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ANAMMOX- AN INNOVATIVE APPROACH TO FUTURE OPERATIONS

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Mark Tosh, *Senior Treatment Plant Operator,* Queensland Urban Utilities

ABSTRACT

Queensland Urban Utilities strives for improved distribution of services that are reliable, robust and economically viable. This ensures confidence amongst our customers, the community and our shareholders, in the services we provide now and into the future. Fundamental to this approach is embracing innovation to seek new and efficient ways of doing business.

The Luggage Point Sewage Treatment Plant (STP) is the largest water utility in Queensland treating 750,000 equivalent persons (EP) in the Brisbane region through an activated sludge treatment process. To meet the evolving needs of the people we serve and protect the surrounding environment, the Innovation Centre at Luggage Point STP is harvesting a novel process called Anammox which utilises special bacteria to remove ammonia at reduced aeration and carbon requirements and ultimately improve plant operations and cost. This is a significant step forward in shaping Queensland Urban Utilities to be the utility of the future.

KEY WORDS
Anammox, centrate, nitrification, denitrification, innovation

1.0 INTRODUCTION

Our customers, the community see us as trusted custodians of major installations and the environment. They expect value for money for the services we provide. At Queensland Urban Utilities, we understand the expectations and priorities of our customers and the importance for us to excel in the delivery of our services. It is our objective to meet their evolving needs to enhance the community. That is our purpose, to "**Enrich Quality of Life.**"

The Luggage Point Sewage Treatment Plant (STP) is the largest wastewater facility in Queensland treating 750,000 equivalent persons (EP) in the Brisbane region through an activated sludge treatment process. The plant incorporates six anaerobic digesters for biological stabilisation of the sludge followed by centrifuge dewatering to reduce bio-solids moisture content. From the centrifuge, 600-900 kL of centrate is pumped to the head of the plant each day and carries an ammonia Nitrogen (NH_3) concentration in the range of 400-1100mg/L. This centrate side stream provides an opportunity for separate treatment to decrease the ammonia nitrogen load to the plant and hence reduce operational costs.

A potential method of pre-treating this centrate stream is through a novel process called Anammox, an abbreviation for anaerobic ammonium oxidation. The research and development of Anammox commenced early 2010 and has been housed at The Innovation Centre based at the Luggage Point STP (Figure 1).

Figure 1: ***Images of the Queensland Urban Utilities Innovation Centre at Luggage Point STP.***

Within the walls of the once forgotten heritage listed warehouse are some of the most novel and innovative pilot plants in Australia. For example, it houses the largest replica sewerage system in the world which allows the monitoring of H_2S and the impact this has on QUU's pipe work and pump stations.

Through close collaboration with education faculties such as the University of Queensland (UQ) - Advanced Water Management Centre (AWMC), and other partners such as Veolia and Aquatec Maxcon, anammox has been identified as one of the most innovative developments in biological wastewater treatment in recent years. To lead this project within the Research and Development Team, Queensland Urban Utilities developed a new Operators role to facilitate the transition, operation and implementation of the anammox process from pilot-plant to large-scale. This role was titled Operator of the Future Strategy.

2.0 DISCUSSION

Anammox describes a microbial process that short-cuts the nitrification-denitrification cycle as shown in Figure 2. In most conventional activated sludge treatment processes, the influent nitrogen load is removed through a sequence of oxidisation – the nitrification of ammonia (NH_3) to nitrite (NO_2) then nitrate (NO_3) under an oxygen-rich environment, followed by reduction – the denitrification of nitrate to inert nitrogen gas (N_2) under an oxygen-poor environment.

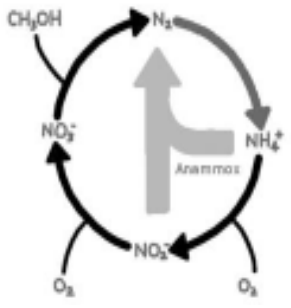

Figure 2: ***Anammox moving bed biofilm (MBBR) exhibition reactor (left) and the Anammox pathway through the nitrogen cycle (right)***

With the anammox process, the NH_3 is converted to NO_2, then by-passes the NO_3 conversion and denitrification process to produce N_2 gas directly as shown in Figure 2. The two types of bacteria that are involved in this anammox pathway include: Ammonia Oxidising Bacteria (AOB) that oxidise NH_3 to NO_2 and annamox bacteria which react NH_4 and NO_2 together to form N_2 gas. This saves 40 per cent of aeration energy for complete nitrification and reduces organic carbon requirements. The result: reduced CO_2 emissions, reduced carbon dosing costs and less sludge production.

The challenge with harnessing anammox is obtaining sufficient anammox biomass since it cannot be imported into Australia. As a result, the anammox bacteria are harvested locally which is more time-consuming due to the slower growth rate (a doubling time of 13 days in comparison to 12-18 hours for common activated sludge bacteria). Furthermore, being a relatively new technology, there is limited knowledge on how to best operate the process and whether different liquor characteristics caused by upstream processes and/or quality of raw sewage will affect performance. By working collaboratively with AWMC at UQ, QUU has taken laboratory reactors to full scale pilots and now to a larger anammox farm. In this way, the gaps in knowledge can be quantified.

The following images show the sequence of steps from preparing and testing the first Australian carrier-based side-stream anammox process in the lab to the larger installation at Luggage Point STP.

Figure 3: ***Scale up of the Anammox enrichment project (Top: University of Queensland lab scale reactor transferring to pilot scale; Bottom: Larger scale moving bed biofilm reactors at the Innovation Centre)***

2.1 Process Controls and Parameters

The operating parameters for effective anammox operation include:

- Nitrite concentration: 0-20 mg/L (> 20 inhibits anammox)
- Minimum pH: 6.5, typical 6.8-8
- D.O.: 0 – 0.5 mg/L (>O.5 mg/L D.O. favours Nitrite Oxidising Bacteria (NOB)
- Feed ammonia concentration: ~1,000 mgNH4-N/L (> 20 mg/L of NH_4 inhibits anammox)
- Temperature: 35^{o}C, (>40^{o}C inhibits Anammox)
- High TSS can also be an issue.

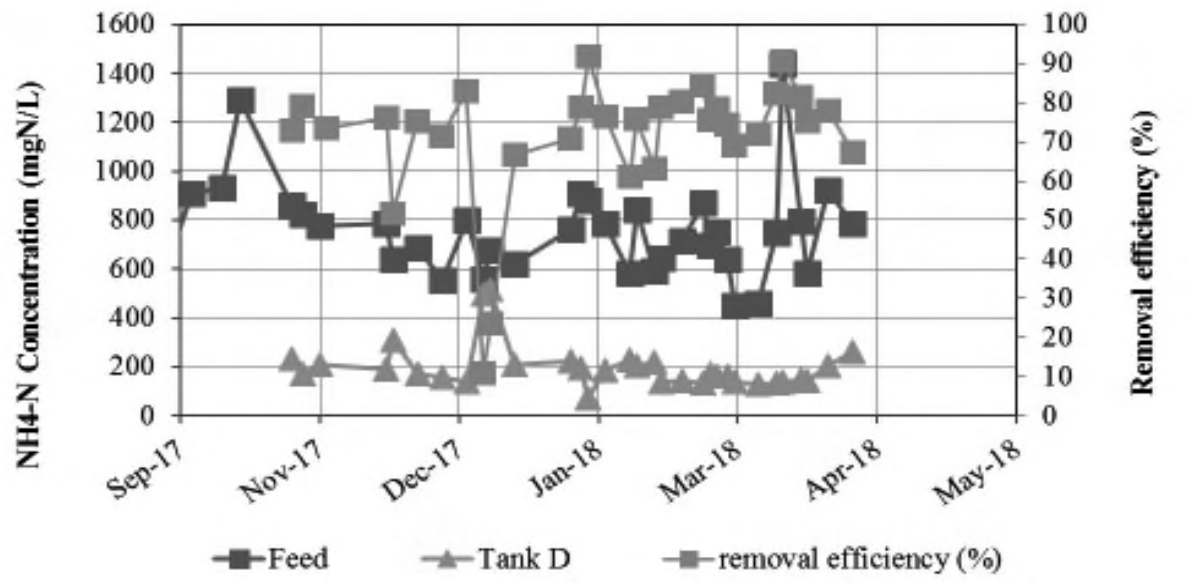

Figure 4: ***Removal efficiency (right axis) and nitrogen concentrations in the centrate feed and the effluent when taken through the Anammox enrichment tank***

Figure 5 shows the variation in ammonia concentration of the centrate feed, fluctuating between 600 and 1,000 mg NH_3-N/L and reaching extreme concentrations of 450 and 1,300 mg NH_4-N/L. Removal efficiency ranged between 70 and 90 per cent but dipped below range in December 2017 due to an onsite electrical power outage. This contrasts with the sudden peak in effluent ammonia concentration resulting in decreased anammox activity and increased nitrite concentration of 25 mgNO_2-N/L compared to the typical range of 1-5 mgNO_2-N/L. Removal efficiency quickly returned to 70-80 per cent which demonstrates the robustness of the anammox biomass.

The anammox process is reliant on frequent monitoring by the operators to ensure oxidation of NO_2 to NO_3 nor the build-up of NO_2 occur. The NO_3 concentrations in the effluent of the Anammox reactors remained below 60 mgNO_3-N/L (average 22±14mgNO_3-N/L) indicating little nitrate oxidising bacteria (NOB) activity.

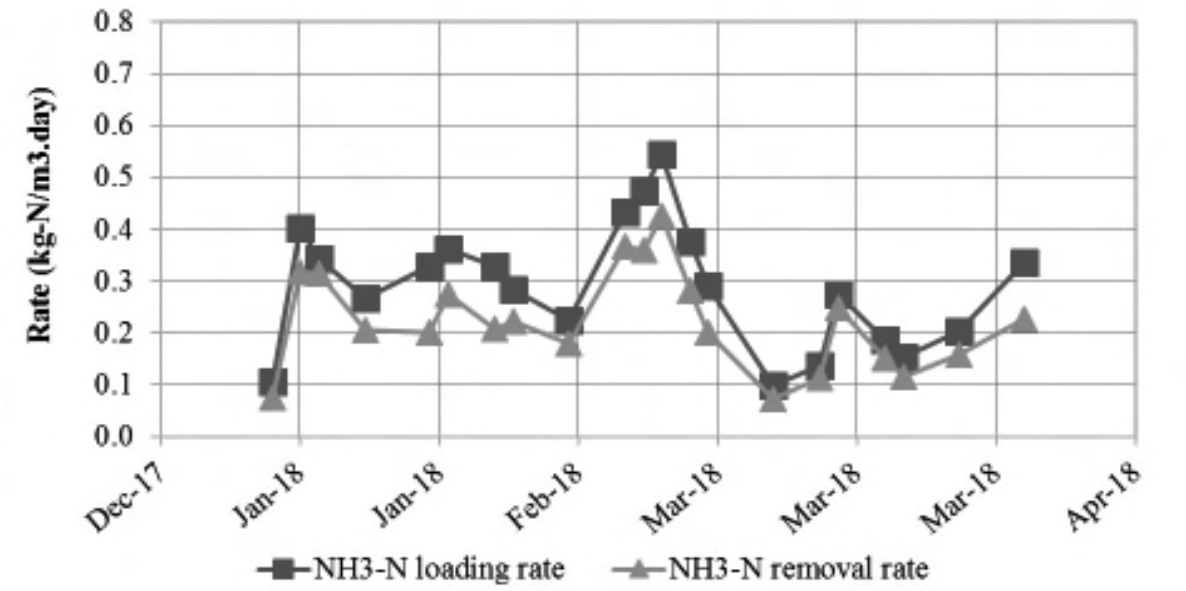

Figure 5: ***Load and removal rate of NH_3-N in the Anammox enrichment tank at Luggage point Innovation Centre.***

2.2 Reactor and Centrate Management

Critical to the management of anammox is the quality of the centrate supply. It is crucial to have sufficient supply so anammox has a constant source of NH_3 and maintains operating conditions previously specified. If the amount of feed is limited, the growth of the anammox bacteria is inhibited. Cationic polymer is also known to be problematic to anammox as it can affect the oxygen transfer in to the liquid phase. However, under dosing polymer can deteriorate centrifuge performance leading to an increase in solids concentrations in the centrate and the anammox tanks. For this reason, a pre-treatment tank was set up at the Innovation Centre to remove solids carried in the centrate before reaching the anammox enrichment farm.

Figure 6: ***Settling tank (left) pre-treating the centrate before entering the centrate feed buffer tank (right)***

Issues can also occur with the air blower, feed pumps and the reliability of the D.O. sensors. Monitoring of instrument performance is important to ensure the enrichment tank receives ideal concentrations in NH_4, NO_2, and in parameters such as temperature and pH.

Keeping the reactor well mixed is also a crucial design feature that must be controlled.

2.3 The Importance of Anammox to Queensland Urban Utilities Future Operations

By introducing a side stream treatment of the centrate through the novel process of anammox, Queensland Urban Utilities has the potential to save 1,000 litres of ethanol dosing per day, approximately $100,000 per annum on reduced power consumption and further extends the need for future plant upgrades.

As the operator of the future, I have been involved in the first steps in moving anammox from pilot scale to larger tank farm operation. In undertaking this activity, I have been exposed to challenges involved in operating this innovative technology and also scaling up the system.

3.0 CONCLUSIONS

Queensland Urban Utilities recognises that the community expects a service that distributes an economical, dependable and excellence in service of its water and sewerage delivery. We understand the community expectation to support the environment and to protect health and safety of the people we serve. This is why our ethos is *to enrich quality of life*.

Innovation is a critical part of Queensland Urban Utilities strategic direction. It is recognised that by exploring different emerging technologies we can deliver a service that reduces the economic and environmental impacts to our customers and the community.

In taking anammox from laboratory to an upscale process, this innovative process will deliver a reduction in power consumption, CO_2 emissions, and ethanol dosing, all of which have a significant production cost saving to the Luggage Point Treatment Plant.

Being involved in the future operations strategy, I have been exposed to challenges related to understanding a new technology and operating parameters.

Let us not consider ourselves as Waste Water Treatment Plants, but as Resource Recovery Centres. Perhaps in time to come we won't be considered as Waste Water Treatment Plant Operators, but instead Resource Recovery Officers.

4.0 ACKNOWLEDGMENTS

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THE TOP 5 CALIBRATION HORROR STORIES TO AVOID

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THE TOP 5 CALIBRATION HORROR STORIES TO AVOID

Fiona Milnes, *Environmental Scientist,* Simmonds & Bristow Pty Ltd

1.0 ABSTRACT

We all know that calibrating your equipment is an important part of getting an accurate testing result. But sometimes, things go wrong. Horribly wrong. In this paper we explore five mini case studies where calibration mistakes have negatively impacted the plant's results, performance and efficiency. We'll look at what happened and how it could have been prevented, including easy techniques to incorporate into your day to day activities so that your plant is never on this list!

KEY WORDS
Calibration, problem solving, pH, dissolved oxygen, troubleshooting, mistakes.

2.0 INTRODUCTION

At Simmonds & Bristow (S&B) we have several different divisions within our business. All of them involve field work of some description. We may find ourselves at a water treatment plant, pollution or sewage treatment plant, conducting irrigation field work, determining parameters for modelling, investigations or troubleshooting.

Our team includes:

- Operators, plumbers and electricians working directly on plants, with daily checks
- Engineers designing and commissioning treatment plants with validation testing or troubleshooting processes
- Scientists performing compliance analyses, surface, ground, soil or other investigative tests
- Trainers mentoring on client sites or teaching and listening to student problems.

The most common pieces of equipment used in field analysis in our industry are;

- Temperature
- pH
- Conductivity
- Dissolved Oxygen
- Chlorine or nutrients (Photometer).

In our field services team we have equipment that is continually in transit and used on multiple sites. It does not have the luxury of having a mini laboratory set up (even if this is a closet or bench near a treatment plant).

We have heavy duty carry cases, with protective inserts to protect our equipment in transit. Due to this heavy use, it is our policy that we do check calibrations before we leave the office to ensure the equipment is in good working order before we arrive at a client site.

We also carry calibration solutions with us, to have the ability of performing calibrations on site, and for a post field check.

Whilst for some in static treatment plant situations, this may seem as overkill, having this ability has ensured we can rely on our results even when equipment starts to fail.

All our team members across S&B work with equipment and all of us need to keep that equipment properly calibrated. Over the years, what we have found is that it is not the many times that things go right that seem to stick with us, it is the times when things go wrong. I'm sure that all of us have, at some point, come back to the office with war stories about when things have gone horribly wrong with equipment, either first or second hand. Calibration is something best treated with respect and care as it can mean the difference between a project running smoothly and a very bad day.

There are lessons to be learned from these stories, even though they may seem like nothing more than stories told around the water cooler. We have found this kind of knowledge sharing to be useful as we explore and troubleshoot what happened. This paper looks at some of the trends we've observed and shares the common lessons we thought were worth passing along.

3.0 DISCUSSION

This paper will review five different mini case studies which feature negative "horror" stories related to calibration. Each case study will explore what happened, why that was a problem and what can be learned from that situation to avoid it in the future.

3.1 Case Study 1 – The Cold, Cold Waters of Sunny Brisbane.

Temperature is a key parameter that affects pH and Dissolved Oxygen readings. It's important to think about the parameters you are analysing rather than just recording the numbers. I discovered this one day while I was out in the field taking samples of surface waters. Being not far from Brisbane it was a relatively warm day, and yet the water temperature was 18˚C.

Immediately I wondered if this could be real. Whilst in some areas, this can be normal, in the climate for the site, and the shallow depth of water, this seemed odd.

I checked to see if the instrument was calibrated. I checked the "Good Laboratory Practice" (GLP) records stored electronically in the instrument and it still retained the last calibration. It also wasn't showing any unusual messages and changed when moved from in and out of the water.

Luckily, I had a glass thermometer in the vehicle. Feeling that something was definitely out of order, I performed a quick temperature calibration and the result returned to a reasonable reading for the circumstance.

However, once I'd packed up and moved to my next sampling point, the same thing occurred. This was strange. Not only was it eating up my field time on a long, hot day, as many field staff can attest to, I was running out of battery on my field equipment. Performing a calibration at every possible moment is not fun or a great use of your time. I repeated to finish that sample point and returned to a power point and charged the instrument.

Lo and behold the error did not occur again for a few hours. We got the battery replaced on that instrument and the failure has not reoccurred.

There are two key lessons here.

The first was to have a back-up plan. An alternate when I was on my break, if I didn't have a glass thermometer to refer to, was to get some ice and make a slurry to check the zero point of the temperature. Second, was that instruments act funny on low battery power, even if the battery integrity is still there. Don't wait until it's too late and your results are compromised. Read your equipment manual to know the signs of low batteries and carry spares and/or chargers.

3.2 Case Study 2 – The Sad Supplies Still in the Box

It could be argued that pH is the most common field analysis. It is also, often the least understood. Again, pH results inform so many other chemical reactions, dosing requirements and decision making processes that its misrepresentation can result in dramatic consequences.

Some time ago a colleague was undertaking some water quality sampling on the Sunshine Coast at a construction site in the sediment ponds before they discharged out of the ponds into an adjacent creek.

The construction contractor on-site had his own hand-held pH meter that he had been using at other sites to test the water pH before discharging. He didn't calibrate his pH meter at all, but each time he tested the pond water the pH meter displayed 7.1 pH units.

My colleague was suspicious of the results, as he knew the site to contain acid sulphate soils, and despite the sediment pond being newly constructed with bare batters, the water in the ponds was crystal clear with all the sediment completely dropped out of suspension.

So, he put our multi-parameter in the water (after calibrating it that morning), and found that the water had a pH of 4.1 pH units. They then took the contractor's pH probe and placed it in the pH 4 buffer, and it continued to read pH 7.1

We shudder to think about how many sites he had used the meter at before arriving at this site, but my colleague certainly made sure to test every water sample himself after that day when dealing with that particular contractor.

Given pH testing is so common; it has more horror stories than most! Case in point, another staff member went to a remote client running a Sewage Treatment Plant (STP). In assessing the process, he asked the client's operator if he had he been doing pH testing. He was relieved that the answer was yes. His next question: "Have you been calibrating?" didn't receive such a good response. In fact, it was a decided "no". The operator said he'd been shown years ago, but hadn't done it since then.

After much searching high and low they found what had been brand-new calibration buffer solutions, unopened, that were 5 years out of date. Upon reviewing the state of the pH probe, it contained no electrolyte, of which there was a beautiful new unused bottle sitting in the same cardboard box as the lovely colourful pH buffer solutions.

Eventually, they discovered that the operator was familiar with the photometer at least, and found some 'in date' Phenol Red and performed the testing via a photometer method until he could replace the equipment and be trained appropriately.

Learning: Training staff on calibration necessity is vitally important. High level decisions on environmental and public health safety can be made on field readings. Make sure that you understand the responsibility you have for the state of the instrumentation you use.

3.3 Case Study 3 – The Caked-Up Probe that Ate Time

In troubleshooting an STP, another staff member asked the operator for the dissolved oxygen readings for the aerated balance tank. The operator indicated that he thought the aeration wasn't working properly, and that the tank was anoxic, so they were making adjustments.

Our staff member was dubious and asked if the Dissolved Oxygen (DO) probe had been cleaned recently. He was assured that it was stored in DI water and swilled in a bucket after checking mixed liquor samples.

Upon inspection of the DO probe, it had no membrane and was caked up. Readings were returning 0.2 or 0.1 mg/L. Encountering confusion when asking for a new membrane kit, a lightbulb went off. They found a new box, cleaned up the probe and installed the new membrane correctly with electrolyte.

Then they checked the tank again, which returned a reading of 7 mg/L of dissolved oxygen. Hours of troubleshooting and process changes could have been avoided with a little bit of calibration.

Learning: If your equipment is not in order, and you don't know how to maintain and calibrate them, you will not be able to troubleshoot effectively. Your process, and ultimately your compliance, depends on your equipment.

3.4 Case Study 4 – If It's Not One Thing, It's Another

Photometers are important equipment. However, there are few little things that can turn "useful" into extremely frustrating. Photometers are set up with automated programs to allow the lay person to select a 'program' and have the correct wavelengths assigned automatically within the instrument.

However, the chemical reaction that is used for very low concentrations of chemicals can be very different from the chemical reaction that is utilised for high range concentrations. For those wanting a bit more information, this is often related to the linearity over a certain range for certain chemical reactions.

In one case, I noticed that Chlorine results from a HACH chlorine meter were not meeting their calibration limits as I was checking and preparing the instrument for the day. Since the solutions were fairly new, and there isn't much to adjust, it was a little puzzling, until I realised it was set for a High Range (HR) instead of Low Range (LR), which is our default. Once this setting was adjusted the readings passed and the instrument was fine to use. If this calibration had not been performed, that setting change may not have been picked up and the readings would have been incorrect for the day's work.

If you have no check solutions, which is often the case in field tests and process troubleshooting where you are not in a lab environment, you can see how incorrect settings can go unheeded and yield some odd conclusions in your decision making.

Often in our collective industry workplaces your lab is a closet, a tin shed or a small room. It can be open to the elements or simply does not have any insulation from the heat or cold. On one site our staff had been to, they picked up the container of reagent to use for calibration and it was so hot they couldn't hold it (it was 42°C outside) and this was in an outdoor shed.

These reagents are not designed to withstand extreme heat or cold, and it is a good idea to review your storage and working conditions, temperature – as it is a form of energy does interact with chemical reactions – and that is exactly what you are doing, just on a small scale! Incidentally, most standard solutions or buffers purchased have a table on the side with the changes in concentration/value for the change in temperature. Make sure you don't ignore this, as it can change quite dramatically.

Similarly, on an investigation recently a site was trying to determine a curve of appropriate dosing. The problem was that the results were not establishing any kind of trend, rather a 'flat line'. Upon checking the instrument, things seemed fine, but eventually when our staff inspected the tablets, although they were not out of date, they were discoloured, and some were 'bulging' in their packs – like a yoghurt container after sitting in the hot car all day. They were disposed of and new tablets were used, and the curve was established.

Learning: Quality in, is quality out. Feed your instrument with good quality parts, solutions and chemicals, and you will get good quality results.

3.5 Case Study 5 – Dilution Delusion

This last story comes from the start-up of a plant. One of our Engineers was getting feedback from field analysis done on site that a new plant was operating well, with good results for nutrients. Given this, he thought things were going well. However, when the lab results were returned a week or two later, the nutrients were an order of magnitude higher than the results obtained on site.

Our engineer was scheduled to go to site for a few weeks. When he arrived and ran the Palintest test for nitrate (which was the problem nutrient), lo and behold, the results matched fairly closely with what the laboratory certificate had reported.

He asked the operator to do the same test and watched carefully. When the operator got an over-range error, he simply did a 1:10 dilution on the developed colour, instead of diluting the raw sample and re-running the test.

After the engineer picked himself up off the floor, he gently informed him that wasn't the right way to do it, and that he need to dilute the raw sample and start the test from scratch.

They were now behind on the commissioning and adjustments to the plant. Once they were getting reasonable readings from the plant, it took about a week to get it under licence compliance, just in time to get the sign off for handover.

Learning: When you're running a plant day-to-day you need to get relatively accurate data, and lab data can often take too long to get back to you to make a rapid decision. If you can't rely on your tests, or on your operators to do the right tests, things can get off the rails very quickly.

4.0 CONCLUSIONS

In summary, when things go wrong there is an opportunity to learn something valuable. How could these horror stories have been prevented? Education, through training, knowledge sharing, and continuous improvement is the key to learning from these mini case studies.

Here are some easy techniques to incorporate into your day to day activities so that your plant is never on this list of horror stories.

Temperature

- Often a basis for other tests (such as pH, EC and DO), don't underestimate a basic test.
- In many instruments, a signal is activated when the Temperature calibration file has been initialised and needs re-calibration. Read your manual and be aware of this.
- Have an alternate source to check your temperature against.

pH

- Are you calibrating, or checking calibration? Do you know the difference?
- Are your solutions in date? Where are they stored and do these conditions affect it?
- What are you storing your pH probe in?
- When was the last time you changed the probe? Is this recorded anywhere for posterity?
- Does the probe have electrolyte?
- What is the condition of the probe head, cables and junctions?

Dissolved Oxygen

- Are you calibrating at all relevant points for your equipment? Some have zero and saturation, some have only one or the other.
- Some equipment items do the calibration checks in a different order or have different acceptance criteria – check your owner's manual.
- Sodium Sulphite – don't reuse if it's been open or standing for some time. It's a chemical reaction that is changing with time.
- Have you checked what Salinity correction, if any, is on your instrument? Is it appropriate?
- Has your calibration considered, Temperature & Altitude?
- Does your probe have a clean and intact membrane, and enough electrolyte?

Colorimeter

- Tablets in good condition?
- Temperature suitable?
- Cover on when required?
- Program selected appropriately?

Dilutions.

- Have you trained and checked staff know how to perform dilutions?

5.0 ACKNOWLEDGEMENTS

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BOTULISM AT MT ST JOHN TREATMENT PLANT

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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 take action 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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QLDWATER PARTNER WITH LUTRA TO PROVIDE DATA VISUALISATION AND REPORTING SERVICES

Paper Presented by:

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43rd Annual WIOA
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QLDWATER PARTNER WITH LUTRA TO PROVIDE DATA VISUALISATION AND REPORTING SERVICES

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Maseina Koneferenisi, *Product Manager,* Lutra Ltd

ABSTRACT

qldwater's Statewide Water Information Management (SWIM) project was created in 2006 to simplify the annual reporting requirements of Queensland's Water and Wastewater Service Providers (WSPs). The SWIM system was very successful in achieving this and ***qldwater*** members using SWIM now report only around one quarter of the indicators that they used to report, and this is done in one format at one time.

Following the success of this significant piece of work, ***qldwater*** identified data issues affecting annual reporting at the WSP level and saw a need to add more value for members by introducing a local data management tool (SWIM*Local*). SWIM*Local* is seamlessly linked to SWIM and allows WSPs to better manage their daily water and wastewater data.

The next part of ***qldwater's*** strategy was the development of data visualisation dashboards to allow users to monitor operational performance.

Developing additional software tools in-house is an expensive and risky undertaking, therefore ***qldwater*** looked at commercially available "off the shelf" systems that would integrate with the SWIM database. The system chosen was Infrastructure Data, developed by specialist water and wastewater process engineers at Lutra Ltd.

Over the past 12 months ***qldwater*** has been working with the Infrastructure Data team at Lutra to provide tools which work in concert with SWIM*Local* to generate automated dashboards and performance reports.

1.0 INTRODUCTION

The capacity of many of Queensland's Water and Wastewater Service Providers (WSPs) to efficiently collect, collate, cleanse, analyse, export and translate their water and wastewater data into valuable information is often inadequate for regular reporting. Across Queensland, WSPs have an enormous diversity of internal data management skills and systems (e.g. paper ledgers, spreadsheets, databases, telemetry, SCADA) – with the majority storing data in a series of Excel files that have evolved on an ad hoc basis, along with a variety of other disaggregated business systems. In addition, data is commonly dispersed across several business groups of reporting organisations (e.g. asset systems, monitoring systems, financial systems) and even within a category/indicator type, data is often generated at numerous, and often disperse, locations (e.g. different storages, stream gauges, water quality test sites). Often data collection is replicated resulting in not only duplicated storage and work effort, but difficulty in establishing actual correct data sources.

These data management issues affect WSPs at three levels; firstly, at an operational level, i.e. having data readily available to manage treatment plants optimally; secondly, at the asset management level, i.e. being able to make well informed decisions on the long-term planning of infrastructure assets; and finally, being able to readily access data at an annual scale for mandatory State and Federal reporting.

The introduction of the Statewide Water Information Management (SWIM) system by ***qldwater*** has streamlined the annual reporting requirements of its 72 members. The SWIM system has helped simplify reporting through removing duplication, aligning reporting times, advocating for improved definitions and indicators, and improving data entry QA/QC through the use of a SQL database. This effectively means that ***qldwater*** members using SWIM now spend much less time on annual reporting than they did 10 years ago, and they now have a centralised location that users can access for a single source of the truth.

Soon after the introduction of SWIM it became obvious that a local data management system was needed to help WSPs manage their data internally. To do this ***qldwater*** developed the SWIM*Local* data management system, whose primary objective was to streamline and add value to the process of collating and reporting WSP data.

SWIM*Local* contains all the usual data management tools like SMS/email alerting, automated data uploading, calculations, mobile (tablet/phone) data entry, etc. and brings QA/QC to the point of data entry. The software was developed in consultation with treatment plant operators (Figure 1) and makes use of data synchronisation via the Internet to allow central reporting, and to share and capture data across organisations which have measurement sites in wide-spread locations. A 'cloud-based' system enables multiple locations to maintain complete and up-to-date datasets that are simultaneously synchronised with the central SWIM system.

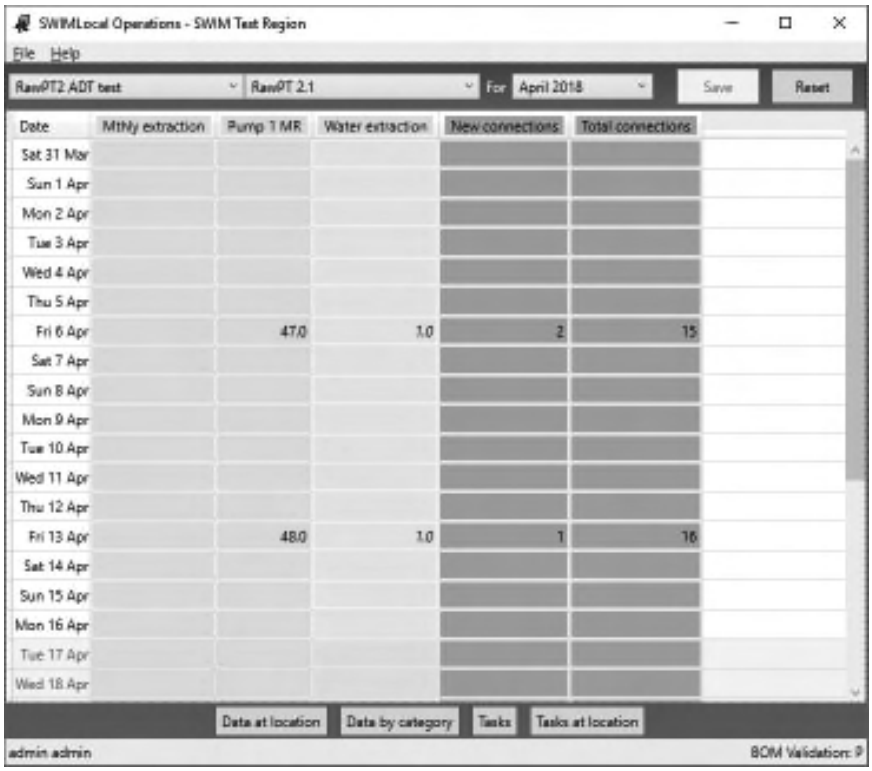

Figure 1: ***Screen grab of the SWIM*Local *Operations data entry Tool – the development of SWIM*Local *was done in partnership with Queensland WSPs, and importantly with treatment plant operators, such that the data entry tools have a 'familiar' spreadsheet look and feel.***

SWIM*Local* drastically reduces the time taken to collate data, improving the efficiency and timeliness of reporting, as well as minimising data handling (e.g. limit cutting and pasting data from one spreadsheet to another).

While SWIM*Local* has been of great benefit to those using it, up until now it has lacked a way of visualising the data collected. A key part of the initial SWIM*Local* strategy, was to use dashboards to help monitor operational performance. This is of particular importance for WSPs that lack SCADA and other visualisation tools and Dr Peter Mosse has kindly assisted in the design process for the benefit of smaller and more isolated WSPs.

The development of additional software tools in-house is an expensive, resource intensive and risky undertaking, so ***qldwater*** decided to look at commercially available "off the shelf" systems that would integrate with the SWIM database.

2.0 DISCUSSION

Although there are a few "off the shelf" reporting systems available in the market, ***qldwater*** was drawn to the Infrastructure Data (ID) system because it was developed specifically for the water and wastewater sector by Lutra, a team of specialist water and wastewater process engineers, operations managers and software developers.

Infrastructure Data is a powerful tool and can be configured to suit the customers' requirements. We used the experience at Lutra plus local expertise and advice from SWIM users to configure powerful analytics and automated reporting that suits the requirements of our WSPs. The result is a set of standard compliance batch reports and dashboards designed to give operators and managers visual trend information to support better plant operations and improved transparency for decision makers.

WSPs who piloted the use of ID are very happy with the new dashboards and as the system is web-based, users can access the dashboards and reports with mobile devices. This gives operators and managers the ability to quickly identify deteriorating performance trends and allow early intervention, thereby reducing water quality or environmental risks and avoiding unnecessary operating expense.

Typical ID dashboards are shown in Figures 2 and 3.

