfer efficiency of all the options, so we considered in detail the jet aerators and aspirating aerators. The oxygen transfer for both of these remaining options was comparable so it came down to cost.

To limit the risk to Council we purchased one new aerator to be controlled on a VSD to give us full control over its performance range. This unit was put through extensive testing to allow a thorough evaluation.

Figure 2: ***Bonny Hills WWTP Aerator Trial***

As can be seen in the trends (Figures 3 & 4) the new aerator has provided a number of improvements, the VSD is allowing the dissolved oxygen (DO) to be controlled to the actual set point and not over aerating.

2.4 Aeration Upgrade



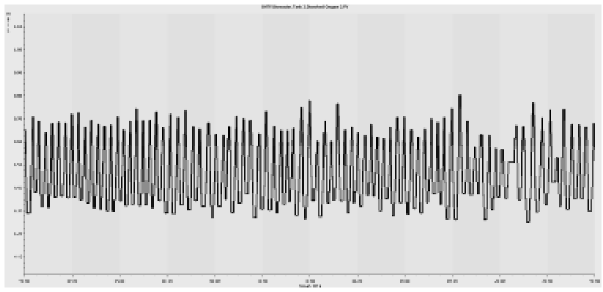


Figure 3: ***Aerator Trial 24hr trend With Surface aerators***

Figure 4: ***Aerator Trial 24hr trend with 1 aspirating aerators***

Also, now with the addition of three new aerators and improved process control we are seeing a much more stable DO.

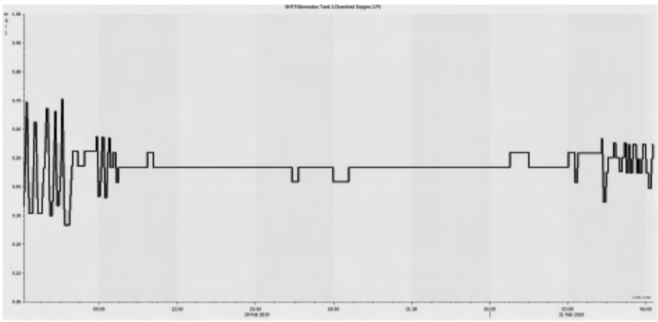


Figure 5: ***Aerator Trial 24hr trend with 4 aspirating aerators under trial control parameters***

2.5 Chemical Dosing Upgrade

In late 2018 a project was scoped to upgrade the current sodium hypochlorite dosing system. The existing system had been in service since the upgrade in 2009 and had a number of design issues from excessively long dosing lines (200m), flow meter measurement issues and pump air locking.

Figure 6: ***New chemical dosing skids***

The scope of works was to:

- Install two new self-contained dosing systems one for primary disinfection and the second for the soon to be commissioned dual reticulated recycled system.
- Utilise the existing bulk storage tank for the main storage and transfer to the dosing skids and dosing tank through dual contained chemical hose.
- Replace all current dosing pipework with dual contained chemical hose.

The skids are installed (Figure 6) and are able to run as a full duty standby rotation on either manual, auto flow paced or auto flow and residual trim control options.

2.6 Control System Optimisation

We are currently working on optimising the MF feed flow and MF duty rotation control systems. The original project in 2009 had some incredibly tight control limits for some of the control level parameters. Our Lamella Settler has a 5% band with for VSD pump control resulting in a flow variation of 10L/s every 60 seconds. We are opening up the 5% band on the Lamella and also increasing the control span on the Equalisation Tank to allow the MF plant to run for longer at a more constant flow rate. The biggest issue this creates is for chemical dosing control for primary disinfection. Dosing into a flow that is so variable is not conducive for accurate process control. Calming this flow rate change down will in turn enable to chlorine residual to be more consistent.

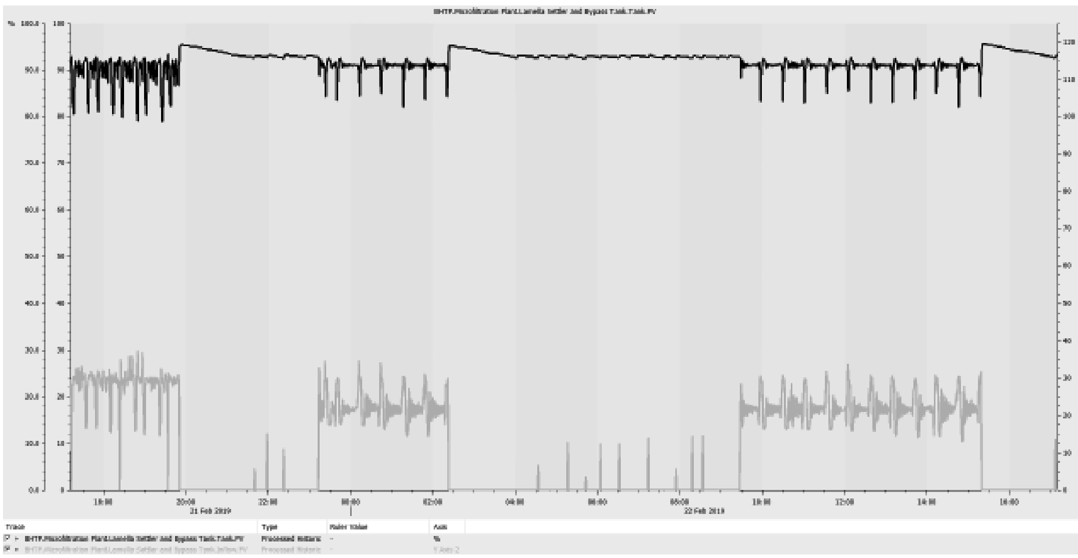


Figure 8: ***SCADA Trend for tank level and flow control***

3.0 CONCLUSION

When you look at all the projects delivered you can conclude that no matter if the project is a large scale infrastructure upgrade or smaller directly delivered projects the outcomes can be the same. Improved process reliability and value for money for the community. With correct planning, prioritisation and design your project outcomes will be value adding. Remember to also think outside the box as doing the same old is not always the best solution.

4.0 ACKNOWLEDGEMENTS

I would like to thank Port Macquarie-Hastings Council and my management team for the opportunity to optimise my treatment plant.

ABCD COMPACT MODULAR OUTDOOR ARC-FLASH CONTAINMENT SWITCHBOARD

Paper Presented by:

Peter Taylor

Authors:

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Allan Morton, *CEO & Chairman,*

P.T. Automation Solutions

13th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
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ABCD COMPACT MODULAR OUTDOOR ARC-FLASH CONTAINMENT SWITCHBOARD

Peter Taylor, *Managing Director & Founder,* P.T. Automation Solutions
Allan Morton, *CEO & Chairman,* P.T. Automation Solutions

PTAS's ABCD (Arc-Blast Containment and Diffusion technology) is a unique invention that enables a compact outdoor switchboard to be capable of containing the catastrophic outcomes of an electrical arc-flash explosion. Such explosions are not common but hospitalise 39* electrical operators and electricians each year with significant 3rd degree burns. Fatalities do occur.

It's the first NATA tested and certified, fully designed, developed product manufactured in Australia. The project was motivated by the adoption of AS61439.1 in May-16 and Sep-17 QLD 'industrial manslaughter' laws.

Technical developments for indoor boards have provided a range of engineering solutions. However severe accidents still occur regularly. Outdoor switchboards had been considered too-hard to reengineer because of their weather-proofing requirement.

The ABCD board adopts fundamentally different approach to arc-flash risk mitigation in outdoor switchboards. PTAS applied mechanical / structural design to reengineer the risk, a highly desirable and very cost-effective strategy. Service life reliability, durability of structure and ease of use were high priority design considerations to reduce lifetime cost.

Capital cost premium is typically 3%. On top of the significant safety benefits, there's rapid operational payback as operators no longer need to wear cumbersome unproductive PPE, nor be licensed electrical staff, nor establish large exclusion zones.

1.0 INTRODUCTION

Significant Impact of Unpredictable Arc Fault Explosions

The result of an arc fault is a massive electrical explosion with unpredictable characteristics. The total incident energy is likened to several of sticks of dynamite.

An arc fault results from either a phase-to-ground or a phase-to-phase fault caused by occurrences such as;

- Unsafe Operation Procedures: accidental contact with electrical systems, dropped tools, and improper work procedures.
- Protection Equipment Failure: Incorrect components and malfunctions.
- Environmental Deterioration: build-up of conductive dust, ingress of snakes, corrosion, aging or poorly maintained equipment
- External Supply Changes: Upstream protection devices and upsized transformers.

Arc-fault incidents generate two dangerous components. Initially the blinding UV and IR light and heat generated by the explosion is the 'arc-flash', where the temperature can reach 22,000°C. This releases hot plasma toxic gases and concentrated radiant energy which melts metal and cause severe radiation burns, damage eyesight, and can result in fatalities.

The ‘arc-blast’ follows as accompanying 165dB pressure waves that can damage hearing and/or brain function. High pressure gas readily blows the doors off switchboards, and sends loosened equipment, machinery and shrapnel debris flying at supersonic speed to cause further injuries to people nearby and more damage to equipment.

Arc Flash Injuries Are Not Insignificant

While arc flash incidents occur less often than other electrical accidents, they represent about 50% of all electrical injury costs.

In November 2018, Workplace Health and Safety Queensland (1) published that since 2013 there have been 32 reported incidents involving an arc flash. Of these, 20 resulted in injuries requiring hospitalisation. It’s generally known many incidents remain unreported, being treated as outpatients.

NSW reported that between 2005 and 2015 (2), that there were on average 11.6 people burned working on or near electrical apparatus each year from arc faults. 81 of the 129 reported incidents for the period involved switchboards. Burns to the head/face area was the second most common burn site, involved in 57% of injuries.

A report published in Industrial Safety and Hygiene News(3) estimated that, on average, there are 30,000 arc flash incidents in the USA every year. The report went on to estimate that those incidents resulted in average annual totals of 7,000 burn injuries, 2,000 hospitalizations, and 400 fatalities per year.

Beyond the initial and direct cost of the incident, which for example may be $100,000, organisations also become exposed to operating losses, reputational loss, future litigation, and ongoing disability claims that can elevate the incident cost towards $1M per incident.

Second Degree Burns Should Not Be the “OK” Standard(4)

The accepted ‘Standards’ used for arc-fault design calculations are probably too low.

The level for acceptable risk is currently defined by ‘survivable 2nd degree burns’; or arc-fault incident energy exposure level, of 1.2 cal/cm^2, which defines the safe boundary where one only gets 2nd degree burns.

A second degree burn causes damage deeper than the top layer of skin. It still represents intense pain and significant suffering from blisters and swelling. Despite the mental health impact of a near miss incident, 2nd degree burns are physically survivable injuries.

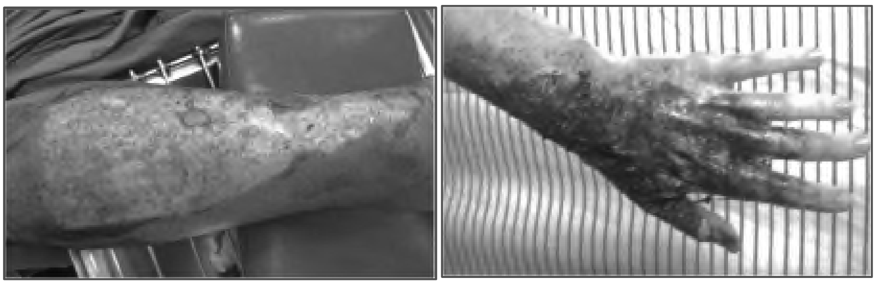

Figure 1: ***Second degree arc-flash burns***

Research indicates that indicated a 330% higher incident energy level is likely in typical switchboard configurations with vertical pathways. This suggests that designers should adopt conservative assumptions.

New Switchboard Standards Introduced; AS61439.1
In May 2016 a new (higher) standard of design safety and testing requirement was adopted in Australia. A change period until 2021 allows the cheaper / older / less safe switchboards to continue to be supplied into the market. Given switchboards have a 25-30 year life, making the change early provides long-term benefits to operating personnel and public.

Changing Safe Work and Health Legislation
Directors and officers of organisations have a legal duty to eliminate and minimise risks as far as "reasonably practical"; meaning within the available knowledge of the hazard, means of reduction and their relative cost to implement. The increasing accountability of PCBUs is characterised by Queensland's 2017 'industrial manslaughter' legislation.

Managing Risk by Reengineering
Administrative controls and requirement to wearing of HRC rated PPE, including bulky 'bomb suits' is the common way organisations manage risk, which works best in large facilities with dedicated switch rooms. Outdoor switchboards are often overlooked as a safety risk to employees and the public, yet they are the most exposed to environmental deterioration, entry by rodents and snakes and the least safety management attention. The outdoor switchboard is designed to contain the arc-flash and blast energy of the explosion inside the switchboard. Modern risk mitigation thinking.

2.0 DISCUSSION

The PTAS R&D project set out to design, build, test & certify an outdoor – public space switchboard that would meet the new standards. To meet the wide range of design configurations and remain economic, an expandable modular design was required. Low total cost of ownership through improved operator productivity, durable materials and construction methods were design drivers.

2.1 Engineering design to deliver in-field safety

Engineering Control of Hazard Risk
Prior to the invention of the ABCD switchboard, safety of personnel relied on lower order PPE and Administrative hazard control measures. The goal was to redesign the switchboard to include Engineering controls. These higher-level controls are preferred as they reduce the need for unreliable controls and enable more productive work practices to be employed.

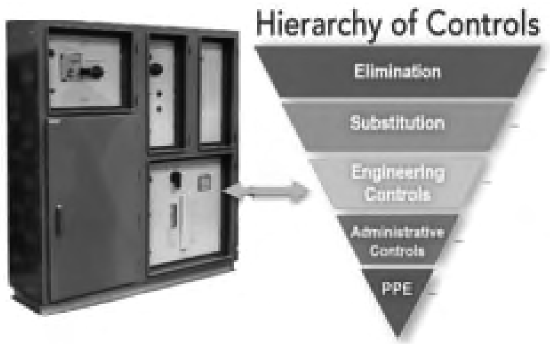

Figure 2: ***Engineering Controls eliminates arc-flash hazard with outer doors opened***

Arc Blast Containment and Energy Diffusion
Core of the ABCD technology is an internal device fitted between each section, which shields and attenuates the pressure waves and energy within the structure of the enclosure.

The design delivered a system that achieves Cat 0 with the outer doors open; at escutcheon level. This allows operators access to controls (for stop – start, meters) and the RTU section.

Modular Design Strategy

A modular design for the ABCD board was required because it's impossible to test every variant of outdoor switchboard employed by industry and public utilities. To date, four different sized modules, a wide range of functional escutcheons and two variants of exterior doors, have been certified. These represent 95% of all water industry outdoor applications.

Figure 3: ***Modular sections required to configure to suit a wide range of applications***

The test unit designs were built and fitted out with VSD and Soft Starter, Distribution section, MCCBs, external button controls, meter enclosures, RTU/PLC sections. This enables PTAS to build a huge variety of switchboards that easily scale up to incorporate combinations of these tested and certified modules.

Durable Construction Materials

PTAS built, tested and certified the design in two materials; marine grade aluminium and stainless steel. Tests proved our belief that these materials would perform differently; it is impossible to verify the effects of destructive energy release by calculation or even extrapolation from a single test. We proved what works.

2.2 Testing Validated Performance

Validation by Testing

While many switchboard characteristics can be verified by calculation or by extrapolation of an existing design, AS61439.1 requires that some important ones can only certified only by testing; like arc-flash containment.

Figure 4: ***Contrasting outcomes demonstrated in testing laboratories***

Tests proved the ABCD switchboard design can endure an arc-fault incident and be returned to service.

This involves;

- Protection against electric shock and integrity of protective circuits
- Strength of materials and parts
- Clearances & creepage distances
- Dielectric properties
- Mechanical operation.

Results Complied

- Verification and Certification by testing conducted at Lane Cove testing facility during March 2018, was for 20,000A for 0.3 sec duration, on both line and load side.
- Tested to the new AS/NZS 61439.1 standard and certified as an outdoor solution
- (Stainless Steel and Aluminium) with certification on arc fault containment (IEC/TR 61641:2014) and ingress protection. (IP56). A first for Australia.

Table 1: ***Results of NATA testing on ABCD modular test board***

	IEC/TR 61641:2014 – Protection of Personnel Criteria Requirements After Arc-flash Incident	**Test Result**
✓ **1**	Doors and covers remain closed	Complied
✓ **2**	Parts remain intact	Complied
✓ **3**	No holes formed in the accessible parts of the enclosure	Complied
✓ **4**	Vertical indication did not ignite (no external flash)	Complied
✓ **5**	Equipotential bonding arrangement of accessible parts remained effective	Complied
✓ **6**	No propagation of arc to other areas of the assembly	Complied
✓ **7**	Satisfied the dielectric test	Complied

2.3 Lowering Cost of Ownership and Improving Safety

Personnel less reliant on PPE for safety
By engineering out the risk, employers are less reliant on their outdoor staff to do the right thing and wear correct standard of PPE, especially at remote regional sites. The ABCD design approach of making the escutcheon the primary blast barrier increases the isolation of the arc-blast hazard from people working on or near a board.

