WATER WORKS

OFFICIAL JOURNAL OF THE WATER INDUSTRY OPERATORS ASSOCIATION

DECEMBER 2007

POLYETHYLENE
METRIC PRESSURE PIPE

STANDARD

Polyethylene Metric Pressure Pipe is manufactured in accordance with AS/NZS4130:2003 "Polyethylene (PE) pipe for pressure applications". Furthermore PPI's pipe has WaterMark Product Certification which entails an independent audit of material selection, production and testing. It signifies an added commitment to quality and is required by all plumbing and water authorities. WaterMark branding is standard on blue or blue stripe pipe.

MATERIAL

The basic polyethylene (PE) material classifications used for pressure pipes are PE80 and PE100. The number classification refers to the strength of the material with PE100 being stronger than PE80. Pipe made from PE100 can withstand a greater pressure than pipe with the same diameter and wall thickness made from PE80 material.

PE100 was first introduced into larger diameters but it is now being adopted as the standard material for all PPI's Metric Pressure Pipe. This change is inline with worldwide trends and it ensures that our customers are able to take advantage of the latest developments in plastics.

PIPE LIFE

The 50-year stress regression data used for classifying PE pipe material has incorrectly lead to the assumption that PE pipe systems have a life expectancy of 50 years. In reality, such systems can reasonably be expected to last much longer than 50 years. Systems that are manufactured and installed correctly can be reasonably expected to last in excess of 100 years before requiring rehabilitation. However a firm prediction can not be made, as there are many unforseeable factors operating in each system.

PRESSURE RATING & SDR

The pressure rating (PN) is quoted at a temperature of 20°C for the conveyance of water. It provides a base guide to the pipes performance but it needs to be adjusted for other fluids and temperatures.

The Standard Dimension Ratio (SDR) is the nominal ratio of the pipe's outside diameter to its wall thickness.

i.e. $SDR = \frac{\text{min. outside diameter}}{\text{min. wall thickness}}$

The higher the SDR, the thinner the pipe and the lower the pressure rating. The term SDR is more widely accepted by engineers as it accurately represents the pipe dimensions and allows the pressure rating to be determined after assessing the installation's conditions.

Conversion Table		
PN3.2	320kPa	46psi
PN4	400kPa	58psi
PN6.3	630kPa	91psi
PN8	800kPa	116psi
PN10	1000kPa	145psi
PN12.5	1250kPa	181psi
PN16	1600kPa	232psi
PN20	2000kPa	290psi
PN25	2500kPa	363psi

Pressure Conversions		
multiply →		
MPa	1000	kPa
Bar	100	kPa
Metre Head	10	kPa
psi	6.9	kPa
		← *divide*

Example:	
Pressure ratings for PE100 50mm PN12.5 SDR13.6	
Water at 20°C	1,250kPa
Water at 40°C	920kPa
Compressed air at 40°	640kPa

	SDR 41	SDR 33	SDR 26	SDR 21	SDR 17	SDR 13.6	SDR 11	SDR 9	SDR 7.4
PE80	PN 3.2	PN 4	–	PN 6.3	PN 8	PN 10	PN 12.5	PN 16	PN 20
PE100	PN 4	–	PN 6.3	PN 8	PN 10	PN 12.5	PN 16	PN 20	PN 25

PIPE COLOURS

PE80 Blue	Water or compressed air
PE100 Blue	Water or compressed air
Purple	Recycled/Reclaimed Water
Grey	Sewer
Red	Fire Services
PE80 Yellow	Gas
PE100 Yellow	Gas
White	Communications
Orange	Electrical

CAPABILITIES

Diameters:	16mm to 500mm
SDR:	41 to 7.4
Material:	PE100 Standard
Colours:	Available in a combination of solid, stripe or jacket – enquire with order

PPI has always shown a willingness to help develop pipes to suit individual projects, so please contact our sales office to discuss your special requirements. Our extra capability includes other PE or PP materials, custom sizing and special colours, jackets and stripes.

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WaterWorks welcomes the submission of articles relating to any operations area associated with the water industry. Articles can include brief accounts of one-off experiences or longer articles describing detailed studies or events. These can be emailed to a member of the editorial committee or mailed to the above address in handwritten, typed or printed form. Longer articles may need to be copied to CD and mailed also.experiences or longer articles describing detailed studies or events. These can be emailed to a member of the editorial committee or mailed to the above address in handwritten, typed or printed form. Longer articles may need to be copied to CD and mailed also.

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THE AUSTRALIAN WATER INDUSTRY - 'THE OTHER CRISIS'

Peter Mosse and George Wall

The shortage of water in this country, at this time, is clearly the major crisis facing the water industry. There is however a second crisis. This crisis relates to the ability of water supply systems in this country to deliver safe drinking water 100% of the time and the ability to ensure this into the future. The consequences of this crisis are worsened by the impending implementation of indirect potable reuse schemes.

Operation

Treatment plant operators are often the last line of defence in the protection of public from waterborne disease. Errors can place thousands of people at risk as has been amply demonstrated in Walkerton (Canada) and Milwaukee (USA).

In Australia at present:

- There is no minimum standard for the operation of treatment plants and there is no minimum educational or training standard required for operators
- There is essentially no minimum standard for the quality of water produced from a water treatment plant. There is certainly no minimum standard for the production of safe drinking water (The ADWG are guidelines not regulations and do not appear to have been widely adopted or used).
- There is no recognition of the need for both training **and** experience and the progressive acquisition of functional knowledge in the appointment and matching of operators to treatment plants. In many cases, water businesses with a vacancy appoint whomever they think best for the job regardless of their level of training or competency. Human society in many areas recognises the progression of responsibility and expectations. A recently qualified pilot with a qualification to fly a single engine Cessna does not fly a jumbo jet – why shouldn't this be extended to the water industry? There are similar deficiencies in the area of distribution system and wastewater treatment plant management as well.
- There is no recognition of the need for ongoing formal refresher training for technical skills. This begs the question of the duration of competency. In the face of changing technology, and changing expectations, water supply operations teams must ensure currency of knowledge and skills. This principal is well established in our society from first aid training, life saving and airline pilots to name just a few professions with responsibility for some aspect of consumer safety.
- Modern businesses including water utilities are experiencing rapid rates of staff turnover. This has been exacerbated recently in the technical areas with technical staff being tempted by the high salaries offered by the mining and other industries. Finding suitably qualified replacements is often very difficult leading to the tendency to train "on the job". This is not compatible with the production of safe drinking water 100% of the time. The rate of remuneration for water industry operators in most cases is not commensurate with their level of responsibility, training, skills or expertise which is also adding to the staff turnover problem.

Training

Education and training are the cornerstones of maintaining a modern society. Training needs to be matched to the specific disciplines and to provide continuity into the future. The water industry faces limitations for both current and future operations.

Our Cover: A montage of photos from various WIOA events held around the country.

WIOA's 2008 EVENTS

- **2nd Annual WIOA NSW Water Industry Engineers & Operators Conference** – 8-10 April 2008 at the Newcastle Jockey Club, Newcastle
- **33rd Qld Water Industry Operations Workshop** – 3-5 June 2008 at the Carrara Indoor Sports Stadium, Gold Coast
- **71st Annual Victorian Water Industry Engineers & Operators Conference** – 2-4 September 2008 at the Exhibition Centre, Bendigo

In Australia at present:

- The mediocre performance a number of Registered Training Organisations (RTOs) has raised a number of issues:
  - RTOs with the Water Industry Training Package are audited against a set of nationally agreed standards the - Australian Quality Training Framework (AQTF). The role of these auditors is to confirm that RTO's are complying with the requirements of the AQTF including Standards 7 and 8 covering the competence of RTO staff and RTO assessments. Competency assessment under the AQTF requires assessors with the necessary knowledge and experience to assess the skills, or assessment to be undertaken in conjunction with an industry expert.
  - Anecdotally it appears that the audit process does not effectively determine if the RTO employs trainers who have demonstrable knowledge, skills and expertise in the areas of the water industry they train in. There is a need for the audit to be conducted in conjunction with an industry expert, designed to assess individuals who have completed training with the RTO to determine that they have met the assessment criteria of the Training Package.
  - Accounts abound of staff from RTO's turning up at water businesses to assess competencies or run courses with limited knowledge or experience in the subject in question. Often they have to first obtain the necessary knowledge from operations staff within the utility.
  - Accounts abound of staff from water utilities undertaking a Recognition of Prior Learning or Recognition of Current Competence process with some RTO's where provided the staff member can answer some relatively simple questions, they are ticked off as competent for units as high as Certificate III level. This is often based on time in the job alone.
- Un-nesting of units within the Water Package, particularly at Certificate II and III levels (removal of the need to demonstrate all the knowledge required at lower levels before embarking on a higher level qualification) is also likely to be problematic for two reasons.
  - Un-nesting should require RTO's to modify their existing training programs to ensure that students have the knowledge and skills to complete the more specialised training at the higher levels by building in the lower level competencies into each training unit, but there are no guarantees that every RTO will do this. This is particularly relevant to technically oriented training which requires a clear progression of the acquisition of knowledge. These changes at a time when the complexity of the industry and the expectations of public and regulators require increased operational skills, are a cause for major concern.
  - The number of units required to complete a Certificate II & III has reduced from 22 under NWP 01 to 19 under NWP 07 but can be as few as 11 units if direct entry to Certificate III is approved. Under NWP 07, individual RTO's can decide at what level a trainee can enter, and therefore how many units they must complete to achieve a qualification. There is no doubt that in efforts to save training dollars, some water businesses will "strongly encourage" RTO's to do only the minimum amount of training to achieve a Certificate.
- Competency assessment criteria are often generic rather than specific and open to a wide range of interpretation according to the experience and motivation of the assessor.
- Within the training package there is scope for individuals to achieve any Certificate level without necessarily combining an appropriate group of units. For example it is possible for a Water Treatment Plant operator to achieve certificate III qualification without having completed any of the key units such as filtration or disinfection or coagulation/flocculation. To successfully employ or train a person appropriate for a job role now requires the Human Resources staff within water authorities to have a high level of understanding of the content of units within the Water Training package and the type of processes the person would be expected to operate. In many authorities, HR staff do not have this expertise. The inclusion of tightly controlled "streamed qualifications" which identify areas of expertise and which specify units to be completed could help eliminate some of this confusion.
- A Level III certification does not necessarily qualify an individual to operate a treatment plant.
- The completion of Certificate III should be the minimum aim for all staff who operate a water or wastewater treatment plant. Importantly though, employers need to recognise that the completion of the Certificate should not be the trigger that ends all technical training.
- Although it is being addressed by Government Skills Australia (GSA) at present, the Certificate IV units in NWP 07 predominately concentrate on front line management. The range of units does not provide adequate scope for persons wishing to complete a technically focussed qualification suitable for high level plant operation or to provide technical specialist support staff to help optimise and trouble shoot plants.

Reporting

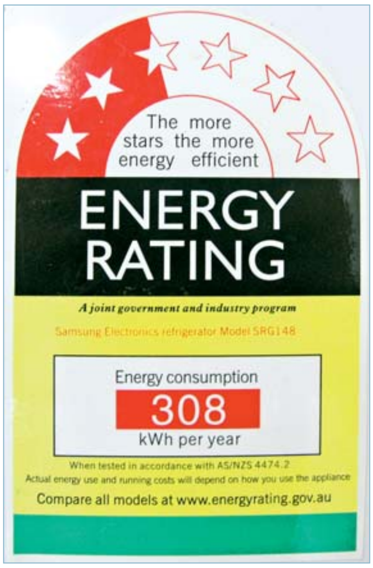
The provision of safe drinking water and adequate wastewater treatment is of such importance to modern society that reporting of performance for external scrutiny is essential. Such expectations are well established in the financial sector. Pathogens are the major risk in the provision of safe water to consumers, reporting requirements need to reflect this knowledge.

In Australia at present:

- There is no requirement to report meaningful safe drinking water measures to regulators on the production of safe drinking water. Recording a value of zero (0) *E coli* is no longer suitable as a stand alone indicator. At a minimum reporting of individual filter performance and disinfection performance is required.

Plant Registration or Classification

Treatment effort needs to be proportional to the risk and to the sensitivity of a community receiving the water. Systems drawing water from high risk catchments with a high probability of pathogen contamination and/or with a large community with highly sensitive industry, health or tourist requirements require a higher level of plant capability and higher operational skills. The plant risk classification therefore needs to be matched with a treatment plant suitable to mitigate the risk. The operator skills set required must then meet the complexity and sophistication of the plant itself.