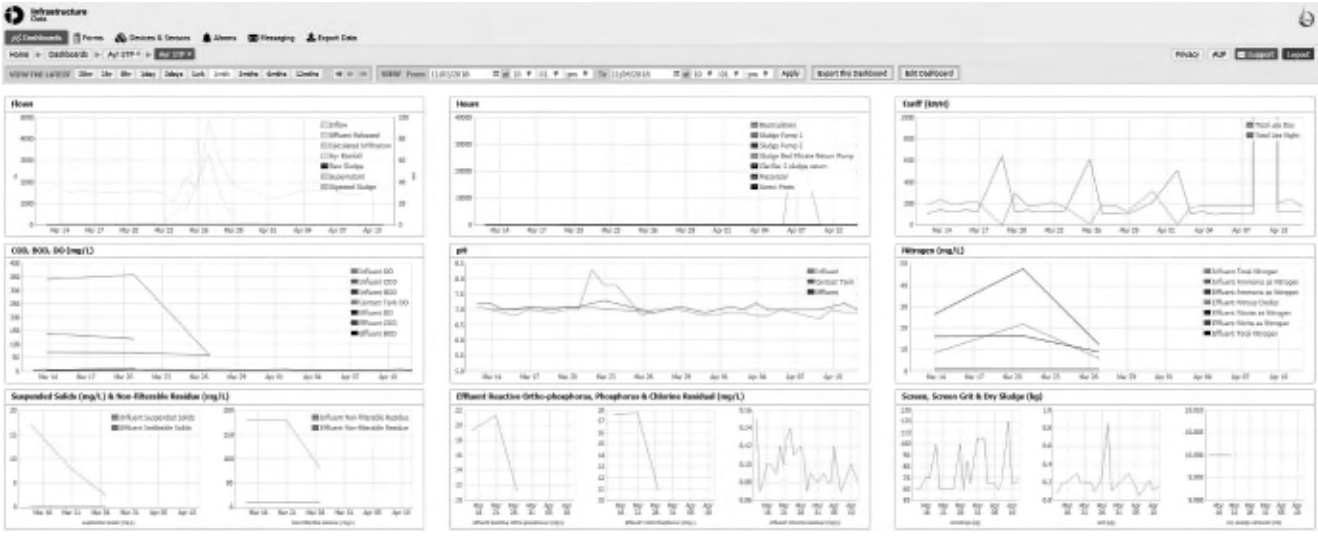

Figure 2: ***Dashboard developed for the Ayr Wastewater Treatment Plant (Burdekin Shire Council) showing the variety of graphs, tables and other information available.***

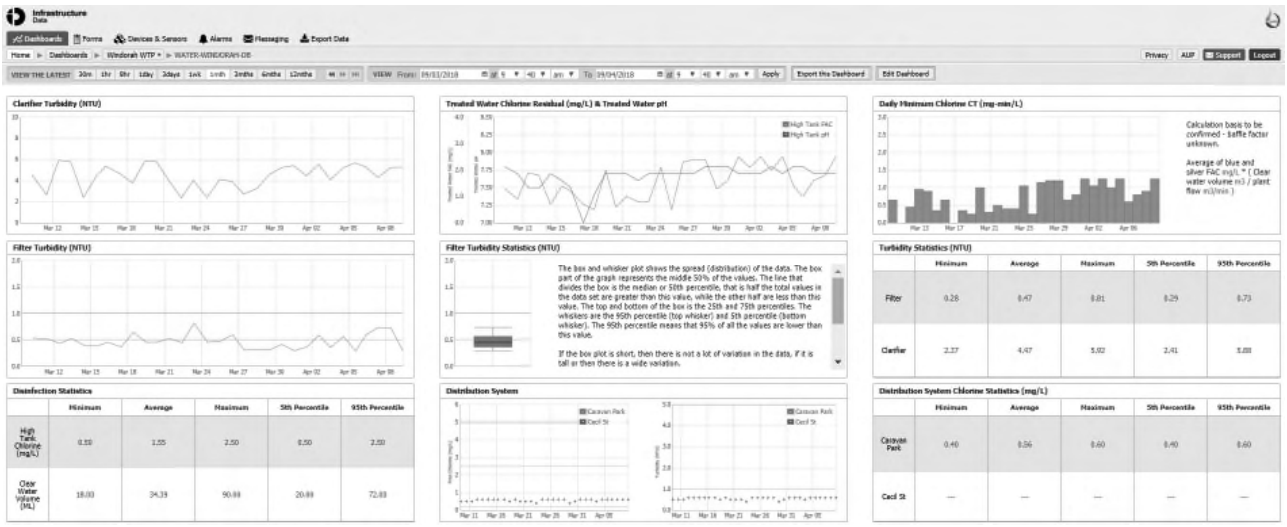

Figure 3: ***Dashboard developed for the Windorah Water Treatment Plant and distribution network (Barcoo Shire Council) showing the variety of graphs, tables and other information available.***

To date the new dashboard visualisation service has been implemented at four water treatment plants and two sewage treatment plants in Queensland. There are plans to increase this with the addition of two more councils over the next few months.

3.0 CONCLUSION

The obligations on water service providers to demonstrate compliance with quality and environmental requirements continue to be a focus. The collaboration between ***qldwater*** and Lutra has resulted in a scalable, affordable and customisable product which addresses many of the typical issues associated with compliance, performance and operational reporting. It has avoided significant development costs and delivers best value to ***qldwater's*** members.

While this project is just completing its trial phase, the people involved have already noted several advantages to the new SWIM*Local* dashboard visualisation system. Shaun Johnston (Burdekin Shire Council Manager Water and Wastewater) recently said that "SWIM*Local* took the best parts from Excel, databases and the Cloud to give an all-round more functional result. The system provides powerful reporting functions to simplify management of large volumes of data and now we have a visual dashboard that provides real-time monitoring. The new ID dashboards will broaden SWIM's appeal to less technical people in the management area and extend its value to operators in a user-friendly, customer focussed way."

4.0 ACKNOWLEDGEMENTS

We would like to thank the following people (councils) for their help in trialling the dashboard visualisation project: Greg Clark (Barcoo Shire Council), Shaun Johnston (Burdekin Shire Council) and Trevor Seth (Goondiwindi Regional Council). The support of Dr Peter Mosse in encouraging and highlighting the use and benefits of visualisation tools for Queensland WSPs is greatly appreciated, as is the time he kindly donated in providing expert advice on dashboard design.

PROTECTING CONCRETE ASSETS: A NEW TECHNOLOGY SOLUTION FOR AN OLD PROBLEM

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PROTECTING CONCRETE ASSETS: A NEW TECHNOLOGY SOLUTION FOR AN OLD PROBLEM

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ABSTRACT

The severe conditions that occur in sewers and Wastewater Treatment Plant (WWTP) structures require concrete surfaces to be protected from biogenic sulfuric acid (BSA) attack and abrasion. Many types of protective coating and lining systems are used, but a new technology developed and supplied by BASF since late 2016, offers a unique combination of application and performance properties. Based on combining the best of complimentary chemistries, the MasterSeal 7000 CR liquid applied coating material, now delivers a full suite of high performance properties, including: excellent chemical resistance particularly to BSA and organic acids, crack bridging ability (both static and dynamic), tolerance to substrate moisture, along with fast and easy application. Suitable for new installations or refurbishments, with low VOC's, the 1 mm thick application by simple equipment (spray or hand) rapidly cures even at low temperatures, meaning reduced application times and enabling fast return to service with minimal downtime, critical for ongoing operations. The benefit of delivering longer maintenance cycles and lower life cycle costs, it's use can significantly reduce the total cost of ownership.

KEY WORDS
BSA corrosion, chemical resistance, crack bridging, damp substrate, application, performance.

1.0 INTRODUCTION

The concrete infrastructure of wastewater treatment systems is subject to complex physical and chemical corrosion processes. Uncoated concrete is particularly susceptible to so-called biogenic sulfuric acid (BSA) corrosion leading to structural concrete damage. BSA corrosion is caused by bacteria from the genus Thiobacillus, which metabolises hydrogen sulfide (H_2S) and liberates sulfuric acid. Chemical attack then takes place very quickly, deteriorating any exposed concrete and steel surfaces. In addition to BSA corrosion in the headspace, chemical attack is also caused by the wastewater itself, either from the organic acids generated as oil and fat are broken down, or from other contaminants.

In 2012, a team of development chemists at BASF were brought together to develop a new material – a membrane for use in the urban wastewater industry that combined chemical resistance with crack bridging and that was a low hazard material that was easy to apply and tolerant to site conditions. Our expertise in polyurethane (PU) and polyurea (PUR) was used to create a new material technology known as Xolutec. The result was the performance-proven MasterSeal 7000 CR, a liquid applied coating system, which significantly extends the life cycle of concrete structures in aggressive sewer and wastewater environments.

MasterSeal 7000 CR is used in waterproofing applications that require a high level of chemical resistance, like wastewater treatment plants in both the inflow and outflow areas, sewage effluent structures, biogas plants and secondary containment.

2.0 DISCUSSION

The system comprises two main components - a primer and membrane, but is backed up by several components including concrete repair mortars and fairing coats if required.

The unique technology has an unmatched combination of application and performance properties summarised below, enabling long maintenance cycles and lower life cycle costs, significantly reduce the total cost of ownership:

- Specific chemical resistance, including high concentrations of BSA.
- Crack–bridging for gaps up to 0.7 mm static and 0.3 mm dynamic.
- Maximum moisture tolerance, including application on humid substrates.
- Fast and easy application by rolling or spray at temperatures from 5^0C to 35^0C (substrate and ambient).
- Excellent curing properties, which reduce downtime.

2.1 System Components

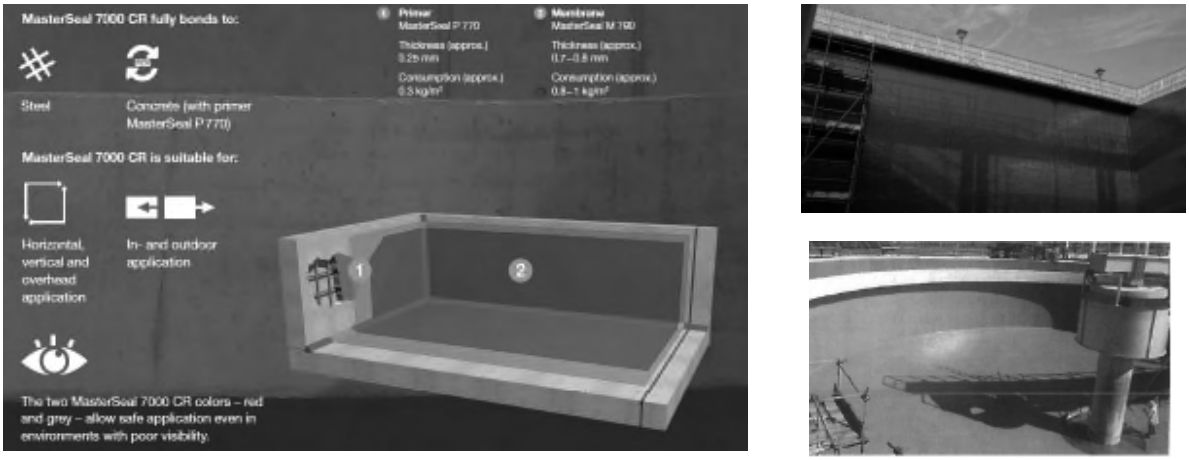

Figure 1: ***MasterSeal 7000 CR system components with coloured membrane M 790***

2.2 Primer

There are two main primers that are designed for the system. The principal primer is MasterSeal P 770, a two-component material consisting of an inorganic polyurea composite, used for smooth and rough substrates, as well as bonding to damp concrete.

2.2 Membrane

MasterSeal M 790 is a two-component crack-bridging membrane consisting of an inorganic polyurea composite that provides high chemical and mechanical resistance. MasterSeal M 790 can be applied to horizontal and vertical substrates, internal and external areas, cementitious concrete mortar or steel substrates, reinforced concrete for protection against carbonation and chloride-induced corrosion, as well as chemical attack in secondary containment bunds in the chemical and petrochemical industries. It has proven resistance to biogenic sulfuric acid corrosion over the long term, as per the testing results from the Fraunhofer Institute, Germany. In addition, it is CE-certified according to EN 1504-2 and meets the EN 13529 standard for chemical resistance. Refer to sections 2.4 and 2.5 for Proof of Performance details.

MasterSeal M 790 features & benefits include:

- Easy hand application by roller/brush or can be spray-applied with selected two-component spray machines for large areas.
- Provides a continuous membrane – no overlaps, welds, or seams for leakage.
- High chemical resistance, including high concentrations of biogenic sulfuric acid.
- Waterproof and resistant to standing water – can be fully submerged.

- Excellent adhesion to different substrates (concrete, steel, existing coatings).
- Moisture-tolerant – can be applied on substrates with high residual humidity.
- High water vapor permeability – low risk of blistering.
- High resistance to CO_2 diffusion – protects concrete from rebar corrosion.
- High tear, abrasion, and impact resistance – suits high traffic areas.
- Tough but flexible and crack-bridging – copes with some structural movement.
- Highly durable and protective – reduced cracking caused by embrittlement.
- Thermoset – does not soften at high temperatures.
- Weatherproof – proven resistance to thundershowers and freeze-thaw cycles and can be applied to external surfaces without an additional protective top coat.
- Available in two colours (red and grey) - Allows even application in environments with poor visibility and as QA/QC and performance measurement.
- Does not contain solvents, low VOC content – User and environmental friendliness.

2.3 System Application

Correct application of the system is of paramount importance in delivering a quality project, to maximise the protection, service life and minimise any ongoing maintenance required. Successful application depends upon correct substrate preparation and suitable mixing and placing techniques by an experienced and qualified applicator. The usual safety measures for handling chemical products should be observed when using MasterSeal 7000 CR system components with reference to the material safety data sheet of the individual product. MasterSeal 7000 CR can be applied to a variety of substrates including concrete or repair mortars (clean and sound with a grit-blasted or high-pressure water jet surface profile to ICRI CSP 3 to 5), existing epoxy or polyurethane coatings (once properly cleaned, degreased and roughened) as well as iron and steel (sandblasted to an SA 2½ standard).

Materials may be applied by hand application (roller and brush) or spray applied using specific high-pressure, plural component spray equipment such as the Graco XM 70, that enables the correct mixing ratios of MasterSeal P 770 and MasterSeal M 790 during application.

Figure 2: ***MasterSeal 7000 CR roller application of primer (L) and membrane (R)***

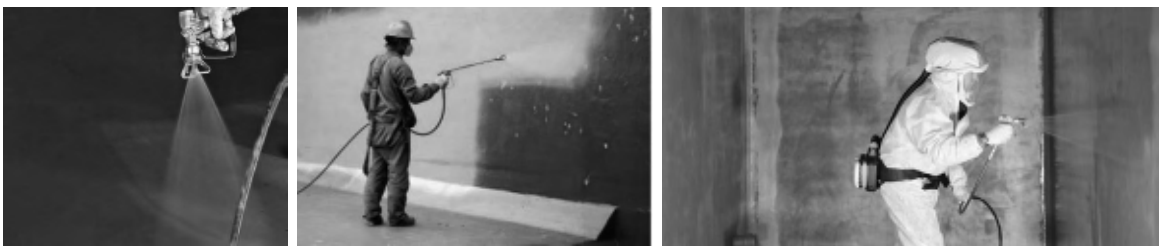

Figure 3: ***MasterSeal 7000 CR spray application of membrane (red and grey)***

2.4 Fraunhofer Institute - Proof of Performance

MasterSeal 7000 CR has been tested in 2013/14 at the Fraunhofer Institute, in an accelerated testing regime for BSA corrosion, equivalent to a five-year period, under conditions that simulate those of a real sewer. The plain and coated concrete samples were placed in the bottom of the chamber, whilst the polymer films were placed above the concrete samples. The bacteria solution was heated up to 30°C and the temperature was controlled during the test. The concentration of H_2S was between 30 und 60 ppm.

Figure 4: ***Fraunhofer testing chamber and various material samples for testing***

The weathering test results show no significant changes on the MasterSeal 7000 CR properties.

- Cleaned samples showed little visual signs of deterioration and still retained some gloss level. Plain reference concrete, showed significant signs of corrosion.
- Adhesion testing in accordance with EN 1542:1999 indicated all tests failed in the concrete, showing no reduction in adhesion strength. It also showed no attack of the substrate concrete below the coating.
- Tensile strength and elongation in accordance with EN ISO 527-1b:1996 showed no significant change in properties.
- Vapour permeability in accordance with ASTM E96 showed no significant change in properties.

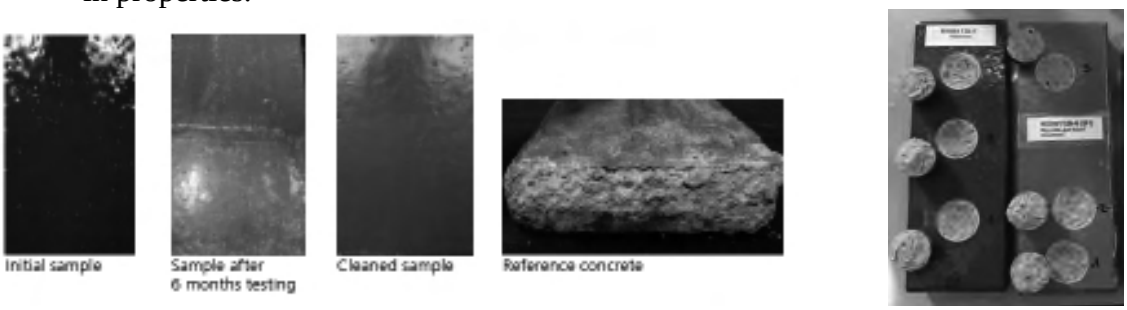

Figure 5: ***Fraunhofer testing results of various samples – deterioration and adhesion***

2.5 Testing to EN 1504-2:2005 Part 2: Surface Protection Systems for Concrete.

In June 2016, coating samples were tested in a laboratory in Spain according to UNE-EN 1504-2:2005 Part 2: Surface Protection Systems for Concrete. Ten different tests were done, including adhesion strength, water-vapour transmission, water and carbon dioxide permeability, abrasion and impact resistance, crack bridging (static and dynamic) and water penetration under pressure, with results shown in Table 1. It also meets the EN 13529 standard for chemical resistance to a wide variety of chemicals including some acids (sulfuric, acetic & lactic), lyes (sodium, potassium hydroxide), organic chemicals (gasoline, ethanol) and specific solutions (silage water, liquid manure and chlorine bleaching).

Table 1: ***Applus Laboratories testing results to EN 1504-2 for MasterSeal 7000 CR***

Essential characteristics	Performance	System of assessment and verification of constancy of performance	Harmonised technical specification
Reaction to fire	NPD	System 4	EN 1504-2:2004
Linear shrinkage	NPD	System 2+	
Compressive strength	NPD		
Coefficient of thermal expansion	NPD		
Cross cut	NPD		
Abrasion resistance	Loss of mass < 3000 mg		
Permeability to CO_2	sd > 50m		
Water vapour permeability	Class III		
Capillary absorption and permeability to water	w < 0,1 kg/m²√h		
Thermal compatibility	≥ 1,5 N/mm² Pass		
Resistance to thermal shock	NPD		
Chemical resistance	NPD		
Resistance to severe chemical attack Class II: 6a Class III: 1,2,3,4,5,5a,6,7,10,11,12,14,15a	Reduction in hardness < 50%		
Crack bridging ability	A3 (23°C) B3.1 (23°C)		
Impact resistance	Class III		
Adhesion strength by pull off test	≥ 1,5 N/mm²		
Skid resistance	NPD		
Artificial weathering	Pass		
Antistatic behaviour	NPD		
Adhesion on wet concrete	NPD		
Dangerous substances	Comply with 5.3 (EN 1504-2)		

2.6 Comparisons to current technologies

The issues surrounding degradation of sewer and wastewater assets due to BSA corrosion are well known and have been an issue within the industry for decades. A wide variety of materials with different properties have been adopted to protect infrastructure assets, including concrete, sulfate resisting concrete, high alumina/calcium alumina (CAC) type mortars, geopolymer concrete, high build epoxies, novolac epoxies, epoxy polysulphides, vinylester & polyesters, polyurethanes, polyureas, polyurea silicates, magnesium hydroxide liquids (MHL), HDPE/PVC liners and acid resistant tiles. Protective coating methods often work well, but experience shows coatings can sometimes delaminate over time because of improper preparation of the concrete surface, inadequate and improper application in the field, or a lack of long term performance characteristics from the chosen material. For example, with inadequate or cracked coatings, Thiobacillus bacteria can penetrate, surviving happily on the concrete surface beneath the coating, and further destroy the adhesive bond of the coating to the concrete. Liners can also delaminate from the walls of sewers or erode, forming an area that requires costly repair. Another method used to prevent corrosion of concrete sewer systems is a continuous or regular dosage of chemicals (including potassium permanganate, chloride, oxygen and magnesium hydroxide) injected directly into the sewer or raw sewage to reduce the original gasses. But these are expensive and temporary fixes, which need ongoing reapplication. So, when assessing a protective system, especially in a refurbishment situation, several key issues need to be considered by engineers, asset owners and plant operators. This includes Total Cost of Ownership (TCO) determining direct and indirect costs vs benefits, installation requirements (expertise, down time, impact to operations), reliability and long-term durability and maintenance costs.

There are significant limitations with existing systems that need to be considered. Concrete based on Ordinary Portland Cement (OPC) is not resistant to BSA, sacrificial repair strategies need to be reapplied (CAC & sulfate resisting mortars and MHL). Furthermore, high chemical resistance does not automatically mean resistance to BSA, and resistance to organic acids is normally very limited. Chemical resistance without some elasticity is not enough and without crack bridging capability, there is no concrete protection. An inability to bond to a damp/humid substrate is a major limitation.

Figure 6 indicates how the MasterSeal 7000 CR exhibits a superior combination of performance characteristics, compared with materials designed to work in similar environments (also shown), with a competitive cost structure.

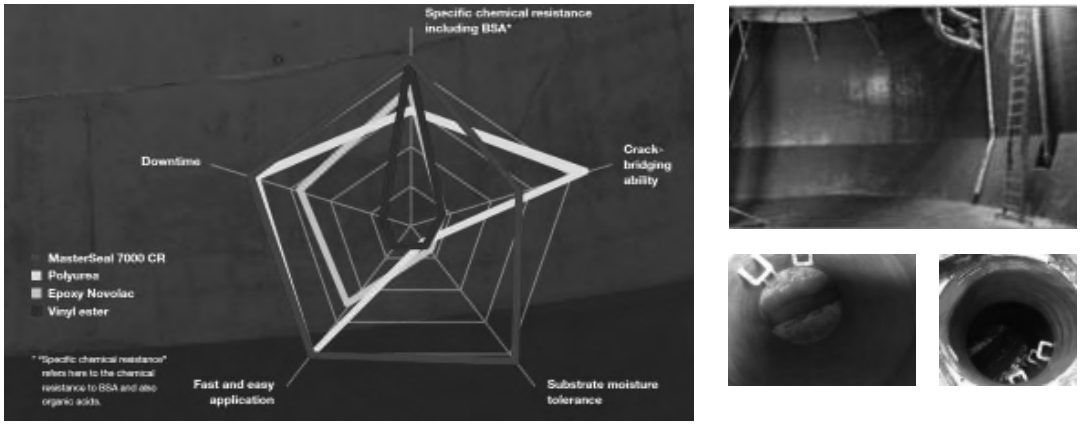

Figure 6: ***Comparative performance characteristics and typical applications***

Since launch in late 2016, there has been significant global interest, with a wide variety of projects having been completed or underway. Some typical examples are indicated below.

Table 2: MasterSeal 7000 CR – Project references

Country	Location	Client	Facility	Size m2	Date
Poland	Poznan	Aquanet	WWTP tank	500	Oct 16
UK	Norwich	Anglian Water	Sewer Shaft	10	Oct 16
Malaysia	Petronas	BASF	WWTP tank	500	Oct 16
China	Shanghai	BASF	WWTP tank	50	Nov 16
China	Shanghai	SCIP	WWTP tanks	12,000	Aug 17
Australia	Nabiac	Mid-Coast Water	WWTP tank	50	Nov 17

3.0 CONCLUSIONS

The issues related to protecting concrete structures in aggressive wastewater environments in WWTP and STP is well documented, with a number of systems available on the market. After extensive research and development, a new and unique technology combines the best coating performance characteristics, into a simple to apply coating system, called MasterSeal 7000 CR. Its high resistance to abrasion and biogenic sulfuric acid (BSA) corrosion, crack bridging capability, ability to be applied to a damp substrate along with easy and fast application, makes it an ideal choice for application to new and refurbishment projects, which are required to withstand the severe conditions that occur.

4.0 ACKNOWLEDGEMENTS

With special thanks to the dedicated and inspired team of BASF development chemists who worked tirelessly to make this new technology available and the various asset owners who are early adopters of new technology. Thanks for the opportunity to work with you.

5.0 REFERENCES

MasterSeal 7000 CR, BASF Construction Chemicals, Master Builders Solutions website. http://masterseal-7000cr.basf.com/en/

Runner up for the Best Operator Paper at the
80th Annual WIOA Victorian Water Industry Operations Conference,
Bendigo, 2017

YACKANDANDAH ENERGY STORAGE PROJECT

Paper Presented by:

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Logan Metro Sports Centre, Logan
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YACKANDANDAH ENERGY STORAGE PROJECT

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ABSTRACT

North East Water in partnership with the Intelligent Water Network (IWN) and the Totally Renewable Yackandandah (TRY) group have just completed the first solar photovoltaic and battery storage installation to run a water treatment plant off grid.

Along the journey North East Water have also partnered with SPAusnet to test energy storage through a mini grid pilot program that will see a sewerage pump station being powered by local housing that will collect solar energy for the batteries to run the station.

Both these projects are helping North East Water meet its carbon pledge of a 50% reduction in carbon emissions by 2025.

This paper will map out the process of how this project came about and the learnings to help other corporations deliver renewable energy projects. Energy storage will be the game changer for the water industry over the next ten years. The introduction of battery storage can deliver water corporations control of the cost and reliability of their energy supply.

1.0 INTRODUCTION

In June 2015 the IWN formed a group to look at energy on behalf of the Victorian water industry. The group held two workshops with representatives from the 17 Victorian water corporations. From these workshops five key projects were selected, they were:

1. Large Scale Energy Generation
2. Energy Storage
3. Energy Procurement Models
4. WSAA/IWN Aeration Benchmarking
5. Pump Efficiency Monitoring

These projects were chosen to assist the industry to better understand the volatile and dynamic energy sector.

This paper will review the progress of the 'Energy Storage' project.

The energy storage project was chosen as it represented three opportunities that could inform the water industry.

Those opportunities were:

- Using energy storage instead of generator back up during power outages
- Saving utilities energy costs by being able to store renewable generated power
- Changing operating hours to suit the use of renewable energy

2.0 THE PROJECT

Early in the project it was identified that a site for this trial needed to be a small water or waste water treatment plant (around 1 ML/d) for risk management purposes.

By selecting a smaller plant, contingency energy or water supply could be supplied if issues with the storage unit were to arise.
It was also helpful if the project could capture community support to promote the project as a positive outcome, and not an argument around climate change verses capital expenditure.

After several sites were investigated, the township of Yackandandah was selected as it had the right sized Water Treatment Plant (WTP), and a community group focused on renewable energy outcomes.

The community group known as TRY or Totally Renewable Yackandandah had set themselves a goal of being 100% renewable by 2022.

The Yackandandah WTP covered the aspects associated with risk, including the ability to cart water if required.

Another feature that made the Yackandandah project attractive to North East Water was that in times of bushfire and heatwave events the town's energy supply can become unreliable at a time it is needed the most. There is no energy back up at this site and energy storage could fill this gap.

Figure 1: ***Yackandandah WTP and Storage***

2.1 First Step - Energy Reduction

The first step to understanding what the project might look like, North East Water first had to assess the energy profile of the plant. This allowed NEW to understand the energy requirements to have sufficient renewable energy and storage to run the WTP "off grid".

It was initially identified through profiling the energy consumption that the WTPs energy use was highly variable showing large spikes during the plants operation as shown in Figure 2.

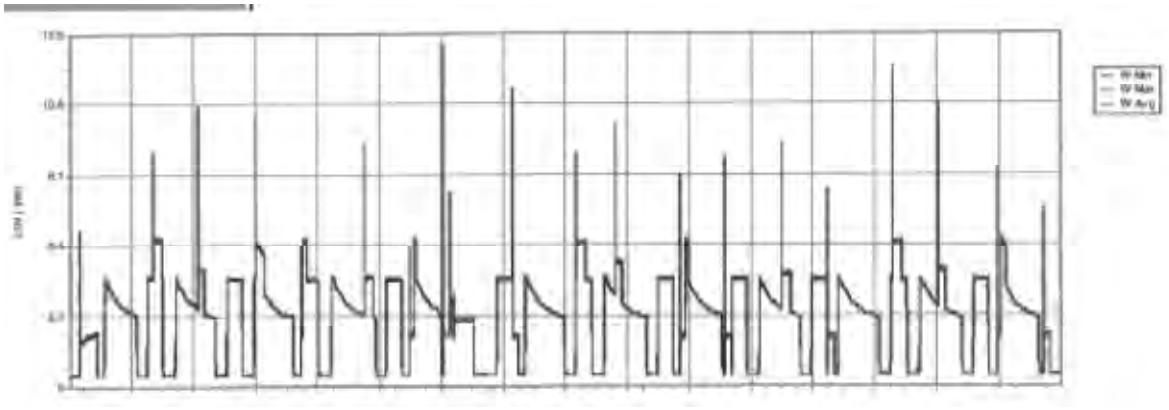

Figure 2: ***Yackandandah WTP energy use***

What this highlighted was that the future solar and battery storage installations would need to be sized for the spikes. North East Water were advised that this could result in the project being twice the size than it needed to, to allow for the energy spikes.

This then led to an in-house project team comprising of operations staff, treatment technicians and electricians to determine whether we could reduce the spiking and optimise energy consumption.

First a variable speed drive was installed to supply power to the water storage pumps that pushed water uphill to the storage tank. The second offender was the air compressor that supplied air for the control valves. The introduction of electrically actuated valves removed the need for the compressor and improved plant operation as the new valves featured better control, due to the smother valve movement delivering better water quality.

Both these changes resulted in a dramatic reduction in power spiking and energy use as highlighted below in Figure 3. As a result of these improvements, the design of energy storage and solar generation plant could be reduced from 100 kW solar and energy storage to 40 kW each, bringing the cost of the installation down significantly.

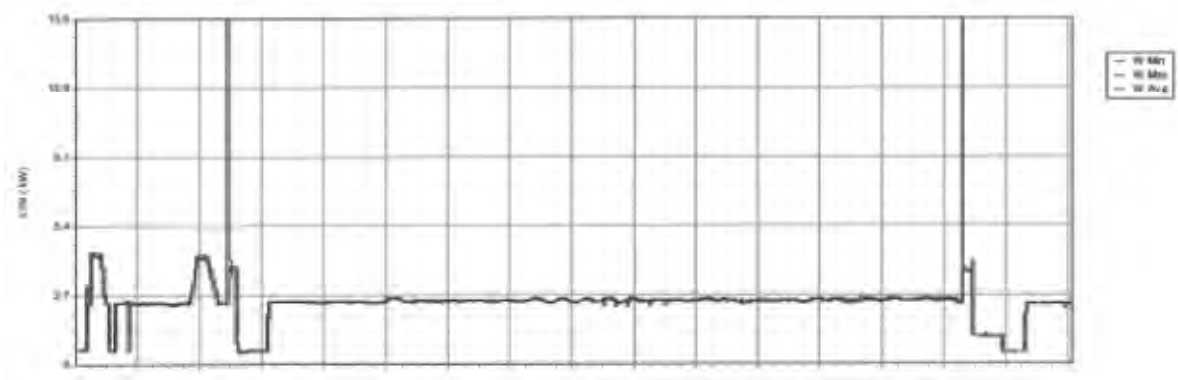

Figure 3: ***Yackandandah WTP energy use after optimisation***

2.2 Community Engagement

The other significant connection with this project was having the community along for the journey and given the project would require North East Water's CAPEX funding (noting supported through IWN), which is essentially the community's dollars, North East Water wanted to ensure it had community support in this project.

At the time energy costs were lower than current prices and would only see a break-even life cycle cost of the 10 year project.

A connection was formed with the Yackandandah community through the 'TRY' group who saw this project as a great initiative for its goal of 100% renewable energy by 2022 for Yackandandah. The TRY group had already achieved the town's energy supplied with 33% renewable energy through their community project, which is one of the highest in Australia.

This connection then saw SPAusnet (Energy network provider), the community and North East Waters network provider coordinate to introduce a mini grid installation. By having the key partnerships with TRY other parties have expressed interest and now wanting to get involved. Further projects are now being investigated to help reach the 2022 target.

2.3 The Installation

Once the two pieces of critical project initiation had been covered off, being energy optimisation and community support, North East Water went out to tender for the supply and installation of 40kW solar photovoltaic panels and 40kW battery storage unit.

Research into the type of battery identified that there was essentially two type of energy storage batteries currently available for this application, either lead acid or lithium ion.

The tender did not specify which type battery was preferred only that they needed to run the WTP in ideal generating conditions, as well as a standalone "off grid" plant for 24 hours. Remembering that this was an IWN trial to test battery storage and its advantages, and not to build an energy storage plant big enough to run continuously.

The trial is intended to assist other Victorian Water Corporations understand performance outcomes of energy storage installations.

The installation consists of a solar photovoltaic array of 140 panels situated at the top of the WTP storage, with a DC powerline down to the plat with 24 lithium ion sulphite batteries and inverter combinations inside a weatherproof switchboard (see Figure 4).

The value of the Lithium Ion batteries North East Water is installing is that the footprint is small enough to fit into the current site.

The generated solar power feeds the plant while the WTP is running, the excess energy tops up the batteries at the same time or when the plant is idle. When the solar panels no longer generate the plant will switch over to the battery supply. The batteries also can top up on cheaper off-peak power then run during the day during high peak power supply. This operating mode can be very useful in overcast periods when solar power isn't generated but real saving in energy costs can be made.

Figure 4: ***Weatherproof switchboard***

3.0 CONCLUSION

The plant has been in operation since October 2017 and has resulted in the following learnings:

1. The value of energy optimisation before the plant is designed and built to ensure cost efficiencies
2. Better utilisation of the clear water storage tank as a battery can optimise solar generation instead of battery consumption (see Figure 5)
    a. Figure 5 is an example of where plant run is called while not generating solar power resulting in draw down of the battery and corresponding grid draw
3. The size of the solar and battery is correct but only if the plant is run off solar during the day and the ancillary plant power is run from the battery at night
4. North East Water have gained extensive learnings into power storage for other sites within the Corporation through this project

Figure 5: ***Daily plant tracking of solar and battery generation***

Along with all these learnings, the biggest highlight for North East Water has been the community support and partnership with the 'TRY' group who have been strong advocates for our business and the project.