Employee productivity
The opportunity to rethink outdoor IP56 & IP66 switchboard design enabled PTAS to add design features that makes it easier to work while increasing safety. Designing for easy access now makes it safe for maintenance and operating staff to work from the switchboard internal escutcheons, without shutdown nor requiring attendance of registered electricians. Systems can be safely kept on-line during maintenance. Less downtime.

Options Tested
A range of alternate doors and internal fittings have been tested to provide variations for different equipment or applications that require sunshields and ventilation cowlings. The ABCD modular design certification offers customers flexible configurations; units are being be built as double sided, three sided, and longer units for a wide range of equipment.

Figure 5: ***Three forms of ABCD modular outdoor board in production and installation***

Public safety assurance

Switchboards in high traffic public spaces, like parks, footpaths and shopping areas, offer a significantly lower hazard. Large (and expensive) exclusion zones required with old designs can be reduced, with less public disruption.

3.0 CONCLUSION

This *IP56 | ABCD arc fault containment modular compact outdoor switchboard development represents a major step forward in hazard reduction for water industry personnel and public. It also reduces the total cost of ownership for utilities by increasing productivity of operations, reduced cost of maintenance and safety.

These switchboards meet and exceed current switchboard standards, with higher safety levels and negligible capital cost premium. This technology allows directors and operators of utilities to better fulfil their obligations under increasingly arduous WH&S legislation.

Having proven that arc-fault containment in outdoor switchboards is achievable with commitment and thoughtful design, we believe that other water utility clients will recognise and specify to this new benchmark. Then other manufacturers will follow PTAS's lead.

4.0 ACKNOWLEDGEMENTS

The authors would like to thank Queensland Urban Utilities electrical and safety management staff for their critical encouragement of our development project. Also, Roland Barrett, PTAS Senior Engineering Project Manager and the team at PTAS who have embraced and supported the development with their ideas and commitment to safety innovations.

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NABIAC BOREFIELD CONSTRUCTION AND COMMISSION

Paper Presented by:

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Authors:

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MidCoast Council, Water Services

13th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Orange PCYC,
3 & 4 April, 2019

NABIAC BOREFIELD CONSTRUCTION AND COMMISSION

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Lindsay Walsh, *Senior Process Operator,* MidCoast Council, Water Services

ABSTRACT

The $34 million Nabiac Inland Dune Aquifer Water Supply System project is a long term goal of MidCoast Council Water Services and aims to provide the community with water security into the future.

It will provide an alternative to the Manning Water Supply Scheme, currently providing water to approximately 70,000 people in the Manning and Great Lakes areas of New South Wales.

1.0 INTRODUCTION

The Nabiac Inland Dune Aquifer is located within a generally flat, low-lying inland dune containing wetlands in the east and elevated dunes in the west. The aquifer is positioned some 6 km south east of Nabiac and approximately 4 km northwest of Tuncurry. It has a total catchment surface area extending over 44 km^2.

The Nabiac scheme will help to reduce the volume of water extracted from the Manning River, which will be subject to stricter environmental flow rules in the near future.

Figure 1: ***Nabiac WTP August 2018***

2.0 DISCUSSION

2.1 The Infrastructure

The Nabiac System is centred on the extraction of groundwater from the Nabiac Inland Dune Aquifer. The scheme includes the following major components:

- The Nabiac groundwater extraction borefield including 14 groundwater bores,
- The Nabiac Water Treatment Plant with capacity to treat up to 10 million litres of water per day, and

- The Darawank Reservoir and Pump Station .Over 16km of pipelines, electrical and telecommunication services will link these components to the existing Manning District Water Supply Scheme.

2.2 Funding

The total project cost is $34.6 million. The project has received $9,432,500 as part of the Federal Government’s National Stronger Regions Fund.

3.0 BOREFIELD HUT

3.1 Raw Water Aquifer

Recharge of the aquifer occurs by direct rainfall infiltration and storm water runoff from Bundacree Creek in the west of the catchment.

Based on a surface area of 44.7 km^2, the shallow aquifer contains about 22,000 ML, the indurated sand layer contains about 20,000 ML and the deep aquifer contains about 154,000 ML.

The preservation of groundwater-dependent ecosystems associated with the Nabiac aquifer will be achieved through the adoption of extraction limits determined by rainfall conditions in the previous 6 months.

Table 1: ***Stage 1 Extraction Limits***

Scenario	Rainfall Trigger	Extraction Limit & Response
Dry (Significant)	Monitoring bores less than 100 percentile values	Reduce below 6 ML/d for all production bores and increase monitoring to weekly
Dry	Rainfall < 400 mm in prior 6 month period	6 ML/d
Average	Rainfall between 400 mm and 600mm in prior 6 month period	8 ML/d
Wet	Rainfall >600 mm in prior 6 month period	10 ML/d

3.2 Raw Water Quantity

The maximum instantaneous supply available if all the stage 1 bores operate together at their design flow rate is 164 L/sec.

In the future, and following confirmation of the sustainable yield from the aquifer, the intention is to increase the capacity of the system through equipping additional bores which will take the maximum instantaneous supply up to ~300 L/sec.

3.3 Treated Water Quality

The plant is designed to produce a treated water that complies with the drinking water requirements specified below in Table 2.

Table 2: ***Water Quality Parameters***

Parameter	Units	95th percentile compliance limit	Absolute Limit
Particle Removal (particles > 3µm as a Pathogen surrogate)	Log removal via direct integrity test	4 log	
True Colour	HU	-	< 5
Hydrogen Sulphide	mg/L	< 0.02	< 0.05
Turbidity	NTU	< 0.1	< 0.3
pH	pH units	7.5 – 8.0	6.5 to 8.5
Calcium	mg CaCO3/L	30-50 mg/L	
Fluoride	mg/L	0.90 – 1.1	1.5
Langelier Index (LI)		-0.5 to -1.0	
Calcium Carbonate Precipitation Potential (CCPP)		-1 to -5	
Aluminium (total)	mg/L	0.3	
Iron (total)	mg/L	0.1	
Manganese (total)	mg/L	< 0.05	
THMs	mg/l	< 0.25	
Coliforms – Total	CFU / 100mL	<1	
Coliforms - Faecal	CFU / 100mL	<1	

Stage 1 of the Nabiac borefield consists of 14 extraction bores as set out in Figure 2. The bores in stage 1 are capable of producing 164 L/s in total.

3.4 Process Flow Summary

Raw water is supplied to the WTP from a network of bores. When the water enters the WTP site the water will be dosed with hydrated lime. The lime dosed raw water then travels to the top of a forced draft packed tower designed to remove greater than 90% of the free CO2.

The water from the packed tower will fall into the first compartment of a pre-treatment tank which allows time for oxidation of soluble metals, coagulation and flocculation as well as buffering the raw water flows.

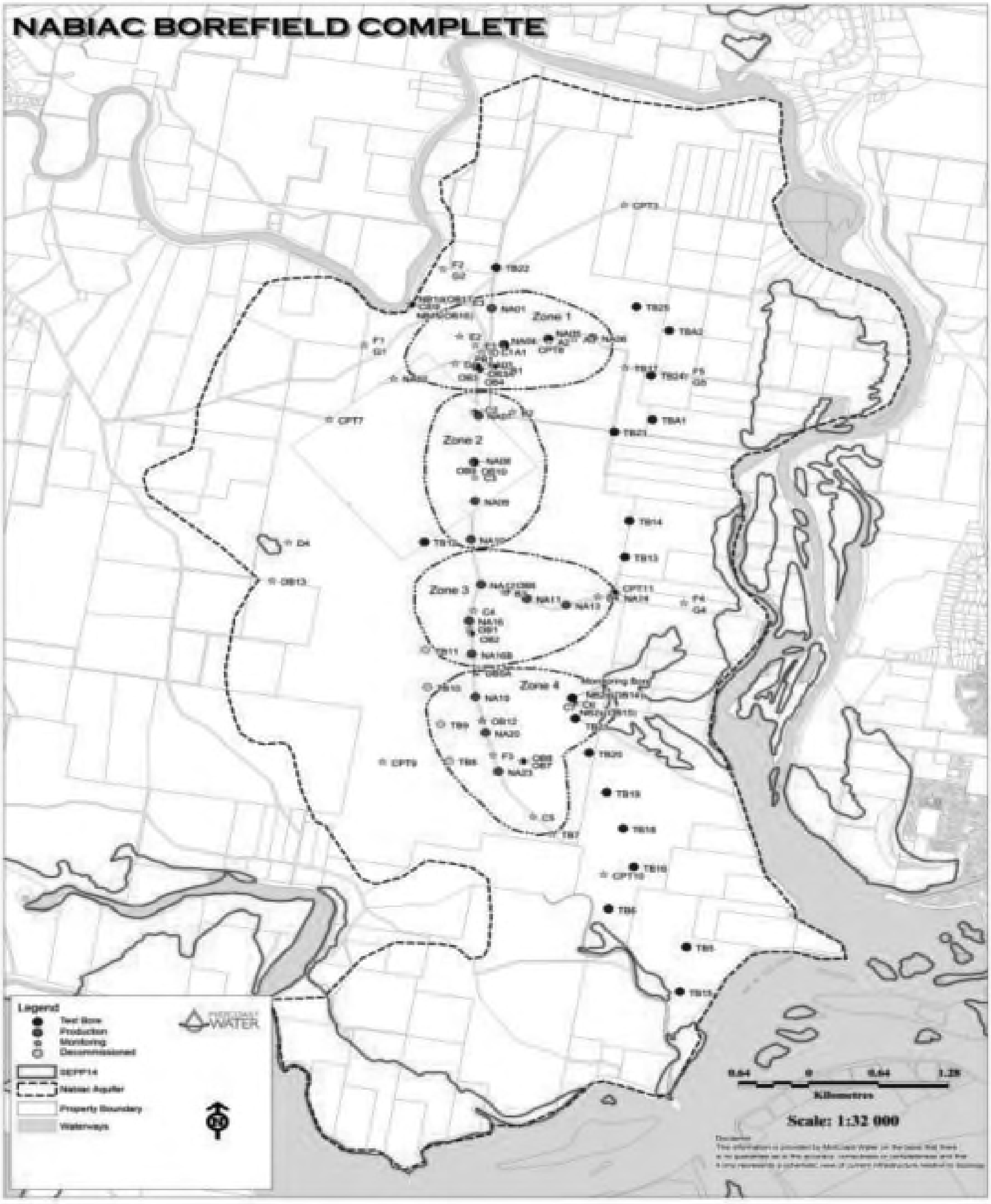


Figure 2: ***The Nabiac Bore Field***

The raw water in the pre-treatment tank will be drawn out by membrane feed pumps and pushed through self-backwashing auto strainers prior to membrane filtration.

The filtered water will be chlorinated and fluoridated with chlorine contact time being achieved through maintaining minimum volume of 1.14 ML in the treated water storage tank and a chlorine level of at least 1mg/L.

3.5 Treated Water Storage and Distribution

Water is stored in a single 7 ML (operating Volume) reservoir (TWST) with the intention that the WTP aims to keep the reservoir full so that transfers can be made as required at rates above that which the WTP operates to take advantage of off-peak power tariffs.

The water from Nabiac WTP is either pumped (Duty/Duty/Standby pump set), or flows by gravity (low rates only) to the Darawank Reservoir with a nominal storage of 2 ML.

4.0 DARAWANK RESERVOIR

Figure 3: ***The Darawank Reservoir***

4.1 Critical Control Points

Monitoring at CCP's is the most crucial for assuring drinking water safety. Monitoring at CCP's should occur frequently and should be alarmed when the value in question exceeds the target band (reaches the adjustment level) and when it reaches the critical limits.

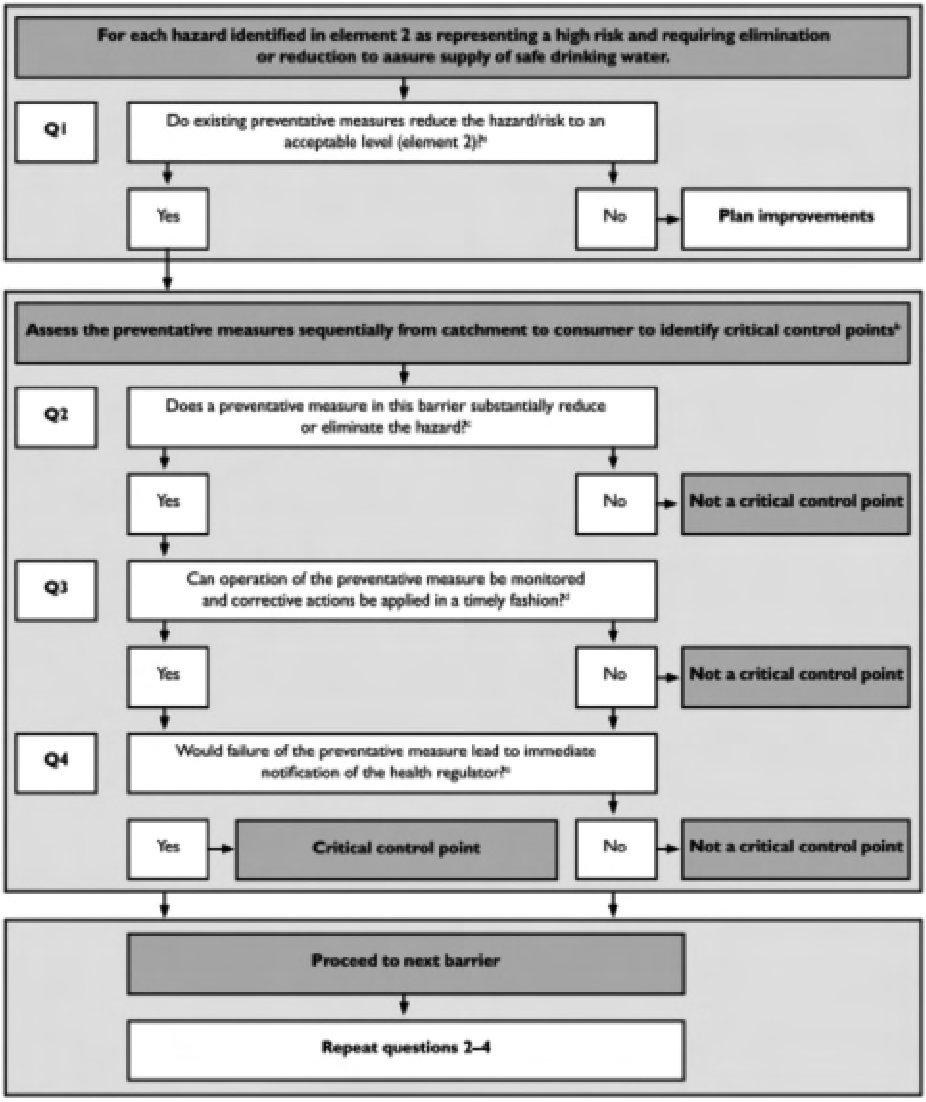


Figure 4: ***The Critical Control Point Decision Tree***

Where alarms exist a protocol for alarm response should be established including the actions required and the response time CCP's typical have a target value, an Adjustment level and a Critical Level, in a general sense these can be described as:

- ***Target*** is the aim of the process and is a way for the Operator to measure the performance of the control point.

- ***The Adjustment Level*** is set to indicate a possible process upset where some level of action is required to ensure that the process is brought back under control. The Adjustment level must be exceeded for a given time before the adjustment level is alarmed/operator notified. This is to avoid unnecessary alarms caused by instrumentation 'blips' and also to reflect the length of time that a process must be out of control prior to there being a real issue.

- ***The Critical level*** is the level at which the process is considered to have lost control and the quality of the water is impacted to the extent that the risk posed by the hazard being controlled at that point is no longer acceptable. The Critical level must be exceeded for a given time before the Critical level is alarmed/operator notified. This is to avoid unnecessary alarms caused by instrumentation 'blips' and also to reflect the length of time that a process must be out of control prior to there being a real issue.

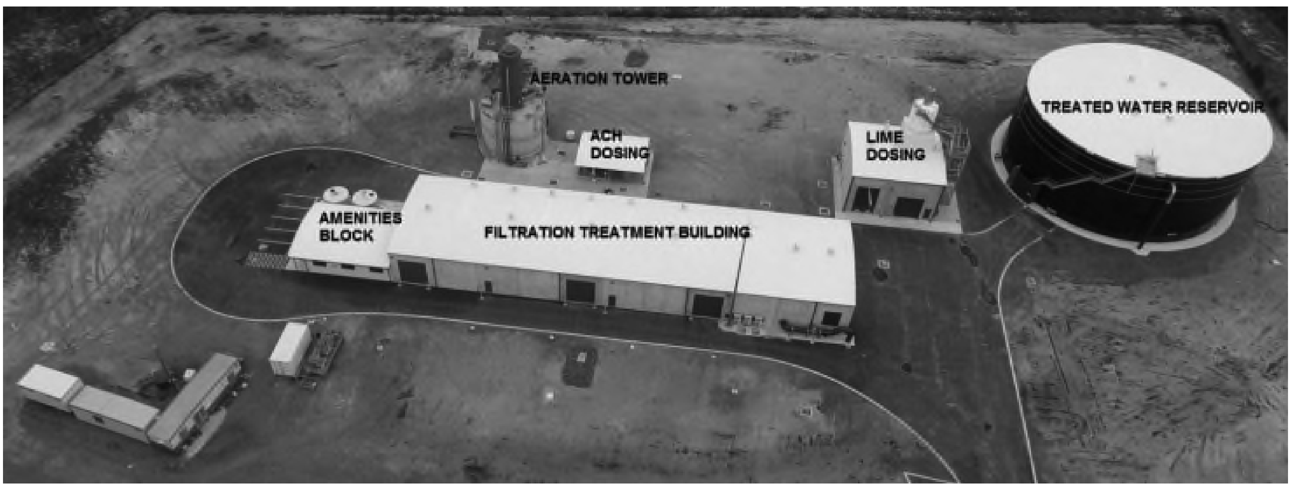
5.0 CONCLUSION

5.1 Benefits of the Nabiac inland dune aquifer project

- Alternative source of drinking water for our communities, sharing the risk between the Manning River and Nabiac Aquifer
- Increasing drought security and the ability to meet water supply service levels
- Less water restrictions for customers into the future
- Direct investment into local economies via critical civil infrastructure
- Platform for future expansion to meet growth of the region
- Securing environmental flows for the Manning River during dry times.