In Australia at present:

- There is no requirement for classification or registration of treatment plants.
- There is no formal recognition of the need for plants capability and operational skills to match the overall risk profile.

This type of system already exists in countries such as the USA, Canada and New Zealand. Sadly, Australia is lagging well behind in this regard.

What We Need!

A national program for the production of safe drinking water is required. This program needs to recognise the need for, and integrate, a classification and registration system for treatment plants, minimum standards of operation and required levels of operation according to the classification level of the plant and formal requirements for appropriate reporting.

More specifically:

- Treatment plant risk and sensitivity profiles need to be assessed and a plant classification established.
- Treatment plant competency requirements need to be assessed and registered. This could be on a rating system similar to restaurants, motels and electrical appliances.
- Minimum levels of operator qualifications and experience needs to be linked to the risk/sensitivity assessment of the plant. A high risk/high sensitivity plant would require a higher operational skills and experience set than a lower risk/lower sensitivity plant.
- A career path with entry from school, university or TAFE needs to be further developed and promoted in conjunction with GSA and the water industry.
- Training courses need to be expanded and controlled to ensure that the skills sets identified above can be achieved by entry from multiple levels (e.g. school leavers, water industry employees, university graduates.)
- Specific training course curricula need to be established.
- Competencies need to be specific rather than generic.
- A higher level technical specialist strand (possibly within the developing Certificate IV or Diploma level) needs to be developed to provide the higher level skills sets necessary for the operation of high risk/high sensitivity plants and the provision of specialist technical support within the industry. The stream would also provide a high level technical career path within the operations sector of the water industry. To achieve this, significant funds need to be injected into resource material development.
- Reporting is required against the two key barriers for the control of pathogens in conventional water treatment, media filtration and disinfection. Chlorine disinfection (practiced at the vast majority of Australian plants) is only effective against bacteria and most viruses. Media filtration is the only barrier to protozoan pathogens. Reporting needs to be able to demonstrate that these barriers are consistently applied.

We realise there are a significant and diverse range of ideas and issues raised within this article. We contend that unless the water industry nationally recognises these issues, understands the potential risks of ongoing inaction and works proactively to address them, the time bomb that is a major water quality incident with potentially serious health implications and possibly even deaths is imminent. Is it going to be your part of the country where an incident occurs? We hope not.

We welcome any comments, ideas, suggestions or feedback on how we can further progress our goal to improve the performance of all operational aspects of the Australian water industry. (You can contact us on info@wioa.org.au).

MITTAGONG UPGRADE AND COMMISSIONING

Chris Carlon and Dave Cochrane

Awarded the Actizyme Prize for the Best Paper by an Operator at the 2007 WIOA NSW Engineers and Operators Conference

Background

Wingecarribee Shire is situated in the Southern Highlands of NSW, approximately 120km south west of Sydney. The Shire is situated in the middle of the Sydney Catchment Area and we were under immense pressure to upgrade our systems to ensure the protection of Sydney's water supply. The Shire has five sewerage plants located at Bundanoon, Berrima, Moss Vale, Bowral and Mittagong and seventy pump stations delivering sewage to these plants.

The Mittagong upgrade was long overdue as pollution from aging septic systems in the northern villages and the inadequacies of the existing plant were having a negative effect on receiving waterways and ultimately Warragamba Dam which provides drinking water to Sydney. The upgraded system needed to be capable of handling wet weather flows, extended power outages and equipment breakdowns with no reduction in effluent quality. For this reason all new pump stations were supplied with 8 hours ADWF storage as well as dual control systems and dual electric power supplies. The treatment plant was supplied with dual power supplies, a wet weather storage pond and was hydraulically sized to treat flows that far exceeded its design capacity.

It was also a requirement that discharge to the environment continue to occur in the same location as previously to prevent any degradation of previously untouched river systems closer to the plant. This involved the construction of a treated effluent transfer main to pump effluent 6.4km from the new treatment plant site to our old effluent outfall at Iron Mines Creek. As this main passed through the Mittagong Golf Course, Council had the option of reusing the treated effluent. We are currently reducing our effluent loadings to the river by using approximately 20% of our effluent in plant operations and in an irrigation system at the golf course.

Alum & Lime Dosing at the Mittagong STP.

Table 1. EPA Licence requirements for the effluent.

Pollutant	Units of Measure	50 percentile concentration limit	90 percentile concentration limit	100 percentile concentration limit
Ammonia	mg/L	1	2	
Oil & Grease	mg/L	-	10	
pH	pH	-		6.5-8.5
Nitrogen (total)	mg/L	7	10	
Phosphorus (total)	mg/L	0.2	0.3	
Faecal Coliforms	mg/L		200	
Total suspended solids	mg/L	10	15	
Biochemical oxygen demand	mg/L	7	10	

The EPA requirements for the system are shown Table 1.

Lessons and Experiences

As with all large projects the commissioning of the new scheme provided the team with a number of hurdles and many valuable lessons were learnt which should be considered in future projects.

Odour Complaints

Odour complaints are not uncommon during the commissioning of new sewerage systems. We tried many different ways to address these issues with varying results. We lowered pump cut off levels and rebenched the bottom of some wet wells so they would be kept cleaner. We dosed chemical into some wet wells both manually and through permanent dosing systems and used odour caps on vent stacks. A very regular pump station cleaning routine was included in our maintenance schedule.

Many complaints were received early in the morning from the rising main which was fed from the main pump station in Mittagong. This main went through the centre of an exclusive residential area so the Member of Parliament for our area was quickly involved. Insufficient flows in the early stages were identified as the main cause of the odour problems. The effluent main from the new plant passed close by this pump station so we thought if we could recirculate some of the effluent through that pump station as a short term solution it would solve our immediate problem. We made changes to the PLC program at the plant so the effluent pump station started at midnight and installed a pipe from the effluent main to the pump station recirculating about 10% of our effluent and making the pump station run more regularly in the early hours. This arrangement solved the problem until the pump station reached its design load.

Delivery System and Inlet Works

All sewage is delivered to the plant through the main pump station at 385 kL/hour for occasional three minute bursts. This intermittent flow has a detrimental effect on the treatment process. It results in a drop in the efficiency of the rag removal systems and the operation of the anoxic zone. It provides the plant with spasmodic flows which make it harder to operate the plant and causes short circuiting. This means operators must be more vigilant with their monitoring and sampling. It

Wet weather storage at the STP.

affects plant stability. Short circuiting is a major problem in our plant considering that we have such a stringent licence. It is particularly bad in the cold Highlands Winters. Our operators are experienced in analysing when the plant is short circuiting and quite often ignore high ammonia results knowing they are not caused by the need for more air, but by short circuiting in peak flow periods. When these results occur they dilute in our catch pond and have minimal affect on our effluent. Not being aware of short circuiting leads to over aeration.

Council is currently investigating the installation of VSDs for the pumps at the main pump station, both to save power costs and to provide a more consistent, controlled delivery of sewage to the plant. Another option is to install a smaller pump for normal flows and only use the bigger pumps in periods of wet weather. Basically you are using the main pump station as a balance tank for the plant which would have a positive effect on the process and minimize short circuiting. To eliminate short circuiting altogether we have asked that automatic penstocks be installed into the inlet works at the divider boxes so as the IDALS can only be fed during aeration. This would eliminate short circuiting completely.

Not That Lime System

When the plant was first handed over to Council, it was expected that substantial biological p removal could be achieved. It was for this reason that a sophisticated lime plant had been constructed to allow for the chemical removal of p from the supernatant return of the drying beds and sludge lagoons. The designers expected with biological p removal that levels of p in the supernatant would have a detrimental effect on the process if delivered back to the head of the works untreated. This would have been the case if a good level of biological p removal was achieved.

Unfortunately the method of delivering the sewage to the plant is not conducive to standard treatment let alone biological p removal. There was no truly anaerobic zone or temperature control at the inlet works as needed. Apart from the limited seasonal success which we achieve at all our plants, biological removal of p has essentially not been achieved.

After carrying out analysis on the supernatant we found that p levels were consistently low as the alum we were dosing kept it chemically bound. This left us with a complex p removal plant with limited use. It seemed senseless to be using power and having to maintain up to 15 machines just to add alkalinity to our IDALS. Not only this, but the very material you were trying to dose to the system would end up settling out in the clarifier and become just another sludge you would have to dry and dispose of. An excessive amount of lime was being used just to maintain alkalinity. The system became a constant burden with continual blockages and breakdowns and the use of it could not be justified.

At present Council operators are manually adding lime to the system. We are currently investigating the installation of a more simplified lime dosing system or a caustic dosing system. We are swinging towards lime as it is a safer chemical, just as effective and the cost savings over the plant lifetime will be significant. In relation to the lime dosing system the plant was very well constructed but not designed for purpose.

Nutrient Removal Issues

The problems already mentioned combined with the fact that we have a very stringent licence, made achieving licence limits consistently very difficult. The short circuiting problem, even after allowing for operator awareness, at times results in over

Looking over the IDAL.

aeration which results in a drop in alkalinity. We dose alum to ensure we meet our required p limits which once again compounds our alkalinity problems. Operators must have a proper understanding of chemical dosing in this situation. Alum dosing is exponential, meaning it takes significantly more alum to drop p from 0.4 to 0.2 than it does from 1 to 0.8mg/L. Also once alkalinity drops, pH problems occur and the alum become less effective resulting in a rise in p. In this case an inexperienced operator will increase the alum dose and compound the problem. Quite often when there is a rise in p we have to add lime and decrease alum as the problem is due to low pH, not insufficient alum. At the plant we have pre-dose and post-dose systems for alum. The post dosing seems to be relatively ineffective forcing us to reduce p level down as low as 0.3mg/L in our IDALS. I think the post-dose is ineffective due to pH problems and lack of mixing. This makes us dose more alum into the IDALS than we would like. Also because the biomass needs p to work we have to ensure we don't strip the p out totally.

Dosing alum also enhances settling which is normally helpful. Unfortunately, when sludge starts to settle too quickly it affects denitrification which once again compounds alkalinity problems. This happens because a quick settling sludge is not in contact with the nitrate loaded liquor long enough to achieve denitrification. The alkalinity return which occurs during denitrification does not happen. This can lead an operator to think

UV Filters.

he is over aerating when he actually may not be. The way we addressed this problem was to continue returning activated sludge to the anoxic zone well into the settling phase to create some mixing so the biomass has time to denitrify before settling.

As you can see, a lot of the above actions lead to a reduction in alkalinity and if operators make the wrong decisions, serious damage to a healthy biomass can occur. Remembering the fact that our plant has no proper method of adding alkalinity apart from manually dosing of lime, you can imagine the problems we face. A proper chemical dosing system which could deliver alkalinity consistently during the aeration phase is what is required to achieve plant stability. The line is very thin and very close process monitoring is required to achieve good results. All our operators have had extra training in chemical dosing.

Sumps in Tanks and Ponds

One simple thing which seems to get overlooked in plant upgrades is the provision of sumps in tanks and ponds. We were supplied with a series of flat bottom tanks and ponds throughout the plant which eventually, either for cleaning or repair purposes will need to be emptied. These include the anoxic zone tanks, average dry weather balance tank, catch pond and sludge lagoons. Totally emptying a pond or tank becomes difficult when there is no sump.

At the commissioning stage of the plant we immediately saw the importance of a cleaning system for the catch pond. We knew we had no chance of meeting our licence unless this pond was kept clean. We insisted that a sump and pump including access walkways and associated pipe work to deliver sludge to the head of the plant be installed straight away. This included a lifting device for retrieving the pump for maintenance and repair. An extension of the effluent re-use system to enable us to hose the catch pond out was also necessary.

When we first started using the new cleaning system we would walk down the sides of the pond to gain access for hosing. As the pond was heavily sloped and rubber lined it was very slippery particularly when wet. On doing a risk assessment immediate rectification of this hazard was necessary. We investigated the use of different footwear, as well as the installation of a non-slip surface. We eventually concluded that a combination of both was needed. We painted the liner with a non-slip surface and included in our SWMS that reef walkers must be worn while doing the task. This method was successful until the non-slip surface started to lift. This again presented us with a dangerous situation. We investigated the availability of a more effective hose nozzle which enabled the hosing to be carried out from the top eliminating the need for entry. Hind-sight is a wonderful thing but this is still our work practice today. This task is carried out once a fortnight.