INSTRUMENTATION - ACCURACY AND CALIBRATION

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INSTRUMENTATION - ACCURACY AND CALIBRATION

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ABSTRACT

In this presentation we will talk about terms like Calibration, Accuracy and Precision. Then discuss calibrating pH and dissolved oxygen instruments and the environmental influence that can cause you to scratch your head.

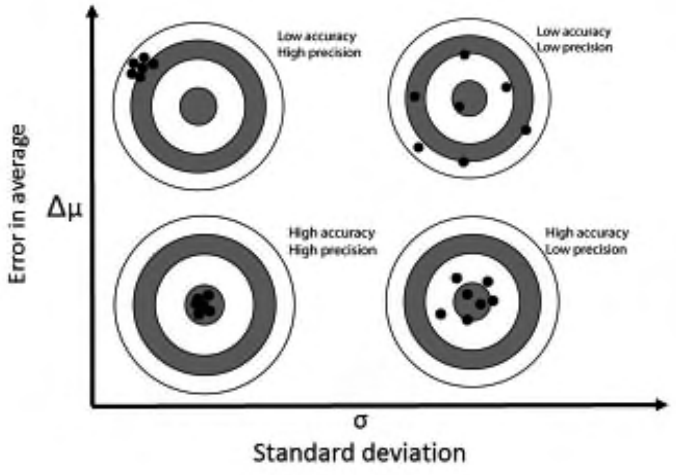
1.0 WHAT IS CALIBRATION?

Calibration is the process of adjusting an instrument to provide a result for a sample within an acceptable range. I was taught "Calibration is a matter of confidence"

Firstly, you need to know the limitation of your calibration device. What is its degree of accuracy and when was it last calibrated. What environmental elements will affect its reading. This sort of detail is often buried in the operations manual. Accuracy is often expressed in percentage of range or percentage of reading. 1% of range of an instrument ranged 0 – 20 mg/L is +/- 0.2 mg/L.

What is precision and accuracy?
Accuracy is the closest measured value to a standard or laboratory test. The accuracy of most instrumentation is dependent on the accuracy of the device, or the method used to calibrate that instrument. I say again, a process instrument is only as accurate as the calibrating instrument or method.

Precision is independent of **accuracy**. It is the measure of the spread of different readings. In many processes, instrumentation precision is more important than accuracy. You can be very **precise** but inaccurate, as seen in this diagram.



What is difference between resolution and accuracy?
Take the average of the measurements and the difference is between it and the true value is **accuracy**.

Resolution is a function of the effectiveness of an analogue to digital converter used in the instrument. On a pressure gauge, resolution is the granularity, or fineness, of a display. Essentially, resolution expresses the number of the smallest equal pieces used for a display.

It is a ratio between the maximum signal measured to the smallest part that can be resolved. The display on the instrument may show 3 decimal points, 0.001, this is the resolution.

Accuracy - Accuracy expresses how close a measurement is to the true value being measured. A clock is only accurate if it is set with the correct time and is manufactured to keep time. A clock can have a resolution of one second (three hands, 60 demarcations), but if it is set seven minutes too slow, or it adds a tenth of second to every minute, the resolution is meaningless.

Accuracy is expressed as a statement of expected error, +/- 0.02 of reading or 2% of full scale for example.

Quoting a resolution that is better than the accuracy of the sensor, can be quite misleading.

2.0 DISSOLVED OXYGEN MEASUREMENT

Much of the scientific data on dissolved oxygen is based on fresh water at room temperature (25°C), at sea level (1 atm), and zero salinity. This is a very different environment to the aeration basin at a wastewater plant. However, we need to know 4 parameters to properly measure dissolved oxygen.

There are 3 parameters that have an effect on a dissolved oxygen measurement. The actual amount of dissolved oxygen (in mg/L) will vary depending on temperature, pressure and salinity. Your calibrating instrument and process instrument should have correction for these 3 parameters.

2.1 Temperature

The solubility of oxygen decreases as temperature increases. Take 2 cans of your favourite carbonated beverage. One refrigerated to 2°C, the other at room temperature, 25-30°C. Note the extras release of gas from the beverage at room temperature. A measurement of D.O. in pure water at 25°C and sea level - i.e. 1 atm - ought to yield 8.3 mg/L.

All DO analysers perform temperature compensation correction. They can use look-up tables that store concentration values for discrete temperatures or they can use a mathematical relationship

Dissolved Oxygen (mg/L) at Saturation in freshwater		
Temperature (C^0)	(F^0)	Dissolved Oxygen at saturation (mg/L)
0^0	32^0	14.6
5^0	41^0	12.8
10^0	50^0	11.3
15^0	59^0	10.1
20^0	68^0	9.1
25^0	77^0	8.3
30^0	86^0	7.6

2.2 Altitude or Pressure

Dissolved Oxygen in water will increase as pressure increases. It can be atmospheric or hydrostatic pressures. Water at lower altitudes can hold more dissolved oxygen than water at higher altitudes. On average, solubility decreases 1.4% with each 100 m increase in altitude. If you have trouble sleeping read up on Dalton's Law and Henry's Law.

Dalton's Law https://en.wikipedia.org/wiki/Dalton%27s_law
Henry's Law https://en.wikipedia.org/wiki/Henry%27s_law

2.3 Salinity

Where does all the salt come from? Those working on plants along the coast will most likely have salt water ingress into the sewer system through inefficient seals in pipes. Salt water holds 20% less oxygen than fresh water, and a correction should be made in both the calibrating instrument and process instrument.

What is the salinity in the bioreactor at your plant?

Regardless of the type of sensor attached to the dissolved oxygen analyser, polarographic, optical or galvanic, they need to be corrected for temperature, altitude and salinity.

TEMPERATURE (°C)	SALINITY (g/kg)								
	0	5	10	15	20	25	30	35	40
0	14.621	14.120	13.636	13.167	12.714	12.277	11.854	11.445	11.051
1	14.216	13.733	13.266	12.815	12.378	11.956	11.548	11.154	10.773
2	13.829	13.364	12.914	12.478	12.057	11.650	11.256	10.875	10.507
3	13.460	13.011	12.577	12.156	11.750	11.356	10.976	10.608	10.252
4	13.107	12.674	12.255	11.849	11.456	11.076	10.708	10.352	10.008
5	12.770	12.352	11.947	11.554	11.175	10.807	10.451	10.107	9.774
6	12.447	12.043	11.652	11.272	10.905	10.550	10.206	9.872	9.550
7	12.139	11.748	11.369	11.002	10.647	10.303	9.970	9.647	9.335
8	11.843	11.465	11.098	10.743	10.399	10.066	9.744	9.431	9.128
9	11.559	11.194	10.839	10.495	10.162	9.839	9.526	9.223	8.930
10	11.288	10.933	10.590	10.257	9.934	9.621	9.318	9.024	8.739
11	11.027	10.684	10.351	10.028	9.715	9.412	9.117	8.832	8.556
12	10.777	10.444	10.121	9.808	9.505	9.210	8.925	8.645	8.379
13	10.537	10.214	9.901	9.597	9.302	9.017	8.739	8.470	8.210
14	10.306	9.993	9.689	9.394	9.108	8.830	8.561	8.300	8.046
15	10.084	9.780	9.485	9.198	8.921	8.651	8.389	8.135	7.888
16	9.870	9.575	9.289	9.010	8.740	8.478	8.223	7.976	7.737
17	9.665	9.378	9.099	8.829	8.566	8.311	8.064	7.823	7.590
18	9.467	9.188	8.917	8.654	8.399	8.151	7.910	7.676	7.449
19	9.276	9.005	8.742	8.486	8.237	7.995	7.761	7.533	7.312
20	9.092	8.828	8.572	8.323	8.081	7.846	7.617	7.395	7.180
21	8.914	8.658	8.408	8.166	7.930	7.701	7.479	7.262	7.052
22	8.743	8.493	8.250	8.014	7.785	7.561	7.344	7.134	6.929
23	8.578	8.334	8.098	7.867	7.644	7.426	7.214	7.009	6.809
24	8.418	8.181	7.950	7.725	7.507	7.296	7.089	6.888	6.693
25	8.263	8.032	7.807	7.588	7.375	7.168	6.967	6.771	6.581
26	8.113	7.888	7.668	7.455	7.247	7.045	6.849	6.658	6.472
27	7.968	7.748	7.534	7.326	7.123	6.926	6.734	6.548	6.366
28	7.827	7.613	7.404	7.201	7.003	6.810	6.623	6.441	6.263
29	7.691	7.482	7.278	7.079	6.886	6.698	6.515	6.337	6.164
30	7.558	7.354	7.155	6.961	6.772	6.589	6.410	6.236	6.066
31	7.430	7.230	7.036	6.846	6.662	6.483	6.308	6.137	5.972
32	7.305	7.110	6.920	6.735	6.555	6.379	6.208	6.042	5.880
33	7.183	6.993	6.807	6.626	6.450	6.278	6.111	5.948	5.790
34	7.065	6.879	6.697	6.520	6.348	6.180	6.017	5.857	5.702
35	6.949	6.767	6.590	6.417	6.248	6.084	5.924	5.768	5.617
36	6.837	6.659	6.485	6.316	6.151	5.991	5.834	5.681	5.533
37	6.727	6.553	6.383	6.218	6.056	5.899	5.746	5.597	5.451
38	6.619	6.449	6.283	6.121	5.963	5.810	5.660	5.515	5.371
39	6.514	6.348	6.186	6.027	5.783	5.722	5.575	5.432	5.292
40	6.412	6.249	6.090	5.935	5.783	5.636	5.492	5.350	5.215

A good principal in instrumentation is to calibrate the sensor as close as possible to the operational temperature range for that process. This is valid when looking at dissolved oxygen we are accustomed to calibrating in air.

In a bioreactor where the process control setpoint is at the low end of the scale, it is good to also perform a zero calibration. And then save this zero calibration, as well as the air calibration, in the analyser. Also ensure your DO hand held comparison instrument makes corrections for temperature, altitude and salinity and can also be calibrated at zero and span.

3.0 "BLOODY" pH

Just when you thought you had water instrumentation sorted, you come across pH and a Nernst of a problem. Nernst Equation https://en.wikipedia.org/wiki/Nernst_equation

The term pH means a measure of the activity of hydrogen ions (H+) in a solution. The "power of hydrogen" With pH, 7, is the "new zero". A probe in pure water, at 25 °C, measures a pH of 7 and outputs a voltage close to 0 millivolts. As the pH drops the probe output increases, and, as the pH increases, the output decreases going negative. Your process instrument tracks this change and corrects for the temperature change based on the most resent calibration.

The pH of calibration solutions changes with temperature. Since water changes its pH with temperature there is no reason why buffer solutions wouldn't be subject to the same temperature change. In practice every dissolved compound that affects pH is temperature dependent. Buffers are solutions of weak acids, which partially dissociate into H+ cations and salt anions. Most buffers decrease in pH for the same reason water does, i.e. as the buffer dissociates the concentration of H+ ions increases. This is not always true.

Fortunately, there are tables and mathematical formulas that give the dependence of the pH buffer actual pH on temperature. This table for correction can be found on the label of your calibration buffers.

Temp (°C)	pH 4	pH 7	pH 10
10	4.00	7.07	10.18
20	4.00	7.02	10.06
30	4.01	6.99	9.95
40	4.03	6.97	9.85
50	4.05	6.96	9.78
60	4.08	6.96	9.75

However, we are seldom working with pure water or water at 25°C.

I recall a call with an operator who was having issues with the pH sensors at an alkaloids processing plant. The process temperature at the point of measurement was close to 40°C. He liked to calibrate the sensors in the laboratory at 25°C. The buffer solution was kept in the refrigerator at 3°C.

He could not understand why when he returned the pH sensor to the process it read low by about 0.3 pH units. The pH analyser had temperature compensation and it was working.

The problem was not the pH sensor or buffers. His problem was not understanding that pH 7 is not always 0 mV. It will be something other than zero if the temperature is not 25°C. That table on the side of the buffer solution (and you always use) tells a little of the sliding electrochemistry involved when dealing with pH sensors, temperature and calibration.

These factors contribute to the offset.

1. The difference in potential between the gel layer on the inside of the glass membrane - the side that is bathed in constant pH 7 solution—and the gel layer on the outside of the glass - the side exposed to the process. Even when the process is neutral, differences in the gel layer produce a non-zero offset.

2. The diffusion potential at the liquid junction. The differing diffusion rates of the ions in the reference chamber - usually K+ and Cl - create a charge separation between the two and a potential. This potential is the one that exists even in an ideal probe and the offset created by the gel layer asymmetry is zero. The potential is on the order of 2 mV. Both contributions are temperature dependent. So, it makes sense that, to minimize changes in the offset that are temperature related, one should calibrate and measure at the same temperature.

3. Allow time for the sensor to adjust to the calibration environment. Typically, 30 to 60 seconds, depending on type of pH sensor. Ensure the sample is continuously mixed while measuring.

The guideline above - calibrating and measuring at the same temperature - will NOT remove the temperature dependence of buffer solutions. You must also input the correct pH of your calibration standard into the analyser when performing the calibration.

For every increase in pH value from 7pH the mV changes by -59.16mV. So 8pH is -59.16mV; 9pH is -118mV and 10pH is -177mV. Likewise, for each pH change below 7pH, the pH changes by +59.16mV. So 6pH is +59.16mV; 5pH is +118.32mV and 4mV is +177.48mV. It is easily to see why many Operators are happy to think that their pH sensors are working correctly because as the sensor ages, it is still reading close to 7. Remember 0mV is pH 7. Regular calibration to ensure the sensor is still responding is important.

Homework: Take a water sample and a pH meter with temperature correction. Gently heat the sample by 20°C and record what happens to the pH value.

A prize to the first 3 people still who send me photos of the before and after results.

4.0 CONCLUSION

It is very easy to believe the marketing brochures published by manufacturers of instrumentation. These are written for perfect world situations and don't always highlight the many outside parameters that can impact on a measurement. These details are buried in the operations manuals.

In closing I borrow from Mark Spencer in the forward of his soon to be published book on Water Quality Instrumentation.

We all know the saying “Give a man a fish and he eats for a day. Teach a man to fish and he eats for a lifetime.”

Translated into our industry: “Give a man a manual for a probe and he can make the probe work. Teach him how the probe works, and he can figure out what went wrong when it breaks.”

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MANAGING THROUGH AND MANAGING TO GET THROUGH A DISASTER

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ABSTRACT

Natural disasters whether they are floods, fires or tropical cyclones impact on a service provider's ability to supply safe drinking water and wastewater services. Important learnings arise during the preparation for them and recovery from them.

With the Whitsundays Region impacted by Tropical Cyclone Debbie in 2017, and a near miss with Cyclone Iris in April this year, learnings from these experiences may assist other service providers with their future disaster management. With improved disaster resilience, preparation and recovery times, overall costs and impacts to customers can be reduced.

1.0 INTRODUCTION

Severe Tropical Cyclone Debbie was the worst cyclone to hit the Whitsunday Region in 6 years, since Yasi in 2011 and Ului before that in 2010. It was also the second worse cyclone in terms of damage ever seen in Australia, behind Cyclone Tracey in Darwin in 1974. It made landfall just north of Airlie Beach on the afternoon of Tuesday, 28th March 2017, as a category 4 system. It delivered the highest wind gust ever recorded in Queensland at 263 Km/hr, and in the span of an hour, 211 mm (8 inches) of rain hit the area. An evacuation order was given for 25,000 people across the region. Over the next 3 days, an estimated 860mm of rain fell on Airlie beach, estimated because none of the 4 closest weather stations survived the cyclone.

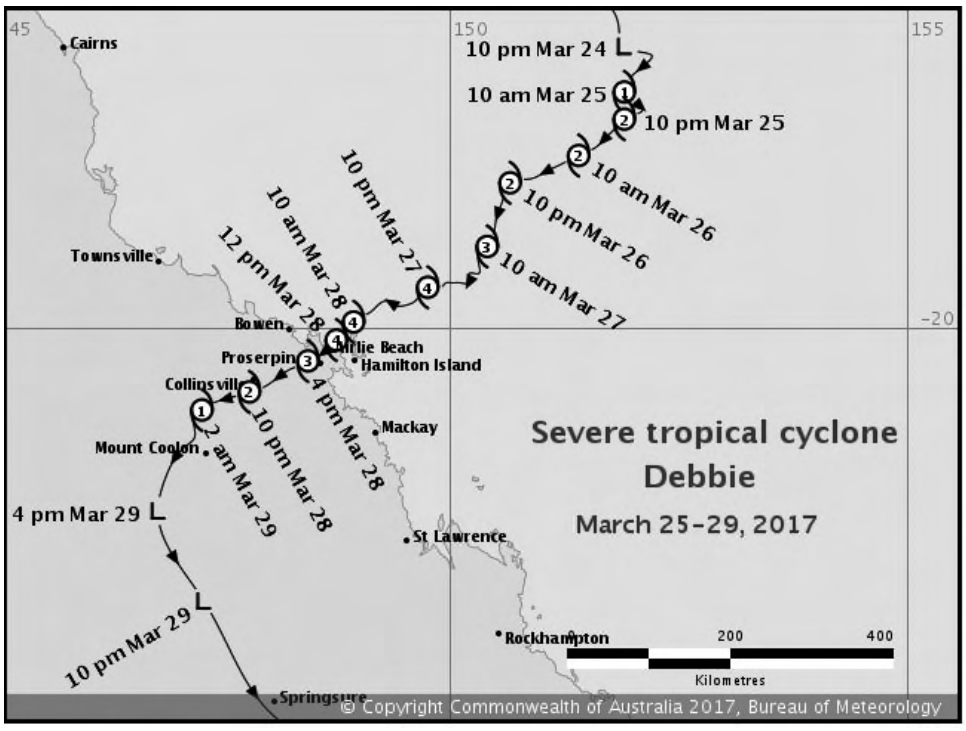

Figure 1: ***Cyclone Debbie Track and Intensity Map (Source: Bureau of Meteorology)***

It was the fact that Cyclone Debbie slowed down to 7km/hr after it made landfall that caused the most damage to Airlie Beach and surrounds. The intense winds near the core lashed the area for approximately 16 - 18hrs.

From a treatment operations perspective, we were unprepared for a cyclone of this magnitude and duration, and the learnings from the two most recent cyclones were not fully implemented.

At the time, there was an estimated 48,000 people without power in Airlie Beach, Proserpine, Bowen, Mackay and Cannonvale.

The entire Whitsunday Regional Council (WRC) region lost power on day 1 of the cyclone in Collinsville, Bowen, Proserpine and Airlie Beach. That's no electricity to four water schemes and four sewerage schemes servicing a regional population greater than 35,000. This includes 18 water Pump stations, 19 water Bores, 25 reservoirs and 78 sewage pump stations. Of this critical infrastructure, only three had generators, two sewerage treatment plants, and our newest sewage pump station. None of the water assets had back-up power, and either didn't have generator connection points or they were non-standardised. This caused major issues as Proserpine and Airlie beach were without power for 11 days.

The main reservoir in Cannonvale drained during the night of the cyclone from hydrants being sheared off by debris and bursts from runoff scouring away pipelines. This caused Airlie Beach and Cannonvale to be without water for 4 days. This reservoir is currently leaking due to a suspected split scour line from ground movement from the torrential rain and an empty reservoir. This scoured away an unknown quantity of bedding sand from underneath the reservoir before a temporary bung could be installed in the pipe, the problem being compounded by the fact that this reservoir cannot be taken offline.

Once the cyclone had passed, the challenge involved checking the safety of all staff, assessing damage to critical infrastructure, organising generators with Ergon staff and private contractors, and arranging local electricians to ensure the plants, bores and pump stations would safely restart once power was resupplied.

In the debriefs that followed, it was obvious that a higher level of self-sufficiency and resilience was required to ensure council was better prepared for future disasters. Numerous improvement suggestions were made in both operational and capital areas which were able to be tested and further improved in April 2018 during Cyclone Iris.

2.0 DISCUSSION

Both internal and external debrief sessions were held post cyclone to determine internally what WRC could do better and what other agencies had learned from the disaster.

2.1 Debrief Sessions

These debrief sessions were not only important for discussing what didn't work well during the cyclone, but also what did work well, and how these positive outcomes were achieved. These were also held for Whitsunday water and wastewater staff and key stakeholders in addition to the higher level debriefs undertaken by the Local Disaster Management Group.

Table 1: ***Summary of Key Findings from Internal and External Debrief Sessions***

Internal	External
Update pre-cyclone procedures and checklists	Communication between key stakeholders (i.e. Council, Ergon, Army, Police)
Purchase of generators and refuelling trailer for critical infrastructure	Organisations to be more resilient (i.e. own generators, not reliant on Ergon)
Better internal communication – too reliant on mobile phones (HF/ VHF)	Availability of (up to date) key contact list for all agencies.
Update incident forms and reporting protocols	Importance of pre-cyclone "check-in" between agencies – faces to names
Standardisation of generator connection points and procedures	Issues with time taken to "Hardwire" generators directly to switchboards
Update list of assets and pump sizes	Locations of critical infrastructure to be shared with agencies

Living in a cyclone prone area, the summary of suggestions in Table 1 seem obvious in hindsight, but a level of complacency tends to develop over time when these natural disasters (albeit not of this severity) become a yearly occurrence. This was confirmed when speaking with other regional councils who are undergoing similar processes to enhance their disaster management capabilities. Results from these have already been shared amongst several of these councils.

2.2 Implementation of Key Suggestions

Several workshops were held to work out an action plan to ensure the outcomes from these briefing suggestions were implemented and followed through and not forgotten for the next cyclone.

Budgets bids were developed for purchasing the larger capital items such as generators, however most of the other suggestions requiring expenditure had to come out of existing operational resources.

2.3 Pre-cyclone Season Preparedness Sessions

In addition to the pre-season checklists that WRC already utilised, it was decided to run semi-formal pre-cyclone season emergency preparedness sessions several months prior to cyclone season each year. These sessions included developing emergency preparedness information kits for each of our regional areas as they were isolated for some time during cyclone Debbie. These contain WRC's Drinking Water Quality Management Plan – with schematics and infrastructure descriptions, checklists, press releases and Boil Water Notices, WRC incident contacts, key contractors numbers, hi-vis vests and councils emergency response procedures.

Next cyclone season, these sessions will also include involving other neighbouring councils for learnings as well as availability of critical spares.

A current work in progress is development of council's disaster asset criticality register, which as we discovered, can be profoundly different to the asset criticality register in our asset management system purely based on financial aspects.

3.0 CONCLUSION

Did implementing any of these changes work? Well WRC got to test out everything that was put in place since Cyclone Debbie in April this year, as the erratic Cyclone Iris made its way towards our region.

The re-vamped site-specific checklists and pre-cyclone preparedness sessions were held in November and early December. These proved to be very successful in reminding operators and support staff of roles, who to contact and generally put everyone into the right mindset.

The emergency boxes developed now also include alternative route maps to access sites that can be cut-off by flood waters, downed powerlines etc. Operators used the maps to access the Bowen WTP due to heavy rainfall from TC Iris recently. This involves accessing a local farmers property that is ironically more flood proof than our roads!

Whitsunday Regional council now have 4 generators at the most critical sites with funding for another 6 applied for. An added benefit of the existing generators is the ability to still run the plants during line maintenance activities or blown fuses which can happen somewhat regularly. Ergon also initiated contact with council and had 5 generators on site at our other critical sites several days before Iris was due to impact the region. Where possible, smaller trailer mounted generators will be utilised to minimise capital and maintenance costs of having multiple fixed plant at less critical sites.

Figure 2: ***Generators Installed on site prior to TC Iris***

Council also now has standardised generator connection plugs and changeover switches at all bores, treatment plants, water and sewerage pump stations, reservoirs and offices. As council discovered this can save a large amount of time and money during a disaster as you don't have to hardwire in generators. Ergon or a hire company can drop the generators off on site and a trained operator or council electrician can set them up. As funding is made available, spare generator connection leads will also be made as several of these went missing after TC Debbie.

Figure 3: ***Standardised Generator Connection Points at all Sites***

If necessity is the mother of invention, then disasters can be the father of innovation as council has also been involved in an Australian and possibly world first underwater Ground Penetrating Radar (GPR) survey of our Cannonvale Reservoir. This technology was utilised to determine the extent of any void created under the reservoir when the scour pipe failed.

It is envisioned that future pre-cyclone preparedness sessions will involve the use of video conferencing to allow our neighbouring councils to share information, earmark resources such as mobile generators or fuel trailers that could be sent to their regions if required.

4.0 ACKNOWLEDGEMENTS

To the Whitsunday Water team who shared their experiences and allowed their actions during the cyclone to be dissected with the benefit of hindsight for the debrief sessions. Their honesty made the sessions and outcomes even more beneficial.

Special thanks to Kerrie Pearson who led the disaster preparedness sessions and helped with the development of the checklists and procedures.

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CO-EXISTING WITH TELECOMMUNICATION CARRIERS

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CO-EXISTING WITH TELECOMMUNICATION CARRIERS

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ABSTRACT

This paper is based on guidelines developed by NSW and Queensland Water Directorates that:

1) Explain the Commonwealth's telecommunication legislative framework that Telecommunication Carriers (Telcos) are required to operate under, and

2) Promote how Local Water Utilities (LWUs) can use the same legislative framework to protect their assets and operations, meet their State's legislative requirements (e.g. NSW Public Health Act, NSW Work Health Safety Act, etc) & provide safe drinking water.

There are documented horror stories when the balance between the burden of Telco infrastructure on water assets and the LWU's need to manage its water supply integrity favour the Telcos. Perhaps our water industry has unknowingly made things too easy for Telcos by simply (albeit sometimes grudgingly) allowing them to dictate how they install and operate their communication equipment on water assets. Or perhaps our State legislation associated with planning approvals, public health, water quality and workers' safety has become incompatible with current telecommunication legislation.

Whatever the case may be, there is now a stronger need for LWUs to understand and exercise their legislative rights to meet water supply and governance requirements, reduce their business costs imposed by Telcos facilities, and to highlight any legislative deficiencies so things can be fixed. This need is further compounded by TPG Telecom's announcement (April 2017) to become Australia's fourth Carrier operator, and the Australian Government releasing its strategy (October 17), to support the timely rollout of 5G in Australia including *"…streamlining arrangements to allow mobile carriers to deploy infrastructure more quickly..."*[1].

It's hoped that the information contained in the NSW Water Directorate's "*Third Party Infrastructure on Water Supply Reservoirs Guidelines, Parts 1 & 2*" will empower and motivate LWUs to protect our obligations to water quality, workforce safety, minimising capital and operational costs, as well as establishing a better a balance between LWU's and telecommunication needs.

1.0 INTRODUCTION

In June-July 2017, the Australian Government (through the Department of Communication and the Arts) sought submission responses on the '*Possible amendments to the telecommunications carrier powers and immunities*' legislation. Many stakeholders (such as water industry associations, water utilities, local governments, and various State government agencies) were unaware of this consultation process as they had not been directly notified of the proposed amendments by the Australia Government, though some still managed to submit their concerns at the last minute.

Submissions lodged can be viewed at: https://www.communications.gov.au/have-your-say/consultation-possible-amendments-telecommunications-carrier-powers-and-immunities

At the similar time, the Queensland and NSW Water Directorates recognised the risks of telecommunication facilities on water supply reservoirs to water quality, worker's safety, water supply operations and asset management.

They were also developing the following guidelines:

1. Third Party Infrastructure on Water Supply Reservoirs Guidelines – Volume 1 Engineering Aspects (September 2017 – available)
2. Third Party Infrastructure on Water Supply Reservoirs Guidelines – Volume 2 Legislative Framework (to be released)

What was apparent after following up consultation meetings with Department of Communication and the Arts regarding their proposed legislative amendments, was that there was little available data highlighting the impacts of telecommunication facilities on reservoirs that have been referred to the Telecommunications Industry Ombudsman (TIO) for action. This is despite various organisations, LWUs and water authorities who have/are experiencing issues jeopardising their operations, worker's safety and public health.

Unfortunately, one cannot say the "system is broken" to manage Telco's communication facilities on reservoirs unless there's legitimate attempts to use the system. The NSW Water Directorate's *Third-Party Infrastructure on Water Supply Reservoirs Guidelines (Parts 1&2)* attempt to educate and promote the various legislative instruments ("the system") that are currently available for LWUs to use, and to bring balance back for a mutually sustainable arrangement between LWUs infrastructure and Telcos.

2.0 LEGISLATIVE FRAMEWORK

The current Commonwealth telecommunication legislation was introduced when Telstra was privatised in the late 1990s, and when the various state legislation for public health, water quality, workers safety was (perhaps) not as developed as it is now.

The *Telecommunication Act 1997 Cth* (Telco Act) provides substantial powers and immunities for Telcos to access, install and operate communication facilities on private property, especially if the facility is categorised as Low Impact under the *Telecommunications (Low-impact Facilities) Determination 1997* (i.e. the *Determination*). There are other supporting legislative instruments that Telco's must adhere to, such as *Telecommunications Code of Practice 1997* (i.e. the Code), *Telecommunications Regulations 2001*, and various Telco Industry Standards and Industry Codes registered with Australian Communication and Media Authority (ACMA). These are also explained in NSW WD's guidelines.

If the facility cannot be categorised as Low Impact under the *Determination*, the Telco must obtain development consent through State planning processes (which includes Local Government planning approvals). This gives LWUs opportunity to stipulate consent conditions to ensure the Telco's facility is compatible with LWU's essential operations and governance requirements.

Consent conditions should address the needs/requirements of the LWU including but not limited to site access; installation and maintenance activities; water quality contamination; work health and safety and lease/licence agreements.

However, if the facility is categorised as Low Impact under the *Determination*, then there's no need for the Telco to obtain development consent through State or local government planning processes. This is the area of greatest concern for LWUs, as many reservoirs, towers, tanks are considered candidates to host Low Impact communication facilities.

Figure 1: ***Example of a Low Impact Facility posing risks to water supply operations and public health***

This paper highlights various potential grounds to raise objections initiated from Telcos' Land Activity Notices (LANs) with respect to installing or maintaining communications facilities under the *Determination.* Submitting objections is the mechanism to begin meaningful discussion / negotiations with Telcos.

3.0 WHAT ARE LOW IMPACT FACILITIES?

Low impact Facilities are facilities which are considered to have a low visual impact because of their size and location. At the time the Telco Act was drafted, they were less likely to raise significant planning, heritage, or environmental concerns.

The NSW Water Directorate guidelines - "*Third Party Infrastructure on Water Supply Reservoirs Guidelines, Part 2"* help to explain what is or not a Low Impact facility under the *Determination*. In particular, "public utility structure" is specifically mentioned in Part 7 of the Schedule of *the Determination* with only limited conditions relating to noise and percentage volume of space being utilised. In other words, water supply reservoirs may be considered as a Low Impact facility more often than not.

There are stringent procedural requirements for:

1) Telcos to access and install communication equipment on Low Impact facilities sites in the legislation,
2) Strict timeframes for Land owners to object and negotiate with Telco and refer matters to the Telecommunication Industry Ombudsman (TIO). The process often begins with the Telco issuing a Land Access and Activity Notice (LAAN).

It's very important for LWUs to immediately review a Telco's proposal to establish a Low Impact facility under the *Determination*, and to be prepared to lodge an objection on legitimate grounds and within certain timeframes. The onus is on the LWU to identify noncompliance and lodge an objection, and failure to do this is interpreted as accepting the Telco's proposal on prima facie. This enabling the Telco to carry out activities stipulated in the LAAN. This is explained further below.

4.0 LAND ACCESS AND ACTIVITY NOTICE AND OBJECTION PROCESSES FOR LOW IMPACT FACILITIES

Schedule 3 of the *Telecommunications Act 1997* (the *Telco Act*) and the *Telecommunications Code of Practice 1997* (the *Telco Code*) set out a process (the "Land Access Process") that allows the Telco to install Low-Impact Facilities without the consent of the Land owner and without obtaining State, Territory or local government approvals.

The objection process may not be successful in stopping the Telco's proposed activity but is an effective mechanism to have constructive dialogue with the Telco to attempt to address issues and concerns of both parties to sustainably co-exist. It also provides the mechanism for the Telco to make reasonable efforts to enter into an agreement with LWUs if a Telco's activities are likely to affect the operations of a public utility.

The *Telco Code* (Clause 4.24) outlines the Land Access and Activity and Objection process for new facilities, and similar processes are outlined for Inspection of Land (clause 2.31) and Maintenance of Facilities (clause 6.23) with different timeframes.

The process for new installations[2] is outlined below:

1. Typically, Telcos will issue a LAAN at least 10 business days before commencing works. To raise/discuss any concerns/issues with the Telco, the Land Owner is expected to lodge an objection at least 5 business days before commencing works.

2. Both Land owner and Telco have 20 business days (i.e. Consultation period) commencing when the Telco receives the Objection to resolve the Objection. During this period, the Telco must make "reasonable efforts" to resolve the Objection commencing within the first 5 business days of the Consultation period.

3. If the Land Owner and Telco cannot resolve the Land Owner's objection by agreement by the end of the Consultation Period, the Telco must issue a "End of Consultation Notice" within 5 business days from the end of the Consultation Period to the Land Owner indicating whether the Telco is making any changes to the original LAAN to address the Land Owner's objection.

4. If the Land Owner is not satisfied with End of Consultation Notice, the Land Owner can write to the Telco and ask the Telco for refer the matter to the Telecommunications Industry Ombudsman (TIO) within 5 business days after receiving the End of Consultation Notice. If this step is not carried out, the Telco will be able to carry out the activity stipulated in the LAAN.

   Referral to the TIO

5. If the Telco wishes to proceed with their activity after receiving the TIO referral request from the Land Owner, they are required to prepare a referral brief and send it to the TIO as soon as practical.
   Unfortunately, the *Code* does not specify a timeframe for the Telco to refer the objection to the TIO. However, if the Telco wishes to proceed with the proposed activities despite the objection, the referral should occur promptly preferably within 20 business days from when the Telco received the Land owner's request to refer.

If the objection complies with the relevant clauses of the Telco Code, a Telco is only able to engage in the land entry activity in the following situations.

- The objection is resolved by an agreement between the Telco and Objector.
- A request to refer the objection to the TIO is not received by the Telco within 9 business days for the inspection of land, or 5 business days for the installation or maintenance of a Low Impact Facility provided in the Telco Code.

Accordingly, time periods are critical.

- The TIO deals with the objection without giving any direction to the Telco and informs the Telco in writing of that outcome.
- The TIO gives a direction to the Telco.

The TIO will review the information provided in the Telco's referral brief and will invite both parties to provide any other information/documents that may be relevant.

It may be appropriate for the Land owner to seek professional legal assistance to collate and respond to any TIO request for information. There are no provisions in the Land Access Process that allow the Carrier or Land owner to appeal decisions made by the TIO by a Court except in limited circumstances. Again, legal advice should be sought if this is being considered.

5.0 VALID GROUNDS FOR AN OBJECTION

Fortunately, Telcos must comply with many conditions that are contained within Division 5 of Schedule 3 to the *Telco Act*, and the *Telco Code*. LWUs can utilise the objection process as a powerful mechanism to negotiate with Telcos, rather than accepting a notification of their planned installation or maintenance of facilities under the *Telco Act*.