6.0 ACKNOWLEDGEMENTS

We would like to thank Josh McLenaghan, Craig Stone and MidCoast Council.



NSW FLUORIDE CODE OF PRACTICE REVIEW WORKSHOP

Workshop by:

Annalisa Contos
&
Josh Tickell

Authors:

Annalisa Contos,
Atom Consulting

Josh Tickell, *Senior Project Officer,*
NSW Health

13th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Orange PCYC,
3 & 4 April, 2019

FLUORIDE CODE OF PRACTICE REVIEW

After receiving a lot of feedback about what needs to be changed, NSW Health is updating the Fluoride Code of Practice.

Join Josh Tickell from NSW Health and Annalisa Contos from Atom Consulting in this interactive workshop to help NSW Health discuss the issues and develop the requirements for the new Code of Practice.

Your feedback will be directly used to help NSW Health develop the new Code.

EFFLUENT REUSE – BRINGING IT INTO THE 21ST CENTURY

Paper Presented by:

Belinda Green
&
Wes Trotter

Authors:

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Kempsey Shire Council

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EFFLUENT REUSE – BRINGING IT INTO THE 21ST CENTURY

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Wesley Trotter, *Manager Water and Sewer,* Kempsey Shire Council

ABSTRACT

This paper outlines the program that Kempsey Shire Council undertook to implement best practice management of some of its effluent reuse facilities and some of the interesting challenges we found along the way.

The legislation that governs how Council manages these facilities has varied over the past 20 years. Initially this guidance focused on environmental risks. In 2007, the *Australian Guidelines for Water Recycling* (AGWR 2006) were introduced with the guidance having an increased focus on managing public health risks. The AGWR is a risk-based framework, which introduces management practices that adopt a "fit for purpose" approach to managing the use of recycled water.

In an endeavour to manage the systems according to best practice, Council have developed Recycled Water Management Systems in accordance with the AGWR (2006) for each of the effluent reuse facilities. The activities that Council has undertaken during this development have included site audits, education workshops, water quality verification and implementing legal agreements for the supply of reclaim water.

The treatment technology for Kempsey's STP's is aging and results in varied reclaim water quality. Adopting management practices that have a greater focus on public health, in these reclaim water systems has met with some challenges. This paper provides details on the process that Council has undertaken to change its management practices and bring them in line with the current guidelines. It also outlines some of the challenges Council has faced in doing this and how Council has overcome these challenges.

1.0 INTRODUCTION

Kempsey Shire Council manages four sewage treatment plants that provide the effluent for reuse irrigation. The treatment technology for each of these treatment plants is varied from trickling filters and intermittent aeration systems combined with maturation lagoons, to sequence batch reactors combined with disinfection. The effluent water quality is varied for each system and is used for irrigation of three community golf courses, racetrack and private cattle grazing property. Effluent irrigation has been occurring for more than 20 years at each of these sites.

The legislation that governs how Council manages these facilities has varied over the past 20 years. Initially this was governed through EPA licence approvals and at some stage, Councils became the approval agency. At this time the guidance on how to manage the reuse was focused on environmental risks. In 2007, the *Australian Guidelines for Water Recycling (AGWR 2006)* were introduced and in NSW all new recycled water systems need to comply with these guidelines as part of their Section 60 approval. For an older system, unless the system has been altered enough to warrant Section 60 approval, there is no current requirement for renewing approval to operate and hence to comply with the AGWR.

In an endeavour to manage the systems according to best practice, Council have developed Recycled Water Management Systems for each of the effluent reuse facilities.

These have been developed in accordance with the AGWR (2006) which is a risk-based framework, based around 12 elements, and has a greater focus on managing the public health risks as well as continuing to manage the environmental risks. It also introduces management practices that adopt a “fit for purpose” approach, according to the water quality, the intended uses and the risks associated with its use.

The AGWR Framework comprises of 12 elements and provides:

- A risk-based approach to identifying hazards, assessment of the level of risk and documenting appropriate preventative measures.
- The identification of Critical Control Points (CCP) monitoring for day to day management and the development of process controls and procedures for managing the CCP’s.
- The use of verification monitoring to ensure that the system functions effectively
- Establishment of incident and emergency management protocols and procedures
- Establishment of organisational commitment to the management of recycled water including processes for continual improvement, evaluation and audit.

Adopting management practices that have a greater focus on public health, in these reclaim water systems has met with some challenges. However, it has also helped Council and the end water users to better understand the risks of using reclaim water, and to negotiate changes in how it is used.

2.0 DISCUSSION

To enable Council to develop and implement a RWMS for each of these systems, a number of activities have been undertaken. These have guided the development of the RWMS, as well as providing the risk management approach to understanding the risks and implementing controls to limit these risks.

2.1 Site Visits

On-Site audits were conducted on all the reclaim water user sites, to understand how the reclaim water is used and analyse the risks. For each site, the person responsible for managing the irrigation was involved. Where possible, key Council staff also attended, to help build their awareness of how the reclaimed water is utilised. The site visits were managed to ensure that no one felt like they were being targeted. All users were keen to have us attend and positive about the opportunity to learn about the reclaim water.

Some of the things that were considered during the visits are listed as follows:

- What is the governance structure for the facility and who makes the decisions?
- What areas are irrigated and at what times?
- What irrigation infrastructure is being utilised and what level of automation does it have?
- How is the reclaimed water stored on site and how protected is the storage?
- Who uses the facilities, how are they utilised and what are the risks for contact with the reclaimed water?
- Who works on the systems and how educated are they on reclaimed water use?
- What are the risks for contamination of the reclaimed water, cross contamination with drinking water or environmental discharge?
- What soil monitoring is undertaken and how are fertilisers and pesticides utilised?
- Is the reclaimed water being utilised for any unapproved purposes?

There were some surprises that we found during these visits!!

Some irrigation systems were manual, there was no automation and irrigation was being undertaken during the daytime. Council had assumed that the irrigators would understand the requirements for night time irrigation with reclaimed water. When questioned about this they indicated that they understood, but in practice its difficult. In fact, this was somewhat common across all the sites, due to operational impracticalities (manual irrigation) or the inability to manage turf die-off during hot weather.

Signage advising the public that reclaim water is used for irrigation was almost non-existent across all sites. While in general, reclaimed water infrastructure was not accessible to the public, very few had signage or purple lids or taps to indicate it contained reclaim water. In some cases, reclaim water was also being used for washdown of equipment and staff had minimal training on the health risks of using and coming in to contact with the reclaim water.

The onsite visits provided the opportunity to advise staff on the health risks and to ensure they cease the practices of using it for anything other than irrigation. Council have also provided updated signage in numerous locations at each site, to ensure that the public are aware of the use of reclaim water.

The reclaim water is utilised by one private property owner, for pasture improvement for cattle grazing. On this site, cattle were able to graze while the paddock is being irrigated and were likely ingesting the reclaim water. The landowner had not been advised of the requirement to allow the grass to dry, prior to grazing, and hence minimise these health risks to his cattle.

Figure 1: ***Travelling Irrigators*** **Figure 2:** ***Old Signage***

It was however not all negative and the sites had many good controls they were utilising to protect the public and environmental health. In addition, all the users have been very positive about the discussions we have had and the learnings they have obtained.

2.2 Water Quality Verification

The AGWR requires all water utilities that provide recycled water, to analyse and understand the quality of the reclaim water. This analysis helps to determine what the reclaim water is fit to be utilised for, and what level of control is required to be implemented on site to manage risks. The verification analysis is focused on Health Based Targets (HBT), looking at the levels of pathogens, protozoa and virus's in the water once discharged and after management controls are implemented on site.

Theoretical water quality, in accordance with the AGWR HBT assessment approach, were first determined. Where possible, the water quality performance data for the reclaim water was analysed to verify the theoretical performance. This was difficult as most of the water quality data is based on the EPA testing requirements, which do not include typical testing parameters to determine HBT. In the end, a combination of theoretical and data analysis was utilised to determine the likely water quality.

Table 1: ***Example of the HBT assessment for intermittent aeration plant***

Treatment Process	Bacteria	Virus	Protozoa
Secondary Treatment	1.0	0.5	0.5
Lagoon Storage	1.0	1.0	1.0
Preventative Measures (site controls)	4	4	4
Total Theoretical	**6**	**5.5**	**5.5**
Required LRV (Municipal Irrigation)	**4.0**	**5.2**	**3.7**
Compliance	**Yes**	**Yes**	**Yes**

Table 2: Example of the HBT assessment for SBR

Treatment Process	Bacteria	Virus	Protozoa
Primary & Secondary Treatment	1.9	0.5	1.1
Chlorination	5	2	0
Onsite preventative measures	3	3	3
Total Actual	**9.9**	**5.5**	**4.1**
Required LRV (Municipal Irrigation)	**4.0**	**5.2**	**3.7**
Compliance	**Yes**	**Yes**	**Yes**

As no surprise to Council, with the levels of treatment at the different STP's, the reclaim water at all sites was unable to meet the AGWR requirements through treatment alone. The AGWR however outlines a "Fit-for-Purpose" approach to utilising reclaim water, which allow Council to implement on-site controls with the users, to meet the required HBT. Table 1 and 2 above, provide a good picture of the reliance on good user controls at the user site, to manage the public health risks.

These controls that have been implemented include:

- Irrigation at night time to reduce the risk of public contact
- Access limited until ground has dried, following irrigation
- Ensure no overspray to adjoining properties

With the implementation of controls, each of these systems were assessed as meeting the HBT for irrigation, in accordance with the AGWR.

Additionally, Council will be implementing increased monitoring of water quality to verify the theoretical water quality.

2.3 User Agreements

User Agreements and Site Management Plans have been developed by Council for each of the sites, based on the AGWR requirements. The User Agreements are a legally binding document that outlines the supplier and user responsibilities when using the reclaimed water, the intention to cease supply if the conditions are not implemented and the ability for Council to audit their practices on a regular basis. The Site Management Plan are owned by the users and outline the manner in which they will utilise the reclaim water, and implement the site controls

Upon the development of draft documents, Council ran a combined workshop with the nominated board member and turf managers. This provided them the opportunity to discuss the requirements and request variations to the agreements. Council took the opportunity to provide training on why they were making changes and also understand the challenges each face with implementing these agreements.

Some of the challenges that council became aware of during this workshop included:

- The time council allowed for after-hours irrigation needed to be increased, to ensure they were able to irrigate the whole course
- Night time irrigation will be difficult due to the noise the manual irrigators make which result in residential complaints
- Difficult to exclude cattle on a small property for 5 days

Following the workshops, Council were able to undertake further investigation and negotiate on the user agreement requirements. For Council, the preferred option for implementing user controls was to implement best practice, but also make sure they were conditions that were feasible. These facilities rely upon the reclaim water, and Councils intention was not to create unachievable conditions and to have to cease supply to these sites. For each of the challenges above, Council and the users were able to agree on negotiated terms, and where this was not possible a commitment for improvement has been included in the agreements.

3.0 CONCLUSION

There were a number of challenges that Council have had to overcome. The biggest challenge is the fact that these facilities are community assets, they don't have a large amount of funding and they rely on the reclaim water for their livelihoods. Council has had to be mindful of this when developing legally binding agreements. It's one thing to make them sign a legally binding agreement with conditions that they cannot meet and say that if they don't do it, then we will turn off the supply. The community outrage and the cost of damage to assets would be huge if they were not provided with the reclaim water, and in reality, it is unlikely that Council would actually turn off the supply.

Establishing controls, that are unable to be implemented, would serve no purpose in controlling risks. The negotiated final agreements ensure that the risks are controlled adequately but are also able to be implemented by the users. Council has also introduced improvement actions in the agreements which allows the users to continue to operate and also aim to improve infrastructure long term.

Council has gained a much greater understanding of how the reclaim water is being used, improved coordination and communications with the owners and operators of the facilities and introduced management controls that improve their ability to manage public and environmental health risks. All sites now have improved signage, improved irrigation practices, and signed user agreements. The owners have gained a much greater understanding of the risks of using the effluent and the controls they need to implement for their own safety and for the safety of the community that utilise their facilities.

4.0 ACKNOWLEDGEMENTS

Council would like to thank all the users for their enthusiasm and ongoing support through the development of the RWMS for each of their sites and their willingness to learn and sign up to User Agreements.

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EMERGENCY PREPARDNESS

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EMERGENCY PREPARDNESS

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ABSTRACT

Being prepared for an emergency within a local water utility is like foreseeing into the future with a crystal ball. Not everything will be known and not everything will go as expected. However, considering what can go wrong with the management of the water and waste water supply, understanding your systems and how they function, and learning from your own past experiences (or from other water utilities), will give you an insight in to how best manage a future incident or event.

Incidents and emergencies can still occur, despite an organisations best effort to mitigate risks. It is therefore essential that an organisation have an Incident and Emergency Response Plan (IERP) in place, to provide practical communication and management steps to manage these incidents and restore normal operational conditions as soon as possible.

Under the *Australian Drinking Water Guidelines (ADWG)* Element 6 of the Framework for management of drinking water quality, a utility is required to have an Incident and Emergency Response Protocol (Plan). Additionally, the utility must implement staff training, have prepared communication procedures, response plans and procedures for investigation and debrief after an incident. These all seem reasonable to do, but where to start?

preparing an IERP and then conducting an in-house mock incident exercise, is a great way to start the process. It also provides the opportunity to engage with other staff that may not normally become involved in the treatment and supply of water. They are the people however that will be confronted with the demand for instant responses from community members, regulators, managers, neighbours etc or have to deal with the challenge of how to cover costs for managing the incident.

This paper outlines a water utility's journey through the development of an IERP and the learnings from conducting a mock exercise as a means to train and test staffs response to a fictious event.

1.0 INTRODUCTION

Dealing with a water quality incident or emergency situation at your place of work can be an extremely challenging experience. It will result in unknown impacts/tolls on staff, disruption to the organisations reputation and customer confidence in the utilities ability to manage the service area. These types of incidents can range from situations that can include customer inconvenience, multiple claims against council and even loss of life.

Drinking water suppliers are required to have and comply with a Drinking Water Management System (DWMS) under the NSW *Public Health Act 2010* and Public Health Regulation 2012. Having an IERP in place is a requirement in managing a dynamic water supply and meeting these regulatory obligations.

The key objectives of an IERP is to have a document that provides:

- Clearly defined response protocols to an incident and emergency
- Defined staff roles and responsibilities, including communication and reporting requirements
- Example of potential incidents and emergencies, with documentation of the response plans.

Preparation starts with understanding the supply system and knowledge of who works within this and who are the key stakeholders that may require response and action. Operational understanding of what needs to be done to isolate and fix the problem, with what needs to be measured and monitored, are a means of understanding the potential impact areas and extent of the problem.

2.0 IERP DEVELOPMENT

To begin the process, the first step is to check in with the local staff to see who has been involved with past incidents and what these involved. Learning from people who have local experiences can save a lot of repeated efforts and is a good way of determining what issues have been experienced in the past, and if there is some relevant documentation that already exists. It is also a way of engaging with longer term staff in the organisation or connecting with newer staff who may have come from other organisations and have useful experiences and knowledge to share.

Organisations may have a Local Emergency Management Plan (LEMP) that details the arrangement for prevention of, preparation for, response to and recovery from emergencies in the Local Government Area. This plan outlines procedures for dealing with hazards or threats such as flooding or hazardous materials spillages and includes the requirements for establishing an emergency, setting up emergency operations and controllers and the combat agencies for the different types of emergencies. By consulting with these representatives and seeing what documentation is in place, will assist with determining when a level of incident elevates into this emergency category. Other documents that may also exist include Business Continuity Plans, Pollution Incident Response Plan and Regional Emergency Plans which may also be of benefit.

Within a workshop environment, gathering information such as listed below, are ways to start the conversation and document draft response protocols:

- What would happen when……?
- What would be your response to…..?
- How would you monitor this event?

Having a number of example incidents such as a dirty water event, or power outages are some typical events that most people can relate to and would have knowledge about. It is important that the utility involve the Local Public Health representative and the Department of Industry Water and Waste Treatment Officers, as they can have valuable inputs into examples and incident situations.

Within this workshop, seeking examples from the participants of documents that may already exist, that have flow charts, response levels displayed, a system of file management, can be of valuable assistance. Gathering the examples that an organisation may have on Critical Control Points procedures, and NSW Health protocols for the response to a chemical or microbiological event (or other google searches) can give a backbone/template to develop from.