We also found that we needed to remove grit from the anoxic zones every two years. If that wasn't done we would have continuous problems with the mixers in this area. Once again there are no sumps in these tanks. This causes us to have to hire super suckers and enter a confined space to carry out the task. If sumps were provided we would definitely be able to save the cost of hiring a super sucker and possibly even entry.

Only this year we installed a sump and pump into the average dry weather balance tank for cleaning purposes. This makes cleaning this area of the plant a lot easier. The sludge lagoons will be our next challenge. They are rubber lined lagoons which one day will require maintenance. It will be a problem to empty them out to carry out this maintenance as they don't have sumps.

Training and Upskilling Operators

If staff have been operating trickling filter plants and are now being asked to run the new plant they will need considerable training, particularly in chemical dosing. Staff should be well trained in the operations of the new system so they can look forward to system commissioning rather than approaching it with fear and uncertainty which creates negativity at the beginning. They should be involved in the pre-commissioning testing to gain experience in operating the plant before sewerage is introduced. Experienced operators should have a chance to discuss design issues before construction starts and have input into areas of concern.

Design Issues

When a project includes reticulation work and plant construction, both sections should be preferably designed by the same company to ensure compatibility in design. This prevents the situation of having the intended design of the plant as biological p removal yet having the reticulation system deliver sewerage to the plant in a mode that makes this impossible. Plant short circuiting should be expected and rectified at the design stage. Asset managers should allocate sufficient funds during the first few years of operation to resolve issues which may have been overlooked.

Drying Beds.

Conclusion

After six years since commissioning, we now have a plant which treats all the effluent from Mittagong and the Northern Villages and consistently achieves licence conditions. We are very fortunate to have dedicated and experienced operators and engineers who often work beyond their required duties to ensure high standards are maintained at all times. Incidentally, the Mittagong plant is nearing its design capacity and we are preparing for the next upgrade.

Acknowledgements

Thanks to Council for allowing me the opportunity to present this paper, the team from the Department of Commerce who worked closely with us during the commissioning stage to achieve the desired results and to Mark Williams who managed the project for Council.

Thanks also to Council operators including Ian Freere and the late Phil Ohearn who worked for many hours unpaid during the commissioning and initial operations of the plant.

Special thanks go to Mark Bruzzone from MWH whose expertise during the initial operations of the plant proved invaluable.

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FIRE AND WATER

John Cameron

Judged Best Operator Paper at the Annual WIOA Victorian Water Industry Engineers and Operators Conference 2007

As storage operators we often view floods as the predominant risk to our structures, but climate change may result in bushfires becoming increasingly prevalent in Eastern Australia. This change in climate may result in more intense and variable rainfall followed by long periods of hot dry weather such as has been experienced over the last decade. Potentially this will lead to periods of rapid growth followed by long dry spells that dry vegetable matter quickly and create increased natural dry fuel loads and risk of wildfire.

Consequently it is imperative that rural utilities implement sound bushfire risk management protocols across all aspects of their business operations. Similarly recovery from bush fires needs to be optimised through advanced planning.

Southern Rural Water (SRW) operates several large dams and smaller diversion weirs in southern Victoria. Amongst these are two high hazard dams (Lake Glenmaggie and Blue Rock Lake), and a major diversion weir (Cowwarr Weir) located in Gippsland. These sites are critical to water harvesting and delivery for a variety of stakeholders. They provide raw water to Victoria's major power generators, industrial and urban consumers within the Latrobe Valley, Macalister Irrigation District customers and environmental flows to the rivers of the Gippsland Lakes system.

Lake Glenmaggie spans the Macalister River; Blue Rock Dam the Tanjil River and

Cowwarr Weir diverts water from the Thomson River.

In December of 2006 these sites were all threatened by fire designated as the Great Divide South Bushfire. At the same time staff and the assets at Cowwarr Weir were threatened by a deliberately lit wildfire.

The lessons learned by SRW from these fires can be used by water authorities to better prepare for future fire events. These include improved risk management of fire threat to capital infrastructure, physical and natural environments and trauma to individuals and the broader community.

Case Study: Wildfire at Cowwarr Weir

In December 2006 SRW recognised that the Great Divide South fire had the potential to place several of its sites at risk and consequently rapid action was taken to prepare them for potential onslaught of that fire. All sites were assessed for risk and priorities set for protection.

Lake Glenmaggie was assigned a high priority as the infrastructure for that site was located in natural bush. Available resources were concentrated on protecting that asset against threat from fire or ember attack. All overground plastic water pipes were buried or replaced with steel, all building apertures were screened to protect against ember intrusion, fire protection equipment was tested, sprinkler systems were installed on critical buildings and residences, excess dry fuels were cleared from critical infrastructure, spouting was filled with water, personnel fire protection kits were prepared (torches, woollen blankets, fire beaters), fire reports were monitored continually and personal and corporate fire plans reviewed and communicated.

Cowwarr Weir and Blue Rock Dam, on the other hand, were classified as low risk as they were located in large clear areas surrounded by pasturelands. Minimal resources were assigned to fire protection at those sites. This proved to be a mistake that would later place two staff and a family member at extreme risk and expose the broader organisational community to unnecessary trauma.

On December 19th a deliberately lit wildfire broke from nearby bushland and raced at an alarming and unchecked rate across dry farmland towards Cowwarr Weir. Staff preparing the site against potential fire threat were suddenly forced to flee to the protection of the nearby weather board residence. The fire then spread rapidly to the adjoining garage and immediately placed the residence under dire threat. (Fortunately staff had all completed the DSE Basic Wildfire Awareness accreditation and were well skilled to manage the fire threat.)

Stored mulch heaps and exposed fodder ignited, stored tyres smouldered, and fencing commenced to burn and the fire entered the office and workshop. At the height of the firestorm power, phone and water supply failed, daylight was obliterated and windstorms created by the fire battered the area. Those in the house became concerned about the ability of the wooden residence to withstand the onslaught of the fire and made plans to evacuate to a safer location. They were able to communicate with their supervisor and emergency services but no direct support was available and, at that time, they believed they were at extreme risk of being engulfed by fire. During lulls in the wind they were able to leave the building and extinguish spot fires threatening it.

At the same time reports were being received at ABC radio that the Cowwarr Weir residence was on fire and two women residents were missing. Colleagues and family were distressed as they were unable to gain accurate information about the people. Unfortunately the report continued to receive national airplay for a further 12 hours despite the fact that the ABC was contacted and informed about the true situation. After the fire front had passed several people placed themselves at extreme (and unnecessary) risk by returning to the site to provide immediate assistance to the supposedly trapped people.

During the event the supervisor was provided with constant updates via mobile phone conversations with the affected staff, however logistical problems arose as the result of the unprecedented number of calls being made to the affected staff by concerned third parties. Consequently there was concern that mobile phone batteries would fail.

After several hours, the fire front had passed and the affected people emerged to survey the damage and advise emergency services that they were no longer at risk.

Rehabilitation of the physical assets commenced immediately and was still in progress several months later. Throughout the recovery period SRW relied heavily on support and assistance from external utilities.

SRW also elected to invest heavily in ensuring that risks from fire would be reduced should bushfire threaten any site in the future.

Lessons Learned

The knowledge gained from the fire at Cowwarr Weir can be summarised as follows:

- The best defence against the mental traumas and physical impact of bushfire is to **develop, review and rehearse bushfire action plans on a regular basis**.
- There is a potential risk to staff, contractors and physical assets.
- Fire activity cannot be predicted accurately.
- Similar standards of protection must be applied to all sites
- Water authorities with assets in rural locations must ensure there is a clearly communicated fire action plan in place at all times.
- Resources must be invested in preparing rural water locations for the eventuality of fire
- Water authorities must undertake regular fire audits at all sites at risk of bushfire.
- Fire plans must be tested and rehearsed regularly.
- All staff that may be exposed to fire should undertake Basic Bushfire Awareness training (**course available at www.dsetraining.org.au**)
- Sensible actions will ensure that firestorms can be confronted and managed if required.
- Personnel external to the fire can be traumatised by the uncertainty surrounding a fire event (The SRW CEO stated after the fire "I never want to have staff placed at such a risk again")
- It is essential to establish a working relationship with local media to ensure released information is accurate and does not place others at risk.
- Reliable communication with staff is essential. (SRW Headworks staff have been issued with trunk radios, their vehicles fitted with tracking devices and a procedure developed requiring them to divert their mobiles to a central location during emergency incidents in order to minimise the drain on their mobile phones and allow them to concentrate their energies on the incident.)

Conclusions

Bushfires threaten infrastructure, water quality and organisational capacity to cope. They have long-term consequences that impact on organizations, individuals and natural environments.

Recovery from any incident requires co-operation between organizations. Bushfire is no exception to this. Consequently it is essential that partnership arrangements be established and maintained, in advance, with external support organisations and utilities.

The media plays a vital role in natural disasters and organisations need to develop strategies for managing communication with media in advance of any event. Communication needs to be succinct, accurate and timely.

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WATER DELIVERY IN PARADISE

David Dickson

Like many Queensland tourist areas, Hamilton Island must cater for a variable population of between 1,500 and 4,000 people. Being privately owned and operated, there is a need to produce and continually supply high standard potable water whilst minimising operational costs. Daily water consumption ranges from 1.2ML up to 2.4ML during peak times.

The island has four freshwater collection and storage dams (Table 1) but their capacity is not sufficient to supply water all year round. As the names suggest, three of the dams are situated within the airport area.

Hamilton Island resort operates a DAFF water treatment plant, and a Reverse Osmosis (RO) plant to treat sea water as a back up during times of limited fresh water availability or when water quality issues require an alternative supply. Unfortunately, the RO plant is expensive to operate and its use must be minimised. Disinfection in the form of chlorine gas and ozone is employed.

There are a number of challenges which the operators must meet in order to maximise the production of high quality water at a minimal cost. This paper describes some of these challenges and how we are able to achieve a satisfactory outcome. Good rainfalls were recorded early in 2006 and in 2007, which filled all four dams to capacity. South Runway and North Runway dams are relatively shallow with depths between 2-3 metres. Their shallow nature combined with the lack of vegetation due to their close proximity to the airport make them susceptible to algal blooms in the warmer months. Water in the storage also has a relatively high electrical conductivity (EC) due to evaporation and sea water ingress

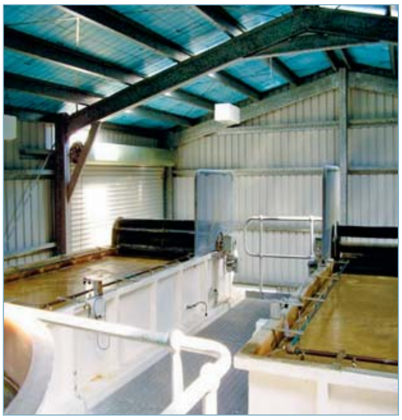
Table1. Island Storages and Capacity.

Storage	Capacity (ML)	Surface Area (m^2)	Usable Capacity (ML)
Terminal Dam	157	17000	149
South Runway Dam	166	88000	117
North Runway Dam	205	109000	184
Palm Valley Dam	74	12500	69

The Treatment System

DAFF Plant

The DAFF plant produces around 2.0 ML per day.



The DAFF plant consists of 2 DAFF tanks, fed from a single flocculation tank. The flocculation tank provides 15-20 minutes detention time depending on flow rate. The DAFF system is very robust and can handle variations in raw water quality reasonably well. As evidence of this Table 2 outlines the DAFF plant performance during recent rain events where 220 mm fell in 24 hrs and the raw water turbidity went from the usual 15 NTU up to 180 NTU.

Table 2. DAFF Plant Performance.

Date	1-2-2007	2-2-2007	3-2-2007	4-2-2007	5-2-2007	6-2-2007
Conductivity (μS/cm)	1,236	1,203	970	930	890	860
Final water pH	6.9	6.8	6.6	6.9	6.9	6.9
Final water turbidity (NTU)	0.25	0.2	0.8	0.24	0.51	0.27
Filtered water turbidity (NTU)	0.33	0.53	1.8	6.35	1.14	2.3
Chlorine residual (mg/L)	1.71	1.88	2.13	1.63	1.57	2.46
Flow rate (L/sec)	24	18	20	20	26	20
Alum residual (mg/L)	.15			.15		
Alum dose (mg/L)	70	70	70	65	75	75

Ozone Disinfection

The ozone generator can produce 400 g/hr of ozone gas. The target residual is between 0.30mg/L to 0.50mg/L depending on the quality of the raw water and algal counts.