NSW Water Directorate's guideline (Part 2)[4] summarises the legislative requirements that Telcos must comply with. These include:

- Telcos to adopt best practice, often with reference to the various industry codes registered by Australian Communication and Media Authority (ACMA) - Clauses 2.11(1), 4.11(1) and 6.11(1) of the *Telco Code*
- Telcos to abide by laws governing noise applicable under State laws - Clauses 2.12, 4.12 and 6.12 of the *Telco Code*
- Telcos must take all reasonable steps to ensure that they cause as little detriment, inconvenience, and as little damage as practicable - Clause 8 of Schedule 3 to the *Telco Act*
- Telcos must take all reasonable steps to ensure that the land is restored to a condition that is similar to that which existed before the activity began - Clause 9 of Schedule 3 to the *Telco Act*
- Telcos must take all reasonable steps (under Clause 10 of Schedule 3 to the Telco Act) to:
    - Act in accordance with good engineering practice.
    - To protect the safety of persons and property.
    - Ensure that the activity interferes as little as practicable with:
        - the operations of a public utility;
        - public roads and paths;
        - the movement of traffic; and
        - the use of land.
    - Protect the environment.
- Telcos must make reasonable efforts to make an agreement with a public utility, when engaging in an activity that is likely to affect that public utility's operations. The agreement must provide the way the Carrier will engage in the: inspection or land; or installation of; or maintenance of a facility - Clause 11(1) of Schedule 3 to the *Telco Act* and clause 2.6, clause 4.6 and clause 6.6 of the *Telco Code.*
- Telcos must give notice to owner of land before engaging in any activities involved with entering land - Clause 17 of Schedule 3 to the Telco. Warning…this clause as many exceptions

- Telcos to give notice to owner of land for any tree lopping - Clause 18 of Schedule 3 to the *Telco Act*
- Telcos must give 10 days' written notice to road authorities and utility authorities before engaging in any of the following activities (Clause 19(1) of Schedule 3 to the Telco Act. Warning…Telcos can often use the exception to maintain adequate levels of service):
    - Closing, diverting or narrowing a bridge.
    - Installing a facility on, over or under a bridge.
    - Altering the position of a water, sewerage, or gas main or pipe.
    - Altering the position of an electricity cable or wire.
- Telcos must ensure that there is reasonable passage for persons, vehicles and vessels when installing facilities over a road, bridge, path, or navigable water. The Telco must install the facility is such a way that satisfies 'reasonable passage' - Clause 20 of Schedule 3 to the Telco Act

6.0 CONCLUSION

It's believed that poor corporate posturing by Telcos (perhaps more so by their contractors and sub-contractors) have enabled them to "work the system" to their advantage to minimise their costs to establish Low Impact facilities on reservoirs. This has caused great concern and expense to LWUs.

As highlighted above, there are substantial grounds for LWUs to hold Telco's (and their agents) to account. Objections raised by LWUs from a Telco's LAAN are essential to begin dialogue with the Telco about their installation, and to establish a more sustainable approach to both parties' legislative requirements.

It's hoped that if the industry is more educated and motivated to exercise their rights under the same telecommunication legislation, the risk to LWU's operations, staff, water quality and public health can be better managed.

NSW Water Directorate is interested to receive information from LWUs so the newly formed working committee comprising of NSW Water Directorate, Qld Water Directorate and WSAA can collate information and highlight any legislative deficiencies to the Department of Communication and the Arts.

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T.I.M.S. (TOTALLY INDEPENDENTLY MANAGED SUPPLY), LOGAN'S ANSWER TO AN EMERGENCY WATER SUPPLY

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T.I.M.S. (TOTALLY INDEPENDENTLY MANAGED SUPPLY), LOGAN'S ANSWER TO AN EMERGENCY WATER SUPPLY

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ABSTRACT

Water Operations over the years, has experienced issues with providing acceptable levels of continuous water supply to residents affected by emergency or planned water outages. Until recently, the only reliable way of maintaining water supply to effected residents was the labour intensive process of installing a temporary water main and connecting individual water services for the duration of the intended planned works. In the case of water main bursts, the only relief from the interruption of supply was in the form of bottles of drinking water supplied by Water Operations to residents that made complaints or stressed hardship due to the outage.

This issue has been highlighted by field staff in the past whom have identified the need for a better delivery system to supply a greater number of residents with potable water when crews are required to isolate supply during emergencies or planned shutdowns.

As a potential solution to these issues, Totally Independently Managed Supply (T.I.M.S.) was developed as a prototype delivery system to address this need whilst improving safety and efficiency of supplying potable water to residents, businesses and schools during periods of water main isolation whether they be emergency or planned isolation

As an indication the current T.I.M.S. system during its work cycle has now been able to supply potable water to up to 500 properties at one time, without any issue with pressure or water quality being recorded or associated to the use of this system to date.

1.0 INTRODUCTION

For many years Logan Water Operations did not have the ability or the equipment to provide continuous water supply to the majority of customers when undertaking water supply outages. Originally it was standard procedure that the field staff performing an emergency water supply interruption would be required to drive the field service vehicle along the effected streets with the water supply interruption announcement playing over the vehicle PA system to warn residents of the impending outage. With planned interruptions there is a requirement to provide effected customers with minimum of 48 hours prior written notification before the supply could be interrupted.

The initial stage was to develop a supply system to provide essential customers with alternate water supply during interruptions, which was when what we call the Camel was developed. The Camel is a tandem trailer which has a 1,500 litre water tank with an electric and petrol pressure pump fitted. This can be fitted to individual critical properties to provide a water supply which was good, but only supplied 1-2 properties at a time.

This equipment had associated issues with its use as it could not be left unmanned as it only held 1,500 litres and was either powered by petrol or electricity which were unreliable as the petrol pump would be only capable of 2-3 hrs continuous operation before it would require refuelling. The electrical pump could only be used if there was a power source present be it 240 ac mains supply or generator supply. This also raised safety issues with the incompatibility of power leads and water in the same area.

In an attempt to minimise bursts and prolong water main life, the water business has undertaken a project in recent times to divide the water reticulation network into pressure management zones that cover the entire network. These zones by design only have one or two water supply feeds to each zone. This approach to water supply heightens the need to be very careful when isolating water mains as there is a potential to affect several hundred residents and/or businesses should there be an issue with a zone supply main, or the requirement for a sluice valve be isolated for maintenance purposes.

This implementation made the need for an alternate method for temporary water supply to be utilised during water main isolation occurrences whether it be planned or reactive at the top of the Water Operations urgency list. Fortunately for Water Operations we have the services of an idea's person in the form of our Water Projects Supervisor, who after some initial sketches came up with the T.I.M.S. concept.

Figure 1: ***T.I.M.S. deployment during flood event Stanmore Rd Yatala to service 14 properties***

2.0 DISCUSSION

Post initial concept designs of the unit and associated equipment, a consultation process was implemented. Discussions were held with experts in their field from other departments within the Council's Water Operations section, as well as outside equipment suppliers to ensure that the equipment being sourced was fit for purpose and to ensure that it meets Water Operations stringent operational requirements.

It was decided to undertake a 5 stage approach to this project:

- Approval for associated funding for the project
- Procurement of the appropriate equipment and associated materials
- Rigorous testing of the equipment prior to the final construction
- Construction of the equipment into its final configuration
- Commissioning and on-site testing.

2.1 Approval

All relevant specifications and materials estimates were then sourced from the identified suppliers and contractors which enabled the project team to ascertain the approximate cost to procure, construct and commission the required equipment.

As per standard Logan City Council procedure, a business case was produced and by the Water Projects Supervisor along with the appropriate support from the Water Network Maintenance Program Leader.

This proposal was then submitted to the authorised approving authority who after following due process, provided the approval to proceed with the project and allocated the relevant funding.

2.2 Procurement

The Water Projects Supervisor in conjunction with the Water Networks Supervisor then went to the market to procure the required equipment whilst following the LCC Procurement procedures.

During the procurement process there were several issues that needed to be dealt with relating to the suitability of the equipment considering the location that the apparatus was potentially located during its intended deployments.

These issues were as follows:

- Noise levels emitted by the pumps and power supply generator
- Adequate power output to meet and exceed the requirements of the equipment used during deployment
- Overall final size / dimensions of the outfit
- Capacity of the water storage supply tank to enable continuous supply at alternating demand rates
- Ability to maintain constant pressures and flow of the provided water supply
- Licencing requirements (as this equipment must comply with the Foods Act 2006 as well as Backflow licencing requirements)
- Safety issue related to this unit being potentially situated on a footpath during deployments for extended periods of time unattended.

2.3 Testing

During this phase of the project there were rigorous equipment tests performed, long before the actual construction of the unit began.

This testing included pump supply rates and pressure under different demand conditions. The Wilo- MHiKE-D, multistage pump system was chosen to pressurise the supply for the unit. This was due to its compact configuration and ease of operations, not to mention its ability to provide the required demand outputs

Several test rigs were set up both in the controlled environment of the Water and Wastewater depot as well as in the public space when performing small non-critical planned shutdowns of the network.

These scenarios were utilised to evaluate the performance of the pump configuration to ensure that it met with the required outputs both in flow and pressure. In the field tests, a local water carrier was utilised as the water storage supply unit for the tests, as the tank had not been purchased at this stage.

Size, and the ability of the generator to meet demands placed on the unit was tested. This also included the potential attachment of additional equipment to be utilised on site. It was decided, after deliberation with relevant staff from the Water Operations Mechanical and Electrical section who have a good knowledge in dealing with these issues, to choose a 9 KVA diesel fuelled generator.

This model has a rated noise output of 66.8 dB @ 7 M and a rated output of 10.3KW.

Figure 2: ***T.I.M.S. diesel powered 9kva generator electrical supply power plant***

The 13,000 litre cartage water storage tank and frame was selected for its size, manoeuvrability and lightweight construction. The mounting frame also had the required allowances to comfortably accommodate the pump and generator setup that was required to power and operate the unit with the minimal of adjustments.

2.4 Construction

The assembly of the unit into its final configuration was handled in house at the LCC Smith Rd Water & Sewage Depot, as a combined effort of the Mechanical & Electrical and the Water Projects sections. This was found to be the most cost effective and efficient option to perform this work, as it enabled us to utilise the professional skills of the internal staff, as well as giving them some ownership of the project.

Figure 3: ***Completed unit ready for commissioning and trials***

During the construction stage of this project, one of the technical experts providing advice on the electrical installation, proposed a suggestion that the unit needed to be connected to the SCADA/ telemetry system to enable the unit to be remotely monitored. This eliminated the need to physically man the unit unless necessary (refuelling the generator, filling the water tank, adjusting / maintaining pressures and flow).

After initial discussions with the Water Operations Manager, it was decided to go ahead with the plan to enable the remote monitoring of the unit by its connection to the SCADA/ telemetry system. This approach was agreed to be the most efficient and economical way of operating the unit.

2.5 Commissioning & On-Site Testing

Commissioning of the unit commenced in March 2016 when the unit was placed on site at several small planned water main isolations to test its ability to cope with differing flow demands, as well as to ensure that adequate pressure was maintained in the mains during the isolation process.

Figure 4: ***Initial on-site testing for planned water main shutdown to replace existing Fire Hydrant spring-top***

During the testing and commissioning stage, there were two opportunities for the unit to undertake large water supply under emergency conditions for an extended period. The first was when we experienced a burst water main that supplied a large retirement village in the Beenleigh area. On this occasion, the unit was utilised to supply approximately 200+ individual units within the village for a period of 2 days whilst the water main was repaired.

Figure 5: ***Utilised to supply 200+ residents during burst water main repairs (retirement village) 22.5hrs continuous use***

During the recent floods in April 2017, the unit was utilised to supply 14 properties that had the water main washed away. The unit on this occasion was operational continuously for approximately 145 hours until the flood waters receded enough for a temporary water main to be installed, to take over the supply demands.

Figure 6: ***Logan Reserve water main isolation during planned works of 500+ residences***

3.0 CONCLUSION

The initial driver for this project was to provide the residents and businesses of Logan City an alternate reliable safe source of drinking water when for one reason or another, the water reticulation network is required to be isolated for maintenance or repair works.

This project is, and will be, an evolving project as there will be improvements in technology and equipment that could potentially be incorporated into this unit to assist it to operate in more efficient ways in the future. However, for the foreseeable future this unit suits the Water Operations branch's needs in its current configuration.

As a resultant outcome of this project the original brief has been met with a high level of success when utilising the T.I.M.S. unit in the case of water mains isolations. The unit is currently in high demand and there is a new unit presently being designed to further improve the level of service that is provided to the residents of Logan.

4.0 ACKNOWLEDGEMENTS

I would like to thank the members of the design and construction team (Steve Young – Water Projects Supervisor, Lester Bridgham – Networks Supervisor) for the information and photos that have been utilised in this presentation.

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Project Business Case "Report on TIMS" Totally Independent Managed Supply: - by Stephen Young 04/06/2016. steveyoung@logan.qld.gov.au

DRINKING WATER QUALITY IMPROVEMENT THROUGH UPGRADING CHLORINATION SYSTEM – ALPHA & JERICHO WTPS

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ABSTRACT

Raw water to supply the Alpha town is drawn from 5 bores. There are quality concerns with high levels of alkalinity, TDS, Silicates, Chlorides with the water and it does not comply with ADWG.

Primary chlorine dosing with Sodium hypochlorite (hypo) exacerbated the drinking water quality issues with Chlorate levels increasing to levels above the recommended aesthetic limit set in the ADWG. Hypo is purchased at a high cost (from a Sydney supplier) in 200 litre drums, in larger volumes than immediately required to optimise freight charges, and it is stored in the open environment.

A significant decay rate in the hypo results in rapidly changing available chlorine levels. This in turn create issues and difficulty in maintaining the required chlorine concentration set point in the final drinking water.

Changing primary chlorination from a Sodium hypochlorite solution to a Calcium hypochlorite dosing system (HTH Briquette tablets), resulted in improved water quality with much lower Chlorate levels, within the ADWG aesthetic limits for drinking water. The system has even more advantages in terms of cost savings, longer storage life, consistent chlorine solution, no manual adjusting of dosing rate, no gassing in dosing lines, smaller footprint and improved safety.

1.0 INTRODUCTION

The towns Alpha and Jericho, both in the Central Queensland Shire of Barcaldine in the heart of the Galilee Basin mining precinct, are located on the Capricorn highway 440 km east of Rockhampton.

Figure 1: ***Shire of Barcaldine - QLD***

Water supply for the Alpha town is from 4 shallow bores (35 m deep) located in the township and one deeper bore (70 m), located 5 km west of Alpha. This water is presently used for town supply and have high alkalinity levels (>200ppm) and high TDS levels (>1,000ppm). This water does not comply with ADWG.

1.1 Operation of the Alpha WTP

Water from the bores is pumped into an aerator, which gravity feeds into a slow mixing tank. Alum is injected between the aerator and mixing tank. Flow is then into a settling tank and then through a sand filter. Chlorine and pH adjustment chemicals are injected after filtration. Water is then pumped into a 1 ML ground level reservoir for storage prior to being pumped into a 25 m high elevated reservoir with a capacity of 258 kL. This tank gravity feeds the town reticulation system.

The WTP is fully automated with bore pumps turned on and off by the level in the 1 ML reservoir. Chemical dosing rates are adjusted automatically by the inflow rate to the WTP. Analysers constantly measure pH, chlorine and turbidity levels after filtration. Manual water testing is carried out on work days to compare against the analyser readings.

A free chlorine residual of between 1-1.2 ppm must be maintained after filtration which gives a residual in the retic system of approx. 0.7 - 0.9 ppm depending on water usage and time of year.

A major concern was that the Chlorine residual set point was extremely difficult to control and maintain between 1-1.2 ppm.

Operational problems with the Sodium hypochlorite primary chlorine dosing system included the following:

- Initially hypo was purchased in bulk, 1,000 litres at a time. This was done on a ‘milk run’ that means the truck only delivered West when there were sufficient orders to fill the bulk tanker.
- With only one storage tank at the plant for hypo, fresh hypo was delivered into this tank that still contained older deteriorated hypo. Consequently, the strength of the hypo solution was unknown to start with.
- The hypo solution deteriorated even further after delivery, especially in summer, causing dosing levels to be gradually increased to keep the same Chlorine set point.
- Gassing in dosing lines created problems.

In addition, Chlorate levels increased in the hypo solution over time with oxidation and resulted in high Chlorate levels in the final drinking water.

Table 1: ***Alpha WTP – Water Quality analysis (trial with Calcium Hypochlorite Briquettes started in April-17)***

Alpha WTP			
Month	**Chlorate ppm**	**Cl_2 Low ppm**	**Cl_2 High ppm**
Aug-16	0.66	1.07	1.46
Sep-16	NA	0.84	1.63
Oct-16	NA	0.92	1.62
Nov-16	0.57	1.34	1.71
Dec-16	NA	1.08	1.92
Jan-17	0.58	0.81	1.7
Feb-17	0.62	1.07	1.34
Mar-17	0.89	0.62	1.31
Apr-17	0.27	0.78	1.47
May-17	NA	0.84	1.41
Jun-17	0.38	0.86	1.2
Jul-17	0.37	0.96	1.3
Aug-17	0.39	0.9	1.35
Sep-17	0.46	0.93	1.26
Oct-17	0.43	0.94	1.59
Nov-17	0.34	0.89	1.16
Dec-17	0.39	0.99	1.51
Jan-18	NA	1.01	1.47
Feb-18	NA	1.18	1.26

2.0 DISCUSSION

In September 2013, Dr Peter Mosse reviewed the operation of the Alpha WTP from the perspective of its ability to consistently produce safe drinking water. From this review, the following observations in the primary chlorine dosing was made:

- Sodium hypochlorite (12%) strength was delivered in large volumes and this stock lasts for many weeks.
- Significant decay occurs rapidly as drums are stored in high temperatures and exposed to UV light.
- Changing hypo concentration makes manual set point of dosing pump difficult.

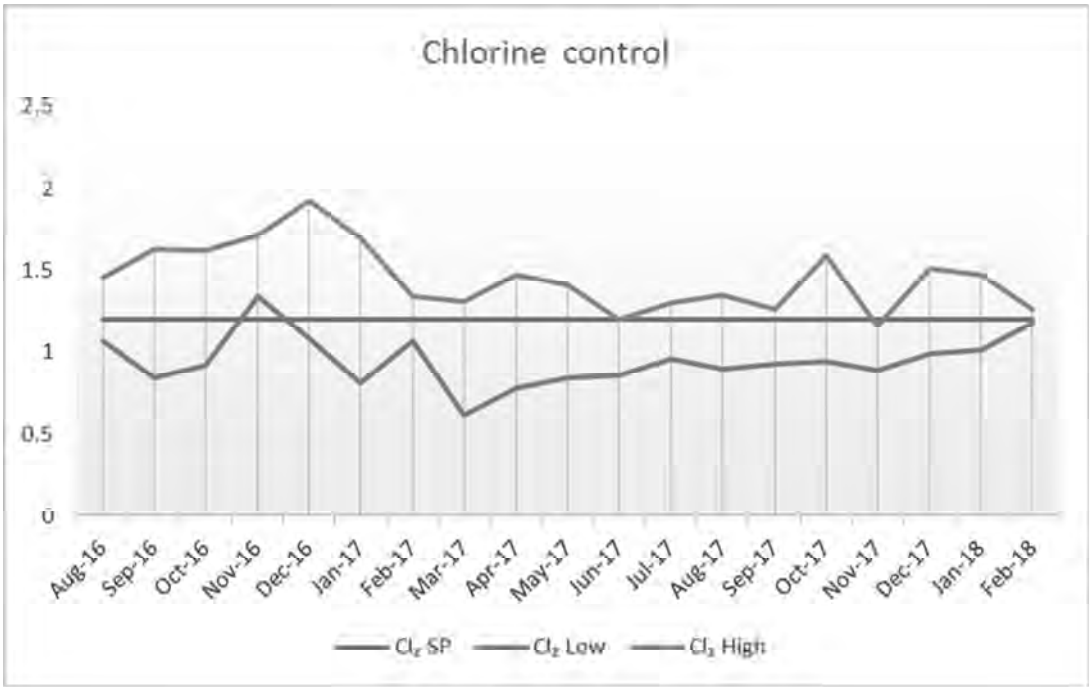

Figure 2: ***Chlorine level in final drinking water***

It was recommended in this report to consider implementing an alternate strategy for primary chlorination. Council decided to purchase Sodium hypochlorite in 200 litre drums to be used as the primary chlorination product. This decision provided similar problems as maintaining a bulk supply, but also added even more problems:

- Higher costs
- Drums needed to be man handled and decanted into larger storage tank which posed a safety risk to operators.
- Chlorate levels continue to be high in the final drinking water.

After much consideration, in April 2017 it was decided to trial a Constant Chlor Chlorinator system using dry Calcium hypochlorite briquettes.

The reasons for this decision was the benefits listed by the supplier on their specific system and the product to be used:

	Calcium Hypochlorite	Sodium Hypochlorite
SAFETY	Solid product is easier and safer to transfer from storage to delivery	IBC storage will require on-site transfer pump or fork-lift
SAFETY	Solid product easier/safer if spilt	Liquid spill difficult to contain
HEALTH	Minimal perchlorates/chlorates	A worrying health problem
QUALITY	Stable - sealed storage (2% AvCl/yr)	Unstable – deterioration varies
SHELF LIFE	> 2 years	3 - 6 months
STABLE	1.2% solution (stable)	6 - 12% solution (typically)
IMPACT	Equipment wear/corrosion reduced	Off-gassing problems
STORAGE	870kg AvCl – 1.44 sq m	870kg AvCl > 8.4 sq m
DELIVERY	68kg AvCl/day – 0.9 sq m	68kg AvCl/day – 2.5 sq m

Also, during the storage of sodium hypochlorite – initial chlorate content is approximately 15 ppm and after 3 months increases to 26 ppm.

Dry Calcium hypochlorite (HTH) initial chlorate content is determined at 2ppm and after 3 months in storage at 3ppm.

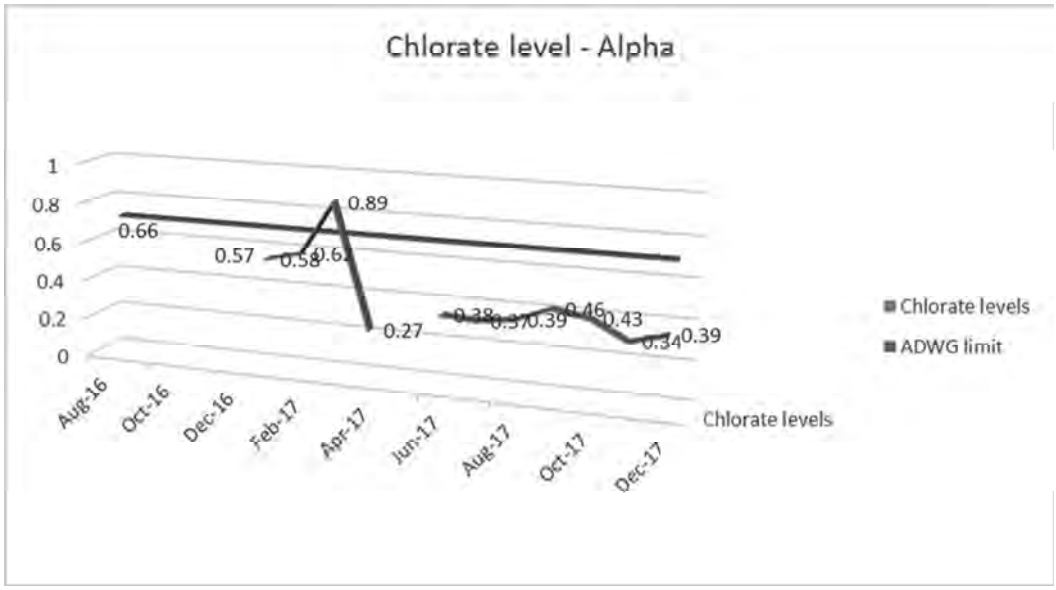

Figure 3: ***Chlorate level in final drinking water***

Installation on the MC4-50 unit was explained to be inexpensive, quick and easy and could be done in-house by the Council's maintenance team.

Site requirements are:

- Dimensions 132 x 69 x 117 cm
- Inlet Water 22.7 L/pm @ 3.11-10.34 bar without dilution or
  56.8 L/pm @ 3.45-10.34 bar with max dilution
- Electrical 10 amp / 240 Volt / 50 Hz

The supplier recommendations on maintenance is highly dependent on the feedwater quality and with the high alkalinity and hardness levels in the water feeding the system, initial scaling problems meant hopper and spray nozzles required regular monthly cleaning.

The feedwater supply was changed to the aerodrome bore that has a much lower alkalinity and hardness level. This resulted in the feeder system maintenance schedule to be revised as necessary to every 3 months. Cleaning of the hopper takes less than half an hour to clean and is now not seen as a problem.

To date, running the Constant Chlor MC4-50 systems is safe, easy and simple and council is satisfied with the results. The advantages of this system include:

- The supplier offered a 3 month trial free of charge, to establish suitability of the system.
- Installation was easy and completed in a few hours in-house
- System footprint is small
- Chlorine solution produced by the system is on demand and always fresh and the system maintains a consistent chorine solution level
- Storage life of the Calcium hypochlorite Briquette tablets is 30 months+

- Calcium hypochlorite Briquettes come in 10 kg pails – easy to handle and store
- No dosing pump adjustments or gassing in dosing lines.

2.2 Regulatory Status for Chlorate in Drinking Water

International research (WHO, AWWA) indicates that chlorate presents a potential health risk to consumers in that it causes damage to red blood cells and demonstrated perturbation of thyroid cells.

WHO has established a provisional guideline of 0.7 ppm.

A new ADWG is expected to be released soon – draft in 2009 included a chlorate health limit of 0.3ppm. Robust debate is ongoing due to insufficient data to set a guideline value.

A health limit in ADWG for chlorite has been established at 0.8 ppm.

3.0 CONCLUSION

The trial was successful as the plant personnel could maintain chlorine levels in final drinking water of between 1-1.2 ppm Cl_2 set point more than 90% of the time.

The automated dosing system has a small footprint and cost savings included $12 kg for Calcium hypochlorite Briquettes vs $18 kg for Sodium hypochlorite in 200 L drums.

Chlorate levels in the final drinking water has been reduced by more than half to 0.27 ppm and is within the drinking water limits set by ADWG.

There is almost no degradation or oxidation of the chlorine solution and a consistent chlorine solution, ready for injection into water mains is available at all times.

Security in supply of chlorine product is secured and no more juggling of stock between sites Jericho and Alpha.

The shelf life extension of Calcium hypochlorite briquettes also meant less purchase orders and optimisation of freight charges.

Storage space has also been reduced as 1 x 10 kg Briquette pail equal 2 x 200 L Sodium hypochlorite drums in terms of available chlorine.

Safer operation and time savings in terms of placing and following up on orders, no decanting of 200 L drums into bulk tank, no spillage clean up or dosing pump adjustments.

4.0 ACKNOWLEDGEMENTS

Barcaldine Regional Council Operator team: Des Lamb and Malcolm White.

5.0 REFERENCES

Australian Drinking Water Guidelines (2011)

OPERATIONAL TOOLS TO DETERMINE TREATMENT STRATEGIES FOR MITIGATION OF CYANOBACTERIA RISKS

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OPERATIONAL TOOLS TO DETERMINE TREATMENT STRATEGIES FOR MITIGATION OF CYANOBACTERIA RISKS

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ABSTRACT

The aim of this project was to provide Australian water utilities with a suite of user-friendly and straightforward resources to support the assessment and management of the aesthetic and toxicity risks associated with cyanobacteria. Based on the many years of research within SA Water, the project team predicted full scale treatment process effectiveness for the removal of cyanobacteria and their metabolites could be modelled using laboratory scale experimental data. The project team reviewed the current literature available on treatment, and with this information developed procedures for 1) treatment plant audit for cyanobacteria (risk and removal) and 2) investigative sampling (verification of treatment barriers). Full scale investigative sampling was conducted when cyanobacteria issues arose to identify unit process effectiveness of intra- and extra-cellular metabolite removal. These were compared to the predicated concentrations within the model. In the case of Myponga, the sampling provided unexpected results which would not have been found with standard sampling methods.

1.0 INTRODUCTION

Despite the volume of research outcomes from over 30 years of global research and the publication of guidance documents such as WaterRA report no. 74 "Management Strategies for Cyanobacteria (blue-green algae) and their Toxins: a Guide for Water Utilities", gaps still exist in the knowledge base that inhibit the confident application of individual treatment strategies for the mitigation of aesthetic and health risks associated with cyanobacteria and their metabolites at the full scale.

Some of the questions that reflect the current knowledge gaps and risks that were addressed during this project were:

- How can we have confidence in the application of various treatment processes when they are often site/system specific?
- What is the evidence the removal of cyanobacteria and metabolites reported in the literature and guidance manuals are achievable at the full scale?
- How can we assess and validate the efficiencies of unit processes at individual treatment plants?
- What is the combined mitigation effect of the entire treatment train?
- In the case of a toxic bloom, how can we determine the point at which we are at risk of distributing water that does not meet the Australian Drinking Water Guidelines (ADWG) for toxin concentrations?

The aim of this project was to provide Australian water utilities with a suite of user-friendly and straightforward resources to support the implementation of the ADWG Framework for Water Quality Management, specifically for the assessment and management of the aesthetic and toxicity risks associated with cyanobacteria.

Specifically, the objective was to deliver:

1) The most current information available on the management of cyanobacteria within

drinking water treatment plants in the form of a literature review and full-scale case study report.

2) A guide for treatment plant operators to perform plant audits and investigative sampling to assess risk associated with cyanobacteria in their plants, and validation of performance of existing unit processes.
3) A validated treatment model that can be applied at any plant and used as a guide to the removal of cyanobacteria and metabolites and the expected quality of treated water under a range of challenges from cyanobacteria.

2.0 DISCUSSION

2.1 Metabolite Removal Through Water Treatment Plants

Routine sampling programs do not generally sample the same batch of water before and after treatment and therefore, do not allow for in depth investigation of plant performance in situations where treatment plants are challenged with high concentrations of metabolites (tastes and odours/toxins). Additionally, while treatment plants are designed to remove cyanobacteria and their metabolites it is difficult to pinpoint which unit processes are working effectively, or not, their individual contribution to removal and in what modes, biological or physical, they are operating in. To address these issues and to better understand water treatment plant performance in general, an investigative auditing procedure was developed. The procedure involves identifying points before/after each unit process where samples can be taken for metabolites and other water quality parameters. Importantly, samples must be taken from the same batch of water as it passes through the treatment plant to obtain a true representation of what is occurring throughout the plant.

2.2 Water Treatment Plant Auditing To Determine Metabolite Removals

The effectiveness of a plant audit is highlighted in a geosmin challenge to the Myponga Water Treatment Plant in early 2017, where over 200 ng/L of geosmin, of which 50-70 ng/L was extracellular (dissolved), was entering the water treatment plant. Despite powdered activated carbon (PAC) dosing of 30 mg/L, between 25-50 ng/L of geosmin was entering the distribution system. Whilst no customer complaints were recorded there was a strong customer response on social media and extensive proactive messaging was used to inform customers.

Initially it was thought the PAC was not working effectively and laboratory testing was undertaken to determine this. Additionally, modified generic water treatment plant auditing designed to suit the Myponga Dissolved Air Flotation (DAF) plant was conducted over two days at the height of this challenge. Samples for total and dissolved geosmin, *Dolichospermum circinale* responsible for the geosmin and other water quality parameters were taken from the raw water and after each step in the treatment train (Figure 1).

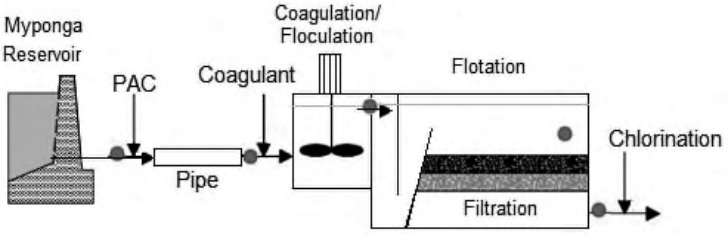

Figure 1: ***Myponga WTP, sampling points in red***

Auditing (Figure 2 a and b) revealed that most, 150-200 ng/L, of the geosmin entering the plant was intracellular with 50-70 ng/L extracellular and the PAC was removing between 72-84% of extracellular geosmin. This was in line with laboratory testing, yet lower than in past experience. The large decrease in total geosmin indicates that intracellular geosmin was being released from the cells in the pipeline from the inlet to the plant where PAC is dosed, thus bringing the reduction of geosmin by PAC up to 87-91%.

Samples taken from the underfloat revealed 100% of remaining geosmin in the plant was extracellular indicating that *D. circinale* cells were lysing in the floatation tank resulting in the increase in geosmin in the floated water. However, samples taken after the filters showed a decrease in geosmin of 65% indicating potential biological removal in the filters which has not been observed before at this site. The cause of cell lysis was not apparent, however, this has been observed before and is potentially a result of a combination of a number of factors including turbulence, abrasion and cell health.

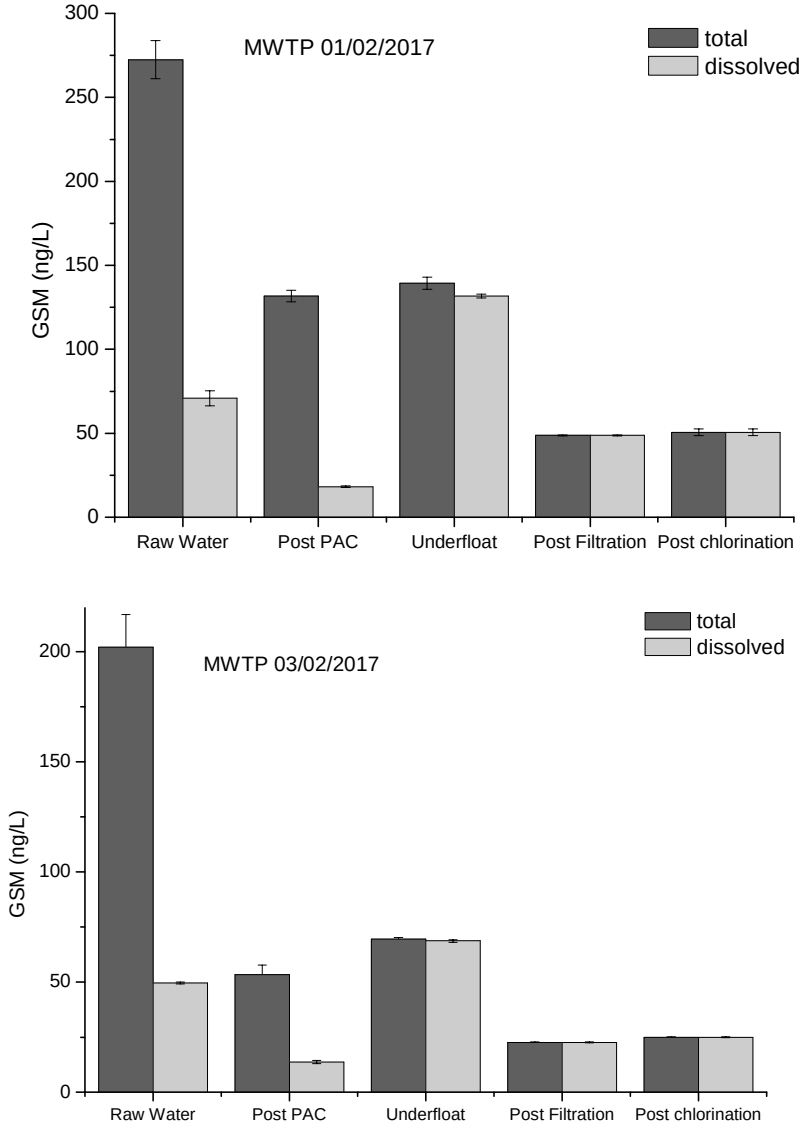

Figure 2: ***Total and dissolved geosmin concentration sampled at strategic points in the treatment process on (a) 02.03.2017 and (b) 03.02.2017. PAC dose = 30 mg/L. Difference between the two column heights represents the intracellular concentration***

Water quality challenges in 2018 have prompted SA Water's Production and Treatment group to request plant auditing to further investigate the root cause of a plant's poor performance. Plant auditing has also been successfully implemented by project partners. Standardised, easy to use, sampling esky kits have been developed where operators can sample when they first detect odours and then return samples to the research laboratory for analysis and investigation.