Once the backbone document has been prepared, then discussion of what levels of response would you expect to see at an operational, supervisory, management, organisational level is important. Below are the incident levels that best describe what is likely to happen for this example:

Level 1 Operational Level
Level 2 An event limited in scope and contamination

Level 3 An unstable, severe or uncontrolled event
Level 4 Emergency

Each of these levels will require a definition of typical parameters, examples of a type of event involved, or time factors that will enable staff to determine the potential severity of the event. This will enable them to know what event level they may be witnessing, or if an event is escalating. Consideration of the following points will assist with this judgment:

- Duration - how long is the event expected to go for? Is it an easy fix, or could it go for a day or over a week?
- Magnitude - how many customers will be disrupted? Is it localised to a small area, easily isolated and contained? Is there a risk of escalation? Is it likely to be widespread and affect the whole town?
- Customers affected - who is affected or impacted? Are the customers likely to be vulnerable (dialysis, aged care) or is it likely to impact on the hospital or major customers? Could this make a customer sick? Could this result in extensive grievance against council?

Defining notification response times and responsibilities, will aid operational staff in understanding how serious/important this event may be, who they should be contacting and consider how it may escalate.

2.1 Documents and Procedures

A number of key documents or procedures will need to be developed as part of the IERP.

Incident and Emergency Management Notification Flow Chart

Preparing a summary of responsibilities, actions and notification requirements, for each of the Incident/ Emergency Levels will ensure staff understand who is the responsible person, what notification steps are required and what actions are to be undertaken for each of the incident levels. See Table 1 below as an example for a Level 2 incident.

<u>Table 1:</u> ***Example of response actions and notification requirements***

Level 2	Responsible Person	Notification	Actions to be undertaken
An event limited in scope and contained	Operational staff	To Manager within 1/2 hr	Operators take remedial actions, inform manager and maintain records.
	Manager	To Director, Regulators & Communications section within 1/2 hr	Manager acts as event controller. Progress is monitored, resources allocated and prepares for possible escalation. Keeps key people informed.
	Communications	Internal staff & Customers	Manages customer enquiries, social media & internal communications.

Displaying this as a flow chart in operational documents will ensure staffs are familiar with the agreed Incident Levels and the required actions/notifications.

Response Protocols

If a utility has experience in dealing with a particular incident, specific response protocols could be developed to help the organisation deal with particular issues. These can also be helpful for other incidents, and the response protocols can be used to help guide these incidents.

Response protocols should be defined around the following four steps:

1. Assess – what is the incident, where is it occurring, how many people may be affected and is there any vulnerable community involved. What level of incident is it and what response is required, and how likely is the incident to be solved quickly or is it likely to escalate?
2. Communicate – what communication is required. What notification is required to staff, management or the regulators. What information do councils customer services team need to answer enquiries and what does the community need to be told.
3. Rectify – what is required to rectify the incident, how long will it take and what resources are required. How do you manage staff fatigue and what sampling is required to determine if the incident has been rectified?
4. Review – what is required to consider during a debrief and what learnings can the utility gain from the incident. Are improvements required and how will they be documented and implemented.

NSW Health have response protocols available on their website that should be included in the IERP and also be referred to by Council when developing specific response protocols. These provide guidance on managing physical, chemical and microbiological quality of drinking water and/or treatment failure and are available from https://www.health.nsw.gov.au/environment/water/Pages/drinking-water-quality-and-incidents.aspx

Other documents that have been prepared for the plan included a ‘log of events’ for documenting actions taken during an event, ‘change over log’ for dealing with responsibilities during shift changes, ‘incident report forms’, and ‘communication log’. Up to date Stakeholder List from the DWMS or key customers with contact details will enable swift communication and notification responses if required. Debrief guidelines have also been prepared to ensure that there is a stepped process followed to understand the incident with what went wrong and what needed to be done to fix or prevent any such event in the future.

2.2 Conducting a Training Exercise

The purpose of conducting a mock water quality exercise was to familiarise Councils Management and Operational staff with the IERP and CCP procedures, and to identify any knowledge gaps and process steps that may need to be developed to ensure council is prepared for a water quality event.

A mock exercise scenario was developed in various stages and was challenged by incorporating a long weekend, weather events, damaged or offline infrastructure and treatment interruptions and a key staff member on leave, which all progressed into a Boil Water Alert. A series of injects were provided to participants during the exercise, using discretion for when to introduce them, while also allowing the scenario and response to develop naturally as much as possible. This allowed the participants to make decisions and demonstrate knowledge of the DWMS, IERP and the Critical Control Point procedures.

The exercise was conducted as a desktop exercise for approximately 2.5 hours and was a first for Council. A debrief with all participants was conducted immediately after the exercise to gather feedback from both participants and observers.

Evaluation of the objectives for the exercise were based around the ability of the council to respond to a water quality incident with knowledge of procedures and communication and notification protocols, and demonstrated decision making arrangements within Council and with other agencies.

2.3 Learnings and outcomes

The provision and supply of safe drinking water is the core role for a utility and therefore a ‘whole of organisation’ approach should be adopted and is critical to a successful outcome when managing a drinking incident.

The mock exercise was deemed as being very successful by the participants and provided an opportunity for Council to review the IERP and understand the improvements required, prior to an actual water quality incident. Contribution from all levels in Council was achieved with participation from council staff which included Water & Sewer operations, Engineering and supervisory, Customer Service officers, Health & Building, Communications, Directorial and General Manager. External agencies included Local Emergency Management Officer (LEMO), Local Public Health Officer and DoI Water and Waste Treatment Officer.

Engaging with staff that might not normally be involved with the supply or treatment of water, was a great benefit in the organisations ability to manage an event.

The exercise also helped to ensure that all involved were made aware of the serious nature of such an event, the regulatory requirements for managing a drinking water supply and how to coordinate a drinking water quality incident or emergency.

Additional key learnings include:

- An understanding of where the supply system documents are held and who has access to them
- Supporting staff that are in the ‘thick’ of the response and may be spending long hours dealing with the actions and responses required. It may also be necessary to provide support to assist with administration duties and documentation of the incident logs and data capture.
- Calling on outside resources to assist, as the sooner supervisors, managers or regulators know about the issues, then additional resources can be obtained. The decision to escalate sooner or not escalate, may minimise the impact of the incident.
- The workshop provided non-operational staff an opportunity to learn about and appreciate the roles that the council water staff undertake and to understand their criticality. It also helped to connect indoor and outdoor staff.
- Administration staff may need to know the technical details as well as take on a key support role during an incident. The On-call Manager has the authority to make decisions and yet may have no knowledge about the supply. The provision of awareness training for non-technical or admin persons, with an introduction to the relevant documents such as flow diagrams of the water supply system and where to find them.
- The IERP document to include the key system description and overviews in the early area of the plan.

- The importance of setting up an Incident Operations Centre for the collaboration and distribution of information and responses, including the ability for remote access to control systems such as SCADA.
- Include annual training of the IERP with new and existing operational and staff. Key management staff are to be inducted into the use of the IERP (to know that it exists!) and include this in the induction process for all new staff.
- Don't underestimate the power of Social Media and how negative comments and un-responded comments can escalate quickly in the community. The monitoring and correction of false information by social media platforms is a critical aspect for managing communications. The community has much higher expectations of responses, due to the social media era.
- Debrief with a broad range of staff and regulatory support agencies to ensure that there are extensive learnings and that others can share support and pre-prepare templates/documents etc for future uses.

Throughout the exercise and during the debrief, a number of improvement actions were identified. A detailed list of actions was provided to the council, to ensure further improvements were implemented and to ensure preparedness for an incident.

3.0 CONCLUSION

Preparing an IERP and having staff aware of its existence and content can be a challenge. Conducting a mock water quality exercise certainly changed a utilities expectation and practicality of what happens when dealing with potential incidents or emergencies. This brought a little 'bit of excitement' to the IERP at the end of the day! The council staff enjoyed undertaking the exercise and this helped them to develop a greater appreciation of the important role that they play in the supply and management of safe drinking water.

4.0 ACKNOWLEDGEMENTS

Thank you to NSW Health - Water Unit, for the opportunity to participate in this project under the Drinking Water Management System Implementation Support Projects funding program.

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MEMBRANE FOULING CAUSED BY INORGANIC LOADING (RAGGING)

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13th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Orange PCYC,
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MEMBRANE FOULING CAUSED BY INORGANIC LOADING (RAGGING)

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ABSTRACT

The Kangaroo Valley water reclamation facility was commissioned in June 2013. The contract was a design and construct agreement with AJ Lucas being awarded the construction tender. Since the facility has been handed over to Shoalhaven City Council for operation there have been several issues that have hindered the efficient operation of the site, the most predominant being inorganic fouling of the membrane filters.

1.0 INTRODUCTION

The treatment facility is a Bio-reactor Membrane Filtration plant that can treat up to 740kL per day. The system comprises of two biological process trains and two membrane filter tanks, 2 digester tanks plus a feed balancing tank that supplies an onsite belt press.
The collection network is all pressure sewer system which incorporates 276 households and small businesses along with two caravan parks, a motel (max cap. 90 people) and three public toilet facilities. All sewage is delivered to the treatment facility by a single pressure transfer line that increases in diameter from the furthest extremity towards the treatment plant.

Each household and small commercial site has a collection tank of approximately 1000L which contains a small macerator pump that can deliver a maximum free flow of 0.6L/s. The larger sites have multiple macerator pumps located within purpose sized fibreglass reinforced tanks. All effluent supplied to the treatment facility is macerated into a fine solution.

The main cause of the inorganic fouling of the filtration membranes can be attributed to the macerated feed solution being pumped to the plant which was not properly filtered during pre-treatment due to incorrect sizing of the inlet works drum screens.

This incorrect sizing of the drum screens then manifested into various problems including ragging of reflux valves, submerged pumps and most importantly the membrane filters.

<u>Figure 1:</u> ***Aerial view of the Kangaroo Valley Water Treatment Facility***

2.0 DISCUSSION

The biological process implemented at Kangaroo Valley treatment facility is a proprietary design of Siemens (subsequently Evoqua). It was originally designed to require filtration of 1mm aperture in the inclined drum screens at the inlet works.

When it came time to source the drum screens the contractor elected to increase the drum screen aperture to 2mm due to concerns for high load / high flow capability, this however in turn allowed a larger volume of inorganic material to pass through the filter and become caught up within the process tanks and membrane filter cells. This build-up of inorganic material overtime became a serious issue in relation to performance and operational stability by causing excessive membrane lumen damage. Some of the issues to become apparent included:

- Lumen breakages
- Increased filter breakthrough (turbidity)
- Reduced flow capability (flux)
- Air entrainment within the filtrate stream

The membrane filter design employed at Kangaroo Valley treatment facility is an un-supported hollow fibre design which are fixed at the bottom and encapsulated in a resin head with a manifold attached above for filtrate removal. The water is drawn in through the wall of the fibre and emitted out the top end under vacuum into the collection manifold.

2.1 Drum Screen Replacement

Early on it was discovered that the inlet works drum screens had been supplied and installed with the wrong size perforation required to suitably filter the fine suspended solids that are received in the influent stream. The initial design required 1mm perforation but 2mm was supplied. This allowed a large portion of the suspended fines to enter the biological process and become entangled in equipment (pumps, refluxes etc.) and also from matting around the head of the filter membrane cartridges and cause serious damage as outlined in the following sub-categories.

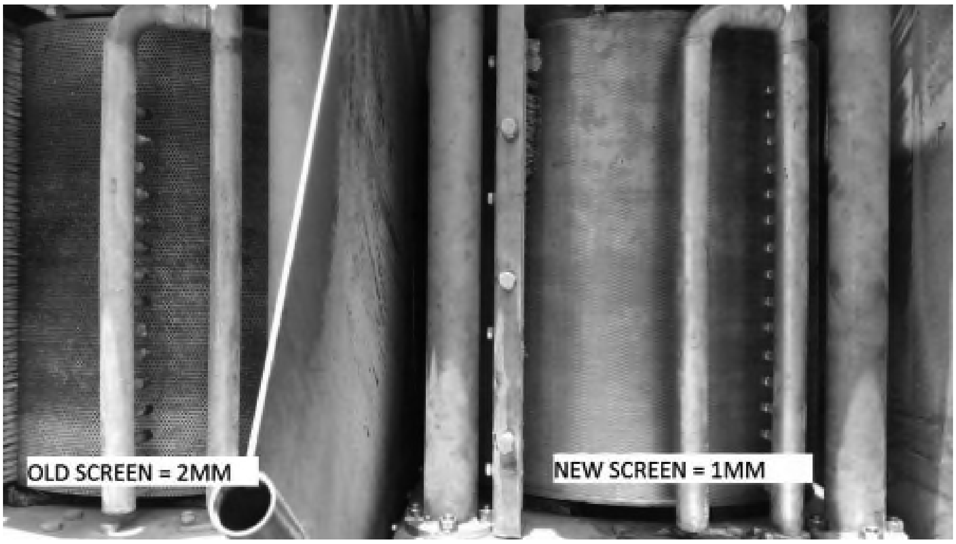
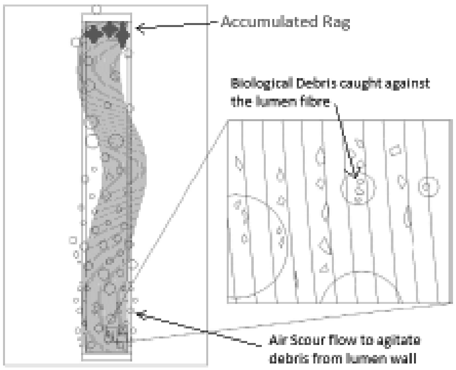


Figure 2: ***2mm V. 1mm Drum Comparison***

2.2 Lumen Breakages

Filter lumen breakages were the first indicator that was witnessed by operational staff that indicated the beginning of filter failure within the filter cell. Due to the excess amount of 'ragging' beginning to form at the head (top) of the filter cartridge, the diffused air agitation that is present within the filter cell began to move the clumps of rag laterally which caused the lumens fibres to shear off under the lateral forces generated by the air scour flow.



<u>Figure 3:</u> ***Membrane Air Scouring Using Diffused Air***

<u>Figure 4:</u> ***Heavily Ragged Membrane Cartridges Removed from the Filtration Tank***

2.3 Turbidity Break Through

Turbidity break through is a significant performance indicator within a membrane filter system as it allows operators to monitor the integrity of the filter and gauge its maintenance requirements.

Turbidity breakthrough and monitoring is crucial as it has a direct correlation to the log removal of pathogens and bacteria from the filtrate stream via the filter.
In the case of Kangaroo Valley’s membranes, it became evident through Citec/SCADA alarms and subsequent analysis that the membranes were starting to experience break through and in turn the log reduction is reduced and the potential for pathogen and bacteria breakthrough increased (these factors are mainly for concern in the potable water filtration process but they are vital performance indicators none the less).

This also had an impact on the ability of the filtration process to filter the required daily volumes as the system has in-built safety measures for high turbidity which causes the process the go into recirculation until the turbidity has fallen below the set point required for discharge (achieved once all broken fibres are blocked).

To investigate the root cause of the break through Pressure Decay Tests were performed on each filter to ascertain if particular filter cartridges ‘leaked’ worse than others. The damage was so widespread that the pressurised tank looked like spa bath. Management decided at this point that all the membrane cartridges of a single filter were to be removed and pinned to eliminate the broken fibres from service and thus reduce break through.

This activity was undertaken on one membrane cell (4 individual racks that house 7 cartridges each, approx. 2000 lumen per cartridge – 4x7x1200= 28,000 lumens in each cell). The pinning was only conducted on one membrane filter tank to gauge the effectiveness of the exercise compared to the operation of the opposing original filter set.

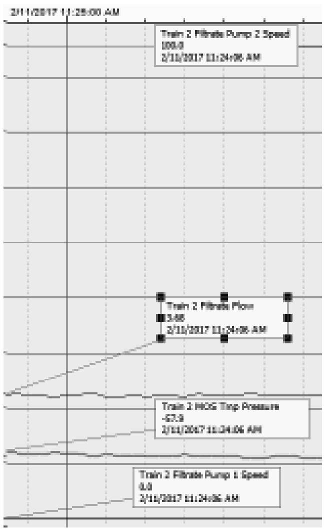
2.4 Increased Trans Membrane Pressure & Reduced Flow Capability (Flux)

The 'trans-membrane pressure' is the difference between the feed and filtrate pressures within the filter. Increases in Trans-membrane pressure are an indicator of fouling occurring on the wall of the lumen fibre. There are many different factors that cause elevated pressures which include reduced overall surface area for filtration (broken lumen fibres), fouling of the surface of the membrane or excessive biomass concentration.

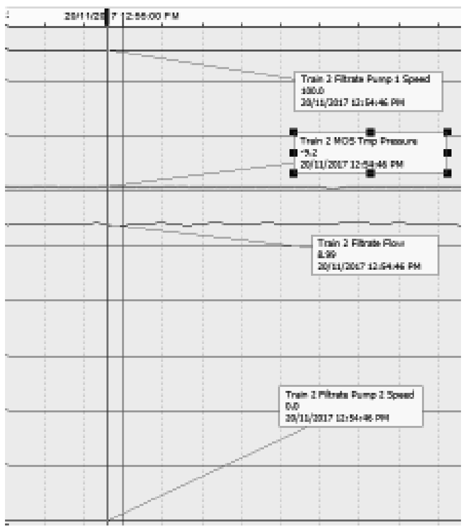
Kangaroo Valley STP experienced all three scenarios at various times but the ragging of the filter head and subsequent lumen breakages proved to be the main contributing factors to poor flux and increased TMP's.