Once the treated water has left the DAFF it is injected with ozone saturated filtered water. Any organic material that has not been taken out by the DAFF process is oxidised by the ozone gas during a five minute contact period.

This process is especially important in the treatment of blue green algae as the ozone attacks the cell walls and destroys the algal toxins that are released by the algae. Ozonation also oxidizes iron and manganese compounds that may be present in the filtered water and this helps improve the taste of the treated water.

BAC (Biologically Activated Carbon)

Once the treated water has been through the ozone disinfection process it passes through a BAC filter where any toxins or organic compounds are removed by the bacteria.

Care must be taken with the ozone disinfection as a residual that is too high can sterilise the BAC bed and turn it into an activated carbon filter. Backwashing of the filter must also be monitored to ensure over washing does not reduce the bacteria to an extent where it is not effective at removing organic compounds produced by the ozonation process. A monthly monitoring regime provides cell counts for both pre and post BAC ozone treatment to ensure the process is operating correctly.

Reverse Osmosis Plant

Reverse Osmosis (RO) is used to convert seawater into safe drinking water. The RO plant at Hamilton Island is capable of producing 1.4ML per day but it is currently operated at around 50% to 75% of its capacity to compliment the DAFF process

Raw water pumps deliver seawater with an EC of around 54,000 µs/cm to the RO plant where the raw water passes through a series of filters. The first are the Spinklin filters which remove larger inorganic compounds such as shell, sand and grit. Water is then split into two banks, each bank consisting of four sand and four carbon filters. One micron filters further filter the water which is then stored in two 20,000 L tanks. These tanks supply the high-pressure pumps that feed the four RO Banks. Each RO bank consists of five pressure vessels each containing six membranes. One bank is capable of producing 4.2 L/sec of permeate flow from a feed rate of 12 L/sec with a final average EC reading of 500µs/cm. The water left over by the process, which has an EC of around 72,000 µs/cm, is returned to the ocean via an outfall pipeline.

Chlorine Dosing

The final step in the treatment process is the addition of chlorine. The final water is directed to a 1.5ML treated water storage which is chlorinated to around 1.2 to 2 mg/L to ensure a residual in the reticulation network of 0.5 to 0.7mg/L in the dead ends.

Operational Challenges

There are three main operational challenges:

- Ensuring all barriers are in place when treating algal blooms
- Reducing the EC of the potable water
- Minimising maintenance and operational costs of RO treatment.

Managing and Treating Algal Blooms

Algal blooms are an inevitable part of the annual weather cycle. The algal counts from the Hamilton Island storages for the period August 2006 through to December 2006 are shown in Table 3.

Table 3. Storage algal counts (cells/mL) from August 2006 to December 2006.

Storage	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06
Palm Valley Blue Green Algae	0	0	0	68,833	30,400
Palm Valley Total Algae	43,000	45,000	250,000	150,000	170,000
Terminal Dam Blue Green Algae	8,185	54,899	126,000	42,000	135,000
Terminal Dam Total Algae	290,000	4,800,000	3,700,000	330,000	780,000
Nth Runway Blue Green Algae	910	12,343	10,467	530	70,143
Nth Runway Total Algae	3,400,000	7,100,000	2,100,000	1,500,000	4,700,000
Sth Runway Blue Green Algae	13,725	50,000	99,800	216,667	17,767
Sth Runway Total Algae	740,000	2,800,000	4,100,000	2,200,000	1,500,000

Schematic of the Hamilton Island treatment system.

North Runway dam is the primary raw water source for supply to the DAFF plant. Algal counts increase as temperatures rise. High numbers of algae are transported to the Terminal dam from North Runway dam. It is at this point increased monitoring checks are made at the plant to ensure all barriers in place to remove any algal toxins are functioning correctly.

Palm Valley dam is used to blend with the other two storages when algal counts become too high. It is also used as a stand-alone water supply when North and South runway dams become unusable. Table 3 shows algal counts in Palm Valley are significantly lower than the other three storages.

An interesting point is that of the four storages, Palm Valley is the most protected from human impact and has a relatively untouched catchment area. The algal counts show how important it is to protect catchments and the benefits this can have on water quality.

A program of bank restoration incorporating fencing and re-vegetation to help reduce nutrients in sediment runoff is currently under way.

When algal blooms do occur, there are several barriers in place to ensure production of safe drinking water. These include:

- The DAFF plant where the bulk of the algae is removed,
- Ozonation to destroy any cells that have made it through the DAFF process.

Table 4. EC of water in Hamilton Island storages (µs/cm).

Date	Palm Valley	Nth Runway	Sth Runway	Terminal Dam	DAF Final Water
01-Nov-06	260	2110	2420	1430	1284
16-Nov-06	270	2250	2470	1640	1254
08-Dec-06	280	2520	2670	1820	1120
20-Dec-06	300	2640	2800	2020	1342
27-Dec-06	310	2850	2900	2070	1740
03-Jan-07	280	2680	2890	1760	1441
18-Jan-07	310	2960	3030	1390	1138
24-Jan-07	240	1670	2630	1320	1225
02-Feb-07	190	360	1900	930	970

- Biologically activated carbon removes any compounds created by the ozone process
- Monthly sampling of pre and post ozone treatment.

Reducing EC

Water in all the storages has a high EC (Table 4). This is largely due to the geographical nature of the island and the fact that the storages are occasionally infiltrated by king tides. Both North and South Runway dams were formed from what was formerly a natural bay before the present day airport was constructed.

Readings of above 3,000µs/cm for South Runway dam are not uncommon, which makes reducing the EC level difficult. To utilise water from South Runway dam it first needs to be pumped into North Runway dam, thereby increasing the EC in North Runway dam. For these reasons South Runway dam is presently used as a back up water supply.

Terminal dam which feeds the DAF and RO plants, has its own catchment area and is topped up by annual rainfall. Both Palm Valley dam and North Runway dam are pumped to the Terminal dam before treatment at the DAF plant. The EC level in North Runway dam can reach 2,900 µs/cm, generally in the warmer months and as the storage levels decrease.

Palm Valley dam has the lowest of all the storage EC's with readings of around 250µs/cm, however it has a very limited capacity of 74ML.

Reducing the EC of the final water to less than 1,000µs/cm is crucial to reduce corrosion damage to pumps, impellors, treatment plant assets and the metal components of the reticulation network. However in practice this is not always possible.

Water from Palm Valley dam is blended with water in North Runway and Terminal dams to help reduce the EC. This generally reduces the EC to between 1100µs/cm and 1350µs/cm with a practical target < 1200µs/cm achieved.

Early rainfall in the past 2 years has reduced the overall EC readings of all the island storages. As the storage levels fall, generally the EC readings increase and two management options are available.

Table 5. Comparison of RO and DAFF Power Usage at different flow rates.

Date	Number RO Banks running	Power Kilowatt Hrs	RO Flow rate (L/sec)	DAFF Flow Rate (L/sec)	Power Kilowatt Hrs
12/12/2006	3	39	12	20	8
13/12/2006	3	40	12	20	7
14/12/2006	3	37	12	20	7
15/12/2006	3	41	12	20	9
16/12/2006	2	29	8	25	5
17/12/2006	2	27	8	25	9
18/12/2006	2	28	8	18	8
19/12/2006	3	35	12	25	7
20/12/2006	2	31	8	25	8

Option 1 - Pump from Palm Valley dam to the Terminal dam. By blending water from Palm Valley, which has a generally low EC, the EC readings in Terminal dam can be reduced.

Option 2 - Reduce the flow rate from the DAF and increase the flow rate from the RO. This is very effective at lowering the EC.

RO Maintenance and Operational Costs

Power requirements for the DAFF and RO plants are shown in Table 5. The RO process requires large amounts of power and is very expensive to run. The RO plant uses nearly five times as much power to produce generally less than half the water of the DAF plant.

Due to the corrosive nature of seawater, the RO is also costly from a maintenance and an operating perspective. Seawater corrodes everything in the RO plant, even the shed that houses the plant. There is a constant program of painting and replacement of non-stainless parts. A full time fitter and turner is employed to run and maintain the RO plant because of the constant repairs and maintenance required.

The membranes used in the RO plant have a life span of 4-5 years provided they remain free from mechanical failure. The cost of replacing membranes is somewhere in the range of $1,600 each and there are 4 banks each with 30 membranes. The total cost of the membranes is around $190,000. There are 2 banks of 1-micron filters, each bank houses 32-filter cartridges at a replacement cost of $21.00 each. One micron filters need to be replaced about every 3-4 weeks depending on the quality of the carbon in the filter banks. The activated carbon in the filters has deteriorated and is due to be replaced; hopefully this will increase the life of the 1-micron filters.

The Future

Hamilton Island is experiencing a development boom at present with a new resort, staff accommodation, yacht club and many private residences presently being constructed.

The current challenges are being met by:

- Constant testing and calibration of all our monitoring equipment
- Construction of silt traps to protecting our storages and catchments from the effects of all the new developments
- Revegetating areas susceptible to erosion
- Rationalising the use of the RO plant.

The new challenge will be to ensure current infrastructure is sufficient to meet the demands of these future developments and implementing new technology to minimise impacts on the very special environment in which we live, work and play.

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BUNDY AND BIOSOLIDS!

Keith Nicholle, Graham Campbell and Kerry Dalton
Awarded the Actizyme Prize for the Best Paper by an Operator at the 2007 Queensland Water Industry Operations Workshop

Background

Changes to environmental legislation have led to more rigorous conditions being placed on the management of Wastewater Treatment Plants (WWTP). As a consequence, the latest EPA licence for Bundaberg City Council (BuCC) has a specific requirement that biosolids should not be disposed of or stored onsite; and that a waste management program be developed identifying waste management strategies with a focus on more efficient and beneficial use of biosolids.

A tender for "Beneficial use of Biosolids" was advertised and BuCC entered into a contract with Camreay Holdings to remove all of the biosolids from Council's WWTPs. The program has commenced with the removal of biosolids from our two largest Wastewater Treatment Plants at East and Millbank.

Millbank External Aeration WWTP.

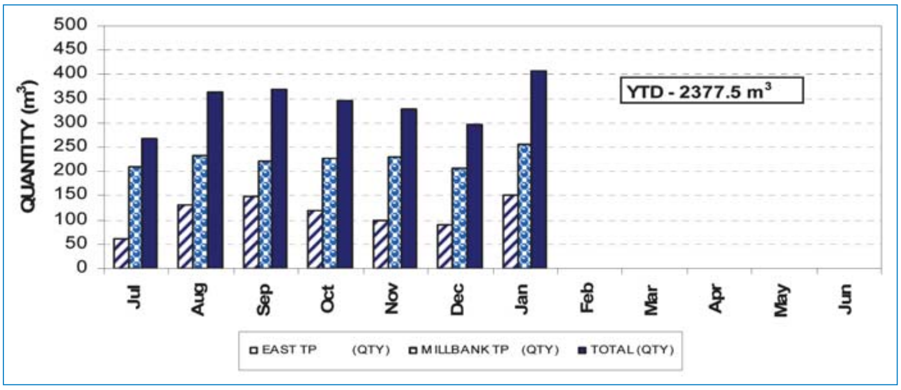

Figure 1. Biosolids removal for the year to date.

Biosolids Production

Treatment of wastewater at the East WWTP is achieved by way of two biological trickling filter (TF) process streams and an extended aeration (EA) stream. The plant treats an Average Dry Weather Flow (ADWF) of approximately 6.0 ML/D from the East Bundaberg catchment. The influent flow is split approximately 1 ML/D to A plant (TF), 2 ML/D to B Plant (TF) with the remaining 3 ML/D going to C Plant (EA).

Solids from the primary sedimentation tanks of A & B plant are transferred to the primary digesters for stabilisation. Waste Activated Sludge (WAS) from C Plant is pumped from the aeration ditch to the sludge thickener. The thickened sludge is then transferred to either of the A, B or C Plant digesters for stabilization, prior to dewatering on the sludge drying beds.