2.3 Tool For Estimation Of Metabolite Removals

To further support the water industry, an Excel based tool that can be utilised to estimate removals of metabolites through each individual unit process of the treatment train as a whole was developed. The Cyanobacteria Risk Assessment Support Tool (CRAST) was developed based on laboratory data and modelling of South Australian waters and conditions, and estimates the risk to finished water quality under optimum conditions during a cyanobacteria bloom and associated metabolite challenge. CRAST only requires knowledge of dissolved and intracellular metabolite concentrations, PAC dose and chlorine CT for toxins to be inputted into the tool (Figure 3). It incorporates the unit processes of a 30 minute PAC contact time (PS1000 or PS1000F), coagulation/clarification and chlorination.

Plant auditing during the geosmin challenge at Myponga was used to validate CRAST. The predictions for CRAST (Figure 3) displayed larger deviation from the actual values recorded (Table 1). This is likely due to the damage to the cells and the release of intracellular metabolites within the flotation tank; however, the final value was not too far removed due to the potential biological filtration occurring on the filters.

Metabolite		initial concentration	PAC dose	after PAC	after coagulation and clarification	Chlorine CT	after chlorination	Final*	PAC
geosmin	dissolved	71	20	3	3		13	13	PAC PS1000F
	intracellular	202		202	10		0	0	
TOTALS		**273**		**205**	**13**		**13**	**13**	

Figure 3: ***CRAST input – predicted geosmin concentration for unit processes for Myponga WTP from 01.02.2017***

Table 1: ***Geosmin concentrations mg/L (average of duplicates) at strategic points of the Myponga WTP on 01.02.2017***

Metabolite		**Initial concentration**	**PAC Dose**	**After PAC**	**After coagulation and clarification**	**Final**
Geosmin	Dissolved	71	30	18	132	49
	Intracellular	202		114	8	0
Total		**273**		**132**	**140**	**49**

CRAST was also applied to other plants where auditing had occurred during metabolite challenges. CRAST was better able to predict geosmin concentrations (Figures 4 and 5; Table 2) in these other plants. Analysis of the 27 plant audits and associated CRAST predictions show good agreement between the auditing results and the tool (Figure 5).

Plants known to achieve effective removal by biological filtration (MoWTP and SRTWTP) displayed the greatest deviation from the predicted values in the final product water. This was as expected as the values in the treated water were below detection, regardless of the filter inlet concentration. When the concentrations in all of the plants were compared prior to the filtration stage, the deviations were less for the two plants with biological filtration and in general very good. However, results from Myponga displayed a greater variation from predicted, as the filters appeared to remove a large percentage of the metabolites (Figures 2a and b).

Metabolite		initial concentration	PAC dose	after PAC	after coagulation and clarification	Chlorine CT	after chlorination	Final*	PAC
geosmin	dissolved	23	30	0	0		1	1	PAC PS1000F
	intracellular	14		14	1		0	0	
TOTALS		**37**		**14**	**1**		**1**	**1**	

Figure 4: ***CRAST input – predicted geosmin concentration for unit processes for Swan Reach WTP***

Table 2: ***Geosmin concentrations mg/L (average of duplicates) at strategic points of the Swan Reach WTP***

Metabolite		**Initial concentration**	**PAC Dose**	**After PAC**	**After coagulation and clarification**	**Final**
Geosmin	Dissolved	23	30	0	0	0
	Intracellular	14		14	0	0
Total		**37**		**14**	**0**	**0**

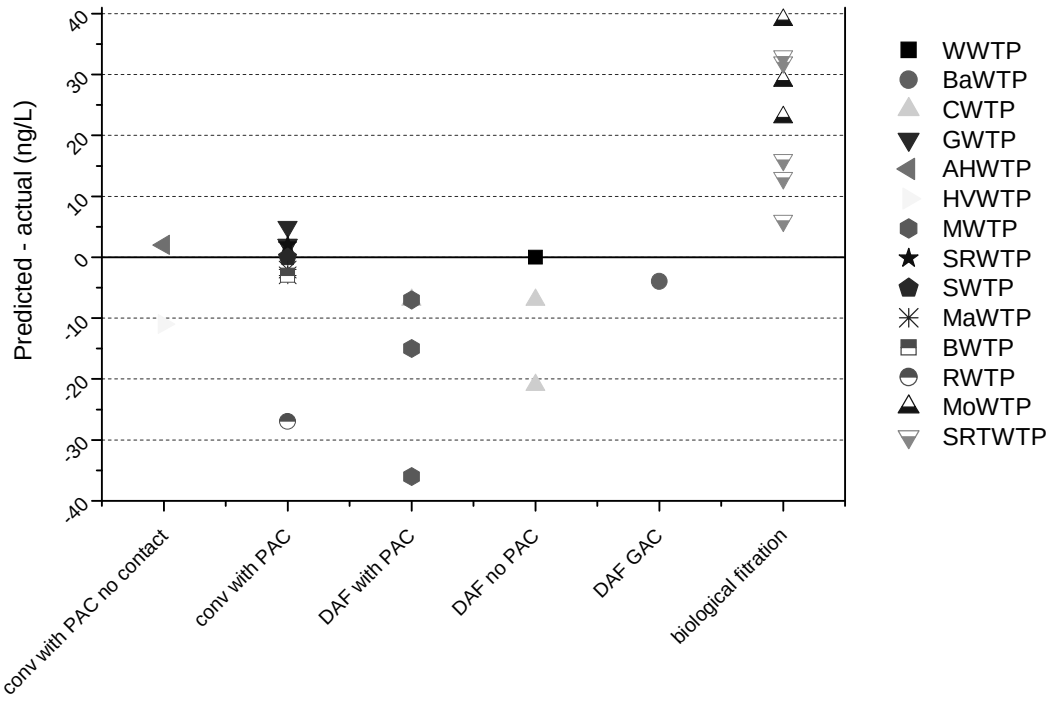

Figure 5: ***Representation of the difference between the measured metabolite concentrations in the treated water and the concentration predicted by the CRAST calculators for 27 water treatment plants***

CRAST can be utilised as a robust guide at different locations, however several assumptions are made by the CRAST tool (Supplementary Information) and as a result an overestimation of metabolite removal may occur. For more accurate predictions empirical models used in the calculations should be developed for each water treatment plant and its specific conditions.

3.0 CONCLUSION

The auditing process revealed unique insights into the Myponga Water Treatment Plant that would not have been elucidated through routine or challenge event sampling. CRAST is a useful tool in estimating risk of metabolites to finished water quality at the full scale to inform operational decisions. Both these approaches assist water utilities in the management of treatment challenges posed by cyanobacteria and their metabolites. Their implementation and adoption by the industry will lead to improved knowledge around water treatment plant performance, lower risk and better aesthetic water quality for customers.

4.0 ACKNOWLEDGEMENTS

This project would not have been possible without Dr Gayle Newcombe bringing her many years of cyanobacteria research knowledge and data. We thank our project partners at Hunter Water, Wannon Water, Melbourne Water and Water Research Australia for funding and access to water plants. We are extremely grateful to the numerous water treatment plant operators from SA Water, Allwater and Trility for their assistance with field sampling and for allowing the sampling team access to water treatment plants. We also thank Customer Value and Water Quality Research and Water Science groups at SA Water for their help and especially Amelie Prevost, Ben Chong, Martin Harris, Con Kapralos and Edith Kozlik for their assistance in the laboratory. Thanks to Florence Choo from UNSW and Kuan-Min Liao from NCKU and SA Water for their work in the field.

5.0 SUPPLEMENTARY INFORMATION

Assumptions made by the CRAST tool

- *When PAC is used there is a contact time of 30 minutes prior to the addition of coagulant*
- *The removals of the metabolites by PAC are the same in all water quality*
- *The PAC used is the equivalent of Activated Carbon Technologies' PS1000F for MIB and geosmin, and PS1000 for STXeq (STXeq is the toxicity equivalent of the natural mixture of saxitoxins used in this study. The concentrations were determined using ELISA kits (enzyme-linked immunosorbent assay), cylindrospermopsin and microcystin LR and LA*
- *PAC adsorption will achieve the same removal of metabolites in the laboratory*
- *PAC application removes only dissolved metabolites, does not affect the intracellular component*
- *The removal of the cyanobacteria through coagulation is constant at 95% regardless of the type of cyanobacteria, coagulant or clarification process*
- *Coagulation and clarification does not affect the concentration of dissolved metabolites*
- *Filtration does not remove dissolved metabolites or uncoagulated cells. It is assumed that any uncoagulated cells will lyse and add to the remaining dissolved component*
- *Chlorination will achieve the same oxidation of toxins in the laboratory*
- *The removals of the cyanotoxins by chlorination are the same in all water quality*

APPLYING IOT TECHNOLOGY TO SEWER MONITORING APPLICATIONS AN ITERATIVE APPROACH

Paper Presented by:

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Kylie Rogers, *Senior Planning Engineer,* Mackay Regional Council
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ABSTRACT

Many utilities face the challenge of inflow and infiltration in sewer systems, and the costs of maintenance and remediation can be significant impost on both capital and operational budgets. Further, the fact that the majority of sewer assets are underground and unmonitored, means issues causing sewer overflows are often unnoticed until reported by members of the public.

Mackay Regional Council has been working with Taggle Systems over the past few years to apply low-power Internet of Things (IoT) technology to other applications including Automatic Meter Reading. The Council and Taggle chose to work together to use similar techniques to light up these normally "dark" assets; collecting data about sewer performance to better understand the system and make wiser decisions about planning, maintenance and capital spend.

This system that collects sewer levels and real-time rainfall data aims to determine the likely causes and locations of inflow and infiltration, and helps predict future overflow events.

This paper describes the development and improvement of this permanent sewer monitoring system over time, and builds on earlier presentations on the project from Mackay Regional Council.

1.0 BACKGROUND

Mackay Regional Council has a long-standing objective of reducing both wet weather and dry weather sewer overflow events, however, benefits realised from costly historic inspection and treatment efforts has not been clearly apparent.

With over 10,000 sewer manholes and limited ways to effectively monitor overflow events, many overflow events are reported by members of the public, and there is the potential for wet-weather overflow events occurring without being noticed at all.

In 2014, the Council embarked on project with Taggle Systems to cooperate on developing low-cost, fixed monitoring system for the Councils sewers. This paper describes the development of several generations of technology and the outcomes it has provided.

2.0 THE CONSTRAINTS

With 10,000 manholes, the Council identified that monitoring 8-10% of those would provide a good overview of the performance of the whole network. Given that this means 800 possible monitoring stations, the proposed system needed to have an appropriately small per-site cost of ownership.

Total costs of ownership were assessed as including multiple factors:

- Cost of the sewer monitor devices
- Cost of installation labour

- Cost of data
- Cost of ongoing maintenance labour
- Working life of the devices.

3.0 THE APPROACH

After a market scan, it became apparent that most existing sewer monitoring technology in the market was designed to be moved from one location to another and had battery life of one year or less. But Mackay's wet weather problems largely occur in the wet season, and require all the locations to be monitored at the same time. This meant that these traditional monitoring devices were not appropriate for a fixed monitoring solution, without incurring significant ongoing maintenance costs.

3.1 First Generation Design

On this basis, the Council and Taggle decided to develop a system optimised for a fixed, long life, low cost monitoring system. The devices would require a long battery life to reduce the costs of revisiting sites. Labour costs of installation were to be kept to a minimum, the device designed to be as in low capital cost as practical.

The Council and Taggle approached this as an iterative process, with the intent of building and testing small numbers of devices, and taking the early results to improve the next batch of devices.

Taggle and the Council approached the first iteration by using proven, off-the-shelf components where possible. The first generation sewer modules utilised existing HP-1 (high power) telemetry modules from Taggle which are designed to transmit from difficult underground situations.

The sensors selected were float switches from Kenrahn, which are simple mercury-switch devices, which provide a sensitive ultra-low power signal, while providing a robust physical enclosure.

The rainfall sensors used standard Hyquest tipping bucket gauges with off-the-shelf Taggle ADC telemetry modules.

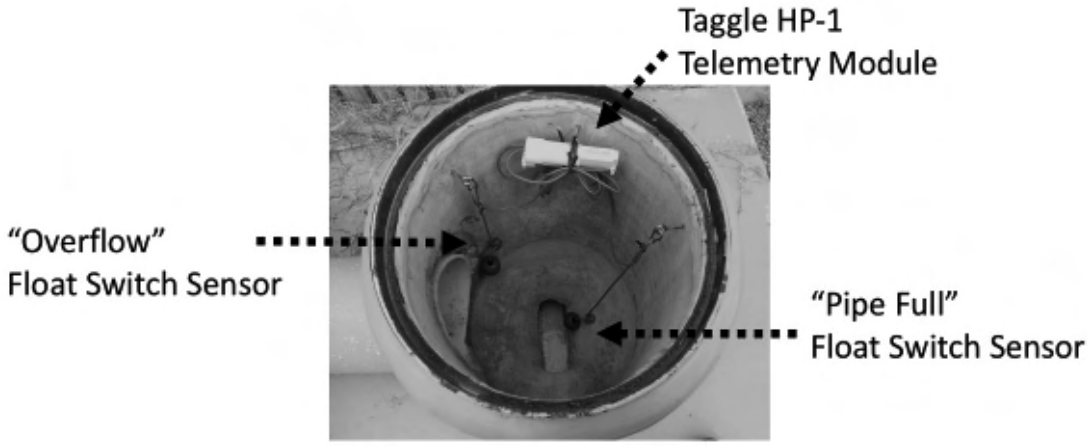

Figure 1: ***Generation-1 Sewer Monitor***
Two float-switches and a Taggle HP-1 Telemetry module

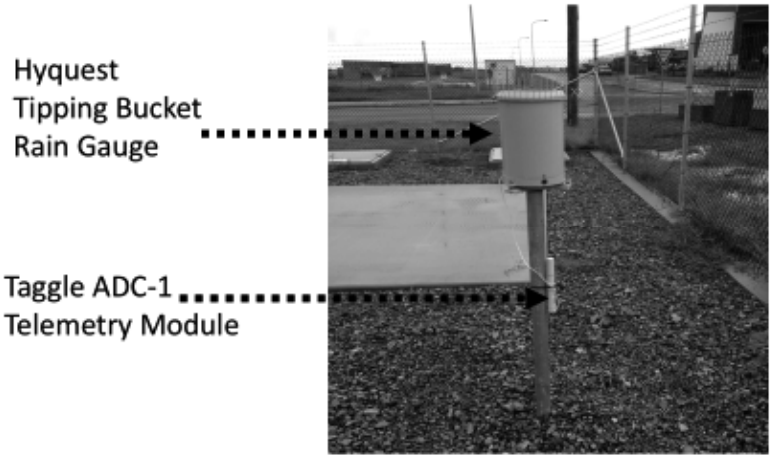

Figure 2: ***Rainfall Gauge with Taggle ADC1 Telemetry Module***

3.2 Initial Results

Initial results were very promising. The telemetry devices were easy to install, without confined entry requirements, being attached at the top of the manhole, under the lid. Taggle radio telemetry signal was able to penetrate the lid, and successfully transmitted events driven by sewer levels.

The Council engaged Tyeware to develop the "MiSewer" application to visualise the data being received from rain gauges and sewer levels.

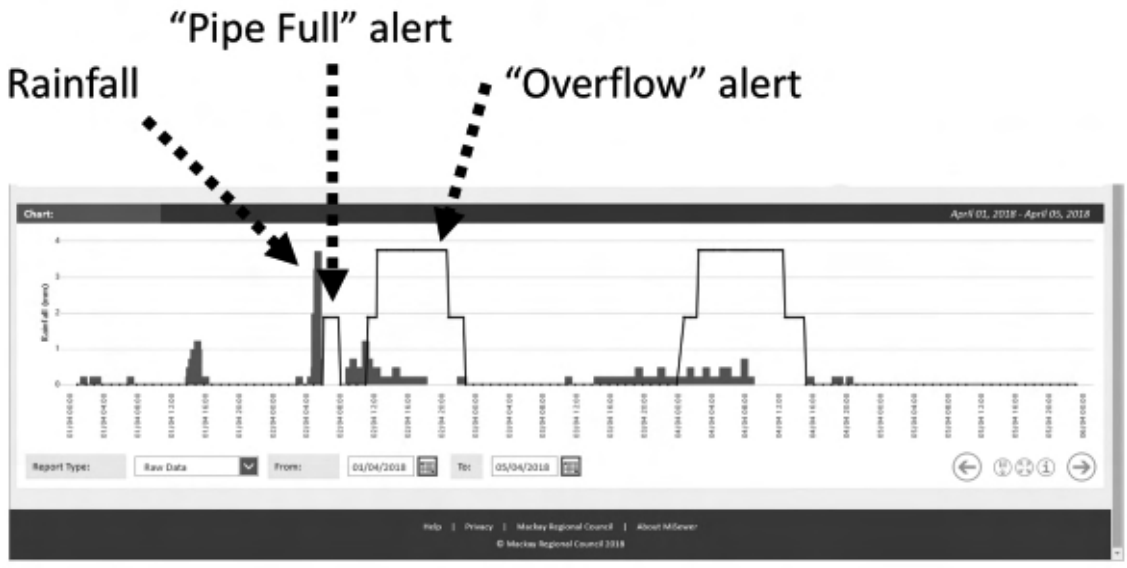

Figure 3: ***MiSewer application showing rainfall quickly being followed by Pipe Full and Overflow Alerts indicating overflow is being generated by water inflow***

3.3 Problems with First Generation Devices

While the float switch devices performed as expected in most situations, in some circumstances, the flow and turbulence of the water in high flow situations resulted in the float switch being tangled or caught in a pipe leaving the switch in the on-state.

This problem has largely been addressed in subsequent installations by paying close attention to the position the float switches were mounted to avoid the chances of fouling. Further, eye bolts have been fixed to the manhole wall to hold the cable in position whilst allowing the float switch to still operate.

Figure 4: ***Float Switch was washed into the overflow gully during overflow event and remained in the "on" state instead of returning to the normal hanging "off" state after the overflow event ended***

Battery life on the first-generation devices fell far short of the desired 10 year design life. The problem was identified to be the number of transmissions the telemetry devices were sending. Every time float switch changes state, the telemetry module would transmit an event message. However, there were two causes of unexpected rapid state change identified. The first was the transport of the sensors from Sydney to Mackay, with vibration of the courier truck triggering unnecessary transmissions. The second was that water flowing in a high-water event is very turbulent, causing the float switch to bounce on and off and send unnecessary transmissions.

Some of the early devices also failed due to water ingress. Subsequent failure analysis identified that damage to the insulation on the cables, potentially due to rat bites, had let water into the cable, which then travelled up the cable via capillary action into the transmitter module causing it to fail.

3.4 Iterative Improvement of The Sewer Sensor Devices

Using these learnings, the Generation 2 devices were designed around a more sophisticated telemetry module from Taggle. The Taggle LSTT module includes a microcontroller unit (MCU) which Taggle programmed with logic to prevent the problems with unnecessary transmissions and to preserve battery life. Current generation devices are expected to last the desired 10 years on a single battery, and results so far seem more promising.

Generation 2 devices also introduced an IP69 stainless steel connector to separate the float switch devices from the inside of the electronics enclosure and prevent water ingress.

Generation 3 devices upgraded the enclosure from IP67 to IP68, in response to some devices that remained immersed for extended periods.

Figure 5: ***Generation 3 Sewer Monitor with MCU telemetry and IP68 Enclosure***

Some Generation 3 devices have recently been modified to provide for external antennas, for those locations where internal antennas under the steel manhole lid were preventing consistent receptions especially in periods of high rainfall.

3.4 Other Lessons Learned

The sewer sensors combined with the MiSewer data analysis interface have provided significant benefits to the Council, identifying the differences between inflow and infiltration.

However, in addition to the desired information, the sewer sensors have identified other events that hadn't been anticipated.

In one location, overflow events were being triggered by a faulty valve that was allowing tidal water in a local river back into the sewer via the overflow gully, and resolved by repairing the faulty valve.

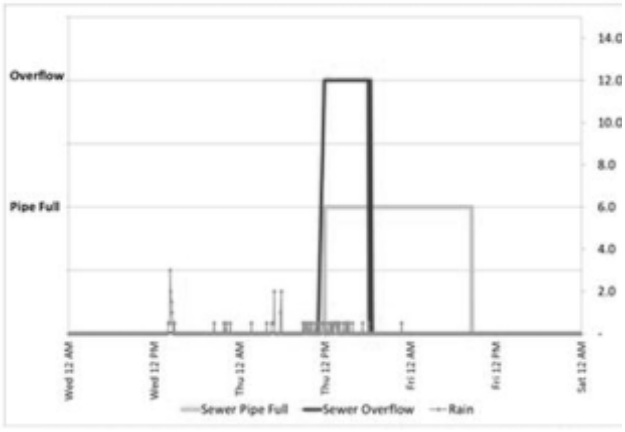

Figure 6: ***Small rainfall events triggered "abnormal" overflow events (left) Subsequent flushing of the sewer line found the pipe had become obstructed by debris (right)***

4.0 FUTURE OPPORTUNITIES FOR IMPROVEMENT

Taggle and the Council are still looking for opportunities to reduce the cost of the system, and improve the ease of installation.

With increasing volumes of data, the opportunities for advanced analytics and machine learning are also increasing. Taggle is exploring opportunities to apply machine intelligence techniques to "learn" what normal behaviour is. This provides the opportunity to predict future overflow events, and also to generate alerts when sewer performance changes from the baseline.

5.0 ACKNOWLEDGEMENTS

The authors would like to acknowledge the contribution and support from:

- Linda Roberts, Zachary Dobbins, Jaie Harris and Matthew Harris from Mackay Regional Council
- Steven Tye from Tyeware
- Mark Halliwell from Taggle Systems.

FERROUS CHLORIDE DOSING FOR RAPID RESPONSE TO REDUCE STP ODOURS

Paper Presented by:

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FERROUS CHLORIDE DOSING FOR RAPID RESPONSE TO REDUCE STP ODOURS

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ABSTRACT

Numerous odour complaints were received from the local community surrounding Maroochydore Sewerage Treatment Plant (STP), including residents, industry and caravan parks. The "nuisance odour" attracted significant attention from the media and the environmental regulator. The odour complaints were due to emissions of elevated levels of gases, including hydrogen sulphide (H_2S).

The solution was to use the existing alum dosing facility, and re-purpose it for ferrous chloride, in combination with installing a new dosing location into the inlet works.

This project was particularly impressive as it was delivered rapidly, four (4) weeks from contract award to commissioning, with no interruption to STP performance or licence compliance, and achieved the objective of preventing further odour complaints being experienced by the local community. Delivery of this project is one of the key strategies employed by Unitywater to minimise the likelihood of continued odour complaints in the future.

1.0 INTRODUCTION

1.1 Maroochydore STP & Odour Issues

Maroochydore STP treats 28 ML/d (ADWF) and is designed to treated sewage for an equivalent population of 136,000 people. The plant provides tertiary treatment and the design is based around Biological Nutrient Removal (BNR) with the following liquids stream and solids stream processes (refer to Figure 1):

- Liquids Stream:
  - Inlet works with screens and vortex grit tanks;
  - Side-stream flow balancing tank;
  - Primary sedimentation tanks;
  - BNR activated sludge and secondary clarifiers;
  - Tertiary treatment using cloth filters and ultraviolet (UV) disinfection.
- Solids Stream:
  - Primary sludge fermenters;
  - Rotary screen thickeners for primary sludge;
  - Rotary drum thickeners for waste activated sludge (WAS);
  - Anaerobic digestion;
  - Centrifuge dewatering;
  - Solar dryers.

This project was initiated due to the number and frequency of continuing odour complaints received from the local community surrounding Maroochydore STP. The "nuisance odour" was attracting significant unwanted attention from the media and the environmental regulator. The odour complaints were due to emissions of elevated levels of several gases, including hydrogen sulphide (H_2S).

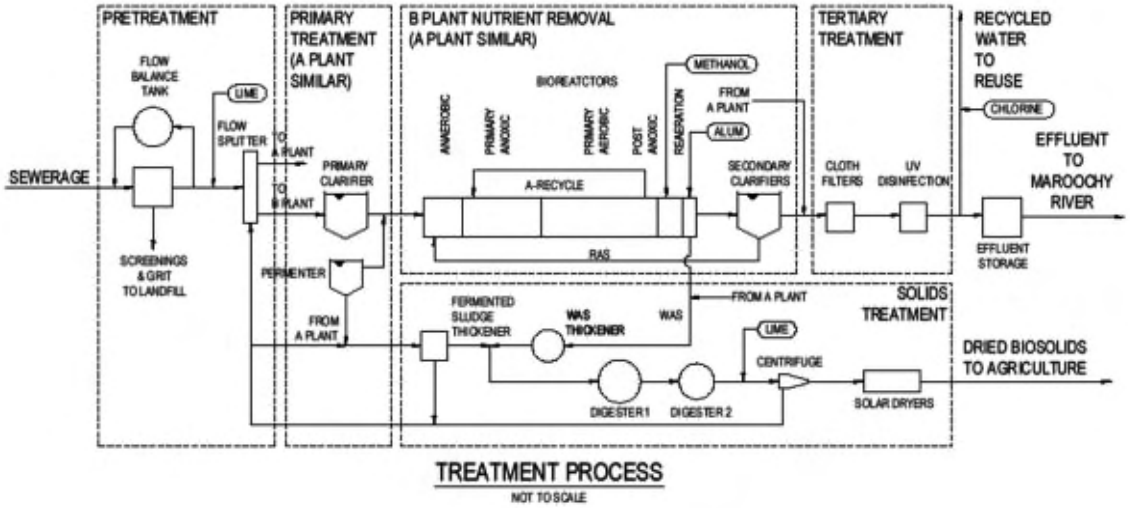

Figure 1: ***Maroochydore STP Process Flow Diagram***

2.0 DISCUSSION

2.1 Sources of Odour – Maroochydore STP

A detailed review of the STP operations revealed that odour was coming from a variety of different sources, especially:

- Inlet works – caused by fugitive emissions from poor sealing at edges of rubber matting odour covers;
- Primary sedimentation tanks – no odour control;
- Sludge thickening units – caused by fugitive emissions resulting from air extraction rates being too low;
- Unflared waste biogas – flare was faulty, and biogas was being released from pressure relief valves on the anaerobic digesters at H_2S = 150 to 180 ppm;
- Sludge solar dryer beds – caused by unintended composting of biosolids, which was not fully stabilised in the highly loaded anaerobic digesters; and
- Poorly performing odour treatment units – caused by a variety of problems with the biofilter units.

Therefore, a multi-faceted solution was required to reduce odour from multiple sources.

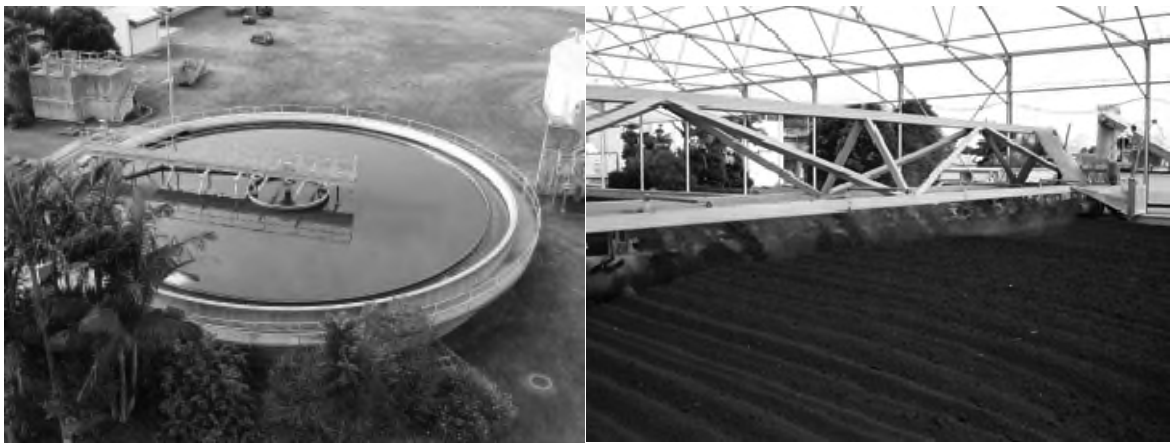

Figure 2: ***Sources of odour - Primary Sed. Tank (left) & Solar Dryer (right)***

2.2 Proposed Solution – Ferrous Chloride

Based on the experience of Unitywater Treatment Plants operations staff, and a review of odour control strategies used by other water utilities (e.g. Queensland Urban Utilities, Sydney Water), ferrous chloride was identified as the preferred solution because:

- It could be implemented quickly, and
- It would reduce odours in several areas of the treatment plant.

The most rapid and practical solution was to use the existing alum dosing facility, and re-purpose it for ferrous chloride, in combination with installing a new dosing location into the inlet works.

2.3 Ferrous Chloride – Why Does It Work?

Ferrous chloride reacts instantaneously with dissolved sulphides in solution to form insoluble iron sulphide according to the following reaction:

$$Fe^{2+} + HS^{-} \rightarrow FeS + H^{+}$$

The sulphide is then 'locked' and is not available for release as gaseous H_2S. Therefore, dosing ferrous chloride significantly reduces sulphide odours and reduces associated corrosion, especially corrosion of concrete and steel that is so common in STPs.

The ferrous chloride and its associated precipitates then flow from the primary treatment area into the bioreactors, where the iron can be converted from ferrous (Fe^{2+}) to ferric (Fe^{3+}). Subsequently, it replaces alum for supplementary chemical phosphorus (P) removal. Therefore, the benefit of ferrous chloride compared to alum was that one chemical performs two treatment functions: (1) H_2S removal, and (2) P removal. Furthermore, since alum was being replaced with ferrous chloride, there was no increase in sludge production. The sludge characteristics simply changed from originally having aluminium (Al) incorporated into the sludge matrix, to now having iron (Fe).

2.4 Rapid Installation & Commissioning

An additional challenge was that the odour emissions were attracting significant unwanted attention from the media and environmental regulator in Oct-Nov 2016. Due to the approaching summer holidays and proximity of the STP to caravan parks and local tourism and recreation areas, there was a significant concern of increased media attention and impact to Unitywater's reputation if nothing was done to solve this problem. Therefore, a rapid solution was required to reduce the odours.

IXOM were engaged to help Unitywater deliver this project, which was completed in rapid time:

- 8 Nov 2016 - Project need and priority was communicated to IXOM.
- 24 Nov 2016 - IXOM mobilised on site to start installation.
- 16 Dec 2016 – ferrous chloride system commissioned & operational.

This was a particularly impressive achievement, from contract award to commissioning in 4 weeks. The importance of having the ferrous chloride dosing system operational prior to the Christmas - New Year holidays could not be understated.

2.5 Benefits of Using Ferrous Chloride

The chemistry of ferrous chloride is interesting because it performs several functions in different locations throughout the treatment process. The selected ferrous chloride dose was at a constant flow of 70 L/hr, which equates to about 80 mg/L into the raw sewage. Monitoring of Maroochydore STP since commissioning of the ferrous chloride dosing system has seen benefits in the following areas:

- Odour Complaints:
  There were nil odour complaints between when ferrous dosing commenced in Dec 2016 through to Jan 2018. A series of odour complaints were received at the beginning of 2018, which were most likely related to dewatering undigested WAS, not due to H_2S emissions.

- Reduction in Dissolved H_2S:
  Raw sewage sulphide concentrations averaged 4 mg/L and varied between 1 and 8 mg/L. After ferrous dosing commenced the primary effluent dissolved sulphide was decreased to an average of 0.25 mg/L, with 5 out of 20 test results less than 0.1 mg/L (target value for minimal odour emissions). It was decided not to increase the ferrous dose any higher to consistently achieve primary effluent dissolved sulphide = 0.1 mg/L, as it would decrease bioreactor pH too close to 6.5.

- P Removal:
  Both the ferrous and ferric ions form insoluble hydroxyphosphate compounds which are removed with the activated sludge in the secondary clarifiers, and phosphate can also adsorb to ferrous and ferric precipitates that are present in the sludge. In the process at Maroochydore STP, ferrous and its associated precipitates flowed out of the primary treatment area into the bioreactors' anaerobic zones where bio-P bacteria are releasing phosphorus. Therefore, the iron is then able to contribute to simultaneous chemical and biological P removal. As a result, there was no change in effluent P concentrations because alum was simply replaced by iron. Furthermore, the iron was then mostly bound up in the waste activated sludge matrix that was pumped into the solids processing stream. Subsequently, the iron was involved in further reactions discussed below.

- Decreased Biogas H_2S:
  Prior to ferrous dosing, the biogas had H_2S levels of 150 to 180 ppm, whereas after the iron-enriched sludge was in the digesters the biogas H_2S decreased to 60 ppm. This was critical for reducing odours because the biogas flare had been faulty, and biogas released from the digesters' pressure relief valves was contributing to odour emissions.

- Improved Dewatering & Reduced Biosolids Costs:
  The iron that is bound up in the sludge changes the surface chemistry and improves sludge dewatering. At Maroochydore STP this resulted in the dewatered cake dryness improving by 2%TS, from 21%TS to 23%TS, resulting in an 8% reduction in operating costs for biosolids transport. For Maroochydore STP, this equated to $50,000 p.a.

It should be noted that ferrous chloride chemical costs were higher than alum chemical costs.