Operational staff began to notice that the broken lumens and resulting filterable surface area reduction had started to impact the flux and TMP as outlined in the picture below left.

Due to broken lumen pinning already being completed, the improved flux and TMP data was not evident until a complete replacement of the filter lumens was conducted pictured below right. A simple comparison of the data from before replacement and after replacement was collected and analysed, this data clearly shows an immediate improvement in both TMP and Flux through the filter.



Before Membrane Replacement



After Membrane Replacement

Figure 5: ***Flow, Turbidity and TMP comparison between old and new membranes***

2.5 Air Entrainment in Filtrate Stream

Entrainment of dissolved air into the filtrate stream has posed a significant problem to the stability of operation for the membrane plant as air accumulated within the pipes eventually moves through into the filtrate pumps and causes air locking and subsequent flow failures. The air becomes entrained in the filtrate system by being vacuumed in through the end of the broken lumen fibre (much larger pore size than available through the wall of the lumen) and once in to the pipe the accumulated bubbles group together causing a bubble which then passes to the pump which causes cavitation and subsequent loss of flow.

Once the pump fails the only way to remove the air is a mechanical vent and re-prime of the pipework. In an attempt to prevent an accumulation of air our mechanical services team installed small mechanical bleed valves on the discharge side of the pump so that the air and a small amount of water could be pressurised out of the system and to the site drain.

It was found though that the large amount of air entrained could not be removed by the automated mechanical bleed valves and as such a larger manualised venturi style bleed valve was required between the filter and filtrate pumps to remove larger bubbles before being entrapped in the pump itself.

The air entrainment problem was finally eliminated once a membrane replacement program had been finished. This was due to the amount of broken lumen fibres in the old cartridges.

Figure 6: ***Automated mechanical bleed valves***

2.6 Membrane Replacement

After investigating all avenues to resolve the TMP, reduced flux and air entrainment issues the decision was made to put a tender out for a complete replacement of both sets of filters.

Figure 7: ***Comparison between old and new membranes***

The photo speaks for itself as the difference between the old and new membranes is immediately noticeable and the system performance dramatically improved.

3.0 CONCLUSION

In summary the integrity and life span of the membrane filters at Kangaroo Valley treatment facility is directly related to effectiveness of the pre-filtration screening and rag collection systems being sized and designed correctly to remove the fine suspended inorganic particles that cause ragging.

The main areas of focus for the future of Kangaroo Valley WRF are:

- Ensuring our drum screens are operating effectively with no by-passes.
- Investigation into a fine screen belt filter to be installed post inlet sedimentation tank to catch remaining inorganic suspended solids before the biological process.
- Automation of filtrate vacuum line air ejection.
- Further to this are some lessons learnt for future membrane filtration plants design to consider which include:
- A detailed analysis of the feed solution into the plant to determine appropriate screening and grit removal systems are developed and installed
- Due to the harsh nature of the waste water environment a comparison between un-supported hollow fibre membranes v. supported fibre membrane v. slat sheet membranes to determine the advantages and disadvantages of them in regard to plant design for inflow composition
- Ensure adequate and detailed operator training along with suitable communication lines between operator and process engineers who are familiar with the design parameters.

4.0 ACKNOWLEDGEMENTS

I would like to thank the following people for the knowledge and support during the commissioning, and early stages of operation whether it be by sharing knowledge and understanding of our particular system, providing examples and possible solutions from un-associated works or by providing physical support during investigative and remedial works.

Daniel Price – Water Headworks Coordinator, Shoalhaven Water
Mark Jennings – Water Manager, Shoalhaven Water
Nathan Carson – SCADA/PLC Programmer, Shoalhaven Water
Peter Clark – Manager Mechanical Services, Shoalhaven Water
Peter Zauner –Process Engineer, Evoqua Water
Craig Chamulko – XXX, Evoqua Water

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Winner of the Best Paper Overall at the
81st Annual WIOA Victorian Water Industry Operations Conference,
Bendigo, 2018

SPOT MARKET INFLUENCES AND POWER SHEDDING PRINCIPALS

Paper Presented by:

Nicholas Moore

Authors:

Michael Chapman, *Wodonga Central Treatment Coordinator,*
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North East Water

13th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Orange PCYC,
3 & 4 April, 2019

SPOT MARKET INFLUENCES AND POWER SHEDDING PRINCIPALS

Michael Chapman, *Wodonga Central Treatment Coordinator,* North East Water
Nicholas Moore, *Finance Manager,* North East Water

ABSTRACT

This paper informs organisations of potential power savings, techniques and principals that have come about through North East Water moving to a spot market power agreement rather than a fixed price contract.

While the spot market has potential for significant overall power cost savings it also exposes organisations to the volatility within the market. This volatility is usually absorbed by the power retailers and is considered when setting the fixed price.

This paper helps to inform organisations of the risks and benefits of being on the spot price market. We will highlight some simple power shedding principals to avoid high price events and show actual demand reductions and cost savings associated with these price spikes and will demonstrate what our response so far and what our future plans for managing power into the future.

We will show that as our level of comfort with being in the spot market increases and our operational control improves, we can make further savings on our total power costs.

Through these savings, investment into renewable or alternative power sources will give us further resilience around high price events and give us greater flexibility in managing unplanned power related events.

1.0 INTRODUCTION

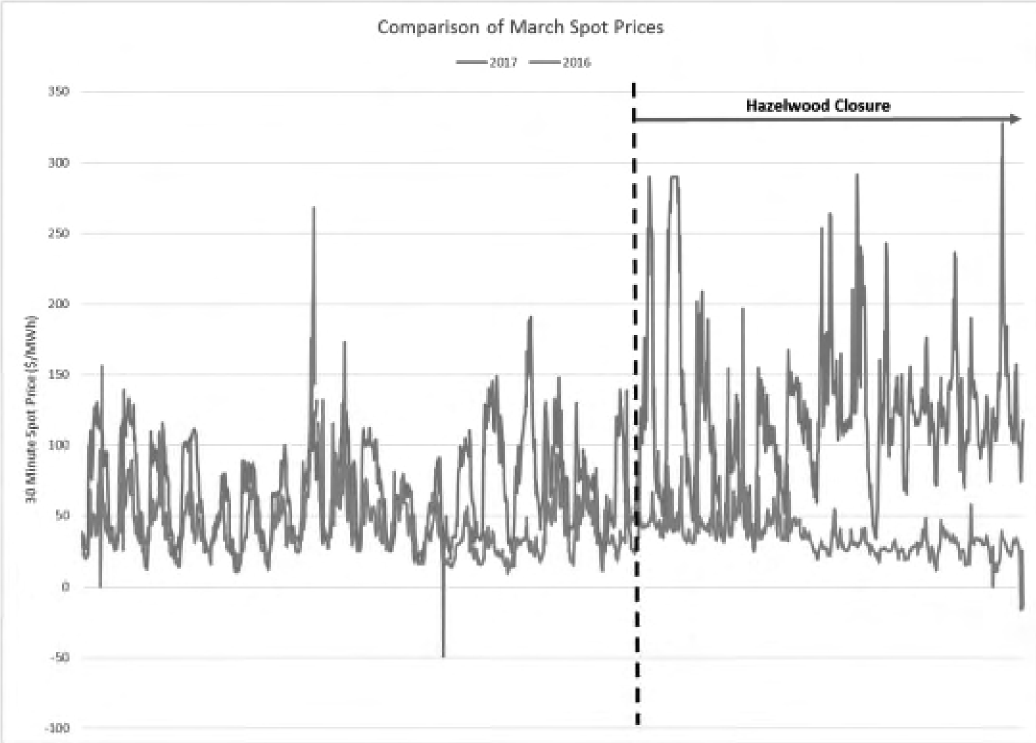
In Australia the production and usage of electricity is undergoing a major transformation. This is related to the changing face of how electricity is produced and the effects of the weather and climate change.

The resources available to supply electricity are changing with the current and forecast closures of conventional thermal generation as they reach the end of their economic life, growing investment in grid-scale wind and solar generation and household solar installations. With the increased generation of household solar power during the day this has the added effect of creating low demand in the middle of the day, with a larger ramp to the evening peak.

The second major factor in transformation of electricity is climate change primarily weather. This has a real time influence on the production and usage of electricity. The climate is changing, in terms of temperature, and extremity and scale of weather events. The growing populations reaction to extreme weather events and the demand for cooling or heating needs can be directly associated with high demand on the electricity network – increased population, more houses with air conditioning which are all on in heat events.

With the transformation of energy usage has come a decrease in supply availability during peak demand events and in turn a significant increase in the spot price for electricity.

The spot price in March 2016 compared against March 2017 is shown in Figure 1– with the closure of Hazelwood, market volatility is greatly increased and with it, electricity costs. The spot pool price can vary from $-1,000/MWh to +$13,800/MWh.



<u>Figure 1:</u> ***Comparison of March Spot Prices 2016/2017***

2.0 DISCUSSION

The purchase of electricity can be done one of three ways: 1) Fixed price contract, 2) Spot Market based on 30-minute intervals and 3) Spot Market combined with hedging arrangements. Spot market prices are volatile; however, you can protect against this with hedges – e.g. *Wholesale Electricity Hedging Policy.* Hedging works by paying a set price per MWh (example $100 MWh) but for the power you use when the spot price is higher than the contract rate you pay the spot price *<u>less</u>* the difference between spot and contract rate. Likewise, if you use power when the spot price is lower than the contract rate you then pay spot *<u>plus</u>* the difference between spot and contract rate.

North East Water consists of 32 large market sites making up 75% of the total electricity spend and 281 small market sites make up remaining 25%. The largest of these is the West Wodonga WWTP which consumes approximately 6,000 MWh of electricity per annum with an energy spend of over $675,000.

In June 2016 North East Water exited Procurement Australia fixed price contract and shifted from a fixed price to open market procurement. NEW has adopted an electricity procurement model based on purchasing electricity on the spot market with hedge contracts to manage risks. As the response improves to price peaks then the hedge amount will slowly be reduced over time until we are solely purchasing from the spot market. This is a new approach to the way we procure and use energy.

North East Water has set out to develop and implement power saving measures for our 32 large market sites based on monthly spot price trends and local operations knowledge.

To reduce excessive electricity costs the company must firstly have the ability to monitor the market spot price in order to forecast price spikes and using the required electricity as effectively as possible. And secondly, to have the ability to load shed – reducing required electricity by shutting down high electricity consuming plant and equipment during peak demand periods. But with load shedding comes the risk to water and wastewater processes and North East Water is invested in ensuring safety and product quality will not be compromised in search of energy savings.

2.1 The Ability to Monitor Spot Prices

North East Water currently monitors spot prices through two main sources – our energy broker and the AEMO.

The AEMO – Australian Energy Market Operator operates Australia's National Electricity Market (NEM), the interconnected power system in Australia's eastern and south-eastern seaboard, and the Wholesale Electricity Market (WEM) and power system in Western Australia. They publish a data dashboard (Figure 2 below) showing the 30min spot price $/MWh, demand MW, forecast spot price $/MWh and scheduled demand MW. This allows the operations staff to monitor real time spot prices and begin power shedding at the appropriate time.

Through our energy broker we receive weekly notifications via email (Figure 3 below) and text message which detail the upcoming week's market activity forecast including temperatures and risk of high demand periods. This helps the operations staff to plan weekly tasks, maintenance, shutdowns and shedding plans in light of upcoming events.

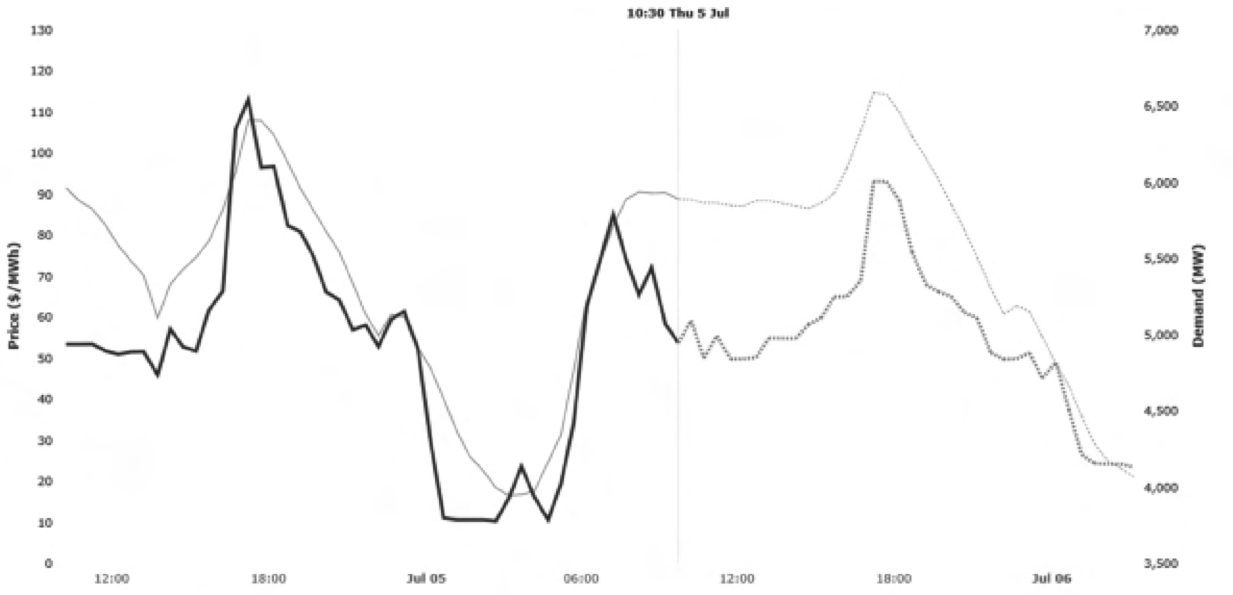


Figure 2: ***AEMO Data Dashboard***

2.2 Load Shedding

There are two main forms of load shedding – voluntary and involuntary.

Voluntary load shedding is the ability for the business to reduce the electricity load by turning off energy intensive plant and equipment for short periods of time.

The plant and equipment might be simply turned off during the required period, else powered by a secondary source such as a diesel-powered generator/battery backup or the use of storages - stored energy in the form of treated water held in a clear water storage or influent held in a storage prior to the wastewater treatment plant. Companies can negotiate with the power provider to voluntarily load shed on a pre-scheduled or on-demand basis.

Involuntary load shedding (Blackouts) occurs when the AEMO directs power companies within Australia to start switching off customers' power supply because the power system is at risk. The system always must remain in balance between supply and demand — if there is no extra supply available, the authorities have no choice but to reduce demand by shutting customers off. If they don't, the entire system can fail, causing a state-wide blackout like what happened in South Australia in September 2016.

Notification Market activity for the week ahead
Friday 10 February 2017

Hi Michael,

Periods of high spot prices can occur at anytime and can occur outside of the higher risk periods shown below. There are many factors that affect spot prices and these cannot always be predicted ahead of time. This information should only be used as guide to assist forward planning of site operations and staffing for sites that are utilizing the pool monitoring system.

TEMPERATURE FORECAST FOR THE WEEK AHEAD

	Sat		Sun		Mon		Tue		Wed		Thu		Fri	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
NSW	24	39	24	28	18	25	19	24	20	27	20	31	23	31
SA	23	36	18	24	18	24	14	28	15	29	17	29	16	28
VIC	19	26	15	19	13	18	14	21	13	29	17	26	15	28
QLD	23	33	24	33	23	32	24	33	24	33	24	32	22	31

VICTORIA

Date	Time				
Saturday 11-2	7am - 10am	10am - 12pm	12pm - 3pm	3pm - 6pm	6pm - 7am
Sunday 12-2	7am - 10am	10am - 12pm	12pm - 3pm	3pm - 6pm	6pm - 7am
Monday 13-2	7am - 10am	10am - 12pm	12pm - 3pm	3pm - 6pm	6pm - 7am
Tuesday 14-2	7am - 10am	10am - 12pm	12pm - 3pm	3pm - 6pm	6pm - 7am
Wednesday 15-2	7am - 10am	10am - 12pm	12pm - 3pm	3pm - 6pm	6pm - 7am
Thursday 16-2	7am - 10am	10am - 12pm	12pm - 3pm	3pm - 6pm	6pm - 7am
Friday 17-2	7am - 10am	10am - 12pm	12pm - 3pm	3pm - 6pm	6pm - 7am

Chart Legend

Low Risk		Medium Risk		High Risk	

Figure 3: ***Market Notification Email***

2.3 Peak Price Event – Usage v Price

In mid-January 2018, North East Water experienced a couple of peak price events which resulted in the spot market pricing increase up to 12,000%. On 18 January, the most prominent event occurred which saw the 30-minute spot market price increase from $90/MWh to $12,900/MWh in a very short space of time. The total event only lasted around one and a half hours but through monitoring the spot market and power shedding energy intensive equipment the company was able to reduce our electricity demand from over 1,100kWh to 700kWh (Figure 4) and produce a potential energy saving of $12,000 if we were purchasing straight from the spot market without hedging (Table 1). This would have given the potential of saving an estimated $30,000 over the events in mid-January.

Operations at North East Water were alerted of the upcoming events, they started plants early to fill clear water storages at the WTP's, gain capacity for influent storage at the WWTP's and then monitored the market to start the voluntary load shed. At our largest energy intensive site – West Wodonga Wastewater Treatment Plant the operations staff switched off the inlet pumping, halted sludge dewatering (centrifuge) and stopped aeration (all 6 blowers turned off) for the peak period. The short outage did not affect effluent quality.