The dewatered biosolids from the drying beds is stockpiled in a clay lined, bunded, hard stand area. Camreay Holdings then collects the stockpiled biosolids and transports it to the farm for processing.

Millbank WWTP is an extended aeration plant with an ADWF of 4 ML per/day. Raw sewage arrives at the plant from the Avoca/Branyan and Millbank catchments. Millbank WWTP also receives all septic discharges. WAS is pumped from the aeration ditch to the belt press for dewatering. The cake from the belt press is transferred directly onto an EPA licenced waste transport vehicle for transport to the Camreay Holdings farm. Approximately 50m^3 per week is delivered in two 5m^3 loads each day. Delivery of biosolids is carried out from Monday to Friday. This frequency has enabled the operators to reduce odours associated with the biosolids remaining in the truck for long periods of time.

Delivery of the sludge.

Table 1. Summary of biosolids production characteristics at the two plants.

Millbank WWTP	East WWTP
% Solids = 14 to 16%	% Solids = 25%
Belt Press	Drying Beds
Aerobic process	Anaerobic process
Less stable on application	Digested biosolids more stable on application
Ability to waste in any weather	Dependant on weather conditions
More prone to odour problems on application	Less problem with odour on application
Waste and dispose same day.	More time consuming waste process
Biosolids removed per week = 50m^3	Biosolids removed per week = 28m^3 (average)
Final use-ground application	Final use-composting
	Total capacity of drying beds - 66Kl

The primary differences in biosolids production between the two Wastewater Treatment Plants are listed in Table 1.

Figure 1 demonstrates the quantity of biosolids transported this financial year.

Biosolids Quality

The type of industry contributing to a catchment can have a significant impact on the final end use for a biosolids product. Typical industries discharging into the Bundaberg system include:

Table 2. Quality of biosolids.

	Parameters	NSW Guidelines Gradings[1]				East Top Beds	East Bottom Beds	Millbank
		Grade A (mg/kg)[3]	Grade B (mg/kg)[3]	Grade C (mg/kg)[3]	Grade D (mg/kg)[3]			
Total	Arsenic mg/kg	20	20	20	20	<5	<5	5.0
	Cadmium mg/kg	3	5	20	32	<1	2.0	1.0
	Chromium mg/kg	100	250	500	600	10.0	25.0	19.0
	Copper mg/kg	100	375	2000	2000	34	310	481
	Nickel mg/kg	60	125	270	300	6.0	24.0	21.0
	Lead mg/kg	150	150	420	500	20.0	101.0	44.0
	Zinc mg/kg	200	700	2500	3500	75	424	582
	Selenium mg/kg	5	8	50	90	<5	<5	<5
	Mercury mg/kg	1	4	15	19	0.7	2.3	2.1
Pesticides	DDT ug/kg	0.5	0.5	1.0	1.0	<50.0	<50.0	<50.0
	DDD ug/kg	0.5	0.5	1.0	1.0	<0.50	<0.50	<0.50
	DDE ug/kg	0.5	0.5	1.0	1.0	<0.50	<0.50	<0.50
	Aldrin ug/kg	0.02	0.2	0.5	1.00	<0.50	<0.50	<0.50
	Chlordane ug/kg	0.02	0.2	0.5	1.00	<0.50	<0.50	<0.50
	Heptachlor ug/kg	0.02	0.2	0.5	1.00	<0.50	<0.50	<0.50
	HCB ug/kg	0.02	0.2	0.5	1.00	<0.50	<0.50	<0.50
	Lindane (BHC gamma) ug/kg	0.02	0.2	0.5	1.00	<0.50	<0.50	<0.50
	BHC ug/kg	0.02	0.2	0.5	1.00	<0.50	<0.50	<0.50
	PCB's ug/kg	0.02	0.2	0.5	1.00	<10	<10	<10

1. In the absence of guideline for the reuse/disposal of biosolids in Queensland, the guidelines published by the NSWEPA are used.

- Food processing plants
- Light industry
- Sugar refinery mill
- Rum distillery
- Soft drink brewery

The lack of heavy industry, ultimately results in a high quality biosolids product, which is very low in heavy metals and other contaminants. High grade biosolids allows the end user a wider scope for land application.

Analysis of the biosolids product is carried out to determine the contaminant levels. The concentrations are then compared against the acceptance limits as prescribed in the NSW EPA Guidelines (2000) to establish the grade of biosolids. Table 2 indicates the quality of the biosolids from both the Millbank and East WWTP's with comparisons to the New South Wales Environmental Protection Agency (NSWEPA) guidelines (2000).

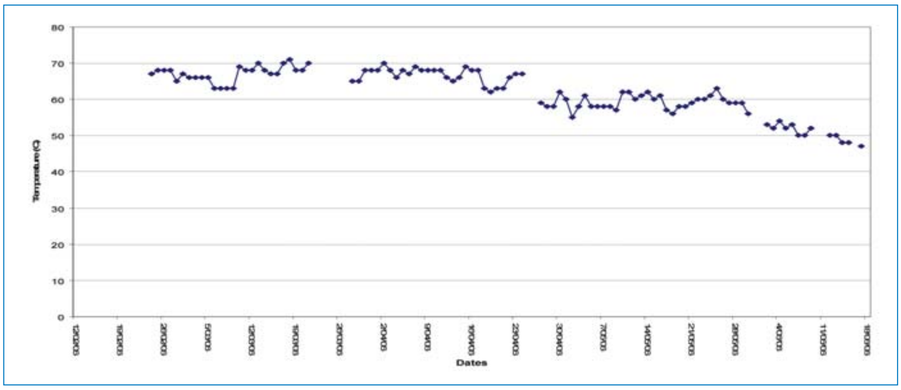

Figure 2. Compost Temperatures.

Transport

The transportation of the biosolids from the treatment plants to Camreay Holdings farm required a separate licence under EPA legislation. Applications were made to the EPA and as part of their licencing conditions for waste transportation BuCC had to implement the following:

- Procedures for the management of spills
- A waste docket system for capturing quantity and frequency of waste removed from site
- Sealing and covering of trucks for the transport of biosolids

Table 3. Compost Analysis Results for November 2006.

	Active Bacterial Biomass (µg/g)	Total Bacterial Biomass (µg/g)	Active Fungal Biomass (µg/g)	Total Fungal Biomass (µg/g)	Hyphal Diameter (µm)	Flagellate	Protozoa Numbers/g Amoebae	Ciliate	Total Nematode Numbers #/g	Plant Available Nitrogen (from predators)
Desired Ranges	15-25	100-3000	15-25	100-300	(um)	10000+	10000+	50-100	20-30	kg/ha
Results	80.9	917	1.87	460	3.0	10026	3730	801	0.87	75-100
Suitability	Excellent	Good	Low	Excellent	Disease suppressive fungi present	Good	Low	OK	Low	

Extracted from Soil Food Web website (2007)

In this case, EPA Waste Tracking exemptions apply as the biosolids are being transported to a farm for use as a soil conditioner or fertiliser. Camreay Holdings was also required to comply with EPA Licencing requirements for transporting and re-processing biosolids waste.

Reuse

The NSWEPA Guideline for Use and Disposal of Biosolids Products (2000) was also used as a guideline for end use application.

Spreading the sludge.

Prior to commencing biosolids removal and reuse, Camreay Holdings had to prepare an Environmental Management Plan (EMP) for submission to EPA. The EMP included aspects such as:

- Soil condition
- Biosolids quality for application
- Potential for groundwater, surface water and soil contamination
- Geographical aspects including contours and natural waterways
- Biosolids receival and composting processes
- Reporting requirements (data capture)

The biosolids cake from Millbank is land applied using a muck spreader at a rate predetermined by calculating the Contaminant Limited Biosolids Application Rate (CLBAR) and the Nitrogen Limited Biosolids Application Rate (NLBAR) as described by the NSWEPA Guidelines (2000).

Initial odour problems were overcome through a consultative process between the operators and Camreay Holdings. It was found that odour was significantly reduced by applying and incorporating the biosolids into the soil immediately after delivery to the farm. In the case of wet weather there is a bunded ramp at the end of a private all weather road where the biosolids can be deposited until they can be applied in more suitable weather conditions.

Composting

Biosolids from the East WWTP are composted by Camreay Holdings. The biosolids are combined with a prepared bed of ground up sugar cane at a predetermined Carbon/Nitrogen ratio. Once there is sufficient biosolids, the biosolids and sugar cane are mixed using a front end loader and windrows are formed. The windrows are irrigated or turned as required depending on the temperature. Temperatures between 55°C and 70°C are maintained for a period of at least five weeks. These temperatures are optimal for the production of high quality compost. The whole windrow must be turned and temperatures must be maintained to avoid pathogen and weed contamination of the compost. This also meets the requirements for Australian Standards AS 4454-2003, Compost, Soil Conditioners and Mulches. Figure 2 shows typical temperatures achieved through-out the composting process.

When the temperature drops significantly and the composting process is nearing completion, the compost is stockpiled and left to mature. This process can take up to 12 weeks. After maturation, a sample is sent to the Soil Foodweb Institute for analysis and grading.

An example of an analysis is shown in Table 3. This compost is suitable for application as a soil conditioner. Compost of this quality would increase the carbon content as well as improving soil, which has been damaged and/or nutrient depleted from over-use. High quality compost can also assist with water retention.

Sludge from the belt press.

Camreay Holdings intends to package the compost in 20 kg bags for the domestic market, as well as selling the compost in bulk to farmers. Compost of this quality can be used to produce compost tea. Other than sugar cane, which has been grown on the blocks with applied biosolids, Camreay Holdings have recently harvested a crop of sunflowers and plan to follow this with a crop of maize. This crop has been grown without the use of additional fertilizers. Camreay Holdings believe that the future lies in liquid biosolids and as a recycler and end user, this is an option that is being explored with interest.

BuCC and Camreay Holdings are excited about being involved in a project that presents a long term, environmentally sustainable solution to waste disposal. The perception of biosolids is no longer that of a waste product; instead it has become a resource with a growing number of applications. BuCC Treatment Plant Operators have enthusiastically contributed to this process working with Camreay Holdings to overcome any problems and issues which may have arisen during the initial inception.

The Authors

Keith Nicholle (millbank@bundaberg.qld.gov.au) is a Treatment Plant Operator, and Kerry Dalton an Environmental Officer (Water and Wastewater) both with, Bundaberg City Council. **Graham Campbell** is the proprietor, Camreay Holdings.

IN AT THE DEEP END!

Mark Samblebe
Judged Best Overall Paper at WIOA's
Victorian Water Industry Engineers and Operators Conference 2007

Fire and Rain!

I was excited! After three years in business development and the commercial side of water treatment, I was about to return to the front lines of water treatment. I had been watching the news reports covering the bushfires which burnt so wildly over the Christmas-New Year period of 2006, predicting the impact it would later have on water supplies. Having been heavily involved in post bushfire water treatment during my time spent with North East Water in Victoria, I was looking forward to the challenges that awaited me, when I returned to the battlefield that is potable water treatment.

On the 8th of January 2007, I started work as Water Treatment Technologist with Gippsland Water. Without having had a chance to settle in, on my second day of employment, Gippsland Water was approached by the Lions Club of Victoria for advice and assistance on treating dirty water from the Macalister River which had degraded significantly after the fires. Having the luxury of being new to Gippsland Water, I was not yet overloaded with other projects and was delegated the task of working out a suitable means of treating what was once pristine mountain water.

Water samples were delivered for testing, and a site visit was undertaken to assess options and available infrastructure, that could some how, be utilised as an emergency water treatment system. On arrival on site, the situation became clear; 280 children staying in the village were allocated water for only 4 hours per day, such was the shortage of supply and the cost of trucking water to the remote town. No hot water was offered for bathing to further minimise use. Exhausted volunteers who had just fought off the fires, were now rebuilding the water distribution system, and awaiting a means of treatment.