However, you don't get odour control for free, and although ferrous replaced the alum that was previously used, the ferrous served two functions of H_2S removal and P removal, whereas the alum served one function, to remove P. Additional "knock-on" benefits likely to be realised, but that are harder to quantify, are as follows:

- Reduced Corrosion:
  H_2S released from sewage and sludge contributes to corrosion, which leads to reduced asset life. H_2S emissions from sewage can be oxidised to sulphuric acid on wet concrete surface (e.g. tanks and pipes) leading to concrete corrosion. H_2S in the biogas can be converted to SO_2, which is then converted to sulphuric acid, which is a known mechanism causing corrosion to metallic equipment that is used with biogas handling and processing. As discussed above, ferrous dosing reduced dissolved sulphide in the primary effluent and decreased H_2S levels in the biogas at Maroochydore, both of which will contribute to lower corrosion rates.

- Reduced Struvite Formation:
  Struvite (i.e. magnesium ammonia phosphate – MAP) is formed in anaerobic digesters and downstream processes, especially when digesting bio-P sludge, due to elevated levels of soluble magnesium, ammonia and phosphate. Its major impact is that it forms a layer of mineral scaling on pipe walls and equipment surfaces in contact with the sludge. Using ferrous chloride to precipitate phosphate decreases the concentration of soluble phosphate and prevents the precipitation of struvite.

2.6 Key Risks and How They Were Overcome

Dissolved iron in the treated effluent has a negative impact on UV disinfection by direct absorption of UV radiation and by causing ferric scaling on the UV lamp sleeves. It was necessary to modify operation of the bioreactors to minimise any adverse impact at Maroochydore. The modifications made to the bioreactors operation were aimed at increasing the redox and increasing the pH in order to maximise the conversion of soluble ferrous (Fe^{2+}) to insoluble ferric (Fe^{3+}). As a result of the iron changing from a soluble form into a solid precipitate, it becomes fully bound in the mixed liquor and does not escape in the secondary clarifier effluent where it can impact UV disinfection. The bioreactor operational modifications adopted at Maroochydore STP were:

- Increase Redox: Dissolved Oxygen (DO) set-points in the aeration zone were increased from 1.2 mg/L to 2.5 mg/L. In the absence of a redox sensor, the best indicator of high redox in a BNR bioreactor is if the effluent ammonia NH_3-N is less than 0.1 mg/L.

- Increase pH: The combination of alkalinity consumption associated with high levels of nitrification necessary to achieve higher redox, and alkalinity consumption directly caused by ferrous dosing, resulted in the bioreactors' pH dropping consistently to 6.7 or lower. The easiest option to increase alkalinity was to maximise denitrification. At Maroochydore STP, this was achieved by increased methanol dosing, and the best indicator of optimum alkalinity recovery in a BNR bioreactor is if the effluent nitrate NO_3-N is less than 1.5 mg/L.

- UV Lamp Cleaning: Despite the best efforts to increase pH and redox, it was not possible to increase bioreactor pH to 7.0, and consequently secondary effluent iron (Fe) levels increased to Fe = 0.2-0.4 mg/L if effluent NH_3-H was less than 0.1 mg/L, compared to Fe = 0.1 mg/L with alum dosing.

However, sometimes if effluent NH_3-H was higher than 0.1 mg/L, then effluent Fe was increased to 0.5-1.0 mg/L. As a result, noticeable ferric scaling was observed on the UV lamp sleeves and greatly increased frequency of acid cleaning was required, depending upon the increased level of Fe in the secondary effluent. Review of long term performance of the UV disinfection process at Maroochydore STP, post implementing of ferrous chloride dosing, resulted in net operating cost increase of approx. $50,000 per year.

2.7 What We Would Do Different Next Time?

The alternative options to prevent ferrous dosing impacting on UV disinfection would have been to use dedicated chemical alkalinity dosing. Two options were possible at Maroochydore, but neither could be implemented rapidly, and both would have involved substantial chemical costs potentially in the order of $500,000 p.a.

1. Refurbish a decommissioned lime silo and dose a powdered alkaline chemical (e.g. lime or MgO) into the inlet works. Historically, this system had been unreliable and prone to blockages, which require higher operator hours for cleaning.

2. Install several magnesium hydroxide liquid dosing systems at multiple locations throughout the Maroochydore sewer network where there was a risk of odour emissions or where sewer concrete corrosion was occurring. This option would both protect the sewer network and increase pH at Maroochydore STP.

Based on the options above, the increased cleaning of the UV system was the most practical and lowest cost outcome for ongoing operation of the Maroochydore STP.

3.0 CONCLUSION

Ferrous chloride dosing was successful in reducing odour emissions coming from multiple areas within the Maroochydore STP. The project was delivered quickly i.e. 4 weeks from contract award to commissioning, with no interruption to STP performance or licence compliance. Delivery of this project was one of the key strategies adopted by Unitywater to minimise the likelihood of continued odour complaints in the future. This project demonstrated ferrous chloride dosing can provide additional benefits for downstream processes, and how to avoid and/or minimise adverse impacts for UV disinfection.

4.0 ACKNOWLEDGEMENTS

The authors would like to acknowledge all the effort that went into implementing and operating modifications to Maroochydore STP (incl. ferrous chloride dosing), especially:

- IXOM for design, installation & commissioning of the ferrous chloride dosing facility;
- Maroochydore STP operators for responding to all the changes at a time when they were under pressure from a variety of other issues that were competing for their attention;
- Treatment Plants branch management team for keeping the pressure on other Branches in Unitywater to ensure odours were addressed quickly; and
- Process Engineer Rui Yang and Technical Officer Casey Staines who worked closely with all parties.

WHO'S WORKING ON YOUR PIPES? THE EVOLUTION OF NETWORK ACCESS

Paper Presented by:

Jessica Cloumassis

Author:

Jessica Cloumassis, *Control Room Operator*,

Queensland Urban Utilities

43rd Annual WIOA
Queensland Water Industry Operations Conference and Exhibition
Logan Metro Sports Centre, Logan
6 & 7 June, 2018

WHO'S WORKING ON YOUR PIPES? THE EVOLUTION OF NETWORK ACCESS

Jessica Cloumassis, *Control Room Operator,* Queensland Urban Utilities

ABSTRACT

Queensland Urban Utilities delivers water and sewerage services to more than 1.4 million residents through water and sewerage networks spanning 18,000 kilometres.

It was only three years ago that we utilised a number of manual processes, paper forms and non-integrated systems to manage applications and issue permits for staff or contractors to conduct work on, or near our assets. The system, entirely paper based, required applicants to submit work plans and associated documents in hard copy for assessment by our technical staff. This manual, resource intensive process was prone to human error and contributed to a lack of control rather than exercising control.

Driven by our commitment to safety, customer service, operational excellence and innovation, we have taken our capability to the next level with the design and implementation of an on-line system for interested parties to apply for a permission to work on or near our assets.

The first of its kind in South East Queensland, this enhanced capability allows us to approve not only who works on our assets, but the type and timing of the activity through detailed shut plans (water assets) and flow control plans (sewerage assets).

1.0 INTRODUCTION

Queensland Urban Utilities is the fourth largest water distributor-retailer in Australia. We deliver water and sewerage services to more than 1.4 million residents, through water and sewerage networks spanning 18,000 kilometres, across a 14,000km^2 geographic area.

We manage an asset base valued at over $5 billion, including over 300 sewage pump stations, 108 in-service reservoirs and 100 water booster and pumps stations.

On average, the Queensland Urban Utilities Control Room will be made aware of up to 80 individual planned projects and 10-30 responsive/unplanned jobs each day.

Operating complex networks over a large geographic area presents considerable risk to the continuity of water and sewerage services to customers, and to the safety of those working on or near our assets. Typical safety issues associated with working on assets includes:

- entry to sewers and pump station wet wells,
- isolation of pump stations and sewer gravity mains, and
- isolation/de-pressurisation of water mains.

Considering the extensive service area and the large asset base, there is a considerable volume of work occurring on any given day, creating potential for clashes or adverse impact.

The importance of visibility was emphasised as we continued to coordinate work that had the potential to compromise the safety of other activities in the network.

As a result, we were compelled to implement systems which allowed us to exercise control over who accesses our network, when and under what conditions.

Figure 1: ***A geographical view of location of works underway on a Friday morning***

2.0 DISCUSSION

No single event triggered the identification of the need for a comprehensive management of network access. Over time, it became apparent that three elements were contributing to the complexity of managing access to network assets. These were:

- an increase in the number of works in the planned maintenance and capital delivery space,
- a reduction in the number of experienced field staff who historically coordinated this work amongst each other, and
- an increase in the use of third party contractors undertaking work on Queensland Urban Utilities' behalf.

This dynamic change in the business landscape led to an increase in the occurrences of office-based operations personnel being engaged by field-based personnel to assist with understanding how to coordinate works activities in the network.

Anecdotally, there was also a perceived increase in the number of adverse impacts on customers due to works activities not going to plan. Although these activities don't in themselves lead to safety issues and injuries, they started to create a perception of a loss of control which if left unmanaged had the potential to lead to injury.

2.1 Solution Development

In response to these trends, we established a dedicated Network Access Team to provide a comprehensive 'one-stop-shop' for all planned activities associated with gaining access to the water and sewerage networks. The Network Access Team became the single point of contact for any contractor requiring permission to work on or near our water and sewerage networks.

These actions ensured that appropriate 'end-to-end' administrative and technical reviews were in place to underpin the production of appropriate network configuration plans which enabled work to be undertaken safely, whilst minimising impacts on customers. The volume of work demanded the development of software tools that would enable the Network Access Team to undertake their activities efficiently and provide visibility of network activity for the whole of the business.

The concept of this dedicated team, coupled with a custom built software system was an original concept generated by in-house subject matter experts. The team of engineers and technical officers identified the need for a fully electronic system with corporate geographic information system (GIS) integration. Based on this recommendation Queensland Urban Utilities, in conjunction with previous collaborators Go2Asset and ESRI, commenced the design of a software solution that would satisfy the needs of the organisation. Through this collaboration, we identified a number of key requirements with Go2Asset and ESRI providing several software ideas that offered significant functionality.

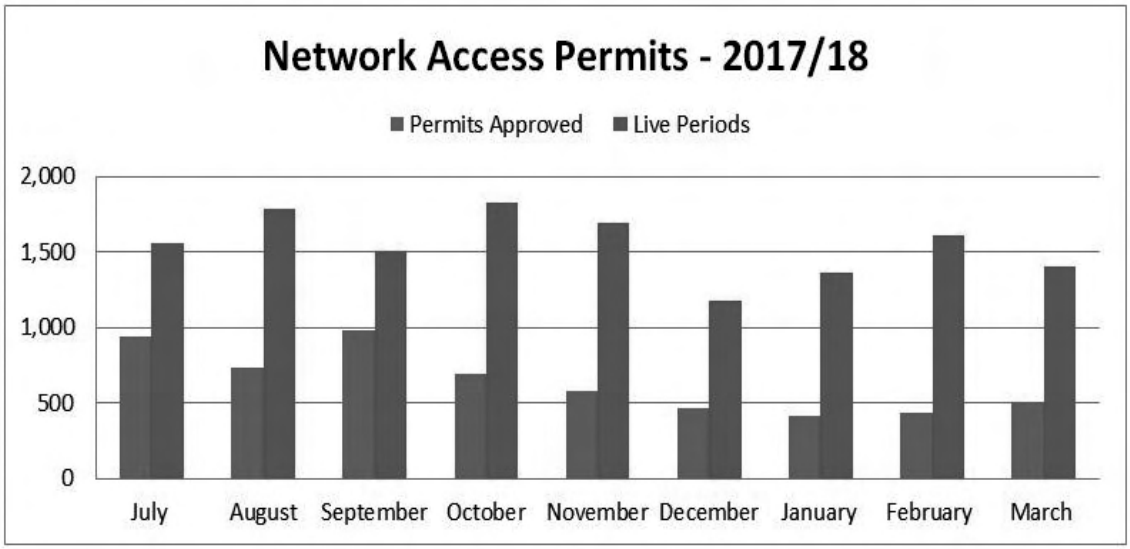

Figure 2: ***The number of permits approved and the total number of 'live periods' or jobs completed for each calendar month***

2.2 The Outcome

The result was an on-line system that satisfied Queensland Urban Utilities' business needs and enhanced our customer service to those requiring access to our complex networks. The system:

- removed the need for paper based applications,
- created a single point of contact for all contractors and internal crews needing to work on our water and sewer networks,
- provided a framework to identify and locate all planned works in the networks across our service territory, and
- enabled all required details to be included in the on-line permit, along with electronic versions of all required documents, creating a record of works which could be accessed retrospectively if the need arises.

For the first time, interested parties were able to apply for a network access permit via an on-line solution. In addition, Queensland Urban Utilities' control room operators had full visibility of all live permits associated with the network via our GIS, which afforded them an element of control and safety management that previously didn't exist. Furthermore, feedback from contractors reinforced that the formation of a dedicated team and the on-line permit scheme provided a consistent approach to managing access permits, which in turn provides confidence that work can be undertaken in a safe environment.

While the on-line permit scheme was custom built for Queensland Urban Utilities, it can be modified for the unique needs of other network utility operators. We are currently progressing detailed investigations into the application of the software system within our sewage treatment plants. This is a modification to the original model, but it does appear to have a strong case for success. At present, sewage treatment plants operate using paper based systems unique to each treatment plant. The adaptation of the on-line permit scheme for the sewage treatment plant arena will facilitate a common view of all permit activities across all treatment facilities.

3.0 CONCLUSION

The first of its kind in South East Queensland, the enhanced on-line system and refreshed administrative processes ensure our employees understand planned activities being conducted on or near our network. Whether it is a control room operator overseeing activities in the field, or contact centre employees delivering customers with service disruption information, they can view the same information and speak the same language. Ultimately, the on-line solution allows Queensland Urban Utilities to successfully maintain reasonable and appropriate control and ensure safe work practices.

4.0 ACKNOWLEDGEMENTS

Special thanks to Igor Jungic and Karen Pollock who supported me during the development of my first conference paper.

MAXIMIZING VALUE FROM SCADA

Paper Presented by:

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MAXIMISING VALUE FROM SCADA

Peter Bell, *Coordinator Telemetry,* Logan City Council
Michael Seymour, *Senior Planning Engineer***,** Logan Water Infrastructure Alliance

ABSTRACT

Logan City Council provides water and wastewater services to 310,000 people, with the city's networks featuring a range of facilities connected to Council's SCADA system.

SCADA has helped Council's water network operations staff to keep their 'fingers on the pulse' of the network and provide rapid response to alarms. However, Council recognises that opportunities exist to gain further value from the data stored in SCADA to improve decision-making about assets.

This paper outlines Council's SCADA system and how it has been set up to provide far more than real-time data monitoring and network control. It will describe how data can be downloaded into a spreadsheet 'dashboard' which provides vital information on the performance of wastewater pump stations; highlighting those which have unusually high or low pump hours, pump starts, pump cycles, faults, outage hours, pump availability and surcharges. These indicators are predictive tools that can warn staff of potential problems. The problems can then be prioritised on a catchment basis, enabling staff to address the most critical issues first.

Development of such a dashboard can assist other small or medium sized water utilities to make full use of SCADA data.

1.0 INTRODUCTION

Logan City Council provides water and wastewater services to 310,000 people, with the city's networks featuring a range of facilities connected to Council's SCADA system. SCADA has helped Council's water network operations staff to keep their 'fingers on the pulse' of the network and provide rapid response to alarms. However, Council recognises that opportunities exist to gain further value from the data stored in SCADA to improve decision-making about assets. This paper outlines Council's SCADA system and how it has been set up to provide far more than real-time data monitoring and network control.

2.0 DISCUSSION

2.1 SCADA Overview

The Logan Water SCADA system was upgraded in conjunction with an electrical switchboard upgrade at 84 water and wastewater sites in 2004. The upgrade allowed the SCADA RTU to be integrated into the electrical switchboard. One of the goals for the upgrade was for the SCADA system to provide outputs that facilitated better management of the assets, as well as real-time operational monitoring and control.

The current SCADA system comprises Kingfisher RTU hardware and ClearSCADA as the software platform. The SCADA system shares information via radio with over 200 water and wastewater sites and 100 district metered area sites using a 3G Cloud. The design of the SCADA system made allowance for operational, planning and asset management data needs.

The SCADA has performed well over the years and allows operational staff to effectively monitor and control the water and wastewater networks and respond to any alarms. As a result, SCADA has made a valuable contribution to Council's ability to meet customer service standards.

A typical reporting system was put in place for standard operational SCADA reports; daily, weekly and monthly reports show run hours, number of starts, number of faults and their duration, number of power outages and their duration, wastewater overflow quantities and duration, rainfall and other similar metrics. While the reports were beneficial to operations staff, they only gave a short-term view of asset performance. The reports were text-based and not user friendly. As a result, their use was limited to a few operational staff with particular requirements and the full SCADA capability remained under-utilised for many years.

Logan Water identified a need for more user-friendly outputs that would:

- Provide a view of longer-term performance trends, enabling operational staff to act well before problems arise
- Give operational and planning staff a better insight on how a pump station and its catchment is performing.

A concern was that further development of the SCADA reporting system would be expensive and time consuming. Other options included the purchase of analytical software; again at considerable time and cost. In-house development of a spreadsheet outside of the SCADA system was considered the best option because:

- It was low-cost and would give operational staff a better idea of desired outputs if more sophisticated analytical software was considered in future
- High-level Microsoft Excel capabilities already existed within the organisation
- In-house development allowed a more collaborative approach to improving the outputs
- Better graphical outputs could be developed using Excel
- Outputs could be readily modified to suit user requirements.

A simple data extraction report was developed in the SCADA system, which allowed for the export of a monthly CSV file to the SCADA spreadsheet. The SCADA spreadsheet allows for large amounts of data from all sites to be combined into one simple spreadsheet.

2.2 SCADA Spreadsheet

The primary use of the SCADA system is to control the operation of wastewater pumps and provide alarms. Pumps are controlled by levels in the wet well and pump start and stop times are recorded along with wet well levels. This information is essential for the direct operation of pumps; however, it can also provide further insight into the performance of the pump stations.

In isolation, when viewed for a short duration the SCADA data contains a lot of 'noise'. However, when analysing the data over longer periods of time, patterns start to appear (for example diurnal weekday and weekend flow patterns). Monthly pump data, which is simply an accumulation of the pump start and stop times, contains a lot of useful information. It is largely free of the noise associated with shorter time spans and can provide important insights into the performance of individual pump stations and how they compare with others in the network.

Logan Water's analysis of pump station monthly data has revealed information including:

- Average daily pump hours – High pump hours indicate that the pump capacity has been exceeded, particularly if it is accompanied with surcharging. Pump stations with low pump hours are oversized and may be passing on excessive flows during wet weather events.

- Increases in pump hours – Pump stations with high pump hour increases need to be monitored. If the increase is not a result of 'natural growth' it could be a result of increasing pump inefficiency or inflow and infiltration issues. Catchment growth is accompanied by increasing operation and maintenance requirements, and pump hours can be helpful when estimating forward expenditure requirements.

- Average pump operating and fill times / cycles – Short pump operating times tend to be inefficient. Conversely, high operating times indicate that operating volumes may be reduced. High fill times result in excessive retention times and may affect odour and corrosion in the network. An analysis of these metrics allows these competing issues to be optimised.

- Comparison of pump capacity of individual pumps at a station – Most pump stations operate pumps alternatively and it is not uncommon for one pump to pump 15% less (which equates to a significant reduction in efficiency). Where there is a difference in pump operating times, it could be a result of several factors including: mismatched pumps, one of the pumps operating inefficiently or partially choked; or poor hydraulics.

- Variability of pump operation during subsequent months – A sudden change in pump capacity could be because of partial chokes or similar issues not revealed in normal alarms.

- Performance of the catchment during wet and dry months – Large differences in pump hours between wet and dry months indicate excessive inflow and infiltration.

- Surcharging – Surcharging and / or overflows during wet weather events are a good indication of how the system is performing. This could be due to pumps not having adequate capacity, or excessive inflow and infiltration.

- Faults, outages and unavailability of pumps – These are monitored and where the metrics are trending upwards, further investigation may be necessary as they may be an indicator that pumps and / or equipment may require improved maintenance or replacement.

Some of the outputs relating to these metrics are included in Figure 1.

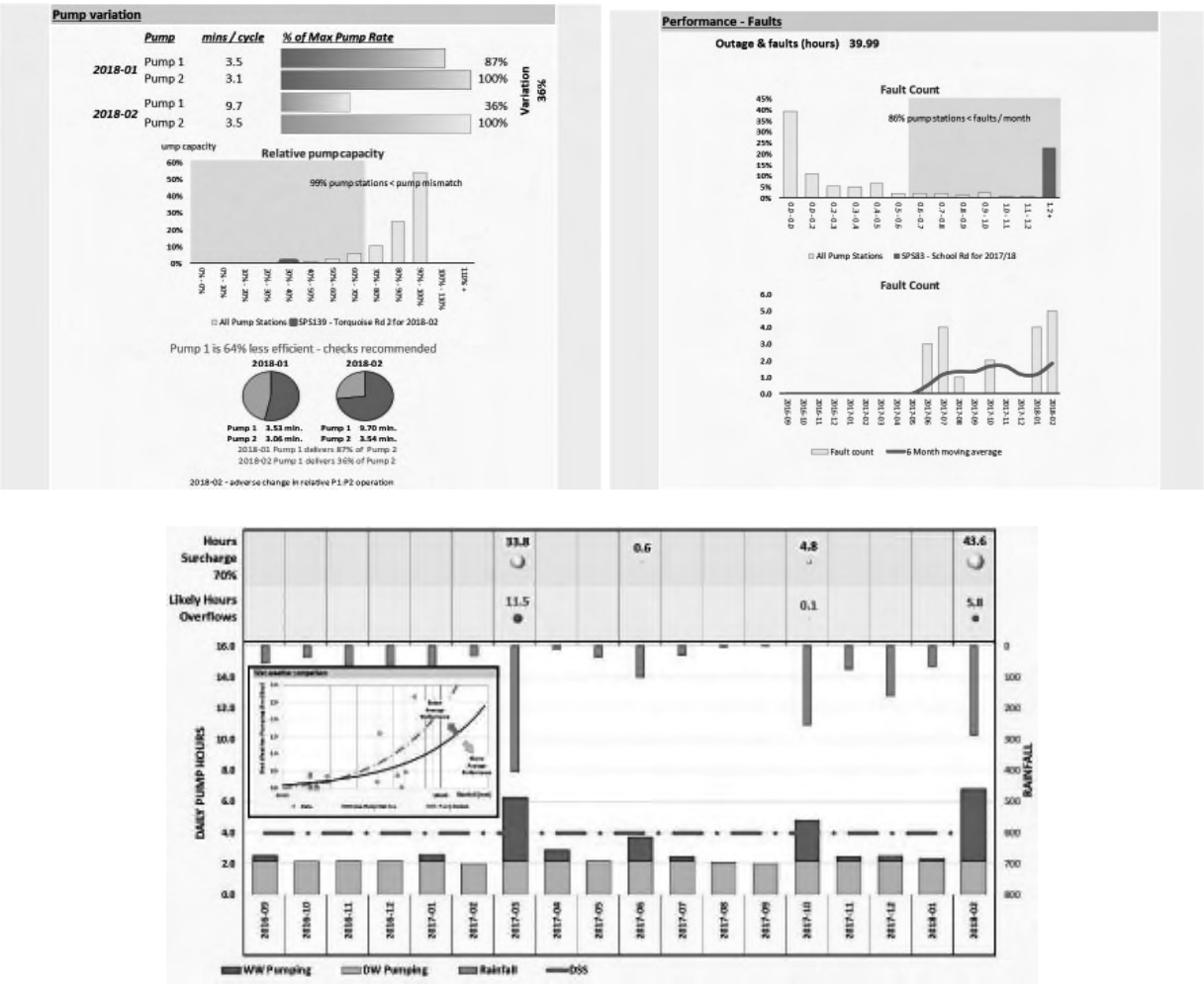

Figure 1: ***Typical outputs for individual pump stations***

Figure 1 highlights where there has been a change in pump capacity, increase in faults and performance in wet weather that would need further investigation.

The performance of the individual pump stations can then be ranked, based on various metrics and the worst performing stations identified for more detailed investigation.

PUMP STATION PERFORMANCE

SUMMARY RANKING 2018-02 (Last month)

Pump time / cycle ***(low operation time / cycle)***

	Pump Station	Pump time / cycle (Minutes / Cycle)	Fill time / cycle (Minutes / cycle)
1	SPS85 - Loganholme Recreation	0.6	124.6
2	SPS60 - Meakin Rd	1.2	297.5
3	SPS79 - Flagstone 2	1.4	11.1
4	SPS18 - Dewar Drive	1.5	94.1
5	SPS111 - Distillery Rd	1.9	78.8
6	SPS121 - Kummara Rd	2.0	31.0
7	SPS093 - Lady Ardee Cct	2.2	658.8
8	SPS66 - Zuleikha Drive	2.4	185.2
9	SPS47 - Third Ave	2.5	16.2
10	SPS21 - Elm Park	2.5	201.1
11	SPS112 - Eagleby Rd		
12	SPS20 - Edenlea		

Fill time / cycle ***(excessive fill time / cycle)***

	Pump Station	Fill time / cycle (Minutes / Cycle)	Pump time / cycle (Minutes / cycle)
1	SPS093 - Lady Ardee Cct	658.8	2.2
2	SPS64 - Riverdale	431.5	6.8
3	SPS88 - Bayes Rd	418.4	6.0
4	SPS146 - Brookhaven Blvd	351.8	5.0
5	SPS34 - Louise Street	322.9	72.4
6	SPS60 - Meakin Rd	297.5	1.2
7	SPS49 - Trevallyan Dr 2	289.0	
8	SPS06 - Bompa Road	235.0	
9	SPS62 - Dulwich Street		
10	SPS56 - Trevallyan Dr 3		

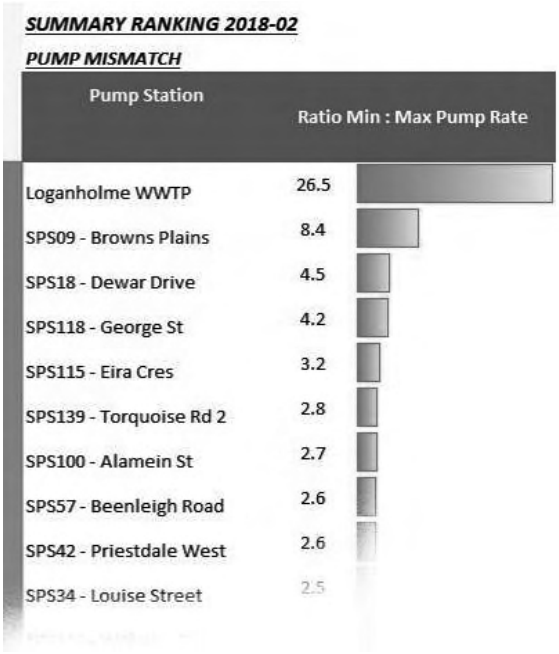

Figure 2: ***Ranking of pump stations based on various metrics***

By focusing in on the worst performing stations, Logan Water can allocate resources and ensure they are efficiently used when undertaking improvements to the overall system.

The performance of the pump stations can be compared against previous months and / or financial years. The various metrics can also be scored for each pump station and then combined / averaged on a system-wide basis to provide an overall measure of performance. By maintaining consistent scoring (that is not subjective) it is possible to develop key performance indicators to measure how the system is performing overall.

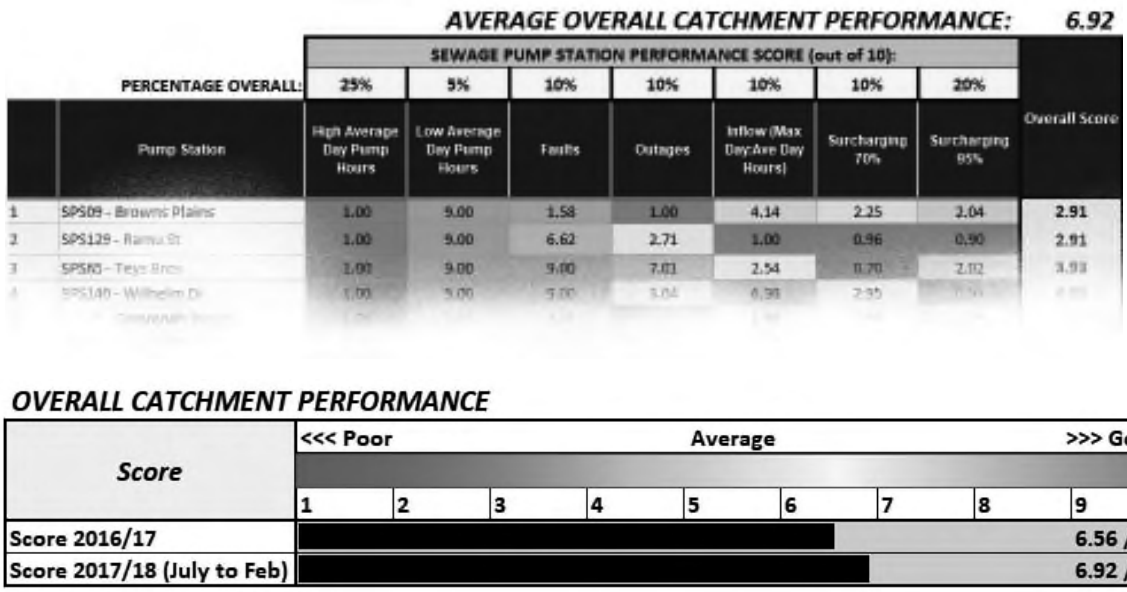

Figure 3: ***Performance scores – individual pump stations and catchment-wide***

The monthly analysis of data ensures that operators do not get bogged down in detail at an early stage. The performance ranking identifies those stations where more detailed investigation may be required to result in an overall improvement in the system.

3.0 CONCLUSION

The ability to provide timely summaries of the monthly wastewater pump station performance allows the early identification of problems.

There is a danger when viewing large data sets of being overwhelmed, and performance ranking allows operators to focus on the more critical issues and ensure an efficient use of resources. Comparing historical records can be used to determine where network upgrades are required and provide evidence to support this. It also allows key performance indicators to be developed that are not subjective, and provide a snapshot on how the catchment is performing.

4.0 ACKNOWLEDGEMENTS

The authors acknowledge Logan City Council and Logan Water Infrastructure Alliance (Logan City Council, Downer, Cardno and WSP) for providing the resources and facilities to develop the SCADA reporting tool.

COST EFFECTIVE RETROFIT OF A CONVENTIONAL PACKAGED PLANT FOR IMPROVED PERFORMANCE

Presented by:

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Authors:

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Peter Greenhalgh, *Senior Process Engineer,*
Craig Jakubowski, *Principal Process Engineer,*
Hunter H2O

43rd Annual WIOA
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1.0 INTRODUCTION

The Giru Water Treatment Plant (WTP) is a 2 ML/d water treatment facility located in Northern Queensland which utilises a conventional "package" style treatment process, constructed in 1989. The WTP receives raw water pumped from the Haughton River, which during high flows has a turbidly of over 100 NTU compared with an average of 2 NTU. Following coagulation (with aluminium sulphate), flocculation, clarification and media filtration, the water is disinfected and pH corrected prior to distribution to the townships of Giru and Cungulla.

As is the case with many package style plants from this era, there was a lack of process control and online monitoring originally included. The control system was also dated making sourcing of replacement parts difficult in the event of a failure. Several WTP design deficiencies also proved problematic in terms of maintaining acceptable filtered water turbidity, filter media condition and overall plant reliability. A series of upgrade plans were developed and delivered by Townsville City Council (TCC) staff, achieving a significant improvement in water quality and extending the life of the plant.

2.0 HIGHLIGHTS

- Retrofit of package plant for improved treated water quality with 95th percentile treated water turbidity reducing from 4.11 NTU before the upgrades to 0.27 NTU after the works (see Figure 1);
- Approximately a 50% reduction in aluminium sulphate and soda ash dose rates;
- Improved filter performance;
- Reduced construction costs through procurement of labour and materials in-house;
- Improved control and monitoring leading to reduced call-outs.

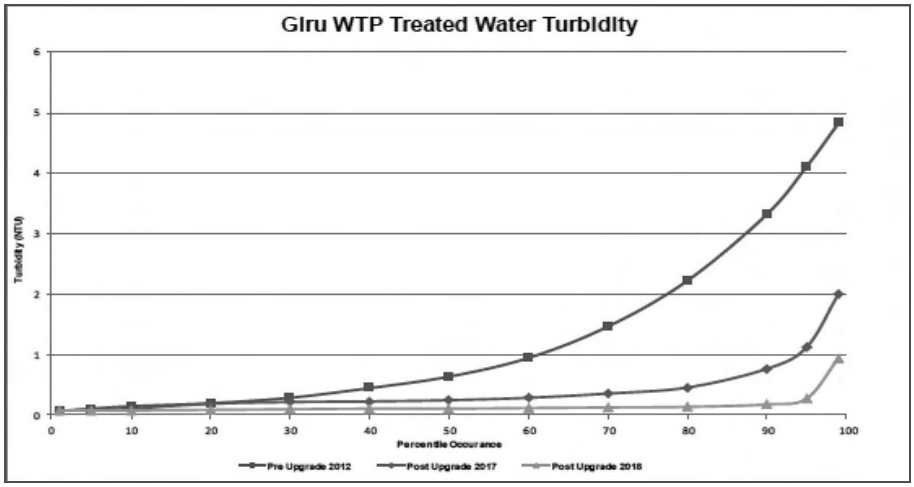

Figure 1: ***Treated Water Turbidity Comparison***

3.0 METHODOLOGY/ PROCESS

In 2012, TCC sourced external process assistance (Hunter H_2O) to develop an overall WTP upgrade strategy and a functional specification to describe the preferred control of the plant. TCC then procured the replacement control equipment and programmed it using the functional specification as input. TCC also installed new chemical dosing pumps and pipework and a new sulphuric acid dosing system to improve coagulation efficiency during times of elevated raw water pH. Additional works included site Work Health and Safety (WH&S) improvements and filter differential pressure monitoring for use as a backwash trigger.

In 2016, TCC commenced upgrades to the media filters to reduce treated water turbidity and preserve media condition. A lack of detailed drawings of the filter internals necessitated an investigation to better aid the upgrade decision making process. The two filter cells cannot be operated individually requiring the WTP to be taken offline when refurbishing the filters. To provide more time to complete the filter upgrade works, temporary modifications were made to the filter walls to isolate the two cells, allowing individual cell operation. This meant the WTP could continue operation, with one cell operating while the other cell was refurbished.

Excavation of the filter media showed that the existing PVC filtered water/backwash laterals were uneven with loose connections (see Figure 2).