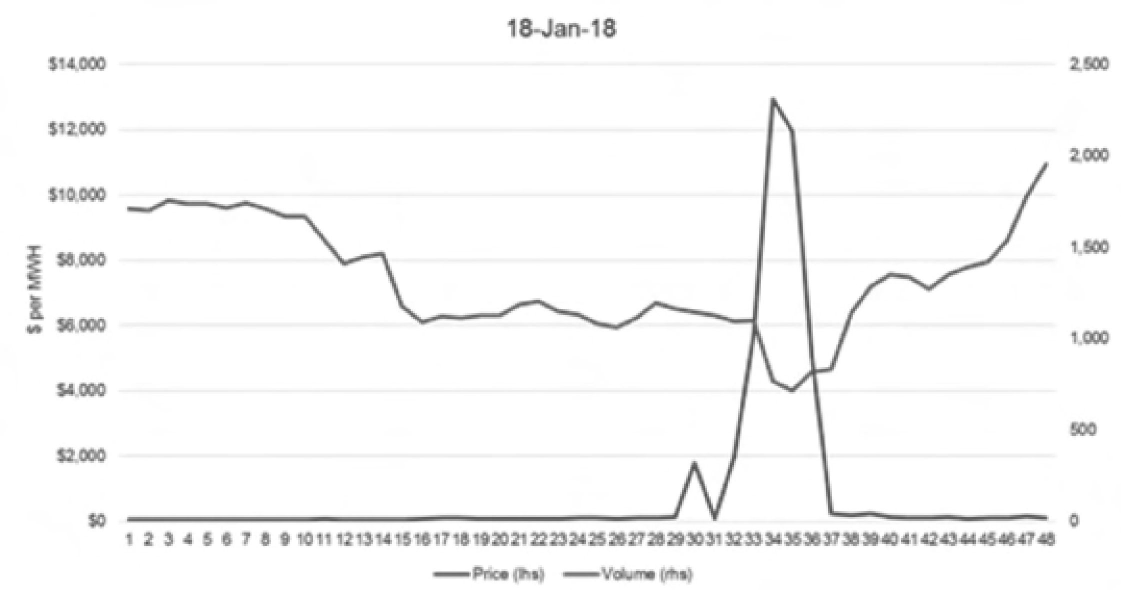


Figure 4: ***Peak Price Event vs Load Shedding***

Table 1: ***Victorian Electricity Total Demand & Price vs NEW Usage & Cost 18/01/2018***

Date	Time	Total Demand VIC	$ per MWh	NEW Usage kWh	NEW $
18/01/2018	12:00	6891.32	94.21		
18/01/2018	12:30	7115.51	100.81		
18/01/2018	13:00	7386.47	93.26		
18/01/2018	13:30	7558.88	105.53		
18/01/2018	14:00	7808.9	107.89		
18/01/2018	14:30	8043.88	136.05		
18/01/2018	15:00	8201.25	1775.2	1,142.63	2,028.39
18/01/2018	15:30	8360.11	86.72	1,124.96	97.56
18/01/2018	16:00	8556.23	1960.54	1,093.70	2,144.24
18/01/2018	16:30	8717.88	5682.01	1,096.74	6,231.70
18/01/2018	17:00	8887.54	12931.04	766.47	9,911.20
18/01/2018	17:30	8899.85	11960.16	713.71	8,536.05
18/01/2018	18:00	8954.82	5078.6	818.45	4,156.59
18/01/2018	18:30	8889.58	238.45		
18/01/2018	19:00	8793.73	178.84		
18/01/2018	19:30	8540.96	230.07		
18/01/2018	20:00	8241.23	124.28		
18/01/2018	20:30	7961	103.98		
18/01/2018	21:00	7566.11	104		

3.0 CONCLUSION

North East Water has decided to reduce rising electricity costs by swapping from reliance on financial hedging to a physical hedge. From a fixed price arrangement which gave guaranteed pricing into the spot market with a reducing level of financial hedging. Physical hedging is developed through a better understanding of energy usage, monitoring of market prices, the ability to effectively curtail energy use when required and to be able source energy from secondary sources where possible.

The next stage in this energy transformation is to automate the electricity shedding by investing in intelligent controllers which will monitor on-site electricity usage and real time monitoring of market pricing, when a short high-priced event is about to occur the unit notifies the operators and automatically starts a sequenced shutdown of pre-selected energy intensive equipment. Once the pricing peak has subsided the system will return operations to normal. This will save operations staff from having to manually stop and start machinery especially during out of hour's periods. Being an automated program will allow operations staff to adjust timings due to different process demand periods, selected equipment, shutdown start up sequences and cancel the program if there are issues with the treatment system such as high flows due to bushfires.

Apart from the financial and environmental savings other bonuses from this transition include the ability to return power to the grid and use alternative energy sources which was not available under a fixed price contract. This is a great bonus with possible future investments in large scale solar power generation and cogeneration as a step from energy consumer to an energy producer.

4.0 ACKNOWLEDGEMENTS

With great thanks I would like to acknowledge Nicholas Moore – Finance Manager NEW and his work on Electricity Procurement and to Aaron Sewell - Manager Maintenance and Operations Alpine NEW for his help in researching and finalising this paper. Also, to Peter Tolsher for allowing me the chance to produce this paper.

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March 2108

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HOW WE SURVIVED THE 2019 RECORD BREAKING HEAT WAVE

Paper Presented by:

Chris Cornell

Authors:

Chris Cornell, *Leading Hand Electricians,*
Heidi Josipovic, *Team Leader Wastewater Services*

Albury City Council

13th Annual WIOA
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Orange PCYC,
3 & 4 April, 2019

HOW WE SURVIVED THE 2019 RECORD BREAKING HEAT WAVE

Chris Cornell, *Leading Hand Electricians,* Albury City Council
Heidi Josipovic, *Team Leader Wastewater Services,* Albury City Council

ABSTRACT

January 2019 has turned out to be our hottest month on record, with record breaking temperatures covering parts of Australia. With this came operational issues around water supply, equipment over heating, staff heat stress and trying to keep our assets running through this period of extreme weather. Customers were using twice as much water compared to the same period from previous years, due to this elevated use some customers experienced low water pressures and in some extreme cases no water during peak usage times. Clear water storage levels were on a steady decline and struggling to recharge during off peak times. Not only did we face water supply issues, but our equipment also struggled with the heat, electrical switch boards were overheating and faulting out critical equipment including sewer pump stations. During the heat wave staff were faced with extreme working conditions and heightened pressure with critical assets failing. This is our story on how we pushed through this event and the remedial actions we took during and after the event to ensure the water and sewer kept flowing through these record high temperatures and be able to cope with future heat waves.

1.0 INTRODUCTION

What a start to 2019, as you may be aware, Victoria, New South Wales and South Australia were hit with some of the hottest temperatures ever recorded for those locations. The extreme heatwave across Northern Victoria and Southern New South Wales produced record high temperatures: 45.3 °C in Albury-Wodonga the hottest day ever recorded on a record spanning over 30 years. With these record temperatures came problems with water supply, electrical equipment overheating, and staff heat stress working in these conditions to keep the water supply to our customer and the sewer network flowing.

Heat Wave Maximum temperatures recorded at Albury Airport – Bureau of Meteorology

Sunday 13th January 2019 – 42.8 °C
Monday 14th January 2019 – 41.9 °C
Tuesday 15th January 2019 – 44.5 °C
Wednesday 16th January 2019 – 45.3 °C
Thursday 17th January 2019 – 42.0 °C

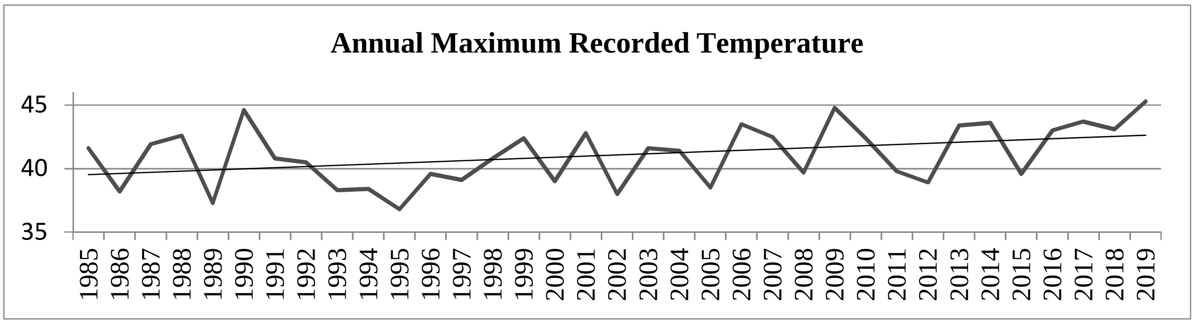

Figure 1: ***Annual Maximum recorded Temperatures – Bureau of Meteorology***

2.0 DISCUSSION – SEQUENCE OF EVENTS

To give you an understanding of the sequence of events that unfolded during the heat wave we have broken down the daily issues we faced and the remedial actions we underwent to keep our assets operational and our customers with water supply.

2.1 Tuesday 15th January 2019 – 44.5 °C

After a few days of temperatures in the 40's and no sign of relief we started to get some failures in sewer pump station switch-boards. The VSD's were the first to fail, members of our electrical team took thermal guns around the sites and recorded temperatures in excess of 60°C ambient cabinet temperatures and some electronic components reached 70°C well above their operating parameters. We immediately looked into ways to cool down the internals of the switch boards to get critical pumps running before any sewer spills or water supply issues occurred. Sites that had minimal venting on the electrical cabinets had large meshed vents cut in, cooling fans were purchased and installed, spare VSD's were purchased for redundancy, gazebos were erected to stop the direct heat on switchboards, some switchboards were opened and continuously manned with a fan blowing on them. The external covers of our critical water pump station switchboards were even given a hose down in an attempt to drop the internal temperatures. All this and we still haven't made it to the hottest day. Figure 2 is a sewer pump station site we had to erect a gazebo over to prevent the direct sunlight on the switch board in an attempt to cool it down so the pumps could be restarted. Due the switchboard being in close proximity to a property boundary fence and pedestrian foot path we had to erect temporary fencing to deter anyone from tampering with the gazebo or tripping over the poles. We had to also ensure there was adequate access for pedestrians to navigate around the barricaded site.

Figure 2: ***Gazebo over sewer pump station switch-board***

2.2 Wednesday 16th January 2019 – 45.3 °C (record temperature)

Extreme heat working conditions were a high risk to outdoor staff. To assist with heat stress, our staff bought and froze some Zooper Doopers for internal cooling and Sqwincher Sachets (electrolyte mix) to mix with water to combat dehydration. These remedies helped staff who reported times of cramping and exhaustion from working in the extreme heat.

Outdoor staff changed their work start time to 6 am for the days in the 40's and prioritised the outdoor task to be completed before lunch. Work that could be done in the air-conditioned workshop was scheduled in the afternoon to eliminate the need for staff to be out in these extreme temperatures. All these small changes made a huge difference to combating heat stress. We are in the process of purchasing a deep freezer so outdoor staff can have continual access to ice for putting in their drink bottles and eskys.

A second round with the thermal gun came with some good news, the remedial actions have helped. The results were better. The hottest internal switchboard temperature recorded now was down to 52 °C Celsius inside. Council has generally rated their VSDs to 50 °C, even though slightly over, it was the worst one and the temperatures have dropped significantly since the previous day even with the hotter ambient temperature.

Now we were facing other problems, the hotter the weather got the more water our customers used. The residents of Albury nearly doubled their average peak water use and were 42% above the average January total demand. With this came strain on our water pump stations and reservoirs. Some customers were experiencing low water pressure and in extreme cases some customers with elevated blocks for short periods of time even ran out of water during peak periods as the reservoir levels dropped below normal operating levels and water demands soared. This was a growing concern as the forecast wasn't offering any cool changes and the maximum level in the, Table Top Reservoir, water reservoir 28 was on a steady decline every day the heat wave continued. This put more households at risk of low or no water pressure. Our teams acted quickly and came up with a solution to put in a generator to run an additional pump, so the water reservoir levels had a chance to replenish overnight, this plan worked, and our water supply issues eased.

Albury City Council are about to upgrade the Water Pump Station supplying water reservoir 28 and with new pipework already installed, this will allow larger pumps to maintain the reservoirs level in peak times into the future. Planned augmentation of the water supply mains north of the reservoir will also assist in ensuring continued water supply to residents during periods of peak water demand.

Figure 3: ***Temporary generator to run the standby pump to increase the water supply to reservoir 28***

2.3 Thursday 17th January 2019 – 42°C

The heating issues at our sewer pump station switch-boards were now under control but they have moved on to our main Wastewater Treatment Plant. One of the clarifier drives decided it was too hot to run and tripped out at 71°C. Luckily, we had spare parts, and this was quickly rectified by our Mechanical and Electrical crew. Recently we had a new band screen installed at the inlet of our wastewater treatment plant. The control panel for this new system is exposed to the elements and didn't cope well with the extreme temperatures even though it already has a radiant heat shade enclosure (Figure 4). We had to install a temporary fan to cool the externals of this control panel. Due to the high hydrogen sulphide levels at the inlet works the option of installing ventilation would pose another risk to the switch board allowing the corrosive gasses to enter. We are still looking into other options for this site for a permanent solution.

Figure 4: ***Fan cooling the new band screen control panel***

2.4 Wednesday 23rd January 2019 – 40.6°C

With only little reprieve from the heat it is back in the 40's yet again. Our heating issues continue. The air conditioner has now failed at our main sewer pump station in the middle of Albury's CBD. The electrical switch board room was warming up fast, luckily, we had local suppliers that sensed our urgency and dropped everything to assist, and source the parts for us, getting the system back up and running within a day.

To rectify heating issues at our raw water pump station switchboard, our electrical staff hired a portable industrial evaporative air conditioner and installed a 2500 L water tank as we had no potable water available on site. Our fitters plumbed up a pump so we could run filtered water to the air conditioner for operation, and the tank was refilled with filtered water twice a week.

We then looked into options to purchase portable evaporative air conditioners as funnily enough we were having trouble finding available air conditioners for hire during this period. We did manage to hire two which we ran a temporary water line to, to service the evaporative cooler (Figure 5).

Figure 5: ***New temporary water line cut in to supply water to the hired evaporative air-conditions and the new permanent air conditioner installed.***

3.0 CONCLUSION – POST EVENT

Following these events, we have engaged a switchboard consultant to do an audit of our sites and to provide options to permanently fix the issues we experienced. We are in the process of upgrading the water pump station and augmenting a number of water mains to ensure our reservoir levels can be sustained to alleviate water supply and pressure issues in the future. We have checked all the VSDs in vulnerable sites and changed the fans in the majority of these drives that are of age. We are in the process of ensuring all our critical sites have adequate cooling for any future extreme temperature events. From historic data and future projections, the weather maximum temperatures are only forecast to get hotter, this is a great concern and the main driver to ensure our assets are designed and built to withstand the hot climate we live in.

4.0 ACKNOWLEDGEMENTS

The Albury City Council Mechanical and Electrical Staff, for working through the event and contributing ideas. Chris Murphy and Heidi Josipovic for your assistance with pulling data together for this paper.

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MAJOR MAINTENANCE REQUIRING COORDINATED FILTRATION PLANT SHUTDOWN

Paper Presented by:

Matthew Benstead

Author:

Matthew Benstead, *Maintenance Coordinator,*

TRILITY

13th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
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3 & 4 April, 2019

MAJOR MAINTENANCE REQUIRING COORDINATED FILTRATION PLANT SHUTDOWN

Matthew Benstead, *Maintenance Coordinator***,** TRILITY

ABSTRACT

To provide an engineered solution that provides an opportunity to refurbish an essential flow control inlet valve (GKILR 800) with minimal shutdown time in a 24/7, 365 day water filtration process operation and mitigate the risk of a single point failure.

Investigations of options included a dual inlet control valve pipe arrangement, a valve replacement to a modern plunger valve design until final selection of a temporary, double flanged 750-30A butterfly valve with modified spool pieces was selected to allow off-site refurbishment of the original GKILR 800.

Challenges included the impost on operations staff time, engaging outside engineering assistance and project management with an additional resource part time R&R engineer position, however timely replacement of the valve was achieved in a twenty (20) hour shutdown with no disruption to the 300,000 customers within the supply network.

1.0 INTRODUCTION

TRILITY is a water utility service provider and the operator of the Macarthur Water Filtration Plant (WFP) as part of a 35 year operation and maintenance contract with our client, Sydney Water. Construction of the plant began in the early 1990's with the plant commissioned and operational by 1995.

The Macarthur WFP is a 265MLD direct filtration plant which operates 24hrs per day, 365 days per year as it is the sole supply of drinking water to approximately 300,000 customers in Sydney's outer south west area of Campbelltown & Narellan. Raw water is supplied to the Macarthur WFP from any of the four (4) dams within the local catchment area. The water goes through two (2) stages of pumping which lift the water approximately 200m in overall height from the Cataract River to the 2 x 5ML Raw Water Storage Tanks. From the Raw Water Tanks, the water then begins its gravitational flow through the filtration plant and onward journey to the Sydney Water Delivery network where the water descends around 140m over a 15km pipeline before Sydney Water take control of the water into their network delivery system for distribution to homes and businesses.