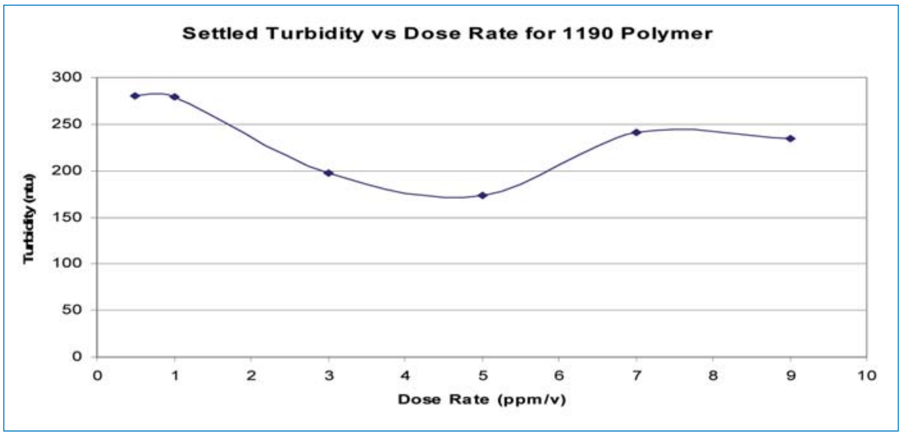

Figure 1. Jar test results for Polymer 1190.

After assessing what was available, the decision was made to utilise the town swimming pool as an emergency clarifier, and work began on determining appropriate chemicals for flocculation and designing dosing systems. Several water industry suppliers provided assistance and donated their time, equipment and chemicals to help the struggling charity, and the communities they serve. Within a week, a temporary system was installed to supplement supply while more work went into creating something of a slightly more permanent type of temporary system. By early February a workable solution was in place and the town had a secure supply of safe drinking water.

Since installation the system has successfully treated water of up to 2500 ntu to well within WHO Guidelines for Drinking Water Quality. Twice the town has been flooded and buried by mud slides, which has impacted on supplies to other towns in Gippsland Waters area downstream on the Macalister River. The lessons learned helping the community of Licola, proved invaluable in helping Gippsland Water prepare their downstream water treatment plants for possible dirty water events after rain.

This report outlines in brief, the process of determining a suitable chemical dosing regime, and problems encountered in achieving a suitable water quality from the system.

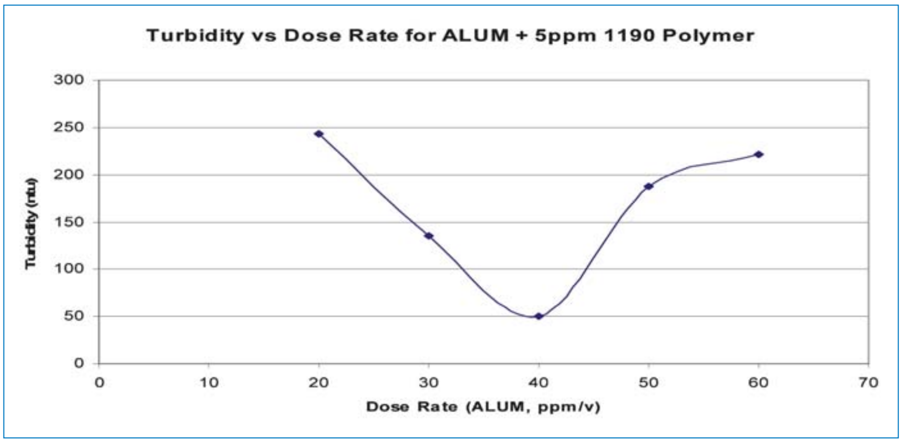

Figure 2. Jar test results for Alum.

Which Coagulant?

Several samples were collected so that different turbidity raw water could be tested for flocculation and settling. To ensure simplicity of the process, a 'single chemical' dosing option was preferred, since no trained water treatment personnel were available to operate the system. Several readily available chemicals were trialled including; Polymer 1190, Alum, PolyAluminiumChloride and Aquapac55.

Polymer 1190 was trialled and found to be unsuitable as a coagulant/flocculant reducing turbidity as seen in Figure 1, where optimal dose only resulted in settled water turbidities of around 160 ntu.

Alum was then dosed in conjunction with 1190 (at 5ppm which showed best results in first trial) showing improved results as seen in Figure 2. Settled water turbidity was reduced to 50ntu. To improve performance further, pH correction was required, and was rejected due to increasing complexity of the process. The fairly narrow working range also made this option less attractive.

Aquapac55 was tested and showed much improved results. Figure 3 shows settled water turbidities of 17ntu at the optimal dose rates, which would be expected to improve in the actual application due to the extra settling time that will be available on site. 45 and 50ppm/v were the optimal dose rates.

The best chemical for flocculation proved to be PAC10LB (10% PolyAluminiumChloride – Low Basicity) as shown in Figure 4. Results of jar tests using PAC10LB gave excellent results with a very broad working range which suited the application and experience of operators likely to manage the system once installed. Settled water turbidity of less than 2ntu were achieved.

The ability of PAC10LB to produce floc over such a wide range of dose rates was seen as being ideal to ensure successful operation of the system. All other chemicals not only produced higher settled water turbidities, but also had a narrower working range which increased the level of expertise and control operators would need to have to keep the system working, especially where raw water turbidities varied so widely in such short time frames.

Putting It Into Practice

Based on results of the jar testing, the chemical selection was complete, now the system had to be set up. A dosing pump was sized and scavenged from within

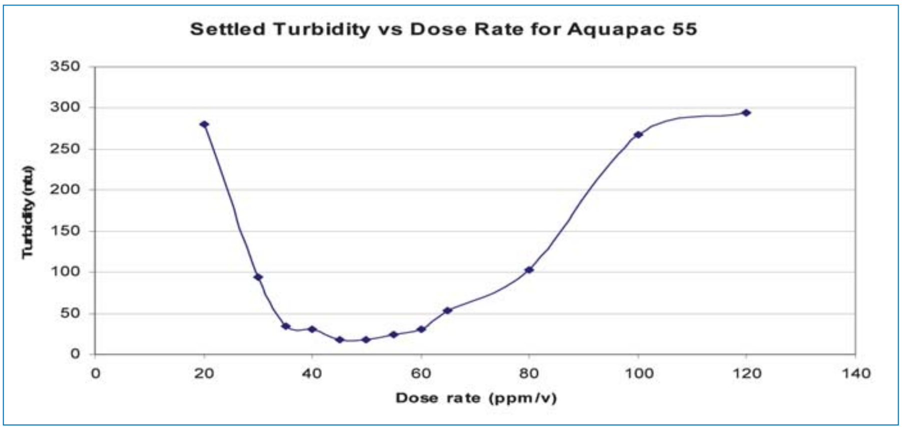

Figure 3. Aquapac55 jar test results.

Gippsland Waters spares. PAC10LB was ordered in small 15L containers to remove the need to install chemical storages and bulk loading/unloading facilities. Since Licola is a small town with relatively low demand, one 15L container was calculated to last between 3 and 9 days depending on the raw water quality. A flow meter was ordered to determine the flow rate to allow calculation of dose rates.

The concept for the system was starting to take shape. The swimming pool was modified by the addition of three plastic baffles to maximise sludge retention and minimise sludge migration through the pool. The baffles also prevented short circuiting. Figures 5 & 6 show the temporary baffles being installed by Lions club volunteers and Gippsland Water staff, and the Macalister River running at a "thick" 4000 ntu.

Chemical dosing systems were set up with rapid mixing provided by a half cocked valve and bends in the pipe work. When the plant was started, slow mixing was insufficient to encourage good floc formation which reduced the efficiency of the process. It was decided to operate the pool as a "batch" system, which operated in fill and drain phases. This enabled the pool more settling time to settle the fine floc. Generally the pool was filled during the afternoon, and allowed to settle overnight, then pumped out in the morning.

After a week of successful operation, the key concerns of staff were that sludge removal from the pool was very labour intensive. A "creepy crawly" pool vacuum was used to remove sludge periodically, however frequently got caught on the plastic baffles rendering it unsuitable for the job. Sludge had to be manually removed via the pool vacuum system. This took a volunteer up to eight hours depending on the raw water quality and how much sludge had been generated.

The second main issue, was an inability to maintain a disinfection residual, despite the treated water quality being below 1.5 ntu, higher organic loads were reducing a 2 mg/L free chlorine residual to nearly nothing in the space of two hours. A few phone calls were made and the team at Activated Carbon Technologies Pty Ltd, came to the party and donated, free of charge to the Lions Club, 3 months supply of pre-wet Powdered Activated Carbon (PAC). All we needed to do was install a PAC batching/mixing tank and dosing system. Aeramix were contacted for help with the PAC mixing system, and proved again that the water industry does have a heart, donating a mixer and a days labour to install and commission the PAC mixing and dosing system (Figure 7). After installation of the PAC dosing system, chlorine residuals increased and were maintained into the reticulation system at satisfactory levels.

In addition to this, we also needed to deal with the sludge migration problem in the swimming pool clarifier! Aeramix donated more time to assist with construction of a more permanent solid baffle system as seen in Figure 8.

The solid baffles worked much better at keeping sludge from migrating throughout

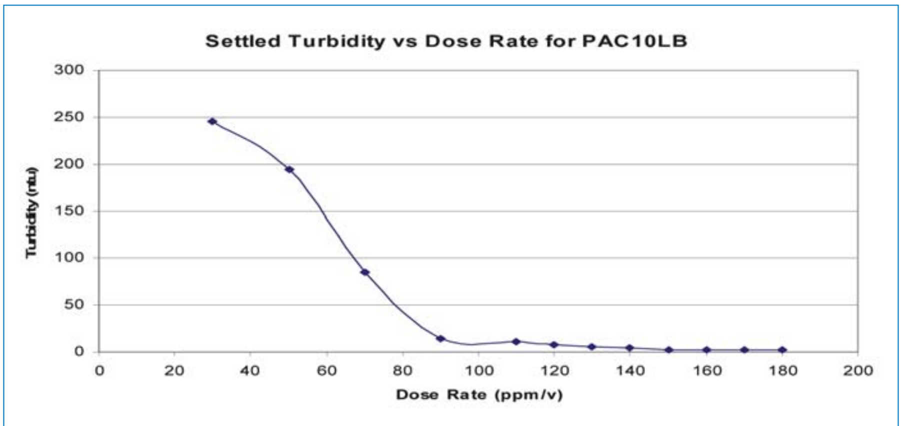

Figure 4. PAC10LB jar test results.

the pool reducing the amount of time and effort required to remove sludge significantly, as well as enabling the process to be run as a "flow through" rather than "batch" system clarifier.

Chemical mixing was improved by adding a 200L container to the flocculation zone into which the inflow entered. This was half filled with rocks to improve the rapid mix and spread or diffuse the flow to minimise short circuiting of the flocculation and settling zones and provide better slow mixing to aid floc formation at the inlet to the flocculation area (Figure 7).

Figure 5. Temporary baffles in the Licola swimming pool.

Figure 6. Macalister River at 4000ntu.

Conclusion

The town of Licola has had a torrid year in 2007, surviving bushfire, re-establishing a water supply and distribution system, flooding and mudslides, and more recently, raging flood waters that saw the destruction of the roads and bridges that permit access to the town.

Beyond the temporary system put together by Gippsland Water, Aeramix, Activated Carbon Technologies and of course the Lions Club Volunteers, preliminary design and investigation into supply of a purpose built water treatment system was undertaken. The water industry showed great support for this project providing many discounts, and donations of equipment and time.

The Lions club submitted an application for funding to secure a safe water supply and were awarded $100,000.00, but to date little progress has been made. Of the allocation to Licola for a water supply, much of this is being spent on consultancy, into the viability of supplying a shallow bore, and after it all the DSE do not intend for the supply to be classified as potable, and it will not be plumbed into the towns reticulation. The Lions club, after all this, will most probably have to generate their own funding to install a treatment plant regardless.

The challenges presented by bushfire affected catchments for the potable water industry are wide and varied. This project shows that even under the worst of conditions, the bare essentials and basics of water treatment theory, if investigated properly and implemented with attention to detail to ensure the process chemistry confined to a less than ideal physical structure can and does work.

Figure 7. The PAC mixing system and 'jerry rigged' rapid mixing and diffuser tank.

Figure 8. The improved baffle system.

Acknowledgements

In a project of this type, many organisations and individuals deserve great thanks for their assistance, with many more being worthy of note for their contribution to equipment for a permanent plant. Thanks to:

- Orica Chemicals Morwell - Scott Laidlaw – chemical supply and selection assistance.
- Activated Carbon Technologies Pty Ltd. – Peta Thiel and Peter Cullum - Supply of 3 months PAC.
- Aeramix – Cole Harvey - Supply and installation of PAC mixing system and construction of baffles.
- Gippsland Water – supply of dosing pumps, tanks, process investigation and materials for baffle construction.