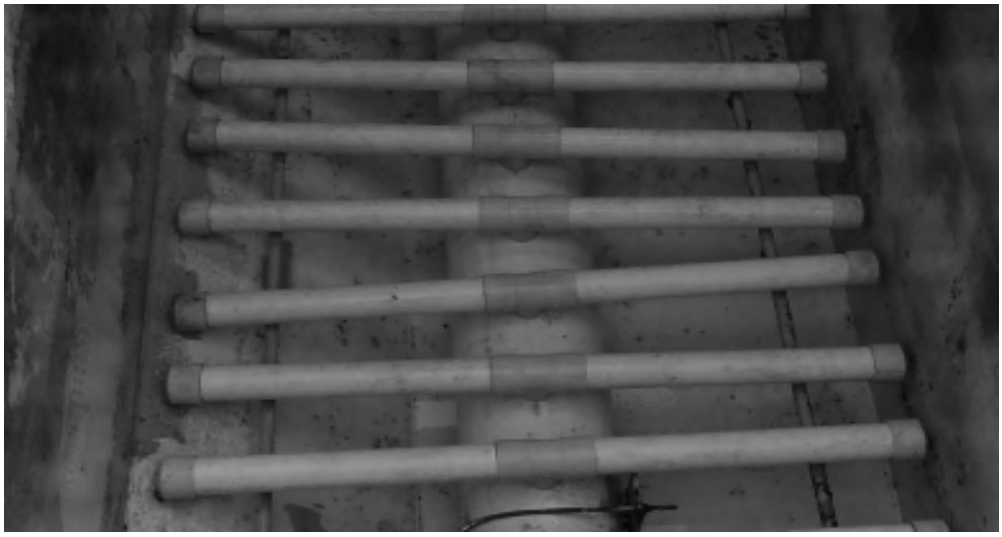

Figure 2: ***Original Filtered Water Manifold In One Filter Cell***.

Council engaged Hunter H_2O to:

- Develop the filter media and support gravel design to maximise treated water quality;
- Design and provide shop drawings for replacement filter laterals, considering the filter access constraints and the time constraints on the installation work;
- Assist Council with the complex construction and installation methodology which involved working on an operating WTP.

Council then fabricated and installed the filter laterals (see Figure 3), support media and filter media. This process was then repeated for both filter cells.

Figure 3: ***New Filtered Water Manifold***

4.0 RESULTS/ OUTCOMES

Since the WTP upgrades, a significant reduction in the treated water turbidity produced by the WTP has been noted. The treated water turbidity has reduced significantly since the upgrade and the WTP consumption of alum for coagulation and soda-ash for pH correction has reduced by approximately 50%. The WTP has also proven to be more resilient to changes in raw water quality as occurs during high flows in the Haughton River.

By implementing the works using in-house resources, Council significantly reduced external costs for the project and maximised control and input to the final process.

It should be noted that the data presented in Figure 1 is from treated water sampling, which is filtered water dosed with soda ash. The soda ash addition is known to increase the treated water turbidity significantly. TCC is currently in the process of installing online filtered water turbidity meters with sampling prior to soda ash addition to enable assessment against proposed health based targets.

5.0 CONCLUSION

TCC completed a cost-effective upgrade to the "package" style Giru WTP through use of in-house resources with the assistance of external process engineering support. Replacement of the original filtered water/backwash laterals yielded a significant improvement to treated water turbidity. The outcomes of the project demonstrate that the life of package WTPs of this type and age can be extended economically and can be undertaken largely by Council's with internal fabrication resources. Modernisation of the control system by TCC has further improved the WTP reliability and control, in a catchment susceptible to significant raw water quality variability. Finally, aluminium sulphate and soda ash dose rates were reduced by ~50% through the addition of a sulphuric acid dosing system and modification of the chemical dosing strategy and dosing control.

UNEARTHING THE PAST, TO CHART THE FUTURE

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43rd Annual WIOA
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Logan Metro Sports Centre, Logan
6 & 7 June, 2018

UNEARTHING THE PAST, TO CHART THE FUTURE

Priyanthi Samarakoon, *Asset Management Engineer*, Logan City Council

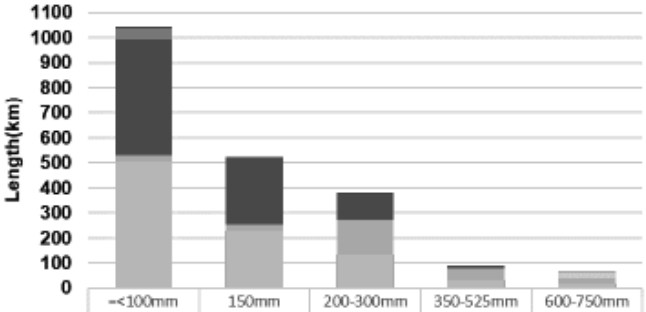
ABSTRACT

Logan City Council provides water and wastewater services to 310,000 people living and working across 957km^2 of urban, semi-rural and emerging neighbourhoods. The water supply network comprises 2,200 km of mains of which nearly 900km are asbestos cement (AC) pipes, between 30 and 55 years old.

Historically, Council's water main renewal programs were reactive; addressing asbestos cement (AC) mains after multiple failures. However, water hydrant flow testing in 2015/16 indicated that some older hydrants were not able to deliver sufficient fire flow rates due to tuberculation of pre-1980 unlined fittings. To address this, Council decided to take a more proactive approach by conducting condition assessments of the mains during replacement of unlined fittings. The first zone selected was the Eagleby District Metered Area 55 (DMA); one of the older networks in the system. In this DMA, an opportunistic AC pipe condition assessment program was implemented using on-site phenolphthalein testing. Results indicated that age is only one of many factors that influence pipe condition/ failure rate. This paper discusses the many challenges and benefits associated with this initiative.

1.0 INTRODUCTION

Logan City Council provides water and wastewater services to 310,000 people living and working across 957 km^2 of urban, semi-rural and emerging neighbourhoods. The water supply network consists of 2,200 km of mains of which nearly 900 km are asbestos cement (AC) pipes with 720 km of these being DN100 and DN150 as shown in Figure 1. The age profile of these mains is between 30 and 55 years old, (Figure 2). A recent review of failure data indicated that the majority of failures occurs in AC reticulation mains (DN100/150mm) (Figure 3). An analysis of the failures of DN100 AC mains (Figure 4) indicates that 47% of failures are pressure related. This is of concern since Council has made a significant investment in pressure management over recent years. It is considered that implementation of pressure management is providing a window of opportunity for renewing AC water mains without causing a major reduction in customer service levels, through minimising pressure-related mains failures.



	=<100mm	150mm	200-300mm	350-525mm	600-750mm
Other	1.6	3.0	4.1	1.4	0.1
MSCL	0.1	1.3	0.2	1.1	21.9
PE	41.2	0.5	0.6	0.2	0.1
PVC	466.1	266.4	105.0	5.7	0.0
DICL	31.2	30.6	141.6	48.7	22.2
AC	500.5	223.1	129.0	30.1	17.6

Figure 1: ***Length of water mains by material and diameter***

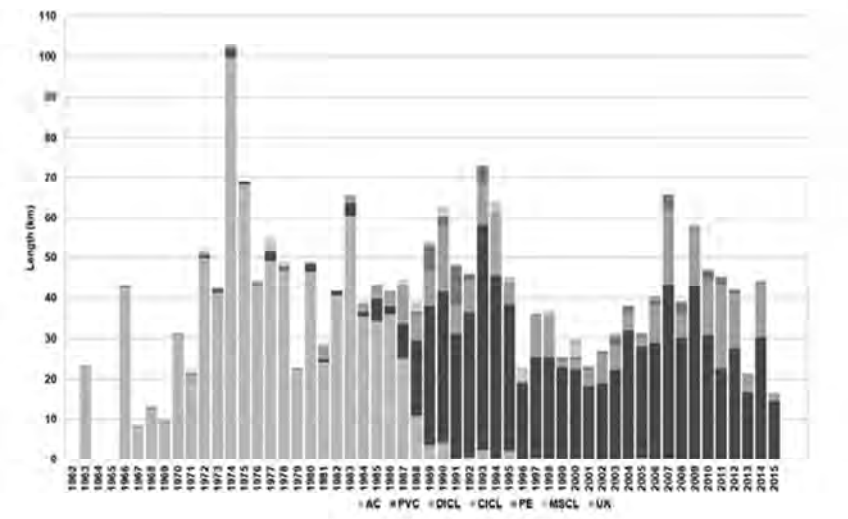


Figure 2: ***Age by material***

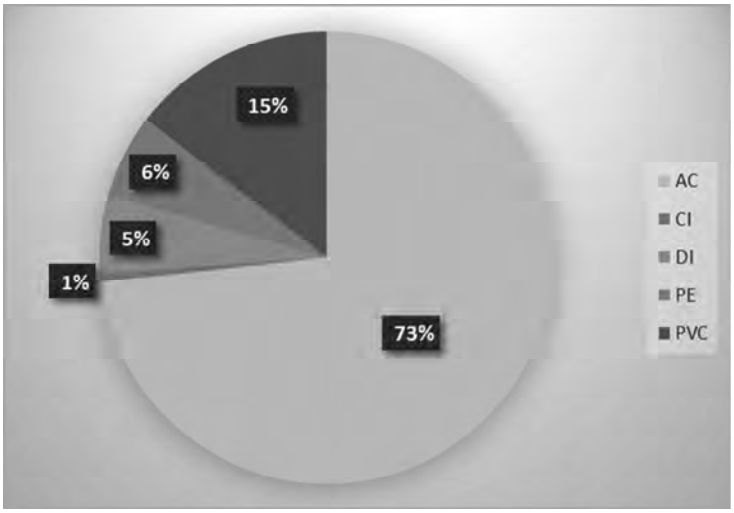


Figure 3: ***Percentage failures by material***

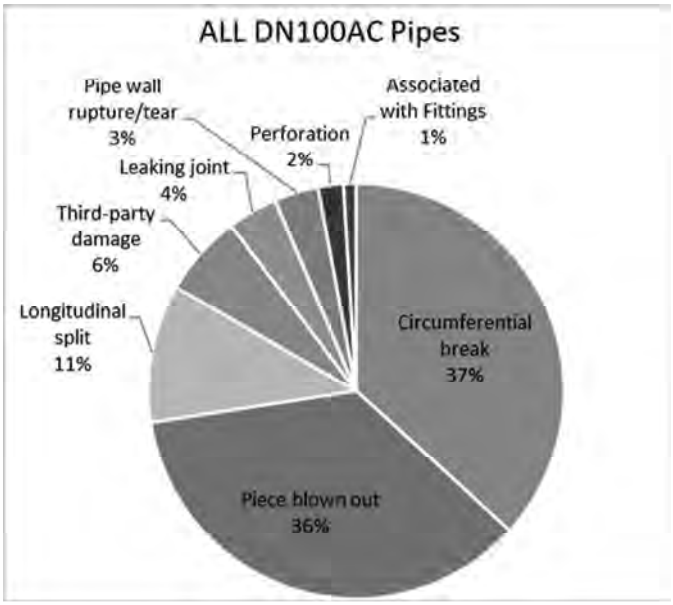


Figure 4: ***Failure modes for DN100AC mains***

Historically, Council's water main renewal programs were reactive and addressed frequently failing AC mains (mainly DN100 reticulation mains). The method of determining performance of AC water mains was based on failure history.

The concern with this approach is that it doesn't give a forward view of likely failure history. With the mains approaching the latter half of their useful lives, there is a risk that renewal investment may not be adequate. The network includes around 5,000 unlined hydrants, valves and tees. Hydrant flow testing in 2015/16 indicated that 11% of older hydrants were not able to deliver 15L/s fire flow rates due to severe tuberculation of pre-1980 unlined fittings. While any flow deficiency could be supplemented by an adjacent hydrant in many instances, Council considered it desirable to accelerate renewal of the unlined fittings. At the same time, there was an opportunity to assess the condition of adjoining AC pipes.

2.0 DISCUSSION

Replacement of water mains can be costly and disruptive for water customers and wider communities. Apart from water supply disruptions, there is considerable impact on community members associated with temporarily closing traffic lanes, driveways and footpaths for pipe removal and installation.

Therefore, in planning the renewals, Council decided to undertake the program on a district metered area (DMA) basis. In this way, unlined fittings (i.e. tee junction) in a whole water service zone would be replaced at once and condition assessments of the mains completed. It was determined that tee junctions offered the best location for undertaking condition assessments as the AC main had to be 'clean cut' to allow for efficient replacement of the fittings.

First, a risk-based desktop analysis was undertaken to determine the priority of replacements in DMAs. This included:

- Likelihood of failure based on a range of criteria such as age, material, pressure, environmental conditions (e.g. reactive clay) and historical performance.
- Assessment of the consequence of failure based on criteria such as diameter, location and critical customers serviced.
- Analysis of historical failures and failure modes to determine trends and hot-spots. This indicated that water pressure on deteriorated pipe walls contributed to nearly 50% of 100mm diameter AC main failures.

One of the DMAs with the greatest percentage of high risk mains was Eagleby, one of the oldest suburbs at the southern end of the City of Logan.

Council's Logan Water Infrastructure Alliance was tasked with delivering the water mains replacements and condition assessments. The team's approach was to first replace all the tees, then follow up with water main renewals. This provided an opportunity to undertake condition assessment of the cut AC main. Based on the effective wall thickness of the AC main (as determined through phenolphthalein testing) a decision would be made as to whether to renew the whole main (if inadequate effective wall thickness) or just the hydrants and tees (effective wall thickness is adequate). This opportunistic assessment could be supplemented by on-site testing of rubber rings and pressure testing of mains as desired.

2.1 Workplace Health and Safety Considerations

Workplace health and safety (WH&S) requirements for handling asbestos have been tightened in recent years in response to community concerns regarding the health impacts of asbestos fibres. During Council's water main renewas program, significant effort was invested in developing safe work practices for the handling, testing and disposal of AC pipes.

2.2 Assessment Approach

Opportunistic condition assessment included:

- Measurement of pipe wall thickness
- Phenolphthalein testing to determine the extent of lime leaching from the pipe (to determine effective wall thickness)
- A hardness test using either a Durometer or Schmidt Hammer to determine the degree of softness of the external pipe wall
- Observation of external exposure conditions (soil and groundwater) and pipe cover
- Observation of unlined cast iron fittings in the replaced main.

Some of the procedures are illustrated in Figure 5.

Figure 5: ***Field tests and measurements***

2.3 Results of Assessments

The results of initial condition assessments revealed that:

1. While age is a factor in the deterioration of AC pipes, there is no direct correlation between age and pipe condition/ failure rate.
2. There was both internal and external deterioration of the pipes.
3. Internal deterioration was not uniform, suggesting that pipe wall composition during manufacture may have been inconsistent. Investigations also revealed possible periods of aggressive water in the pipe.
4. There was no overall consistency in results, with deterioration levels considerably different each side of the pipe fitting. This could be due to varying quality of AC mains from various suppliers, and installation by different contractors. This was evident where a tee had a bitumen-coated main on one leg, and uncoated mains on the remaining two legs. Generally, bitumen coating did not appear to reduce the rate of pipe wall deterioration.
5. Ageing unlined cast iron fittings have severe tuberculation.

Some of the images from field assessments are shown in Figure 6.

<u>Figure 6</u>: ***Images from field assessments***

Figure 7 illustrates the phenolphthalein test results, analysed to determine the effective wall thickness of tested samples.

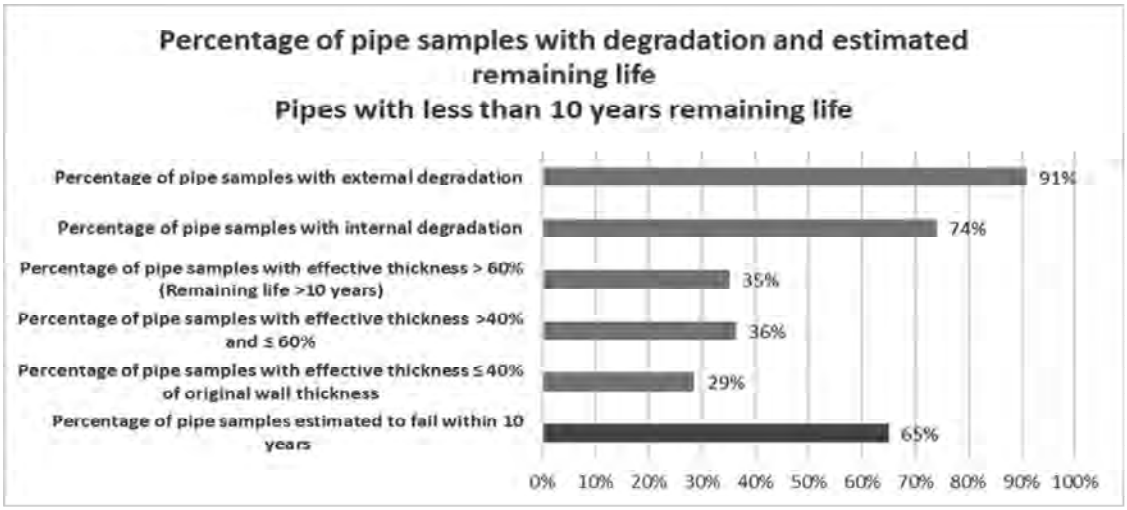


Figure 7: ***Results of effective wall thickness assessment***

A decision was made that any main unlikely to provide an additional 10 years of life would be replaced in Eagleby, and only unlined fittings such as hydrants and valves would be replaced for the rest of the mains.

2.4 Further Developments

Council is currently setting up a small facility for pressure testing water main pipe samples at the Beenleigh Wastewater Treatment Plant. This testing will assist in verifying (or otherwise) the results of the phenolphthalein testing.

Council is regularly reviewing its approach to renewals planning and delivery to ensure that it is taking an optimal approach in asset renewals.

3.0 CONCLUSION

Opportunistic condition assessments and failure analyses to date have increased Council's knowledge of the variable condition of its 900 km of AC water mains. Gaining this knowledge by 'unearthing the past' is assisting Council to make informed decisions about how to best manage ageing, buried AC mains.

4.0 ACKNOWLEDGEMENTS

The author acknowledges Logan City Council and Logan Water Infrastructure Alliance (Logan City Council, Downer, Cardno and WSP) for developing and implementing the opportunistic condition assessment process.

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BALLINA RECYCLED WATER SCHEME

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Queensland Water Industry Operations Conference and Exhibition
Logan Metro Sports Centre, Logan
6 & 7 June, 2018

BALLINA RECYCLED WATER SCHEME

Thomas Lees, *Treatment Plant Process Engineer,* Ballina Shire Council

ABSTRACT

Ballina Shire Council launched its Lennox Head Dual Urban Reticulated Recycled Water Scheme in July 2016.

This article intends to review the process leading to and following this event. Identifying the issues experienced within the first twelve months of operations and prior decisions made that contributed to the smooth implementation of the scheme.

1.0 INTRODUCTION

Lennox Head is located approximately 20km south of Byron Bay situated on New South Wale's picturesque far north coast. During the early 1980's the town received reticulated sewer with the accompanying treatment plant (plant) constructed as a twin 4,000 EP Intermittent Decant Extended Aeration (IDEA) or "Bathurst Box" design, which included an ocean outfall discharging at the low tide mark of Boulders Beach. Constant population growth meant that by the early 1990's the capacity was increased with the installation of an additional 10,000 EP IDEA with ultra-violet disinfection pre-treatment added to the original ocean outfall.

1.1 Recycled Water Inception

During Council's master planning phase of the early 2000's, expansion of the existing ocean outfall was initially identified; however due to public resistance to this proposal (Boulders Beach being a popular surfing beach) and a community priority for better environmental outcomes, Council adopted a master plan that advocated the creation of two dual urban reticulated recycled water scheme in 2003.

This master plan specified 80% water reuse within the Shire by 2026, with all future developments in Lennox Head and Ballina being built to accept dual urban reticulated recycled water as defined by the Australian Guidelines for Water Recycling (AGWR). In terms of the effects on the individual dwellings attached to the scheme, this meant that the laundry cold water washing machine tap, all toilet cisterns and all but one external taps were plumbed to the recycled water main through a separate recycled water meter.

2.0 DISCUSSION

The resulting recycled water schemes identified as part of the 2003 master plan (Ballina Recycled Water Scheme [not covered in this article] and the Lennox Head Recycled Water Scheme) were by far Ballina Shire Council's largest capital works project and at project completion the schemes will supply approximately 7,200 houses with dual urban reticulated recycled water from two discrete recycled water treatment plants (Ballina and Lennox).

2.1 Treatment Plant Configuration

To meet the water quality requirements specified by the AGRW for dual urban reticulated recycled water (Table 1), a major upgrade of the existing Lennox Head WWTP was required. These works focused on the addition of a separate recycled water process train parallel to the existing ocean outfall stream. This was an important feature of the Lennox Head Treatment Plant design; allowing the balance between plant inflow and recycled water demand to be discharged through the existing ocean outfall.

Table 1: ***AGWR log reduction values for prescribed uses***

Pathogen		Protozoa and Helminths	Viruses	Bacteria
Indicators		Cryptosporidium	Rotavirus	Campylobacter
LRV per Use	Commercial food crops	4.8	6.1	5
	Dual Reticulation	4.9	6.3	5.1
	Fire Fighting	5.1	6.5	5.3
Log Reduction Requirement		**5.1**	**6.5**	**5.3**

The Lennox Head recycled water process train design consists of an ultra-filtration module (Pall Aria™ AP6) followed by ultra-violet disinfection (Trojan UVFIT™ 18AL40) and chlorine disinfection through sodium hypochlorite addition (125kL Chlorine Contact Tank). The Plant operates at a peak instantaneous flow of 40 L/s, with the log reduction performance listed in Table 2.

Table 2: ***Claimed log reduction values for the Lennox Head Recycled Water Treatment Train***

Pathogen		Protozoa and Helminths	Viruses	Bacteria
Indicators		Cryptosporidium	Rotavirus	Campylobacter
Claimed LRV	Ultra-Filtration Module	4.0	4.0	4.0
	Ultra-Violet Disinfection	2.0	-	-
	Chlorination	-	3.0	3.0
Total Log Reduction Claimed		**6.0**	**7.0**	**7.0**
System Redundancy		*0.9*	*0.5*	*1.7*

The implementation of a Hazard Analysis Critical Control Point (HACCP) approach is suggested in the AGWR as a suitable risk management approach to ensuring continuous adherence to the required log reduction values (Table 2).

Ballina Shire Council invested significant time and effort streamlining the critical control points and parameters to determine the fewest parameters still able to ensure safe production (Table 3). This is because there needs to be a balance between;

- too few critical control parameters, the plant performance cannot be ensured, and
- too many, the process may become unreliable and prevented from operating unnecessarily.

Table 3: ***Critical Control Points, Parameters and Values for the Lennox Head Recycled Water Treatment Train***

Critical Control Point	Parameter	Critical Value	Shutdown Timer	Measurement Frequency
Ultra-Filtration Module	Turbidity	>0.15 NTU	5 seconds	Continuous
	Trans-membrane Pressure	>250 kPa	5 seconds	Continuous
Ultra-Violet Disinfection	Dose	<33.6 mJ/cm^2	30 seconds	Continuous
	Flow	>40 L/s	30 seconds	Continuous
Chlorine Contact Tank Outlet	Free Chlorine	<0.65 mg/L	1,800 seconds	Continuous

All control parameters that were identified as non-critical but still required to operate the plant were categories as quality control parameters and are listed below (Table 4).

Table 4: ***Quality Control Points, Parameters and Values for the Lennox Head Recycled Water Treatment Train***

Quality Control Point	Parameter	Quality Value	Quality Timer	Measurement Frequency
Ultra-Filtration Module	Direct Integrity Test	>7.63 kPa/5min	N/A	Daily
	Flow	>40 L/s	30 seconds	Continuous
	Temperature	>40 °C	30 seconds	Continuous
Ultra-Violet Disinfection	Transmittance	<60 %	30 seconds	Continuous
	Lamp Age	>12,000 hours	N/A	Continuous
	Lamp Failure	>2 lamps	N/A	Continuous
Chlorine Contact Tank Inlet	pH	>9 pH units	1,800 seconds	Continuous

2.2 Section 60 Application and Pre-Launch Activities

Though Council had existing Recycled Water Schemes operating (agricultural reuse and sporting fields), the higher exposure risks associated with dual urban reticulation meant a complete redevelopment of Council's accompanying systems and policies.

This included the creation of a new Recycled Water Management System in keeping with the twelve elements outlined by the AGWR, an Incident Management Plan and the implementation of an 88E Positive Covenant, requiring all new dwellings in dual reticulated areas to make plumbing provision for recycled water to be approved by Council.

Consistent with an equivalent drinking water process the AGWR supports a "risk-based framework" for managing schemes and systems. The biggest risk for any Dual Reticulated Recycled Water Schemes is the cross-connections between drinking water and recycled water, either within the reticulation or more likely within individual dwellings.

Satisfactorily managing this risk is one of the biggest ongoing operational challenges faced by operators of these schemes. Ballina Shire Council addresses this risk through several complimenting strategies consisting of:

- regulator plumbing audits (pre-occupancy certificate, every 5 years and upon sale of property),
- quarterly pressure testing of both recycled and drinking water mains in dual reticulated areas, and
- meeting Australian Drinking Water Guideline (ADWG) requirements on the recycled water.

N.B. Ballina Shire Council does not allow the use of recycled water outside of its approved uses, but instead treats the water to this level to mitigate risks associate scheme cross-connections.

Prior to launch Council also developed a communication strategy to ensure all key stakeholders were aware of the acceptable uses for dual urban reticulated recycled water. This was especially critical as at the time in far northern NSW there were no comparable schemes. This meant that required consumer behaviours were not well understood.

Council addressed this through the following methods;

- Supplying new occupants with information packs (figure 1),
- Supply of factsheets to key stakeholders,
- Development of a Ballina Water website,
- Installation of treatment plant tour signage and promotion of community group, university and local school tours, and
- Development of FAQs for front line staff

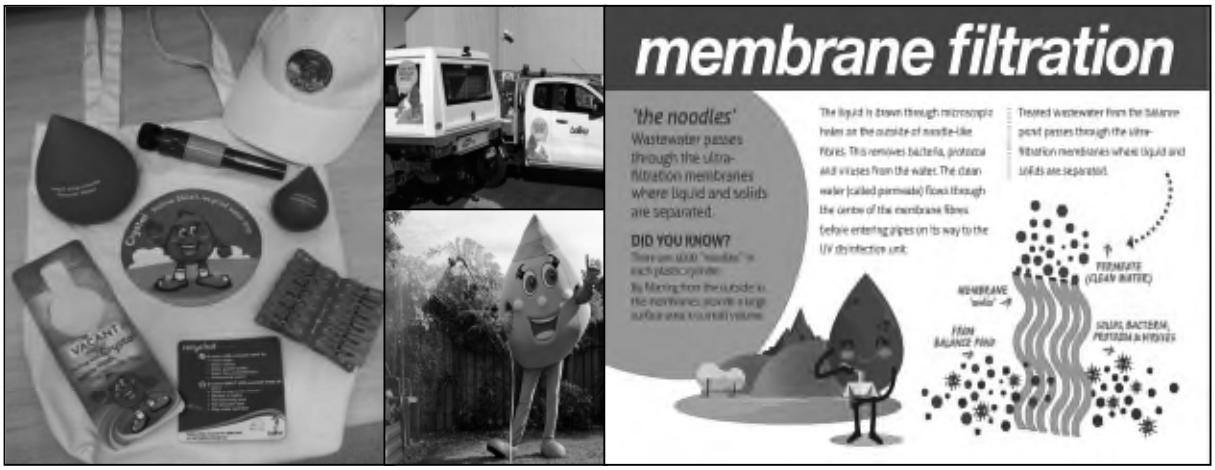

Figure 1: ***left) recycled water information pack for all new occupants, top middle) Council vehicle livery promoting recycled water, middle bottom middle) Crystal – Ballina Shire Council's recycled water mascot and right) is example of the treatment plant tour signage.***

2.3 Launch and Go Live

The commencement of supply for the scheme was scheduled for July 1 2016. This date was chosen as it nicely coincided with; a new billing quarter (recycled water is charged in Ballina Shire Council at 80% of the drinking water tariff), Section 60(c) approval and completion of all outstanding plumbing audits.

Commencement began with the removal of cross connections that had fed drinking water into recycled water mains. Barring a couple of minor issues, within a couple of days all eligible dwellings were connected to the live scheme.

2.4 Transitioning to Business as Usual

The transition from launch to business as usual operations has gone relatively smoothly. That said, there have been several water quality issues Council has been managing over the first 12 months:

Free Chlorine and Trihalomethanes (THMs); due to relatively few connections to the scheme at launch (approximately 700 dwellings or 10% final utilisation) and elevated Dissolved Organic Carbon (DOC) concentrations found in the recycled water, managing free chlorine residuals has been the biggest issue with the scheme so far.

Some parts of the reticulation currently have hydraulic retention times more than 7 days. This is contrasted with Council's self-imposed requirements to meet ADWG requirements especially the 0.25 mg/L for THMs (chlorination by-products), therefore maintaining free chlorine has been a balancing act between re-chlorination (in Reservoirs) and routine flushing (predominantly in underutilised parts of the reticulation).

Hardness; has also been another area of interest for Council. This is mostly due to the softness of the existing drinking water supply, typically 30-60 mg$CaCO_3$/L. Even though the recycled water is only moderately hard at 80-110 mg$CaCO_3$/L, the contrast is noticeable enough for some residences to complaint about white streaks left on glass. Council has managed this through promotion of hand drying rather than evaporation when using recycled water for window cleaning.

Demand Management; even though approximately 700 dwellings were connected to the scheme at launch, the clear majority of demand comes from local sporting fields, especially the East Ballina Golf Course. This means that the demand on the scheme is still very weather dependent, ranging from <50 kL/d to 2.5 ML/day depending on rainfall.

This is expected to stabilise over the coming years as more dwellings are connected to the scheme.

3.0 CONCLUSION

The first 12 months of the Lennox Head Recycled Water Scheme was a reasonably smooth transition from pre-launch to business as usual operations.

The biggest factors in this success have been down to:

- Effective management of the cross-connection risk through 88E covenant on scheme dwellings, regular plumbing audits and high water quality requirements,
- Streamlined HACCP approach allowing for only five critical control parameters, and
- Supply redundancy through drinking water top up facilities within the scheme to guarantee supply.

Issues still being managed with the scheme into the future are:

- Maintaining desired free chlorine residues within the reticulation, and
- Demand management / demand stabilisation.

4.0 ACKNOWLEDGEMENTS

To all the members of this recycled water project, weather from the very beginning to the present, as mentioned above this process has been the culmination of fifteen years of work across all departments of Council and to date has been a resounding success.

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SOLAR POWERED ELECTROCHLORINATOR AT ROUND MOUNTAIN RESERVOIR

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43rd Annual WIOA
Queensland Water Industry Operations Conference and Exhibition
Logan Metro Sports Centre, Logan
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SOLAR POWERED ELECTROCHLORINATOR AT ROUND MOUNTAIN RESERVOIR

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ABSTRACT

Solar power, battery storage and electrolysis technologies have been combined at the Round Mountain chlorinator to deliver a reliable and safe solution for water disinfection boosting at a site without sealed road access or mains power. The $3 million project was completed in December 2017 to improve water quality to one of Australia's fastest-growing local government areas.

KEY WORDS
Solar, battery, off-grid, electrolyser, hypochlorite, disinfection.

1.0 INTRODUCTION

Water is supplied to the Round Mountain Reservoir from the Mt Crosby Water Treatment Plant with chloramine as the residual disinfectant. The 20 megalitre reservoir was brought online in 2014 to provide drinking water for residents in the developing southern areas of the city. Water is retained in the network serviced by this reservoir for longer than is desirable because the population is still growing and demand is low. This results in no effective chloramine residual in the network and an increased risk to consumers from contamination events.

Water quality analysis following the reservoir's construction confirmed that over summer months there was no effective disinfectant residual across most of Logan South. An investigation considered how chorine could be boosted in the supply zone. Water age modelling results for existing and future demand scenarios indicated that dosing at the reservoir outlet would provide the most significant improvement in water quality across the zone by adding free chlorine to the network during periods of low total chlorine exiting the Round Mountain reservoir.

2.0 DISCUSSION

2.1 Site

The Round Mountain Reservoir is 3 km from the nearest development and grid power.

The access road to the site is unsealed and not suitable for trucks in wet weather. The cost for upgrading of the road to a standard suitable for tanker delivery in all weather conditions was estimated at $1.6M. The supply of mains power was estimated to cost up to $1M.

2.2 Dosing System Selection

The Logan Water Infrastructure Alliance undertook a detailed planning investigation to determine the appropriate chlorinator system technology to be installed at Round Mountain Reservoir.

Planning considered sodium hypochlorite dosing of 10 - 12% solution; electro-chlorination which involves running an electrical current through a salt brine solution to produce a low strength hypochlorite solution and use of calcium hypochlorite by spraying calcium hypochlorite briquettes to form a hypochlorite solution. Use of liquefied chlorine gas was excluded due to delivery challenges and site security constraints.

The specific options considered were:

- Option 1 – Commercial sodium hypochlorite dosing;
  - 1A – 14 days sodium hypochlorite storage & rehabilitation of access road;
  - 1B – 14 days Sodium hypochlorite storage with no road upgrade;
- Option 2 – Electro-Chlorination;
  - 2A – 14 day brine storage & rehabilitation of access road;
  - 2B – 28 days brine storage with no road upgrade;
  - 2C – 14 days brine storage with salt storage on-site;
- Option 3 – Calcium hypochlorite;
  - 14 days calcium hypochlorite storage & rehabilitation of access road.

Option 1B had the lowest capital cost however Options 2B & 2C had the best overall cost due to lower operation and maintenance costs over the adopted 10 year design life of the system. Calcium hypochlorite had the highest cost for this application. Multi-criteria assessment of the options determined that Option 2B – an electrochlorinator with 28 days brine storage was the most cost effective and reliable solution for Council for providing chlorination at Round Mountain Reservoir.

The major advantage of electrochlorination is that it removes the need to have chemical delivered to the site on a regular basis and as a result, it eliminates the requirement for Council to upgrade the access road to allow delivery trucks access during adverse weather conditions. A bonus is that it produces low strength (<1%) hypochlorite which is not classified as a hazardous material and is not subject to the high rates of chemical degradation of standard 12% sodium hypochlorite.

2.3 Hypochlorite Generation

The electrolyser unit converts brine solution into a weak (0.6% – 0.8%) solution of sodium hypochlorite and hydrogen. The electro-chlorination system consists of the following components:

- Water softener to reduce scaling of the electrolysis cells;
- Salt gantry loader to transfer 600 kg salt bags to the brine tank;
- Brine tank where salt is dissolved in softened water;
- Brine pumps to transfer brine to the electrolysis cells;
- Water chiller to reduce electrolyser temperature and improve efficiency;
- Electrolyser (including rectifier) to convert salt to sodium hypochlorite;
- Hypochlorite tank to store the produced 0.6% sodium hypochlorite solution;
- Hydrogen blower to remove the gas by-product of electrolysis;
- Gas sensor alarm to detect flammable hydrogen gas;
- Water quality analysers to control sodium hypochlorite dosing;
- Hypo dosing pumps to inject sodium hypochlorite into the reservoir outlet.