Whilst the Filtration plant relies heavily on gravity for water movement, there are a range of moving parts, pumps, valves and equipment that are integral to the plant’s operation. These all require maintenance or replacement at some point in their life and whilst there are a range of Duty/Standby systems in place as part of the plant design, the inlet flow control valve to the plant is one asset that is a stand-alone item identified as being a single point of failure for the process during 2013 and presented a significant risk due to the asset age.

Once this issue was identified steps were taken to commence the mitigation of this risk, however, being the sole supply of water for this network, it was not an easy fix which has taken years of investigation and planning to find the best solution and work harmoniously with a range of stakeholders.

2.0 DISCUSSION

2.1 G.K.I.L.R 800

The Raw Water Inlet Control Valve is critical to the operation of the water filtration plant. In normal operation, the valve opens and closes automatically allowing raw water to enter the filtration plant via gravity flow and meets the flow demands of the customer network.

The valve itself was manufactured by GEC Alsthom Australia, it is sized with an 800 mm nominal bore internal control cone. The upstream/inlet flange is a diameter of 1060 mm and the downstream/outlet flange is 1910 mm. To drive the 800mm disc there is an attached hydraulic motor and 3 hydraulic cylinders. The entire unit weighs approximately 4500kg's and is more accurately described by the manufacturer as an "In Line Regulator" however, more affectionately known as a "G.K.I.L.R 800"

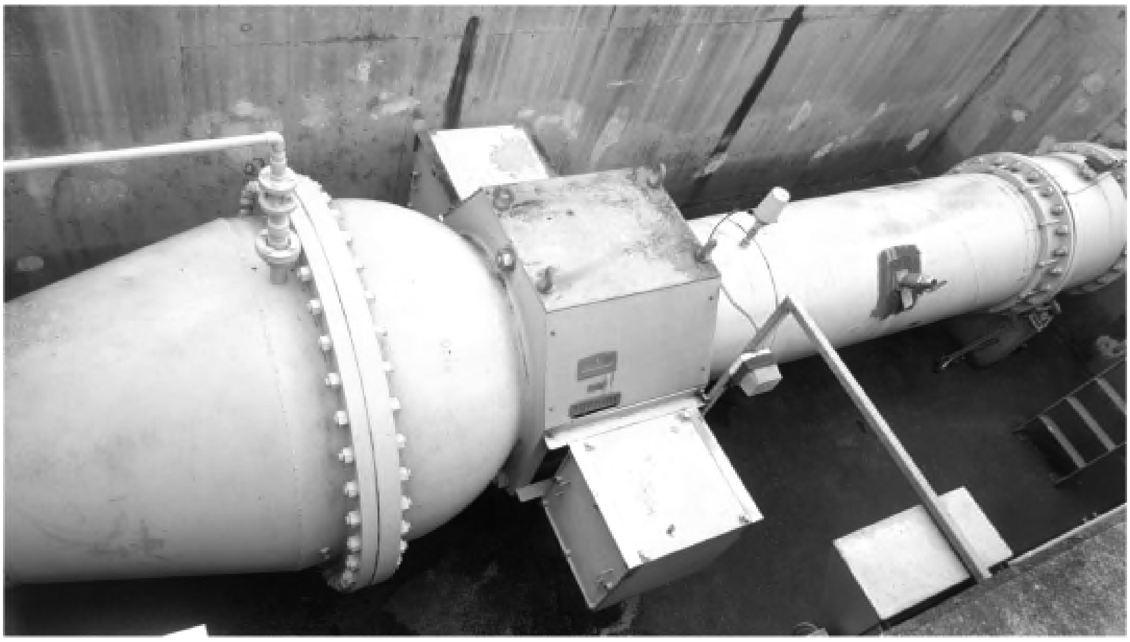


Figure 1: ***Raw Water Inlet Flow Control Valve (GKILR 800)***

2.2 Recognising the Risk

In 2013, TRILITY underwent some restructuring within the business and I was appointed to the dual role of Process Controller/Maintenance Coordinator. This occurred at the same time as Pat Nolan was appointed Plant Manager. Negotiations were also held with Sydney Water to extend the operating contract from a 25-year agreement to a 35-year agreement. This contract extension triggered us to reconsider the 'whole of life' maintenance strategy for the plant. At this point the Raw Water Inlet Control Valve was identified as a single point of failure with no alternative option or strategy in place if the valve were to fail without notice.

2.3 Initial Steps

Our initial investigations commenced in late 2013 and extended into 2014. We identified the valve was now approximately 20 years old, it was not a mass manufactured item, and therefore not something that was easily replaced. We reviewed the maintenance history that had occurred to date and found there had been little maintenance undertaken other than visual inspections as the valve had operated almost faultlessly until now.

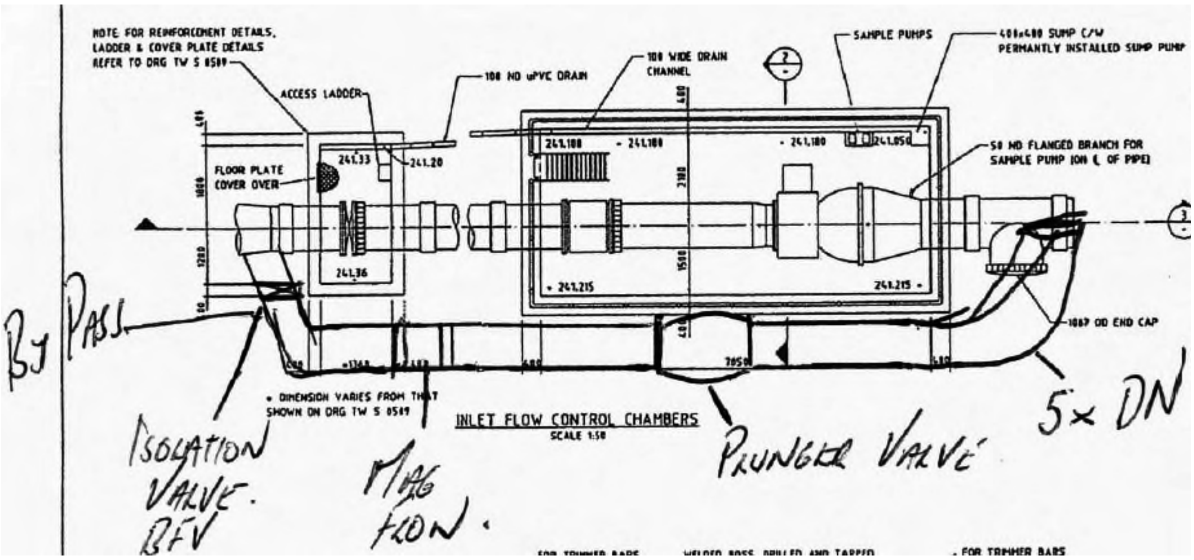
It was decided the first thing we needed to know (other than the potential risk of failure) was the condition of the valve and the control system as the process controller team had also noticed that the flow controller output was not completely repeatable on flow changes made via the control valve.

A new flow meter was purchased and installed. A new linear displacement transducer was purchased and installed on the control valve (for valve position output feedback). A hydraulic specialist was engaged to undertake an assessment of the hydraulic drive unit for the valve where it was found there was a large gap between the cylinder rod to valve plate adjustment. This explained the lag in the system when required to operate in one direction and then the other - which is the core function of a flow control valve.

2.4 Finding a Solution

Being a 24/7 operation and single source of supply, a key aspect to all of this was that we could not afford to be shutdown/offline for a significant amount of time. This is primarily driven by the requirements of the distribution system and the expectations of our client. A significant amount of time was deemed required to undertake this piece of work - around sixteen (16) to twenty (20) hours. This forced us to continue to investigate what options we had to address all the concerns associated with the valve without impacting our client.

During the remainder of 2014 we commenced investigations into how we might source a replacement valve which would mean we could minimise the downtime by undertaking a straight "like for like" replacement. We also considered installing the "new" valve in a bypass style arrangement as this would provide the redundancy, we sought for risk mitigation.



<u>**Figure 2:**</u> ***Bypass Option***

With a straight valve replacement being seen as an option, we attempted to source an identical replacement, but unfortunately discovered this was no longer possible as production of the GKILR 800 had ceased, so the next consideration was to source a valve of similar style operation and our investigations found a Plunger Style valve might suit this purpose, however after some time invested into this and a quoted price of approximately A$125,000ea for a valve only, we realised this was going to be an expensive exercise and we required more expertise than our experience on site had the capability to manage.

2.5 Solution Development Progress

The Macarthur operation utilises a lean manning format for operation and maintenance of the Macarthur WFP. At this point in time (2015) of the solution gathering, the site was managed by the Plant Manager, with three (3) full time Process Controllers as well as myself in the dual maintenance coordinator/process controller role and a site administrator.

TRILITY Senior management, Asset management and Engineering team members were now engaged to assist in finding a solution, however due to resourcing availability we once again needed to rely on external support, and an external engineering company was proposed and utilised to scope the best way to achieve solution delivery. As part of that process, it was soon realised by TRILITY that along with delivering this project, a significant amount of work was still required to deliver a range of other requirements at the Macarthur site. In conjunction with those other needs of the business, a 'Repair and Refurbishment (R&R) Asset Engineer' was appointed to the Macarthur site on a part-time basis from 2016.

The addition of the R&R Asset Engineer provided focus and direction to specific tasks at the Macarthur site such as finalising the solution strategy for the risks associated with the GKILR 800. This provided the plant operations team with some relief and an opportunity to get back to their main focus of the day to day operational and maintenance requirements the plant.

The R&R asset engineer was able to work with our engineering contractor to develop a cost effective and sound engineering solution.

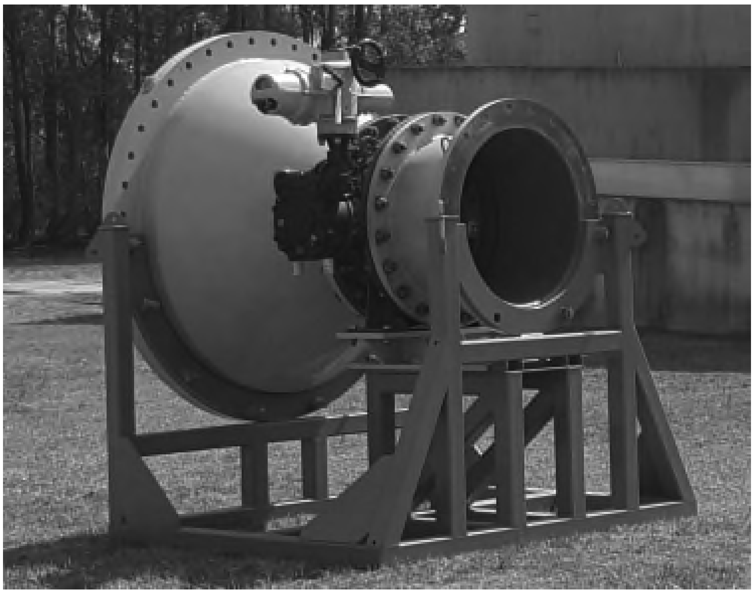
2.6 The Agreed Solution

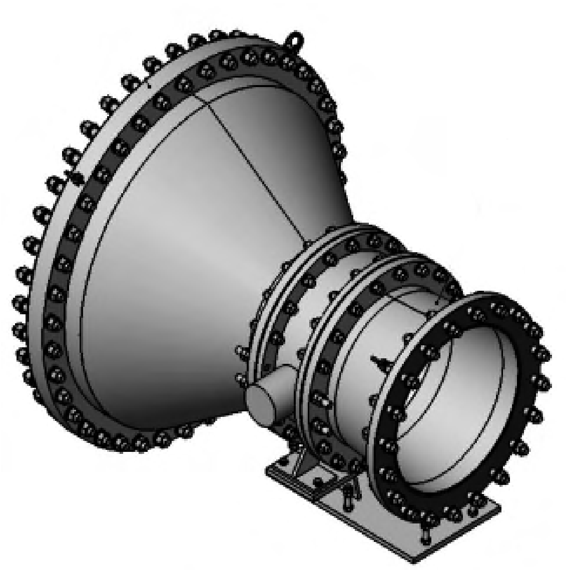
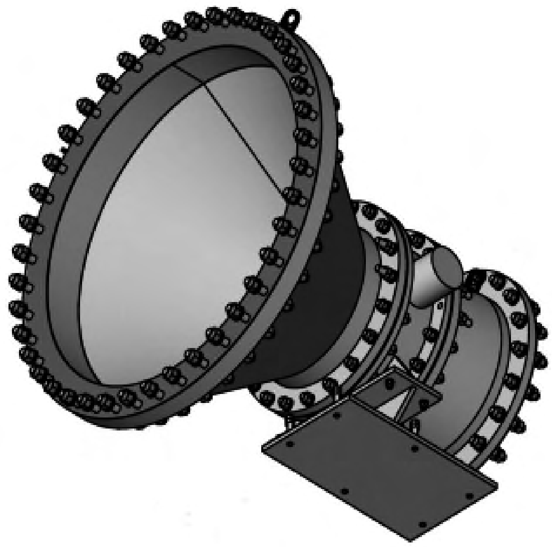
During 2016 and the early part of 2017 an agreed solution was adopted. The solution would be a three (3) part process.

The first part would be to develop a valve arrangement that could be used temporarily. The second part would be to overhaul the GKILR 800 and the third part would be to re-install the GKILR 800 and mothball the temporary valve for use as a future spare should the GKILR 800 ever fail.

This solution centred around the use of a double flanged, 750-30A" butterfly valve with a webbed disc which provides improved flow control as the water transitions across the valve in comparison to a standard flat-disc type valve.

With a valve now selected and approved by the engineers, the next part of the solution delivery was for the engineering contractor to develop two (2) spool pieces that could accurately match the upstream and downstream flange dimensions and bolt patters and then all fit within the 1800mm distance between flanges of the upstream and downstream faces. This was successfully achieved, however an increase in flow noise was identified as a side effect of this option which would require pre and post temporary valve installation noise surveys to be undertaken. Changeout from the GKILR 800 to the temporary valve was planned to be undertaken within sixteen (16) hours and another four (4) hours allowed for plant shutdown and start up. A maximum total of twenty (20) hours downtime.



Remote control of the valve via the plant operation software was also required and obtained by selection of an appropriately sized gearbox and electronic actuator. This was probably the easy part of the process once the valve and spool piece designs were complete.

2.7 Solution Delivery

Many would think that once you have agreed on a solution, the rest is easy, however this was probably the most complex stage of the process as delivering your solution requires the planning, coordination and management of bringing all of your stakeholders together for a seamless execution of the plan.

This step has the potential for unforeseen risks and problems to develop which can impact on the client and ultimately the supply network. Ultimately it is the client who takes the biggest risk in this situation because if their network runs out of water, it's their customers who make the complaint.

After multiple risk assessment reviews and planning sessions with the client, an implementation strategy was devised and planned.

This plan incorporated aspects such as the controlled shutdown and start-up of the filtration plant, lockout/tag out isolations of the process, PLC changes and post installation testing of the valve, the required trade labour in the preparation for installation and on the day, cranes and dogman for the delivery of the temporary valve to site and installation as well as removal of the GKILR 800 back to the engineering workshop for overhaul.

I am pleased to say, that on September 19th, 2018, the plan was executed safely and almost faultlessly.

3.0 FINAL STEPS

The final steps remaining in this process now are to:

1. Complete the overhaul of the GKILR 800.
2. Once the overhaul is complete, a date will be selected in consultation with our client and the overhauled/original GKILR 800 valve will be put back into place.
3. The temporary valve will then be mothballed and managed as a working spare part within our spare parts inventory. This spare provides the redundancy we sought all the way back in 2013 as we now know that upon failure of the GKILR 800, that within a very short timeframe, we can have the temporary valve installed and have the filtration plant operational once again.

4.0 ACKNOWLEDGEMENTS

Phil De groot - TRILITY R&R Asset Engineer
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Leussink Engineering
K&R Fabrications
Sydney Water

VHF Ethernet Communication

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Port Macquarie Hastings Council

13th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Orange PCYC,
3 & 4 April, 2019

VHF ETHERNET COMMUNICATION

Alex McCaffrey, *Telemetry Technician,* Port Macquarie Hasting Council

ABSTRACT

Long Flat Water Treatment Plant (LF WTP) is an unmanned microfiltration plant that is controlled by SCADA via a UHF radio link. The Water Process Team responsible for running the plant and ensure water quality compliance currently rely on a limited amount of information available on the SCADA system.

LF WTP has always struggled with unreliable communications to the radio repeater with a mountain range in between making it difficult to maintain a reliable signal path.

The Remote Telemetry Unit (RTU) is the limiting factor. The RTU limitations mean important data can't be returned to SCADA for the Water Process Team to access. The current RTU limitations can't be changed to meet the needs of the Process Teams requirement for data. The Australian Drinking Water Guidelines and our Drinking Water Management Plan has reporting requirements that we needed to provide data for water quality compliance.

The directive from the Water and Sewer Process Engineer was and I Quote "If we have the data and control on site, I want it on SCADA". This meant we need to return more data.
We commenced our search for other options that would support the expectations of the Process Team, deliver future integration and expand the RTU IO. Key features that we needed to include, connection directly with site PLC's, HMI's VSD's and other smart devices remotely via Ethernet and utilise DNP3 in the future.