The Author

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COAGULANT DOSING CONTROL MOVES FORWARD

Chris Laidlow

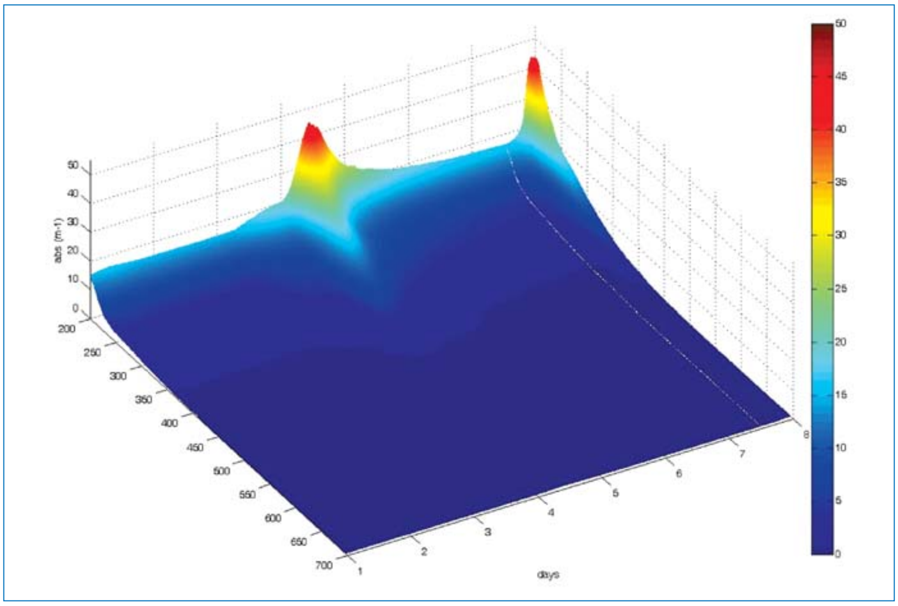

Figure 1. UV Absorption Profile at Wainuiomata WTP.

Background

One of the main challenges for the operators of a typical surface water treatment plant is to achieve that 'optimum' coagulant dose. This is particularly important where the source water quality varies considerably.

Over the years many attempts have been made at automating the process of coagulant control, arguably the most successful of these has been the Streaming Current Meter (SCM). SCM's operate in a feed back control loop, taking measurements downstream of the coagulant dosing point and feeding information back to adjust the coagulant dose.

Past efforts at developing feed forward (predictive) control, based around either UV 254 or colour measurements, have been largely unsuccessful due to the very narrow representation of removable contamination that these parameters reflect.

This article is a summary of the operational impacts that we have experienced with a unique feed forward system which was put into service in 2006 at the Wainuiomata Water Treatment Plant (WTP) in Wellington, New Zealand. The new system predicts the coagulant dose based on a combination of turbidity, UV_{254} and Dissolved Organic Carbon (DOC) measurements.

The Wainuiomata WTP is a 'run of river' plant which treats water from two catchment areas to the north-east of Wellington. The catchments are bush clad and reserved solely for water supply purposes. Raw water quality can change rapidly from very good (turbidity 0.5 NTU, colour 5 deg Hazen and DOC 1.0 mg/l) to very poor (turbidity > 500, colour > 100 and DOC > 15 mg/l). Raw water alkalinity is low at 16 mg/l (average) as $CaCO_3$.

The treatment process can, to a certain extent, handle poor raw water conditions but the plant would normally be shutdown if the cost of treatment exceeds that of other treatment sources.

The plant treats a maximum continuous flow of 50 MLD and the treatment processes are; alkalinity addition and pH control (lime and CO_2), coagulation (PACl), polymer addition, flocculation, separation (DAF), filtration, pH adjustment and chlorination.

In 2005 we replaced our old colour meters with s::can spectrophotometers. The s::can records the UV Vis absorption spectrum between 200 and 750 nm. These spectra are used to determine a range of parameters including DOC, TOC, UV_{254}, colour and turbidity.

Figure 1 shows the raw water absorption profile from the Wainuiomata WTP inlet over a 7 day period. The profile shows two short-term rain events during days 3 and 7. It can be seen that there is very little change in absorption in the colour range (375nm – 435nm) but a significant increase in the DOC range (250nm - 350nm).

Coagulant dose at the plant was controlled by an SCM. Whilst the SCM could be relied upon to cope with minor/moderate raw water quality fluctuations it did have its limitations. pH variations affected the SCM output and, as the SCM control is a feedback system, it often failed to respond quickly enough or completely enough to sharp changes in raw water quality, thus leading to filter turbidity problems due to under dosing.

During moderate to heavy rainfall the plant operators had to keep an eye on filtered water quality for signs of deterioration and when faced with an unfavourable weather forecast they would often adjust the SCM set point to increase the coagulant dose in order to pre-empt raw water quality changes. Since the price of under dosing would be a six hour call out to wash all the filters and get the plant back on line, the tendency was to play safe and overdose.

The SCM was also slow to react to **improving** water conditions and the resulting dose often over or under the optimum dose. This is clearly illustrated in Figure 2 which shows actual trends of the

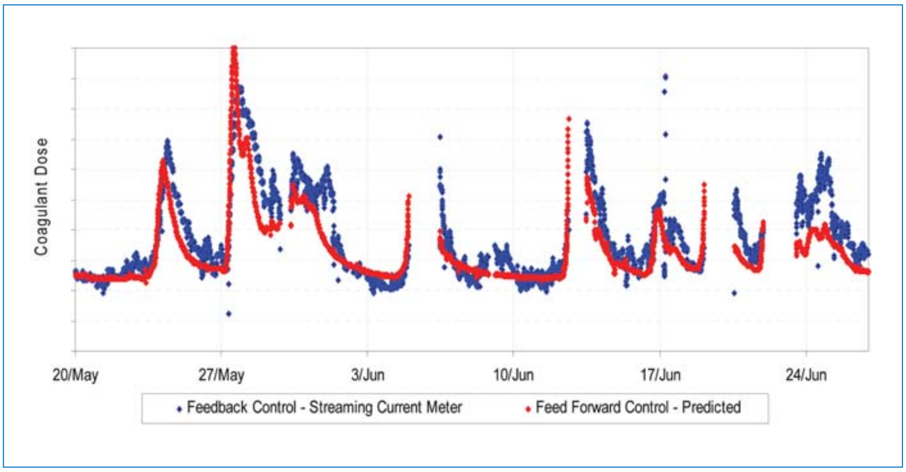

Figure 2. Comparison of Feedback and Feed Forward Coagulant Dose (Courtesy of h2ope Controls Ltd, Wellington, New Zealand).

dose controlled by the SCM compared with the dose predicted by the feed forward system.

Feed Forward Control System

In 2006 Dr Jason Colton of h2opeControls Ltd developed a coagulant control system that uses data from the plant inlet s::can and turbidity meter to derive a coagulant dose set point which, with the plant inlet flow, is used to control the speed and stroke of the coagulant dose pump.

We installed the control system into the plant PLC in August 2006 and the plant has been running continuously on this system since then.

For a few days after installing the feed forward system we stayed on SCM control and compared the output of both systems. The first thing that struck us was the instantaneous reaction of the feed forward system to raw water quality variations. It was also noticeable how the feed forward control tracks the variations in a much tighter fashion than the SCM output.

The feed forward system can operate in two modes; conventional mode and enhanced mode. In conventional mode the feed forward algorithm optimises coagulant dosing for economy, which means that it will calculate the minimum dose required to achieve acceptable filter outlet turbidity and run times. In enhanced mode the algorithm optimises for DOC removal, which means that it will calculate the minimum dose required to achieve maximum DOC removal.

The feed forward system at Wainuiomata WTP has now been in service for over 9 months and over that time we have seen a significant reduction in plant outages due to 'front end' dosing problems.

By operating in conventional mode we have reduced our coagulant costs by 15%. When trialling the plant in enhanced mode, the coagulant dose increased by about 10%, however, due to the reduced organic load in the filtered water, the chlorine demand dropped by almost 15%.

The plant technicians have now gained confidence with the s::can and the feed forward system and pay it little attention apart from checking the trend screens on the plant SCADA. We are currently investigating ways to connecting the output of the s::can to our SCADA network so that the units can be accessed remotely.

As the s::can measures turbidity, we had it in mind that we could dispense with the raw water turbidity meter as well as the colour meter and the SCM, but we have yet to resolve discrepancies between the existing turbidity meter and the s::can turbidity measurement. We suspect that the cause of the discrepancy is due to air bubbles in the s::can sample chamber and will be trialling a modified sample chamber in the near future.

The instrument display is situated in an IP 65 enclosure which is mounted adjacent to the probe (Figure 3).

This unit has a touch screen display from which the operator can select various displays, including the current value of each parameter, historic trending and viewing of the raw spectral data which shows a fingerprint of the water at that moment in time.

We had some initial issues with making sure that the instrument was properly ‘zeroed’ and discovered that it is important to use water that is free of organics. We use distilled water that has been passed through a mixed bed ion exchange resin.

The instrument probe sits in a sample chamber, essentially just a piece of PVC pipe, to which a raw water sample is connected (Figure 3). The only connections to the probe are a small diameter air purge connection for automatic cleaning, and a cable to connect it to the touch screen display.

Unlike our old colour and streaming current meters, the s::can is a very robust piece of equipment. It has no moving parts and pre-filtration of the sample flow is not needed as the system can measure and compensate for solids. The instrument has an air cleaning cycle that can be controlled from the touch screen.

From a maintenance point of view it has been trouble free and requires little attention. The units are inspected weekly when the sample chamber drain plug is removed to clear any accumulated sediment. In addition to that, we carry out a monthly zero check.

In financial terms the investment in new instrumentation and process control technology has netted immediate savings in the order of $50,000 per year from reduced chemical use, maintenance and unscheduled plant shutdowns. In addition there will be a favourable long term impact on the capital replacement, operations and maintenance budgets as we will ultimately have the s::can replacing three instruments; colour, turbidity and streaming current.

Figure 3. The s::can unit is shown mounted against the right hand wall with the output display touch screen situated above it on the back wall. The old colour meter is shown on the left on the back wall.

The broader benefits of improved water quality are harder to define at this stage but we expect to see a reducing trend in organically derived compounds (taste & odour & DBP’s) in the distribution system over time.

Operator confidence, easing those nagging doubts, is also difficult to define but it is pleasing to see high levels of interest for the new technology among our staff.

The combination of new instrumentation and process control has been very successful and the bottom line results speak for themselves. We expect to see even greater savings after installing the control system at our other surface water treatment plant later in the year.

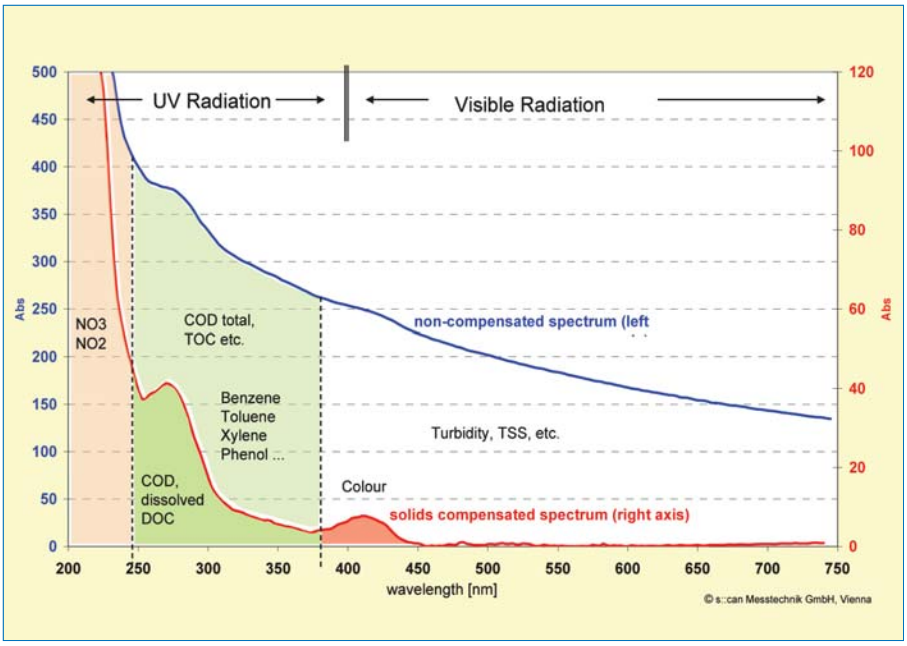

Figure 4. S::can Parameters and Measuring Principals (Courtesy of s::can Messtechnik GmbH, Vienna, Austria).