To produce 1 kg of chlorine requires approximately 3.3 kg of salt and 5.0 kWh of electrical power. Two 2.2 kg/hr Hyprolyser (electrolyser) units are installed to produce a total of 32kg of chlorine per day with the available solar power. At full production the plant will use 143 kg of salt a day (1,000 kg/week). The brine tank is sized to hold 28 days of brine. An extra 4 weeks of salt can be stored on site in 600 kg bags.

Figure 1: ***Electrolysers***

Figure 2: ***Brine tank***

2.4 Hypochlorite Dosing

Dosing pumps inject sodium hypochlorite into a carrier water line that discharges into the reservoir outlet. The dosing pumps have a capacity of 412 L/hr into a line with up to 100kPa back pressure. The dosage rate is calculated using a feed forward control loop based on the reservoir outlet total chlorine value. Downstream free chlorine is monitored to ensure that the target level is achieved. A 45 minute detention tank is used to ensure reactions have been completed before free chlorine is measured. The hypochlorite storage tank holds enough chemical to continue dosing for 5 days if the electrolysers are not available.

2.5 Power Supply

The Round Mountain reservoir site will not have mains power electricity for the ten year design life adopted for the project. All power requirements will be generated through 323 solar panels in an 87 kW solar array installed on the roof of the reservoir. Power is provided during times with no solar generation by a commercial battery with a capacity of 95 kWh. The roof of the reservoir was not originally designed to take the weight and wind load of solar panels, so careful planning of the panel layout and walkways was needed to ensure the arrangement met structural design code requirements.

The solar panel sizing will produce enough power to generate the site's daily sodium hypochlorite requirement during daylight hours, and maintain dosing through the night using battery storage. The Tesla battery storage can supply a minimum of 3 days backup power for hypochlorite dosing and instrumentation. The battery does not have sufficient capacity to operate the electrolysers. Dosing relies on the chemical storage tank when power generation is not available from the solar panels.

Due to security and vandalism concerns at the site all solar panels are mounted on the reservoir roof. The electrolysers, battery and dosing equipment are housed in a secure concrete building.

Figure 3: ***Solar array***

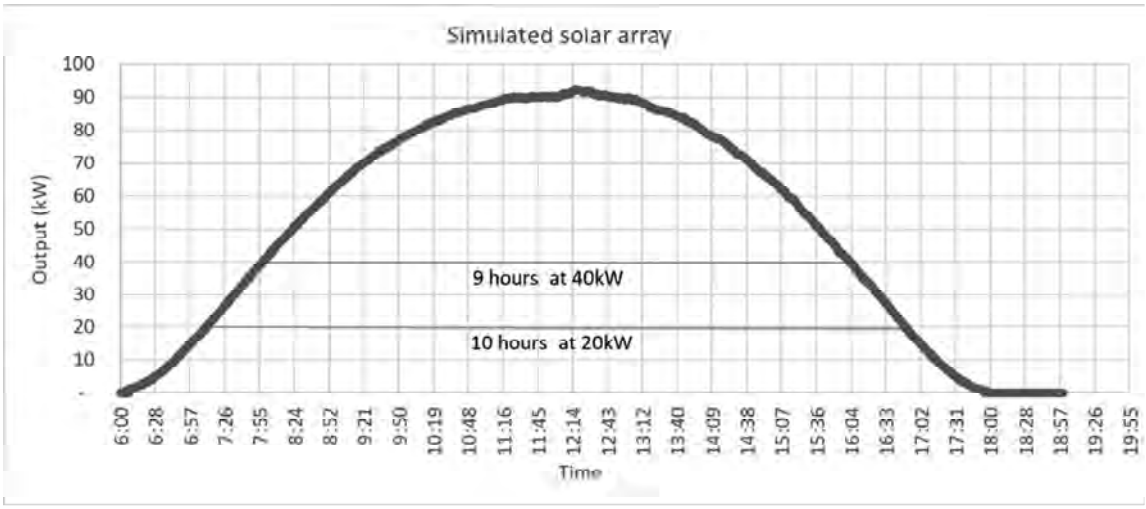

Figure 4: ***Solar array output***

2.6 Operational requirements

The Round Mountain electrochlorination facility has been in continuous operation over the last summer.

Other than some initial difficulty with chlorine analysers and a failed valve, the facility has run without problems. Operator experience to date is that:

- There has been some minor dust build up on the solar panels and they may need cleaning once a year (more often than predicted);
- The battery storage capacity is being monitored but there have been no issues with availability;
- Salt loading and unloading is straight forward and requires 30 mins per month to load bags. There have been some cases of bags being split on delivery;
- Cutter spikes in the brine tank work well to open bags. The spreader bar is essential for an even bag lift;
- Electrolysers have had a few issues with the valves crusting up making them stick requiring manual cleaning. This problem has now been rectified;
- Hypochlorite tank has been adequate with no problems other than a valve that came loose during commissioning;
- Analysers have performed well after some initial problems with cabling. Multiple inlet and outlet analysers require the operator to be mindful of which is being tested or recorded;
- Hypochlorite dosing pumps have had no issues other than the usual crust that forms around fittings;
- Waste tank is being pumped out once a week due to higher volumes than anticipated. This could be a problem in wet weather due to truck access;
- Water softeners have performed well;
- In total, operator input has been one visit per week with time on site being one hour maximum.

3.0 CONCLUSIONS

The Round Mountain Reservoir solution has provided a reliable off-grid power supply and chlorination system to maintain drinking water quality. The facility has high reliability due to the 28 days of brine storage, bagged salt storage, five days of sodium hypochlorite storage on site and battery back-up power for the dosing equipment. This solution has saved the $1.9 million capital cost of upgrading the access track to the reservoir and saves operational costs of $50,000 a year as solar power provides 100% of the energy needed to run the electro-chlorinator. The facility so far has been a low-maintenance asset which is safe to operate.

TECHNICAL COMPETENCY FRAMEWORKS AND OPERATOR CERTIFICATION

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43rd Annual WIOA
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Logan Metro Sports Centre, Logan
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TECHNICAL COMPETENCY FRAMEWORKS AND OPERATOR CERTIFICATION

Kathy Northcott, *Technical Operations Officer,* Water Industry Operators Association

ABSTRACT

In the water industry, operational staff have a direct influence on water quality and, consequently, may have an impact on environmental and public health outcomes. A water business that can demonstrate their people have the skills and knowledge to safely and competently carry out their roles in water industry operations provides assurance to regulators, communities and the users of drinking water and recycled water. That message being, staff are capable of identification and appropriate response to drinking water, wastewater and/or recycled water quality risks and incidents.

Recent major public health incidents (e.g. Flint Michigan, USA, and Havelock North, NZ), and the outcomes of subsequent investigations, have highlighted the critical importance of technical competency in the water industry. This recognition of the level of risk posed by poor management of water treatment and networks has reinvigorated interest in the development of industry licensing and certification schemes for water operations professionals worldwide.

This paper is intended to communicate examples of good practice in implementing technical competency in water industry operations. The Operator Certification Framework will be presented as an example of implementation of a technical competency framework, demonstrating approaches for planning and delivery of learning and development (L&D) programs to achieve this.

1.0 INTRODUCTION

Regardless of the specifics of role and responsibilities, technical staff in the water industry need skills and knowledge in the following areas:

- Workplace Health & Safety
- Quality & Risk Management
- Team Skills – such as Self-management, Communication & Leadership
- Technical proficiency

The scope of this paper is primarily the *Quality & Risk Management*, as well as *Technical Proficiency* requirements of water industry operations staff. Together, these two areas form the basis of a technical competency framework suitable for operational staff to manage public health and environmental risks.

The Certification Framework for Operators within Drinking Water, Wastewater and/or Recycled Water Treatment Systems (Certification Framework) provides a set of nationally consistent criteria that define and recognise minimum levels of technical competency and capability. The Framework is designed for those operators who manage the treatment of water, wastewater and/or recycled water, to ensure that the final product does not have an adverse impact on public health or the environment, and that its quality is fit for purpose and safe to use. The Certification Framework is not intended to over-ride the local regulatory requirements placed upon a Drinking Water Supplier, Wastewater Authority or Recycled Water Supplier.

Instead, Certification provides an assurance to regulators, communities and users that operators are competent to manage drinking water, wastewater and/or recycled water quality, and can identify and respond to water quality risks and incidents.

The Certification Framework introduces a minimum level of technical competency for Certified Operators across all states and territories by aligning skills, knowledge and competency requirements to national Vocational Education and Training (VET) standards. Further, the Certification Framework ensures that there is a requirement for the on-going maintenance/development of skills and knowledge.

WIOA is currently the endorsed certifying body for the Certification Framework. The Water Industry Operator Certification Scheme (Certification Scheme), which complies with the requirements of the Certification Framework, opens the door for operator certification in all Australian States and Territories. The aim of the WIOA Certification Scheme is to verify that an operator meets the minimum competency requirements certification, and is, therefore, by extension, qualified and competent to perform their role within the water industry.

2.0 IDENTIFICATION OF TECHNICAL COMPETENCY REQUIREMENTS

The first step in designing an organisational technical competency framework is identifying the roles that the framework will relate to. For each role identified there should be a position description which outlines; key responsibilities, qualifications, experience, and other relevant skills (e.g. drivers licence, first aid)

Based on each position description, it should be possible to create a list of technical roles and competency skills sets across an organisation. In broad terms water businesses will have technical roles that fit into the following categories:

- Operational – such as Catchment management, Bulk water transfer, Water/Wastewater/Recycled water treatment, Networks and Distribution.
- Maintenance (may or may not be part of operations – depending on organisational structure)
- Process engineering
- Water quality/ Process science.

Table 1 gives an example of an operator's qualifications and skills requirements. Note this table does not cover the specific OH&S training or business systems training requirements of the role.

Table 1: ***Operator technical skills requirements based on position description***

Role	Qualification/s	Technical Skills
Operator	Certificate II, III or IV in appropriate water industry operations stream from the National Water Package (NWP).	• Operation of water treatment systems, processes and/or networks • Water quality sampling and analysis • Capability to perform basic mechanical, electrical and / or instrumentation maintenance • Application of quality management systems and procedures • Using computers and process control systems

Based on the position description, and knowledge of the operational activities and processes managed, it should be possible to create a technical skills matrix specific to each operational role. The skills matrix contains the required training and competencies for an operator to carry out their duties.

For example; a drinking water operator works at plant with the following treatment processes:

- *Potassium Permanganate dosing*
- *Powdered activated carbon dosing*
- *pH and alkalinity adjustment*
- *Coagulation/flocculation*
- *Dissolved air flotation*
- *Granular media filtration*
- *Chlorine disinfection (gas)*
- *Fluoride dosing*

Using this example, a drinking water operator would be required to have technical knowledge and skills in; drinking water quality and risk management, environmental risk management, sampling and testing for water quality, operational knowledge and skills for treatment processes, and skills in calibration of equipment and instrumentation relevant to their treatment process.

Table 2 gives an example of the skills matrix for this water operator. Process specific technical competencies are mapped directly to units of competency from the National Water Training Package (NWP). Units of competency that are required to achieve certified operator status under the Certification Framework and WIOA Certification Scheme are shown in black.

3.0 ONGOING PROFESSIONAL DEVELOPMENT TO MAINTAIN SKILLS

Supporting staff to maintain professional skills and knowledge throughout their career is one of the biggest challenges businesses face. Managing a large workforce with disparate skills sets, as well as meeting any regulatory requirements for ongoing training can be expensive and time-consuming.

To address this, the WIOA Certification Scheme takes a broad-ranging and flexible approach to Continuing Professional Development (CPD) through a simple points-based recertification process, which can be implemented in a cost-effective way. The recertification points required for an operator for each period of recertification, currently set to 5 years for the Certification Framework, are specified in Table 3.

Hence CPD does not just include formal training programs or conferences. WIOA recognises a large range of L&D activities, allowing certified operators and managers to choose those options that best suit their learning styles and preferred L&D pathways. For the WIOA Certification Scheme, development activities are classified into the following categories:

- Accredited Training
- Non-Accredited Training
- Other Activities
- Significant Workplace Project
- Exceptional Activities

Table 2: ***Example skills matrix for a drinking water operator***

		Quality/Risk		Treatment Processes							
Technical Competency	**NWP Unit of Competency**	**Health & environmental risk**	**Water quality testing**	**Potassium Permanganate**	**Powdered activated carbon**	**pH and alkalinity adjustment**	**Coagulation/flocculation**	**Dissolved air flotation**	**Granular media filtration**	**Chlorine disinfection (gas)**	**Fluoride dosing**
Quality and Risk Management											
Risk management principles of the water industry	GEN001	■									
Environmental & Licensing Procedures	GEN003	■									
Management of change			On-the-job								
Sampling and testing											
Sample/test Water	GEN007		■								
Laboratory testing	GEN009		■								
Drinking water treatment											
Iron and manganese removal	TRT014			■							
Activated Carbon	TRT034				■						
Chemical dosing						On-the-job					
Coagulation/Flocculation	TRT015						■				
Dissolved Air Flotation	TRT033							■			
Granular media filtration	TRT041								■		
Chlorine (gas) disinfection	TRT013									■	
Fluoride dosing	TRT012										■
Maintenance			trade qualification or equivalent on-the-job experience								

Table 3: ***Required points accrual for recertification for different operational streams***

Classification and Complexity Rating	Required Points
DRINKING WATER - LOW	5 in 5 years
DRINKING WATER – HIGH	15 in 5 years
WASTEWATER - LOW	5 in 5 years
WASTEWATER - HIGH	15 in 5 years
RECYCLED WATER	15 in 5 years

3.1 Planning and Undertaking Professional Development

CPD should be carefully planned and managed such that the points are accumulated throughout a 5year recertification cycle. This ensures that the operator does not have a large burden of training to undertake towards the end of the cycle. Required training and development should be discussed and documented between manager and staff member during annual performance appraisals or through a process of competency assessments.

Taking your preferred L&D style into consideration is important for planning professional development. The **VAK learning styles model** suggests that most people can be divided into three preferred styles of learning, or a combination of the three styles. These are described as follows:

- **Visual** learning style - prefers seen or observed things.
- **Auditory** learning style - prefers listening.
- **Kinaesthetic** learning style - prefers physical experience.

Additionally, there are three main modes of delivery of learning. Typical preferred learning delivery modes include:

- **Formal learning** – training courses, seminars and presentations, reading technical books & journals. Ideally makes up no more than 10% of learning.
- **Coaching/Mentoring and knowledge sharing** – mentoring programs, team-based development activities. Makes up about 20% of learning
- **Work-related** – informal learning through projects and special assignments, job rotations and networking activities. Up to 70% of learning via this mode.

For example; a certified drinking water operator who works at a conventional filtration plant is required to undertake 15 points of professional development in a 5year period. The operator prefers to learn on-the-job and be more hands-on (kinaesthetic). As such, over the 5 years, in consultation with their manager and as per their annual performance plan, the operator undertakes the CPD Program outlined in Table 4.

3.2 Maintaining Records for Professional Development

Keeping track of professional development activities and points allocations can be a relatively simple process. WIOA provides a downloadable "Individual Professional Development Register" on their certification website. This is a simple excel spreadsheet where staff can record activities they have undertaken that meet the criteria for points. In addition to the professional development register, documentary evidence of activities undertaken also needs to be provided. Table 5 provides examples of suitable evidence of various activities.

4.0 CONCLUSION

Using the Certification Framework, and WIOA's Operator Certification Scheme as an example, this paper demonstrates how to develop an organisational technical competency framework for water industry operations professionals, along with a systematic process for managing ongoing professional development to maintain competency. Recognition of informal learning as a major component of L&D can also open the door for more beneficial and cost-effective learning in the workplace.

5.0 ACKNOWLEDGEMENTS

Thanks to the team at WIOA for their support in the preparation of this paper.

ANNUAL OPERATING STRATEGY – EMBEDDING DROUGHT SECURITY INTO THE BUSINESS

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43rd Annual WIOA
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ANNUAL OPERATING STRATEGY – EMBEDDING DROUGHT SECURITY INTO THE BUSINESS

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ABSTRACT

The Annual Operating Strategy was developed due to the key business drivers of optimising operation cost whilst not adversely impacting water security or water quality. The Annual Operating Strategy is now embedded into our daily business and is reviewed every six months to ensure current operations are optimised considering both cost of operation and longer-term water security and demand drivers.

Seqwater's Water Security Program or "Water for Life" document, published in March 2017, details the longer-term strategy for timing of new sources based on growth in population and demand including the overall Drought Response Plan. The Annual Operating Strategy ensures that the Drought Response Plan is followed at the start of the next drought. The Annual Operating Strategy also considers the current capability of the system and any programmed impacts due to major capital projects or maintenance activities and adapts the Drought Response Plan as required. The Annual Operating Strategy ensures that there is an ongoing emphasis on drought management outside of the crisis management phase during a drought. Essentially, it also provides opportunities to learn and improve the Drought Response Plan before it is ultimately required.

1.0 INTRODUCTION

The Annual Operating Strategy process was first developed after the Millennium drought in 2008 to provide clear direction to the multiple bulk water supply organisations on how to operate the newly created Grid. The original process was regulated, however when one water authority was created in 2013 the process was no longer regulated. The process continued as it was seen as an important enough internal document to provide direction on the operation of the Grid. The Annual Operating Strategy now has an organisation based key performance indicator, placing even more emphasis on how we follow the strategy daily.

Before the Millennium drought (Figure 1), South East Queensland was made up of over ten individually operated and independent water supplies and as a result had varying levels of drought security. By creating the Grid, South East Queensland now has the capability to move water around as the drought impacts some areas worse than others, ensuring that the combined sources are now more secure than the sum of the individual supplies. As it is relatively expensive to move water and produce additional water via desalination and recycled water, the Annual Operating Strategy provides direction on balancing the operating cost with drought security.

Seqwater is the Queensland Government statutory authority responsible for providing a safe, secure and cost-effective bulk drinking water supply for 3.1 million people across South East Queensland.

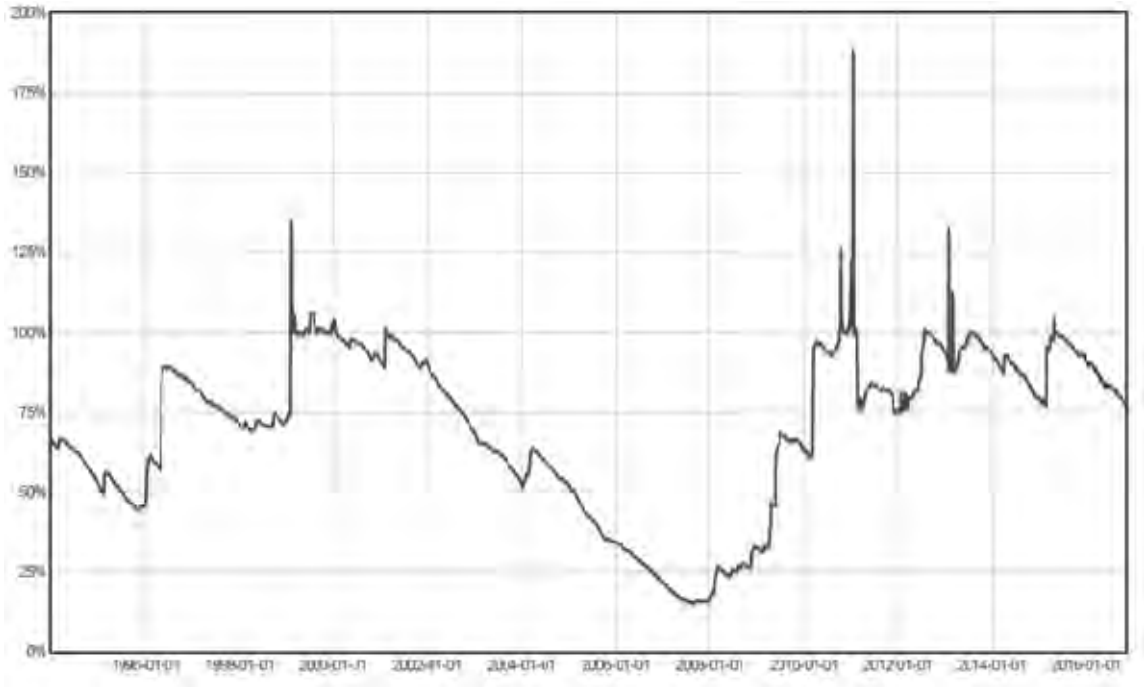

Figure 1: ***Millennium Drought – actual Wivenhoe storage levels***

Seqwater also:

- provides essential flood mitigation services
- manages catchment health and offer community recreation facilities
- provides water for irrigation to about 1,200 farmers across seven water supply schemes.

We are one of Australia's largest water businesses with the most geographically spread and diverse asset base of any capital city water authority. Our operations extend from the New South Wales border to the base of the Toowoomba ranges and north to Gympie.

We manage up to $12 billion of water supply assets - including the SEQ Water Grid - and the natural catchments of the region's major water supply sources. This includes dams, weirs, conventional water treatment plants and climate resilient sources of water through the Gold Coast Desalination Plant and the Western Corridor Recycled Water Scheme. A 600 kilometre reverse flow pipeline network enables drinking water to be transported around the region, from the Sunshine Coast to Greater Brisbane, to Redlands and south to the Gold Coast.

Seqwater also manages recreation facilities at our dams, lakes and parks that provide more than 50% of the green space in SEQ outside of national parks.

Seqwater was formed on 1 January 2013, through a merger of three State-owned water businesses, the SEQ Water Grid Manager, LinkWater and the former Seqwater. We also assumed some responsibilities undertaken by the former Queensland Water Commission, such as the long-term planning of the region's future water needs.

The Annual Operating Strategy informs how we currently operate the bulk water supply system in a cost-efficient way whilst following and if need be adapting the Drought Response Plan as per the longer-term Water Security Program.

The Annual Operating Strategy is a one to five-year operation document that considers current operation limitations due to planned maintenance or capital works, current storage levels and demands, projected storage levels and probability and timing of drought response actions.

2.0 DISCUSSION

The current Drought Response Strategy can be best summarised with Figure 2, which demonstrates that whilst the storages are full, use of surface water is maximised to drawdown the storages and providing opportunity to catch and store rainfall events. At 60% manufactured water sources are maximised and demand management formally commences.

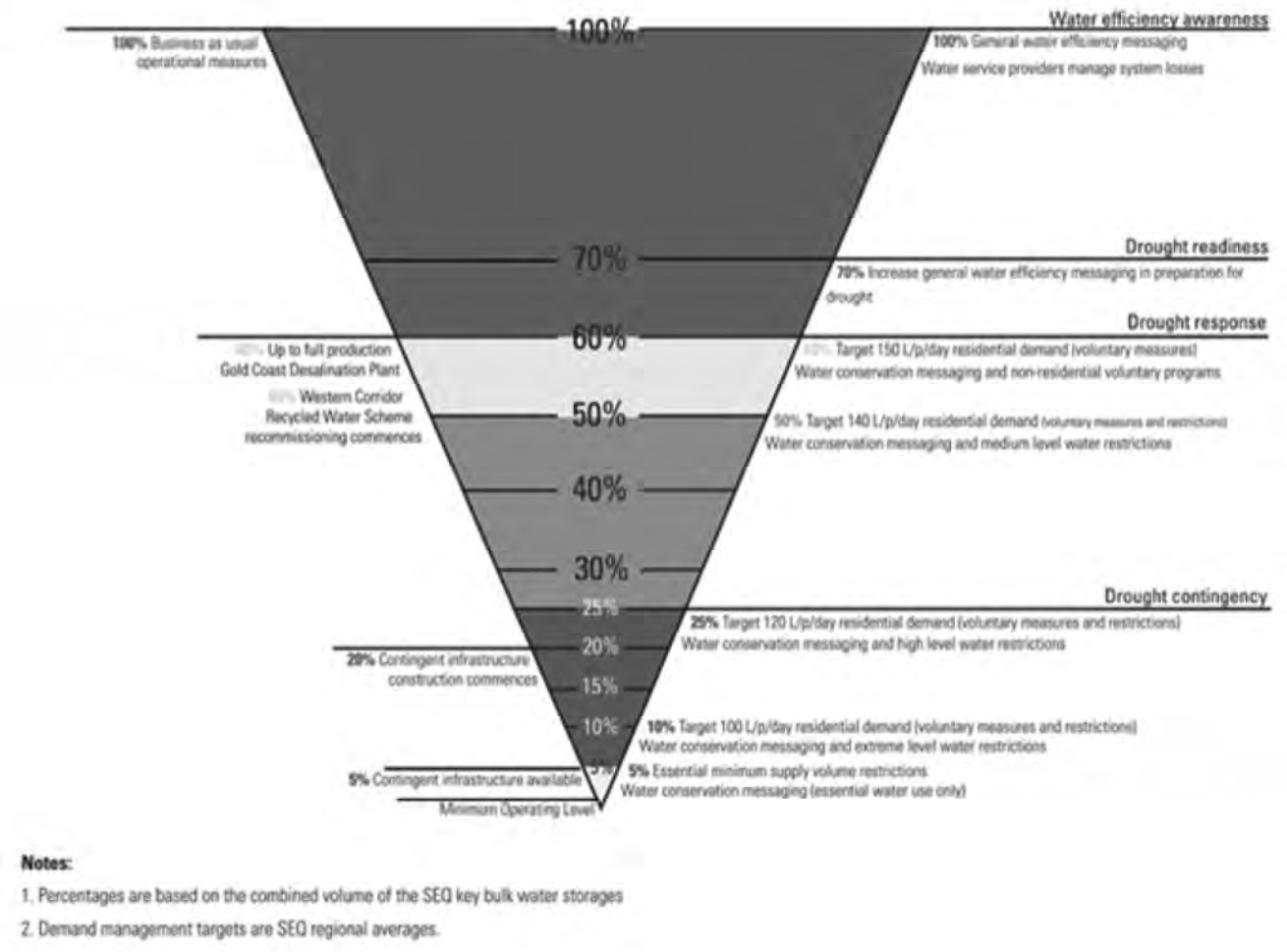

Figure 2: ***South East Queensland adaptive drought response approach***

Seqwater is no longer planning for Historic No Failure Yield and as such we are now planning for droughts far worse than the Millennium drought. Figure 3 demonstrates how the Grid would perform today with today's demands and current Drought Response Strategy. The lowest storage level of 40% compared to 15% during the actual Millennium drought demonstrates the influence of lower demands whilst the Grid resolves local supply issues.

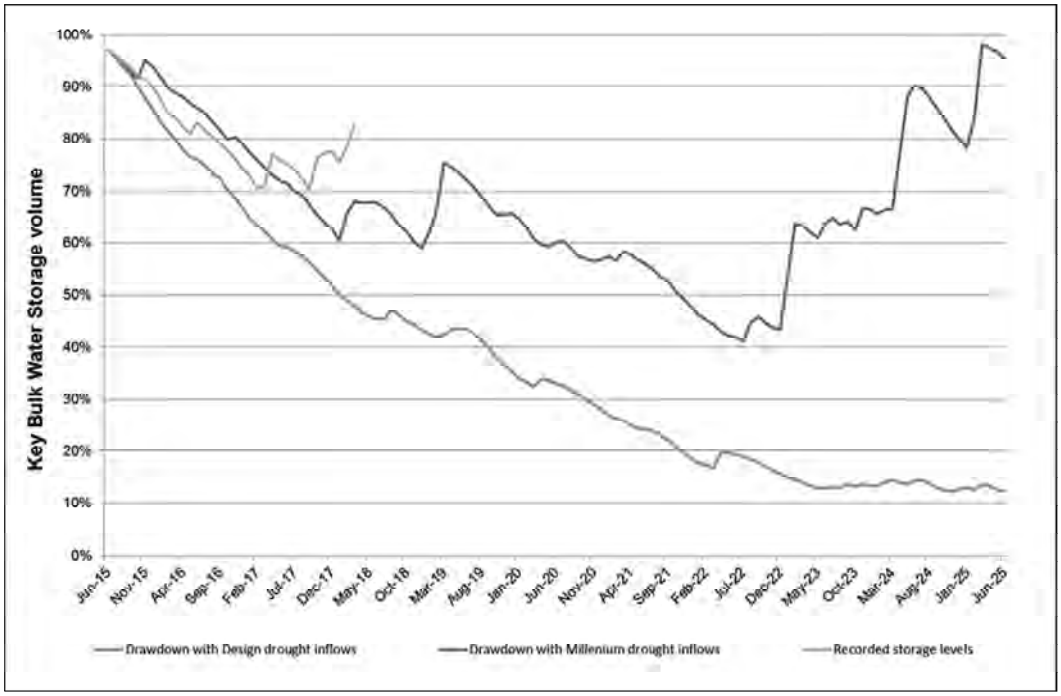

Figure 3: ***KBWS drawdown curves (May 2015-2017)***

Figure 3 shows three droughts or climate/inflow sequences with current demands. The first drought is a repeat of the Millennium drought resulting in a minimum storage level of 40%, whilst the Design drought (being the worse ten droughts in our stochastical data set) results in a minimum storage level of 12%. The third drought is the current undeclared drought and is tracking the actual storage drawdown. The current drought appears to be over and the storages are recovering, however in the first eighteen months the three droughts are indistinguishable and raises the important issue that you do not know how severe the drought is until it is over and they all start the same way.

2.1 Methodology/Process

Using a stochastic climate data set, the Regional Stochastic Model is used to determine the earliest possible dates for drought response actions including probabilities. Current storage levels are also tracked against the Design drought and Millennium drought as Seqwater now prepares for droughts worse than the worst recorded historic drought.

Planned maintenance and capital works are assessed with regards to programming and risk to drought security. These works may require earlier drought response action to mitigate risk, acceptance of risk or delaying work depending on the current drought situation. These works are then included in water production and transport estimates.

Water production and transport estimates are provided based on current demands for annual budgeting purposes for a continued drought scenario and a normal (storage full) scenario to assess the possible range of operating cost.

The Annual Operating Strategy is then used at least monthly to make operational decisions based on actual demands and system capability. Due to minimum flow requirements in pipelines and mechanical breakdowns, it is not always possible to follow the strategy exactly, however the strategic philosophy is considered and adapted to maximise drought security whilst minimising cost.

Annual Operating Strategy forms an organisational Key Performance Indicator and is reported to Seqwater's executive management and Board monthly.

2.2 Results/Outcomes

Every six months a document is prepared including earliest possible dates for drought response triggers including probability of occurring in the next year and five-year periods and exceedance curves of major storages and projected drawdown curves based on the Millennium and Design droughts.

Figure 4 is an example of the exceedance curves from the May 2017 Annual Operating Strategy for the KBWS. These are not drawdown curves, these curves summarise the results of 10,000 model runs from wet to extremely dry and the 99.99%ile curve shows the lowest level on that date from any of the 10,000 runs being 10% minimum storage level, whilst the 50% curve shows the level where 50% of the runs had a higher storage level than that shown on that date resulting in a mean storage level of 80-90%. The 99%ile curve could be considered close to a 1 in 100 year probability whilst the 99.9%ile curve would be considered close to a 1 in 1,000 year probability and the 99.99%ile is simply the worse drought from 10,000 runs and could be considered an outlier and extremely unlikely, however this drought is considered possible and as such we need to be prepared and ready to manage the water supply during such an event.

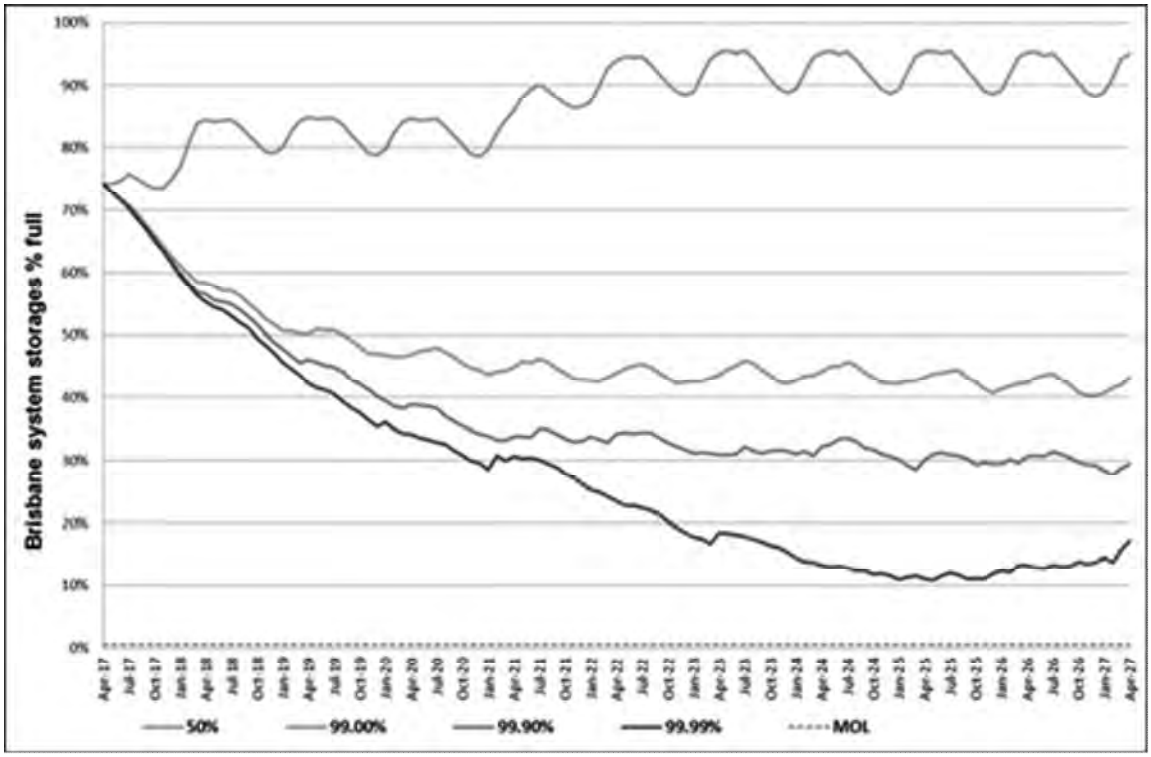

Figure 4: ***KBWS exceedance curves (May 2017)***

3.0 CONCLUSION

Seqwater is now more prepared for drought than ever and is constantly improving our knowledge of the supply system, operational impacts and consequences due to the Annual Operating Strategy process.

4.0 ACKNOWLEDGEMENTS

Wendy Auton for completing the modelling and Dimity Lynas for demand management advice; together as a team we created the Detailed Drought Implementation Plan.

5.0 REFERENCES

Water for Life – South East Queensland's Water Security Program
http://www.seqwater.com.au/sites/default/files/PDF%20Documents/Water%20Security%20Program%20-%20Regulated%20Document%20-%20WEB%20version%20with%20clickable%20links.pdf

Seqwater – Latest dam levels
http://www.seqwater.com.au/water-supply/dam-levels