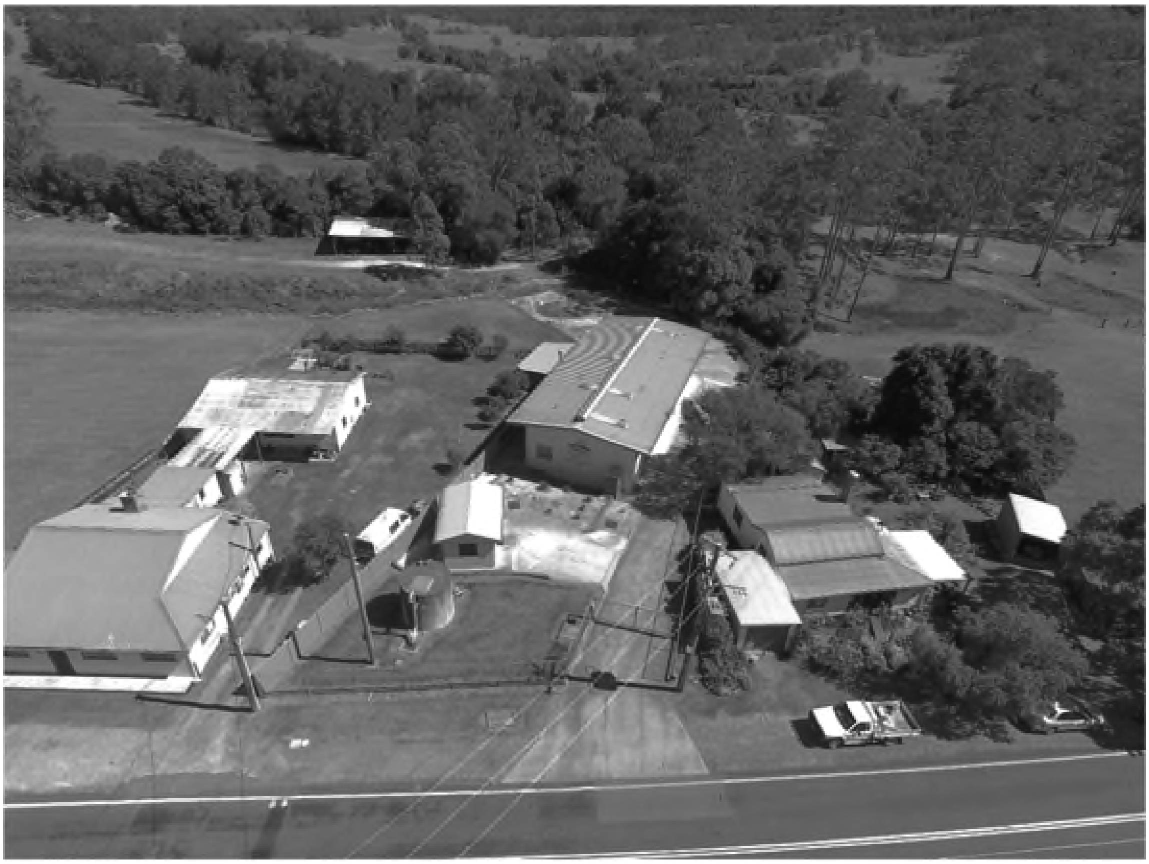
1.0 INTRODUCTION

Long Flat WTP is located 50km drive west of Wauchope in the beautiful Hasting river valley and services a community of 250 people. The WTP has a capacity of 100KL/day utilising Microfiltration and Sodium Hypochlorite for primary disinfection. The WTP plant is unmanned and fully controlled via our SCADA system. Instruments onsite include 5 Turbidity, 2 Chlorine, 3 pH, 8 tank levels, 7 flow meters and many other analogue and digital sensors used to control the plant.

The Water Process Team asked to access all available data from the WTP on SCADA to assist them in their responsibility to monitor and operate this remote plant. Their request was for the additional data was to enable their centralised reporting database direct access to the raw data for onward reporting on process compliance. Having a central single version of the truth and automated reporting was the vision but our remote SCADA and Telemetry network was at its IO capacity. Using Elpro RTUs and SCADA-C software we were limited by the RTU frame type. The WTP RTU could only transfer 128 digitals inputs, 128 digital outputs, 24 analogue inputs, 8 analogue outputs and 4 pulsed inputs. This meant that some important data couldn't be collected via the RTU to our SCADA system and in turn not be available to the Water Process Team and could not be easily saved and made available for reporting requirements.

The Water section of Council has budgeted to replace the exist SCADA software in 2021 and anything we planned for LF WTP to deliver the Water Operators request must integrate with the planned but not designed SCADA upgrade.

Long Flat WTP has been a long-standing communications (coms) problem for PMHC. The remote site has always struggled to have reliable coms of data. The radio repeater at a distance of 20km from the WTP is not overly troubling but with a 200m high mountain range in between the radio path makes it difficult to maintain reliable robust radio signal and reliable coms.



2.0 DISCUSSION

The challenge:

- How to improve the radio data speed and capacity that we can transmit from LF WTP to the new SCADA system without using Third party providers e.g. NBN, Mobile phone/data providers or installing new communications towers and multiple radio links.

- Methods of transferring communication data has been rapidly changing over many years, but all seem to have some limitations that influence what works and what is unreliable.

  - Availability to the area,
  - Physical obstructions,
  - Distance between sites,
  - Required data,

Option 1:

- Microwave links are far the fastest wireless communication at 400Mbps in a 56MHz channel using 256QAM, but microware requires unobstructed line of sign to link and pass data.

Option 2:

- Investigate existing, new and improved radio technologies.

    - UHF 450 MHz radios can link and transfer limited data over this distance and terrain. UHF signal does not require absolute line of sign, but the speed and reliable data transfer is reduced as obstruction and distance increase.

    - VHF 150 MHz has speed and signal reliability and is least impacted by distance and obstruction of all the radio types we considered. 150 MHz VHF does have speed and data bandwidth limitations, but new modulation techniques is overcoming these limitations.

    - 900 MHz spread spectrum radio will deliver the require speed and bandwidth but not in this situation. The distance and terrain would prevent reliability of this link.

Option 3:

- VPN/NBN

    - VPN/NBN will deliver speed and data bandwidth but connection to third party providers reduced network security from possible outside attacks, needing managed routers to limit and control this risk. This option also attracts monthly rental charges. 3rd party provider reduces our control of outages, response and outage repair times.

Option 4:

- Expand the current system capabilities

    - The current Elpro Radio wasn’t suitable to meet the request and future SCADA as it couldn’t pass Ethernet traffic.

As Councils current PLC platform is Omron and mostly communicating on the sites via Ethernet, we decided the new radio link must also communicate via Ethernet.

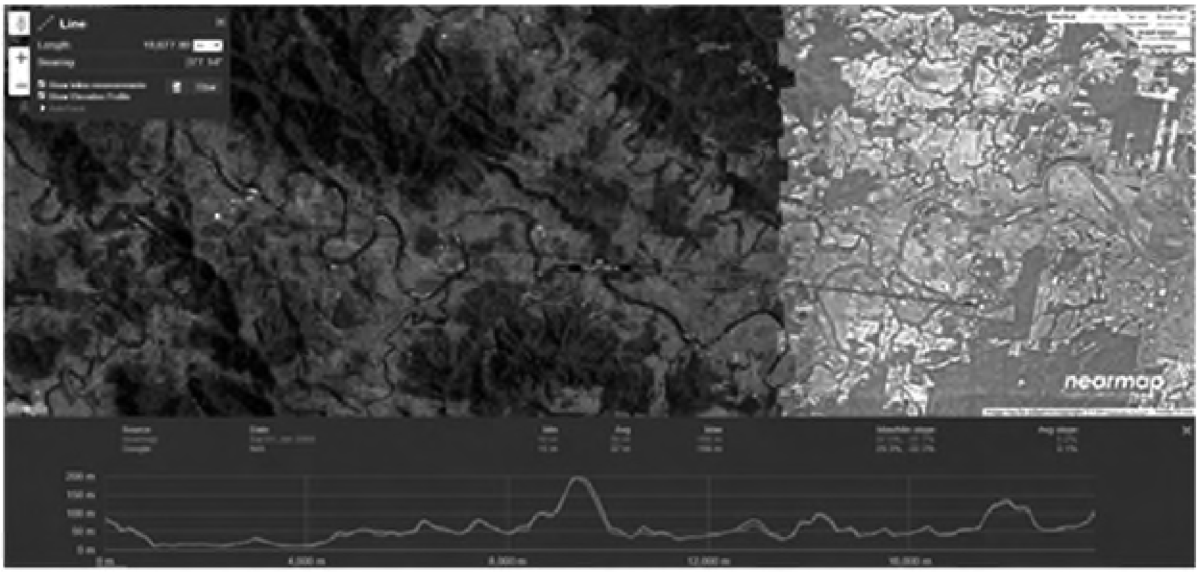
2.1 Radio and Signal Path

The investigation commenced with a desktop radio path survey using Nearmaps elevation profile feature. Our local knowledge and current network using 450 Mhz worked but delivered minimal data transfer.

The radio path is obstructed with a 200M high mountain range in the middle of the 20Kms distance. The mountain eliminates any chance of a microwave link being used to cover this distance even with a tower added to each end.

The existing link was on 450 MHz has a RSSI of around -90 dBm with an 11 dBd gain 9 element yagi gain Antenna.

We searched the market for a radio technology that could provide higher speeds over this distance. We found that the recent VHF and UHF radio technology which utilises Quadrature Amplitude Modulation could deliver increased speeds and data bandwidth. UHF and VHF radios utilising 16 QAM are capable of 80kbit/s when using a 25 kHz channel or 160kbit/s when using a 50 kHz channel.



<u>Figure 1:</u> ***Signal Path from Wauchope to Long Flat***

2.2 Limited I/O

We could have simply added another Elpro processor to carry the data but that would leave us with no DNP3 capability for the future, and we would be left with the same radio signal issues. Doing this would have been the same amount of work as changing and upgrading the system.
Increased speeds and conversion to Ethernet means we are able to run the WTP on an Ethernet network, giving us limitless I/O and almost instant data fed into our SCADA system. This also provides head room to be able to program and diagnose faults, or change PLC code live over the network, eliminating the need to travel an hour to connect to the PLC to respond to a fault.

Already having Omron PLCs on site to control the site that had all the I/O fed into it, we needed to utilise them to pass the data Omron PLCs can provide more I/O than we will ever need, at a higher resolution then the Elpro cards.

The benefits that comes with Ethernet communication includes, signal stability and consistency, signal and to an extent network security and scalable to wide area networks. Ethernet communication will permit our staff to connect to the LF WTP site PLC's from their office in Port Macquarie for interrogation and fault finding. Council contractors will also have remote access to the same PLC code.

Long Flat WTP Status

WTP Building Security System	Armed
WTP Building Security	Normal
MCC-S Skid Cabinet Security	Normal
Station Mains Power	Normal
MCC PLC Unit	Normal
CMF-S Plant	Stopped
WTP Emergency Stop	Normal
Shutdown	Off
Shutdown Alarm	Normal
Warning Alarm	Active
Filtration	Off
Standby	On
Backwash	Off
Pressure Decay Test	Off
LeakTest	Off
Acid CIP	Off
Hypo CIP	Off
CIP Halted	Off
CIP Extended Soak	Off
CMF-S Control Air Pressure	Normal
CMF-S HP Air Pressure	Normal
CMF-S Exhaust Fan Flow	Normal
CMF-S Tank Overflow	Normal
WTP Bldg Pipe Pit Flood	Normal
Raw Water Strainer Pressure	Normal
Blower 1 Run	Stopped
Blower 1 Fault	Normal
Blower 2 Run	Stopped
Blower 2 Fault	Normal
Both Blowers Fault	Normal
Air Compressor 1 Run	Stopped
Air Compressor 1 Fault	Normal
Air Compressor 2 Run	Stopped
Air Compressor 2 Fault	Normal
Both Air Compressors Fault	Normal
Exhaust Fan Fault	Normal
Exhaust Fan	Stopped
Local Time Clock Inhibit	On
UPS Healthy	Normal
UPS Battery Healthy	Normal
UPS AC Healthy	Normal
MCC Air Conditioner	Stopped

Raw Water River Pump 1	Stopped
Raw Water River Pump 1	Auto
Raw Water River Pump 1	Normal
Raw Water River Pump 2	Stopped
Raw Water River Pump 2	Auto
Raw Water River Pump 2	Normal
Raw Water River Pump Flow	Off
Both Raw Water River Pumps	Normal
Filtrate Backwash Pump 1	Stopped
Filtrate Backwash Pump 1	Auto
Filtrate Backwash Pump 1	Normal
Filtrate Backwash Pump 2	Stopped
Filtrate Backwash Pump 2	Auto
Filtrate Backwash Pump 2	Normal
Both Filtrate Backwash Pumps	Normal
Clear Water Pump 1	Stopped
Clear Water Pump 1	Auto
Clear Water Pump 1	Normal
Clear Water Pump 2	Stopped
Clear Water Pump 2	Auto
Clear Water Pump 2	Normal
Both Clear Water Pumps	Normal
Backwash Tank Pump 1	Stopped
Backwash Tank Pump 1	Auto
Backwash Tank Pump 1	Normal
Backwash Tank Pump 2	Stopped
Backwash Tank Pump 2	Auto
Backwash Tank Pump 2	Normal
Both Backwash Tanks Pumps	Normal
Backwash Tank Pump Flow	Off
Chemical Tank	Normal
Chemical Tank	Normal
Chemical Tank Security	Normal
BackwashTank	Normal
BackwashTank	Normal
Backwash Tank Security	Normal
Clearwater Tank Security	Normal
Clearwater Tank	Normal
Filtrate CL2/pH Inst	Normal
Filtrate CL2/pH Inst Flow	Normal
Clearwater Tank Outlet Turbidity	Normal
Clearwater Tank Outlet Turbidity Flow	Normal
Clearwater Tank Outlet CL2/pH Inst	Normal
Clear/W Tank Outlet CL2/pH Inst Flow	Normal

Filtrate Water Turbidity	0.02	NTU
CMF pH	7.22	pH
Filtrate Water Temperature	10.20	Deg C
Filtrate Residual Chlorine	4.08	mg/L
Filtrate pH	7.80	pH
Shutdown Alarm Number	0	No.
Warning Alarm Number	153	No.
Filtration Flow Setpoint	4.31	L/s
CMF-S Cell TMP	25.10	kPa
Backwash Pressure	0.00	kPa
Pressure Decay Test Result	0.51	kPa/min
CMF-S Tank Level	90.20	%
Clear Water Tank Level	95.69	%
Backwash Tank Level	30.20	%
Chemical Tank Level	2.75	%
Raw Water Pump Speed	0.00	Hz
Filtrate BW Pump Speed	0.00	Hz
Filtration Since Last BW	15.69	mins
Filtration Since Last CIP	122.35	Hrs
Time Since Last PDT	183.53	Hrs
Membrane Resistance	1.33	No.
Current FFI	3.92	No.
Current Recovery	97.25	%
Filtrate Backwash Flowrate	0.00	L/s
Filtrate Backwash Flow Total	0	kL
Backwash Flowrate	0.00	L/s
Backwash Flow Total	0	kL
Clear Water Flowrate	0.14	l/S
Clear Water Flow Total	0	kL
Backwash Outlet Flowrate	0.00	L/s
Backwash Outlet Flow Total	0	kL
Raw Water Flowrate	0.00	L/s
Raw Water Flow Total	37.00	kL
Power Consumption	0.00	kWh
Daily Operating Hours	0	Hrs
Daily Backwashes	0	B/W

Figure 2: ***This is the current I/O that is drawn front LF WTP with the current limited system***

2.3 DNP3

DNP3 is a set of communications protocols used between components in process automation systems. Its main use is in utilities such as electric and water supply. It was developed for communications between various types of data acquisition and control equipment. The foremost benefits are the back fill of data and network bandwidth control. This is achieved by time stamping each bit of data, saving the data at the RTU until the next communication and then the SCADA back filling the data for seamless trending. This provides faster sampling time with less radio traffic and seamless data following communication fail restoration.

3.0 CONCLUSION

After exploring all options, it was clear the VHF radio link was the best option for our needs. We also required a 50 kHz channel and a radio that is capable of at least 16QAM.

Having business relationships with Schneider Electric and Automation Group we approached both organisations to trial radios that meet our requirements.

Automation Group provided the 4RF Aprisa SR+ that is capable of 240 kbit/s over a VHF 50 kHz channel using 64QAM.

Schneider Electric offered the Trio QR450, but it is limited to 56kbit/s and a 25 kHz Channel.

The preliminary onsite testing is achieving a signal level of -80dBm and a signal to noise ratio of 25dB using a 3dBd 3 element Yagi yielding 16QAM. Achieving reliable data speeds of 160 Kbit/s.

160Kbit/s shall deliver reliable DNP3 communication and with some SCADA development we shall deliver the expectations of the Water Operators and Process Engineer. The SCADA will access the site PLC to display and record all data and control that is available on site.

This is early days of testing for the new radio path and we have some SCADA network modifications for final speed and capacity testing. I will have inclusive testing results at the WIOA conference in Orange.

4.0 ACKNOWLEDGEMENTS

Thanks to Todd Penson for guiding me and pushing me to write this paper and further my skills

5.0 REFERENCES

www.nearmap.com.au