Acknowledgements

I would like to thank Alastair Forsyth (Wainuiomata Treatment Technician) for his advice and clarification, Jason Colton (H2ope Controls) and Rob Dexter (DCM Process Controls) for assistance with implementation of the technology.

The Author

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Note: H2ope Controls are now marketing this patented coagulant control system by the name of Com::pass (ed)

GOLD COAST WATER IMPROVES

Craig Bolin

The Molendinar Water Treatment Plant (WTP) is one of two plants supplying water to the Gold Coast. Figure 1 shows the turbidity of finished water produced at the Molendinar WTP for the period July 1999 to April 2007.

The graph clearly shows a dramatic improvement in the quality of water supplied to the Gold Coast. What has brought about this improvement?

There have a been a number of key events in the journey from relatively high and variable filtered water quality to low and consistent filtered water quality.

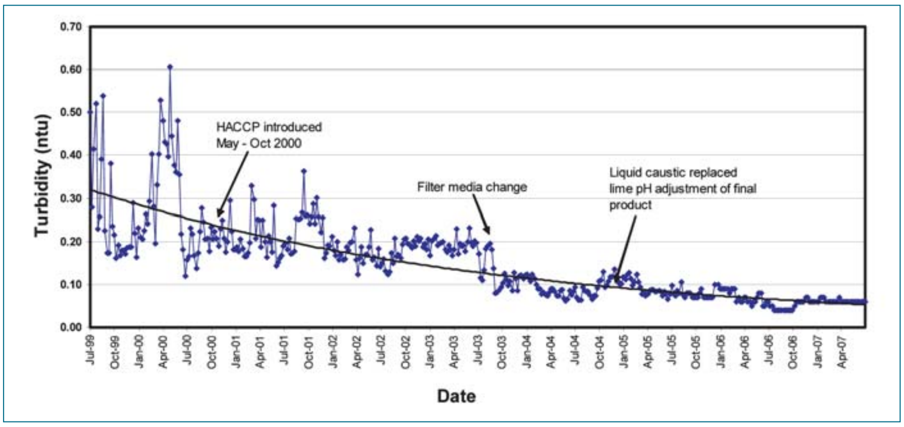

Figure 1. Long term turbidity trend of finished water from the Molendinar WTP from 1999 to 2007.

HACCP

A HACCP quality control philosophy was introduced in 2000. This introduced Gold Coast Water (GCW) to the concepts of control points and monitoring of control points and the identification of poor performing points and formed a basis of implementing improvement strategies.

Water Treatment Alliance

GCW joined the Water Treatment Alliance in 2002. The WTA is a self improvement program for the optimisation of WTP operation. The WTA introduced the concept of extensive monitoring of filtered water turbidity as a measure of total WTP performance and the key role of filters in achieving consistent low turbidity. Filters after all are the only barrier to protozoan pathogens and must be optimised at all times. As a result GCW started to collect more extensive filtered water turbidity data.

Filter Upgrades

Both the HACCP and WTA programs heightened our awareness of filters and their key role as barriers to pathogens in water treatment. Detailed inspection of the filters quickly identified the need for a filter rebuild. Figure 2 shows the state of the filters at GCW's other plant Mudgeeraba WTP in 2003 where a thick layer of mud covered most of the surface of the filter and filter performance was at best marginal.

A complete upgrade was carried out from the base up on the 16 filters at Mudgeeraba WTP with the underdrains replaced and the media upgraded from mono to dual media.

The filters at Molendinar WTP were upgraded from the nozzles up and also dual media.

ADWG 2004

The "Framework for the Management of Drinking Water Quality" incorporated in the "Australian Drinking Water Guidelines 2004" concentrates on a risk management approach to the management of drinking water supplies. This approach was completely compatible with the HACCP program and the principles of the WTA and extended our knowledge of this risk management approach to water quality.

Operator Training

The Framework emphasises the importance of operator training.

Operations staff are encouraged by GCW to gain Certificate 3 in water industry operations qualifications and dual ticket competencies are looked upon favourably.

In addition, the majority of GCW water treatment operations staff participated in specialist "Filter Assessment and Optimisation" courses offered by the WTA. As part of these courses operators were introduced to the responsibilities of GCW and their own responsibilities with respect to water quality. Simply stated,

Water Authorities have a responsibility to:

- Produce safe drinking water at all times
- Produce the best quality water possible from the existing system.

Operators have a responsibility to ensure:

- Their actions do not compromise the production of safe drinking water at any time.
- They actively provide feedback to management when they are aware of shortcomings in the treatment sequence that may contribute to the production of unsafe drinking water.
- They are alert to changes in the system they operate within.
- They act to produce water that is aesthetically pleasing.

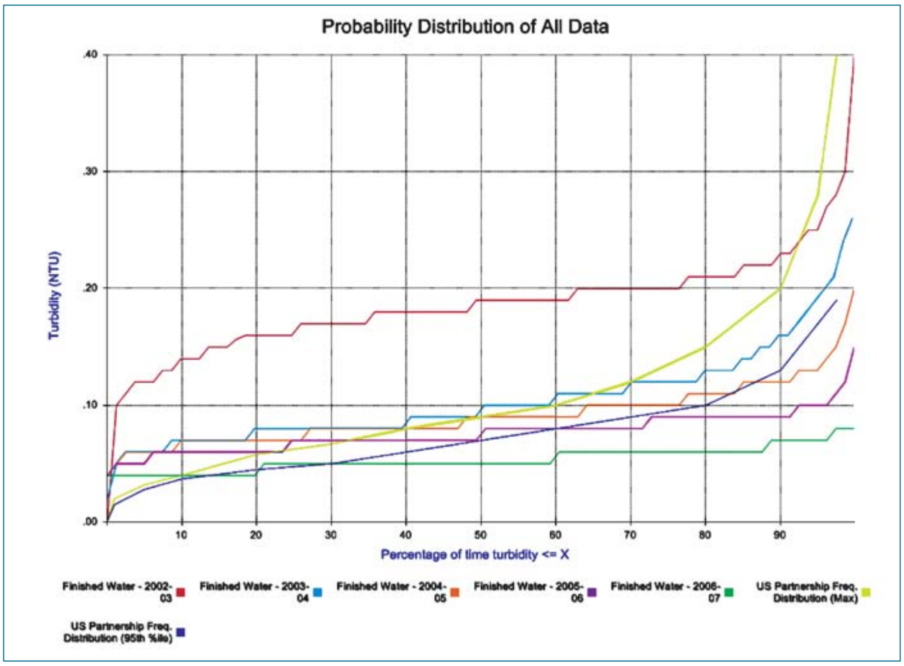

Figure 3. Cumulative probability graphs for the finished water turbidity from the Molendinar WTP from 2002 through 2007.

Figure 2. The surface of one of the sand filters at the Mudgeeraba WTP in 2003 prior to a rebuild. Note the extensive thick layer of mud on the surface.

Clearly staff training and awareness is a high priority. It needs to be remembered though, that in order to be effective, training should not be confined to a one off event. Ongoing training is required to maintain the awareness needed to ensure staff are aware of the relevant operational and management issues and can respond competently in the event of a water quality incident.

Optimisation of Filter Function

Currently both of GCWs water treatment plants have adopted the philosophy described in "The Practical Guide to the Operation and Optimisation of Media Filters" (Mosse and Murray 2006) with the view to achieving the longest possible service life from the filters as well as discovering any potential problems before major rectification is needed and above all else consistently produce the best quality drinking water possible.

With the staff trained appropriately and the existing equipment operating at optimum, forward planning can be carried out to upgrade the existing equipment or introduce new and/or improved treatment methods.

Replacement of Hydrated Lime with Liquid Sodium Hydroxide

The use of hydrated lime for post pH correction results in an increase in turbidity. While this does not represent an increased risk to consumers, GCW saw an opportunity to improve water quality even further and replaced the lime system with a liquid sodium hydroxide system with the added benefit of a major improvement in the physical working conditions in this area.

Replacement of Gas Chlorine with Hypo

One additional improvement was that the chlorine gas disinfection system was replaced with sodium hypochlorite. Whilst providing minimal impact on product turbidity and more expensive, the hypo eliminated high risk WH&S issues and provided improved low range manganese oxidization – this was appreciated by operational staff.

Long Term Records

The importance of keeping long term records as well as operator training and awareness, having an improvement strategy in place and a firm commitment from management is demonstrated in the above information and also provides the ability to showcase the organisation's operation.

Recently the Water Treatment Alliance has developed a database to store and report on long term turbidity data submitted by participating water authorities with the view to creating a benchmark for comparison of individual plant performance. This system has been operating in the USA since the Milwaukee water quality event in 1993 where 400,000 people became ill drinking poorly treated water. GCW has recently submitted data to the WTA. Figure 3 shows what are called cumulative probability graphs for the finished water turbidity from the Molendinar WTP from 2002 through 2007.

The cumulative probability graphs show the performance of the individual plants/filters against the performance of all the US surface water WTPs participating in the Partnership for Safe Water (The US equivalent of the WTA). The yellow and dark blue lines are the monthly maximum and monthly 95%ile performance for the US plants. These graphs show that approximately 98% of the monthly 95%ile turbidity results reported by all the plants were less than 0.2 NTU. Similarly 96% of the monthly maximum turbidity values were less than 0.3 NTU.

A simple way to interpret the graphs is that if the line for a filter is above those for the US plants, then the filter is producing water with a higher turbidity than the maximum monthly values recorded by all the US plants. If the line for a filter is between the maximum and 95%ile plots for the US plants then the filter is producing water with a turbidity lower than the maximum monthly values recorded by the US plants but higher than the monthly 95%ile values. If the line is below the 95%ile line for the US plants then the filter is producing water with a turbidity lower than both the maximum monthly and 95%ile monthly values and can be considered to be performing more efficiently. The lower the line the better the performance of the filters.

Clearly the Molendinar WTP started off in 2003 producing water of relatively poor quality. Over the years as a result of all the events described above, there is a clear improvement to the current situation in 2007. The strength of this type of monitoring is also apparent in that it clearly shows the drop in performance in 2005-06 and the dramatic improvement in 2006-07. This was due to experimenting with different polymers during a period whilst the plant was experiencing shortened filter runs due to excessive head loss after a change in raw water quality. Traditionally non-ionic polymer had performed best at Molendinar WTP and did so during this period in regard to turbidity however at the expense of shortened filter runs due to high head loss. Cationic polymer improved the filter head loss performance but resulted in poorer turbidity in the filtered water. It was decided to put up with the shorter filter runs and keep the turbidity as low as possible (<0.1NTU) until the raw water characteristics improved as occurred around February "06"

Benchmarking offered by this type of long term monitoring data naturally creates a form of competition between participants and therefore adds weight to any CAPEX/OPEX requests for new and improved methods/equipment for the provision of drinking water to their customers.

In providing a benchmark figure, the opportunity exists for an authority to display its product to the general user so they have an understanding of the value they are receiving each time they pay their water account and increases their confidence in using its service.

Understandably budget constraints and resources impact on the time it takes to implement improvements to any system, therefore it is recommended a long term plan be put in place.

Logically, the first place to direct the focus is to the existing equipment and resources that are already in place. This is an important message in the principles of the WTA and in the Mosse and Murray (2006) book. Apart from the infrastructure, the most important asset an authority has is its staff, after all there are not many systems out there that operate without human input.

The long term data show that it can be done and the importance of actually having the data to show that improvement. If anyone needs encouragement to start have a look at the state of our filters and the quality of our water in early 2000 and see where we are now. There are still things to be done but GCW is confident it is now providing the residents and tourists to the Gold Coast with much safer water now than we were then.

Acknowledgements

Peter Mosse, John Jacobs, Stan Stevenson and Nigel Garson for their assistance in preparing this article

The Author

Craig Bolin is Recycled Water Treatment Plant Supervisor at Gold Coast Water. He can be contacted on (cbolin@goldcoastwater.com.au). Craig is currently part of a team preparing to commission a new class A+ Recycled Water Treatment facility at Pimpama on the northern Gold Coast.